SINAMICS G130

Built-in converter units 75 kW to 800 kW

Operating Instructions · 05/2010

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SINAMICS G130
Inverter chassis units

Operating Instructions

Control version V4.3 SP2

05/2010
A5E00331449A

Legal information

Warning notice system

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

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

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

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

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

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

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

Qualified Personnel

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

Proper use of Siemens products

Note the following:

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

Trademarks

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

Disclaimer of Liability

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

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Ⓟ 08/2010

Preface

User documentation

> **⚠ WARNING**
>
> Before installing and commissioning the converter, make sure that you read all the safety notes and warnings carefully, including all the warning labels on the components. The warning labels must always be legible. Missing or damaged labels must be replaced.

Structure of this documentation

The customer documentation comprises the following documents:

- Converter Operating Instructions
  The Operating Instructions consist of the following sections:
  - Device description
  - Mechanical installation
  - Electrical installation
  - Commissioning guide
  - Description of functions
  - Maintenance instructions
  - Technical specifications
- Operating instructions of additional system components
  - AOP30
  - BOP20
  - Line filter
  - Line reactors
  - Braking Modules and braking resistors
  - Motor reactors
  - Sine-wave filter
  - dv/dt filter plus VPL
  - TB30
  - VSM10
  - Cabinet design and EMC
  - Line harmonics filter

- **Basic function diagrams**
  These provide an overview of the basic functions of the converter unit for simple applications.
- **List Manual**
  The List Manual consists of the following sections:
  - Parameter list
  - Function diagrams
  - Fault / warning list
- **Documentation for Drive Control Chart (DCC)**
  - Programming and Operating Manual: DCC Editor description
  - Function Manual: Description of the standard DCC blocks

Technical support

If you have any questions, please contact our hotline:

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

Time zone America	
Phone	+1 423 262 2522
Fax	+1 423 262 2200
Internet	techsupport.sea@siemens.com

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

Spare parts

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

Internet address

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

Table of contents

1 Safety information

1.1 Warnings

⚠ WARNING

Hazardous voltages are present when electrical equipment is in operation.
Severe personal injury or substantial material damage may result if these warnings are not observed.
Only qualified personnel are permitted to work on or around the equipment.
This personnel must be thoroughly familiar with all the warnings and maintenance procedures described in these operating instructions.
The successful and safe operation of this device is dependent on correct transport, proper storage and installation, as well as careful operation and maintenance.
National safety guidelines must be observed.

⚠ DANGER

Five safety rules

When carrying out any kind of work on electrical devices, the "five safety rules" defined in EN 50110 must always be observed:

1. Disconnect the system.
2. Protect against reconnection.
3. Make sure that the equipment is de-energized.
4. Ground and short-circuit.
5. Cover or enclose adjacent components that are still live.

NOTICE

For a UL-approved system use 60/75°C copper conductors only.

1.2 Safety and operating instructions

DANGER

This equipment is used in industrial high-voltage installations. During operation, this equipment contains rotating and live, bare parts. For this reason, they could cause severe injury or significant material damage if the required covers are removed, if they are used or operated incorrectly, or have not been properly maintained.
When the machines are used in non-industrial areas, the installation location must be protected against unauthorized access (protective fencing, appropriate signs).

Prerequisites

Those responsible for protecting the plant must ensure the following:

- The basic planning work for the plant and the transport, assembly, installation, commissioning, maintenance, and repair work is carried out by qualified personnel and/or checked by experts responsible.
- The operating manual and machine documentation are always available.
- The technical specifications regarding the applicable installation, connection, environmental, and operating conditions are always observed.
- The plant-specific assembly and safety guidelines are observed and personal protection equipment is used.
- Unqualified personnel are forbidden from using these machines and working near them.

This operating manual is intended for qualified personnel and only contain information and notes relating to the intended purpose of the machines.

The operating manual and machine documentation are written in different languages as specified in the delivery contracts.

Note

We recommend engaging the support and services of your local Siemens service center for all planning, installation, commissioning and maintenance work.

1.3 Components that can be destroyed by electrostatic discharge (ESD)

⚠ CAUTION

The board contains components that can be destroyed by electrostatic discharge. These components can be easily destroyed if not handled properly. If you do have to use electronic boards, however, please observe the following:

- You should only touch electronic boards if absolutely necessary.
- When you touch boards, however, your body must be electrically discharged beforehand.
- Boards must not come into contact with highly insulating materials (such as plastic parts, insulated desktops, articles of clothing manufactured from man-made fibers).
- Boards must only be placed on conductive surfaces.
- Boards and components should only be stored and transported in conductive packaging (such as metalized plastic boxes or metal containers).
- If the packaging material is not conductive, the boards must be wrapped with a conductive packaging material (such as conductive foam rubber or household aluminum foil).

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 = cabinet ground connection
- g = contact with conductive flooring

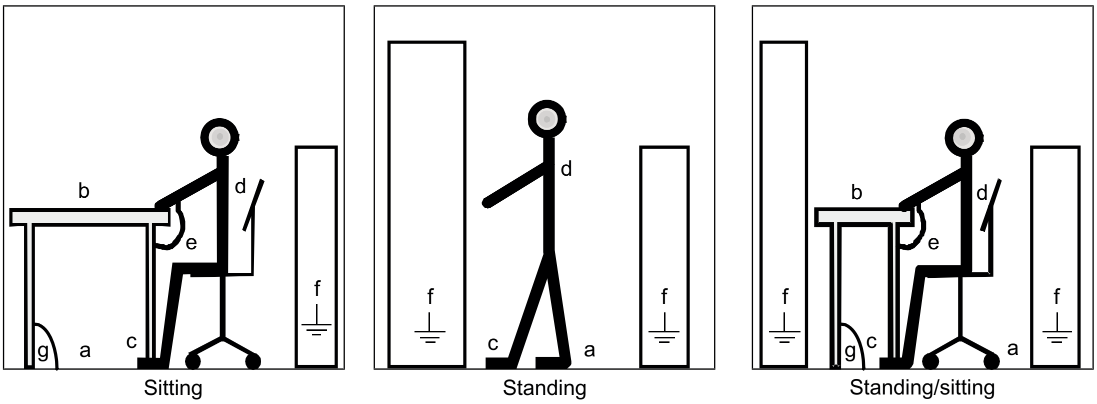


Figure 1-1 ESD protective measures

Residual risks of power drive systems

When carrying out a risk assessment of the machine/plant in accordance with the EU Machinery Directive, the machine manufacturer/plant operator must consider the following residual risks associated with the control and drive components of a power drive system (PDS).

1. Unintentional movements of driven machine components during commissioning, operation, maintenance, and repairs caused by, for example:
   - Hardware defects and/or software errors in the sensors, controllers, actuators, and connection technology
   - Response times of the controller and drive
   - Operating and/or ambient conditions not within the scope of the specification
   - Parameterization, programming, cabling, and installation errors
   - Use of radio devices / cellular phones in the immediate vicinity of the controller
   - External influences / damage
2. Exceptional temperatures as well as emissions of light, noise, particles, or gas caused by, for example:
   - Component malfunctions
   - Software errors
   - Operating and/or ambient conditions not within the scope of the specification
   - External influences / damage
3. Hazardous shock voltages caused by, for example:
   - Component malfunctions
   - Influence of electrostatic charging
   - Induction of voltages in moving motors
   - Operating and/or ambient conditions not within the scope of the specification
   - Condensation / conductive contamination
   - External influences / damage
4. Electrical, magnetic and electromagnetic fields generated in operation that can pose a risk to people with a pacemaker, implants or metal replacement joints, etc. if they are too close.
5. Release of environmental pollutants or emissions as a result of improper operation of the system and/or failure to dispose of components safely and correctly.

For more information about residual risks of the Power Drive System components, see the relevant chapters in the technical user documentation.

⚠ WARNING

Electromagnetic fields "electro smog"

Electromagnetic fields are generated by the operation of electrical power engineering installations such as transformers, converters or motors.

Electromagnetic fields can interfere with electronic devices, which could cause them to malfunction. For example, the operation of heart pacemakers can be impaired, potentially leading to damage to a person's health or even death. It is therefore forbidden for persons with heart pacemakers to enter these areas.

The plant operator is responsible for taking appropriate measures (labels and hazard warnings) to adequately protect operating personnel and others against any possible risk.

- Observe the relevant nationally applicable health and safety regulations. In Germany, "electromagnetic fields" are subject to regulations BGV B11 and BGR B11 stipulated by the German statutory industrial accident insurance institution.
- Display adequate hazard warning notices.

- Place barriers around hazardous areas.
- Take measures, e.g. using shields, to reduce electromagnetic fields at their source.
- Make sure that personnel are wearing the appropriate protective gear.

2 Device overview

2.1 Chapter content

This chapter provides information on the following:

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

2.2 Overview of the chassis units

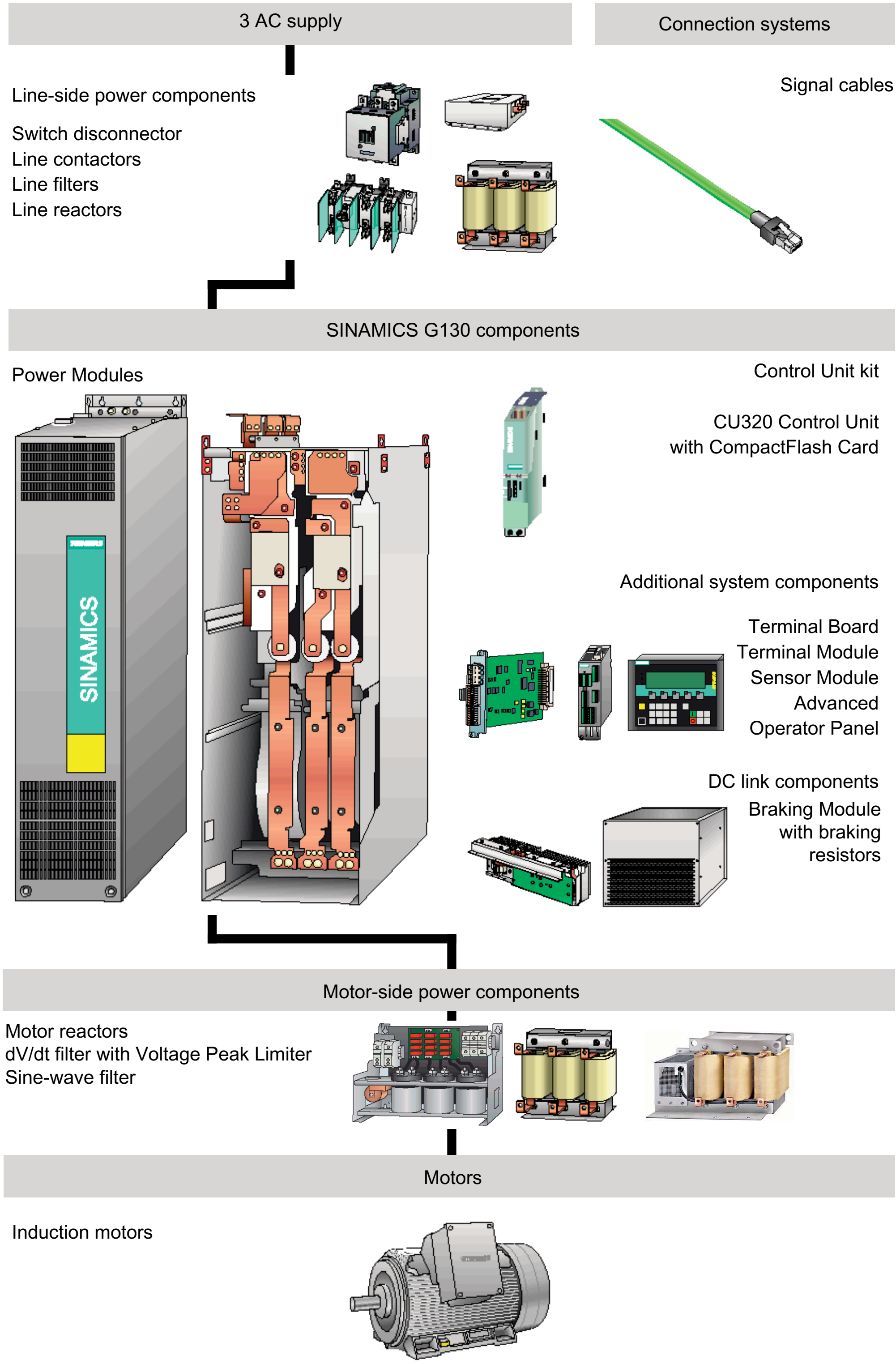


Figure 2-1 Overview of the chassis units

2.3 Overview of the Power Modules

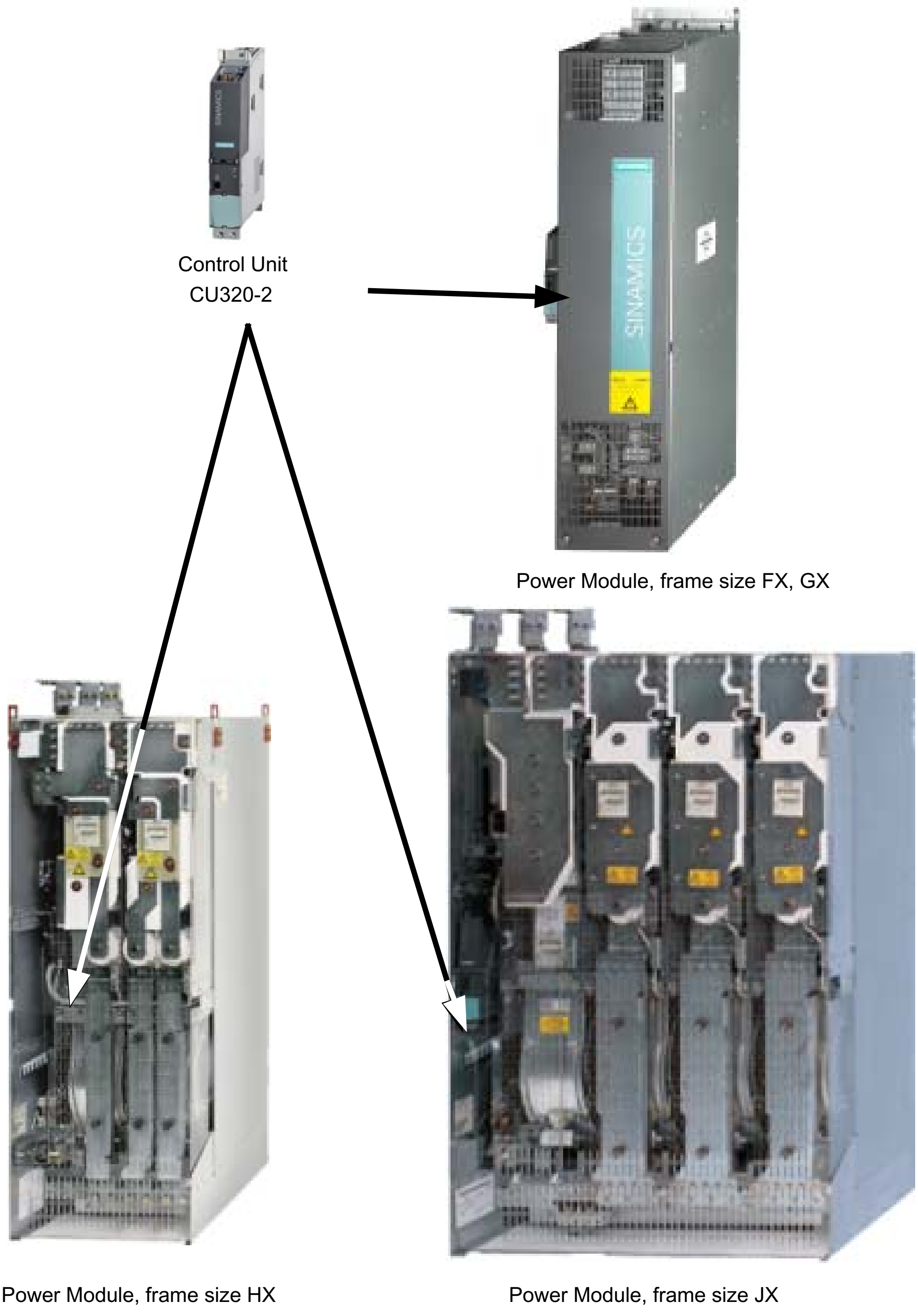


Figure 2-2 Overview of the Power Modules

2.4 Applications, features, and design

2.4.1 Applications

SINAMICS G130 chassis units are specially designed to meet the requirements of variable-speed drives with a quadratic and constant load characteristic, medium performance requirements, and no regenerative feedback.

As a result, SINAMICS G130 chassis units are a cost-effective drive solution for all types of industrial applications that involve moving, conveying, pumping, compressing, or extracting solids, liquids, or gases.

2.4.2 Features, quality, service

Features

From configuration to operation, SINAMICS G130 built-in units are easy to use and offer the following benefits:

- Compact, modular, service-friendly design.
- Straightforward planning and design thanks to the Sizer and Starter tools.
- Ready to connect to facilitate the installation process.
- Quick and easy commissioning thanks to practical menu guidance and integrated optimization routines.
- A user-friendly graphical operator panel with measured values, messages, and a quasi-analog display for measured values is also available as an option.
- 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 fully 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 G130 built-in units are manufactured to meet high standards of quality and exacting demands.

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

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

Service

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

For detailed contact information and the current link to our Internet pages, refer to chapter "Diagnosis / faults and alarms", section "Service and Support".

2.5 Wiring principle

Wiring principle for SINAMICS G130

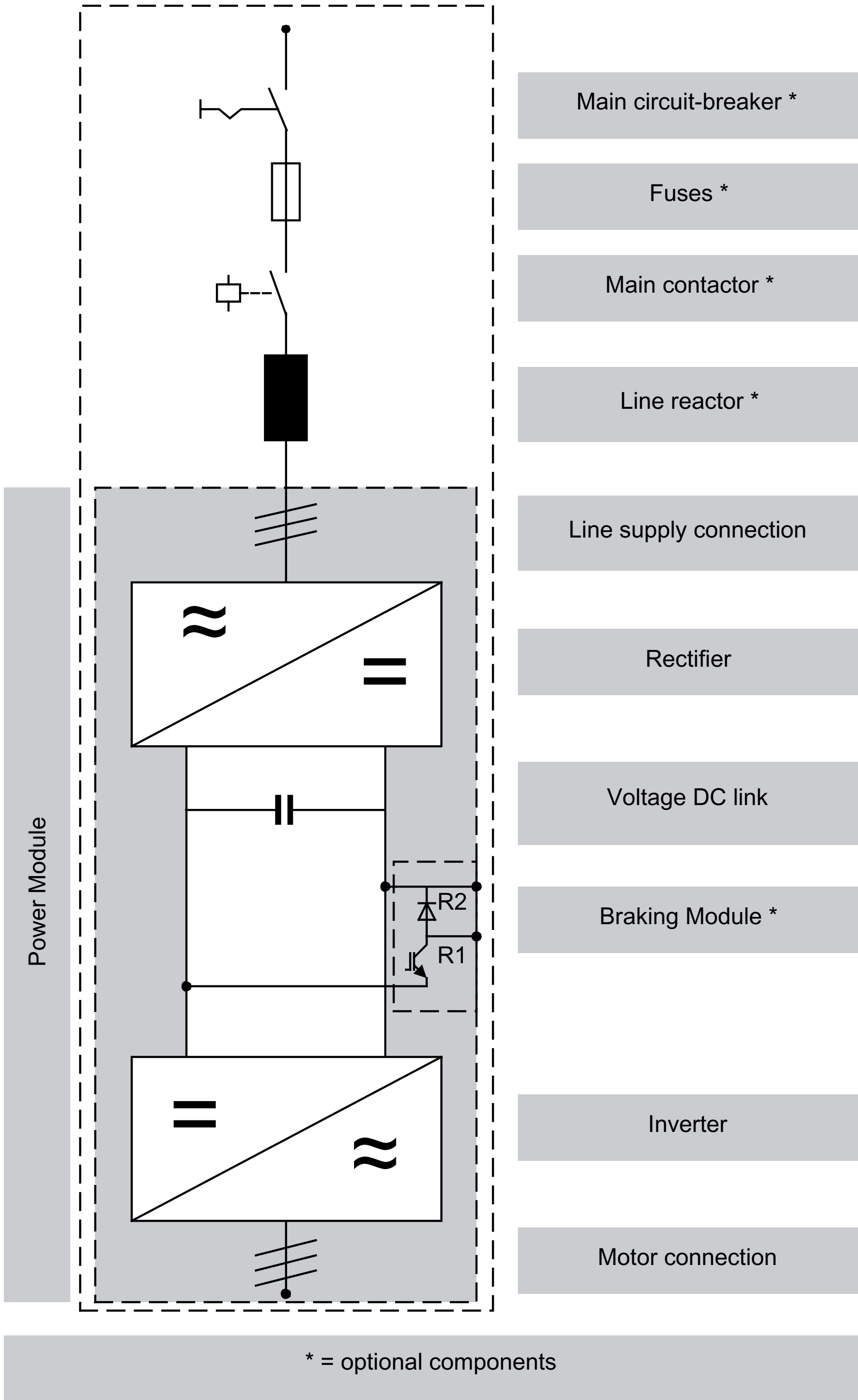


Figure 2-3 Wiring principle for SINAMICS G130

2.6 Type plate

Specifications on the type plate

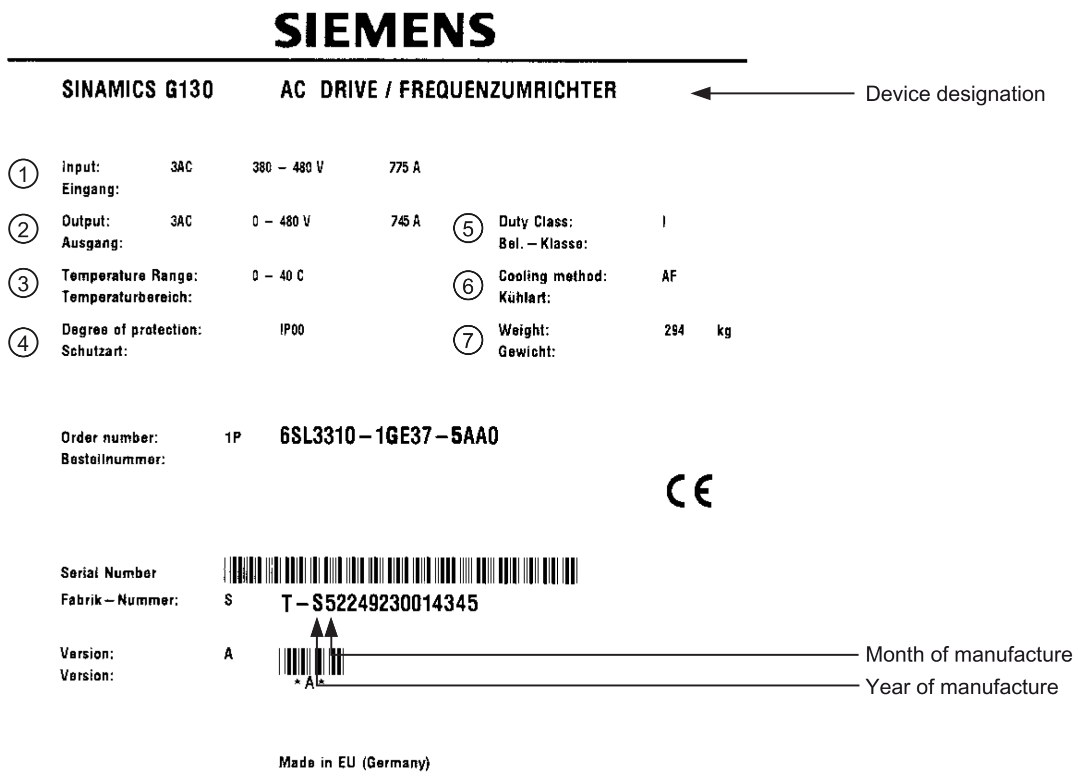


Figure 2-4 Type plate of built-in unit

Type plate specifications (from type plate above)

Position	Specification	Value	Description
①	Input	3 AC 380 – 480 V 775 A	Three-phase connection Rated input voltage Rated input current
②	Output	3 AC 0 – 480 V 745 A	Three-phase connection Rated output voltage Rated output current
③	Temperature range	0 – 40 °C	Ambient temperature range within which the built-in unit can operate under 100% load
④	Degree of protection	IP20	Degree of protection (for frame sizes FX, GX: IP20 for frames size HX, JX: IP00)
⑤	Duty class load class	I	I: Duty class I to EN 60146-1-1 = 100% (continuously) (with the specified current values, the built-in unit can operate continuously under 100% load)
⑥	Cooling method	AF	A: Cooling medium: air F: Circulation method: forced cooling, drive unit (fan) in the device
⑦	Weight	294 kg	Type plate of built-in unit

Date of manufacture

The date of manufacture can be determined as follows:

Table 2- 1 Production year and month

Letter/number	Year of manufacture		Letter/number	Month of manufacture
S	2004		1 to 9	January to September
T	2005		O	October
U	2006		N	November
V	2007		D	December
W	2008			
X	2009			
A	2010			
B	2011			
C	2012			
D	2013			
E	2014			

Mechanical installation 3

3.1 Chapter content

This chapter provides information on the following:

- The conditions for installing the chassis units and optional components.
- The preparations for installing the chassis units and optional components.

3.2 Transportation and storage

Transport

⚠ WARNING

The following must be taken into account when the devices are transported:

- The devices are heavy. Their center of gravity is displaced, and they can be top heavy.
- Suitable hoisting gear operated by trained personnel is essential due to the weight of the devices.
- The devices must only be transported in the upright position indicated. The devices must not be transported upside down or horizontally.
- Serious injury or even death and substantial material damage can occur if the devices are not lifted or transported properly.

Note

Notes regarding transportation

- The devices are packaged by the manufacturer in accordance with the climatic conditions and stress encountered during transit and in the recipient country.
- The notes on the packaging for transportation, storage, and proper handling must be observed.
- For transportation using forklifts, the devices must be set down on a wooden pallet.
- When the devices are unpacked, they can be transported using the transport eyebolts attached. The load must be distributed evenly. Chains attached to the transport eyebolts must only be loaded vertically from above. Heavy blows or impacts must be avoided during transit and when the devices are being set down, for example.
- Permissible ambient temperatures:
  Ventilation: -25°C to +70°C, class 2K3 to IEC 60 721-3-2
  Down to -40°C for max. 24 hours

Note

Notes regarding damage in transit

- Carry out a thorough visual inspection of the device before accepting the delivery from the transportation company.
- Ensure that you have received all the items specified on the delivery note.
- Notify the transportation company immediately of any missing components or damage.
- If you identify any hidden defects or damage, contact the transportation company immediately and ask them to examine the device.
- If you fail to contact them immediately, you may lose your right to claim compensation for the defects and damage.
- If necessary, you can request the support of your local Siemens office.

⚠ WARNING

Damage in transit indicates that the device was subject to unreasonable stress. The electrical safety of the device can no longer be ensured.

Non-observance can result in death, severe personal injury or substantial property damage.

Storage

The devices must be stored in clean, dry rooms. Temperatures between –25°C and +70°C are permissible. Temperature variations greater than 20 K per hour are not permitted.

If the device is stored for a prolonged period once 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.

⚠ WARNING

The device should not be stored for more than two years. If the device is stored for more than two years, the DC link capacitors of the devices must be reformed during commissioning.

The reforming procedure is described in "Maintenance and servicing”.

3.3 Assembly

⚠ WARNING
To ensure that the devices operate safely and reliably, they must be properly installed and commissioned by qualified personnel, taking into account the warnings provided in these operating instructions. In particular, the general and national installation and safety guidelines for high-voltage installations (e.g. VDE – the Union of German Technical Engineers) as well as the guidelines relating to the proper use of tools and personal protective equipment must be observed. Death, serious injury, or substantial material damage can result if these factors are not taken into account.

3.3.1 Preparation

On-site requirements

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

The operating areas must be dry and free of dust. The air supplied must not contain any electrically conductive gas, vapors, or dust, which could impair operation. It may be necessary to filter the air supplied to the installation room.

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

At temperatures > 40 °C (104 °F) and installation altitudes > 2000 m, the devices must be derated.

Built-in units with frame sizes FX and GX comply with degree of protection IP20; with frame sizes HX and JX, they comply with degree of protection IP00 to EN 60529.

The built-in units are installed in accordance with the dimension drawings supplied. The clearance between the top of the devices and the ceiling is also specified on the dimension drawings.

The cooling air for the power unit is drawn from the lower part of the device. The warmed air is expelled through the heat sink. When installing the device in cabinet units, you must ensure that suitable barriers are in place to ensure that the warmed air is not drawn back into the suction area of the heat sink.

According to EN 61800-3, the built-in unit is not suitable for use in low-voltage public networks that supply residential buildings. High-frequency interference may occur if it is used in this type of network.
Through additional measures, for example the use of a line filter, the built-in unit can, however, also be used in the "First environment" in accordance with EN 61800-3 category C2.

Unpacking the cabinets

Check the delivery against the delivery note to ensure that all the items have been delivered. Check that the devices are intact.

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

Required tools

To install the connections, you will require:

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

3.4 Power Module

Description

The Power Module is the power unit of an AC-AC converter. Line or motor-side components can be added to create a converter system. If required (e.g., for braking operation), a Braking Module can also be installed in the DC link of the converter. A slot is provided in the Power Module for this purpose.

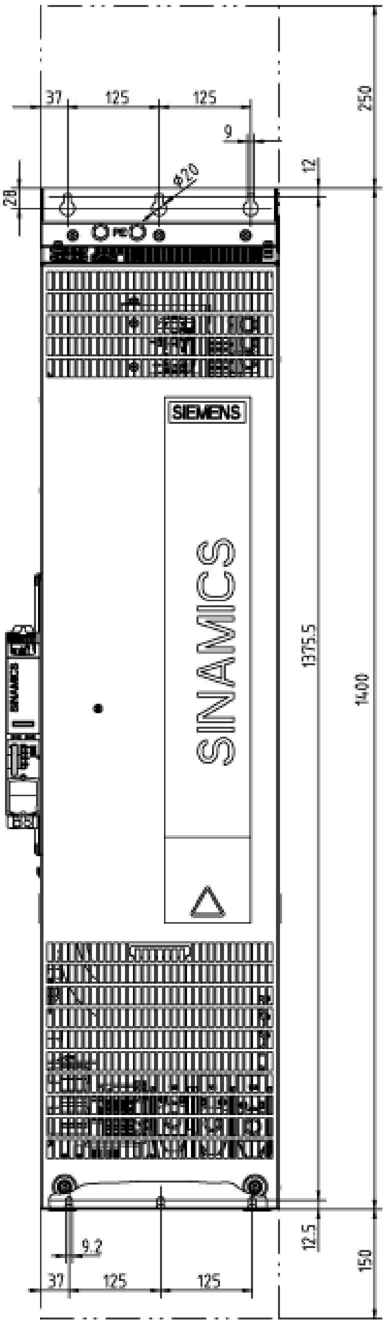
The Power Module creates an output voltage with variable amplitude and frequency from a supply voltage with constant amplitude and frequency.

⚠ CAUTION
The ventilation clearances above, below, and in front of the Power Module, which are specified in the dimension drawings, must be observed. If these clearances are not observed, this can result in a thermal overload of the Power Module.

3.4.1 Dimension drawings

Dimension drawing frame size FX

Table 3- 1 Dimension drawing frame size FX

<table>
<tr><th>Front view</th><th>Side view</th></tr>
<tr><td>


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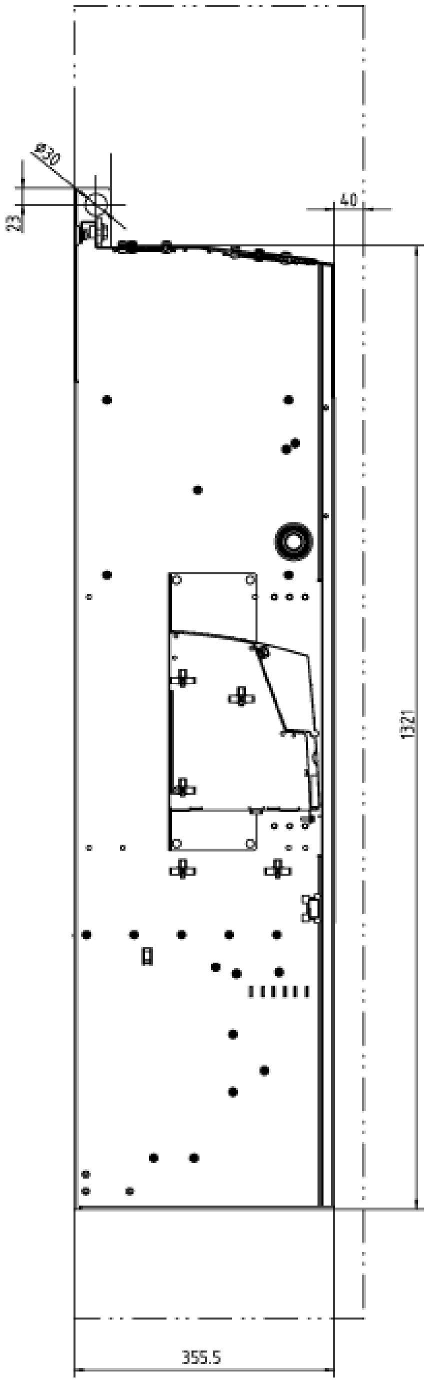
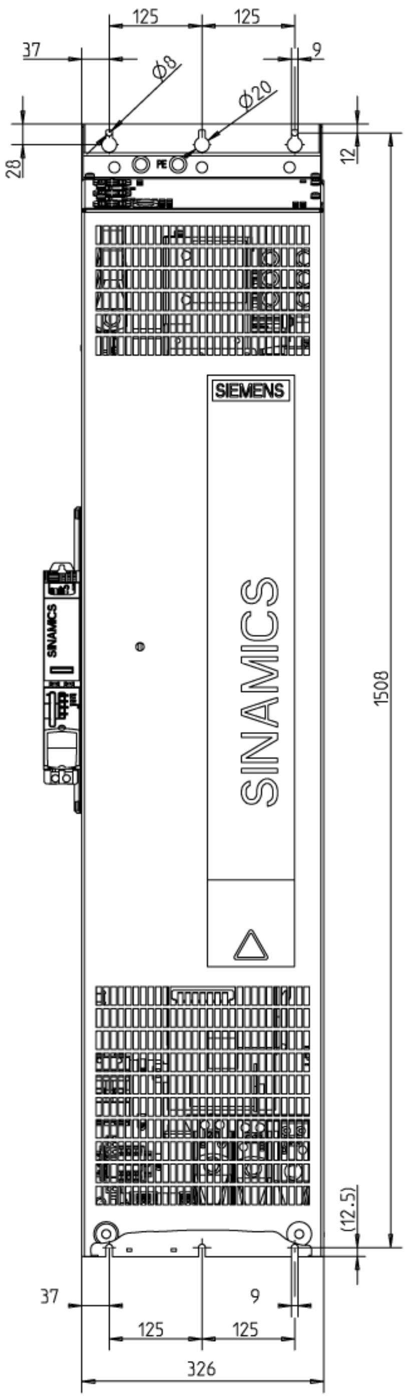


</td></tr>
</table>

Dimension drawing, frame size GX

Table 3- 2 Dimension drawing, frame size GX

<table>
<tr><th>Front view</th><th>Side view</th></tr>
<tr><td>


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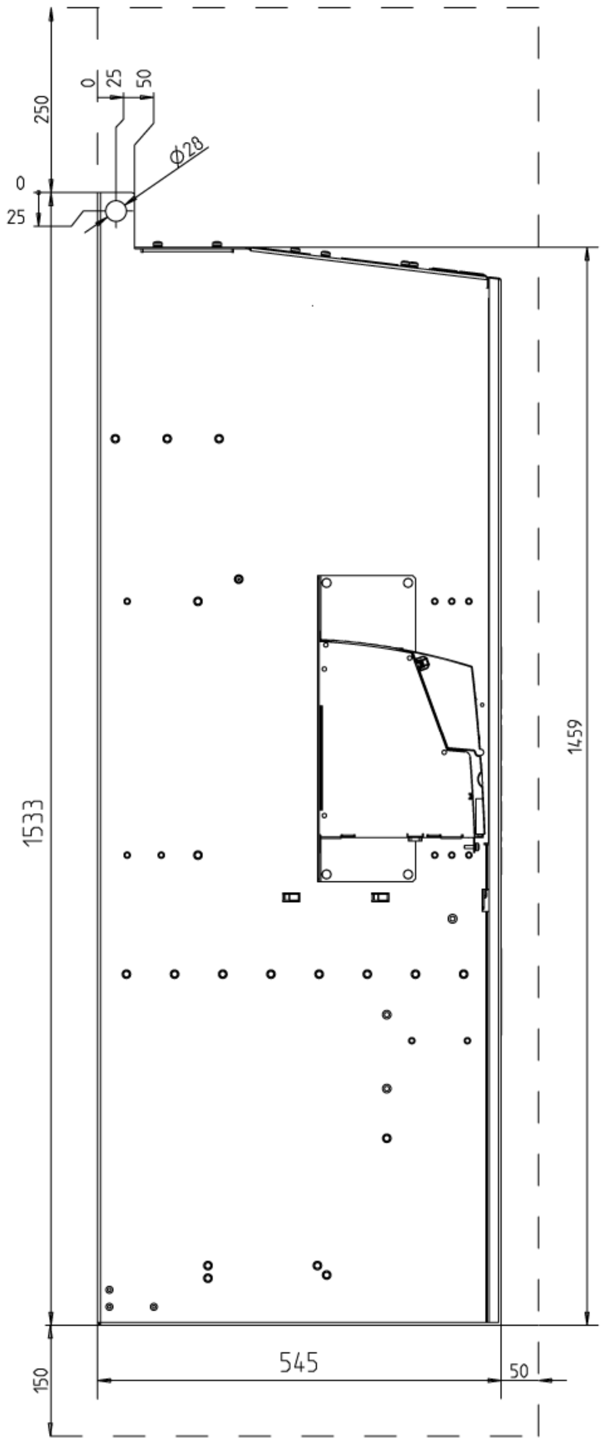

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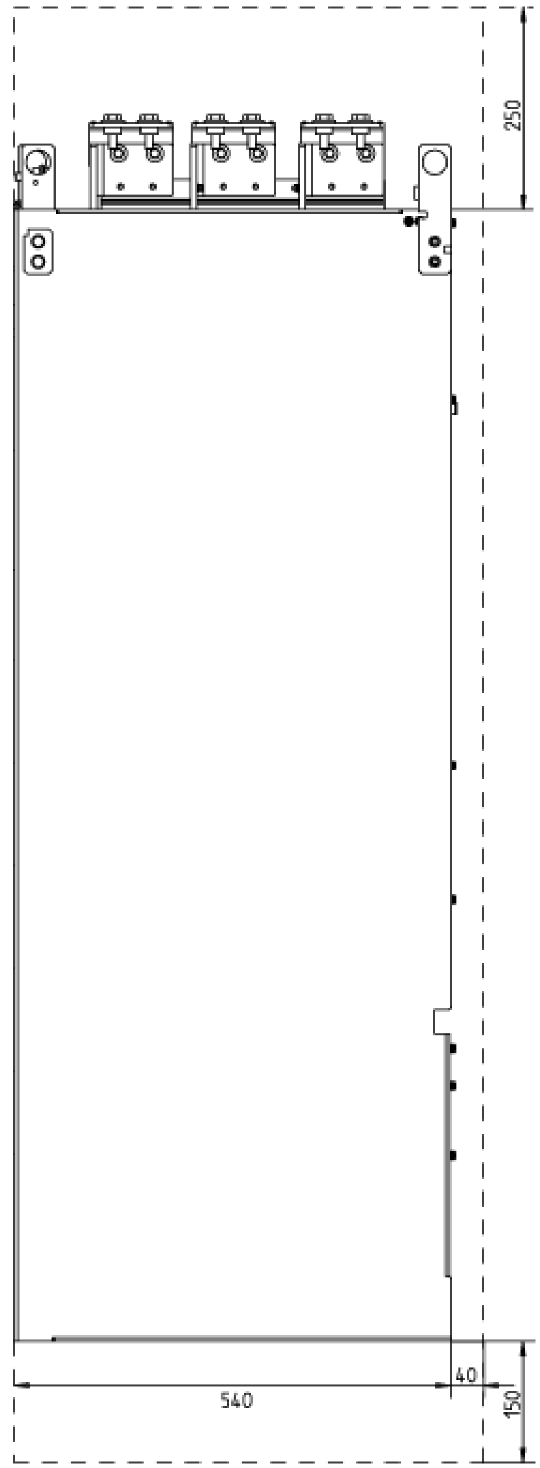
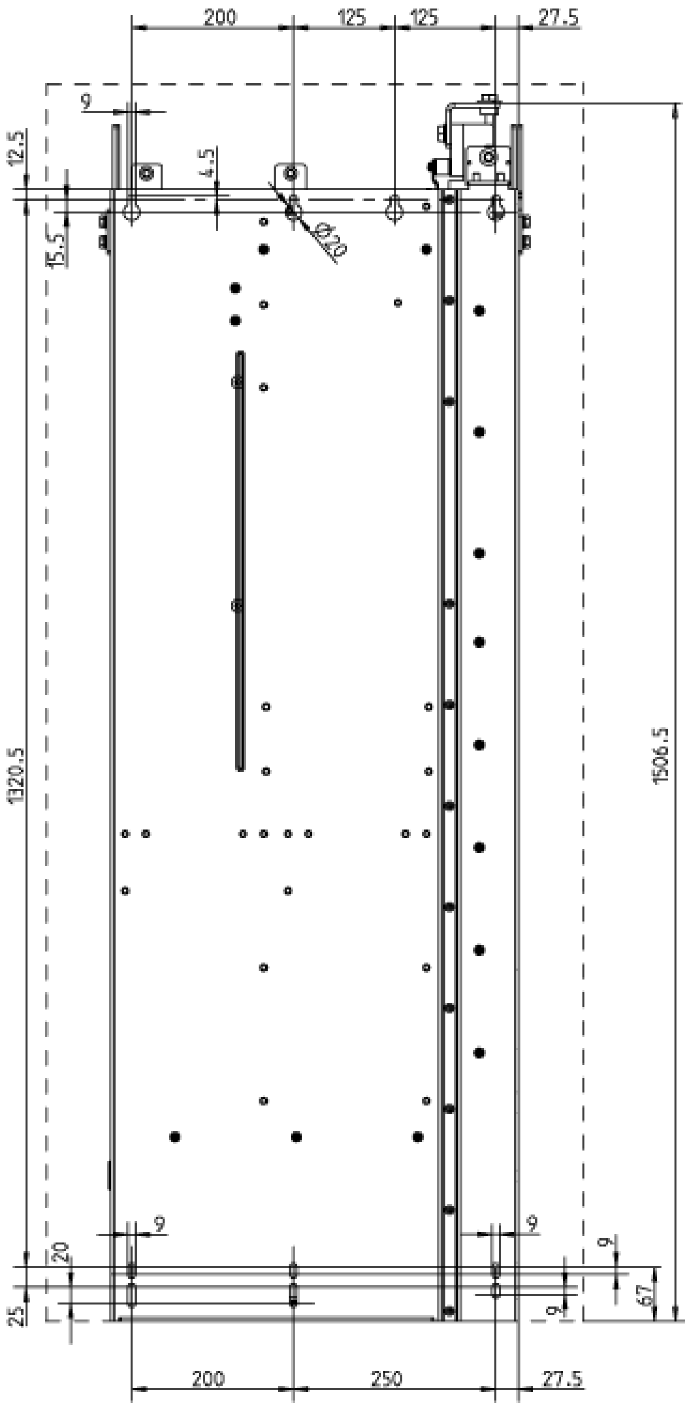
</table>

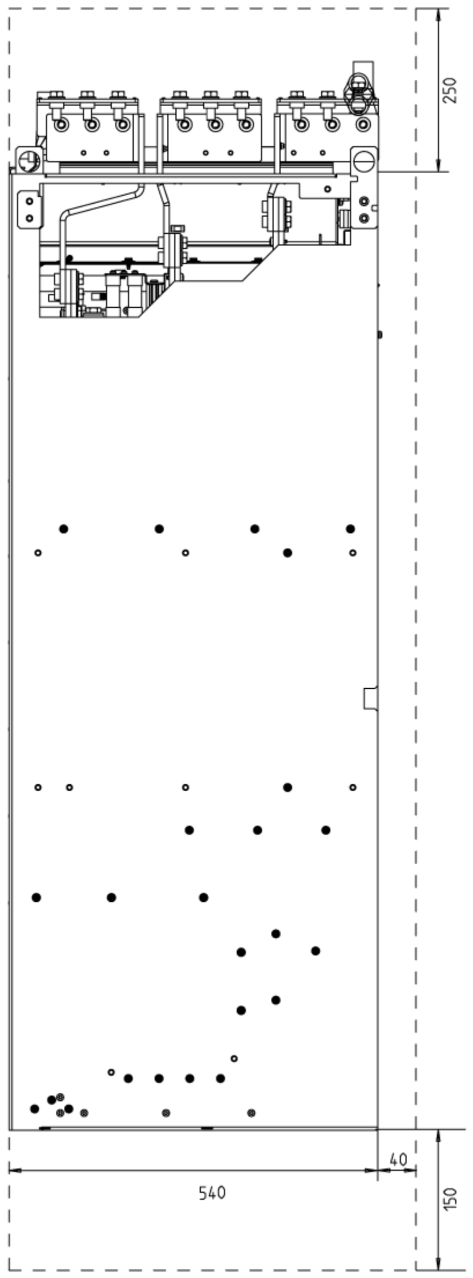
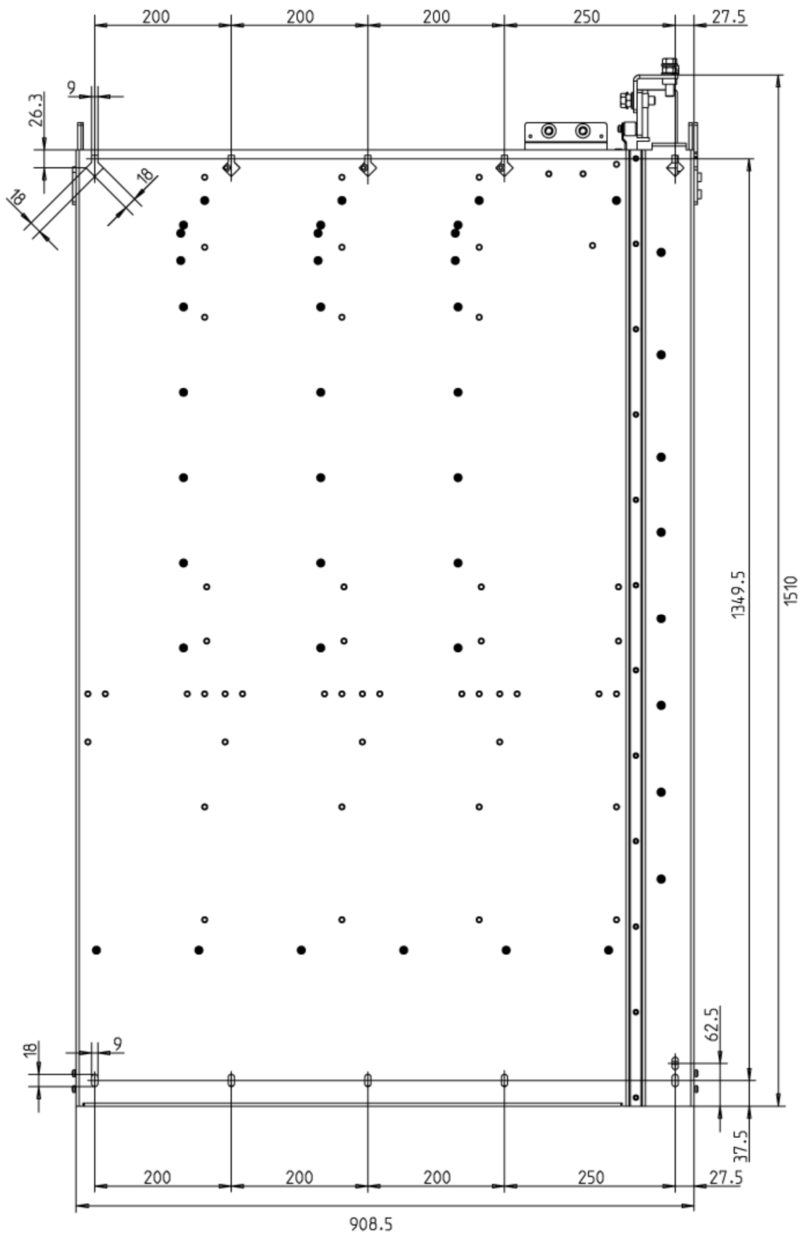
Dimension drawing (frame size HX)

Table 3- 3 Dimension drawing (frame size HX)

Side view	Rear view
	

Dimension drawing (frame size JX)

Table 3- 4 Dimension drawing (frame size JX)

Side view	Rear view
	

⚠ WARNING
The Power Modules can be lifted using the lifting eyebolts attached. A lifting harness with a vertical rope or chain must, however, be used. The device must not be lifted at an angle because this can damage the housing or connection busbars. Rope spreaders may have to be used.

⚠ WARNING
For Power Modules of frame sizes HX and JX, the hoists must be removed once the devices have been installed.

3.5 Control Unit CU320

Description

The CU320-2 is the central Control Unit in which the closed-loop and open-loop control functions are implemented.

⚠ CAUTION
The 80 mm ventilation clearances above and below the Control Unit must be observed. If these clearances are not observed, this can result in a thermal overload of the Control Unit.

Dimension drawing

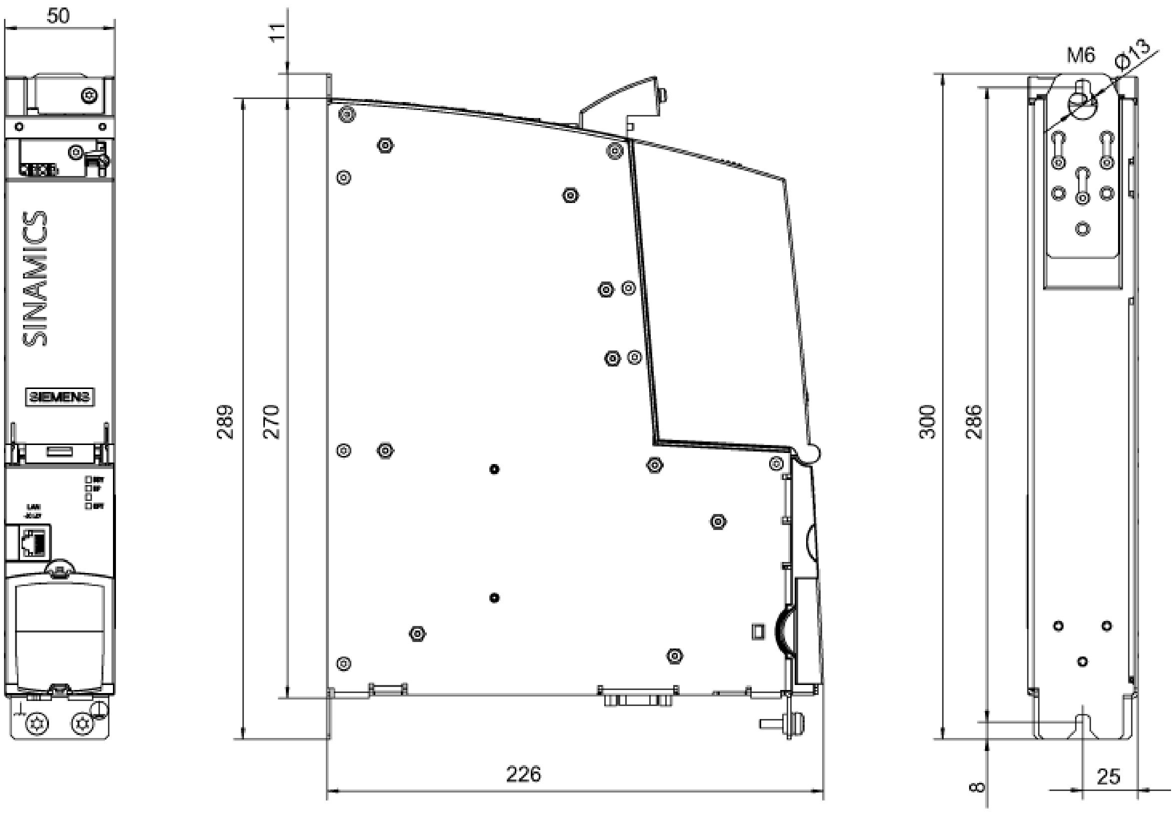


Figure 3-1 Dimension drawing CU320-2

Note

With frame sizes FX and GX, the Control Unit is installed to the left of the Power Module. The required connection elements are supplied with the Power Module.

With frame sizes HX and JX, the Control Unit is installed in the Power Module.

Control Unit: CompactFlash card

The CompactFlash card contains the control software and parameters.

Note

The CompactFlash card may only be inserted and removed when the Control Unit is disconnected from the power supply.

If it is inserted and removed when the power supply is connected, this can damage the CompactFlash card and/or result in data being lost.

3.6 TM31 Terminal Module

Description

The TM31 Terminal Module is a terminal extension board. It can be used to increase the number of digital inputs/outputs. Analog inputs and outputs are also available on the TM31.

⚠ CAUTION
The 80 mm ventilation clearances above and below the Terminal Module must be observed. If these clearances are not observed, this can result in a thermal overload of the Terminal Module.

Dimension drawing

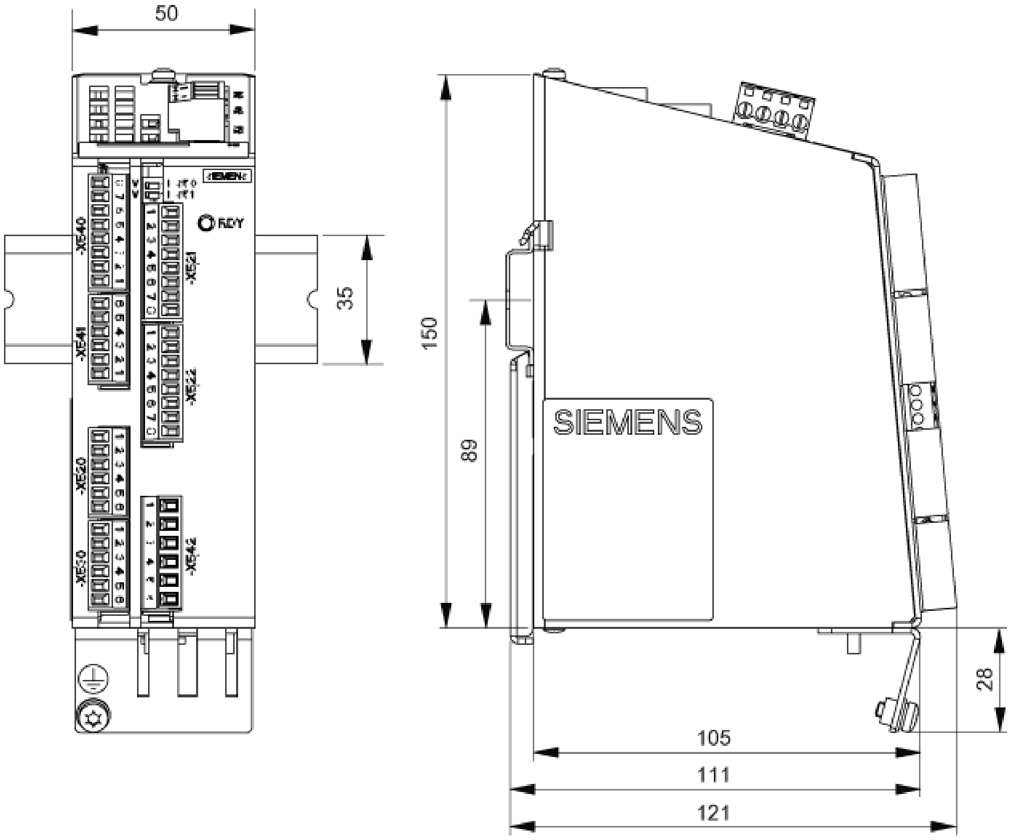


Figure 3-2 Dimension drawing of the TM31 Terminal Module

Note

The TM31 is installed near the Power Module on a mounting rail, which must be provided by the customer.

3.7 SMC30 Sensor Module

Description

The SMC30 Sensor Module is a module for evaluating encoder signals. TTL/HTL encoders (with or without open-circuit monitoring) can be connected to the SMC30. The motor temperature can also be detected using KTY84-1C130 or PTC thermistors.

⚠ CAUTION
The 80 mm ventilation clearances above and below the SMC30 Sensor Module must be observed. If these clearances are not observed, this can result in a thermal overload of the Sensor Module.

Dimension drawing

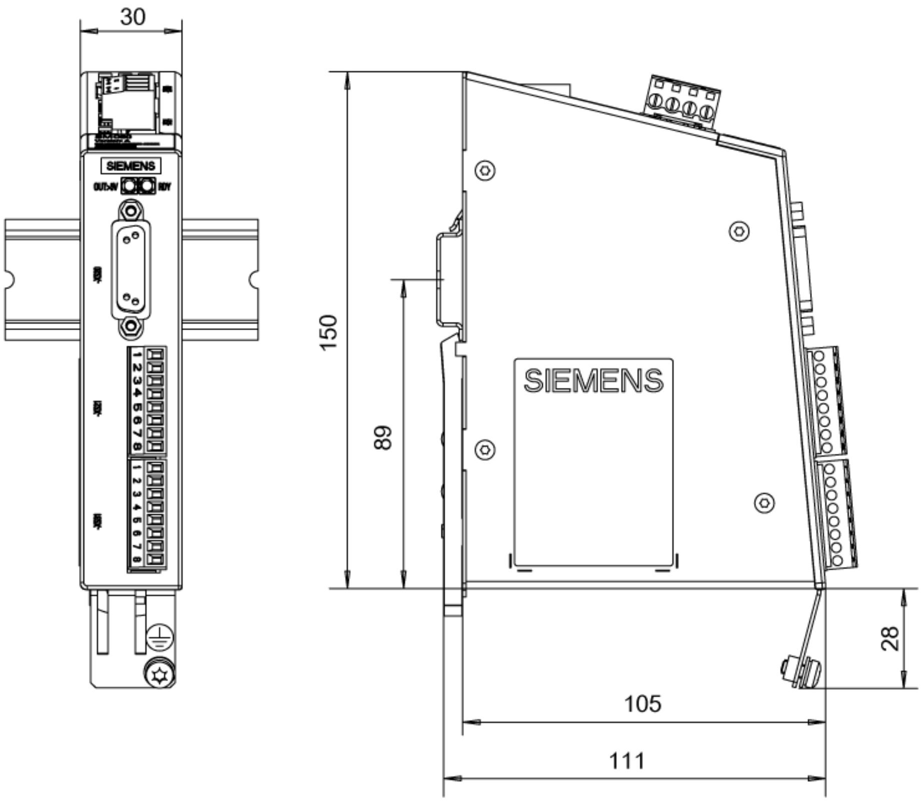


Figure 3-3 Dimension drawing of the SMC30 Sensor Module

Note

The SMC30 is installed near the Power Module on a mounting rail, which must be provided by the customer.

Electrical installation 4

4.1 Chapter content

This chapter provides information on the following:

- Establishing the electrical connections for the Power Module, the CU320-2 Control Unit, and the optional TM31 Terminal Module and SMC30 Sensor Module.
- Adjusting the fan voltage and the internal power supply in line with local conditions (supply voltage)
- The interfaces for the CU320-2 Control Unit, TM31 Terminal Module, and SMC30 Sensor Module.

4.2 Preparation

Required tools

To install the connections, you will require:

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

4.3 Important safety precautions

⚠ WARNING
The built-in units are operated with high voltages. All connection procedures must be carried out when the cabinet is de-energized. All work on the device must be carried out by trained personnel only. Non-observance of these warning notices can result in death, severe personal injury or substantial property damage. Work on an open device must be carried out with extreme caution because external supply voltages may be present. The power and control terminals may be live even when the motor is not running. Dangerously high voltage levels are still present in the device up to five minutes after it has been disconnected due to the DC link capacitors. For this reason, the unit should not be opened until a reasonable period of time has elapsed. Reforming the DC link capacitors: The storage period should not exceed two years. If the device is stored for more than two years, the DC link capacitors of the devices must be reformed during commissioning. The reforming procedure is described in "Maintenance and Servicing”. The operator is responsible for ensuring that the Power Module and other components are installed and connected in accordance with the recognized technical rules in the country of installation and applicable regional guidelines. Special attention should be paid to cable dimensioning, fuses, grounding, shutdown, disconnection, and overcurrent protection. If an item of protective gear trips in a branch circuit, a fault current may have been disconnected. To reduce the risk of fire or an electric shock, the current-conducting parts and other components in the cabinet unit should be inspected and damaged parts replaced. When an item of protective gear trips, the cause of the trip must be identified and rectified.

Note

On systems with a grounded phase conductor and a line voltage >600 V AC, line-side components should be installed to limit overvoltages to overvoltage category II in accordance with IEC 61800-5--1.

CAUTION
To ensure that the entire system functions properly, you are advised to use the original Siemens accessories. Only original DRIVE-CLiQ cables may be used for wiring the DRIVE-CLiQ nodes.

4.4 Introduction to EMC

What is meant by EMC?

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

EMC therefore represents a quality feature for the

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

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

Operational reliability and noise immunity

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

Noise emissions

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

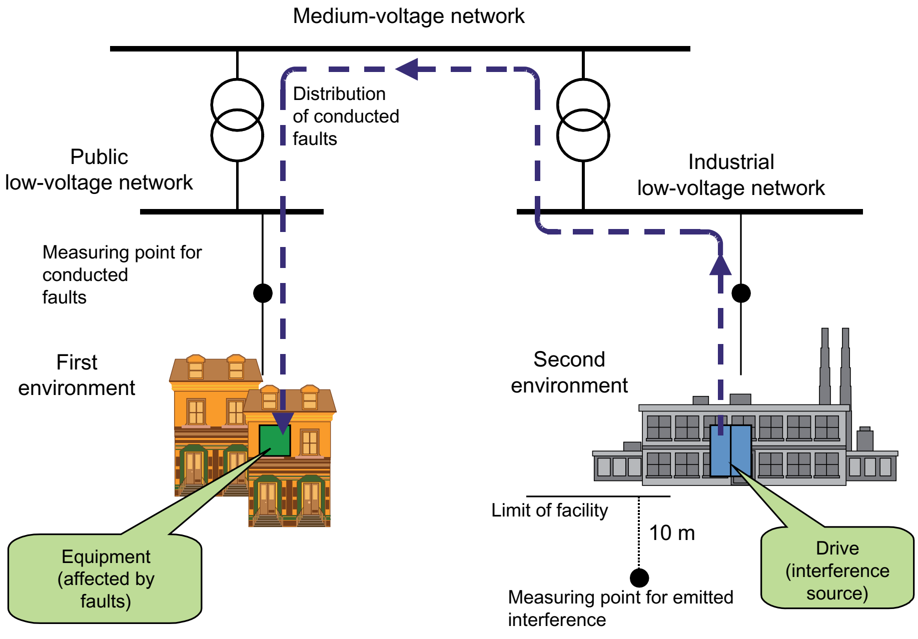


Figure 4-1 Definition of the first and second environments

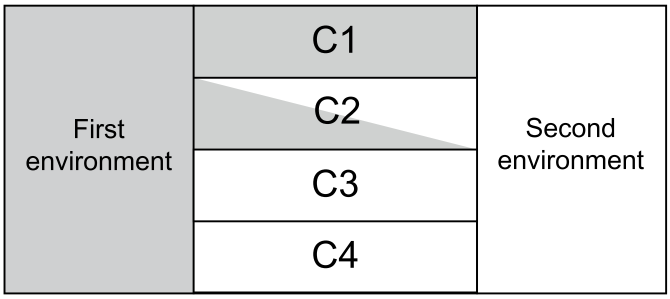


Figure 4-2 Definition of categories C1 to C4

Table 4- 1 Definition of the first and second environments

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

Table 4- 2 Definition of categories C1 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; 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 conductor system (ground).

Shield gaps

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

Using large cross-sections

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

Laying the motor supply cable separately

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

Use anti-interference elements

- Lay an equalizing cable parallel to the control cable (the cable cross-section must be at least 16 mm²).
- If relays, contactors, and inductive or capacitive loads are connected, the switching relays or contactors must be provided with anti-interference elements.

Cable installation

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

Shield connection

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

I/O interfacing

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

Filtering cables

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

Protective ground conductors

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

4.6 Connection overview

Power Module, frame size FX

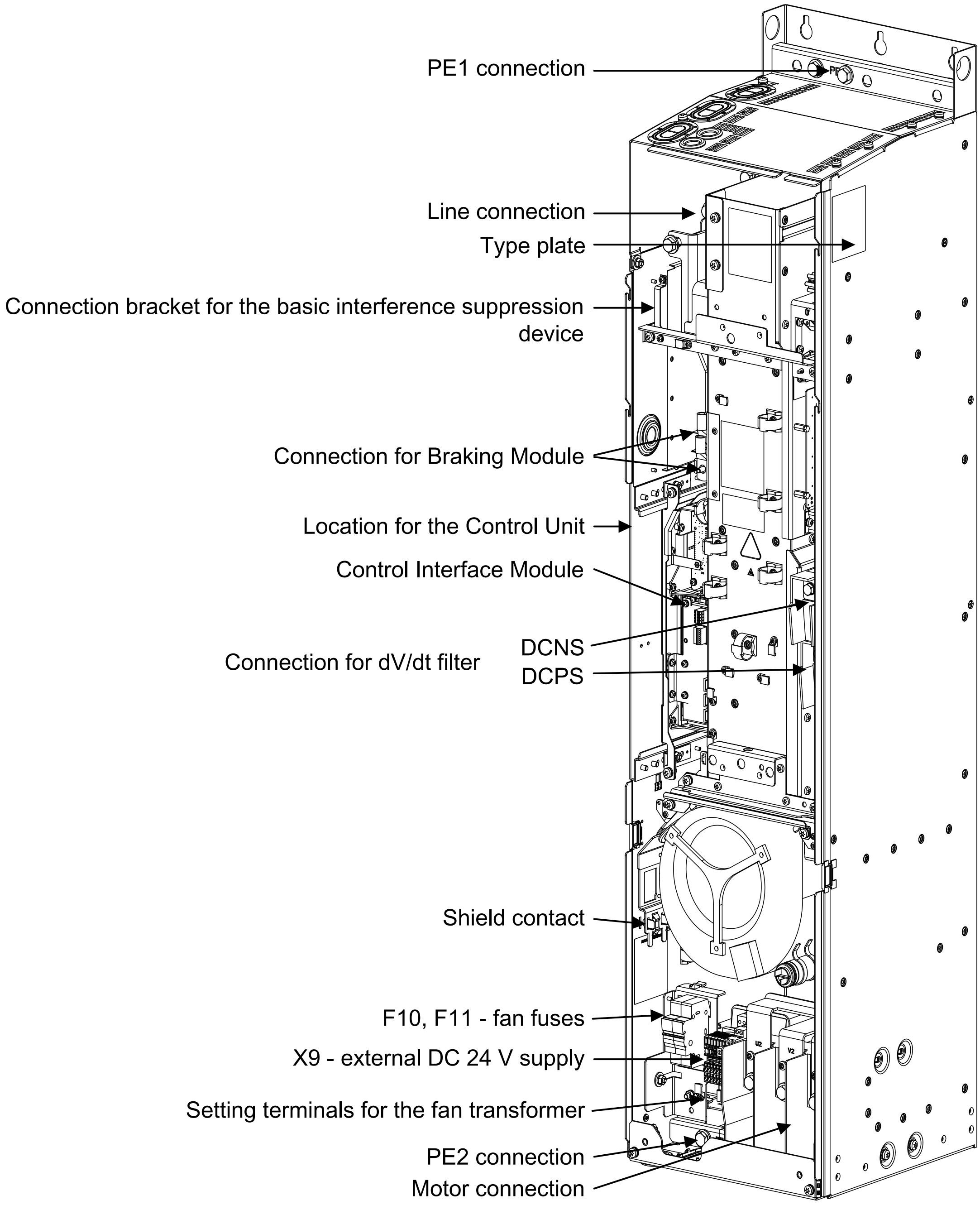


Figure 4-3 Connection overview of Power Module, frame size FX (without front cover)

Power Module (frame size GX)

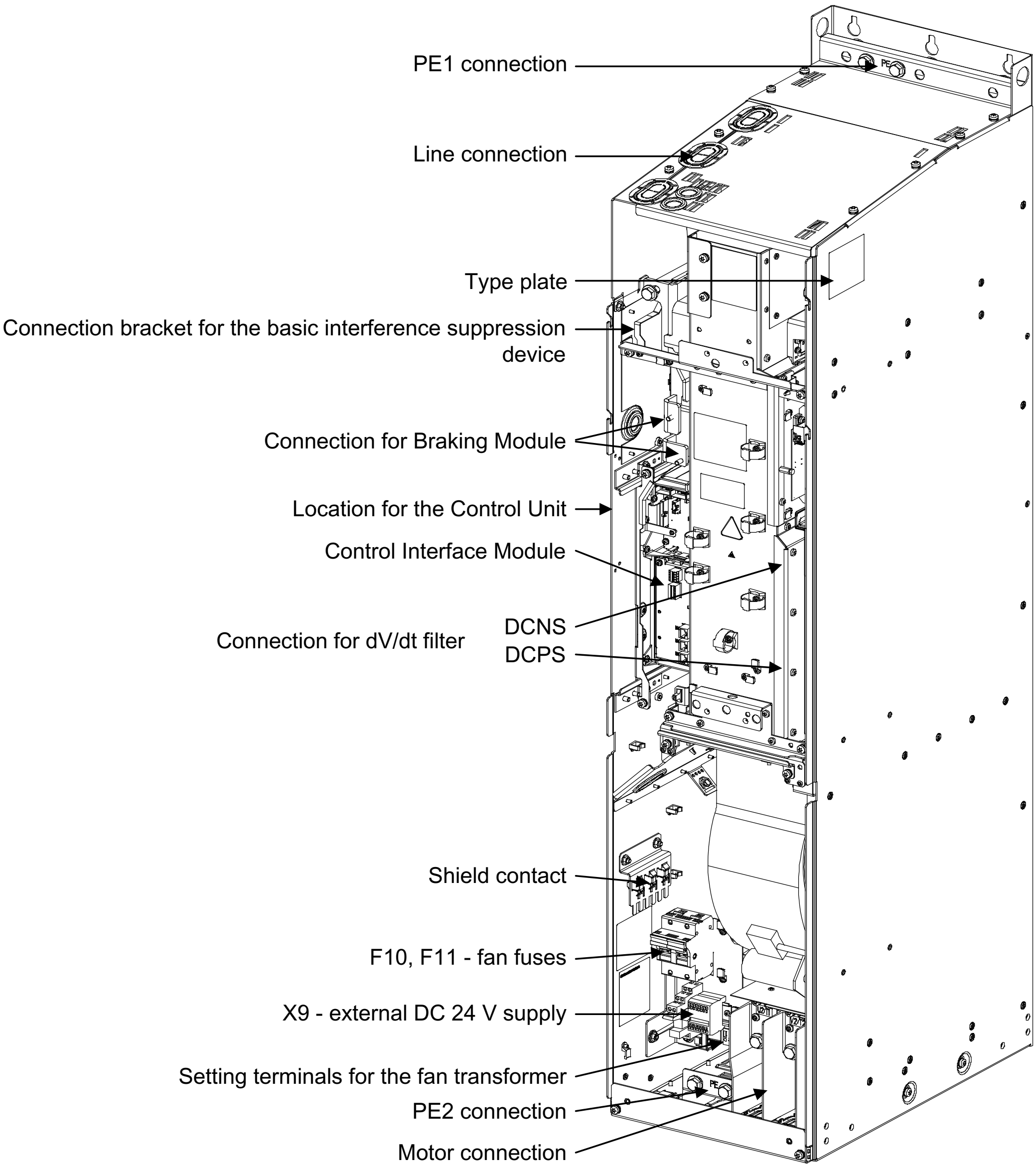


Figure 4-4 Connection overview of Power Module (frame size GX) (without front cover)

Power Module (frame size HX)

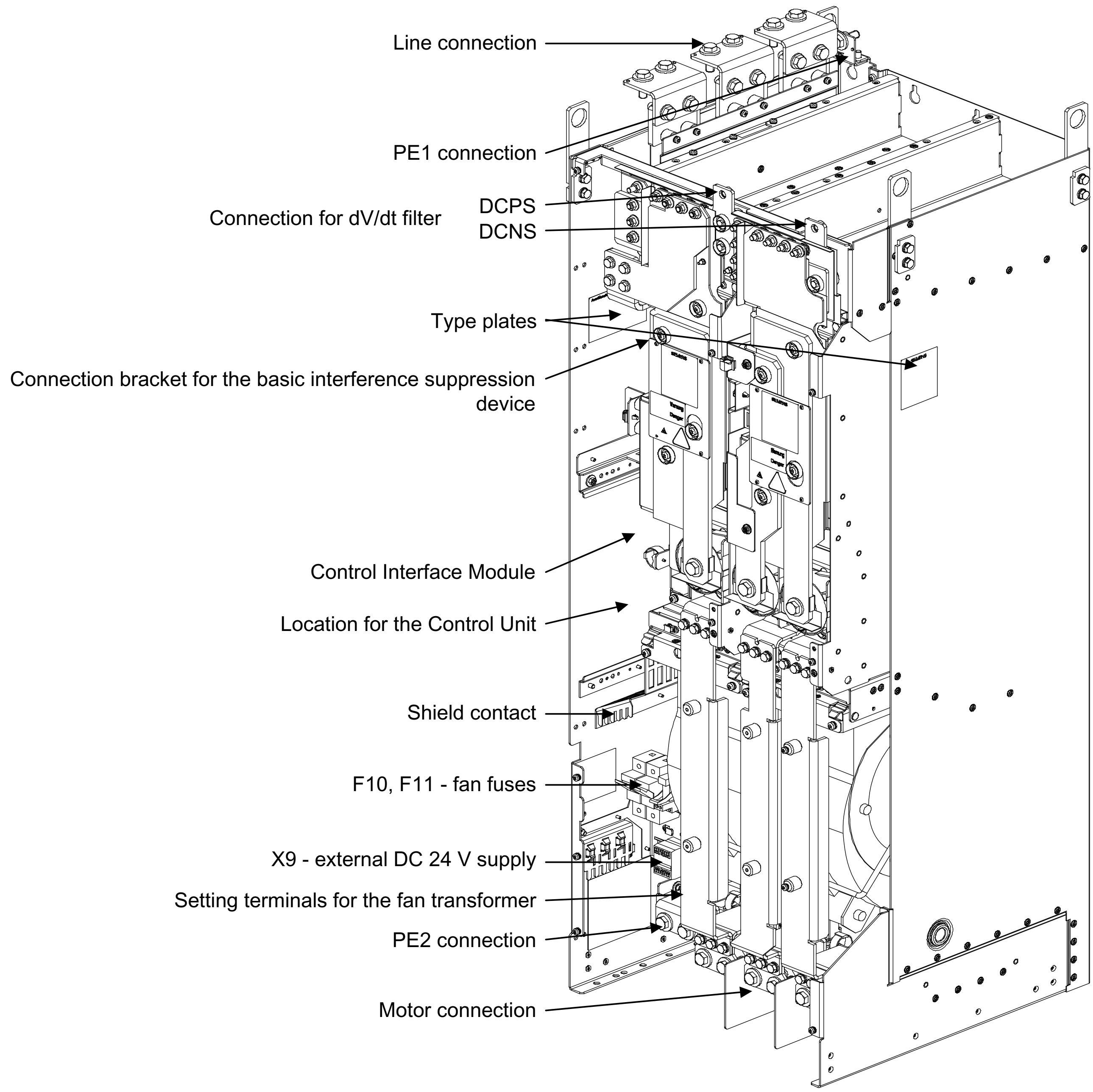


Figure 4-5 Connection overview of Power Module (frame size HX) (without front cover)

Power Module (frame size JX)

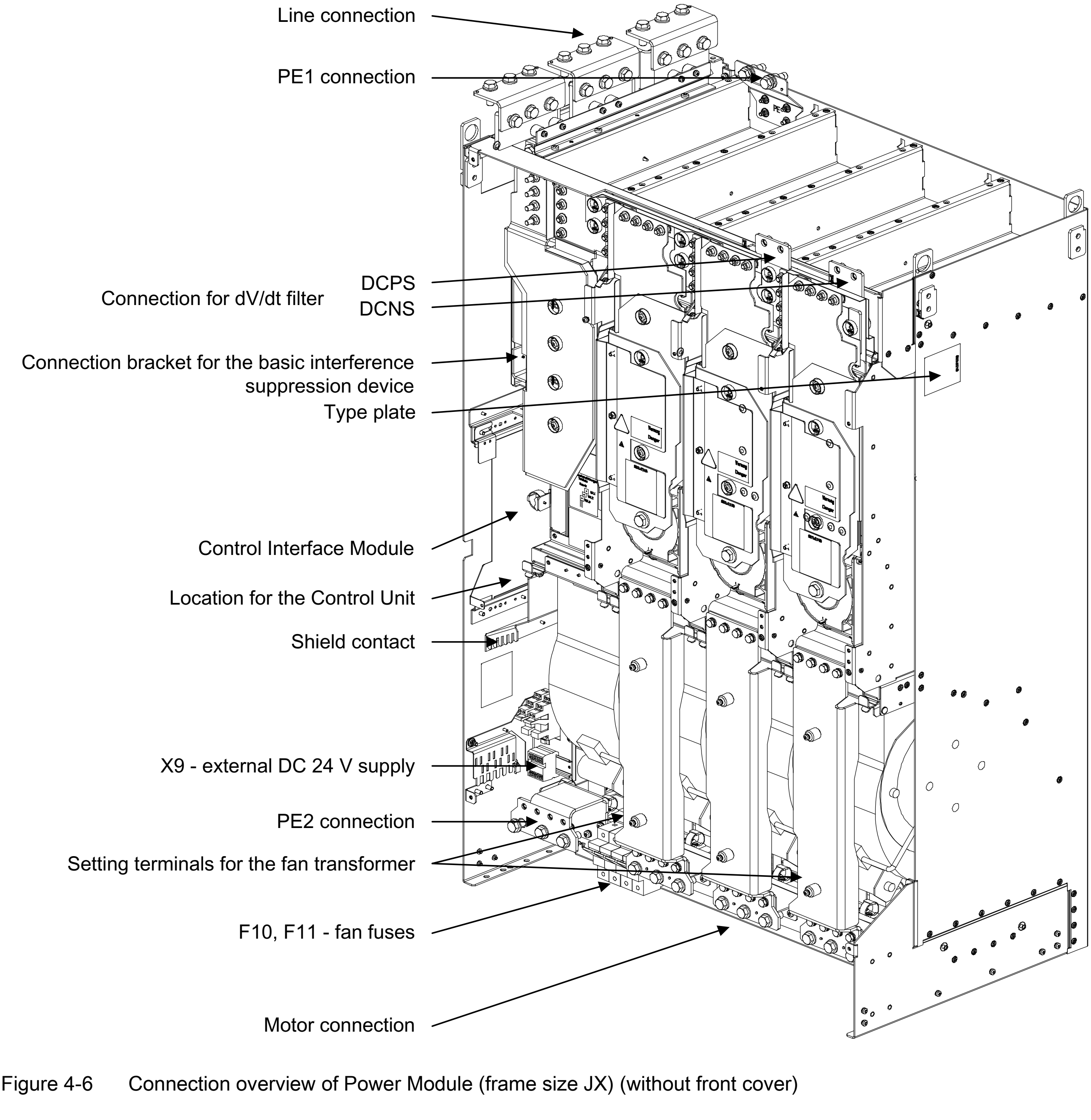


Figure 4-6 Connection overview of Power Module (frame size JX) (without front cover)

4.7 Power connections

> ⚠ **WARNING**
>
> Swapping the input and output terminals can destroy the device!
>
> Swapping or short-circuiting the DC link terminals can destroy the device!
>
> The contactor and relay operating coils that are connected to the same supply network as the device or are located near the device must be connected to overvoltage limiters (e.g. RC elements).
>
> The device must not be operated via a ground-fault circuit interrupter (EN 61800-5-1).

4.7.1 Connection cross-sections and cable lengths

Connection cross-sections

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

Cable lengths

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

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

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

Note

The cable lengths specified are also valid if a motor reactor is in use.

Note

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

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

4.7.2 Connecting the motor and power cables

Connecting the motor and power cables on the Power Module

1. If necessary, remove the covers or front covers in front of the connection panel for motor cables (terminals U2/T1, V2/T2, W2/T3; X2) and power cables (terminals U1/L1, V1/L2, W1/L3; X1).
2. Screw the protective earth (PE) into the appropriate terminal (with earth symbol) (50 Nm for M12) at the points provided in the cabinet.
3. Connect the line and motor cables to the 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!

CAUTION
Tighten the screws with the appropriate torque (50 Nm for M12), otherwise the terminal contacts could catch fire during operation.

Note

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

Direction of motor rotation

With induction machines with a clockwise phase sequence (looking at the drive shaft), the motor must be connected to the Power Module as follows:

Table 4- 3 Power Module and motor connection terminals

Power Module (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 (looking at the drive shaft).

Note

If an incorrect rotating field was connected when the cables were installed, and the rotating field cannot be corrected by swapping the motor cables, it can be corrected when commissioning the drive via p1821 (rotating field direction reversal) by changing the rotating field and thus enabling a direction reversal (see section "Functions, monitoring and protective functions / Direction reversal").

With motors that can be operated in a star/delta configuration, the windings must be checked to ensure that they have been connected properly. Refer to the relevant documentation for the motor and note the required insulation voltage for operating the device.

4.7.3 DCPS, DCNS connection for a dV/dt filter with Voltage Peak Limiter

Table 4- 4 DCPS, DCNS

Frame size	Connectable cross-section	Terminal screw
FX	1 x 70 mm²	M8
GX	1 x 70 mm²	M8
HX	1 x 185 mm²	M10
JX	2 x 185 mm²	M10

With frame sizes FX and GX, the connecting cables are routed down through the Power Module and out.

4.7.4 Adjusting the fan voltage

The power supply for the device fan (1 AC 230 V) in the Power Module is generated from the line supply using a transformer.

The transformer is fitted with primary taps so that it can be fine-tuned 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.

For the position of the setting terminals, see the "Connection overview" section.

Note

One transformer is installed in frame sizes FX, GX and HX; two transformers are installed in frame size JX. The two primary terminals on these devices must be set together.

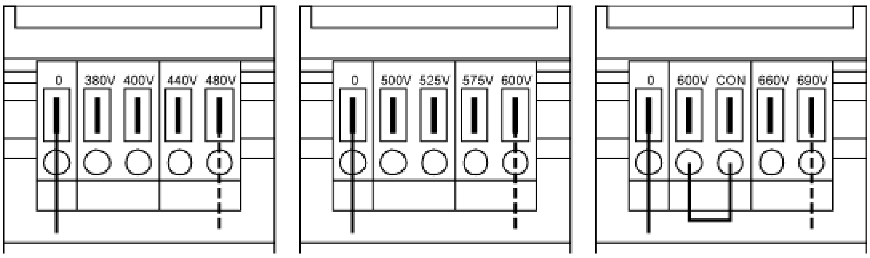


Figure 4-7 Setting terminals for the fan transformer (380 V - 480 V 3 AC / 500 V - 600 V 3 AC / 660V - 690 V 3 AC)

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

Note

With the 660 V – 690 V 3 AC fan transformer, a jumper is inserted between the "600 V" terminal and "CON" terminal. The "600V" and "CON" terminals are for internal use.

NOTICE

If the terminals are not reconnected to the actual line voltage:

- The required cooling capacity cannot be provided because the fan rotates too slowly.
- The fan fuses may blow due to an overcurrent.

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

Line voltage	Taps of the fan transformer
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 V – 600 V 3 AC)

Line voltage	Taps of the fan transformer
500 V ± 10%	500 V
525 V ± 10%	525 V
575 V ± 10%	575 V
600 V ± 10%	600 V

Table 4- 7 Line voltage assignments for setting the fan transformer (660 V – 690 V 3 AC)

Line voltage	Taps of the fan transformer
660 V ± 10%	660 V
690 V ± 10%	690 V

4.7.5 Removing the connection bracket for the interference-suppression capacitor with operation from an ungrounded supply

If the built-in unit is operated from a non-grounded supply/IT system, the connection bracket for the noise suppression capacitor of the Power Module must be removed.

For the position of the connection bracket, see the "Connection overview" section.

⚠ WARNING
Failing to remove the connection bracket for the noise suppression capacitor on a non-grounded system/IT system can cause significant damage to the built-in unit.

4.8 External 24 V DC supply

Description

An external 24 V DC supply is always recommended if communication and closed-loop control are to be independent of the supply system. An external auxiliary supply is particularly recommended for low-power lines susceptible to short-time voltage dips or power failures.

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

The power requirement is 4 A.

Connection

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

4.9 DRIVE-CLiQ wiring diagram

The diagram below shows the specifications for the DRIVE-CLiQ connections between the components.

CAUTION
These specifications for the DRIVE-CLiQ connections should be observed, otherwise faults may occur during commissioning via STARTER or the AOP30 operator panel.

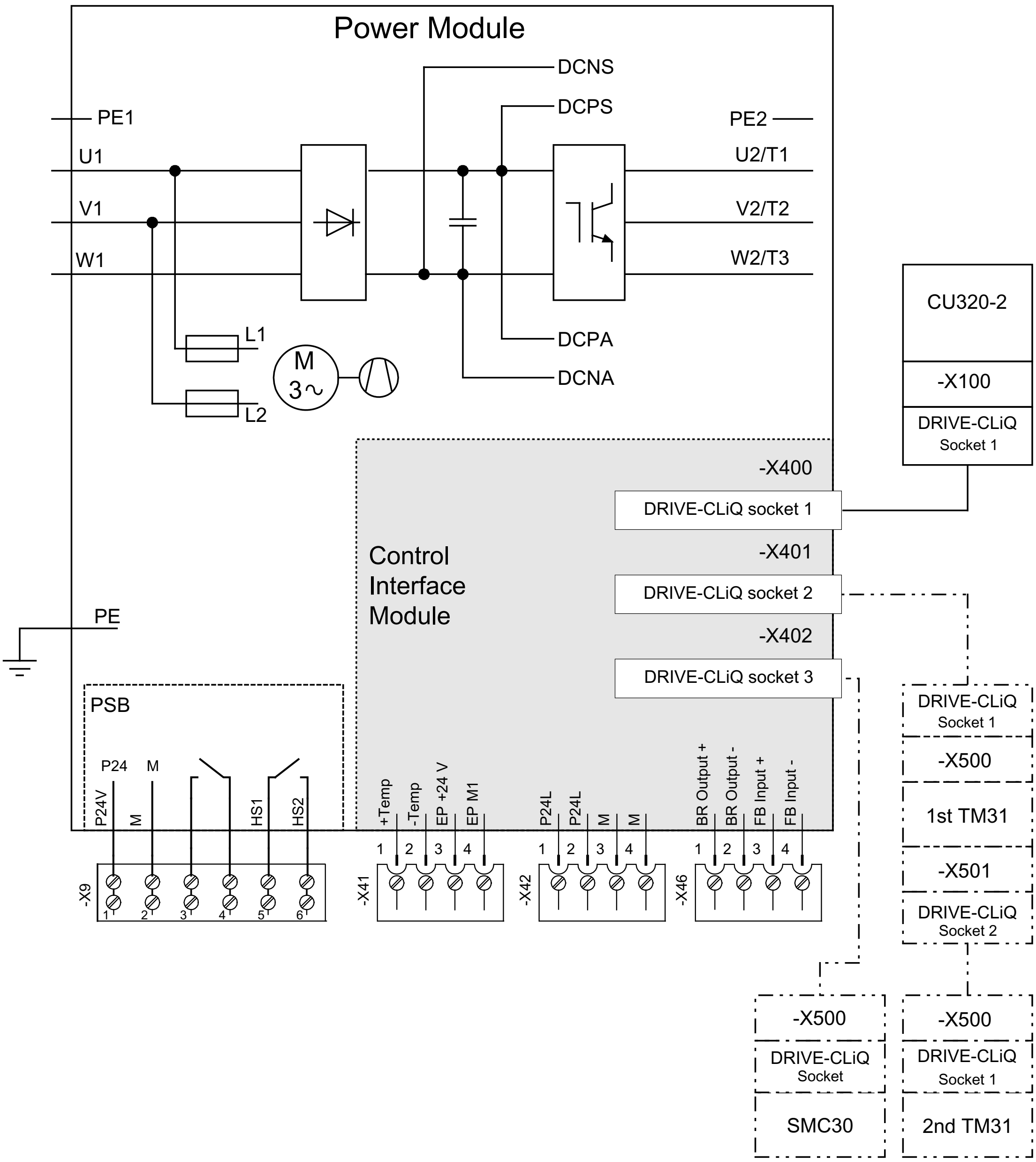


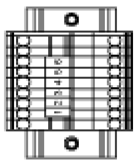
Figure 4-8 DRIVE-CLiQ wiring diagram

4.10 Signal connections

4.10.1 Power Module

X9: Terminal block

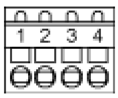
Table 4- 8 Terminal block X9

	Terminal	Function	Technical specifications
	1	P24V	Voltage: 24 V DC (20.4 V - 28.8 V) Current consumption: max. 4 A
	2	M	
	3	Reserved, do not use	
	4	Reserved, do not use	
	5	HS1	Line contactor control
	6	HS2	Line contactor control

Max. connectable cross-section: 1.5 mm²

X41: EP terminals/temperature sensor connection

Table 4- 9 Terminal block X41

	Terminal	Function	Technical specifications
	1	EP M1 (enable pulses)	Supply voltage: 24 V DC (20.4 V - 28.8 V) Current consumption: 10 mA Signal propagation times: L → H 100 µs H → L: 1000 µs The pulse inhibit function is only available when Safety Integrated Basic Functions are enabled.
	2	EP +24 V (enable pulses)	
	3	- Temp	Temperature sensor connection KTY84–1C130 / PTC / PT100
	4	+ Temp	

Max. connectable cross-section: 1.5 mm²

DANGER

Risk of electric shock!

Only temperature sensors that meet the safety isolation specifications contained in EN 61800-5-1 may be connected to terminals "+Temp" and "-Temp".

If these instructions are not complied with, there is a risk of electric shock!

Note

The following probes can be connected to the temperature sensor connection:
KTY84-1C130 / PTC / PT100.

CAUTION

The temperature sensor connection must be shielded. The shielding must be attached to the shield support of the Power Module.

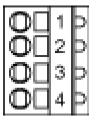
NOTICE

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

NOTICE

The function of the EP terminals is only available when Safety Integrated Basic Functions are enabled.

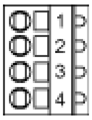
Table 4- 10 Terminal block X42: Voltage supply for Control Unit, Sensor Module and Terminal Module

	Terminal	Function	Technical specifications
	1	P24L	Voltage supply for Control Unit, Sensor Module and Terminal Module (18 to 28.8 V) maximum load current: 3 A
	2		
	3	M	
	4		
Max. connectable cross-section 2.5 mm^2			

⚠ CAUTION

The terminal block is not intended for free 24 V DC availability (for example for supplying further line-side components), as the voltage supply of the Control Interface Module could also be overloaded and operating capability could thus be compromised.

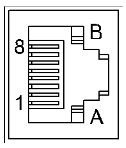
Table 4- 11 Terminal block X46: Brake control and monitoring

	Terminal	function	Technical specifications
	1	BR output +	The interface is intended for connection of the Safe Brake Adapter.
	2	BR output -	
	3	FB input +	
	4	FB input -	
Max. connectable cross-section 1.5 mm²			

CAUTION
The length of the connecting lead at terminal strip X46 must not exceed 10 m, and the lead must not be brought out outside the control cabinet or control cabinet group.

X400 – X402: DRIVE-CLiQ interface

Table 4- 12 DRIVE-CLiQ interface X400 – X402: Power Module

	Pin	Signal name	Technical specifications
	1	TXP	Transmit data +
	2	TXN	Transmit data -
	3	RXP	Receive data +
	4	Reserved, do not use	-
	5	Reserved, do not use	-
	6	RXN	Receive data -
	7	Reserved, do not use	-
	8	Reserved, do not use	-
	A	+ (24 V)	Power supply
	B	M (0 V)	Electronics ground
Blanking plate for DRIVE-CLiQ interfaces (50 pcs.) Order number: 6SL3066-4CA00-0AA0			

4.10.2 Control Unit CU320-2 DP

Connection overview

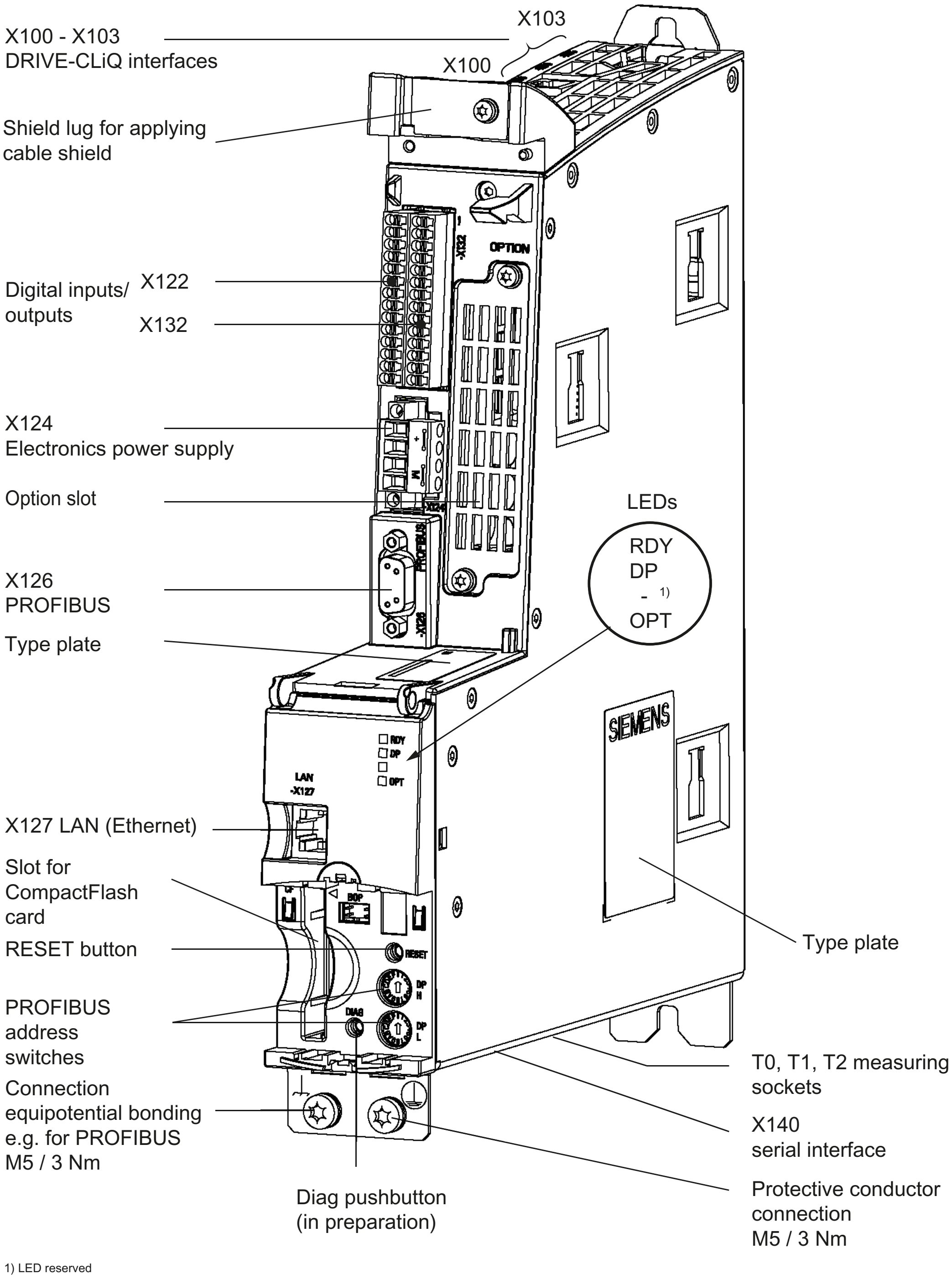


Figure 4-9 Overview of connections for CU320 DP Control Unit (without cover)

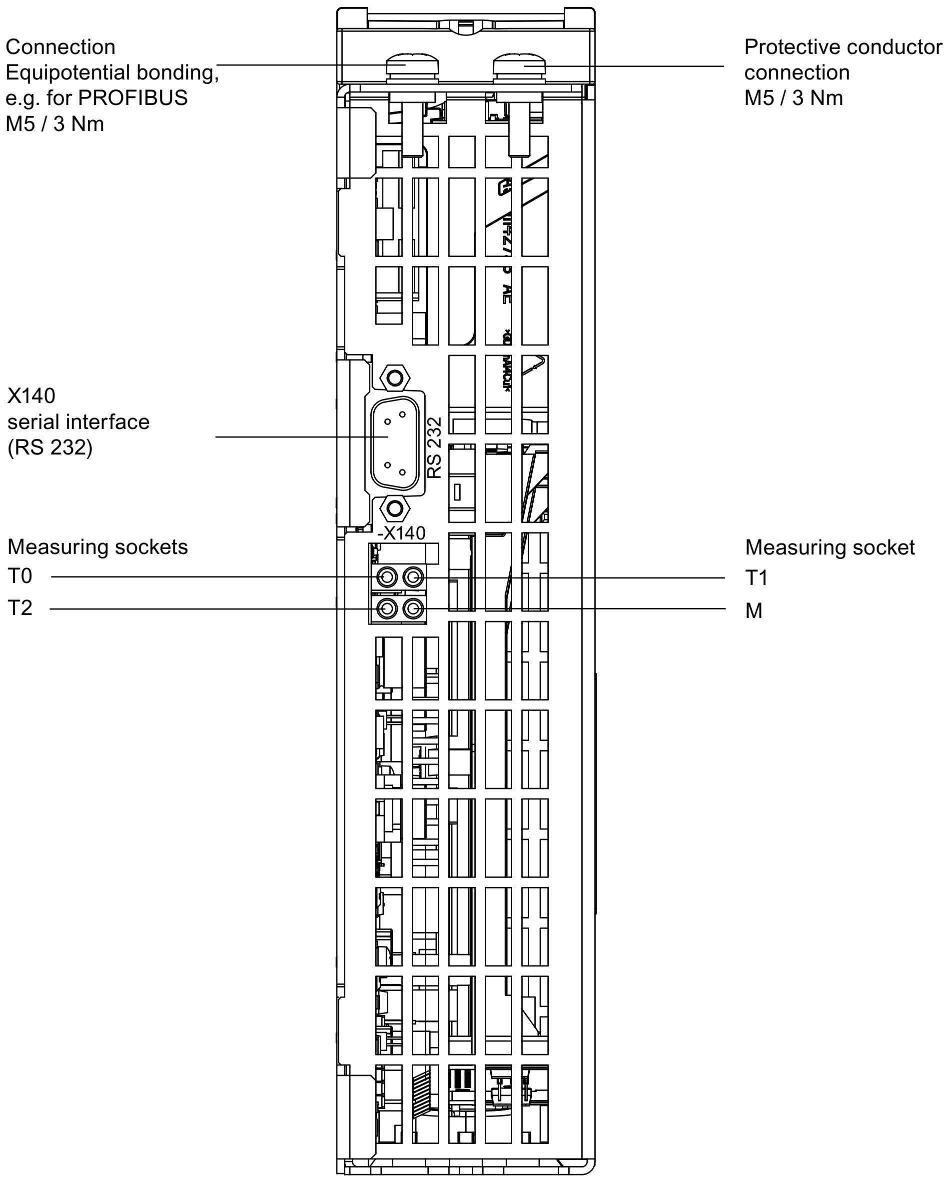


Figure 4-10 Interface X140 and measuring sockets T0 to T2 - CU320-2 DP (view from below)

⚠ CAUTION

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

If a potential bonding conductor is not used, high leakage currents that could destroy the Control Unit or other PROFIBUS nodes can be conducted via the PROFIBUS cable.

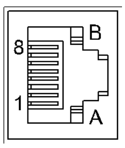
CAUTION
The CompactFlash card may only be inserted or removed when the Control Unit is in a no-voltage condition. Non-compliance can result in a loss of data during operation and possibly a plant standstill.

CAUTION
The CompactFlash card is an electrostatic sensitive component. ESD regulations must be observed when inserting and removing the card.

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

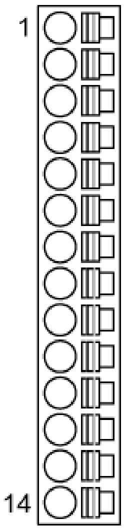
X100 – X103: DRIVE-CLiQ interface

Table 4- 13 DRIVE-CLiQ interface X100 - X103

	Pin	Signal name	Technical specifications
	1	TXP	Transmit data +
	2	TXN	Transmit data -
	3	RXP	Receive data +
	4	Reserved, do not use	
	5	Reserved, do not use	
	6	RXN	Receive data -
	7	Reserved, do not use	
	8	Reserved, do not use	
	A	+ (24 V)	Power supply
	B	M (0 V)	Electronics ground
Connector type: RJ45 socket Blanking plate for DRIVE-CLiQ interfaces (50 pcs.) Order number: 6SL3066-4CA00-0AA0			

X122: Digital inputs/outputs

Table 4- 14 Terminal block X122

	Pin	Designation [1]	Technical specifications
	1	DI 0	Voltage: -30 V to 30 V Typical current consumption: 9 mA at 24 V DC Electrical isolation: reference potential is terminal M1 Level (incl. ripple) High level: +15 V to +30 V Low level: -30 V to +5 V Input delay (typ.): L -> H: approx. 50 µs H -> L: approx. 150 µs
	2	DI 1	
	3	DI 2	
	4	DI 3	
	5	DI 16	
	6	DI 17	
	7	M1	Reference potential for terminals 1 to 6
	8	M	Ground
	9	DI/DO 8	**As input:** Voltage: -30 V to 30 V Typical current consumption: 9 mA at 24 V DC Level (incl. ripple) High level: +15 V to +30 V Low level: -30 V to +5 V DI/DO 8, 9, 10, and 11 are "rapid inputs" [2] Input delay (typ.): L -> H: approx. 5 µs H -> L: approx. 50 µs **As output:** Voltage: 24 V DC Max. load current per output: 500 mA, continued-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: Ground reference

2) The rapid inputs can be used as probe inputs or as inputs for the external zero mark.

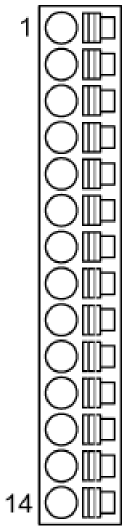
3) Data for: V_{cc}= 24 V; load 48 Ω; high ("1") = 90% V_{out}; low ("0") = 10% V_{out}

Note

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

X132: Digital inputs/outputs

Table 4- 15 Terminal block X132

	Pin	Designation [1]	Technical specifications
	1	DI 4	Voltage: -30 V to 30 V Typical current consumption: 9 mA at 24 V DC Electrical isolation: The reference potential is terminal M2 Level (incl. ripple) High level: +15 V to +30 V Low level: -30 V to +5 V Input delay (typ.): L -> H: approx. 50 μs H -> L: approx. 150 μs
	2	DI 5	
	3	DI 6	
	4	DI 7	
	5	DI 20	
	6	DI 21	
	7	M2	Reference potential for terminals 1 to 6
	8	M	Ground
	9	DI/DO 12	**As input:** Voltage: -30 V to 30 V Typical current consumption: 9 mA at 24 V DC Level (incl. ripple) High level: +15 V to +30 V Low level: -30 V to +5 V DI/DO 12, 13, 14, and 15 are "rapid inputs" [2] Input delay (typ.): L -> H: approx. 5 μs H -> L: approx. 50 μs **As output:** Voltage: 24 V DC Max. load current per output: 500 mA, continued-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: Ground reference

2) The rapid inputs can be used as probe inputs or as inputs for the external zero mark.

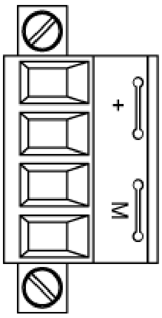
3) Data for: V_{cc}= 24 V; load 48 Ω; high ("1") = 90% V_{out}; low ("0") = 10% V_{out}

Note

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

X124: Electronics power supply

Table 4- 16 Terminal block X124

	Terminal	Function	Technical specifications
	+	Electronics power supply	Voltage: 24 V DC (20.4 V - 28.8 V) Current consumption: max. 1.0 A (without DRIVE-CLiQ or digital outputs) Max. current via jumper in connector: 20 A at 55°C
	+	Electronics power supply	
	M	Electronics ground	
	M	Electronics ground	
Max. connectable cross-section: 2.5 mm²			

Note

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

The power can be supplied via terminals X41.1/2 on the Power Module.

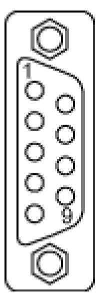
Note

The terminal block must be screwed on tightly using a flat-bladed screwdriver.

X126: PROFIBUS connection

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

Table 4- 17 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 V - 28.8 V)
	8	RxD/TxD–N	Receive/transmit data N (A)	RS485
	9	-	Not assigned	

Note

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

CAUTION

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

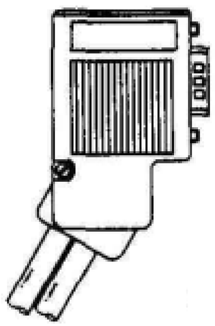
CAUTION

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

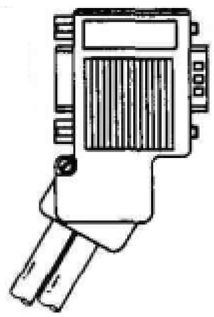
Connectors

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

The figure below shows suitable PROFIBUS connectors with/without a PG/PC connection.



PROFIBUS connector
without PG/PC connection
6ES7972-0BA41-0XA0



PROFIBUS connector
with PG/PC connection
6ES7972-0BB41-0XA0

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 be connected at both ends over large-surface area contacts.

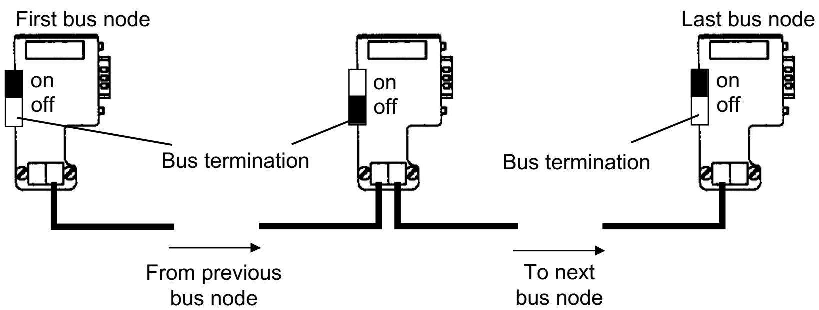
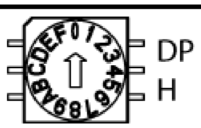
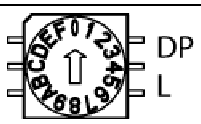


Figure 4-11 Posisition of the bus terminating resistors

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- 18 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

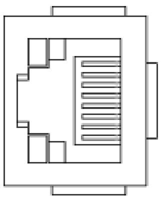
The factory setting for the rotary coding switches is 0_{dec} (00_{hex}).

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.

The address switch is behind the blanking plate. The blanking plate is part of the scope of supply.

Table 4- 19 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 X127 interface supports commissioning and diagnostic functions. It must not be connected for normal operation.

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

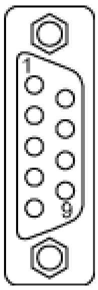
Table 4- 20 LED statuses for the X127 LAN interface

LED	State	Description
Green	On	10 or 100 Mbit link available
	Off	Missing or faulty link
Yellow	On	Sending or receiving
	Off	No activity

X140: serial interface (RS232)

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

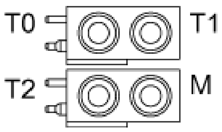
Table 4- 21 Serial interface (RS232) X140

	Pin	Designation	Technical specifications
	2	RxD	Receive data
	3	TxD	Transmit data
	5	Ground	Ground reference
Connector type:		9-pin SUB D socket	

CAUTION
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 sockets

Table 4- 22 Measuring sockets T0, T1, T2

	Socket	Function	Technical specifications
	T0	Measuring socket 0	Voltage: 0 V to 5 V Resolution: 8 bits Load current: max. 3 mA Continued-short-circuit-proof The reference potential is terminal M
	T1	Measuring socket 1	
	T2	Measuring socket 2	
	M	Ground	
The measurement sockets are only suitable for bunch pin plugs with a diameter of 2 mm.			

Note

The measuring sockets support commissioning and diagnostic functions. It must not be connected for normal operation.

Slot for the CompactFlash card

Figure 4-12 CompactFlash card slot

CAUTION

The CompactFlash card may only be removed and inserted when the Control Unit is in a voltage-free state; doing this during operation instead could result in a loss of data and, where applicable, a plant standstill.

The CompactFlash card may only be inserted as shown in the photo above (arrow at top right).

CAUTION

The CompactFlash card is an electrostatic sensitive component. ESD regulations must be observed when inserting and removing the card.

NOTICE

When returning a defective Control Unit, remove the CompactFlash card and keep it for insertion in the replacement unit. This is important otherwise the data on the CompactFlash card (parameters, firmware, licenses, and so on) may be lost.

Note

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

Wiring diagram

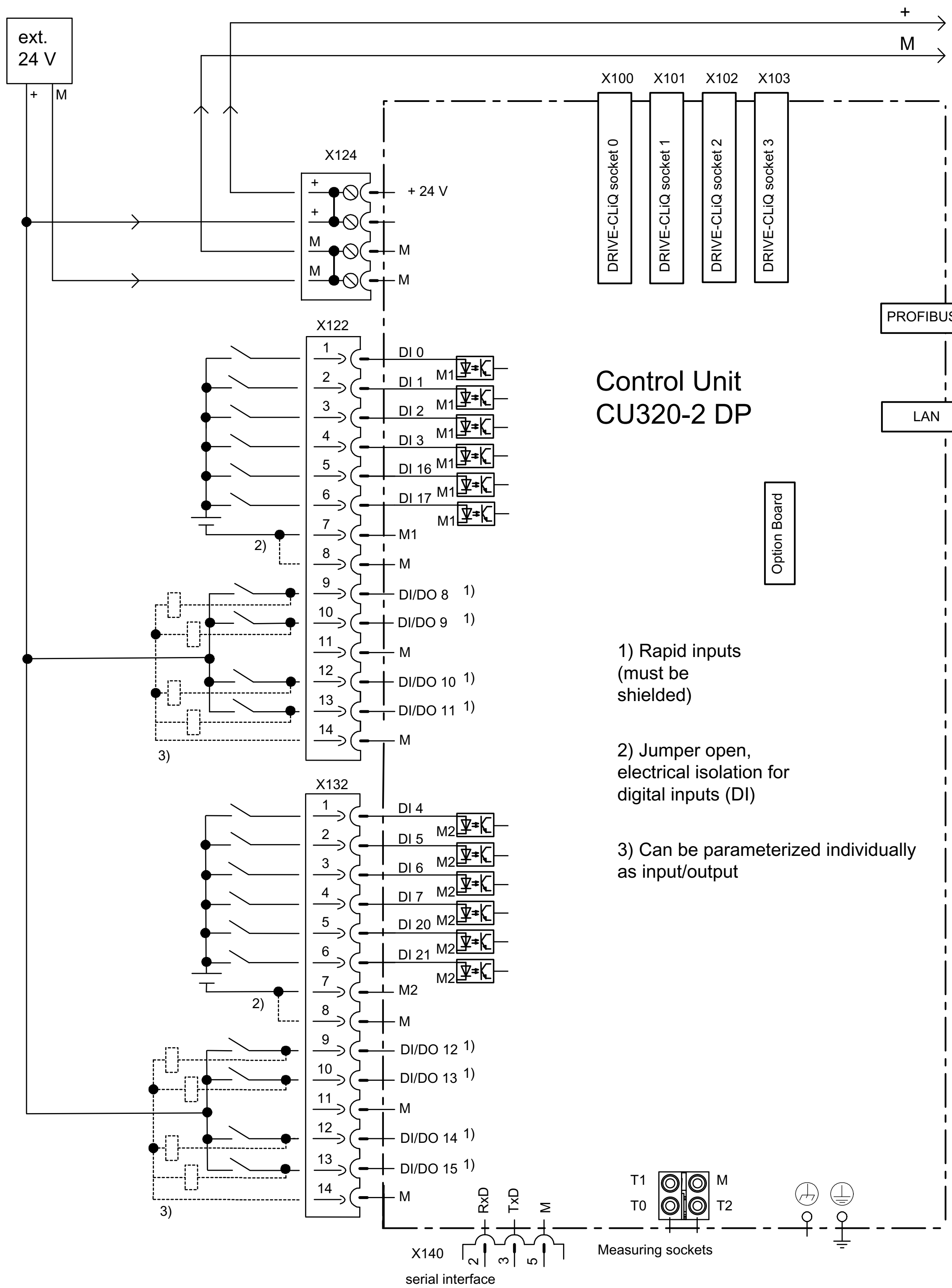


Figure 4-13 Wiring diagram of the CU320-2DP

4.10.3 TM31 Terminal Module

Description

The TM31 Terminal Module is a terminal extension board. It can be used to increase the number of available digital/analog inputs/outputs within a drive system.

Connection overview

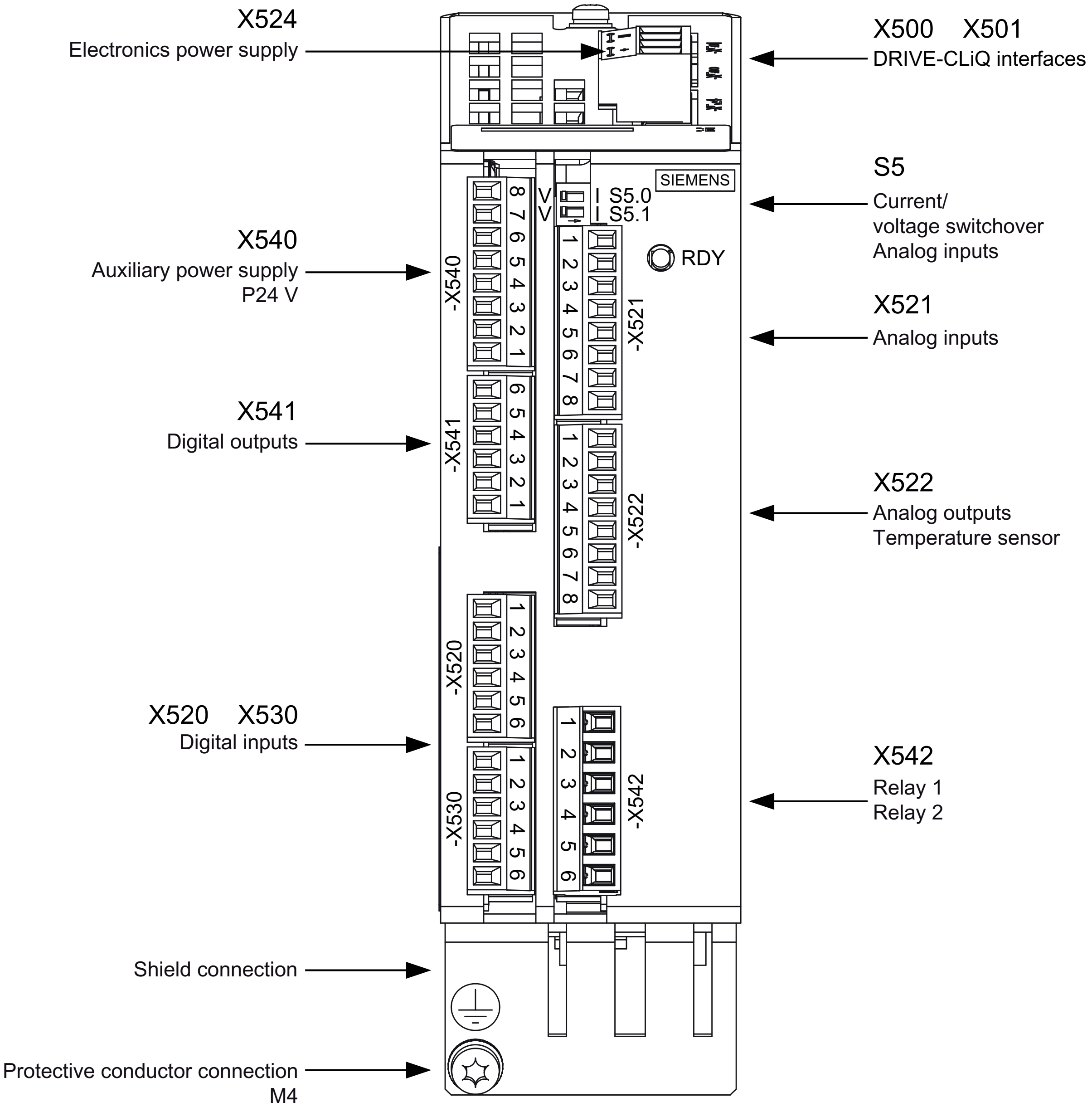


Figure 4-14 TM31 Terminal Module

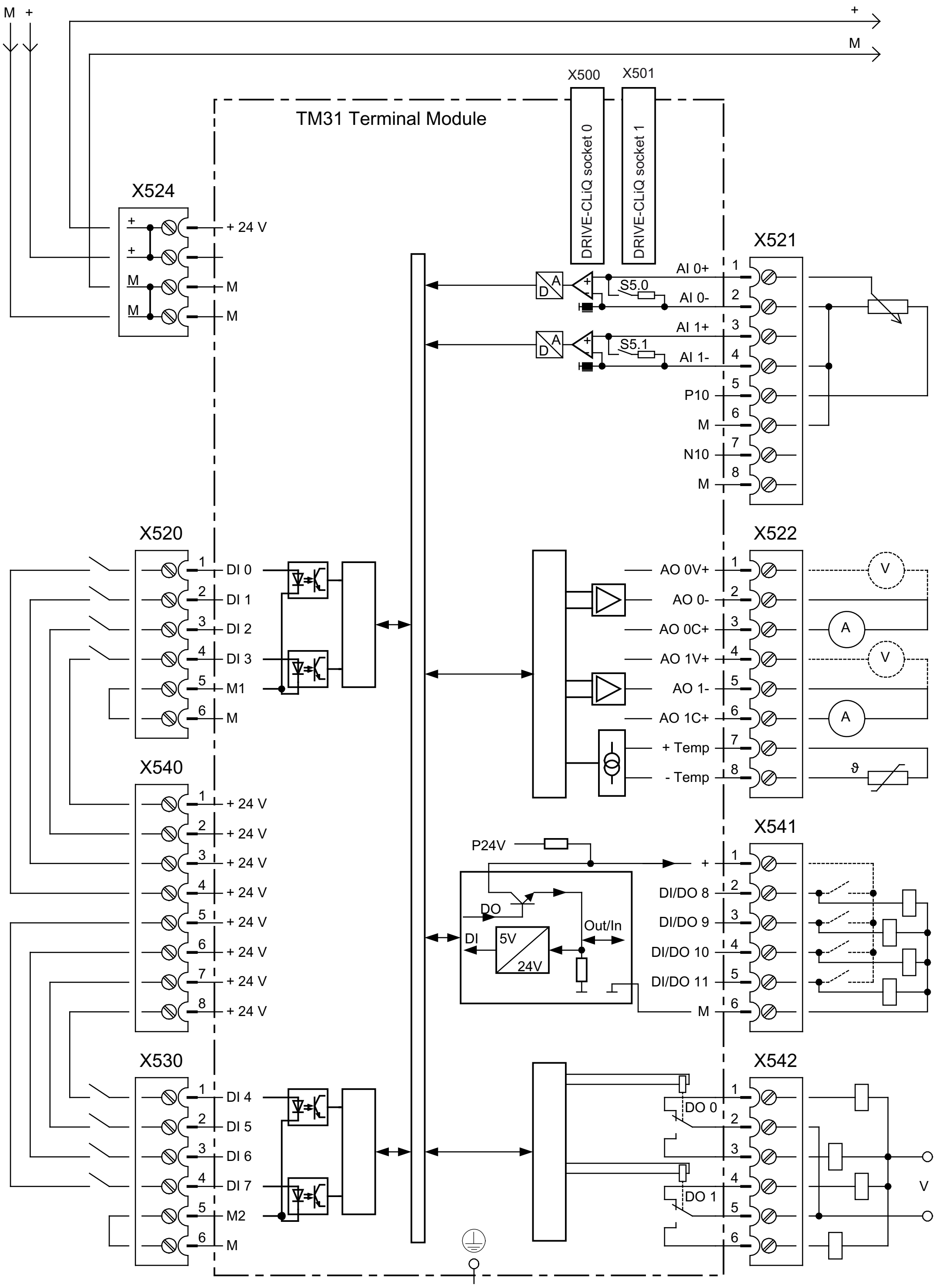


Figure 4-15 Connection overview of TM31 Terminal Module

Note

The diagram of the Terminal Module shows the factory setting. The digital inputs (terminals -X520 and -X530) in the example are powered by the internal 24 V supply of the Terminal Module (terminal -X540).

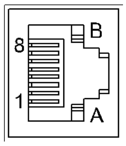
The two groups of digital inputs (optocoupler inputs) have a common reference potential for each group (ground reference M1 or M2). To close the circuit when the internal 24 V supply is used, the ground references M1 / M2 must be connected to internal ground (M).

If the power is not supplied from the internal 24 V supply (terminal –X540), the jumper between ground M1 and M or M2 and M must be removed and M1 or M2 must be connected to the ground of the external 24 V DC supply.

If you do not do this, this can result in potential rounding.

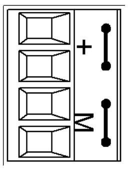
X500, X501: DRIVE-CLiQ interface

Table 4- 23 DRIVE-CLiQ interface X500 and X501

	Pin	Signal name	Technical specifications
	1	TXP	Transmit data +
	2	TXN	Transmit data -
	3	RXP	Receive data +
	4	Reserved, do not use	
	5	Reserved, do not use	
	6	RXN	Receive data -
	7	Reserved, do not use	
	8	Reserved, do not use	
	A	+ (24 V)	Power supply
	B	M (0 V)	Electronics ground
Blanking plate for DRIVE-CLiQ interfaces (50 pcs.) Order number: 6SL3066-4CA00-0AA0			

X524: Electronics power supply

Table 4- 24 Terminal block X524

	Terminal	Function	Technical specifications
	+	Electronics power supply	Voltage: 24 V DC (20.4 V - 28.8 V) Current consumption: max. 0.5 A Max. current via jumper in connector: 20 A at 55°C
	+	Not used	
	M	Electronics ground	
	M	Electronics ground	

Max. connectable cross-section: 2.5 mm²

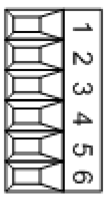
Note

The two "+" and "M" terminals are jumpered in the connector and not in the unit.
This ensures that the supply voltage is looped through.

The power can be supplied via terminals X41:1/2 on the Power Module.

X520: 4 digital inputs

Table 4- 25 Terminal block X520

	Terminal	Designation [1]	Technical specifications
	1	DI 0	Voltage: - 3 V to 30 V Typical current consumption: 10 mA at 24 V Reference potential is always terminal M1 Level: - high level: 15 V to 30 V - low level: -3 V to 5 V
	2	DI 1	
	3	DI 2	
	4	DI 3	
	5	M1	Ground reference
	6	M	Electronics ground

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

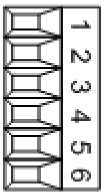
Max. connectable cross-section: 1.5 mm²

Note

An open input is interpreted as "low".

X530: 4 digital inputs

Table 4- 26 Terminal block X530

	Terminal	Designation [1]	Technical specifications
	1	DI 4	Voltage: - 3 V to 30 V Typical current consumption: 10 mA at 24 V Reference potential is always terminal M2 Level: - high level: 15 V to 30 V - low level: -3 V to 5 V
	2	DI 5	
	3	DI 6	
	4	DI 7	
	5	M2	Ground reference
	6	M	Electronics ground

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

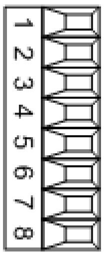
Max. connectable cross-section: 1.5 mm²

Note

An open input is interpreted as "low".

X521: 2 analog inputs (differential inputs)

Table 4- 27 Terminal block X521

	Terminal	Designation [1]	Technical specifications
	1	AI 0+	**As voltage input:** -10 V - +10 V, Ri = 100 kΩ Resolution: 11 bits + sign **As current input:** +4 mA - +20 mA / -20 mA - +20 mA / 0 mA - +20 mA, Ri = 250 Ω Resolution: 10 bits + sign
	2	AI 0-	
	3	AI 1+	
	4	AI 1-	
	5	P10	Auxiliary voltage +10 V, continued short-circuit proof
	6	M	Ground reference
	7	N10	Auxiliary voltage -10 V, continued short-circuit proof
	8	M	Ground reference

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

Max. connectable cross-section: 1.5 mm²

CAUTION

The input current of the analog inputs must not exceed 35 mA when current measurements are performed.

S5: Selector for voltage/current AI0, AI1

Table 4- 28 Selector for voltage/current S5

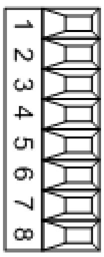
	Switch	Function
	S5.0	Selector voltage (V) / current (I) AI0
	S5.1	Selector voltage (V) / current (I) AI1

Note

When delivered, both switches are set to voltage measurement (switch set to "V").

X522: 2 analog outputs, temperature sensor connection

Table 4- 29 Terminal block X522

	Terminal	Designation [1]	Technical specifications
	1	AO 0V+	-10 V - +10 V (max. 3 mA) +4 mA - +20 mA (max. load resistance ≤ 500 Ω) -20 mA - +20 mA (max. load resistance ≤ 500 Ω) 0 mA - +20 mA (max. load resistance ≤ 500 Ω) Resolution: 11 bits + sign continued short-circuit proof
	2	AO 0-	
	3	AO 0C+	
	4	AO 1V+	
	5	AO 1-	
	6	AO 1C+	
	7	+Temp	Temperature sensor connection: KTY84-1C130 / PTC
	8	-Temp	

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

Max. connectable cross-section: 1.5 mm²

⚠ DANGER
Risk of electric shock!
Only temperature sensors that meet the electrical separation specifications contained in EN 61800-5-1 may be connected to terminals "+Temp" and "-Temp". If these instructions are not complied with, there is a risk of electric shock!

Note

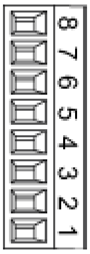
The following probes can be connected to the temperature sensor connection: KTY84-1C130 / PTC.

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

CAUTION
The permissible back EMF at the outputs is ±15 V

X540: Joint auxiliary voltage for the digital inputs

Table 4- 30 Terminal block X540

	Terminal	Designation	Technical specifications
	8	P24	24 V DC Max. total load current of +24 V auxiliary voltage of terminal blocks X540 and X541 combined: 150 mA continued short-circuit proof
	7	P24	
	6	P24	
	5	P24	
	4	P24	
	3	P24	
	2	P24	
	1	P24	

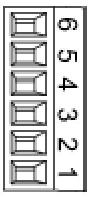
Max. connectable cross-section: 1.5 mm²

Note

This voltage supply is only for powering the digital inputs.

X541: 4 non-floating digital inputs/outputs

Table 4- 31 Terminal strip X541

	Terminal	Designation [1)]	Technical specifications
	6	M	Electronics ground
	5	DI/DO 11	**As input:** Voltage: -3 V to 30 V Typical current consumption: 10 mA at 24 V DC **As output:** The summation current of the four outputs (including the currents of the inputs) is limited by the software: - for p4046 = 0: 100 mA (delivery condition) - for p4046 = 1: 1 A continued short-circuit proof
	4	DI/DO 10	
	3	DI/DO 9	
	2	DI/DO 8	
	1	P24	Auxiliary voltage: +24 V DC Max. total load current of +24 V auxiliary voltage of terminal blocks X540 and X541 combined: 150 mA

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

Max. connectable cross-section: 1.5 mm²

Note

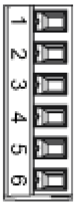
An open input is interpreted as "low".

When externally generated 24 V DC signals are connected to a digital input, the ground reference of the external signal must also be connected.

CAUTION
The aggregate current set via p4046 must be provided via the external electronic power supply. Due to the limitation of the aggregate of the output currents an over-current can cause a short circuit on an output terminal or even intrusion of the signal of a different terminal.

X542: 2 relay outputs (two-way contact)

Table 4- 32 Terminal block X542

	Terminal	Designation [1]	Technical specifications
	1	DO 0.NC	Contact type: Changeover contact max. load current: 8 A Max. switching voltage: 250 V AC, 30 V DC Max. switching voltage: - at 250 V AC: 2000 VA (cosϕ = 1) - at 250 V AC: 750 VA (cosϕ = 0.4) - at 30 V DC: 240 W (ohmic load) Required minimum current: 100 mA
	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

Max. connectable cross-section: 2.5 mm²

Note

If 230 V AC is applied to the relay outputs, the Terminal Module must also be grounded via a 6 mm² protective conductor.

4.10.4 Sensor Module Cabinet-Mounted SMC30

4.10.4.1 Description

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

In conjunction with SINAMICS G130 the following sensors can be connected to the SMC30 Sensor Module:

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

Table 4- 33 Connectable encoders with supply voltage

Encoder type	X520 (D-Sub)	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- 34 Maximum signal cable lengths

Encoder type	Maximum signal cable length in m
TTL	100
HTL unipolar	100
HTL bipolar	300

Note

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.

Table 4- 35 Specification of measuring systems that can be connected

Parameters	Designation	Threshold	Min.	Max.	Unit
High signal level (TTL bipolar at X520 or X521/X531) 1)	U_{Hdiff}		2	5	V
Low signal level (TTL bipolar at X520 or X521/X531) 1)	U_{Ldiff}		-5	-2	V
High signal level (HTL unipolar)	U_H 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 next but one rising edge of track B.

4) The threshold can be set via p0405.04 (switching threshold); the setting on delivery is "Low".

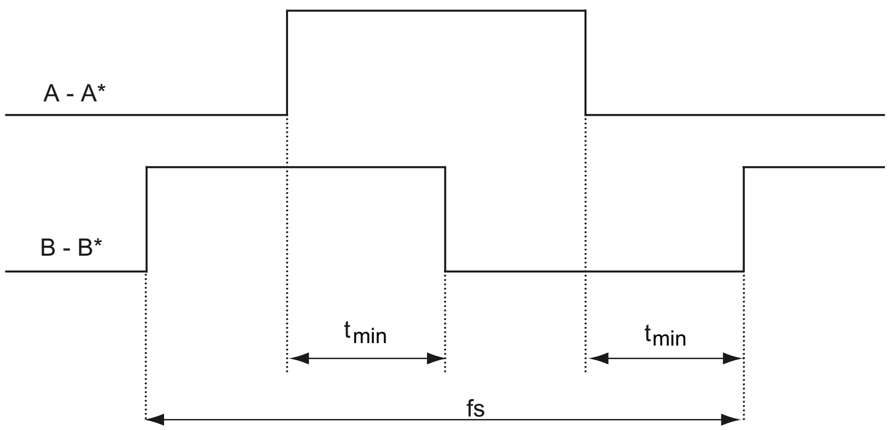


Figure 4-16 Signal characteristic of the A and B track between two edges: Time between two edges with pulse encoders

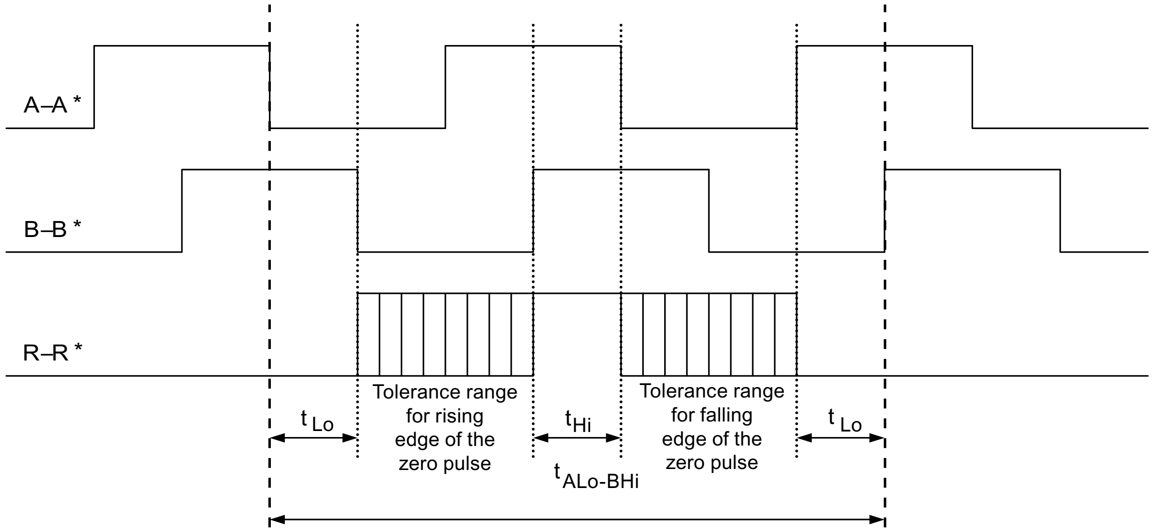


Figure 4-17 Position of the zero pulse to the track signals

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

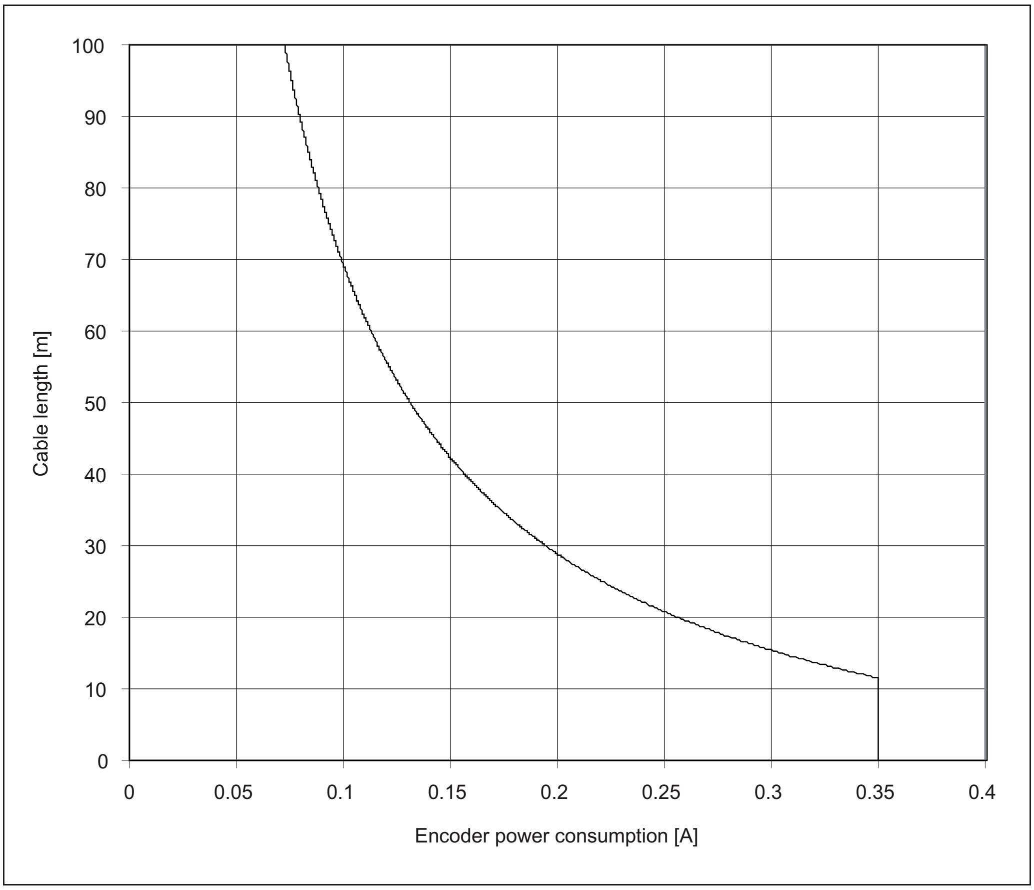


Figure 4-18 Signal cable length as a function of the sensor current consumption

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

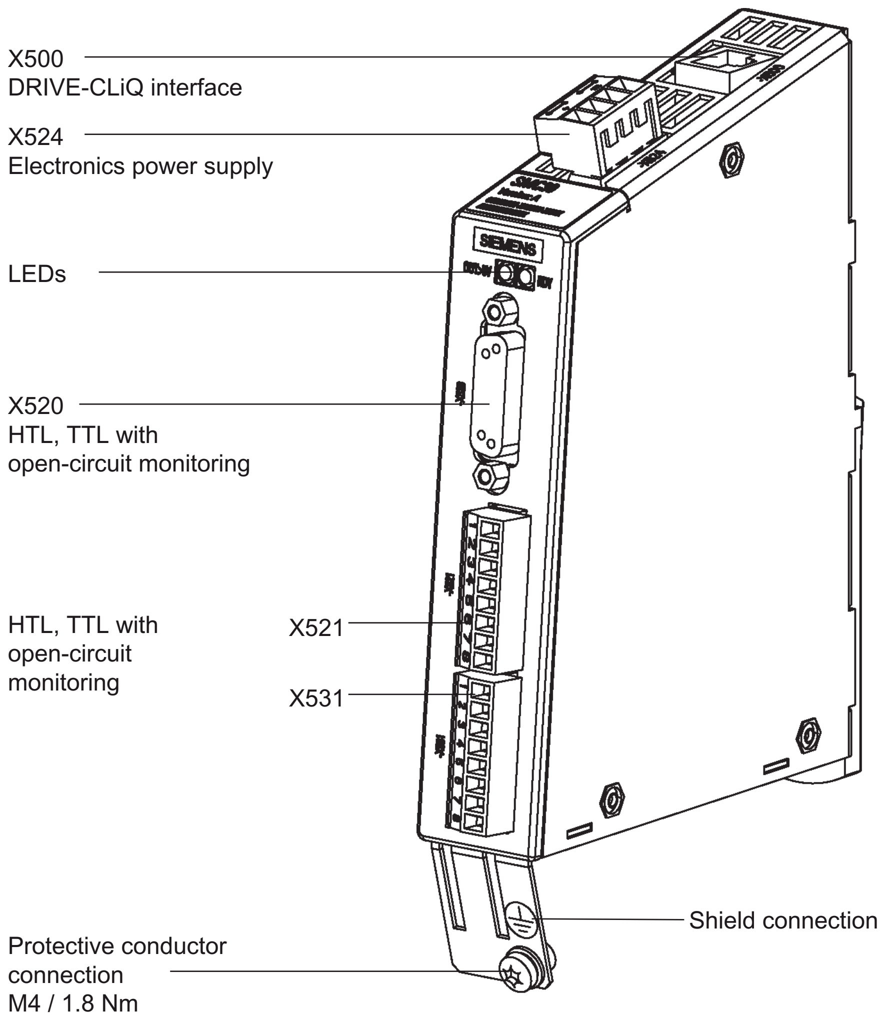
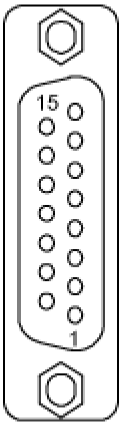


Figure 4-19 SMC30 Sensor Module

4.10.4.2 Connection

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

Table 4- 36 Encoder connection X520

	Pin	Signal name	Technical specifications
	1	+Temp	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 power supply
	7	M encoder (M)	Ground for encoder power supply
	8	-Temp	Temperature sensor connection KTY84-1C130/PTC
	9	M sense	Ground sense input
	10	R	Reference signal R
	11	R*	Inverse reference signal R
	12	B*	Inverse incremental signal B
	13	B	Incremental signal B
	14	A*	Inverse incremental signal A
	15	A	Incremental signal A

Connector type: 15-pin socket

DANGER

Risk of electric shock!

Only temperature sensors that meet the electrical separation specifications contained in EN 61800-5-1 may be connected to terminals "+Temp" and "-Temp".

If these instructions are not complied with, there is a risk of electric shock!

CAUTION

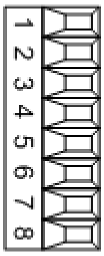
The encoder power supply can be parameterized to 5 V or 24 V. The encoder may be destroyed if you enter the wrong parameter.

NOTICE

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

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

Table 4- 37 Encoder connection X521

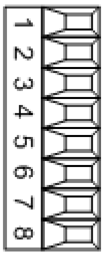
	Terminal	Signal name	Technical specifications
	1	A	Incremental signal A
	2	A*	Inverse incremental signal A
	3	B	Incremental signal B
	4	B*	Inverse incremental signal B
	5	R	Reference signal R
	6	R*	Inverse reference signal R
	7	CTRL	Control signal
	8	M	Ground via inductivity

Max. connectable cross-section: 1.5 mm²

Note

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

Table 4- 38 Encoder connection X531

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

Max. connectable cross-section: 1.5 mm²

⚠ DANGER

Risk of electric shock!

Only temperature sensors that meet the electrical separation specifications contained in EN 61800-5-1 may be connected to terminals "+Temp" and "-Temp".

If these instructions are not complied with, there is a risk of electric shock!

Note

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

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

4.10.4.3 Connection examples

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

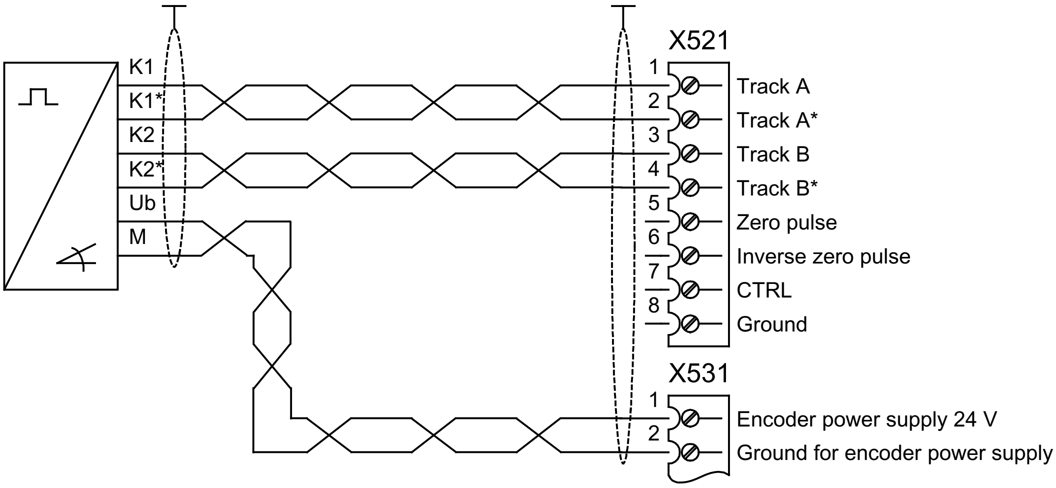


Figure 4-20 Connection example 1: HTL encoder, bipolar, without zero marker

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

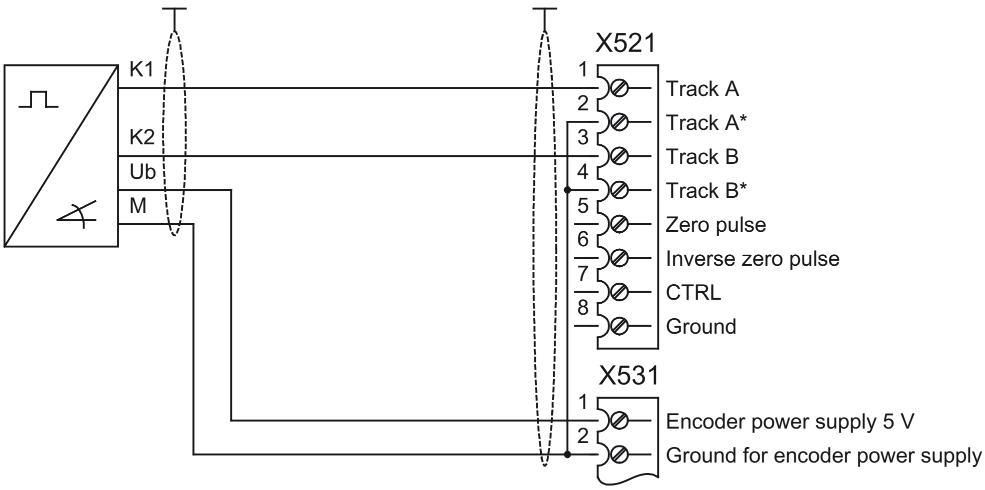


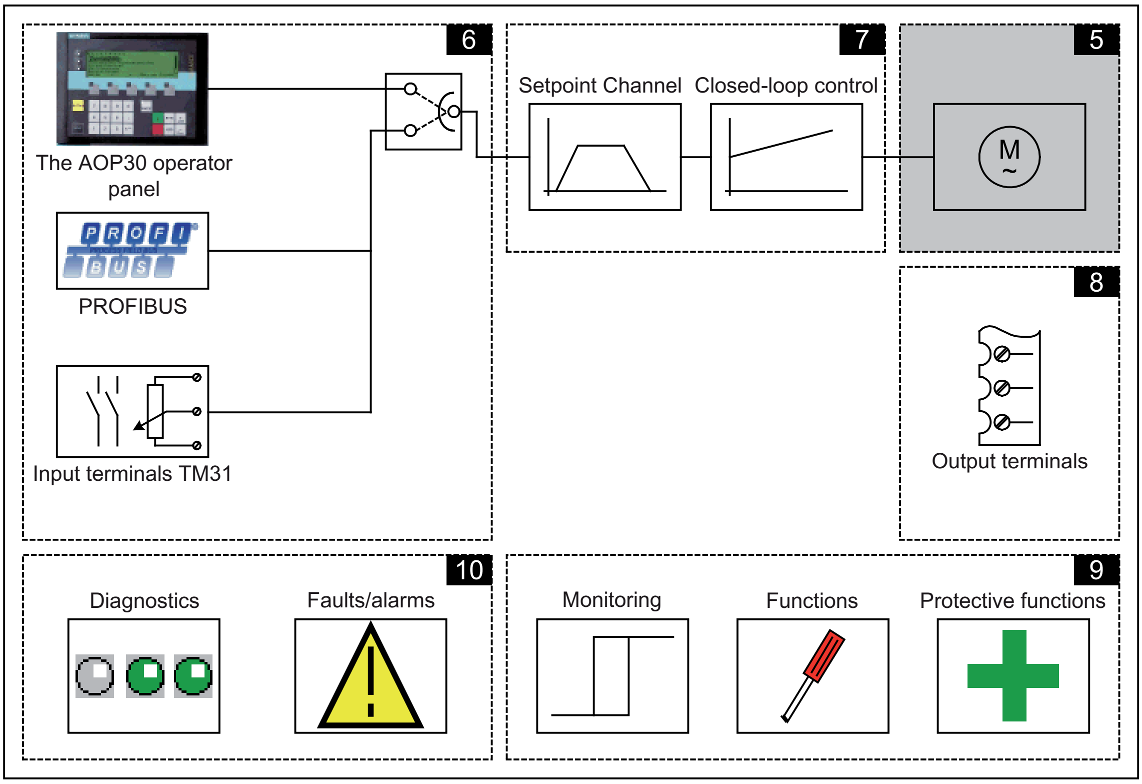
Figure 4-21 Connection example 2: TTL encoder, unipolar, without zero marker

Commissioning 5

5.1 Chapter content

This chapter provides information on the following:

- Initial commissioning of the built-in unit (initialization)
  - 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 built-in unit offers a varying number of signal interconnections depending on the additional modules connected. For the converter control to be able to process the signals correctly, several software settings must be made.

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

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

5.2 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

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

Prerequisite: STARTER Version

The following STARTER version is required for commissioning SINAMICS with firmware V4.3 SP2:

- STARTER V4.1.5 +SSP for SINAMICS V 04.32.10.00

Prerequisites for installing STARTER

Hardware
The following minimum requirements must be complied with:

- PG or PC
- Pentium III, 800 MHz min., (> 1 GHz recommended)
- 512 MB main memory (1 GB recommended)
- Screen resolution 1024×768 pixels, 16-bit color depth

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

- Microsoft Windows 2000 SP4
- Microsoft Windows 2003 Server SP1, SP2
- Microsoft Windows XP Professional SP2, SP3
- Microsoft Windows VISTA Business SP1 (without DCC)
- Microsoft Windows VISTA Ultimate SP1 (without DCC)
- Microsoft Internet Explorer V6.0 or higher
- STARTER setup is possible with native Windows XP versions with far east languages only if the Windows XP software is an MUI version.
- Acrobat Reader V5.0 or higher is required to open the function diagrams in the online help.

Note

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

5.2.1 Installing STARTER

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

5.2.2 The STARTER user interface

STARTER features four operating areas:

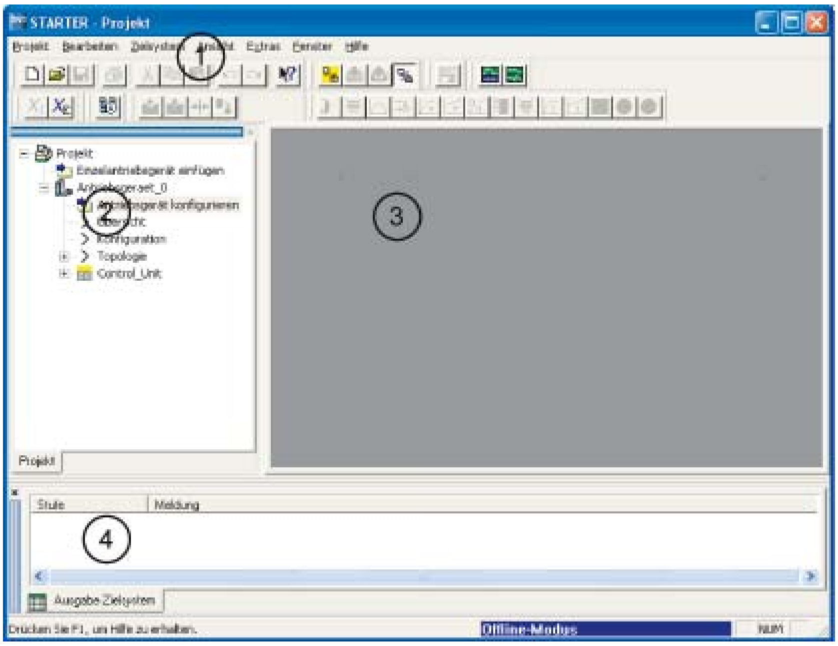


Figure 5-1 STARTER operating areas

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

5.3 Procedure for commissioning via STARTER

Basic procedure using STARTER

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

NOTICE
These dialog screens contain default settings, which you may have to change according to your application and configuration. This is intentional because 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 a project

Click the STARTER icon on your desktop or choose the following menu path in the Windows start menu to call up STARTER: Start > Simatic > STEP 7 > STARTER.

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

- STARTER Getting Started Drive Commissioning
- STARTER Project Wizard

The commissioning steps are listed below in numerical order.

Accessing the STARTER project wizard

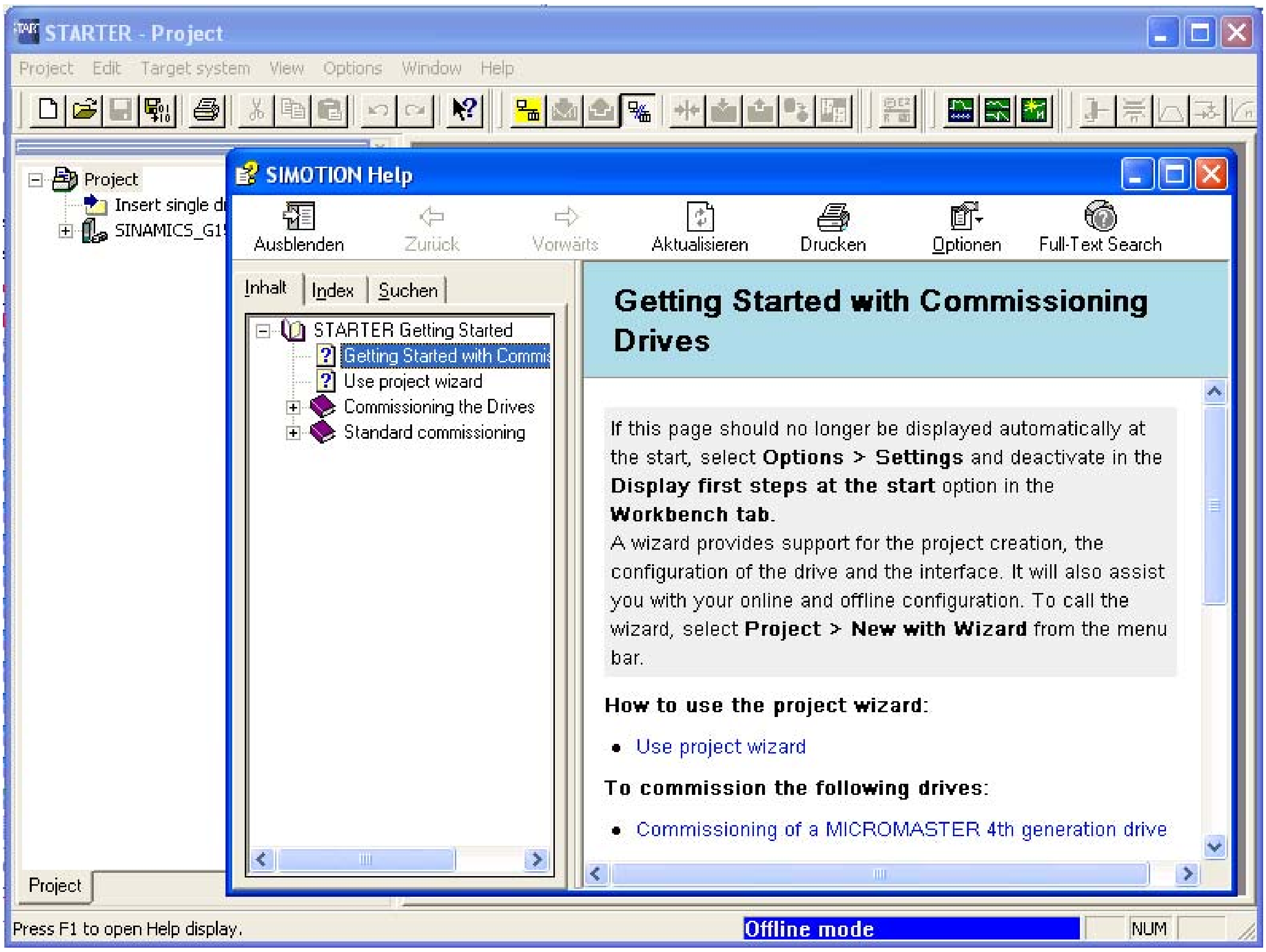


Figure 5-2 Main screen of the STARTER parameterization and commissioning tool

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

Note

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

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

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

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

STARTER features a detailed online help function.

The STARTER project wizard

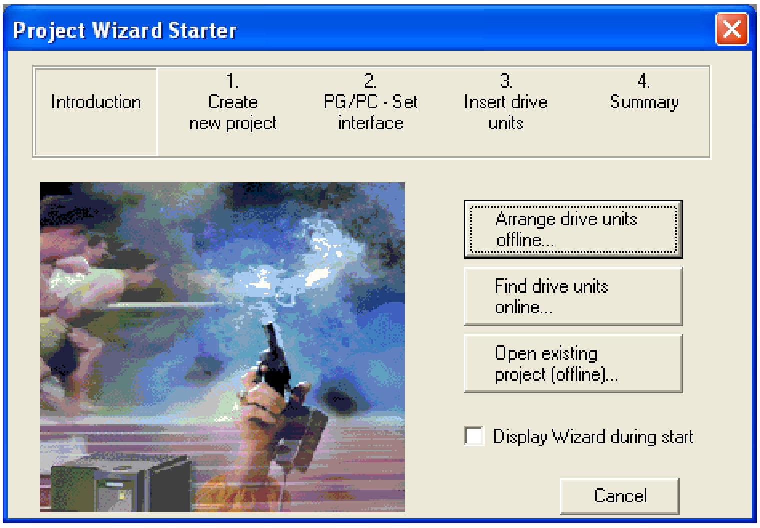


Figure 5-3 STARTER project wizard

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

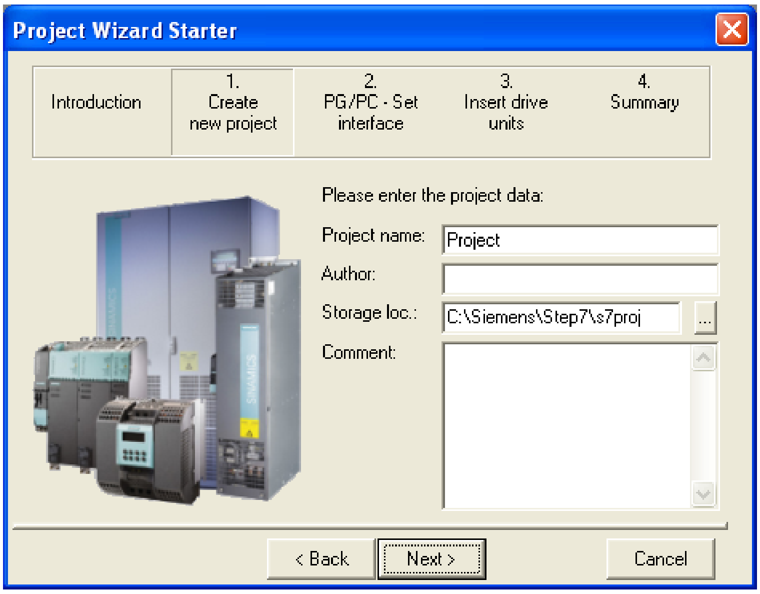


Figure 5-4 Create new project

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

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

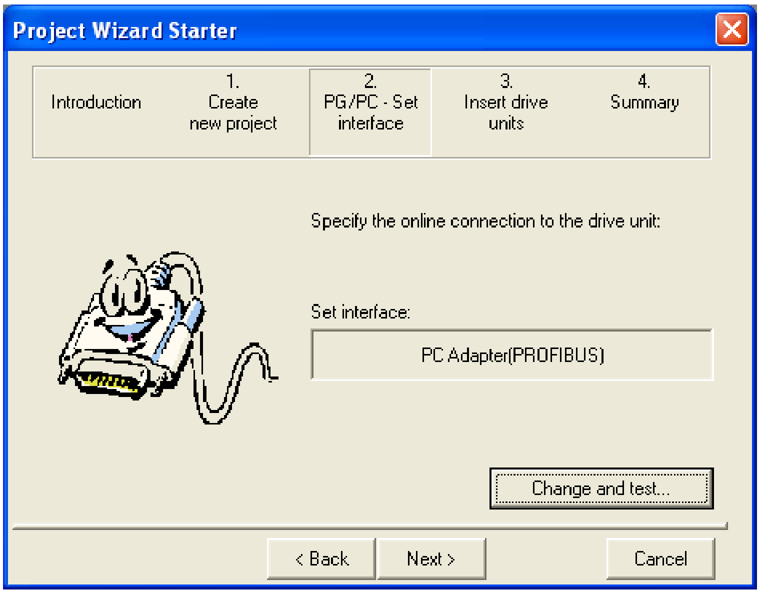


Figure 5-5 Set up interface

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

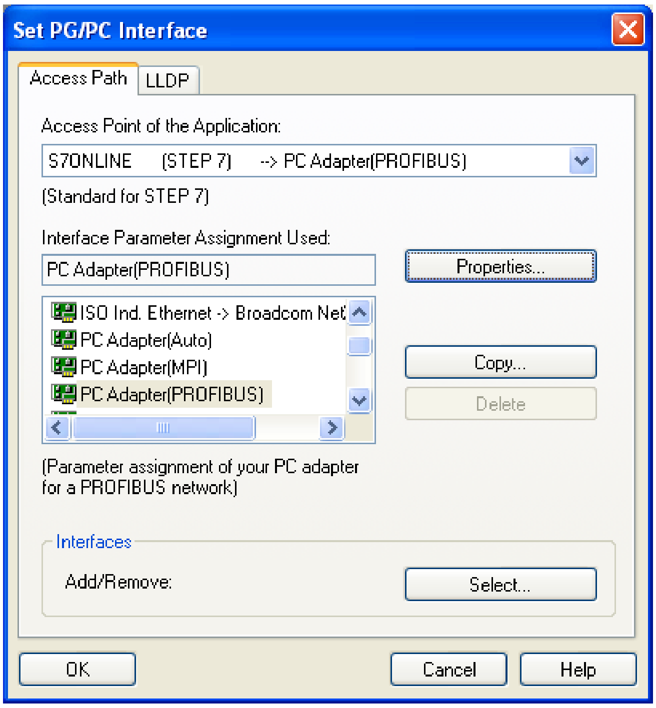


Figure 5-6 Setting the interface

Note

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

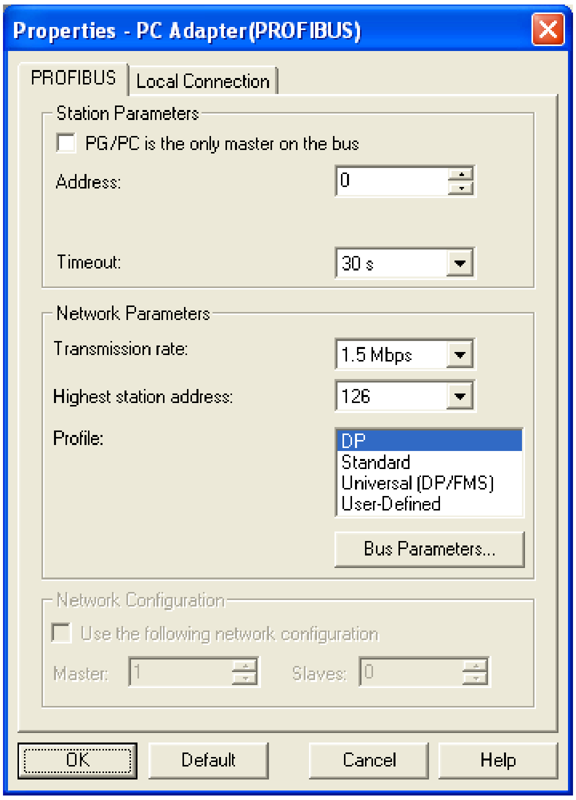


Figure 5-7 Setting the interface - properties

NOTICE
You must activate **PG/PC is the only master on bus** if no other master (PC, S7, etc.) is available on the bus.

Note

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.

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

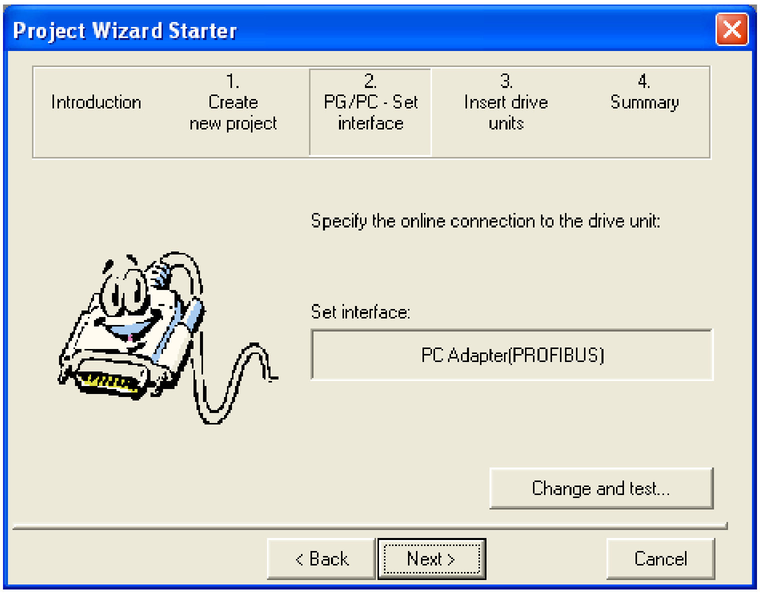


Figure 5-8 Setting the interface

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

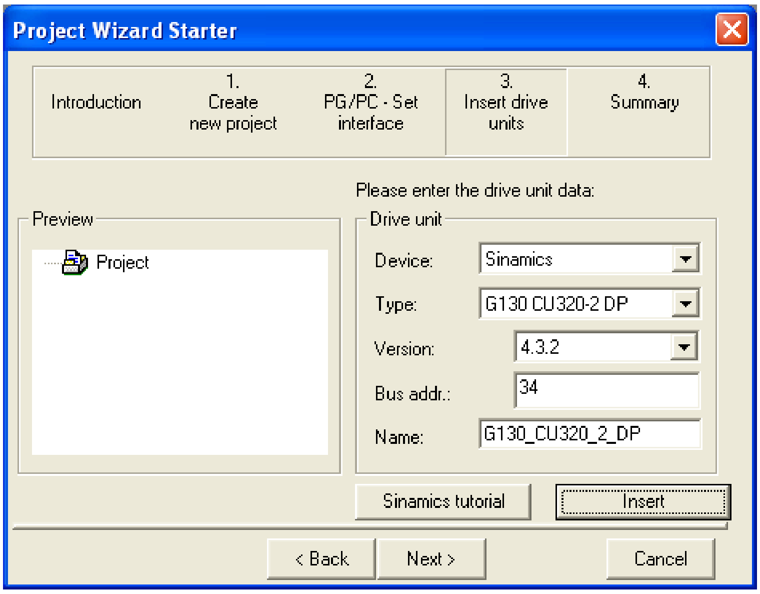


Figure 5-9 Inserting the drive unit

⇒ Choose the following data from the list fields:
Device: Sinamics
Type: G130 CU320-2 DP
Version: 4.3.2
Bus address: The corresponding bus address for the converter
The entry in the **Name:** field is user defined.

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

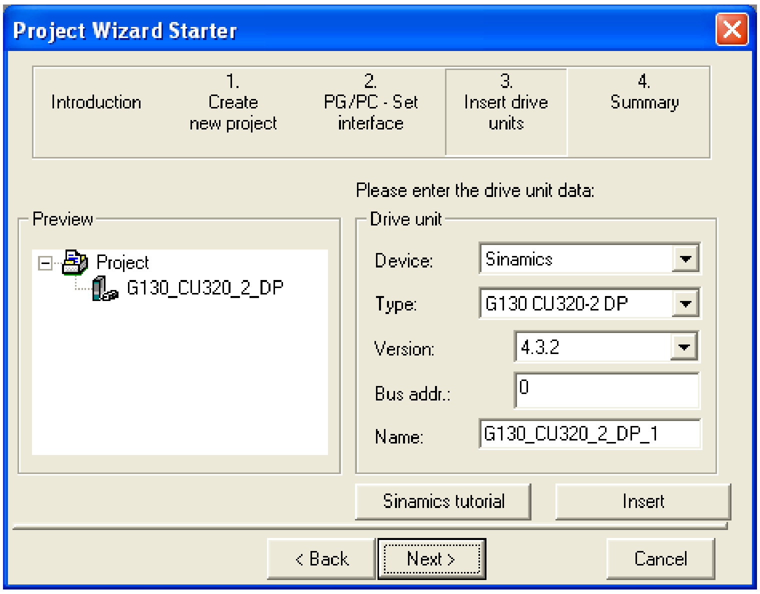


Figure 5-10 Inserting the drive unit

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

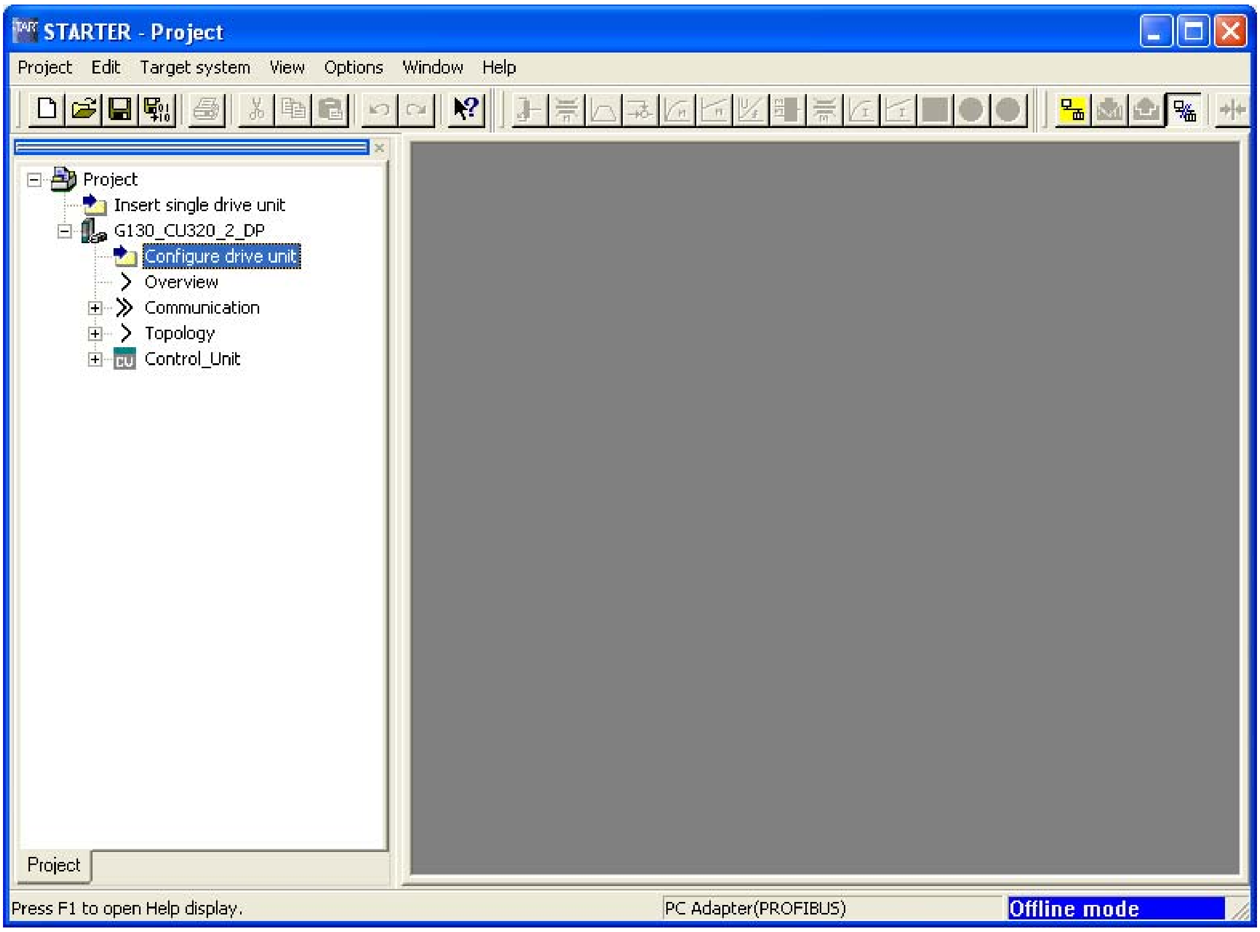


Figure 5-12 Project navigator – Configure drive unit

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

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

Configuring the drive unit

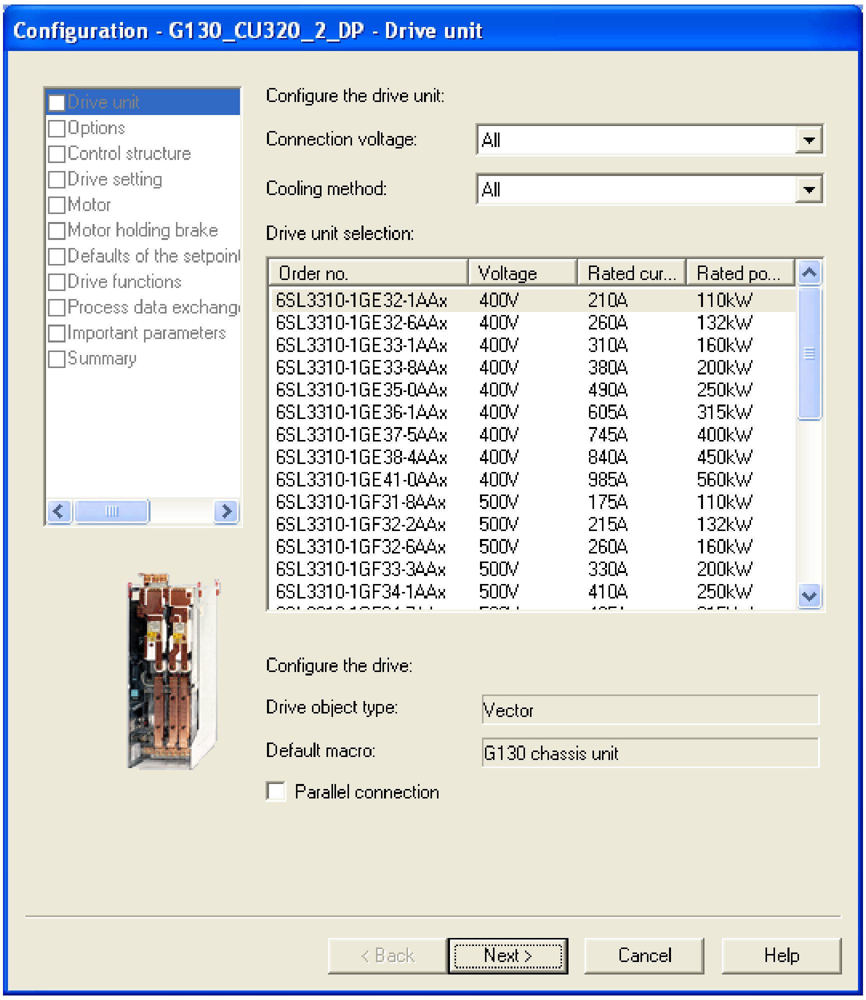


Figure 5-13 Configuring the drive unit

⇒ Under **Connection voltage**, choose the correct voltage. Under **Cooling method:** choose the correct cooling method for your drive unit.

Note

In this step, you make a preliminary selection of the chassis units. You do not define the line voltage and cooling method yet.

⇒ A list is now displayed under **Drive unit selection:**. Choose the corresponding drive unit according to type (order no.) (see type plate).

⇒ Click **Continue >**

Choosing the options

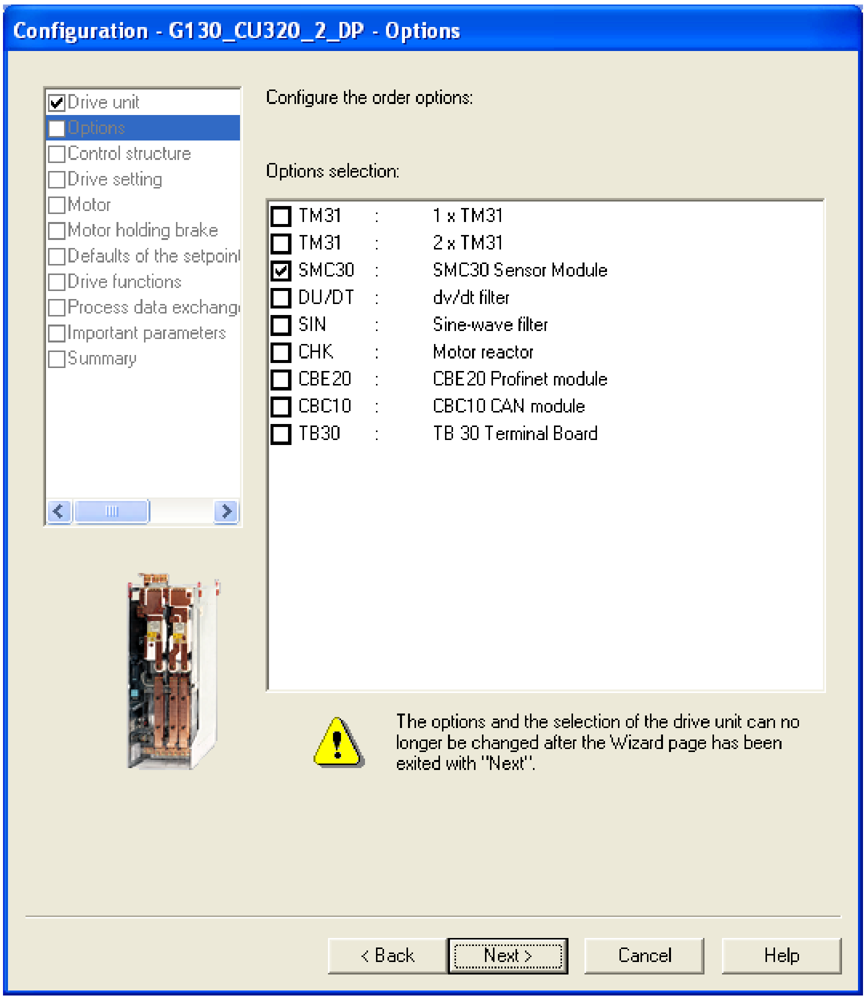


Figure 5-14 Choosing the options

⇒ From the combination box **Options selection:** select the options belonging to your drive unit by clicking on the corresponding check box.

CAUTION
If a sine-wave filter is connected, it must be activated when the options are selected to prevent the filter from being destroyed.

NOTICE
During option selection it is essential to activate any motor reactor or dV/dt filter present, otherwise the motor control will not perform at its best.

Note

Carefully check whether the selected options are connected to your chassis unit.

Since the wizard establishes internal interconnections on the basis of the options selected, you cannot change the selected options afterwards by clicking **< Back**.
If you make an incorrect entry, you will need to cancel the drive commissioning and start again from the beginning!

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

Selecting the control structure

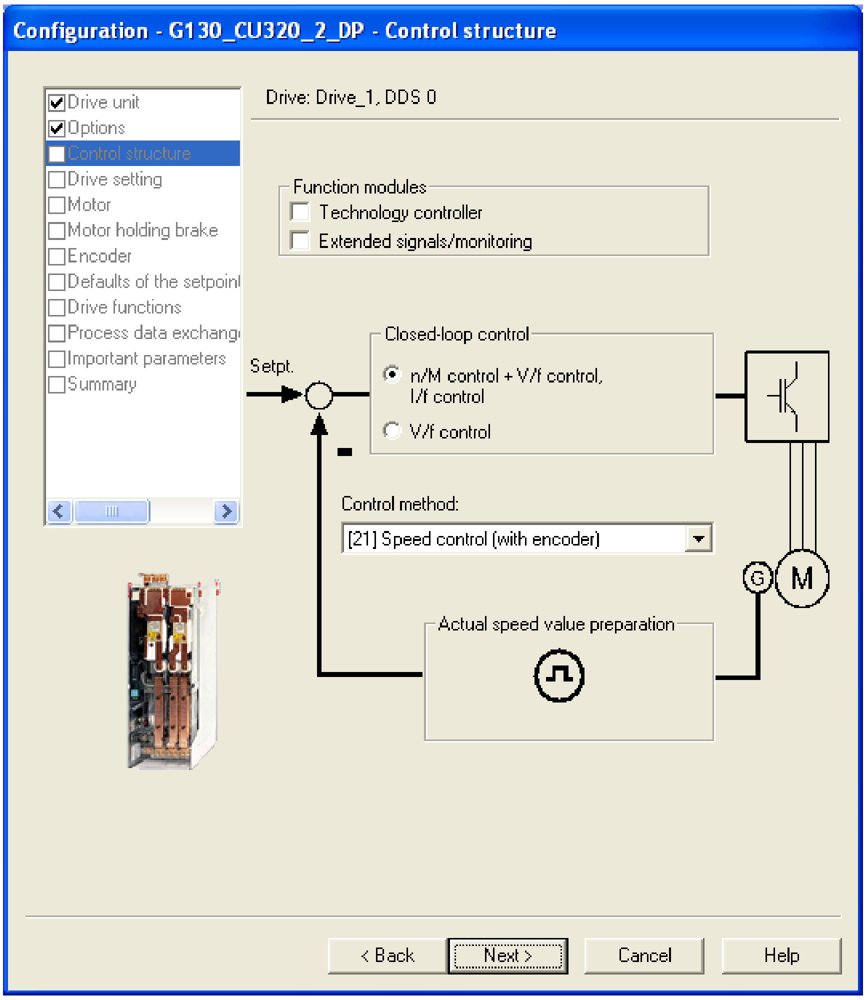


Figure 5-15 Selecting the control structure

⇒ Select the required data:

- **Function modules:**
  - Technology controller
  - Extended messages/monitoring
- **Control method:**
  choose one of 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 parameterizable 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
  - 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 unit properties

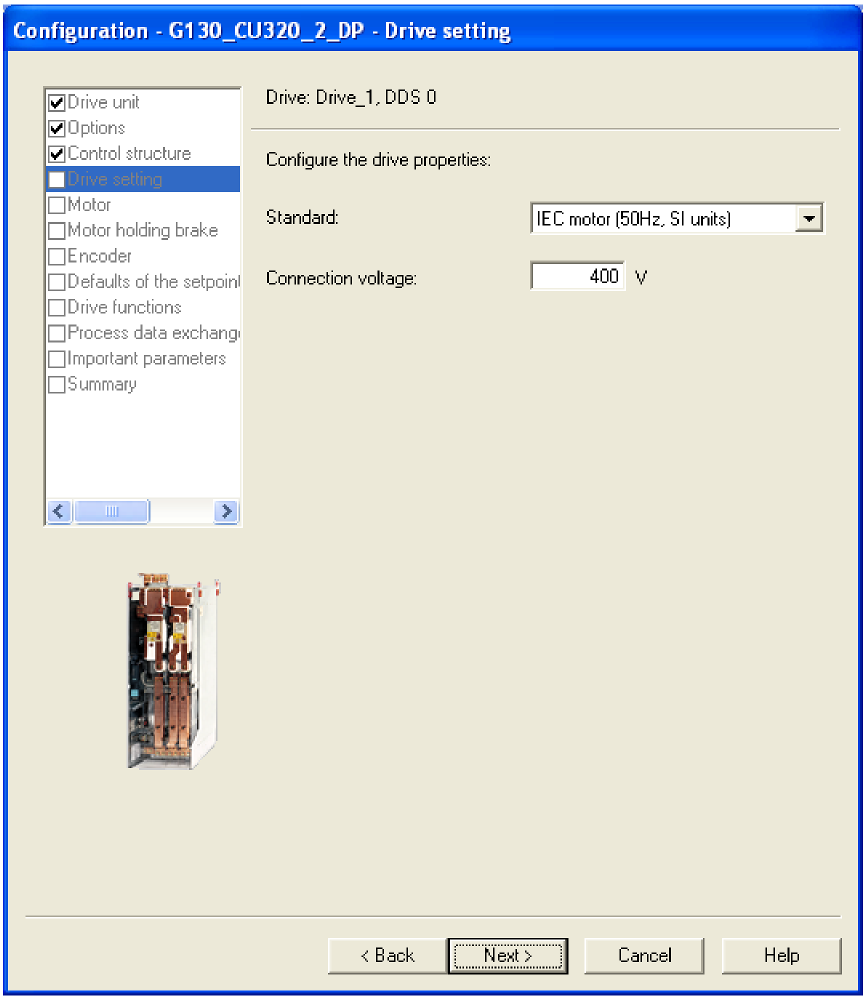


Figure 5-16 Configuring the drive unit properties

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

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

⇒ Under **Connection voltage:**, enter the appropriate voltage of the device.

⇒ Click **Continue >**

Configuring the motor – Selecting the motor type

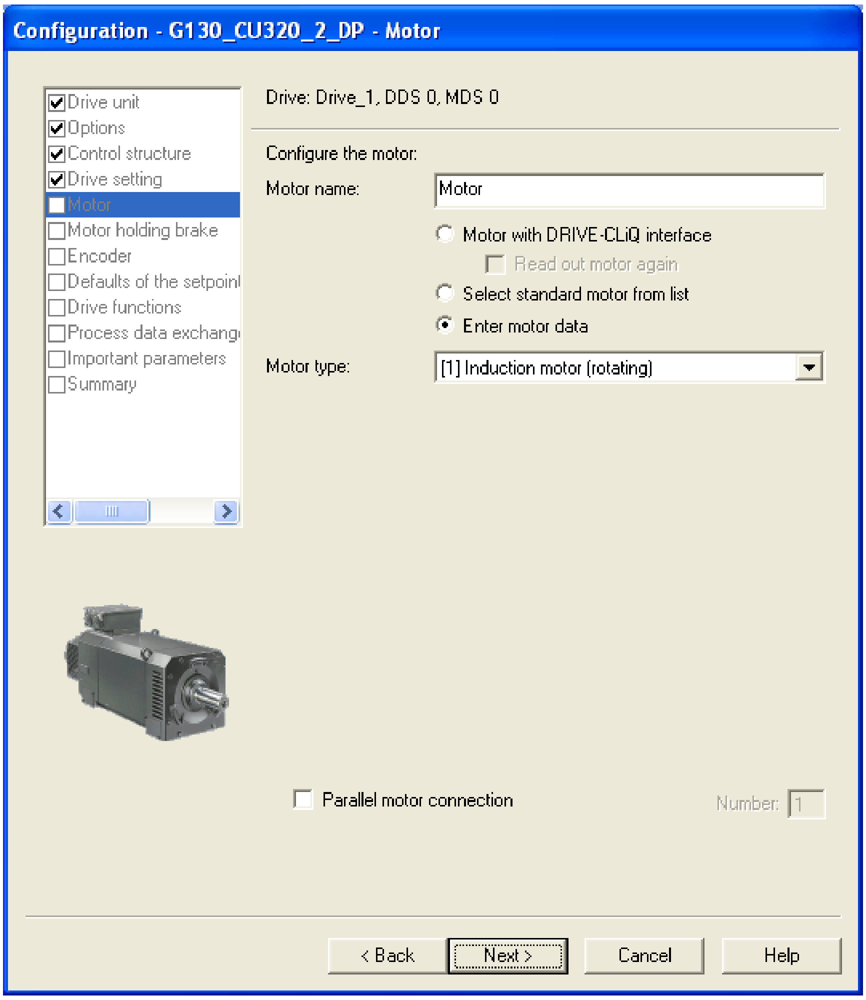


Figure 5-17 Configuring the motor – Selecting the motor type

⇒ Under **Motor name:** enter a name for the motor.

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

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

Note

The steps described below also apply to commissioning an induction motor.

When commissioning a permanent-magnet synchronous motor, there are a few special conditions that apply, which are detailed in a separate chapter (see "Setpoint channel and closed-loop control/Permanent-magnet synchronous motors").

⇒ Click **Continue >**

Configuring the motor – Entering motor data

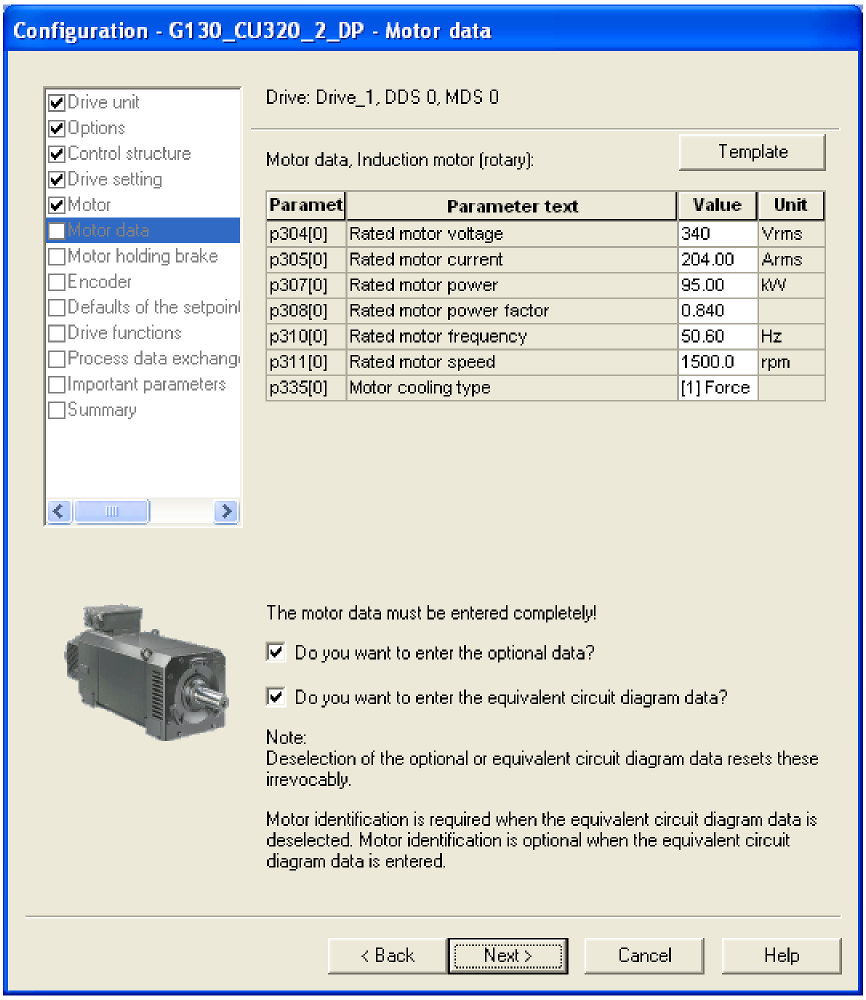


Figure 5-18 Configuring the motor – Entering motor data

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

⇒ If necessary, check **Do you want to enter the optional data?**

⇒ If necessary, activate **Do you want to enter the equivalent circuit diagram data?**

Note

Click **Template** to open another selection screenform where you can choose the motor used in your application from a long list of standard motor types. Select a motor from the list to enter the data stored in the system for that motor automatically in the data fields.

NOTICE
You should only check the "Do you want to enter equivalent circuit diagram data?" box 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

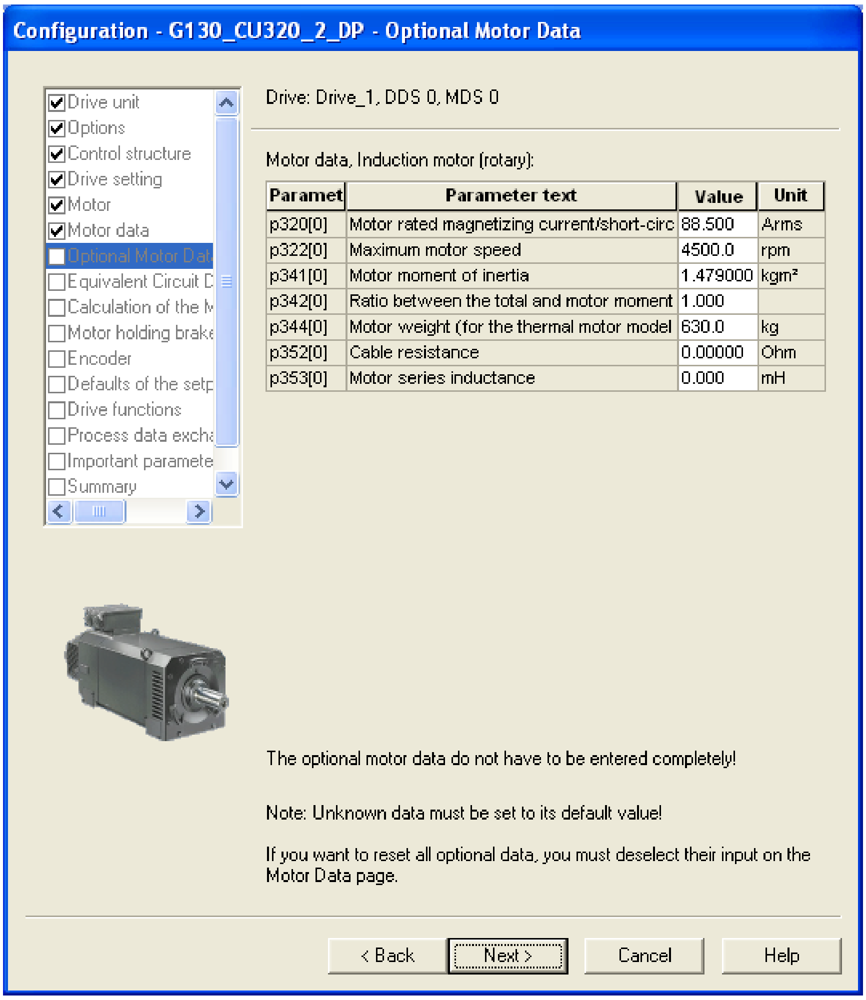


Figure 5-19 Entering optional motor data

⇒ If required, enter the optional motor data.

⇒ Click **Continue >**

Configuring the motor – Entering the equivalent circuit diagram data

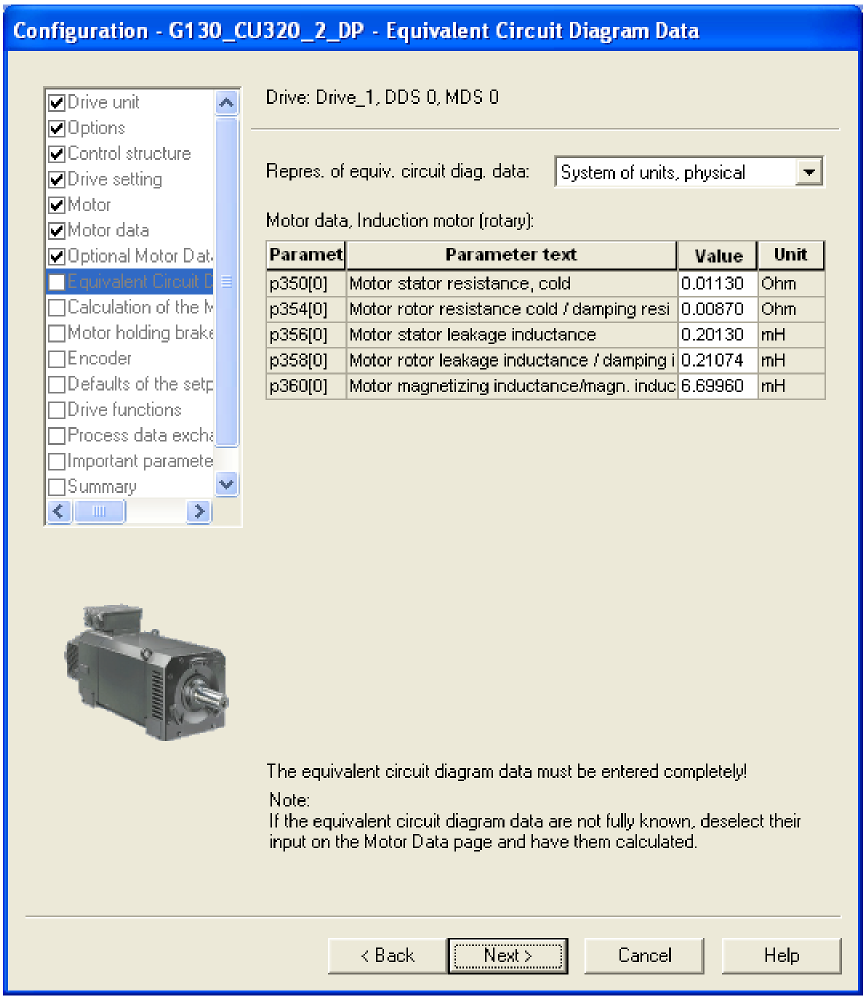


Figure 5-20 Entering equivalent circuit diagram data

⇒ If required, enter the equivalent circuit diagram data.

⇒ Click **Continue >**

Calculating the motor/controller data

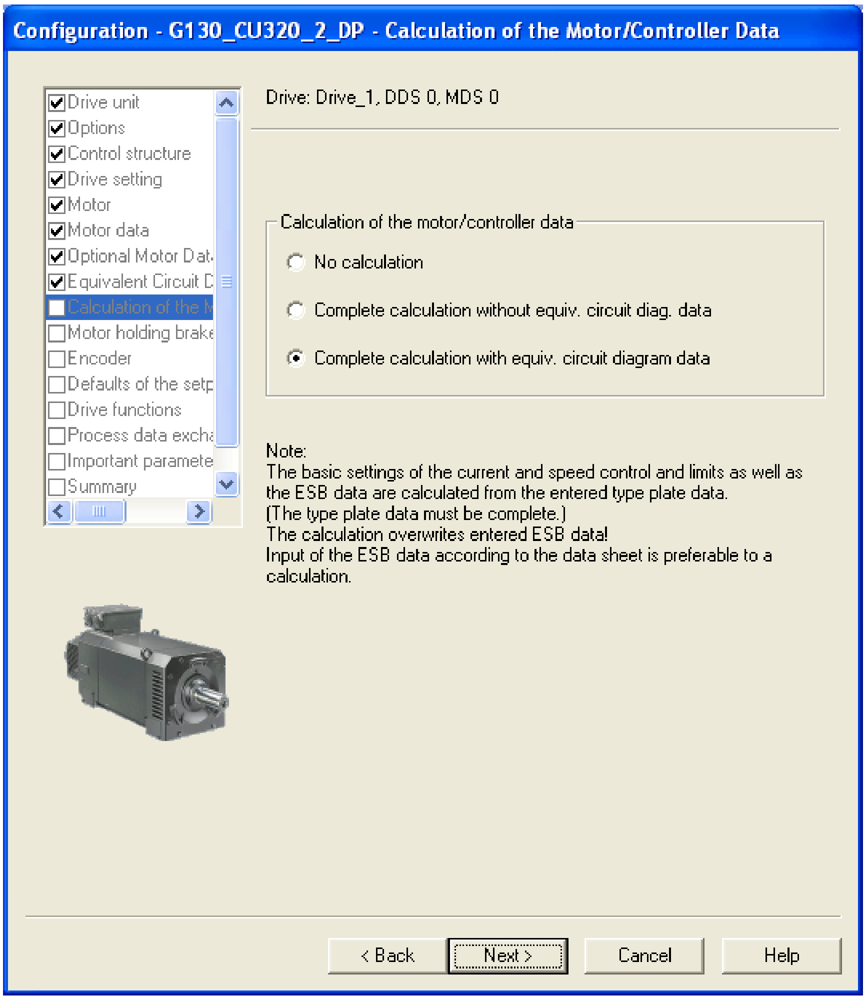


Figure 5-21 Calculating the motor/controller data

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

Note

If the equivalent circuit diagram data was entered manually (see figure "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

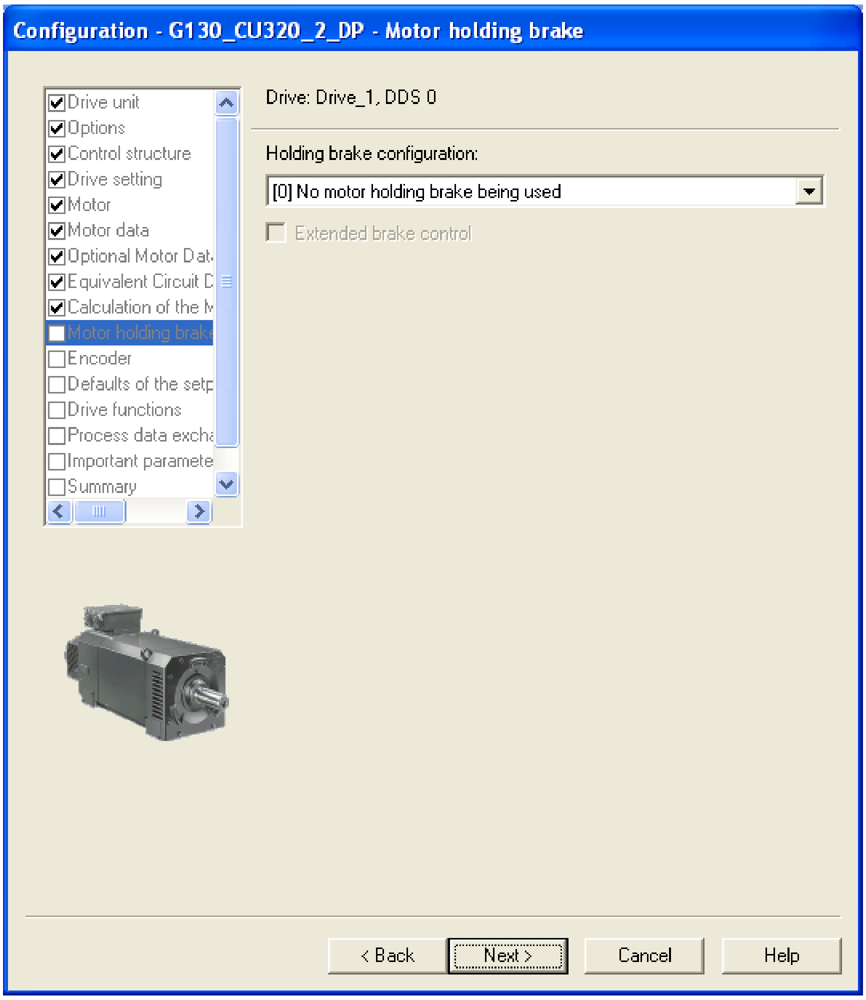


Figure 5-22 Configuring the motor holding brake

⇒ Under **Holding brake configuration:** choose the appropriate settings for your device configuration.

⇒ Click **Continue >**

Entering the encoder data (option: SMC30 Sensor Module)

Note

If you specified the SMC30 Sensor Module when choosing the options, the following screen is displayed in which you can enter the encoder data.

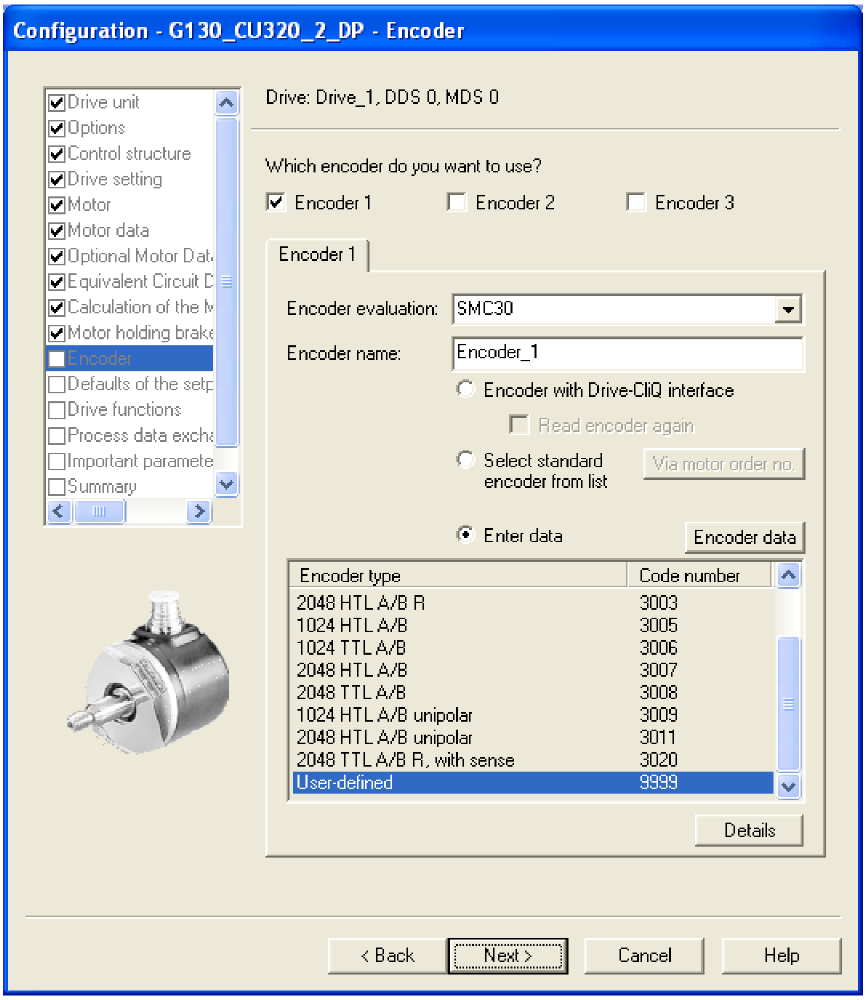


Figure 5-23 Entering the encoder data

⇒ In the **Encoder name:** field, enter a name of your choice.

Note

The delivery condition is a bipolar HTL encoder with 1024 pulses per revolution at terminal X521/X531 of the encoder module SMC30.

⇒ To select a different predefined encoder configuration, check 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 screen is displayed in which you can enter the required data.

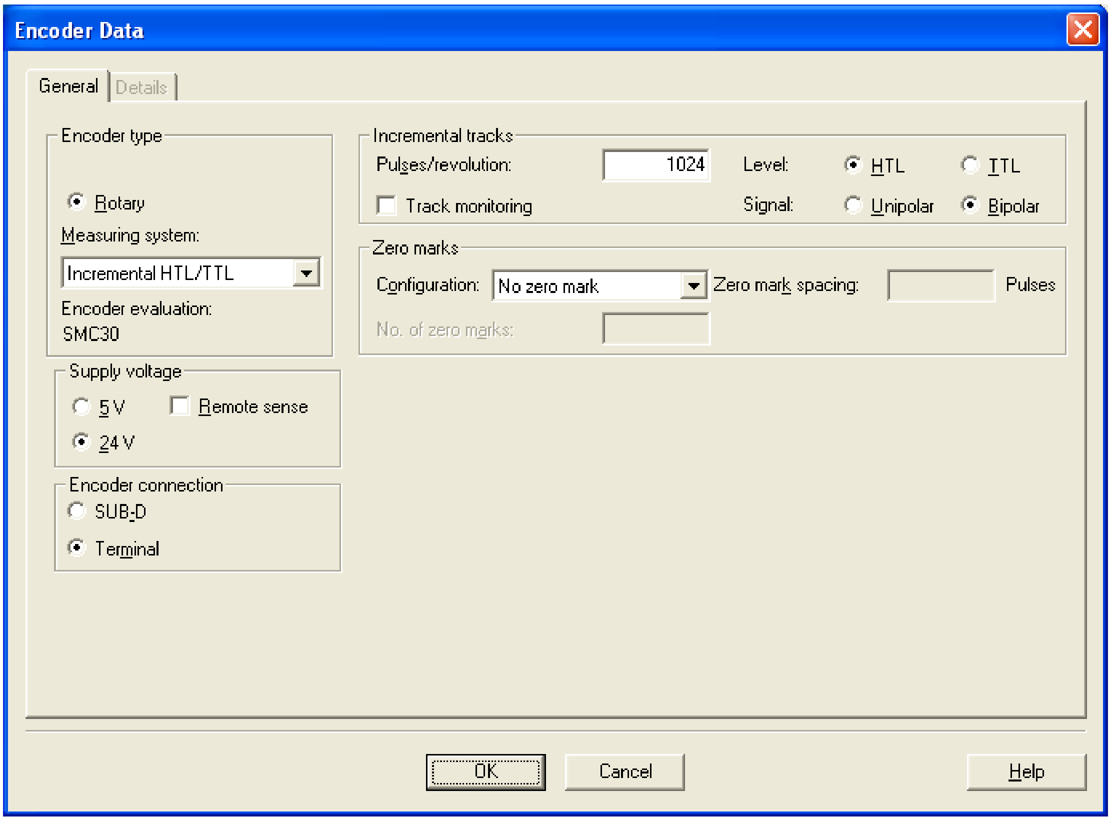


Figure 5-24 Entering encoder data – User-defined encoder data

⇒ Select the **measuring system**.
You can choose the following encoders in conjunction with SINAMICS G130:

- HTL
- TTL

⇒ Enter the required encoder data.

⇒ Click **OK**.

CAUTION
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.

Default settings for setpoints/command sources

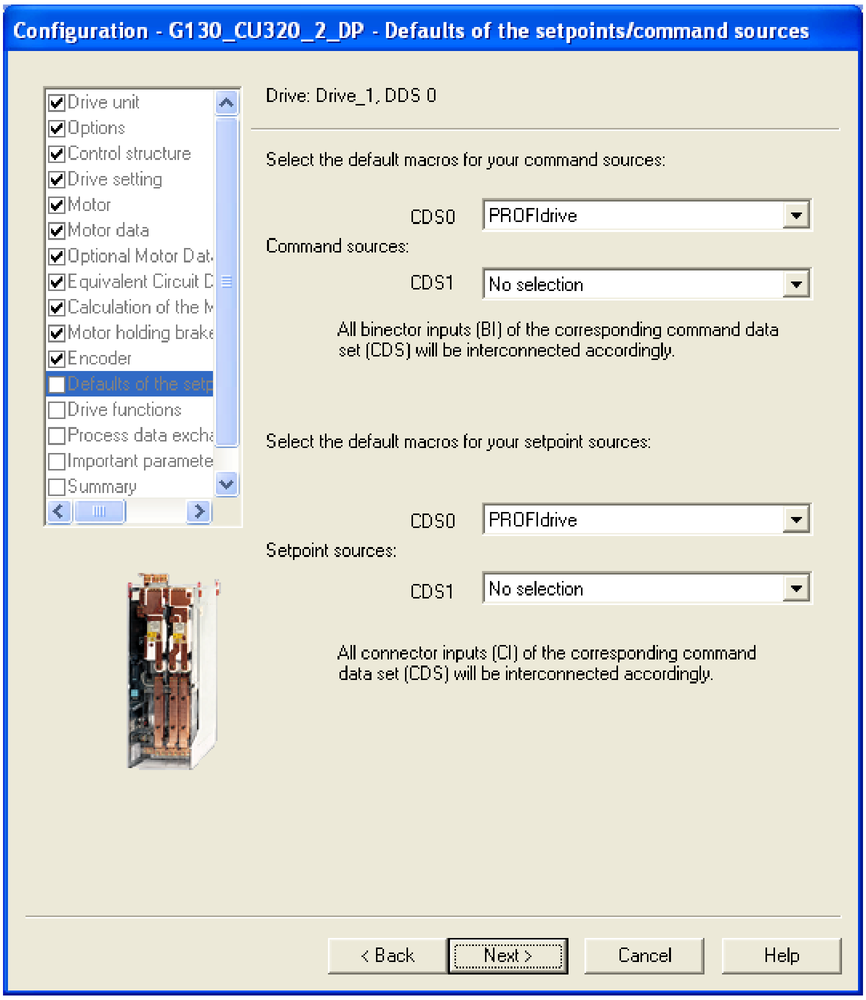


Figure 5-25 Default settings for setpoints/command sources

⇒ Under **Command sources:**, choose and **Setpoint sources:** choose the appropriate settings for your device configuration.

The following command and setpoint source options are available:

Command sources:	PROFIdrive (default)
	TM31 terminals
	CU terminals
	PROFIdrive+TM31
Setpoint sources:	PROFIdrive (default)
	TM31 terminals
	Motorized potentiometer
	Fixed setpoint

Note

With SINAMICS G130, 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

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 >**

Defining the technological application/motor identification

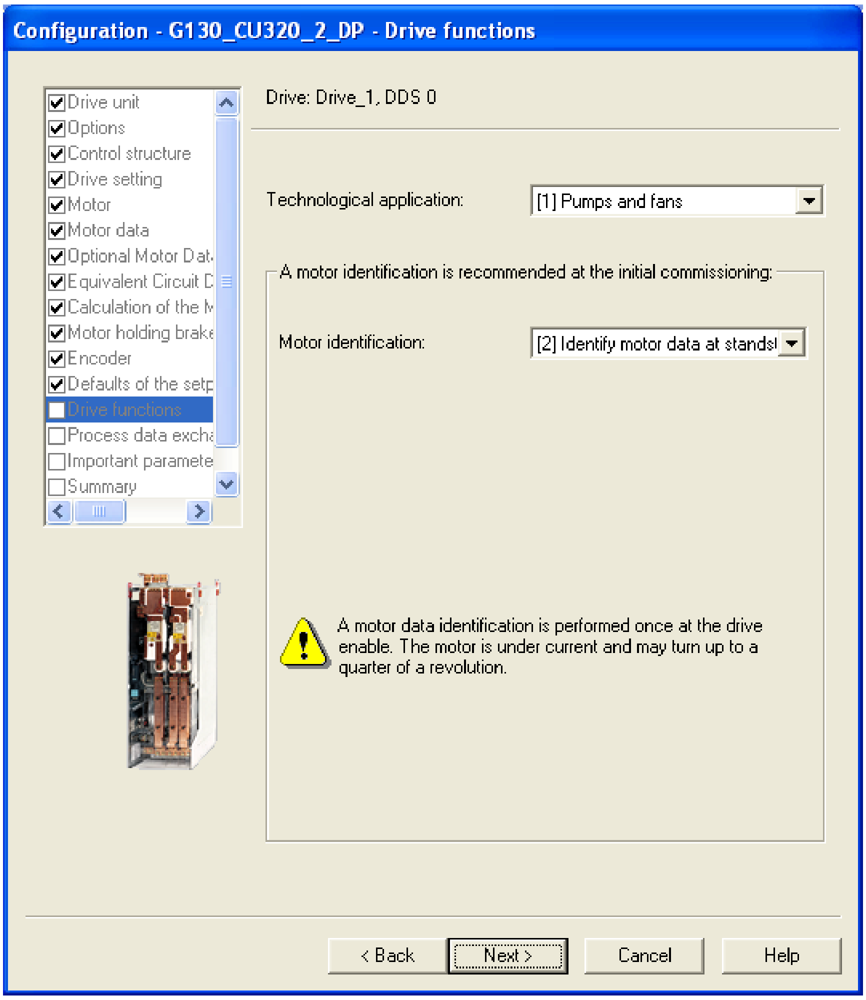


Figure 5-26 Defining the technological application/motor identification

⇒ 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) (Encoderless control down to f = 0 (passive loads)"
    Controlled operation down to standstill 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.
- Motor identification:
  In most cases, "Motor data identification at standstill" is the appropriate default setting for SINAMICS G130.
  "Motor identification at standstill and with motor running" is the recommended setting for motor identification if the speed is controlled with an encoder; this measurement is normally performed on non-coupled machines.

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

⇒ Click Continue >

Selecting the PROFIdrive telegram type

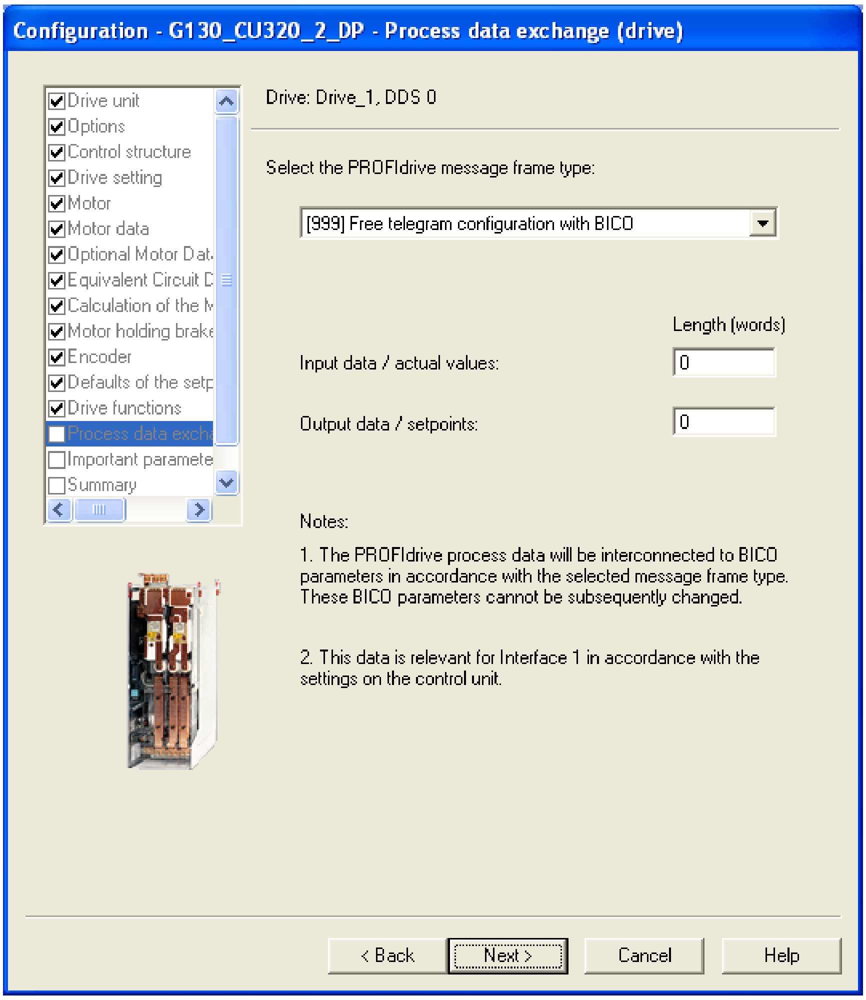


Figure 5-27 Selecting the PROFIdrive telegram type

⇒ Select under **PROFIdrive telegram type:** select the PROFIdrive telegram type.

Message frame types

- 1: Standard telegram 1
- 2: Standard telegram 2
- 3: Standard telegram 3
- 4: Standard telegram 4
- 20: SIEMENS telegram 20 (VIK-NAMUR)
- 220: SIEMENS telegram 220 (metal industry)
- 352: SIEMENS telegram 352 (PCS7)
- 999: Free telegram configuration with BICO

⇒ Click **Continue >**

Entering important parameters

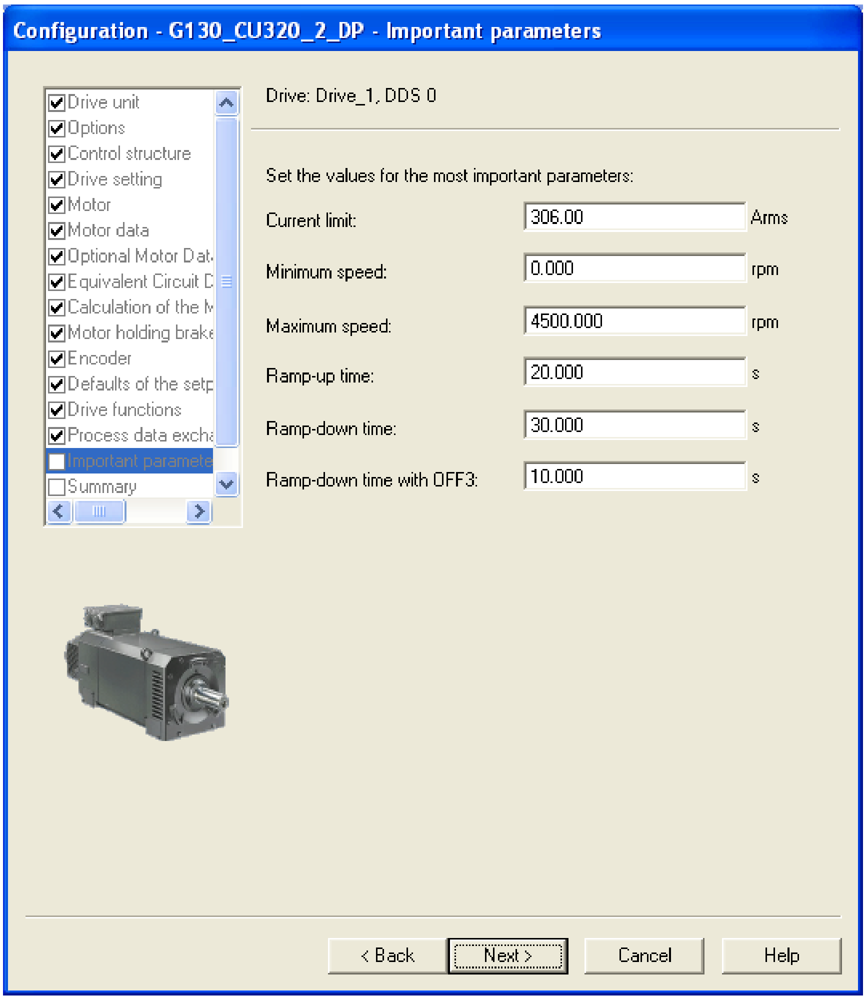


Figure 5-28 Important parameters

⇒ Enter the required parameter values.

Note

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

⇒ Click **Continue >**

Summary of the drive unit data

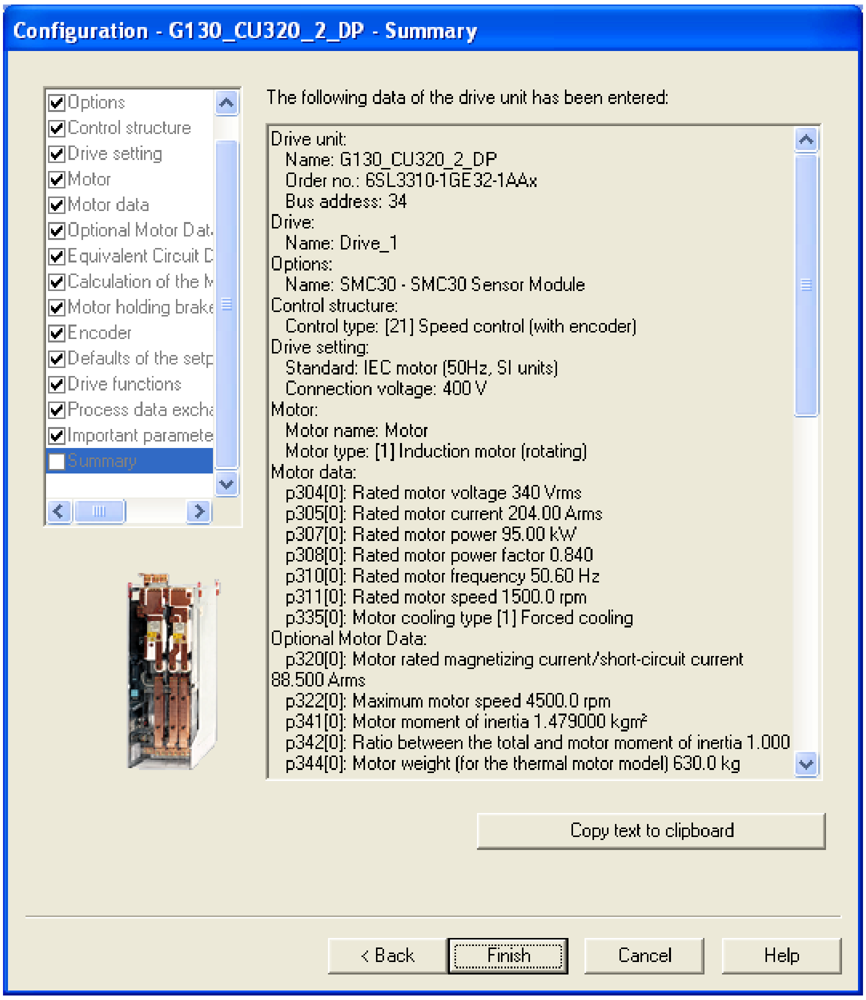


Figure 5-29 Summary of the drive unit data

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

⇒ Click **Finish**.

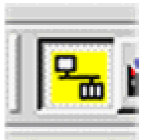
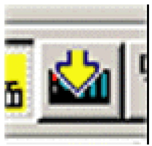
⇒ Save your project to the hard disk by choosing **Project** > **Save**.

5.3.3 Starting the drive project

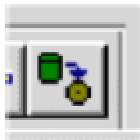
You have created a project and saved it to your hard disk. You now have to transfer your project configuration data to the drive unit.

Transferring the STARTER project to the drive unit

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

Step		Selection in toolbar
1	Choose Project > Connect to target system	
2	Choose Target system > Load project to target system	

NOTICE
The project has now been loaded to the drive unit. The data is currently only stored in the volatile memory of the drive unit and not on the CompactFlash card. To store the project data on the CompactFlash card so that it is protected in the event of a power failure, carry out the following step.

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

Note

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

Results of the previous steps

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

Note

The STARTER commissioning tool supports complex drive system operations.

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

5.3.4 Commissioning with STARTER via Ethernet

Description

The Control Unit can be commissioned using 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.

Preconditions

- STARTER from version 4.1.5 or higher
- Control Unit CU320-2 DP with device version "C"

STARTER via Ethernet (example)

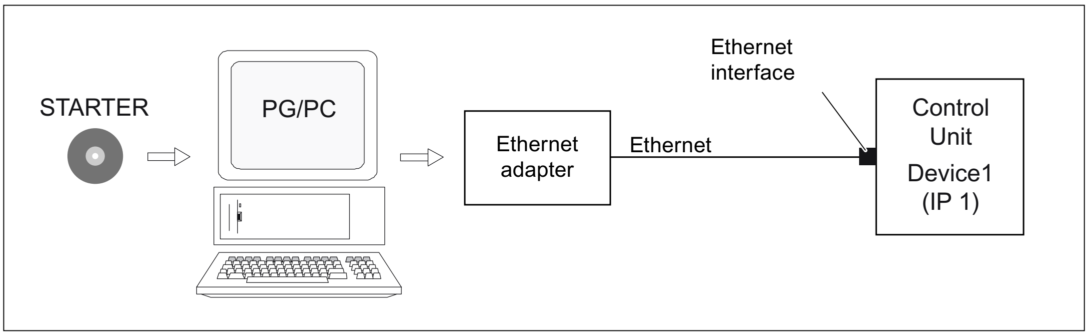


Figure 5-30 STARTER via Ethernet (example)

Procedure for establishing online operation via Ethernet

1. Installing the Ethernet interface in the PG/PC according to the manufacturer's specifications
2. Setting the IP address in Windows XP.

   The PG/PC is assigned 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. Setting the online interface in STARTER.
4. Assigning the IP address and the name via STARTER (node initialization).

   The Ethernet interface must be initialized so that the STARTER can establish communication. Selecting online mode in STARTER.

Setting the IP address in Windows XP

On your desktop, right-click "Network environment" -> Properties -> double-click on the network card and choose -> Properties -> Internet Protocol (TCP/IP) -> Properties -> Enter the IP addresses and the subnet mask.

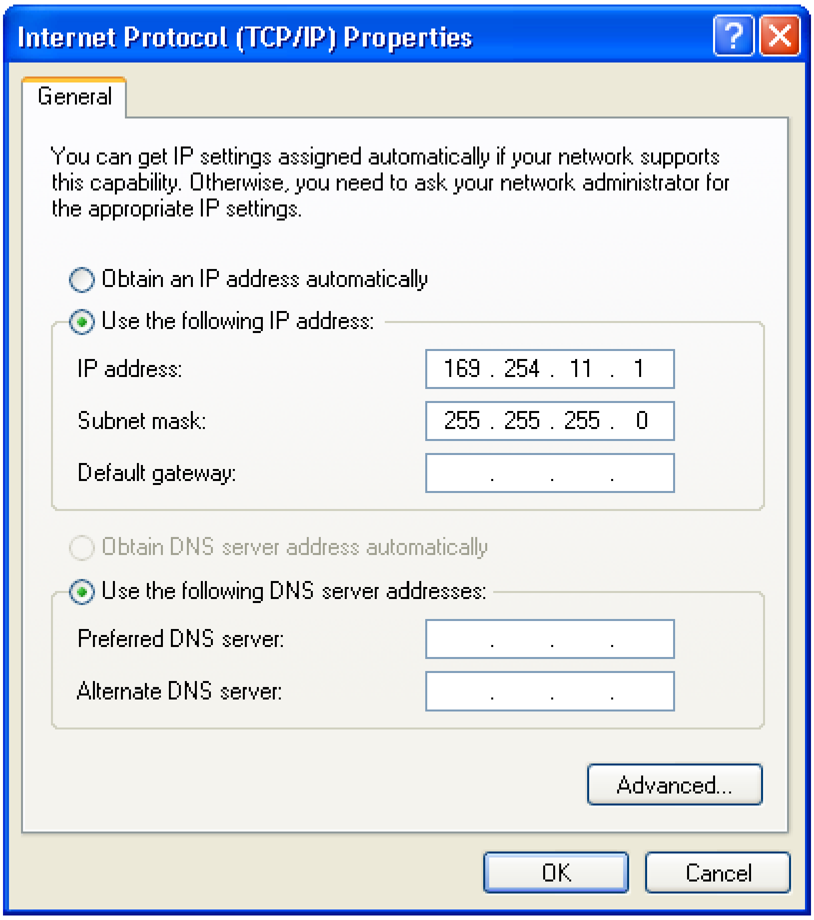


Figure 5-31 Internet Protocol (TCP/IP) properties

Assigning the IP address and the name via STARTER, "Accessible nodes" function

Use the STARTER to assign an IP address and a name to the Ethernet interface.

- Connect the PG/PC and the Control Unit using an Ethernet cable.
- Switch on the Control Unit.
- Open STARTER.
- Either create a new project or open an existing project
- A search is performed for available nodes in Ethernet via Project -> Accessible nodes or the "Accessible nodes" button.

- The SINAMICS drive object is detected and displayed as a bus node with IP address 169.254.11.22 and without name.

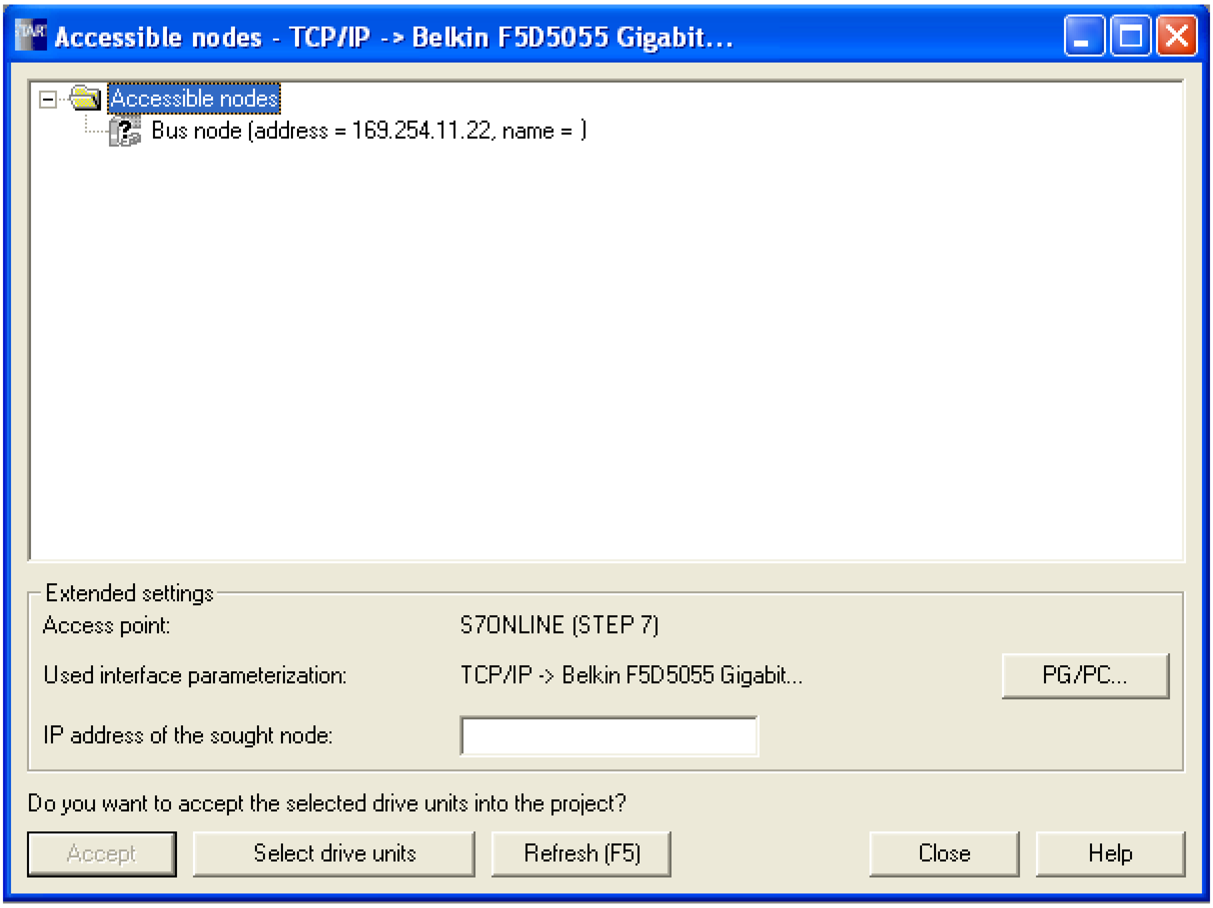


Figure 5-32 Accessible nodes

- 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 Ethernet interface (e.g. "drive1") and click the "Assign name" button. Enter the IP address (e.g. 169.254.11.10) in the IP configuration and specify the subnet screen (e.g. 255.255.255.0). Then click the "Assign IP configuration" button and close the mask.

Note

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.
The characters "-" and "." are not permitted in the name of an IO device.

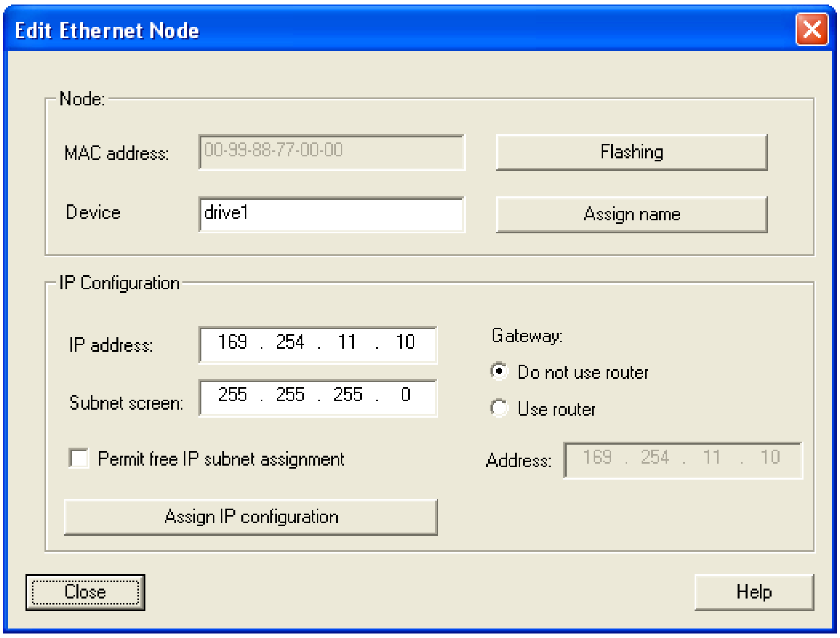


Figure 5-33 Edit Ethernet Node

- Pressing 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 Ethernet interface is displayed as bus node, mark the entry and press the "Accept" button.
- The SINAMICS drive is displayed as drive object in the project navigator.
- You can now configure the drive unit (see Chapter "Configuring the drive unit").

Note

The IP address and device name are stored on the memory card of the Control Unit (non-volatile)..

Parameters

Parameters can also be used to modify and/or display the properties of the Ethernet interface.

- p8900 IE name of the station
- p8901 IE IP address of the 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

5.3.5 Connection via serial interface

In addition to using the PROFIBUS connection, data can also be exchanged via a serial interface.

Requirement

The PC from which the connection is to be made must be equipped with a serial interface (COM).

Settings

1. In STARTER, choose **Project > Set PC/PG interface** and select the **serial cable (PPI)** interface.
   If this is not available from the dropdown list, you first have to add it by choosing **Select**.
2. Make the following settings. Address "0" is important in this case; the transmission speed can be chosen freely.

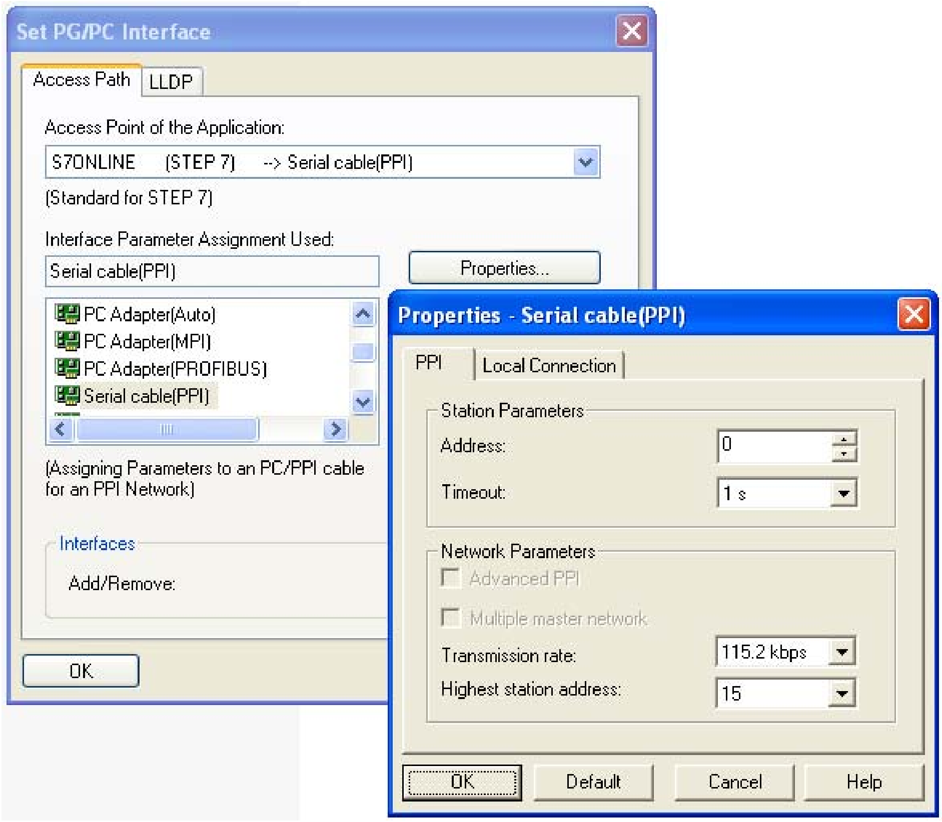


Figure 5-34 Setting the interface

3. When creating the drive unit in conjunction with a serial interface (serial cable), bus address "3" is set automatically.
4. The connecting cable from Control Unit to the AOP30 must be disconnected on the Control Unit. A null modem cable must be used there to connect the PC (COM interface) to the Control Unit.
   This interface must not be switched.

5.4 The AOP30 operator panel

Description

An optional operator panel for operating, monitoring, and commissioning purposes is available. It has the following features:

- Graphical, back-lit LCD for plain-text display and a "bar chart display" for process variables
- LEDs for indicating the operating modes
- Help function describing causes of and remedies for faults and alarms
- Keypad for controlling drives during operation
- LOCAL/REMOTE switchover for selecting the control terminal (master control assigned to operator panel or terminal block / PROFIBUS)
- Numeric keypad for entering setpoint or parameter values
- Function keys for prompted navigation through the menus
- Two-stage security concept to protect against accidental or unauthorized changes to settings
- Degree of protection IP 54 (when installed)

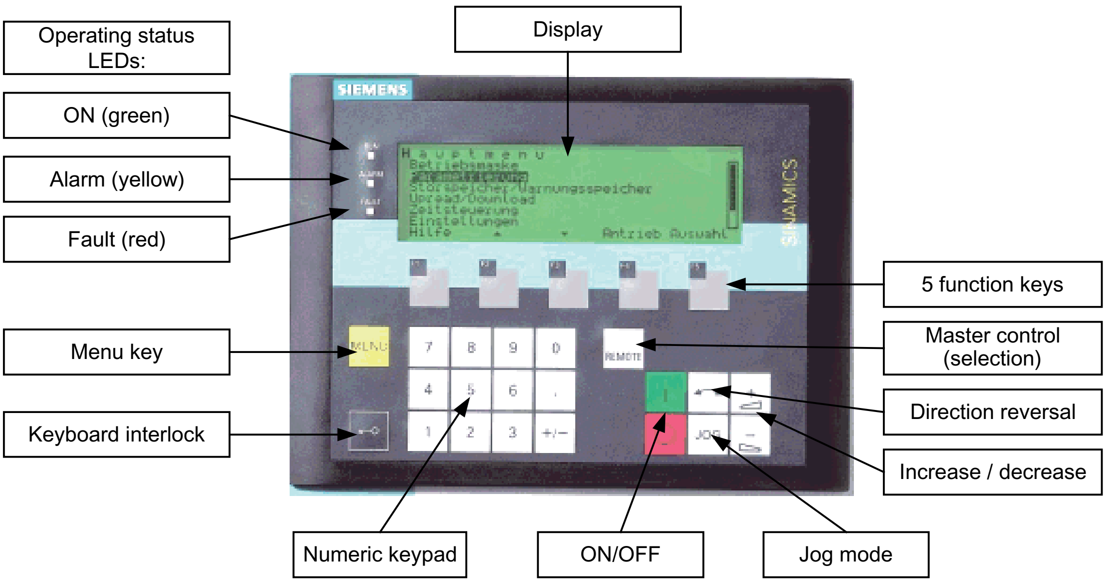


Figure 5-35 Components of the chassis unit operator panel (AOP30)

5.5 First commissioning with the AOP30

5.5.1 First commissioning

Start screen

When the system is switched on for the first time, the Control Unit is initialized automatically. The following screen is displayed:

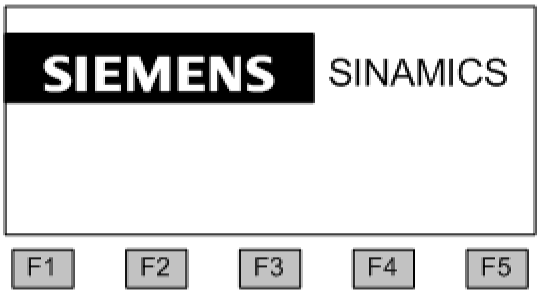


Figure 5-36 Initial screen

When the system boots up, the parameter descriptions are loaded into the operating field from the CompactFlash card.

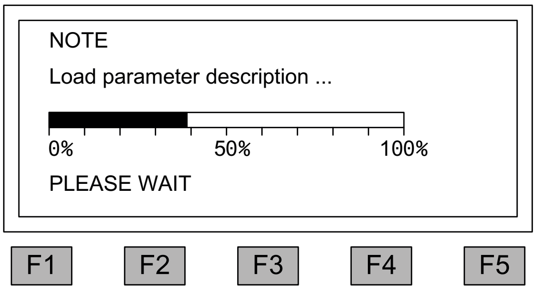
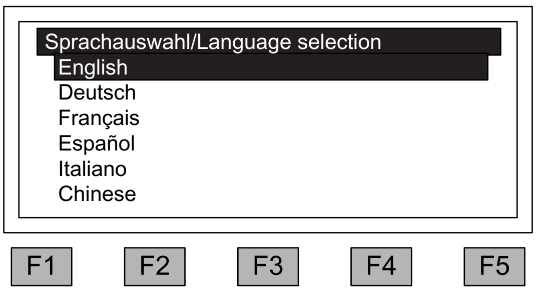


Figure 5-37 Load the parameter descriptions while booting up the system

Selecting the language

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



You can select the language in the dialog screen.

To change the language, choose <F2> or <F3>.
To select the language, choose <F5>.

Once the language has been selected, the booting up process continues.

Once the system has successfully ramped up, the drive has to be commissioned when the system is switched on for the first time after it has been delivered. The converter can then be switched on.

When the system is then ramped up again, it can be operated immediately.

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" and/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 "Next" or "Previous" 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.

5.5.2 Basic commissioning

Entering the motor data

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

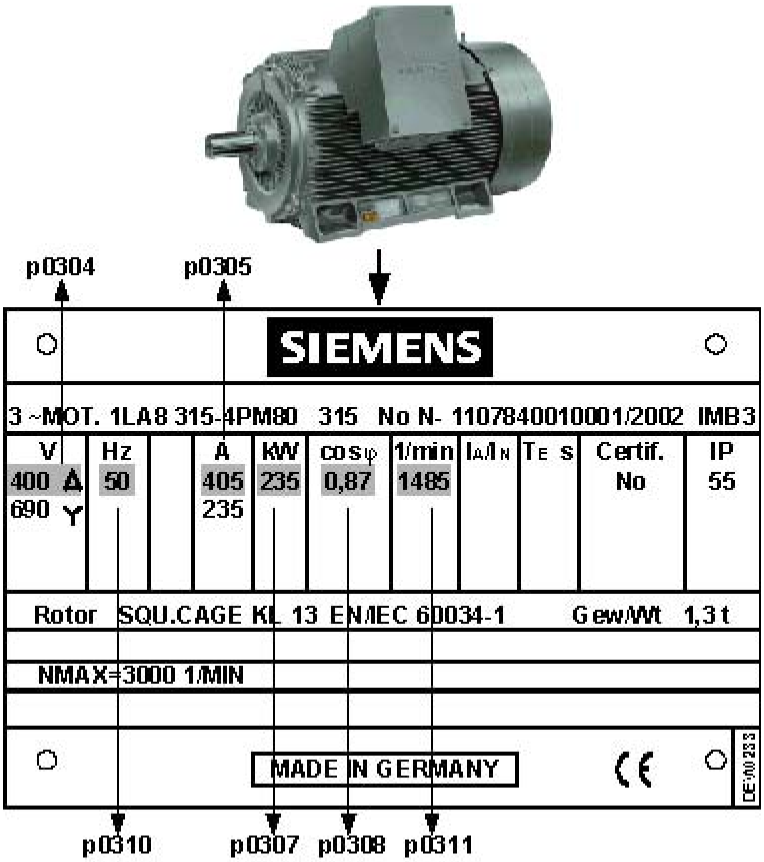
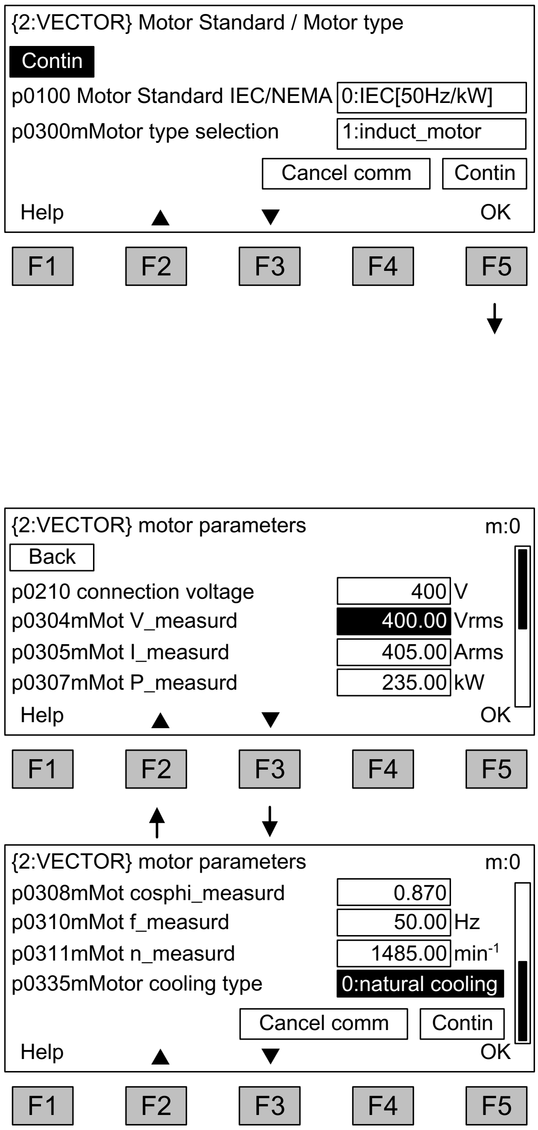


Figure 5-38 Example of a motor type plate

Table 5- 1 Motor data

	Parameter no.	Values	Unit
System of units for line frequency and entering 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 (at p0100 = 0 only) Rated efficiency η (at p0100 = 1only) Rated frequency Rated speed	 p0304 p0305 p0307 p0308 p0309 p0310 p0311		 [V] [A] [kW] / [hp] [%] [Hz] [min-1] / [rpm]

Basic commissioning: Selecting the motor type and entering the motor data



You can 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 following selection options are available for the motor type:

1: Induction motor
2: Permanent-magnet synchronous motor
Other values are not permitted.

To navigate through the selection fields, choose <F2> or <F3>.
To activate a selection, choose <F5>.

Entering 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.

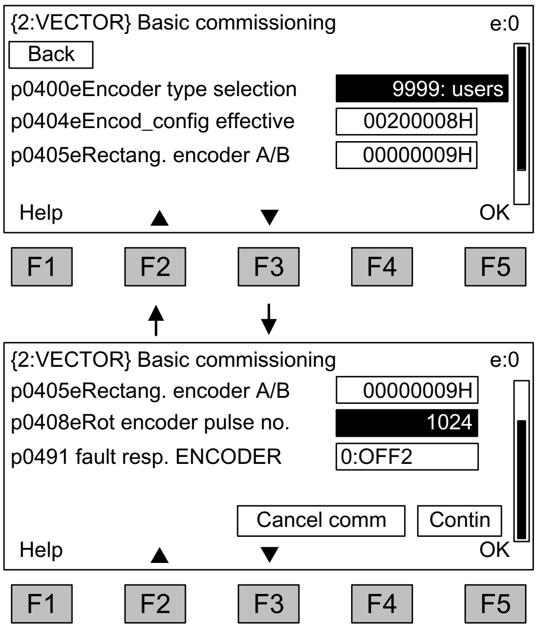
When you have finished entering the motor data, choose "Continue" underneath the final parameter value and activate with <F5>.

Note

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 that apply, which are detailed in a separate chapter (see "Setpoint channel and closed-loop control/Permanent-magnet synchronous motors").

Basic commissioning: entering the encoder data (if available)



When the SMC30 is connected for encoder evaluation, it is recognized by the AOP30 and a screen is displayed in which you can 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

The delivery condition is a bipolar HTL encoder with 1024 pulses per revolution and a 24 V power supply.

The section ("Electrical Installation") contains two connection examples for HTL and TTL encoders.

Note

If the connected encoder does not match any of the encoders predefined in p0400, follow the simple procedure below for entering the encoder data:

- Via p0400, select an encoder type whose data is similar to that of the connected encoder.
- Select "User-defined encoder" (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

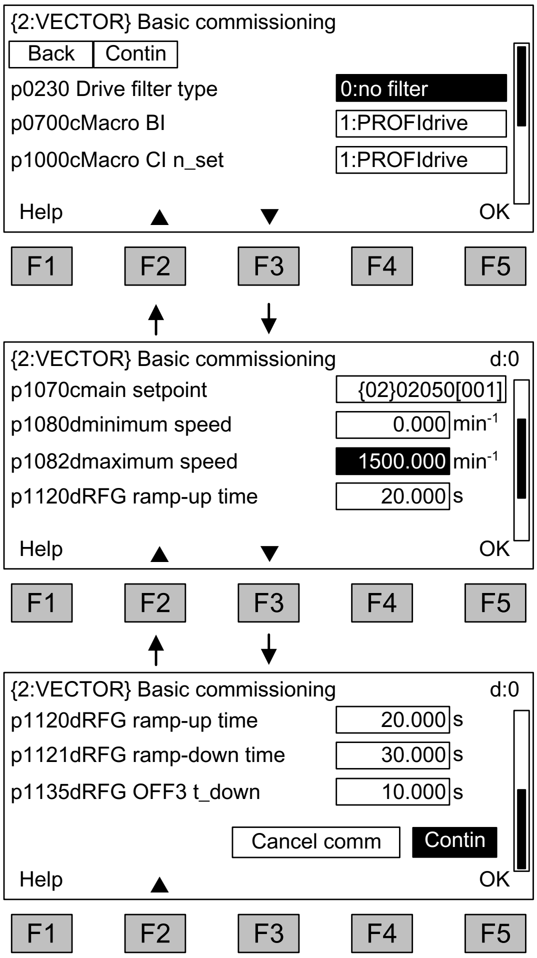
Table 5- 3 Meaning of the bit settings for p0405

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

CAUTION

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 via p0404 (bit 20 = "Yes", bit 21 = "No"), the encoder may be damaged.

Basic commissioning: Entering the basic parameters



Entering the basic commissioning parameters:

If a sine-wave filter is connected, it must be activated in p0230 (p0230 = 3/4). Otherwise, it could be destroyed.

p0700: Preset command source
1: PROFIdrive
2: TM31 terminals
3: CU terminals
4: PROFIdrive+TM31

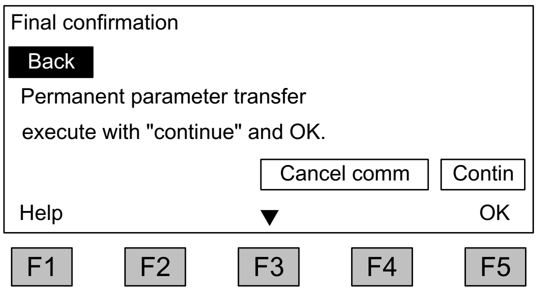
p1000: Preset setpoint source
1: PROFIdrive
2: TM31 terminals
3: Motorized potentiometer
4: Fixed setpoint

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 in which 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.

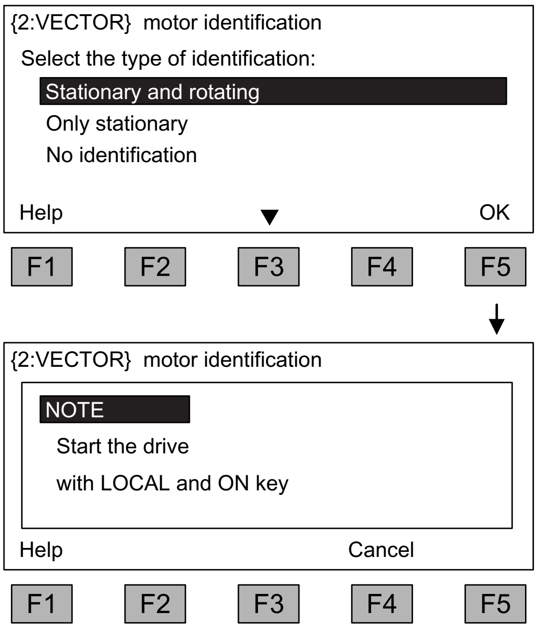
NOTICE

A filter on the motor side must be entered in p0230 (motor reactor: p0230 = 1, dV/dt-Filter compact plus Voltage Peak Limiter / dV/dt-Filter plus Voltage Peak Limiter: p0230 = 2, Siemens sine-wave filter: p0230 = 3, third-party sine-wave filter: p0230 = 4), otherwise motor control does not function properly.

Note

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 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.

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.

⚠ DANGER

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

Note

If a fault is present when selecting the stationary or rotary measurement, 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)

- You switch to LOCAL mode by pressing the "LOCAL/REMOTE" key.
- Control (ON/OFF) is carried out via the "ON" and "OFF" keys.
- You can specify the setpoint using the "increase" and "decrease" keys or by entering the appropriate numbers using the numeric keypad.

Analog outputs (for version with TM31)

- The actual speed (r0063) is output as a voltage output in the range 0 to 10 V at analog output 0 (X522:1 and 2).
  10 V is equal to the maximum speed in p1082.
- The actual current value (r0068) is output as a voltage output in the range 0 to 10 V at analog output 1 (X522:4 and 5).
  10 V corresponds to the current limit (p0640), which is set to 1.5 x the rated motor current (p0305).

Digital outputs (for version with TM31)

- 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 to start" signal is output at digital output 8 (X541:2).

5.7 Parameter reset to factory settings

The factory settings represent the defined original status of the device on delivery.

Resetting the parameters to the factory settings means that all the parameter settings made since the system was delivered are reset.

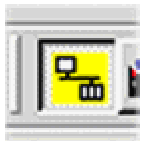
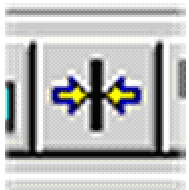
Resetting Parameters via AOP30

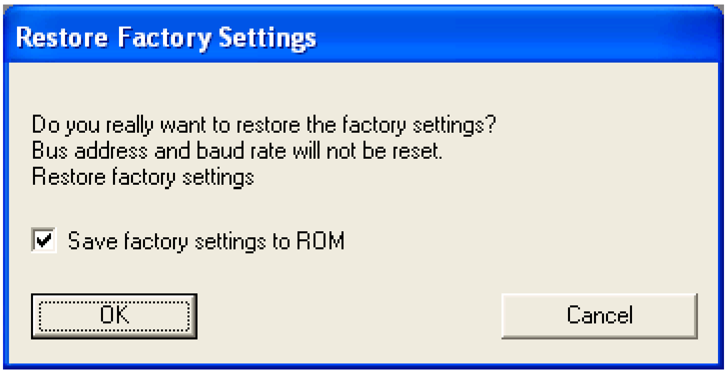
Table 5- 4 Procedure for resetting parameters to the factory settings with AOP30

"Advanced" access level	**Setting the "Extended" access level on the operator panel** <Key pushbutton> - <Access level> - Set "Extended"
↓	
Select parameter reset	**Setting the parameter filter to "Parameter reset"** <MENU> <Commissioning/Service> <Device commissioning> <OK> <30: Parameter Reset> <OK>
↓	
Press OK	**Reset all parameters to factory settings** The factory settings for all the device parameters are restored.

Parameter reset via STARTER

With STARTER, the parameters are reset in online mode. The required steps are described below:

Step	Selection in toolbar
Choose **Project > Connect to target system**	
Click the drive unit whose parameters you want to reset to the factory settings and click **Restore factory settings** icon in the toolbar.	

Step	Selection in toolbar
To confirm, click **OK**. 	
Choose **Target system > Copy from RAM to ROM**	

Note

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

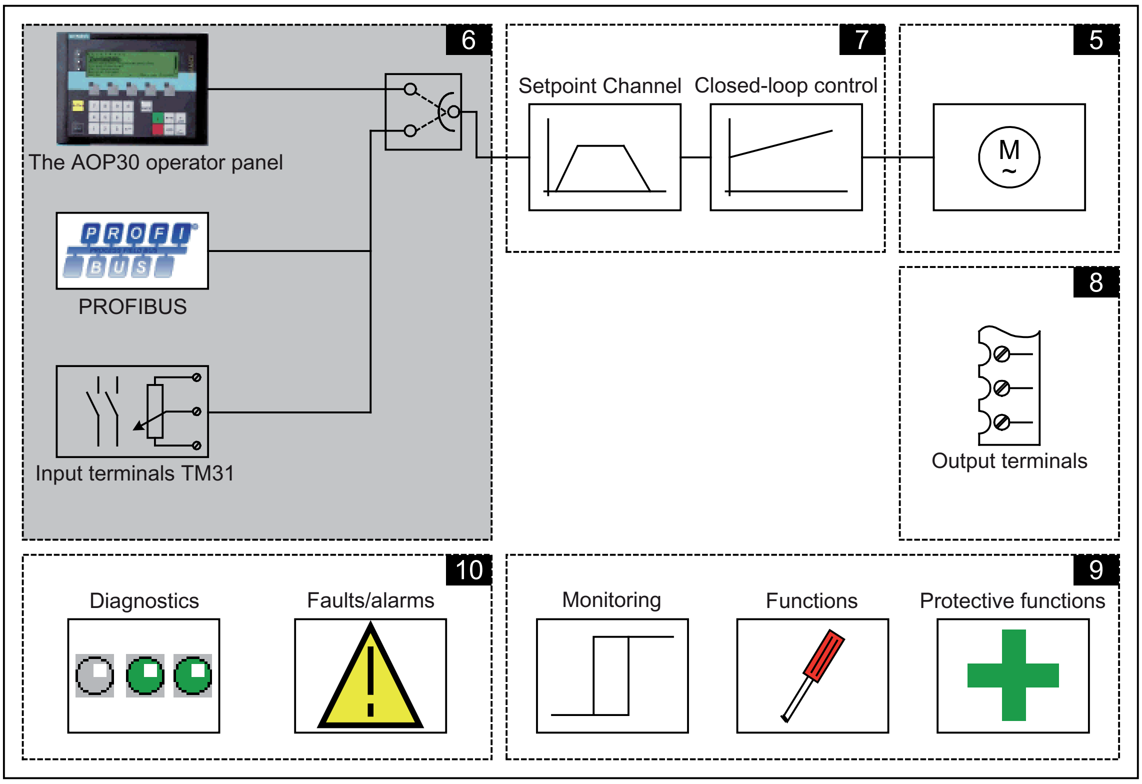
When the parameters have been reset to the factory settings, initial commissioning needs to be carried out.

Operation 6

6.1 Chapter content

This chapter provides information on the following:

- Basic information about the drive system
- Selecting command sources via:
  - PROFIdrive
  - TM31 terminal block
  - CU320 terminal block
- Specifying setpoints via:
  - PROFIdrive
  - Analog inputs
  - Motorized potentiometer
  - Fixed setpoints



6.2 General information about command and setpoint sources

Description

Four default settings are available for selecting the command sources and four for selecting the setpoint sources for the SINAMICS G130. 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
- CU terminals
- PROFIdrive+TM31

Setpoint sources

- PROFIdrive
- Analog inputs
- Motorized potentiometer
- Fixed setpoints

The various assignments are explained in the following sections.

Note

Make sure that the default settings you choose during commissioning are compatible with the system configuration (for more information, see "Commissioning")

Function diagrams

To supplement these operating instructions, the CD contains simplified function diagrams describing the operating principle of the SINAMICS G130.
The diagrams are arranged in accordance with the chapters in the operating instructions. The page numbers (6xx) describe the functionality in the following chapter.

At certain points in this chapter, reference is made to function diagrams with a 4-digit number. These are stored on the CD 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 means:

- PC with the "STARTER" commissioning tool via PROFIBUS
- The user-friendly AOP30 Operator Panel

Parameter types

The following adjustable and display parameters are available:

- Adjustable parameters (write/read)

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

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

  These parameters are used to display internal variables.

  Example: current motor current

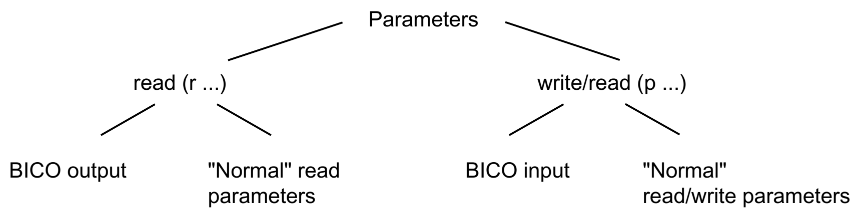


Figure 6-1 Parameter types

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

Parameter categories

The parameters for the 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 various types of data set:
  - CDS: Command data set
    By parameterizing several command data sets and switching between them, the drive can be operated with different pre-configured signal sources.
  - DDS: Drive data set
    The drive data set contains the parameters for switching between different drive control configurations.

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

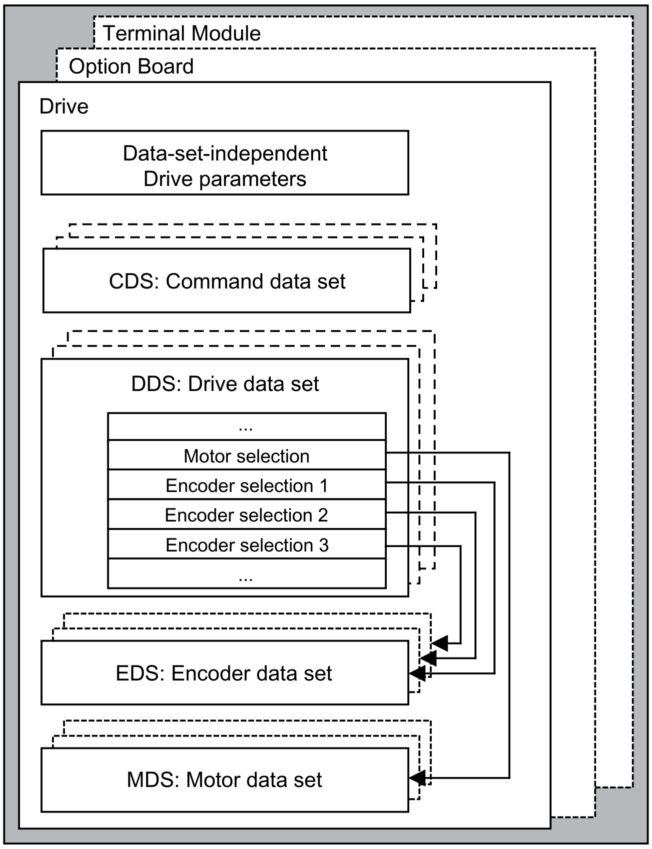


Figure 6-2 Parameter categories

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).

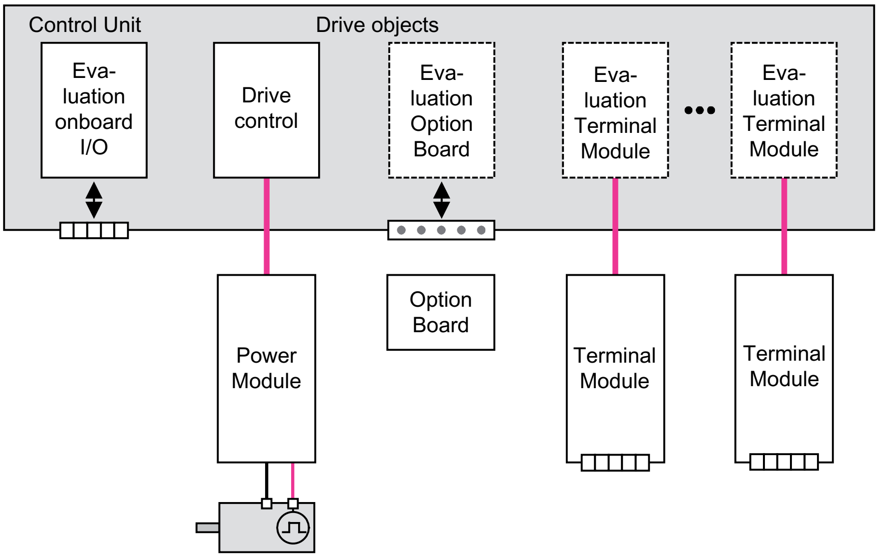


Figure 6-3 Drive objects

Standard drive objects

- Drive control
  Drive control handles closed-loop control of the motor. 1 Power Module and at least 1 motor and up to 3 encoders are assigned to the drive control.
- Control Unit, inputs/outputs
  The inputs/outputs on the Control Unit are evaluated within a drive object.

Optionally installed 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 evaluation of the respective optional Terminal Modules.

Properties of a drive object

- Separate parameter space
- Separate window in STARTER
- Separate fault/alarm system
- Separate PROFIdrive telegram 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" which 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 parameterization mode.

Note

Each installed drive object is allocated a number between 0 and 63 during initial commissioning for unique identification.

Parameters

- p0101 Drive object numbers
- r0102 Number of drive objects
- 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

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

CDS: Command data set

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

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

A command data set contains the following (examples):

- Binector inputs for control commands (digital signals)
  - ON/OFF, enable signals (p0844, etc.)
  - Jog (p1055, etc.)
- Connector inputs for setpoints (analog signals)
  - Voltage setpoint for V/f control (p1330)
  - Torque limits and scaling factors (p1522, p1523, p1528, p1529)

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

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

Table 6- 1 Command data set: selection and display

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

If a command data set, which does not exist, is selected, the current data set remains active.

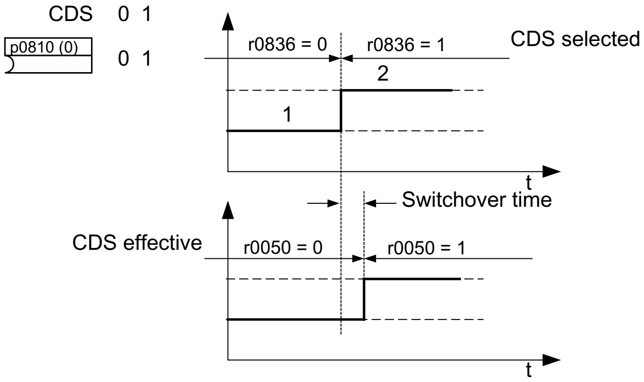


Figure 6-4 Example: Switching between command data set 0 and 1

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 parameterize 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, for example, used 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

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

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

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

Note

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

Binectors, BI: binector input, BO: Binector output

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

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

Table 6- 3 Binectors

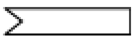
Abbreviation and symbol	Name	Description
BI 	Binector input Binector Input (signal sink)	Can be interconnected to a binector output as source. The number of the binector output must be entered as a parameter value.
BO 	Binector output Binector output (signal source)	Can be used as a source for a binector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

Connectors, CI: connector input, CO: Connector output

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

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

Table 6- 4 Connectors

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

Interconnecting signals using BICO technology

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

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

- Binectors: Parameter number, bit number, and drive object ID
- Connectors with no index: Parameter number and drive object ID
- Connectors with index: Parameter number, index, and drive object ID

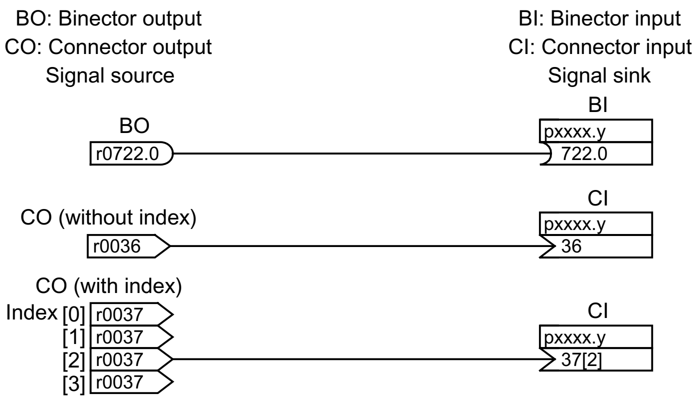


Figure 6-5 Interconnecting signals using BICO technology

Note

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

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

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

Notation:

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

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

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

Internal encoding of the binector/connector output parameters

The internal codes are needed, for example, to write BICO input parameters via PROFIdrive.

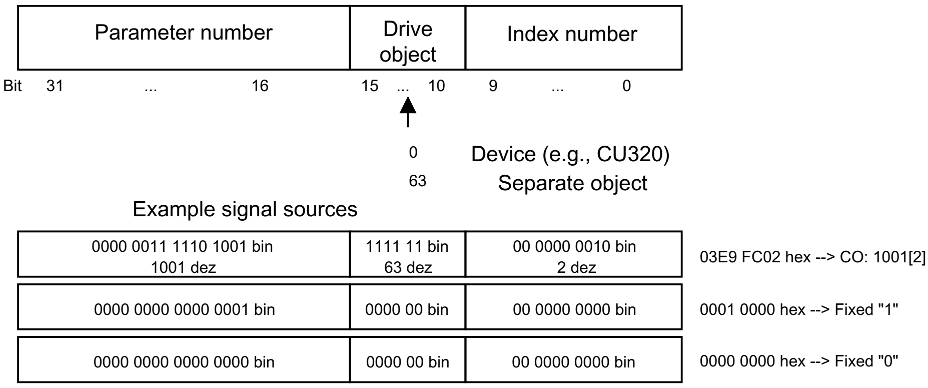


Figure 6-6 Internal encoding of the binector/connector output parameters

Example 1: interconnecting digital signals

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

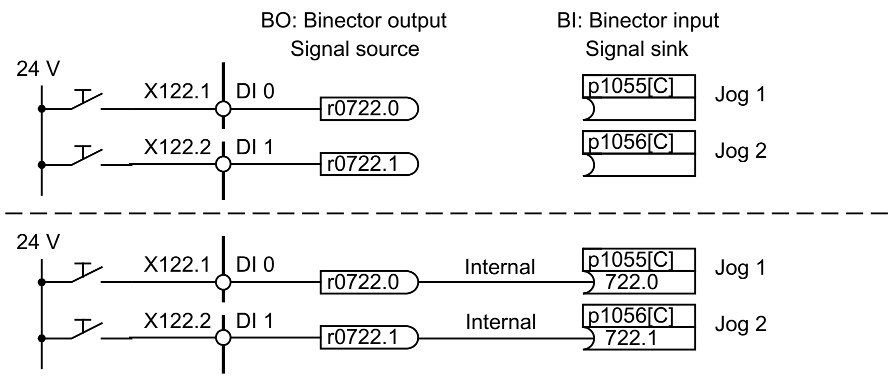


Figure 6-7 Interconnection of digital signals (example)

Example 2: connection of OC/OFF3 to several drives

The OFF3 signal is to be connected to two drives via terminal DI 2 on the Control Unit.

Each drive has a binector input 1. OFF3 and 2. OFF3. The two signals are processed via an AND gate to STW1.2 (OFF3).

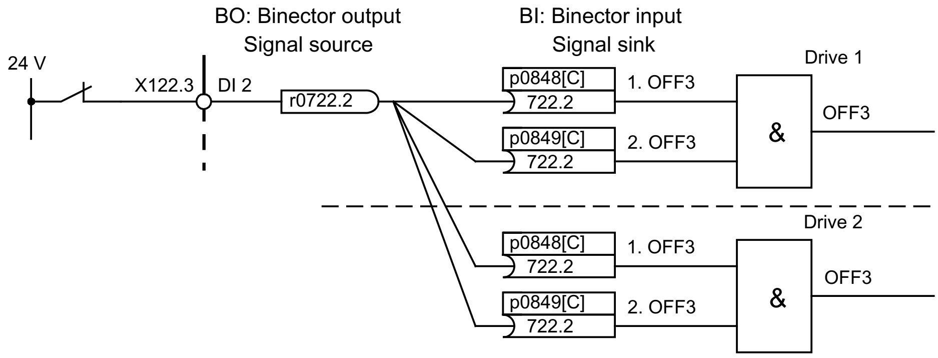


Figure 6-8 Connection of OFF3 to several drives (example)

BICO interconnections to other drives

The following parameters are available for BICO interconnections to other drives:

- r9490 Number of BICO interconnections to other drives
- r9491[0...15] BI/CI of BICO interconnections to other drives
- r9492[0...15] BO/CO of BICO interconnections to other drives
- p9493[0...15] Reset BICO interconnections to 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.

6.4 Command sources

6.4.1 "PROFIdrive" default setting

Prerequisites

- The Power Module and CU320 have been correctly installed.
- The "PROFIdrive" default setting was chosen during commissioning:

- STARTER: "PROFIdrive"
- AOP30: "1: G130 PROFIdrive"

Command sources

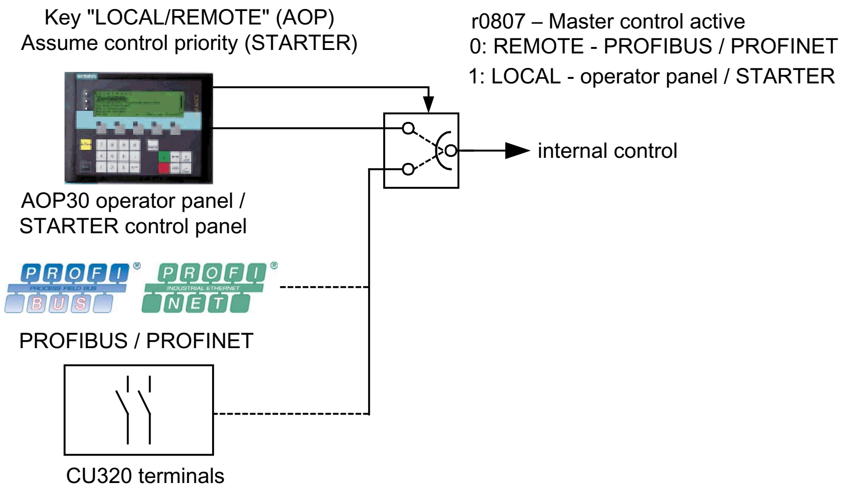


Figure 6-9 Command sources - AOP30 ←→ PROFIdrive

Priority

The command source priorities are shown in the diagram "Command sources - AOP30←→PROFIdrive".

Note

All of the supplementary setpoints are deactivated for LOCAL master control.

CU320 terminal assignment with "PROFIdrive" default setting

When you choose the "PROFIdrive" default setting, the terminal assignment for CU320 is as follows:

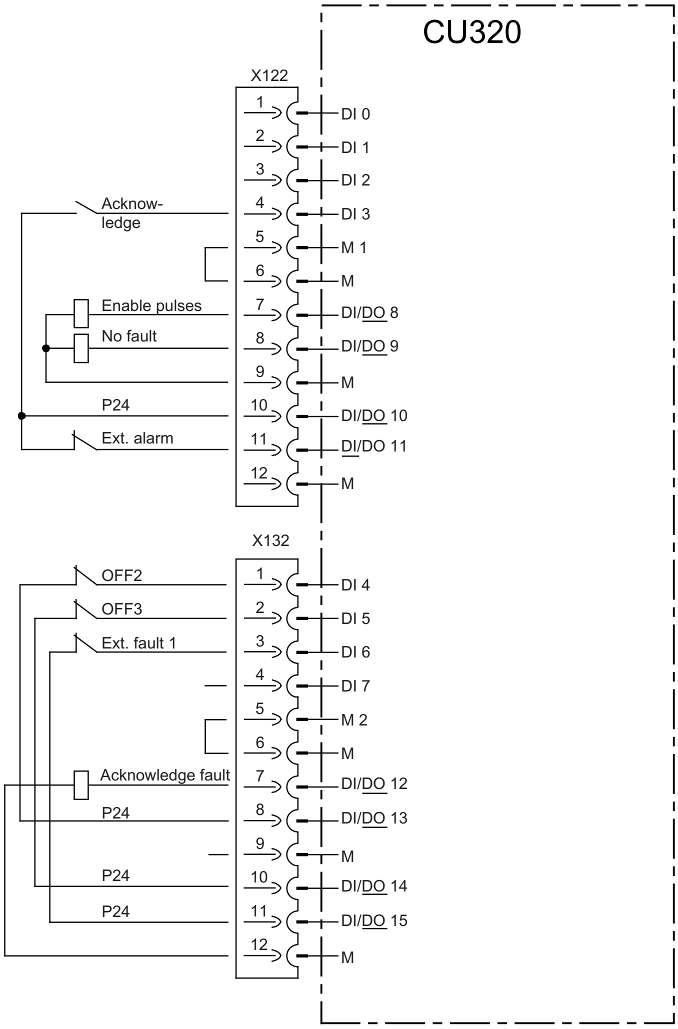


Figure 6-10 CU320 terminal assignment with "PROFIdrive" default setting

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

Prerequisites

- The Power Module, CU320, and TM31 have been correctly installed.
- The "TM31 terminals" default setting was chosen during commissioning:

- STARTER "TM31 terminals"
- AOP30: "2: TM31 terminals

Command sources

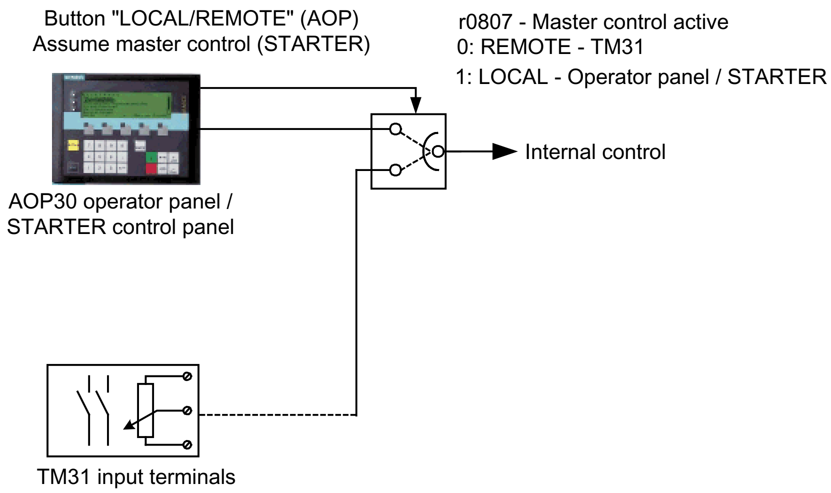


Figure 6-11 Command sources AOP30 ←→ terminal TM31

Priority

The command source priorities are shown in the diagram "Command sources AOP30 ←→ TM31 terminals".

Note

All of the supplementary setpoints are deactivated for LOCAL master control.

TM31 terminal assignment with "TM31 terminals" default setting

When you choose the "TM31 terminals" default setting, the terminal assignment for TM31 is as follows:

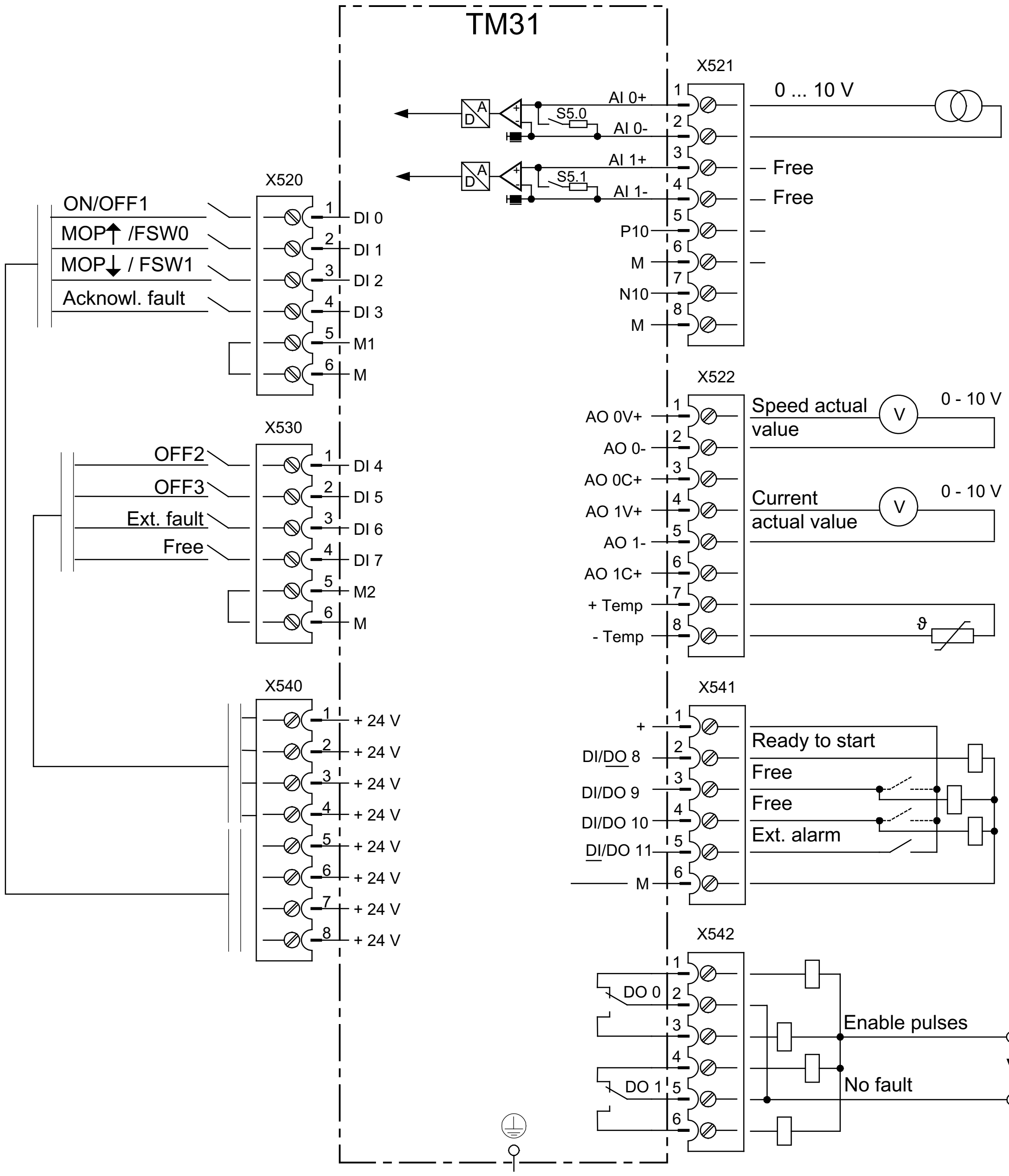


Figure 6-12 TM31 terminal assignment with "TM31 terminals" default setting

Switching the command source

If necessary, the command source can be switched using the LOCAL/REMOTE key on the AOP30.

6.4.3 "CU terminals" default setting

Prerequisites

- The Power Module and CU320 have been correctly installed.
- The "CU terminals" default setting was chosen during commissioning:

- STARTER: "CU terminals"
- AOP30: "3: CU terminals"

Command sources

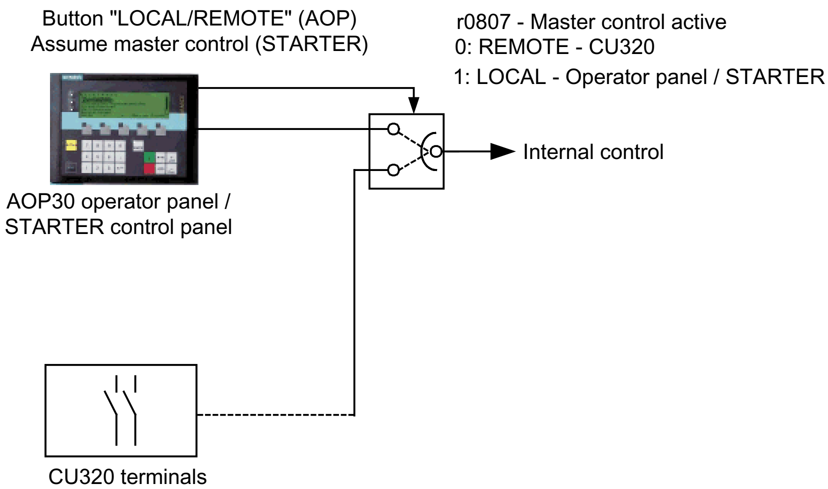


Figure 6-13 Command sources AOP30 ←→ CU terminal

Priority

The command source priorities are shown in the diagram "Command sources AOP30 ←→ CU terminals".

Note

For LOCAL master control, all of the supplementary setpoints are deactivated.

CU320 terminal assignment with "CU terminals" default setting

When you choose the "CU terminals" default setting, the terminal assignment for CU320 is as follows:

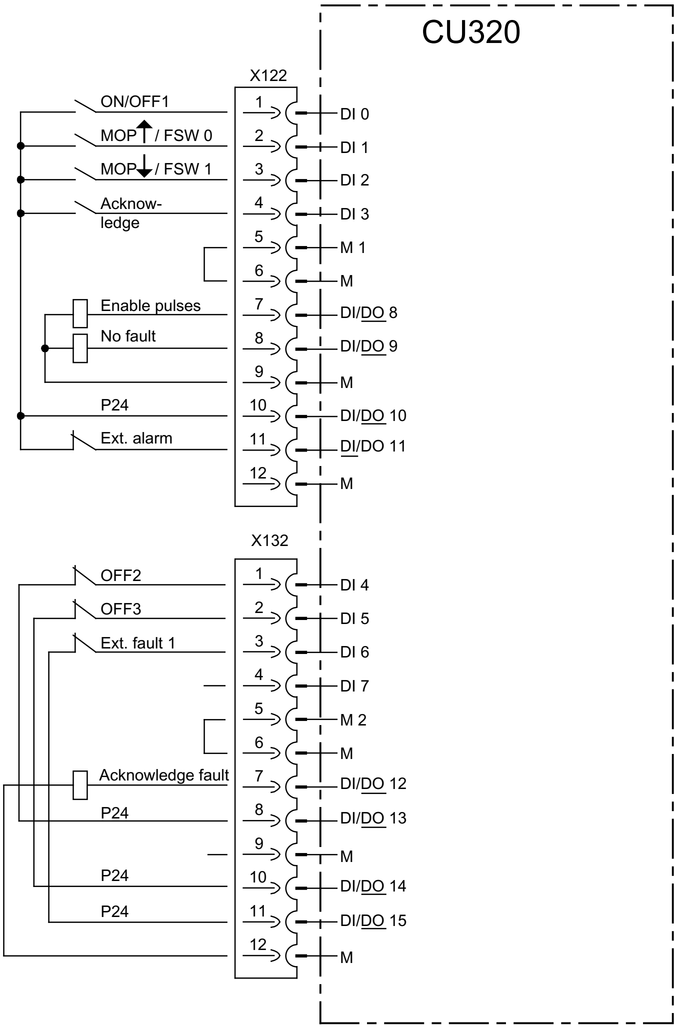


Figure 6-14 CU320 terminal assignment with "CU terminals" default setting

Switching the command source

If necessary, the command source can be switched using the LOCAL/REMOTE key on the AOP30.

6.4.4 "PROFIdrive+TM31" default setting

Prerequisites

- The Power Module, CU320, TM31, and PROFIBUS have been correctly installed.
- The "PROFIdrive+TM31" default setting was chosen during commissioning:

STARTER: "PROFIdrive+TM31"
AOP30: "4: PROFIdrive+TM31"

Command sources

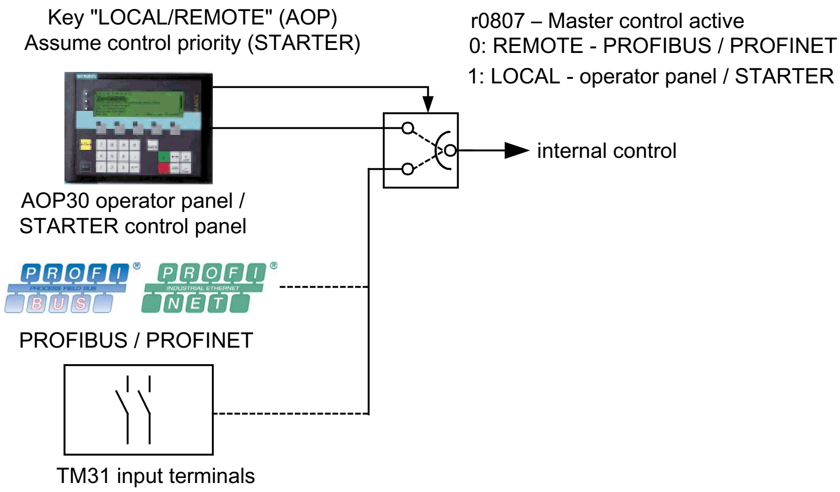


Figure 6-15 Command sources - AOP30 ←→ PROFIdrive+TM31

Priority

The command source priorities are shown in the diagram "Command sources - AOP30 ←→ PROFIdrive+TM31".

Note

All of the supplementary setpoints are deactivated for LOCAL master control.

TM31 terminal assignment with "PROFIdrive+TM31" default setting

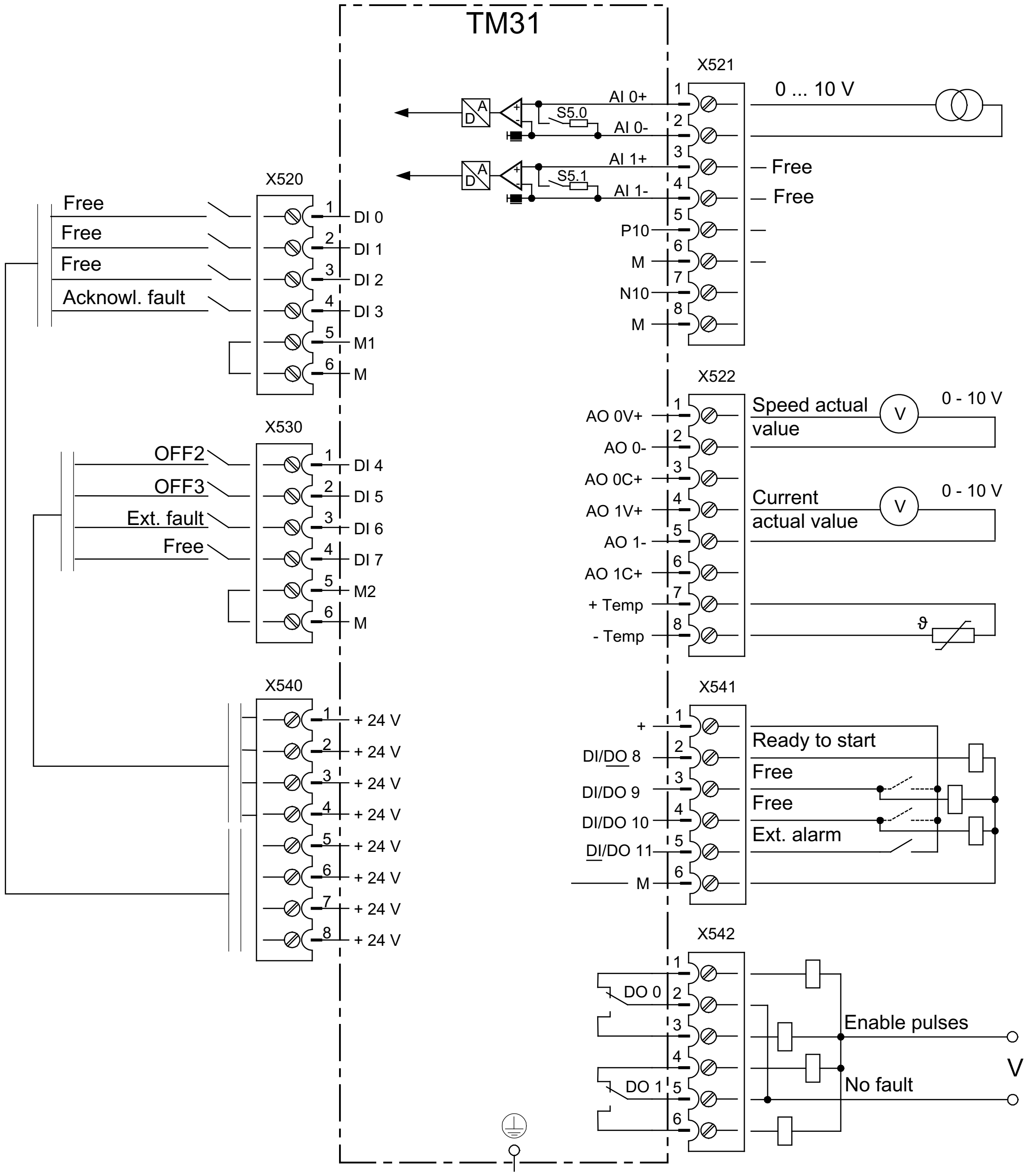


Figure 6-16 TM31 terminal assignment with "PROFIdrive+TM31" default setting

Switching the command source

If necessary, 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 block TM31 features two analog inputs for specifying setpoints for current or voltage signals.

In the factory setting, analog input 0 (terminal X521:1/2) is used as a voltage input in the range 0 ... 10 V.

Prerequisites

- The TM31 has been correctly installed.
- The default setting for analog inputs was chosen during commissioning:

- STARTER: "TM31 terminals"
- AOP30: "2: TM31 terminals

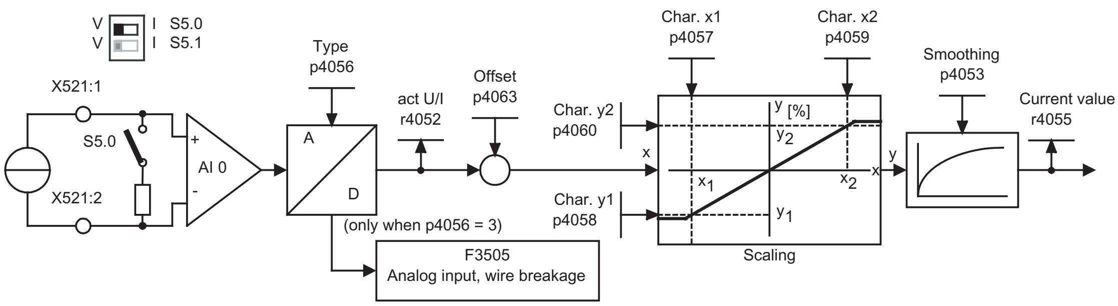


Figure 6-17 Signal flow diagram: analog input 0

Function diagram

FP 9566 TM31 – analog input 0 (AI 0)
FP 9568 TM31 – analog input 1 (AI 1)

Parameters

- r4052 Actual input voltage/current
- p4053 Analog inputs smoothing time constant
- r4055 Current referenced input value
- p4056 Analog inputs type

- p4057 Analog inputs, characteristic value x1
- p4058 Analog inputs, characteristic value y1
- p4059 Analog inputs, characteristic value x2
- p4060 Analog inputs, characteristic value y2
- p4063 Analog inputs offset

Note

In the factory setting and after basic commissioning, an input voltage of 10 V is equal to the main setpoint 100% reference speed (p2000), which has been set to the maximum speed (p1082).

Example: changing analog input 0 from voltage to current input 0 - 20 mA

Table 6- 5 Example: setting analog input 0

S5.0 = "I"	**Curren/voltage switchover** Set current /voltage selector to "Current" ("I").
↓	
p4056[0] = 2	Set analog input type 0 to 0 ... 20 mA.

Note

The change to the 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 is triggered when the analog input type (p4056) is set to 3 (4 ... 20 mA with open-circuit monitoring) and the input current of 2 mA has been undershot.

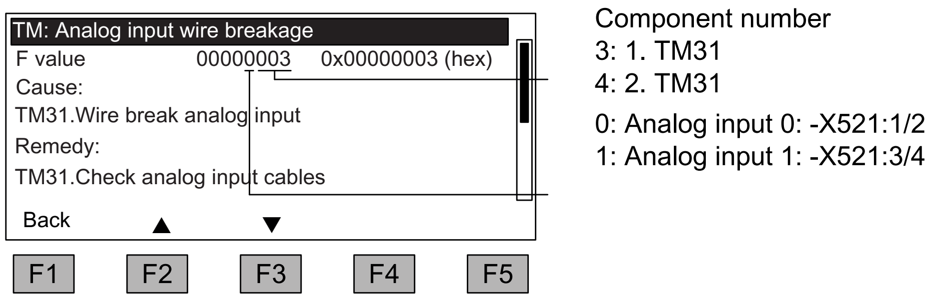
The fault value can be used to determine the analog input in question.

F3505 – Fault: "Analog input wire break"

This fault is triggered when the analog input type (p4056) is set to 3 (4 ... 20 mA with open-circuit 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- 6 Fault screen



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 PROFIBUS. As long as a logical 1 is present at signal input "MOP raise" (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 lower". The deceleration ramp can be set using parameter p1048.
Configuration parameter p1030.0 = 1 (default setting = 0) is used to activate that the actual motorized potentiometer is saved in a non-volatile fashion when powering-down the drive unit. When powering-up the drive unit, the starting (initial) value of the motorized potentiometer is set to the last, actual value that was present when the drive unit was powered-down.

Prerequisites

The default setting for the motorized potentiometer was chosen during commissioning:

- STARTER: "Motorized potentiometer"
- AOP30: "3: Motorized potentiometer"

Signal flow diagram

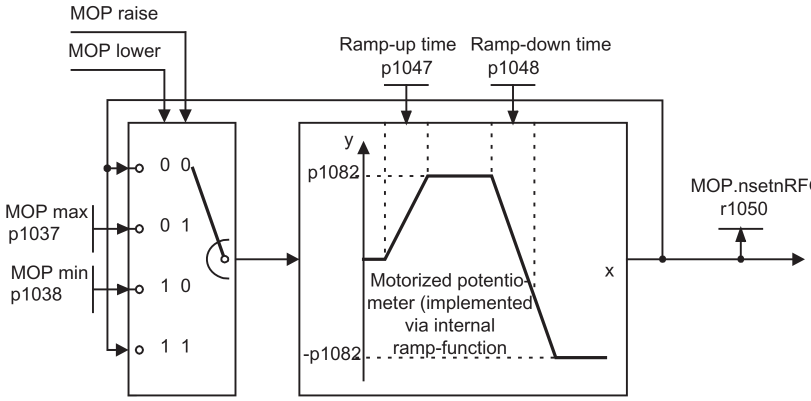


Figure 6-18 Signal flow diagram: Motorized potentiometer

Function diagram

FD 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 PROFIBUS.

Requirement

The default setting for the fixed speed setpoints was chosen during commissioning:

- STARTER: "Fixed setpoint"
- AOP30: "4: Fixed setpoint"

Signal flow diagram

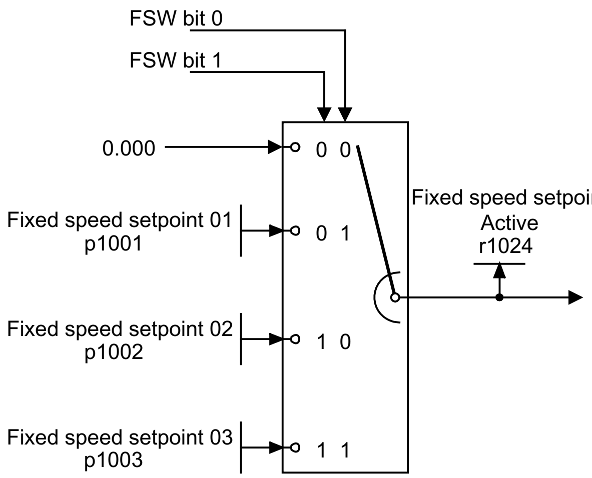


Figure 6-19 Signal flow diagram: Fixed speed setpoints

Function diagram

FP 3010 Fixed speed setpoints

Parameter

- 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. They can be selected using p1020 to p1023.

6.6 PROFIBUS

6.6.1 PROFIBUS connection

For more information about the PROFIBUS connection, see "Electrical installation".

6.6.2 Control via PROFIBUS

More information on PROFIBUS programming

For more information about the PROFIBUS programming, refer to the section "PROFIBUS DP/PROFINET IO communication" in the documentation "SINAMICS S120 Function Manual".

"DP1 (PROFIBUS)" diagnostics LED

The PROFIBUS diagnostics LED is located on the front of the Control Unit. Its states are described in the following table.

Table 6- 7 Description of the LEDs

Color	State	Description
-----	OFF	Cyclic communication has not (yet) taken place.
Green	Steady light	PROFIBUS is ready for communication and cyclic communication is taking place.
Green	Flashing, 0.5 Hz	Full cyclic communication is not yet taking place. Possible causes: The master is not transmitting setpoints.
Red	Steady light	Cyclic communication has been interrupted.

Setting the PROFIBUS ID number

The PROFIBUS Ident 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 Ident Number 3AA0 hex).

- 0: SINAMICS S/G
- 1: VIK-NAMUR

New settings do not become active until after POWER ON, reset, or download.

Note

The advantages of Totally Integrated Automation (TIA) can only be utilized when selecting "0".

6.6.3 Monitoring: Telegram failure

Description

Following a telegram failure and after a monitoring time has elapsed (t_An), 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 a delay time (p2044) has elapsed, fault F01910 is output and fault reaction OFF3 (quick stop) is triggered. If no OFF response is to be triggered, the fault response can be reparameterized accordingly.

Fault F01910 can be acknowledged immediately. The drive can then be operated even without PROFIBUS.

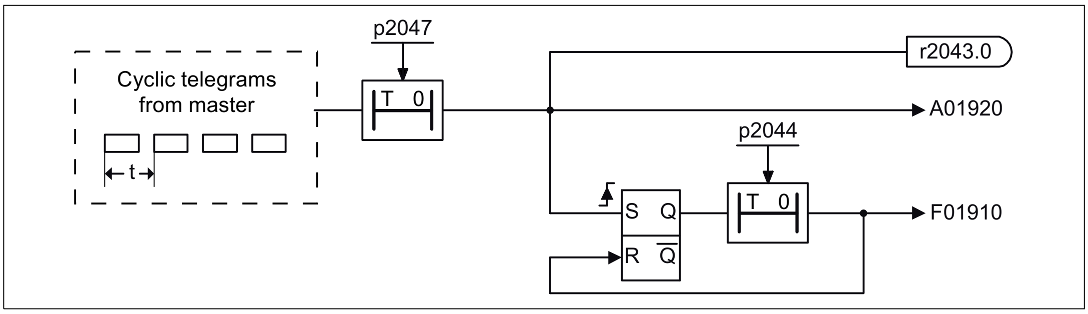


Figure 6-20 Monitoring: Telegram failure

6.6.4 Telegrams and process data

General information

Selecting a telegram via CU parameter p0922 determines which process data is transferred between the master and slave.

From the perspective of the slave (SINAMICS), the received process data comprises the receive words and the process data to be sent the send words.

The receive and send words comprise the following elements:

- Receive words: Control words and setpoints
- Send words: Status words and actual values

Default setting "Profidrive"

When the "Profidrive" default setting is chosen for command and setpoint selection (see "Command sources / "Profidrive" default settings"), "Free telegram" (p0922 = 999) is selected.

The receive message frame is parameterized as follows as a result of the default setting (plan 622):

STW1	NSOLL_A

The send telegram is parameterized as follows (factory setting, plan 623):

ZSW1	NIST_GLATT	IAIST_GLATT	MIST_GLATT	PIST_GLATT	FAULT_CODE

You do not have to make any further settings in order to use these telegrams.

User-defined telegram selection

a. Standard telegrams

Standard telegrams are structured in accordance with PROFIdrive profile or internal company specifications. The internal process data links are established automatically in accordance with the telegram number setting in CU parameter p0922.

The following standard telegrams can be set via parameter p0922:

- p0922 = 1 -> Speed setpoint, 16 bit
- p0922 = 2 -> Speed setpoint, 32 bit
- p0922 = 3 -> Speed setpoint 32 bit with 1 position controller
- p0922 = 4 -> Speed setpoint 32 bit with 2 position controller
- p0922 = 20 -> Speed setpoint, 16 bit VIK-NAMUR
- p0922 = 352 -> Speed setpoint, 16 PCS7

Depending on the setting in p0922, the interface mode of the control and status word is automatically set:

- p0922 = 1, 352, 999:
  STW 1/ZSW 1: Interface Mode SINAMICS / MICROMASTER, p2038 = 0
- p0922 = 20:
  STW 1/ZSW 1: Interface Mode PROFIdrive VIK-NAMUR, p2038 = 2

b. Manufacturer-specific telegrams

The manufacturer-specific telegrams are structured in accordance with internal company specifications. The internal process data links are set up automatically in accordance with the telegram number setting.

The following vendor-specific telegrams can be set via p0922:

- p0922 = 220 Speed setpoint 32 bit, metal industry

c. Free telegrams (p0922 = 999)

Send and receive telegrams can be configured as required by using BICO technology to interconnect the send and receive words. The default process data assigned under a) is retained during the changeover to p0922 = 999, although it can be changed or supplemented at any time.

To maintain compliance with the PROFIdrive profile, however, the following assignments should be retained:

- Interconnect PZD receive word 1 as control word 1 (STW 1)
- Interconnect PZD send word 1 as status word 1 (STW 1)

For more information about possible interconnections, see function diagrams FP2460 and FP2470 and the simplified diagrams 620 to 622.

Telegram interconnections

After changing p0922 = 999 (factory setting) to p0922 ≠ 999, the telegrams are interconnected and blocked automatically.

Note

Telegrams 20 and 352 are the exceptions. Here, the PZD06 in the send telegram and PZD03 to PZD06 in the receive telegram can be interconnected as required.

When you change p0922 ≠ 999 to p0922 = 999, the previous telegram interconnection is retained and can be changed.

Note

If p0922 = 999, a telegram can be selected in p2079. A telegram interconnection is automatically made and blocked. However, the telegram can also be extended.

This is an easy method of creating extended telegram interconnections on the basis of existing telegrams.

6.6.5 Structure of the telegrams

Table 6- 8 Structure of the telegrams

Telegr.	PZD 1	PZD 2	PZD 3	PZD 4	PZD 5	PZD 6	PZD 7	PZD 8	PZD 9	PZD 10
1	STW1	NSOLL_A								
	ZSW1	NIST_A								
2	STW1	NSOLL_B		STW2						
	ZSW1	NIST_B		ZSW2						
3	STW1	NSOLL_B		STW2	G1_STW					
	ZSW1	NIST_B		ZSW2	G1_ZSW	G1_XIST1		G1_XACT2		
4	STW1	NSOLL_B		STW2	G1_STW	G2_STW				
	ZSW1	NIST_B		ZSW2	G1_ZSW	Further assignment, see FP2420				
20	STW1	NSOLL_A								
	ZSW1	NIST_A_ GLATT	IAIST_ GLATT	MIST_ GLATT	PIST_ GLATT	MELD_ NAMUR				
220	STW1_ BM	NSOLL_B		STW2_BM	M_ADD	M_LIM	free	free	free	free
	ZSW1_ BM	NIST_A	IAIST	MIST	WARN_ CODE	FAULT_ CODE	ZSW2_ BM	free	free	free
352	STW1	NSOLL_A	PCS7_3	PCS7_4	PCS7_5	PCS7_6				
	ZSW1	NIST_A_ GLATT	IAIST_ GLATT	MIST_ GLATT	WARN_ CODE	FAULT_ CODE				
999	STW1	free	free	free	free	free	free	free	free	free
	ZSW1	free	free	free	free	free	free	free	free	free

6.6.5.1 Overview of control words and setpoints

Table 6- 9 Overview of control words and setpoints

Abbreviation	Description	Parameters	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
NSOLL_A	Speed setpoint A (16-bit)	p1070	FP3030
NSOLL_B	Speed setpoint B (32-bit)	p1155	FP3080
PCS7_x	PCS7-specific setpoints		

6.6.5.2 Overview of status words and actual values

Table 6- 10 Overview of status words and actual values

Abbreviation	Description	Parameters	Function diagram
ZSW1	Status word 1 (interface mode SINAMICS, p2038 = 0)	See table "Status word 1 (interface mode SINAMICS, p2038 = 0)"	FP2452
ZSW1	Status word 1 (interface mode VIK-NAMUR, p2038 = 2)	See table "Status word 1 (interface mode VIK-NAMUR, p2038 = 2)"	FP2451
ZSW1_BM	Status word 1, metal industry (interface mode SINAMICS, p2038 = 0)	See table "Status word 1, metal industry (interface mode SINAMICS, p2038 = 0)"	FP2428
ZSW2	Status word 2 (interface mode SINAMICS, p2038 = 0)	See table "Status word 2 (interface mode SINAMICS, p2038 = 0)"	FP2454
ZSW2_BM	Status word 2, metal industry (interface mode SINAMICS, p2038 = 0)	See table "Status word 2, metal industry (interface mode SINAMICS, p2038 = 0)"	FP2429
NIST_A	Speed setpoint A (16 bit)	r0063[0]	FP4715
NIST_B	Speed setpoint B (32 bit)	r0063	FP4710
IAIST	Actual value of current	r0068[0]	FP6714
MIST	Actual torque value	r0080[0]	FP6714
PIST	Actual power value	r0082[0]	FP6714
NIST_GLATT	Actual speed value smoothed	r0063[1]	FP4715
IAIST_GLATT	Current actual value, smoothed	r0068[1]	FP6714
MIST_GLATT	Torque actual value, smoothed	r0080[1]	FP6714
PIST_GLATT	Power actual value, smoothed	r0082[1]	FP6714
MELD_NAMUR	VIK-NAMUR message bit bar	r3113, see table "NAMUR message bit bar"	--
WARN_CODE	Alarm code	r2132	FP8065
ERROR_CODE	Error code	r2131	FP8060

6.6.6 Further information about communication via PROFINET

Further information about communication via PROFIBUS

For more information about PROFINET IO communication, refer to "PROFIBUS communication" in the accompanying "SINAMICS S120 Function Manual".

6.7 PROFINET IO

6.7.1 Communication Board Ethernet CBE20

Description

Interface module CBE20 is used for communication via PROFINET.

The module must be installed line-side in the option slot of the Control Unit.

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

Interface overview

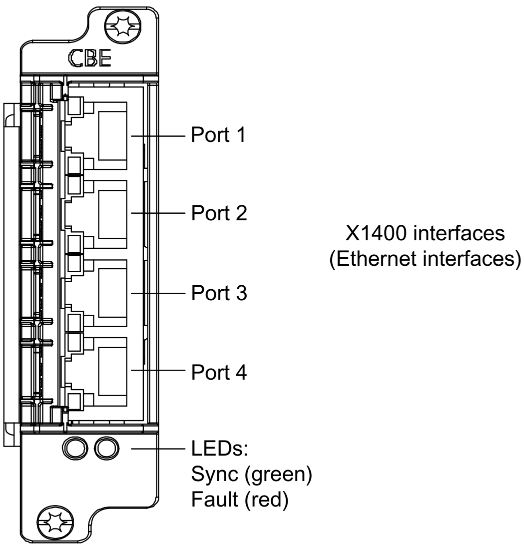


Figure 6-21 Communication Board Ethernet CBE20

MAC address

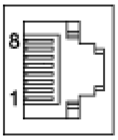
The MAC address of the Ethernet interfaces is indicated on the upper side of the CBE20. The label is only visible when the module has not yet been installed.

Note

Please note the MAC address prior to installing the module so that it is available to you for the subsequent commissioning.

X1400 Ethernet interface

Table 6- 11 Connector X1400, port 1 - 4

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

Mounting

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

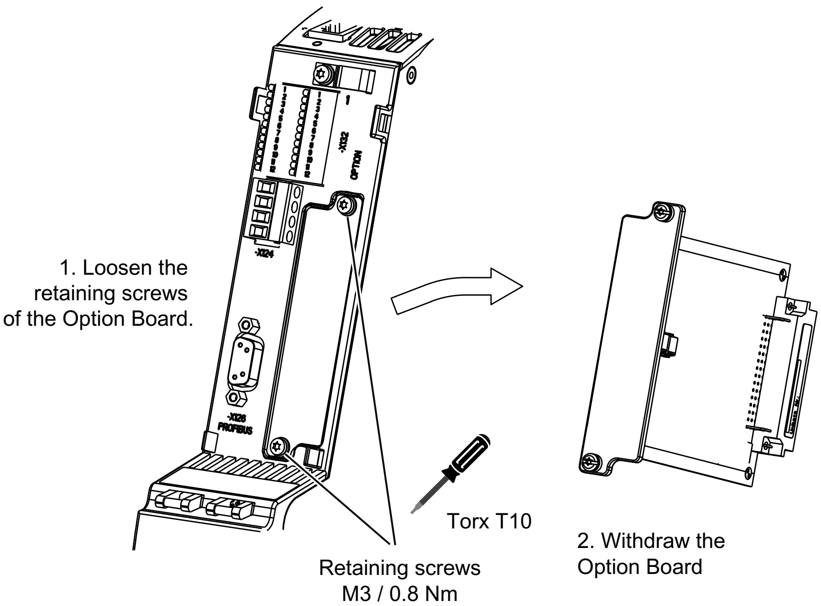


Figure 6-22 Mounting the CBE20

6.7.2 Activating online operation: STARTER via PROFINET IO

Description

Online operation with PROFINET IO is implemented using TCP/IP.

Prerequisites

- STARTER from version 4.1.5 or higher
- Latest version of the initialization tool PST (Primary Setup Tool)

  The Primary Setup Tool is available on the STARTER DVD or it can be downloaded free of charge from the Internet: http://support.automation.siemens.com/WW/view/de/19440762
- CBE20

STARTER via PROFINET IO (example)

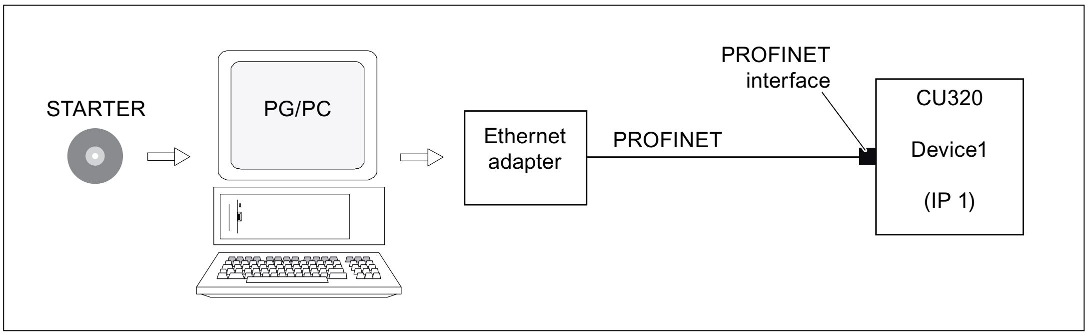


Figure 6-23 STARTER via PROFINET (example)

Procedure, establishing online operation with PROFINET

1. Set the IP address in Windows XP

   The PC/PG is referred here to a fixed, free IP address.
2. Settings in STARTER
3. Assigning the IP address and the name via PST (node initialization) or STARTER

   The PROFINET interface must be "baptized" so that the STARTER can establish communication.
4. Select online operation in STARTER.

Set the IP address in Windows XP

On the desktop, right-click on "Network environment" -> Properties -> double-click on Network card and choose -> Properties -> Internet Protocol (TCP/IP) -> Properties -> Enter the freely-assignable addresses.

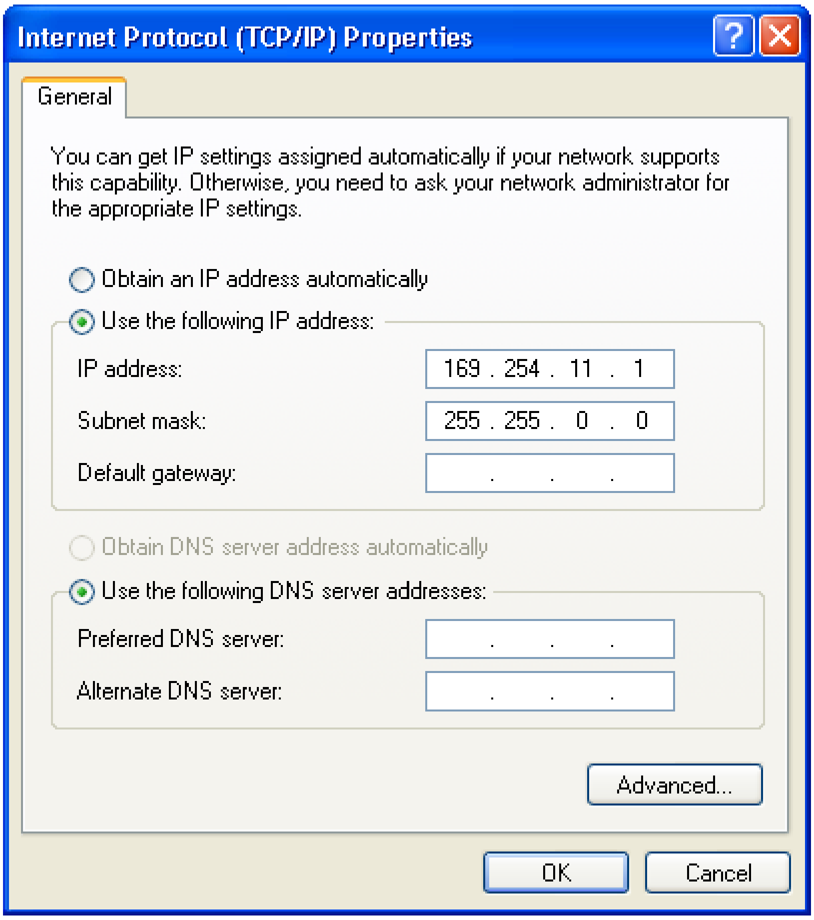


Figure 6-24 Properties of the Internet Protocol (TCP/IP)

Settings in STARTER

The following settings are required in STARTER for communication via PROFINET:

- Extras -> Set PG/PC interface

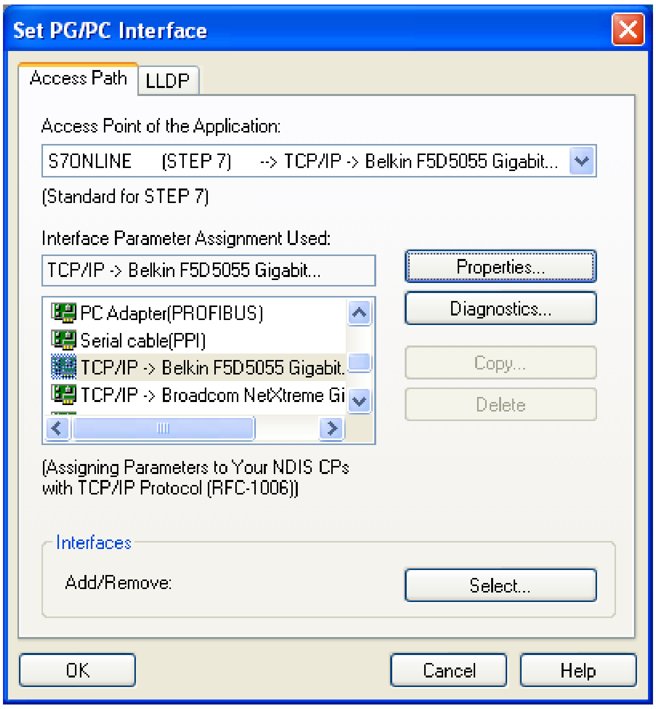


Figure 6-25 Set the PG/PC interface

- Right-click Drive unit -> Target device -> Online access -> Module address

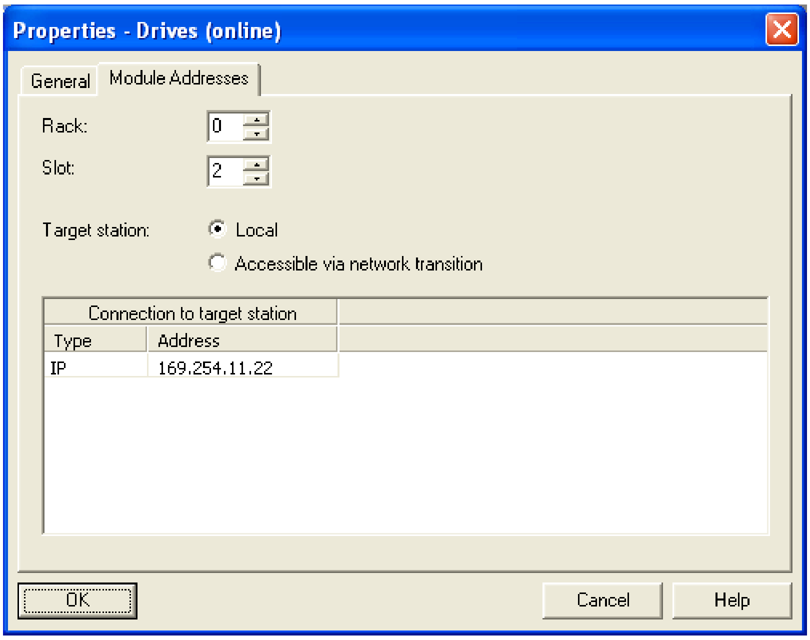


Figure 6-26 Activating online operation

Assigning the IP address and the name

Note

ST (Structured Text) conventions must be satisfied for the name assignment of IO devices in PROFINET (SINAMICS components). The names must be unique within PROFINET.
The characters "-" and "." are not permitted in the name of an IO device.

Assignment with the PST initialization tool

You can use the PST initialization tool (Primary Setup Tool) 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.
- Starting the Primary Setup Tool.
- Settings -> Network card -> Select the network card
- Network -> Search (or F5)
- Select the PROFINET device -> Module -> Assign name -> Enter the station name -> OK
- Module -> Load
- Network -> Search (or F5)
- Select "Ind. Ethernet interface" branch under the PROFINET device -> Assign IP address -> Enter the IP address (e.g. 169.254.11.22) -> Enter the subnet mask (e.g. 255.255.0.0)

  The subnet masks must match before STARTER can be run.
- Module -> Load

Note

The IP address and device name for the Control Unit are stored on the memory card (non-volatile).

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 with CBE20 is detected and displayed as a bus node with IP address 0.0.0.0 and without 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 screen (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 bus node, mark the entry and click the "Accept" button.
- The SINAMICS drive with CBE20 is displayed as 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

The IP address and device name for the Control Unit are stored on the memory card (non-volatile).

6.7.3 General information about PROFINET IO

6.7.3.1 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.

The following standards ensure open, multi-vendor systems:

- International standard IEC 61158

PROFINET IO is optimized for high-speed, time-critical data communication at field level.

PROFINET

Within the context of Totally Integrated Automation (TIA), PROFINET IO is the systematic development of the following systems:

- PROFIBUS DP, the established field bus, and
- Industrial Ethernet, the communications bus for the cell level.

Experience gained from both systems was and is being integrated into PROFINET IO. As an Ethernet-based automation standard defined by PROFIBUS International (PROFIBUS user organization), PROFINET IO is a manufacturer-independent communication and engineering model.

PROFINET IO defines every aspect of the data exchange between IO controllers (devices with so-called "master functionality" and the IO devices (those with so-called "slave functionality") as well as parameterization and diagnostic processes. An IO system is configured by virtually the same method used for PROFIBUS.

A PROFINET IO system is made up of the following devices:

- The IO controller controls automation tasks.
- An IO device is controlled and monitored by an IO controller. An IO device consists of several modules and submodules.
- IO supervisor is an engineering tool typically based on a PC that is used to parameterize and diagnose individual IO devices (drive units).

IO devices: Drive units with PROFINET interface

- SINAMICS G130 with CU320-2 DP and inserted CBE20

SINAMICS G130 and CBE20 can be used for communication via PROFINET IO with RT.

Note

PROFINET for drive technology is standardized and described in the following document:

PROFIBUS Profile PROFIdrive – Profile Drive Technology

Version V4.1, May 2006,

PROFIBUS User Organization e. V.

Haid-und-Neu-Straße 7,

D-76131 Karlsruhe

http://www.profibus.com,

Order Number 3.172, spec. Chp. 6

- IEC 61800-7

CAUTION
Inserting the CBE20 Communication Board deactivates the cyclic PZD channel for PROFIBUS DP.

6.7.3.2 Real-time (RT) and isochronous real-time (IRT) communication

Real-time communication

When communication takes place via TCP/IP, the resultant transmission times may be too long and non-deterministic to meet production automation requirements. When communicating time-critical IO user data, PROFINET IO therefore uses its own real-time channel, rather than TCP/IP.

Determinism

Determinism means that a system will react in a predictable ("deterministic") manner. With PROFINET IO, it is possible to precisely determine (predict) transmission times.

PROFINET IO with RT (Real Time)

Real time means that a system processes external events over a defined period.

Process data and alarms are always transmitted in real time (RT) within the PROFINET IO system. RT communication provides the basis for data exchange with PROFINET IO. Real-time data are treated as a higher priority than TCP(UDP)/IP data. Transmission of time-critical data takes place at guaranteed time intervals.

PROFINET IO with IRT (Isochronous Real Time)

Isochronous Real Time Ethernet: Real time property of PROFINET IO where IRT telegrams are transmitted deterministically via planned communication paths in a defined sequence to achieve the best possible synchronism and performance between the IO controller and IO device (drive unit). This is also known as time-scheduled communication and uses knowledge about the network structure.
IRT requires special line components that support a planned data transfer.

Cycle times of minimum 500 μs and a jitter accuracy of less than 1 μs can be achieved when this transmission method is implemented.

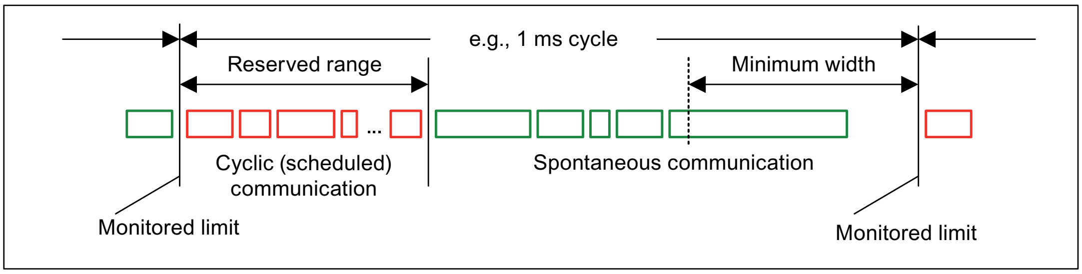


Figure 6-27 Broadband distribution/reservation, PROFINET IO IRT

Note

Operation of S7-300 stations with SINAMICS drives: communication via PROFINET IO currently only possible with RT and IRT High Flexibility.

6.7.3.3 Addresses

Definition: MAC address

Each PROFINET device is assigned a worldwide unique device identifier in the factory. This 6-byte long device identifier is the MAC address. The MAC address is divided up as follows:

- 3 bytes manufacturer's ID and
- 3 bytes device identifier (consecutive number).

The MAC address is usually indicated on the front of the device.

e.g.: 08-00-06-6B-80-C0

IP address

To allow 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 is made up of

- The address of the (sub-) network and
- The address of the node (generally called the host or network node)

IP address assignment

The TCP/IP protocol is a prerequisite for establishing a connection and parameterization. This is the reason that an IP address is required.

The IP addresses of IO devices can be assigned by the IO controller and always have the same sub-network 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.

If the IP address is to be stored in a non-volatile memory, the address must be assigned using the Primary Setup Tool (PST) or STARTER.

This can also be carried out in HWConfig in STEP 7, where the function is called "Edit Ethernet node".

Note

If the network is part of an existing Ethernet company network, obtain the information (IP address) from your network administrator.

Device name (NameOfStation)

When it is shipped, an IO device does not have a device name. An IO device can only be addressed by an IO controller, for example, for the transfer of project engineering data (including the IP address) during startup or for user data exchange in cyclic operation, after it has been assigned a device name with the IO supervisor.

NOTICE
The device name must be saved in a non-volatile fashion either using the Primary Setup Tool (PST) or using HW Config from STEP 7.

Replacing Control Unit (IO device)

If the IP address and device name are stored in a non-volatile memory, this data is also forwarded with the memory card (CF card) of the Control Unit.

If a complete Control Unit needs to be replaced due to a device or module defect, the new Control Unit automatically parameterizes and configures using the data on the memory card. Following this, cyclic exchange of user data is restarted. The memory card allows module exchange without an IO supervisor when a fault occurs in a PROFINET device.

6.7.3.4 Data transmission

Features

The Communication Board CBE20 supports:

- IRT – isochronous real-time Ethernet
- RT – real-time Ethernet
- Standard Ethernet services (TCP/IP, LLDP, UDP and DCP)

PROFIdrive telegram for cyclic data transmission and non-cyclic services

Telegrams to send and receive process data are available for each drive object of a drive unit with cyclic process data exchange.
In addition to cyclic data transfer, acyclic services can also be used for parameterizing and configuring the drive. These acyclic services can be utilized by the IO supervisor or IO controller.

Sequence of drive objects in the data transfer

The sequence of drive objects is displayed via a list in p0978[0...15] where it can also be changed.

Note

The sequence of drive objects in HW Config must be the same as that in the drive (p0978).

6.7.4 Further information about communication via PROFINET IO

Further information about communication via PROFINET IO

For more information about PROFINET IO communication, refer to "PROFINET IO communication" in the accompanying "SINAMICS S120 Function Manual".

6.8 SINAMICS Link

6.8.1 Basic principles of SINAMICS Link

SINAMICS Link enables data to be directly exchanged between several Control Units, which for this purpose must be equipped with the CBE20 supplementary module. Other nodes cannot be integrated into this communication. Possible applications include e.g.:

- Torque distribution for n drives
- Setpoint cascading for n drives
- Load distribution of drives coupled through a material web
- Master/slave function for infeed units

Send and receive data

The most frequently used node comprises a drive unit with a CU and a number of connected drive objects (DOs). A telegram of a SINAMICS Link has space retainers for 16 process data (PZD). Each PZD is precisely one word long. Slots that are not required are filled with zeros

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

SINAMICS Link

Every node can send a telegram with 16 PZD. A drive object can receive up to 16 PZD from every other DO of the connected nodes as long as the transferred data within a telegram does not exceed 16 words. Single words and double words can be sent and received. Double words require 2 consecutive PZDs. It is not possible to read in your own send data.

Transmission time

A transmission time of 3.0 ms is possible when using SINAMICS Link (for a controller cycle, max. 0.5 ms; bus cycle, 2.0 ms).

6.8.2 Topology

Only a line topology with the following structure is permitted for SINAMICS Link.

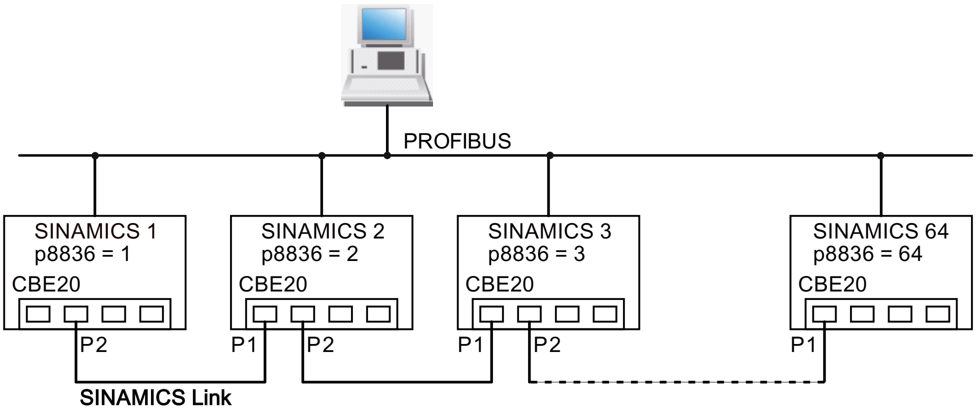


Figure 6-28 Maximum topology

- The numbers of the various nodes are entered into parameter p8836[0...63] in ascending order.
- Gaps in the numbering are not permitted.
- The node with the number 1 is automatically the sync master of the communication link.
- When configuring the communication, the **NameOfStation** (SINAMICSxLINKx001 … SINAMICSxLINKx064) and the **IP address** (169.254.123.001 … 169.254.123.064) of the particular node are automatically set up by allocating the node number and cannot be changed.
- For the CBE20 connection, the ports must be used as shown in the diagram above – this is mandatory. This means that Port 2 (P2) of node **n** is always connected with Port 1 (P1) of node **n+1**.

6.8.3 Configuring and commissioning

Commissioning

When commissioning, proceed as follows for the Control Unit:

- Set parameter p8835 to 3 (SINAMICS Link).
- Using parameter p8836, assign node numbers to the nodes (the first CU is always assigned the number 1). Observe the specifications under "Topology". Node number 0 means that SINAMICS Link is shut down.
- Perform a POWER ON (switch-off/switch-on).

Sending data

Proceed as follows to send data:

- In parameter p2051[x], for each drive object, define which data (PZDs) should be sent. p2061[x] must be used for double word quantities.
- In parameter p8871, for each drive object, assign the send parameter to the send slot of its own node. Double words (e.g. 2+3) are assigned two consecutive send slots, e.g. p8871[1] = 2 and p8871[2] = 3.

Receiving data

Proceed as follows to receive data:

Note

The first word of the receive data must be a control word, where bit 10 is set. If this is not the case, then you must deactivate the evaluation of bit 10 using p2037 = 2.

- Received data are saved in parameter r2050[x]/r2060[x].
- The address of the node from which the relevant PZD is to be read is defined in parameter p8872[0 … 15] (0 ≙ nothing is read in).
- In parameter p8870[0 … 15], the PZD is defined which is read from the sent telegram and is to be stored in its own receive slot, r2050 for PZD or r2060 for double PZD (0 ≙ no PZD selected).

  Note

  For double words, 2 PZD must be read; e.g.: Read in a 32-bit setpoint, which is located on PZD 2+3 for node 5 and map this to PZD 2+3 of its own node: p8872[1] = 5, p8870[1] = 2, p8872[2] = 5, p8870[2] = 3

Activation

To activate SINAMICS Link connections, perform a POWER ON for all nodes. The assignments of p2051[x]/2061[x] and the links of the read parameters r2050[x]/2060[x] can be changed without a POWER ON.

6.8.4 Example

Task

Configure SINAMICS Link for two nodes (here, in example 2, SINAMICS S120) and transfer the following values:

- Send data from node 1 to node 2
  - r0898 CO/BO: Control word, drive object 1 (1 PZD), in the example PZD 1
  - r0079 CO: Total torque setpoint (2 PZD), in the example PZD 2
  - r1150 CO: Ramp-function generator speed setpoint at the output (2 PZD) in the example, PZD 3
- Send data from node 2 to node 1
  - r0899 CO/BO: Status word, drive object 1 (1 PZD), in the example, PZD 1

Procedure

1. For all nodes, set the SINAMICS Link mode:
   p8835 = 3
2. Assign node numbers for the two devices:
   - Node 1: p8836 = 1 and
   - Node 2: p8836 = 2
3. Define the send data (node 1)
   - For node 1/DO VECTOR, define the PZD to be sent:
     p2051.0 = Drive1:r0898, p2061.1 = Drive1:r0079, p2061.3 = Drive1:r1150
   - Assign this PZD to the send buffer (p8871) of its own DO:
     p8871.0 = 1, p8871.1 = 2, p8871.2 = 3, p8871.3 = 4, p8871.4 = 5

This means that you have defined the position of the data in the 16-word telegram of the drive unit.

1. Define the send data (node 2)
   - For node 2/DO VECTOR, define the PZD to be sent:
     p2051.0 = Drive1:r0898
   - Assign this PZD 1 to send buffer 0 (p8871) of its own DO:
     p8871.0 = 1
2. Define the receive data (node 1)
   - Define that receive buffer 0 should be filled with data from node 2:
     p8872.0 = 2
   - Define that PZD 1 of node 2 should be saved in this buffer:
     p8870.0 = 1
   - r2050.0 now contains the value of PZD 1 of node 2.

3. Define the receive data (node 2)
   - Define that receive buffers 0 to 4 should be filled with data from node 1:
     p8872.0 = 1, p8872.1 = 1, p8872.2 = 1, p8872.3 = 1, p8872.4 = 1
   - Define that PZD 1, PZD 2 and PZD 3 of node 1 should be saved in these buffers:
     p8870.0 = 1, p8870.1 = 2, p8870.2 = 3, p8870.3 = 4, p8870.4 = 5
   - r2050.0, r2060.1 and r2060.3 now contain the values from PZD 1, PZD 2 and PZD 3 of node 1.
4. For both nodes, perform a POWER ON in order to activate the SINAMICS Link connections.

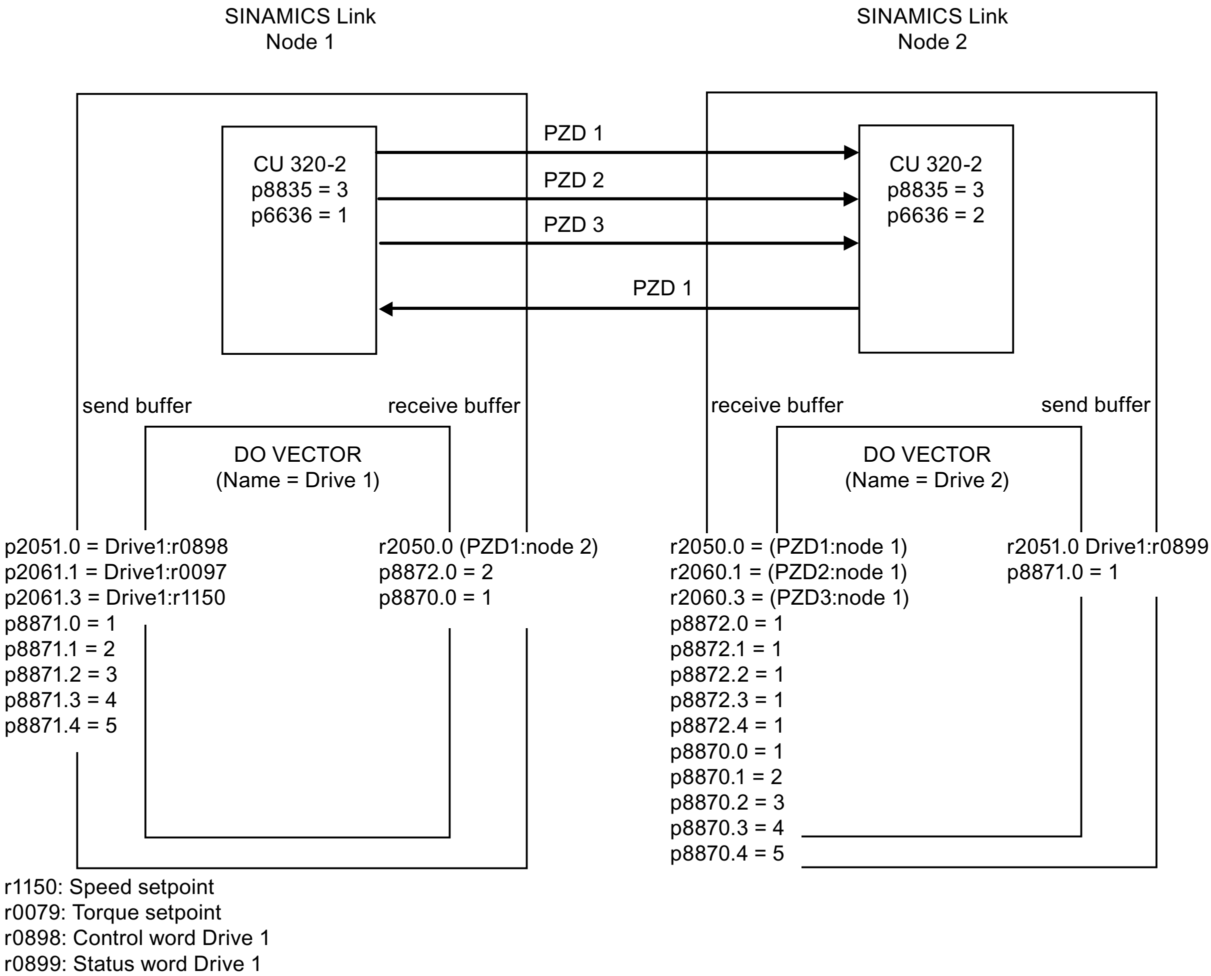


Figure 6-29 SINAMICS Link: Configuration example

6.8.5 Diagnostics

Communication failure when booting or in cyclic operation

If at least one sender does not correctly boot after commissioning or fails in cyclic operation, then alarm A50005 is output to the other nodes: "Sender was not found on the SINAMICS Link."
The message contains the number of the faulted node. After you have resolved the fault at the node involved and the system has identified the node, the system automatically withdraws the alarm.

If several nodes are involved, the message occurs a multiple number of times consecutively with different node numbers. After you have resolved all of the faults, the system automatically withdraws the alarm.

When a node fails in cyclic operation, in addition to alarm A50005, fault F08501 is output: "COMM BOARD: Monitoring time, process data expired".

6.8.6 Parameters

- r2050[0...19] CO: IF1 PROFIdrive PZD receive word
- p2051[0...14] CI: IF1 PROFIdrive PZD send word
- r2060[0...18] CO: IF1 PROFIdrive PZD receive double word
- p2061[0...26] CI: IF1 PROFIdrive PZD send double word
- p8835 CBE20 firmware selection
- p8836 SINAMICS Link address
- p8870 SINAMICS Link telegram word PZD receive
- p8871 SINAMICS Link telegram word PZD send
- p8872 SINAMICS Link address PZD receive

6.9 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

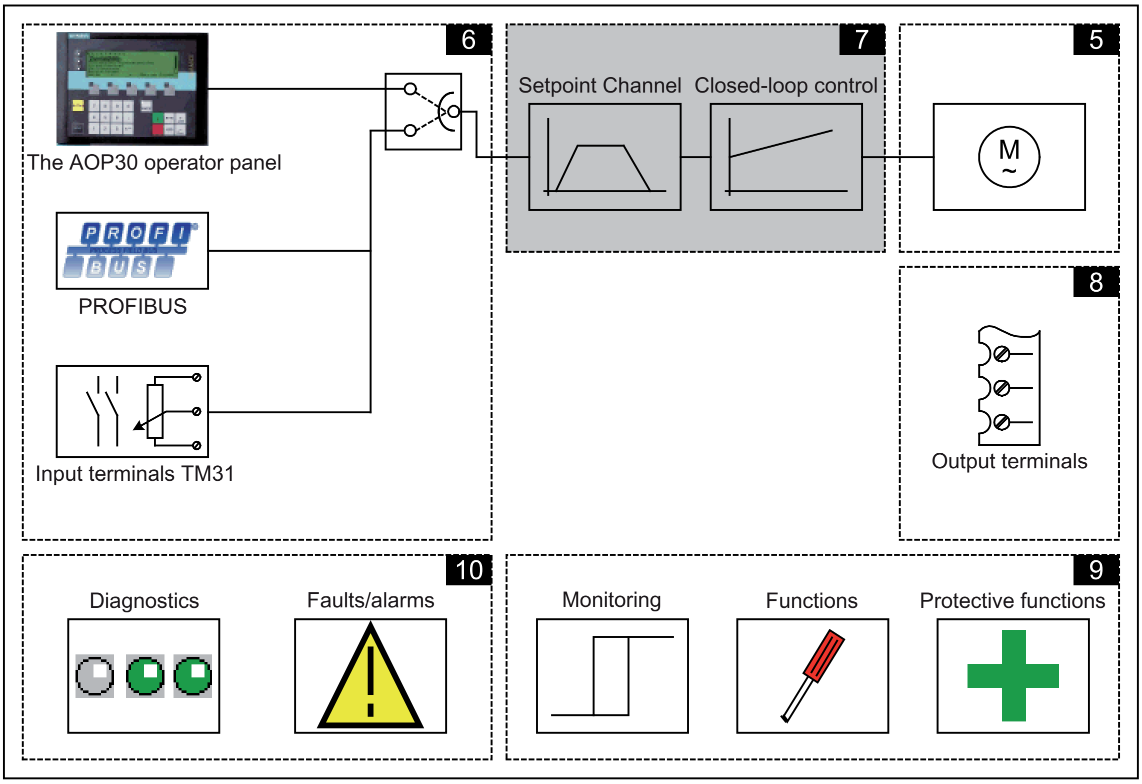
A detailed description of the DCC Editor and the available Drive Control Blocks is given in the relevant documentation. This documentation is available on the CD.

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 limitation
  - Ramp-function generator
- V/f control
- Vector speed control with / without encoder



Function diagrams

To supplement these operating instructions, the CD contains simplified function diagrams describing the operating principle.
The diagrams are arranged in accordance with the chapters in the operating instructions. The page numbers (7xx) describe the functionality in the following chapter.

At certain points in this chapter, reference is made to function diagrams with a 4-digit number. These are stored on the documentation CD 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 implemented using the summing point of 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

FD 3030 Main/added 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 with the same setpoint polarity.

Use the p1110 or p1111 parameter to block negative or positive direction of rotation.

Note

If an incorrect rotating field was connected when the cables were installed, and the rotating field cannot be corrected by swapping the motor cables, it can be corrected when commissioning the drive via p1821 (rotating field direction reversal) by changing the rotating field and thus enabling a direction reversal (see section "Direction reversal").

Prerequisites

Direction reversal is triggered:

- via PROFIBUS by means of control word 1, bit 11
- via the cabinet operator panel (LOCAL mode) with the "Direction reversal" key.

Note

Note that only one direction of rotation is enabled in the delivery condition when control is carried out via the AOP30.

Function diagram

FP 3040 Direction of rotation limiting and direction of rotation changeover

Parameters

- p1110 Inhibit negative direction
- p1111 Inhibit positive direction
- p1113 Direction reversal

7.2.3 Skip speeds and minimum speeds

Description

Variable-speed drives can generate critical whirling speeds within the control range of the entire drive train. This prevents steady-state operation in their proximity; 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 whirling speeds occur in a drive train can vary depending on age or thermal factors, a broader control range must be blocked. To ensure that the speed does not constantly increase and decrease in the suppression bandwidth (speeds), the bands are assigned a hysteresis.

Specifying a minimum speed allows a specific range to be disabled around speed 0 rpm for steady-state operation.

Signal flow diagram

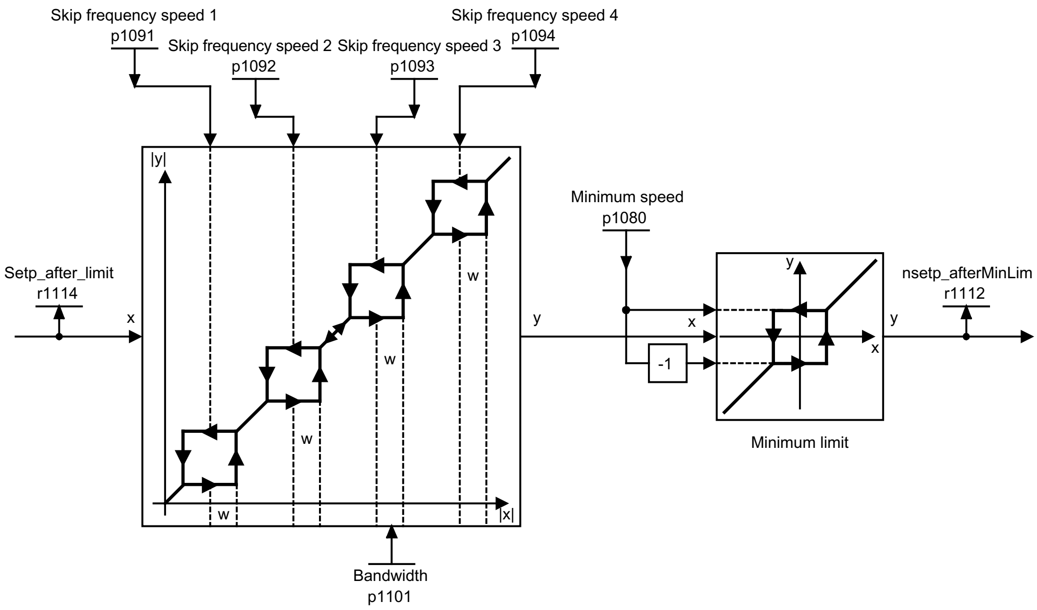


Figure 7-1 Signal flow diagram: Skip frequency speeds and minimum speeds

Function diagram

FP 3050 Skip frequency bands and speed limiting

Parameter

- p1080 Minimum speed
- p1091 Skip frequency speed 1
- p1092 Skip frequency speed 2
- p1093 Skip frequency speed 3
- p1094 Skip frequency speed 4
- p1101 Skip frequency speed bandwidth
- r1112 Speed setpoint after minimum limiting

7.2.4 Speed limitation

Description

Speed limitation aims 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

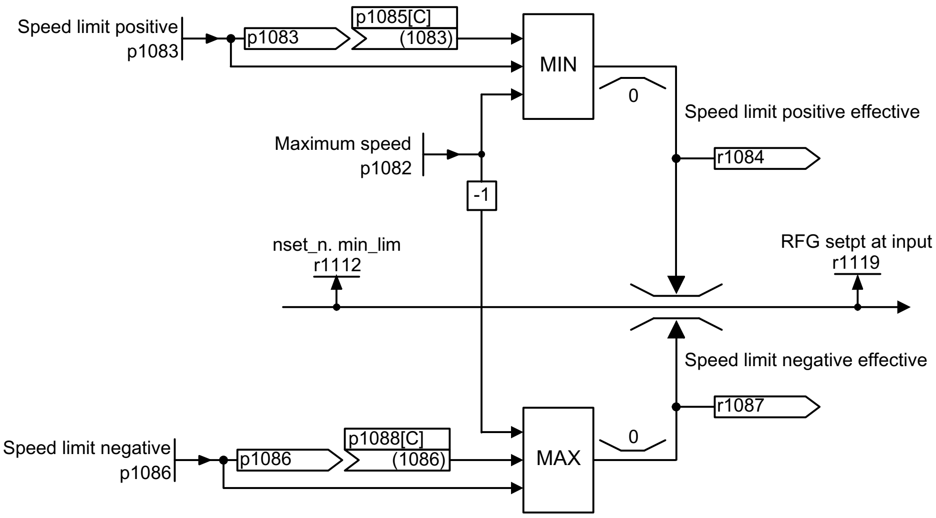


Figure 7-2 Signal flow diagram: Speed limitation

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 excessive setpoint step changes from damaging 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 actual speed value from being overshot when the setpoint is approached, thereby improving control quality.

Notice: if rounding times are too long, this can cause the setpoint to be overshot if the setpoint is reduced abruptly during ramp-up. 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 start rounding, the ramp-up time, and end rounding. Rounding times that can be set separately are active in the event of a fast 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.

Note

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

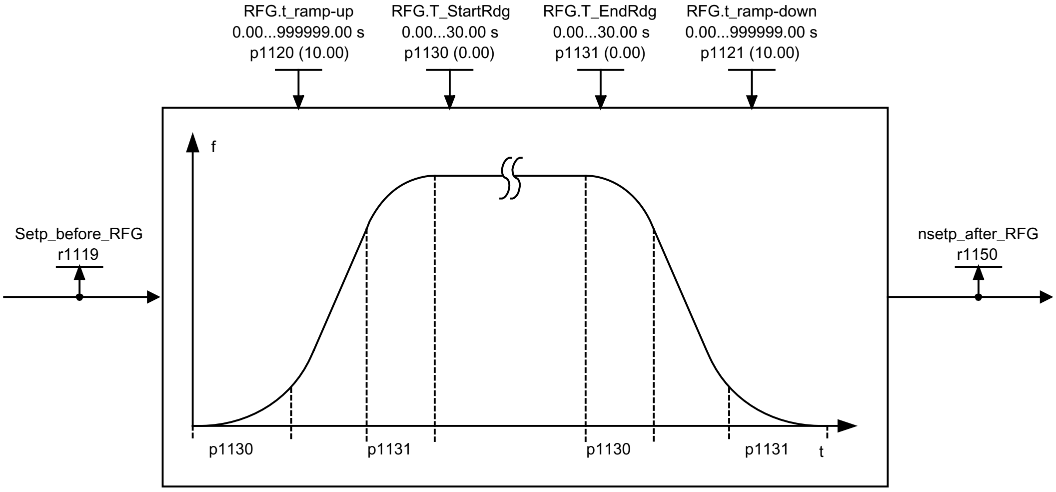


Figure 7-3 Signal flow diagram: Ramp-function generator

Ramp-function generator tracking

If the drive is in range of the torque limits, the actual speed value moves away from the speed setpoint. The ramp-function generator tracking updates the speed setpoint in line with the actual speed value and so levels the ramp.

p1145 can be used to deactivate ramp-function generator tracking (p1145 = 0) or to set the permissible deviation (p1145 > 1). If the permissible deviation is reached, then the speed setpoint at the ramp-function generator output will only be increased further in proportion to the speed setpoint.

Parameter r1199.5 displays whether the ramp-function generator tracking is active.

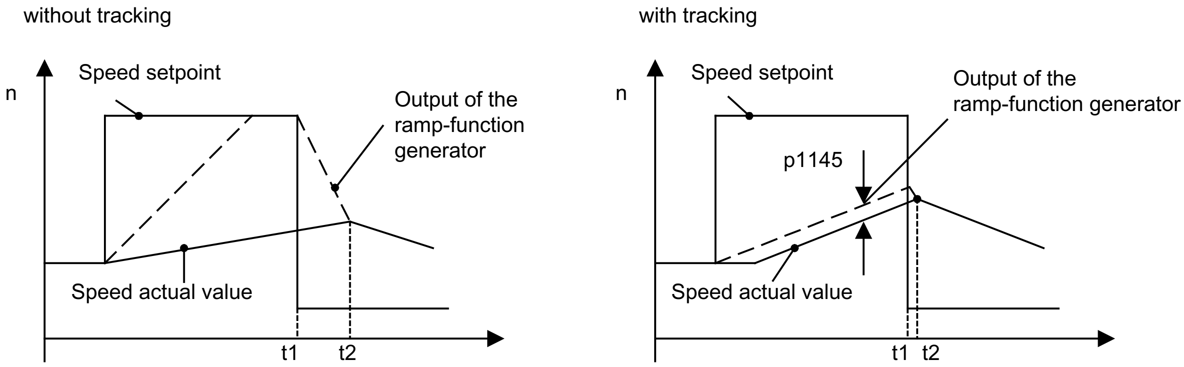


Figure 7-4 Ramp-function generator tracking

Without ramp-function generator tracking

- p1145 = 0
- Drive accelerates to t2, although 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 actual speed value by the deviation value defined in p1145.
- t1 and t2 are almost identical

Function diagram

FP 3060	Simple ramp-function generator
FP 3070	Extended ramp-function generator
FP 3080	Ramp-function generator selection, status word, tracking

Parameters

- r1119 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
- p1145 Ramp-function generator tracking intensity
- r1150 Ramp-function generator speed setpoint at the output
- p1151 Ramp-function generator configuration

7.3 V/f 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 proved 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 (U) to frequency (f).

$\Phi \sim I\mu \sim V/f$

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.

$M \sim \Phi \times I$

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.

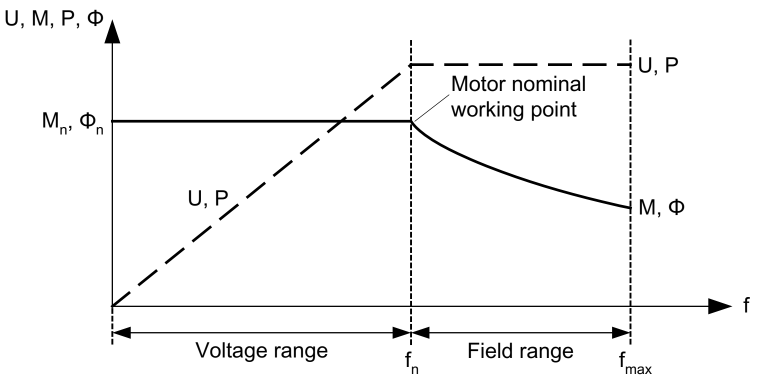
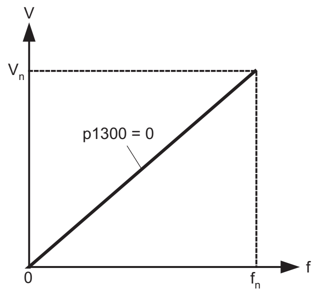
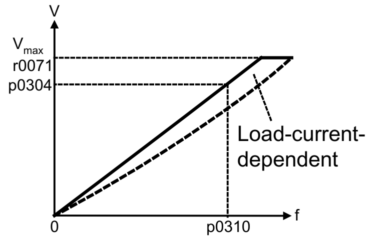
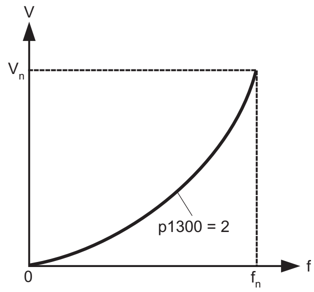
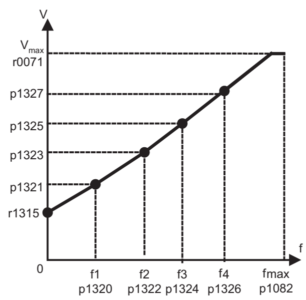


Figure 7-5 Operating areas and characteristic curves for the induction motor with converter supply

Several variations of the V/f characteristic exist, which 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 constant operating point. • At constant operating point, the efficiency is optimized by varying the voltage. • Active slip compensation is necessary here; the scaling must be set so that the slip is fully compensated (p1335 = 100%).
5	Precise frequency drives (textiles)	Characteristic (see parameter value 0) that takes into account the specific technological features of an application (e.g. textile applications). • The current limitation (Imax controller) only affects the output voltage and not the output frequency. • The slip compensation and resonance damping are disabled.

<table>
<tr><th>Parameter value</th><th>Meaning</th><th>Application / property</th></tr>
<tr><td>6</td><td>Precise frequency drives with flux current control (FCC)</td><td>Characteristic (see parameter value 1) that takes into account the specific technological features of an application (e.g. textile applications).
The current limitation (Imax controller) only affects the output voltage and not the output frequency.
The slip compensation and resonance damping are disabled.
Voltage losses in the stator resistance for static / dynamic loads are also compensated (flux current control, FCC). This is particularly useful for small motors, since they have a relatively high stator resistance.</td></tr>
<tr><td>7</td><td>Parabolic characteristic and ECO</td><td>Characteristic (see parameter value 1) and ECO mode at constant operating point.
At constant operating point, the efficiency is optimized by varying the voltage.
Active slip compensation is necessary here; the scaling must be set so that the slip is fully compensated (p1335 = 100%).</td></tr>
<tr><td>19</td><td>Independent voltage setpoint</td><td>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]).</td></tr>
</table>

Function diagram

FP 6300 V/f characteristic and voltage boost

Parameters

- p1300 Open-loop/closed-loop control operating mode

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.

The output voltage may, however, 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). In addition, a one-off voltage boost in the first power up after pulse enable can be set via p1312.

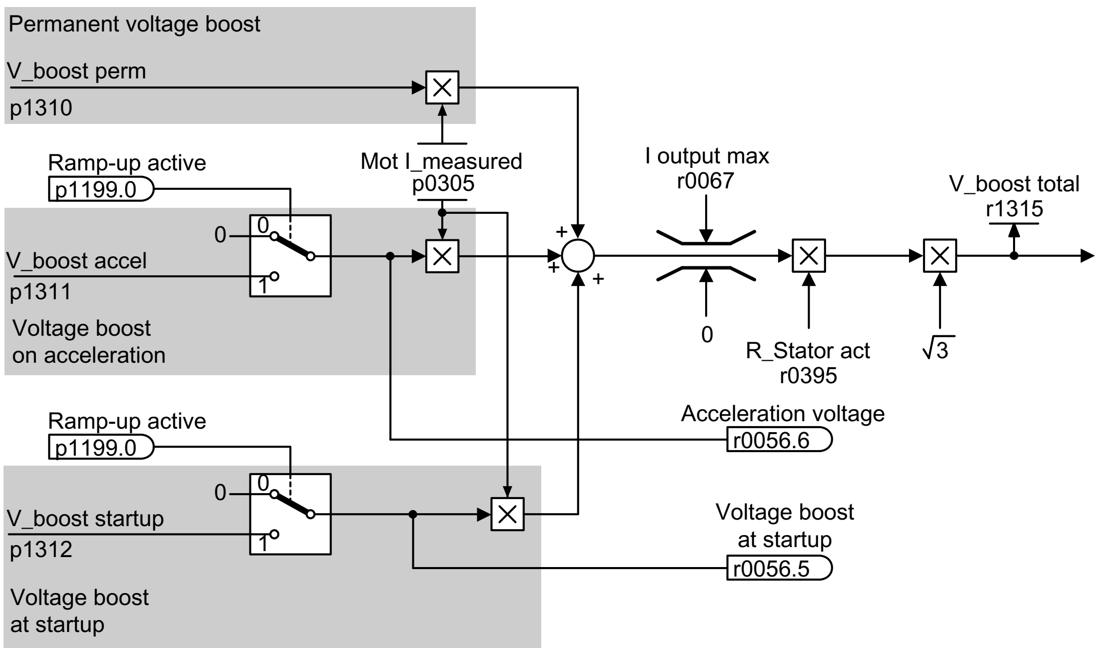


Figure 7-6 Voltage boost total

Note

The voltage boost affects all V/f characteristics (p1300) from 0 to 7.

NOTICE
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.

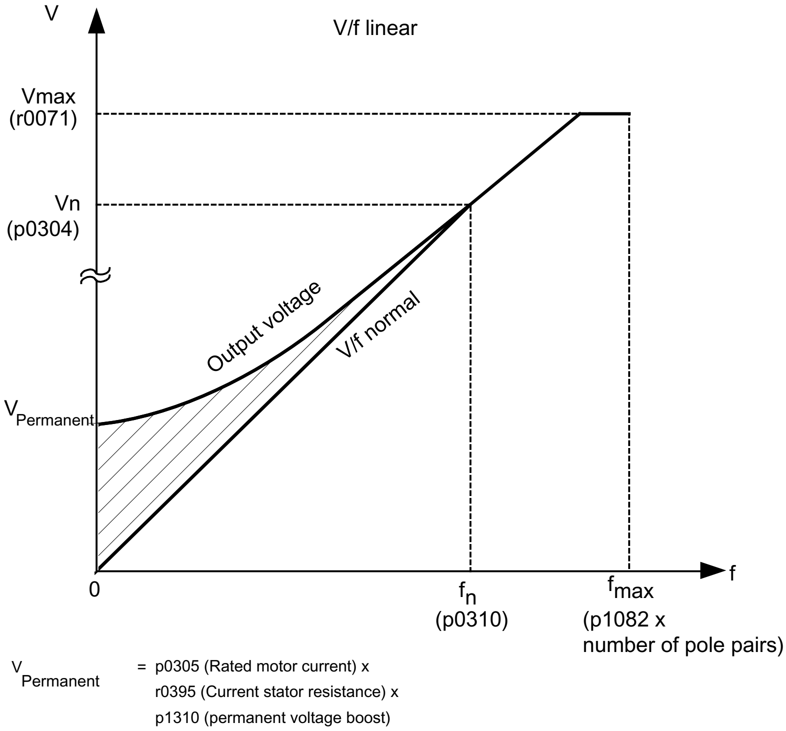


Figure 7-7 Permanent voltage boost (example: p1300 = 0, p1310 >0, p1311 = p1312 = 0)

Voltage boost during acceleration (p1311)

The voltage boost is only effective for one acceleration operation and only until the setpoint is reached.

Voltage boost is only effective if the signal "ramp-up active" (r1199.0 = 1) is present.

You can use parameter r0056.6 to observe whether the voltage boost is active during acceleration.

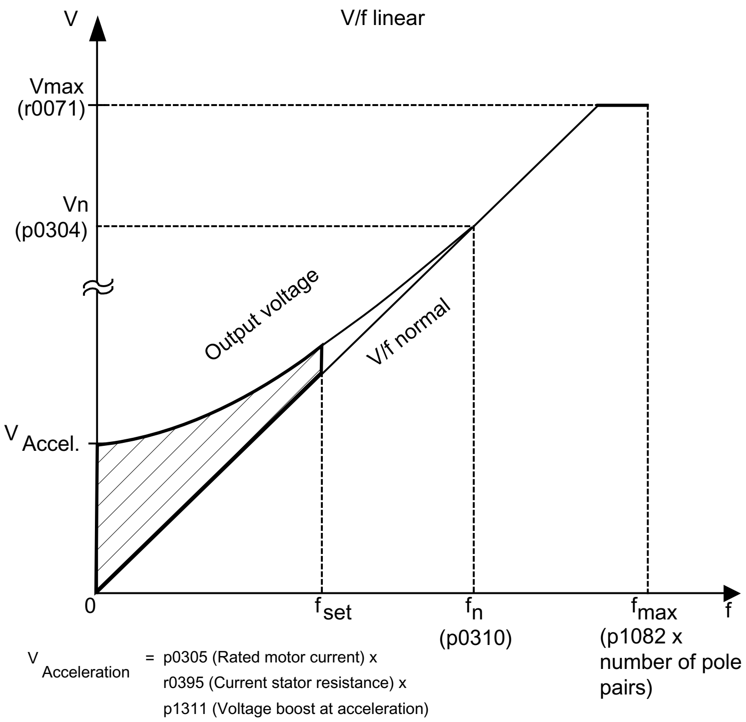


Figure 7-8 Voltage boost during acceleration (example: p1300 = 0, p1310 = 0, p1311 > 0)

Voltage boost at startup (p1312)

The voltage boost is only effective for the first acceleration operation after pulse enable and only until the setpoint is reached.

Voltage boost is only effective if the signal "ramp-up active" (r1199.0 = 1) is present.

You can use parameter r0056.5 to observe whether the voltage boost is active at startup.

Function diagram

FP 6300 V/f characteristic and voltage boost

Parameters

- r0056.5 Voltage boost at startup active/inactive

- r0056.6 Acceleration voltage active/inactive
- p0304 Rated motor voltage
- p0305 Rated motor current
- r0395 Stator resistance, actual
- p1310 Permanent voltage boost
- p1311 Voltage boost during acceleration
- p1312 Voltage boost at start up
- r1315 Voltage boost total

7.3.2 Resonance damping

Description

Resonance damping damps oscillations in the active current, which often occur during no-load operation. Resonance damping is active in the range between approximately 5% and 90% of the rated motor frequency (p0310), up to 45 Hz at most, however.

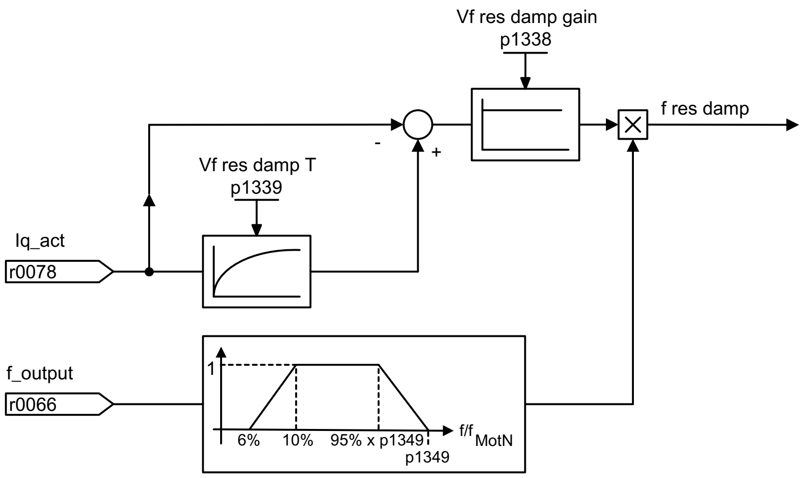


Figure 7-9 Resonance damping

Note

At p1349 = 0 the switching limit is automatically set to 95% of the rated motor frequency, up to 45 Hz at most, however.

Function diagram

FP 6310 Resonance damping and slip compensation

Parameters

- r0066 Output frequency
- r0078 torque-generating actual current value
- p1338 Resonance damping gain
- p1339 Resonance damping filter time constant
- p1349 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).
For an increase in the load from M_1 to M_2, the setpoint frequency is automatically increased so that the resulting frequency and therefore the motor speed remains constant. For a decrease in the load from M_2 to M_1, the setpoint frequency is automatically decreased accordingly.

If a motor holding brake is applied, a setting value can be specified at the slip compensation output via p1351. If parameter p1351 > 0 then the slip compensation is switched on automatically (p1335 = 100%).

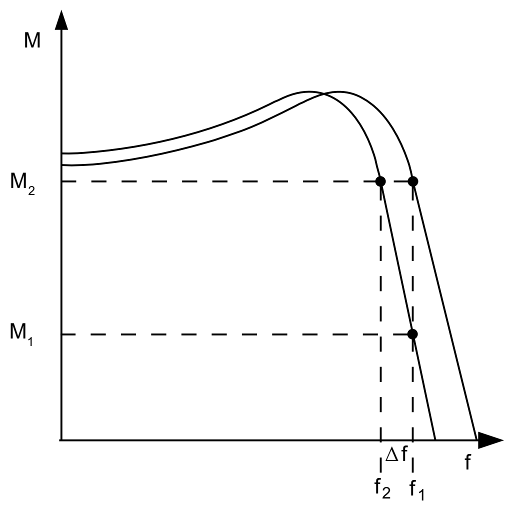


Figure 7-10 Slip compensation

Function diagram

FP 6310 Resonance damping and slip compensation

Parameters

- r0330 Rated motor slip
- p1334 Slip compensation start frequency
- p1335 Slip compensation
  p1335 = 0.0%: slip compensation is deactivated.
  p1335 = 100.0%: slip is fully compensated.
- p1336 Slip compensation limit value
- r1337 Actual slip compensation
- p1351 CO: Motor holding brake start frequency

7.4 Vector speed/torque control with/without 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:

- Speed control
- Torque/current control (in short: torque control)

7.4.1 Vector control without encoder

Description

For sensorless vector control only (SLVC: Sensorless Vector Control), the position of the flux and actual speed must be determined via the electric motor model. The model is buffered by the incoming currents and voltages. At low frequencies (approx. 1 Hz), the model cannot 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).

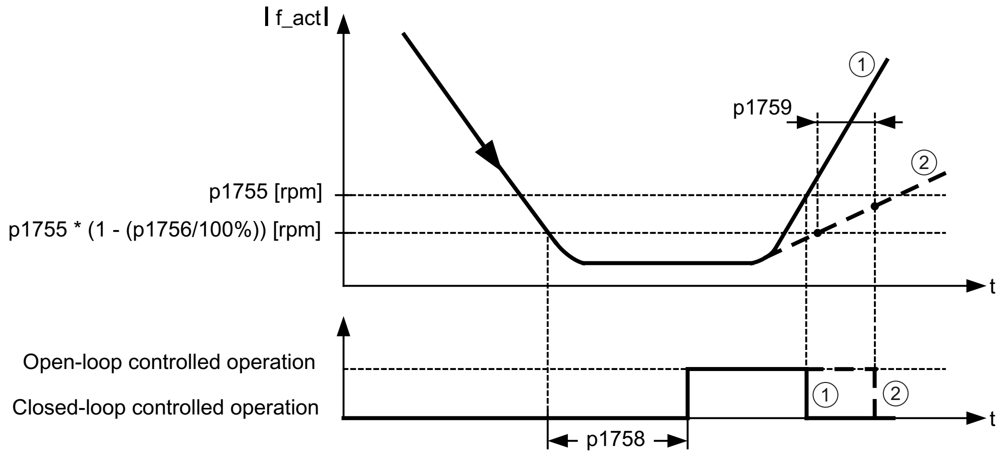


Figure 7-11 Changeover conditions

In open-loop operation, the calculated actual speed value is the same as the setpoint value. For vertical loads and acceleration processes, parameters p1610 (constant torque boost) and p1611 (acceleration torque boost) must be adjusted 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 pre-control absolute value derived from the supplementary torque r1515 remains instead of the magnetizing current. To ensure that the drive does not stall during acceleration, p1611 can be increased or acceleration pre-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.

Vector control without a speed sensor has the following characteristics at low frequencies:

- Closed-loop operation up to approx. 1 Hz output frequency
- Starting in closed-loop operation (directly after the drive has been energized) (induction motors only)

Note

In this case, the speed setpoint upstream of the ramp-function generator must be greater than the changeover speed in p1755.

Closed-loop operation up to approx. 1 Hz (settable via parameter p1755) and the ability to start or reverse at 0 Hz directly in closed-loop operation (settable via parameter p1750) result in the following benefits:

- No changeover required within closed-loop control (smooth operation, no dips in frequency).
- Stationary speed–torque control up to approx. 1 Hz.

Note

When the motor is started or reversed in closed-loop control at 0 Hz, it is important to take into account that a switchover is made from closed-loop to open-loop control automatically if the system remains in the 0 Hz range for too long (> 2 s or > p1758, if p1758 > 2 s).

Closed-loop operation down to standstill for passive loads

By restricting to a passive load at the starting point, it is possible to maintain stationary 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 passive 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 impressed.

Steady-state regenerative operation at a frequency close to zero is not possible.

It is also possible to select sensorless control for passive loads during commissioning by setting p0500 = 2 (technology application = passive loads (for sensorless 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).

Permanent-magnet synchronous motors

Standard procedure: open-loop controlled operation at low speeds

Normally, permanent-magnet synchronous motors are started and reversed in open-loop controlled 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.

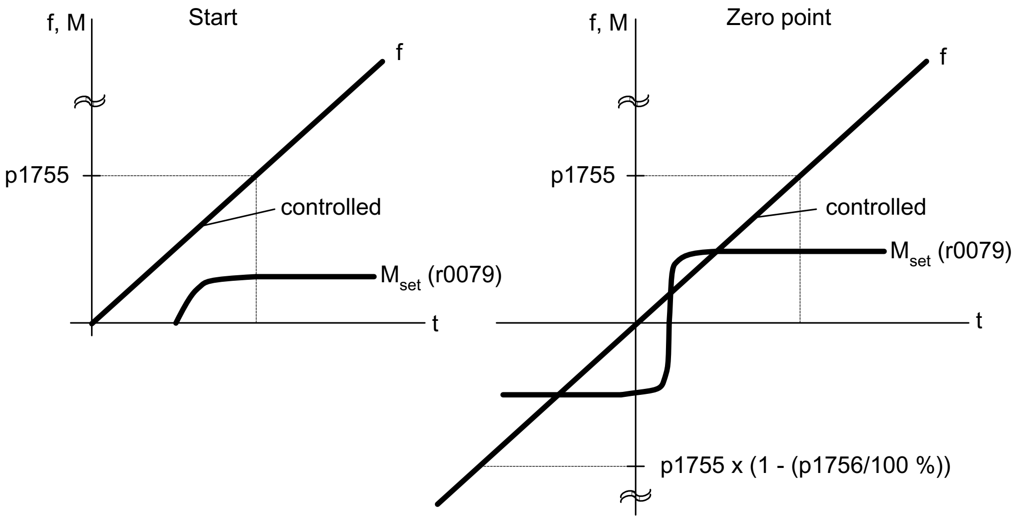


Figure 7-12 Zero crossing in open-loop controlled operation at low speeds

Extended procedure: closed-loop controlled operation to zero speed

By superimposing high-frequency pulses on the driving fundamental voltage and evaluating the resulting offset pulse in the machine current, it is possible to determine the continuous rotor position up to frequency zero (standstill).

1FW4 and 1PH8 series Siemens torque motors can be started from standstill with any load up to the rated torque or even hold the load at standstill.

The procedure is suitable for motors with internal magnets.

Note

If a sinewave filter is used, the open-loop controlled procedure should be used.

The following advantages are obtained by maintaining closed-loop controlled operation:

- No switchover required within closed-loop control (smooth switching, no discontinuities in the torque).
- Closed-loop speed and torque control without encoder (sensorless) up to and including 0 Hz.
- Higher dynamic performance when compared to open-loop controlled operation.
- Encoderless operation of drive line-ups (e.g. in the paper industry, master-slave operation).
- Active (including hanging/suspended) loads down to zero frequency.

Supplementary conditions for the use of third-party motors:

- Experience shows that the procedure is very suitable for motors with magnets within the rotor core (IPMSM - Interior Permanent Magnet Synchronous Motors).
- The ratio of stator quadrature reactance (Lsq): Stator direct-axis reactance (Lsd) must be > 1 (recommendation: at least > 1.5).
- The possible operating limits of the procedure depend upon up to what current the asymmetrical reactance ratio (Lsq:Lsd) is retained in the motor. If the procedure should be operable up to the rated motor torque, then the reactance ratio must be retained up to the rated motor current.

A prerequisite for optimum behavior is the entry of the following parameters:

- Enter the saturation characteristic: p0362 - p0369
- Enter the load characteristic: p0398, p0399

Commissioning sequence for closed-loop controlled operation to zero speed:

- Run through the commissioning with motor identification at standstill.
- Enter the parameters for the saturation characteristic and the load characteristic.
- Activate closed-loop controlled operation to zero speed via parameter p1750 bit 5.

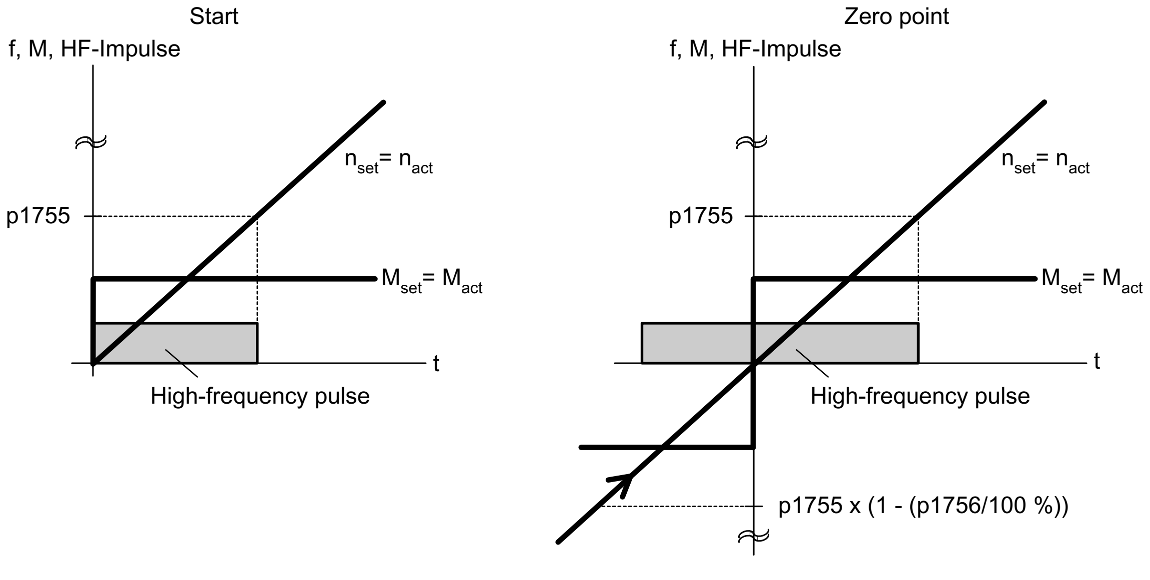


Figure 7-13 Zero crossing in closed-loop controlled operation to zero speed

Function diagram

FP 6730 Interface to Motor Module (ASM), p0300 = 1)
FP 6731 Interface to 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 Calculating technology/unit-dependent parameters
- p1605 Pulse technique pattern configuration
- r1606 CO: Actual pulse technique pattern
- p1607 Pulse technique stimulus
- r1608 CO: Pulse technique answer
- 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 model 2
- p1798 Motor model pulse technique speed adaptation Kp
- p1810.3 Modulator configuration - current measurement oversampling activated (for pulse technique PEM)

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 current model and the observer model within the speed range p1752 x (100 % - p1756) and p1752. In the current-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 supplementary conditions: For example, if a KTY sensor is not used for temperature detection and the ambient temperatures fluctuate significantly or the overtemperatures of the motor (p0626 ... 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
FD 6030	Speed setpoint, droop
FP 6040	Speed controller
FP 6050	Kp_n-/Tn_n adaptation
FP 6060	Torque setpoint
FP 6490	Speed control configuration

7.4.3 Speed controller

Description

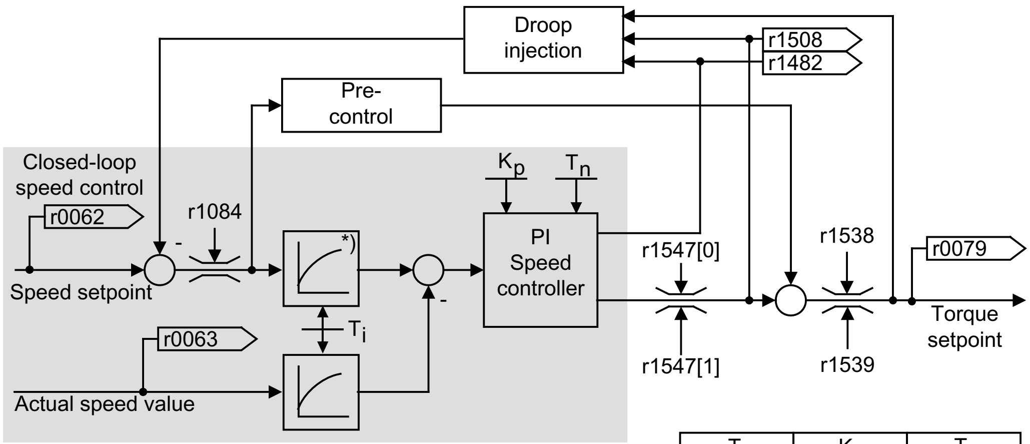
Both closed-loop control techniques with and without encoder (SLVC, VC) have the same speed controller structure that contains the following components as kernel:

- PI controller
- Speed controller pre-control
- Droop Function

The torque setpoint is generated from the total of the output variables and reduced to the permissible magnitude by means of torque setpoint limitation.

The speed controller receives its setpoint (r0062) from the setpoint channel and its actual value (r0063) either directly from the speed actual value encoder (vector control with encoder) or indirectly via the motor model (encoderless vector control). The system difference is increased by the PI controller and, in conjunction with the pre-control, results in the torque setpoint.

When the load torque increases, the speed setpoint is reduced proportionately when the droop function 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.



*) only active if pre-control is active (p1496 > 0)

	T_i	K_p	T_n
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 parameterization (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.
- Although reducing Tn will also speed up the controller, it will increase overshoot.

When setting 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 remember that 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

In comparison with speed control with an encoder, the dynamic response of drives without an encoder is significantly reduced. The actual speed is derived by means of a model calculation based on the converter 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

Parameter

- r0062 CO: Speed setpoint after the filter
- r0063 CO: Actual speed value smoothed
- p0340 Automatic calculation, control parameters
- r0345 CO: Rated motor startup time
- p1442 Speed-actual-value smoothing time (VC)
- p1452 Speed-actual-value smoothing time (encoderless VC)
- 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: Torque output I speed controller
- r1508 CO: Torque setpoint before supplementary torque
- p1960 Speed controller optimization selection

Examples of speed controller settings

A few examples of speed controller settings with vector control without encoders (p1300 = 20) are provided below. These should not be considered to be generally valid and must be checked in terms of the control response required.

- **Fans (large centrifugal masses) and pumps**

  Kp (p1470) = 2 … 10

  Tn (p1472) = 250 … 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.

- **Stone mills, separators (large centrifugal masses)**

  Kp (p1470) = 12 … 20

  Tn (p1472) = 500 … 1000 ms

- **Kneader drives**

  Kp (p1470) = 10

  Tn (p1472) = 200 … 400 ms

  Note

  We recommend checking the effective speed control gain (r1468) during operation. If this value changes during operation, the Kp adaptation is being used (p1400.5 = 1). Kp adaptation can if necessary be deactivated or its behavior changed.

- **When operating with encoder (p1300 = 21)**

  A smoothing value for the actual speed value (p1442) = 5 … 20 ms ensures quieter operations for motors with gear units.

7.4.3.1 Speed controller pre-control (integrated pre-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 line side of the speed controller. This torque setpoint mv is applied to the current controller/the current controller is pre-controlled using adaptation elements directly as additive reference variable (enabled via p1496).
The torque setpoint (mv) is calculated from:

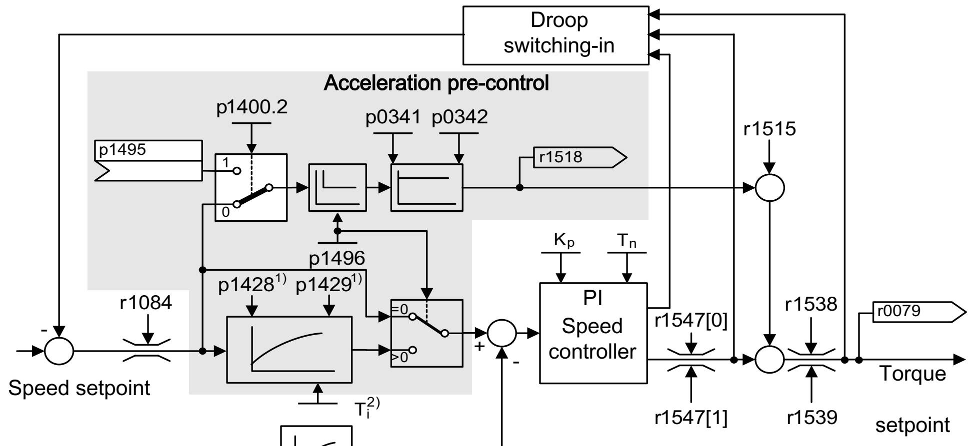
mv = p1496 x J x (dω/dt) = p1496 x p0341 x p0342 x (dω/dt), ω = 2πf

The motor moment of inertia p0341 is calculated when commissioning the drive system. 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.

Note

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 pre-control scaling (p1496) is set to 100 %.

If p1400.2 = p1400.3 = 0, then the pre-control balancing is automatically set.



	$T_i^{2)}$	K_p	T_n
SLVC:	p1452	p1470	p1472
VC:	p1442	p1460	p1462

1) only effective if p1400.2 = 1
2) only effective if p1400.2 = 0

Figure 7-15 Speed controller with pre-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 pre-control variable can be adapted according to the application using the weighting factor p1496. For p1496 = 100%, pre-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 acting against the injected torque setpoint. The time constant of the balancing filter corresponds to the equivalent delay time of the speed control loop. Speed controller pre-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, pre-control allows a new speed setpoint to be approached without overshoot (prerequisite: torque limiting does switch in and the moment of inertia remains constant).

If the speed controller is pre-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 pre-control is activated, the speed setpoint must be specified continuously or without a higher interference level (avoids sudden torque changes). An appropriate signal can be generated by smoothing the speed setpoint or activating 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 unloaded 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

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 pre-control.

Acceleration pre-control using a connector input (p1495) is activated by the parameter settings p1400.2 = 1 and p1400.3 = 0. p1428 (dead time) and p1429 (time constant) can be set for balancing purposes.

Function diagram

FP 6031 Pre-control balancing reference/acceleration model

Parameter

- 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 pre-control source
- p1428 Speed pre-control balancing dead time
- p1429 Speed pre-control balancing time constant
- p1496 Acceleration pre-control scaling
- r1518 Acceleration torque

7.4.3.2 Reference model

Description

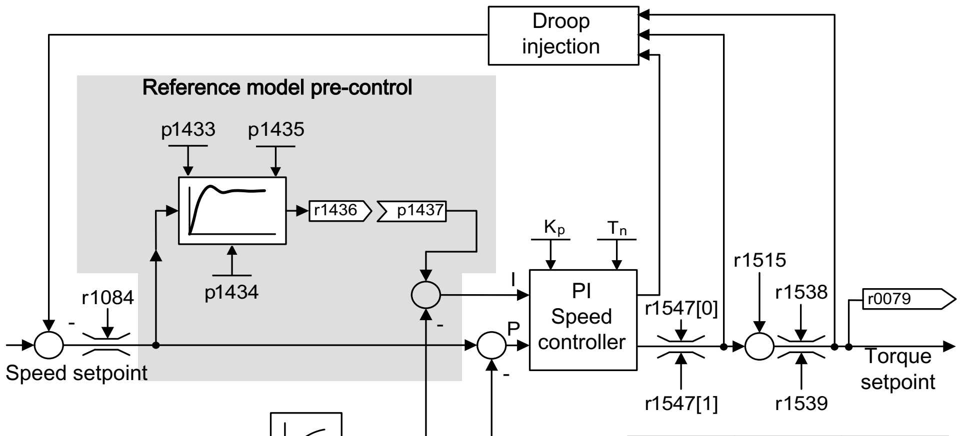
The reference model becomes operative when p1400.3 = 1 and p1400.2 = 0.

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 becomes effective 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.



	T_i	K_p	T_n
SLVC:	p1452	p1470	p1472
VC:	p1442	p1460	p1462

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 dead time
- r1436 Speed controller reference model speed setpoint output
- p1437 Speed controller reference model I component input

7.4.3.3 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.

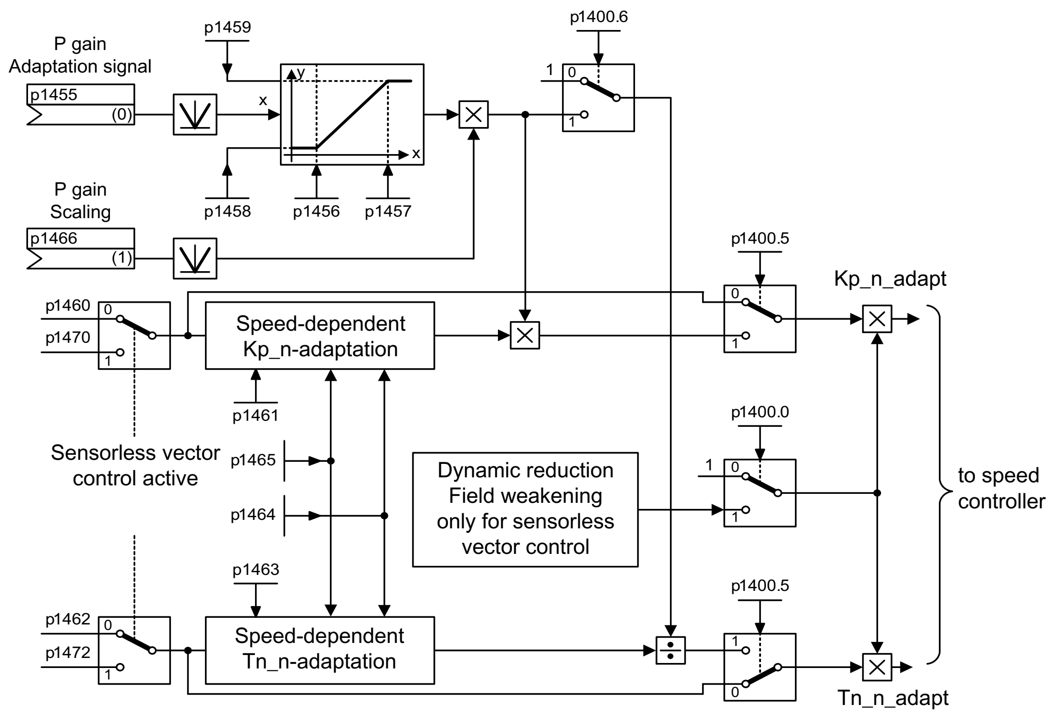


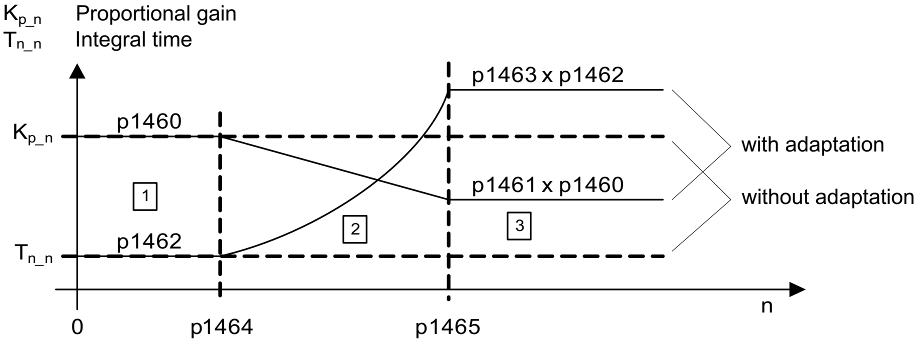
Figure 7-17 Free Kp adaptation

A 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

This type of adaptation is only active in "operation with encoder" mode.



1 Constant lower speed range (n < p1464)

2 Adaptation range (p1464 < n < p1465)

3 Constant upper speed range (n > p1465)

Figure 7-18 Example of speed-dependent adaptation

Function diagram

FP 6050 Kp_n-/Tn_n adaptation

Parameters

- p1400.5 Speed control configuration: Kp/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 amplifier 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 P gain adaptation speed upper
- p1462 Speed controller integral time adaptation speed lower
- p1463 Speed controller integral time adaptation speed upper
- 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

7.4.3.4 Droop Function

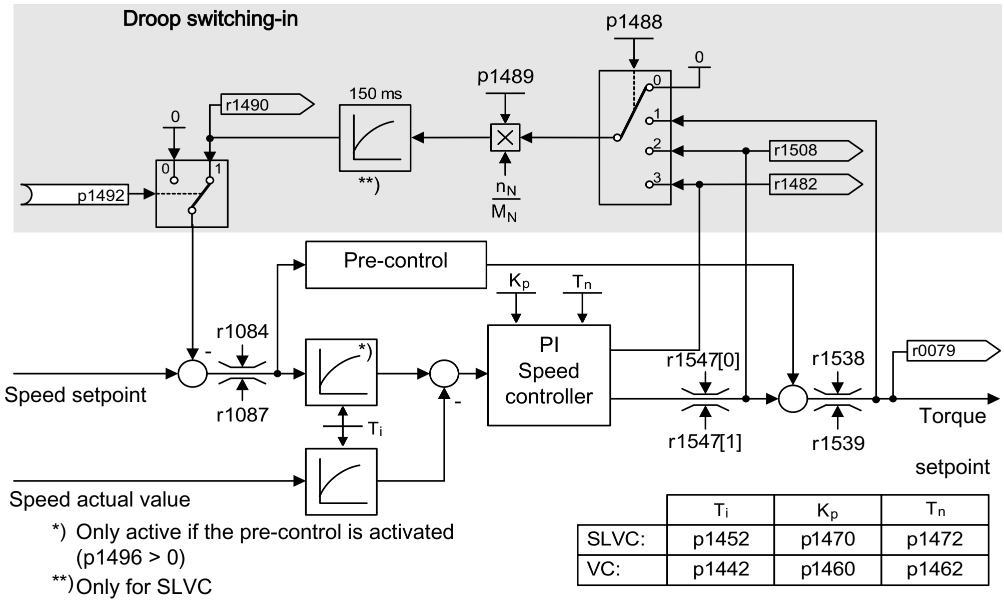
Description

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. guide roller on a goods train). 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).



	T_i	K_p	T_n
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

Parameter

- 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

7.4.3.5 Open actual speed value

Description

The signal source for the open actual speed value of the speed controller is specified via parameter p1440 (CI: speed controller actual speed value). The unsmoothed actual speed value r0063[0] has been preset as the signal source in the factory.

Depending on the machine, parameter p1440 can be used, for example, to switch on a filter in the actual value channel or feed in an external actual speed value.

Parameter r1443 is used to display the actual speed value present at p1440.

Note

When infeeding an external actual speed value, care should be taken that the monitoring functions continue to be derived from the motor model.

Behavior for speed control with an encoder (p1300 = 21)

A motor encoder must always be available for the speed or position signal of the motor model (e.g. evaluation via SMC, see p0400). The actual speed of the motor (r0061) and the position information for synchronous motors still 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, take care that the scaling of the speed is the same (p2000).

The external speed signal should correspond to the average speed of the motor encoder (r0061).

Behavior for speed control without an encoder (p1300 = 20)

Depending on the transmission route of the external speed signal, dead times occur which must be taken into account in the parameterization of the speed controller (p1470, p1472) and correspondingly may lead to dynamic losses.
For this reason, the signal transmission times must be kept as small as possible.

p1750.2 = 1 should be set so that the speed controller is also able to work at standstill (closed-loop controlled operation to zero frequency for passive loads). Otherwise, at low speeds it switches over to speed-controlled operation, so that the speed controller is switched off and the measured actual speed no longer has an influence.

Monitoring of the speed deviation between motor model and external speed

The external actual speed (r1443) is compared with the actual speed of the motor model (r2169). Should the deviation be larger than the tolerance threshold set in p3236, after the switch-off delay time in p3238 has expired the fault F07937 (Drive: Speed deviation motor model to external speed) is generated and the drive is switched off according to the reaction set (factory setting: OFF2).

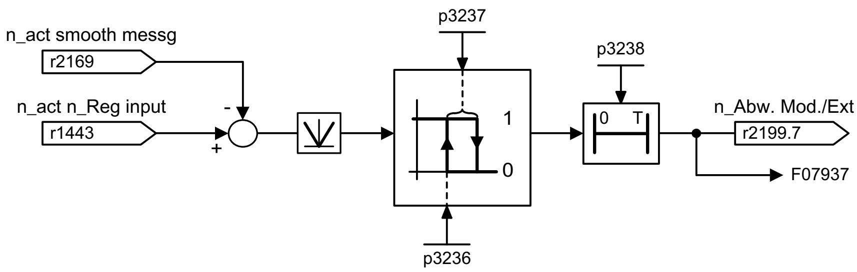


Figure 7-20 Monitoring "Speed deviation model / external in tolerance"

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 value unsmoothed
- p1440 CI: Speed controller actual speed value
- p1443 CO: Actual speed value at speed controller actual speed value input
- r2169 CO: Actual speed value smoothed messages
- r2199.7 Speed deviation model / external in tolerance
- p3236 Speed threshold 7
- p3237 Hysteresis speed 7
- p3238 Switch-off delay n_act_motor model = n_act_external

7.4.4 Closed-loop torque control

Description

For sensorless closed-loop speed control (p1300 = 20) or closed-loop speed control with encoder VC (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 closed-loop speed 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 acts both for closed-loop torque as well as for the closed-loop speed control. As a result of this characteristic, a pre-control torque can be implemented for the closed-loop speed control using the supplementary torque setpoint.

Note

For safety reasons, assignments to fixed torque setpoints are currently not possible.

If energy is regenerated and cannot be injected back into the line supply, then a Braking Module with connected braking resistor must be used.

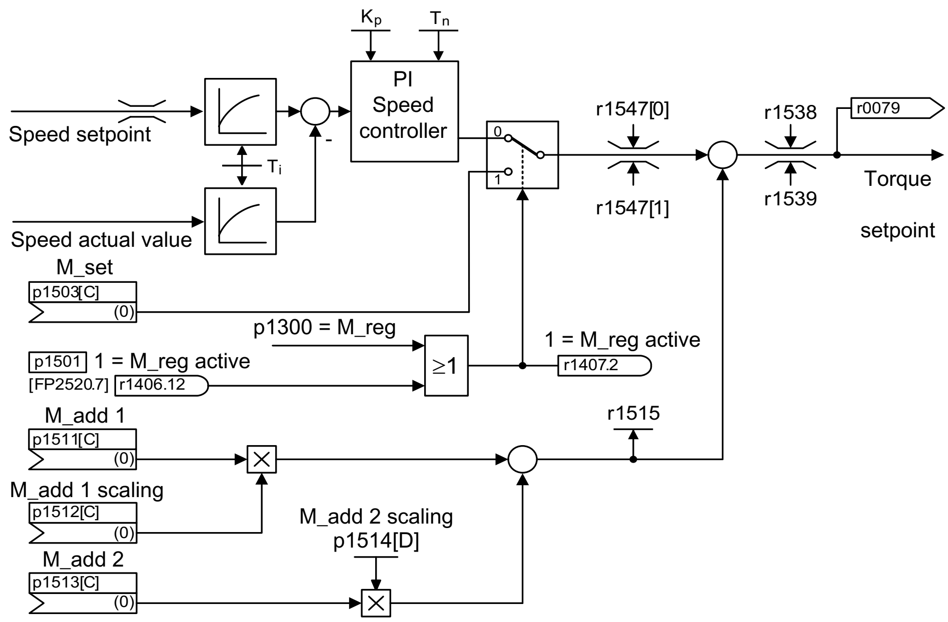


Figure 7-21 Closed-loop speed/torque control

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 sensorless 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 sensorless 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 speed actual value of the speed threshold (p1226) is undershot or when the monitoring time (p1227) started when speed setpoint ≤ speed threshold (p1226) expires.
  - Switching on inhibited is activated.
- OFF2
  - Immediate pulse suppression, the drive coasts to standstill.
  - The motor brake (if parameterized) is closed immediately.
  - Switching on inhibited 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 parameterized) is closed.
  - The pulses are inhibited when the motor brake closing time (p1217) has elapsed. Standstill is detected when the speed actual value of the speed threshold (p1226) is undershot or when the monitoring time (p1227) started when speed setpoint ≤ speed threshold (p1226) expires.
  - Switching on inhibited 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

7.4.5 Torque limiting

Description

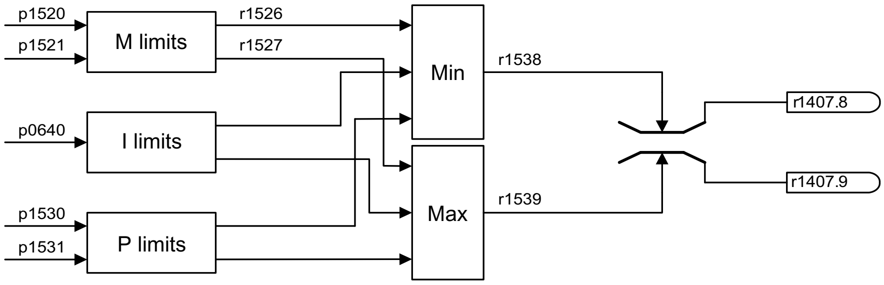


Figure 7-22 Torque limiting

The value specifies the maximum permissible torque whereby 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, regenerating

The currently active torque limit values 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 – that is either available at the speed controller output for closed-loop speed control or as torque input, for closed-loop torque control. The minimum or the maximum is used for the various limits. 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 or indicate the instantaneous max. possible torque. 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

7.4.6 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 complete torque motors of the 1FW3 series. When these drives are used, gear units and mechanical parts subject to wear can be dispensed with if the application allows this.

WARNING

As soon as the motor starts to rotate, a voltage is generated. When work is carried out on the converter, the motor must be safely disconnected. If this is not possible, the motor must be locked by a holding brake, for example.

Features

- Field weakening of up to approx. 1.2 x rated speed (depending on the supply voltage of the converter and motor data, also see supplementary conditions)
- Capture (only when using a VSM module to record the motor speed and phase angle (option K51))
- Speed and torque control vector
- V/f control for diagnostics vector
- Motor identification
- Speed controller optimization (rotary measurement)

Supplementary conditions

- Maximum speed or maximum torque depend on the converter output voltage available and the back EMF of the motor (calculation specifications: EMF must not exceed $U_{rated, converter}$).
- Calculating the maximum speed:
$$n_{max} = n_n \cdot \sqrt{\frac{3}{2}} \cdot \frac{U_{DC\ link\ max} \cdot I_n}{P_n}$$
- 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 by using 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 being 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 type plate

Parameters	Description	Comment
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:

$$k_T = \frac{M_N}{I_N} = \frac{60 \frac{s}{min} \times P_N}{2\pi \times n_N \times I_N} \quad \text{or} \quad k_T = \frac{M_0}{I_0}$$

The optional motor data can be entered if it is known. Otherwise, this data is estimated from the type plate data or determined by means of motor identification or speed controller optimization.

Table 7- 3 Motor data type plate

Parameters	Description	Comment
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 pre-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 converter 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 converter develops a fault with a shutdown response, at the instant in time that the pulses are inhibited, the motor is isolated from the drive converter so that energy is not fed back to the fault location.

Function diagram

FP 6721 Current control - Id setpoint (PEM, p0300 = 2)

FP 6724 Current control – field weakening controller (PEM, p0300 = 2)

FP 6731 Current control - interface to Motor Module (PEM, p0300 = 2)

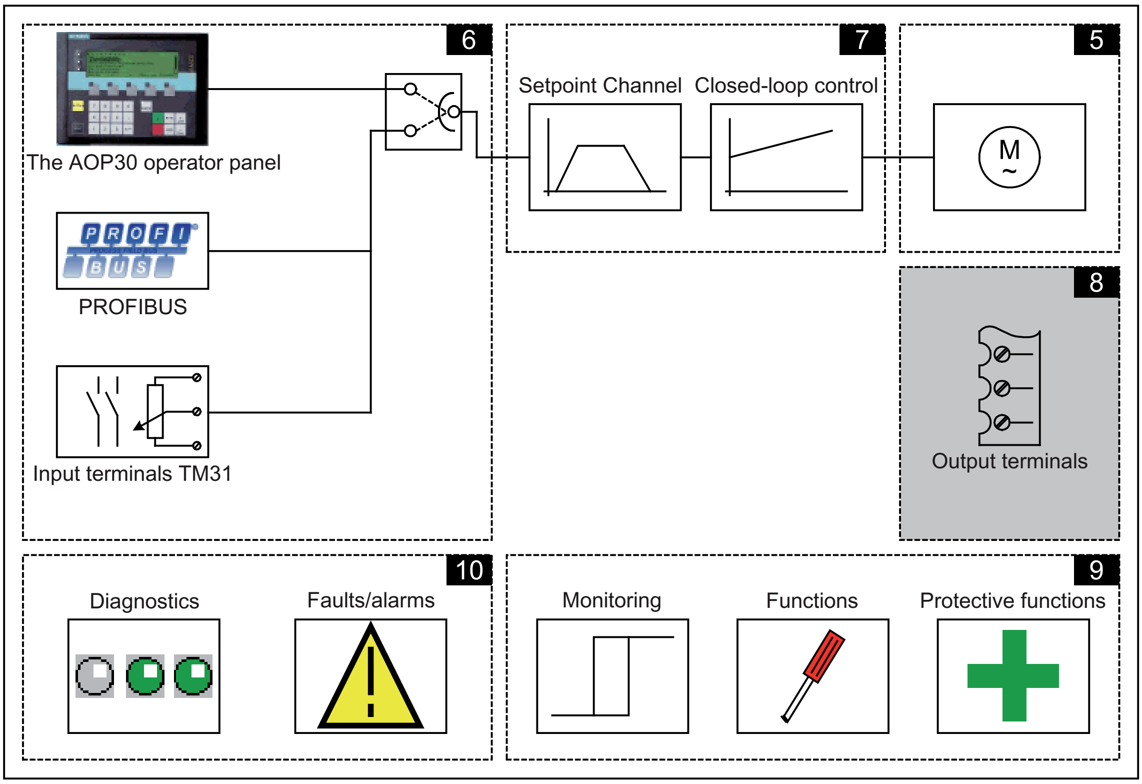
Output terminals

8

8.1 Chapter content

This chapter provides information on:

- Analog outputs
- Digital outputs



Function diagrams

To supplement these operating instructions, the CD contains simplified function diagrams describing the operating principle.
The diagrams are arranged in accordance with the chapters in the operating instructions.
The page numbers (8xx) describe the functionality in the following chapter.

At certain points in this chapter, reference is made to function diagrams with a 4-digit number. These are stored on the CD in the "SINAMICS G130/G150 List Manual", which provides experienced users with detailed descriptions of all the functions.

8.2 TM31 analog outputs

Description

The TM31 terminal block module features two analog outputs for outputting setpoints via current or voltage signals.

Delivery condition:

- AO0: Actual speed value: 0 – 10 V
- AO1: Actual motor current: 0 – 10 V

Prerequisites

- The Power Module, CU320, and TM31 have been correctly installed.
- The "TM31 terminals" or "PROFIdrive+TM31" default setting was chosen during commissioning:

STARTER:	"TM31 terminals" or "PROFIdrive+TM31"
AOP30:	"2: TM31 terminals" or "4: PROFIdrive+TM31"

Signal flow diagram

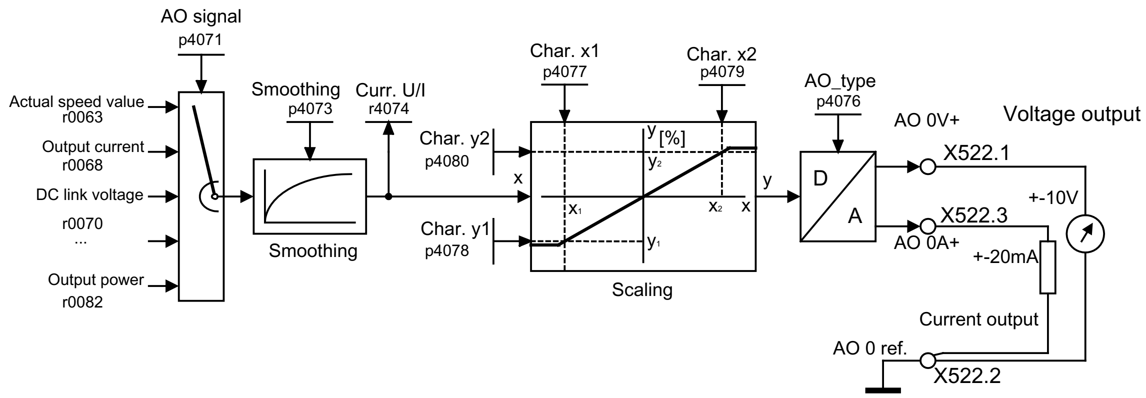


Figure 8-1 Signal flow diagram: analog output 0

Function diagram

FP 1840, FP 9572	TM31 - analog outputs (AO 0 ... AO 1)

Parameters

- p4071 Analog outputs, signal source
- p4073 Analog outputs, smoothing time constant
- r4074 Analog outputs, actual output voltage/current
- p4076 Analog outputs, type
- p4077 Analog outputs, characteristic value x1
- p4078 Analog outputs, characteristic value y1
- p4079 Analog outputs, characteristic value x2
- p4080 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 smoothed	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			
Control 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 diagnostic purposes			
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% = 100°C	

Example: changing analog output 0 from voltage to current output 0 ... 20 mA

X522: 3,2	Current output present at terminal 3, ground is at terminal 2
p4076 = 0	Set analog output type 0 to 0 ... 20 mA.

Example: changing analog output 0 from voltage to current output 0 ... 20 mA and setting the characteristic

X522: 3,2	Current output present at terminal 3, ground is at terminal 2
p4076[0] = 0	Set TM31.AO_type [analog output 0] to 0 ... 20 mA.
p4077[0] = 0.00	Set TM31.AO_char. x1 to 0.00%.
p4078[0] = 0.000	Set TM31.AO_char. y1 to 0 mA.
p4079[0] = 100.00	Set TM31.AO_char. x2 to 100.00%.
p4080[0] = 20.000	Set TM31.AO_char. y2 to 20 mA.

8.3 TM31 digital outputs

Description

Four bi-directional digital outputs (terminal X541) and two relay outputs (terminal X542) are available on the optional TM31 terminal block module. These outputs are, for the most part, freely parameterizable.

Prerequisites

- The Power Module, CU320, and TM31 have been correctly installed.
- The "TM31 terminals" or "Profidrive+TM31" default setting was chosen during commissioning:

STARTER: "TM31 terminals" or "Profidrive+TM31"

AOP30: "2: TM31 terminals" or "4: Profidrive+TM31"

Signal flow diagram

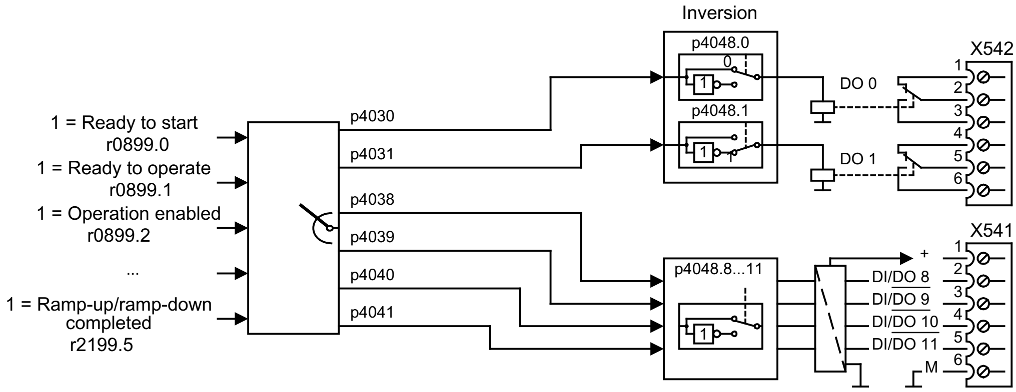


Figure 8-2 Signal flow diagram: Digital outputs

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

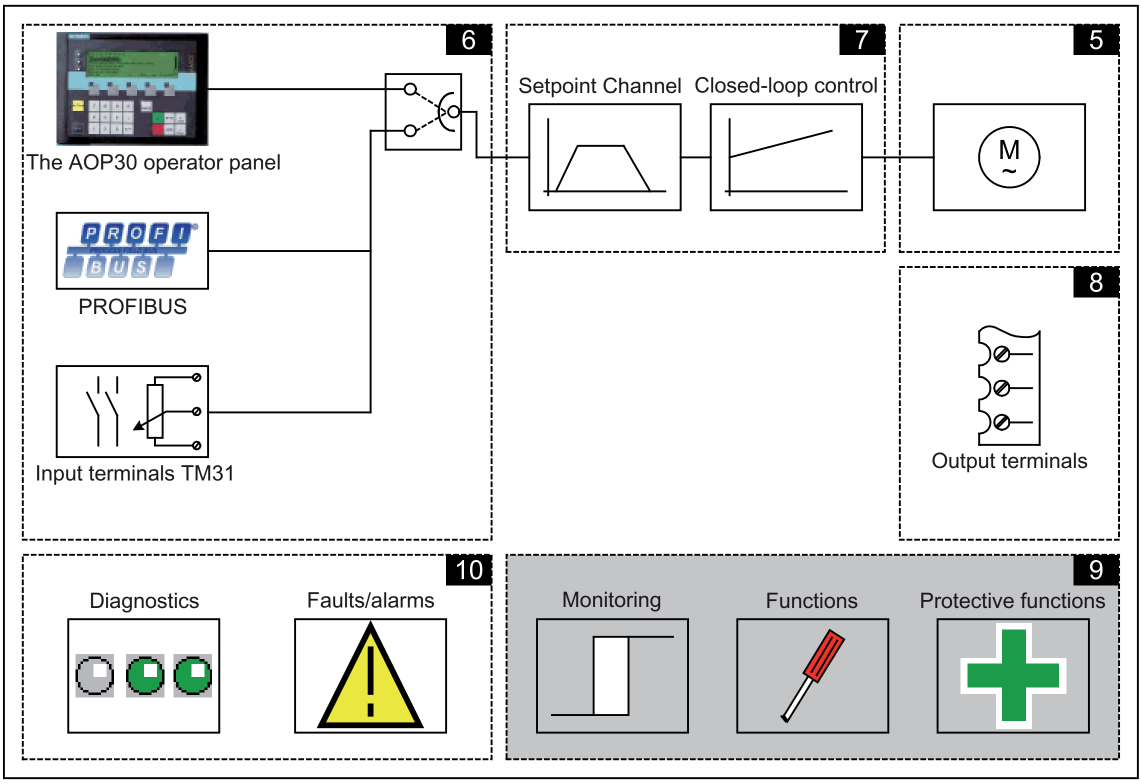
Signal	Bit in status word 1	Parameters
1 = Ready to start	0	r0889.0
1 = Ready to operate (DC link loaded, pulses blocked)	1	r0889.1
1 = Operation enabled (drive follows n_set)	2	r0889.2
1 = Fault present	3	r2139.3
0 = Coast to stop active (OFF2)	4	r0889.4
0 = Fast stop active (OFF3)	5	r0889.5
1 = Power-on disable	6	r0889.6
1 = Alarm present	7	r2139.7
1 = Speed setpoint/actual deviation in the tolerance bandwidth (p2163, p2166)	8	r2197.7
1 = Control required to PLC	9	r0899.9
1 = f or n comparison value reached or exceeded (p2141, p2142)	10	r2199.1
1 = I, M, or P limit reached (p0640, p1520, p1521)	11	r1407.7
Reserved	12	
0 = Alarm motor overtemperature (A7910)	13	r2129.14
Reserved	14	
0 = Alarm thermal overload in power unit (A5000)	15	r2129.15
1 = Pulses enabled (inverter is clocking, drive is carrying current)		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 = Torque setpoint < p2174		r2198.10
1 = LOCAL mode active (control via operator panel or control panel)		r0807.0
0 = Motor blocked		r2198.6

9 Functions, monitoring, and protective functions

9.1 Chapter content

This chapter provides information on:

- Drive functions:
  Motor identification, Vdc control, automatic restart, flying restart, motor changeover, friction characteristic, increase in the output frequency, runtime, simulation operation, direction reversal, unit changeover
- Extended functions:
  Technology controller, bypass function, extended brake control, extended monitoring functions
- Monitoring and protective functions:
  Power unit protection, thermal monitoring functions and overload responses, blocking protection, stall protection, thermal motor protection.



Function diagrams

To supplement these operating instructions, the CD contains simplified function diagrams describing the operating principle.
The diagrams are arranged in accordance with the chapters in the operating instructions. The page numbers (9xx) describe the functionality in the following chapter.

At certain points in this chapter, reference is made to function diagrams with a 4-digit number. These are stored on the CD 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 Increasing the pulse frequency

Description

The pulse frequency can be increased in a virtually continuously variable manner to between the value preassigned in the factory and the maximum pulse frequency which 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 booting, the pulse frequencies recommended in r0114[i] (i = 1, 2, ...) can be entered in parameter p1800 "Pulse frequency" of the DO VECTOR.

NOTICE
The pulse frequency entered in p1800 must correspond precisely to the value given in r0114[i]; otherwise, the entry will be rejected.

9.2.2 Motor identification and automatic speed controller optimization

Description

Two motor identification options, which are based on each other, are available:

- Standstill measurement with p1910 (motor identification)
- Rotating measurement with p1960 (speed controller optimization)

These can be selected more easily via p1900. p1900 = 2 selects the standstill measurement (motor not rotating). p1900 = 1 also activates the rotating measurement; setting p1910 = 1 and p1960 depending on the current control type (p1300).

Parameter p1960 is set depending on p1300 as follows:

- p1960 = 1, if p1300 = 20 or 22 (encoderless control)
- p1960 = 2, if p1300 = 21 or 23 (control with encoder)

The measurements parameterized using p1900 are started in the following sequence after the corresponding drive has been enabled:

- Standstill (static) measurement - 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

To set the new controller setting permanently, the data must be saved with p0977 or p0971 in a non-volatile memory.

⚠ DANGER
During motor identification, the drive might set the motor in motion. The EMERGENCY OFF functions must be fully operational during commissioning. To protect the machines and personnel, the relevant safety regulations must be observed.

9.2.2.1 Standstill measurement

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 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 type plate 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 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 type plate (rated data):

Table 9- 1 Data determined using 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 converter valve threshold voltage (p1825) • Converter valve interlocking times (p1828 ... p1830)	• Stator resistance (p0350) • Stator resistance q axis (p0356) • Stator inductance d axis (p0357) • Drive converter valve threshold voltage (p1825) • Converter valve interlocking times (p1828 ... p1830)
p1910 = 3	• Saturation characteristics (p0362 ... p0366)	not recommended Notice: When encoder adjustment is complete, the motor is automatically rotated approx. one revolution in order to determine the zero marker of the encoder.

Since the type plate data provides the initialization values for identification, you must ensure that it is entered correctly and consistently (taking into account the connection type (star/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.

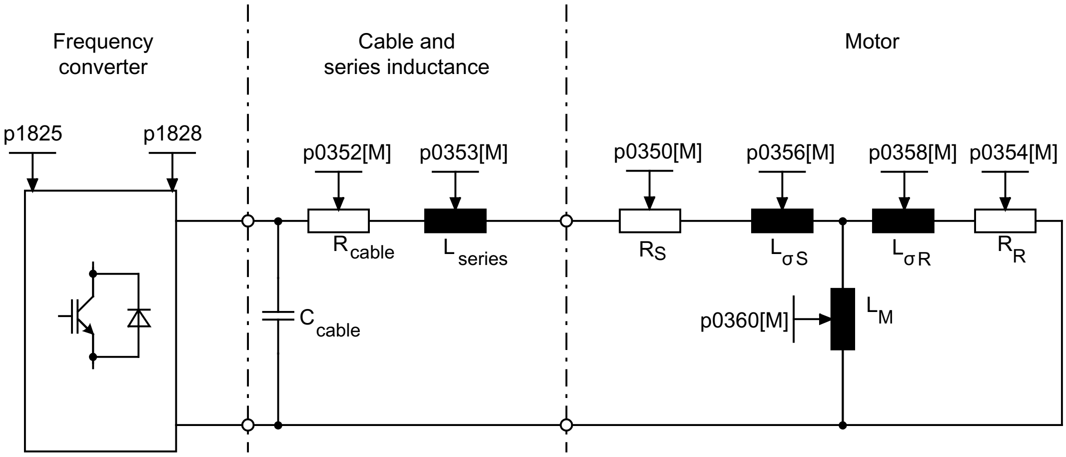


Figure 9-1 Equivalent circuit diagram for induction motor and cable

If an output filter (see p0230) or series inductance (p0353) is used, its data 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

Leakage values in excess of 35 to 40% of the rated motor impedance will restrict the dynamic response of speed and current control in the voltage limit range and in field-weakening operation.

Note

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 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

In comparison with standstill measurement (p1910) for induction motors, rotating measurement (p1960) allows the rated magnetization current and saturation characteristic to be determined more accurately.

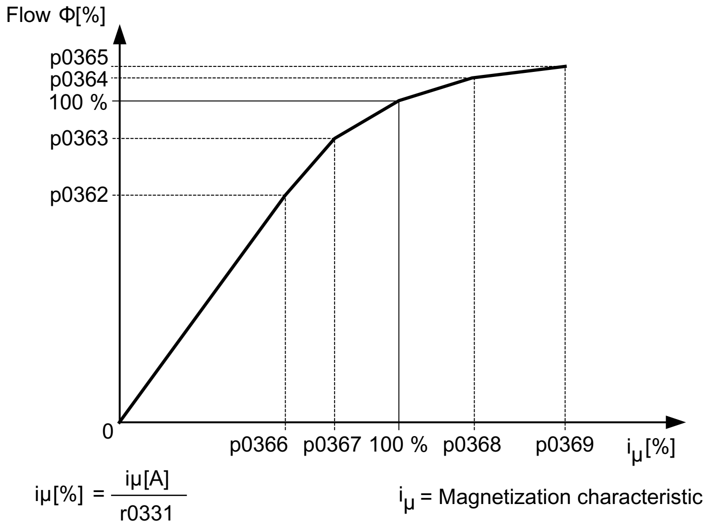


Figure 9-2 Magnetization characteristic

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

To set the new controller setting permanently, the data must be saved with p0977 or p0971 in a non-volatile memory.

WARNING

During motor identification, the drive might set the motor in motion.

The EMERGENCY OFF functions must be fully operational during commissioning. To protect the machines and personnel, the relevant safety regulations must be observed.

9.2.2.2 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 speed controller is set. On induction motors, the saturation characteristic and rated magnetization current are also measured.

If rotating measurement is not to be carried out at 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 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 parameterized 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 realized by selecting parameter p1960 (without encoder: p1960 = 3; with encoder: p1960 = 4).
  During the speed optimization, the saturation characteristic recording 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 = 1, 2)

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.
- Only for induction motors:
  - Measurement of the magnetization characteristic (p0362 to p0369)
  - Measurement of the magnetization current (p0320) and determination of the offset voltage of the converter 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 pre-control setting (p1496)
- Setting for ratio between the total moment of inertia and that of the motor (p0342)

Note

To set the new controller setting permanently, the data must be saved with p0977 or p0971 in a non-volatile memory.

⚠ DANGER

During speed controller optimization, the drive triggers movements in the motor that can reach the maximum motor speed.

The EMERGENCY OFF functions must be fully operational during commissioning. To protect the machines and personnel, the relevant safety regulations must be observed.

Note

If speed controller optimization is carried out for operation with an encoder, the control mode will be changed over to encoderless speed control automatically, in order to be able to carry out the encoder test.

Parameters

- r0047 Status identification
- p1300 Open-loop/closed-loop control operating mode
- p1900 Motor data identification and rotating measurement
- p1959 Speed controller optimization configuration
- p1960 Speed controller optimization 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 Speed controller optimization encoder test pulse number determined
- p1980 Pole position identification procedure
- r3925 Identification complete indicator
- r3927 MotId control word
- r3928 Rotating measurement configuration

9.2.3 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

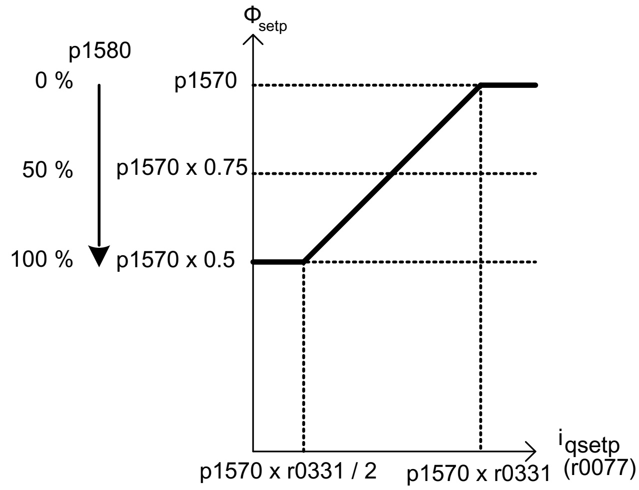


Figure 9-3 Efficiency optimization

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 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

9.2.4 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 impressing a field-producing current at the current limit, which considerably reduces the magnetization time.
- If the "Flying restart" function is activated, the excitation build-up time set in p0346 is still used.

Commissioning

Parameter setting p1401.6 = 1 is necessary to activate fast magnetization.

This setting initiates the following sequence during motor starting:

- The field-producing current setpoint jumps to its limit value: 0.9*r0067 (I_{max}).
- 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, set via p1573, is reached (default value 100%, min. 10% and max. 200%), the excitation is finished and the speed setpoint 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

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 by means of a flux controller with P gain (p1590) and the parameterized smoothing factor (p1616).

Notes

When quick magnetization is selected (p1401.6 = 1), smooth starting is deactivated internally and alarm A07416 displayed.

When the stator resistance identification function is active (see p0621 "Identification of stator resistance after restart") is active, 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
- p1401 Flux control configuration
- p1570 Flux setpoint
- p1573 Flux threshold value magnetization
- p1590 Flux controller P gain
- p1616 Current setpoint smoothing time

9.2.5 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**
>
> When switching off or during rapid load changes, if failure often arises and fault F30002 "DC link overvoltage" is reported, 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 supply 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.

Characteristics

- 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 delaying the drive.
- Vdc_max control
  - This function can be 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)

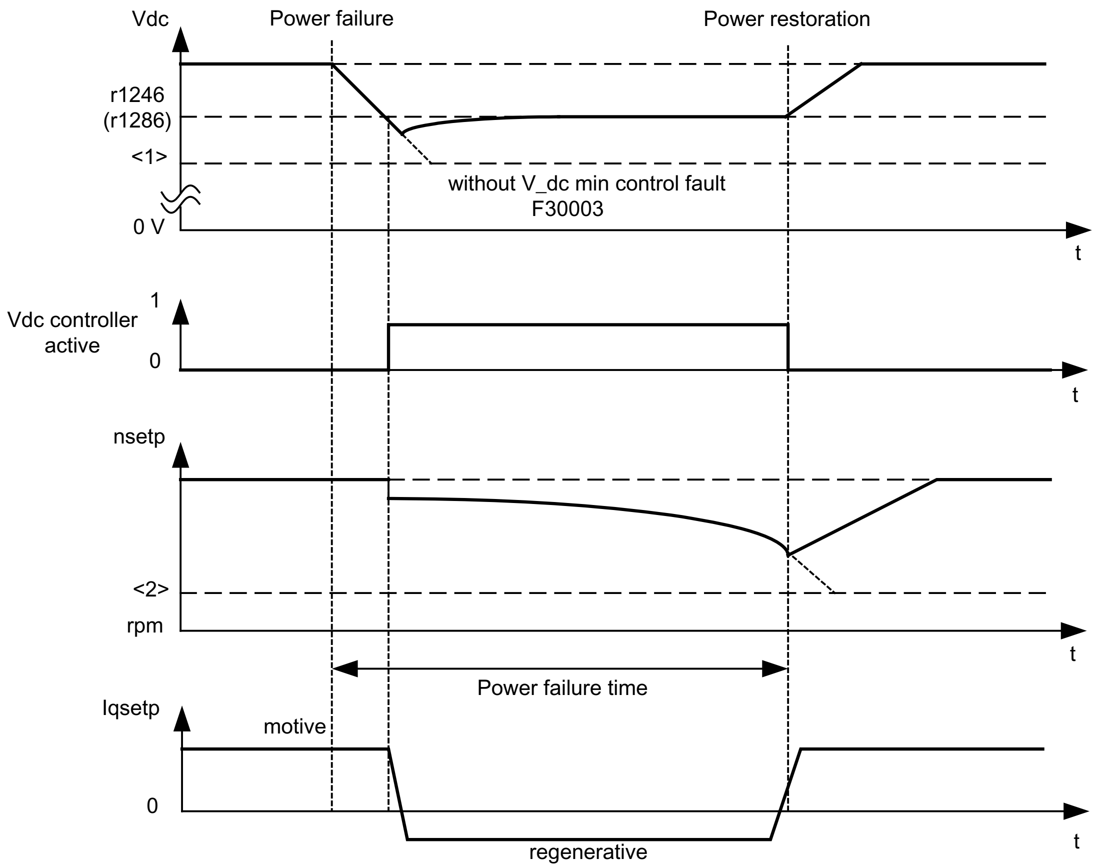


Figure 9-4 Switching Vdc_min control on/off (kinetic buffering)

Note

Kinetic buffering must only be activated when the optional components (TM31, SMC30, VSM, etc.) are supplied by an external voltage source.

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 converter; 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 SINAMICS system continues operating until the shutdown threshold of the DC link voltage is undershot (see "Switching Vdc_min control on/off" <1>).

Note

All parameter specifications in parentheses refer to V/f 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. Alarm A7402 (drive: DC link voltage minimum controller active) is issued while the Vdc_min controller is active.

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 is switched off with fault F30003 (power unit: DC link undervoltage).

If a speed threshold set with parameter p1257 (p1297) for active Vdc_min control (see "Switching Vdc_min control on/off" <2>) is undershot, the drive is shut down with F7405 (drive: kinetic buffering minimum speed undershot).

If a shutdown with undervoltage in the DC link (F30003) occurs without the drive 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 is switched off 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

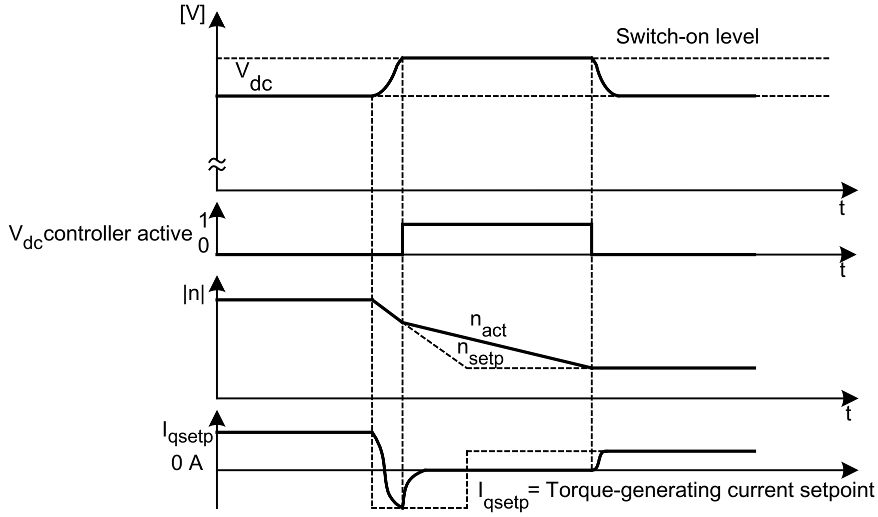


Figure 9-5 Activating/deactivating the Vdc_max control

The switch-on level of the Vdc_max control (r1242 or r1282) is calculated as follows:

- when the automatic switch-on level sensing is disabled (p1254 (p1294) = 0)
  - ACAC device: r1242 (r1282) = 1.15 x √2 x p0210 (device supply voltage)
  - DCAC device: r1242 (r1282) = 1.15 x p0210 (device supply voltage)
- when the automatic switch-on level sensing is enabled (p1254 (p1294) = 1)
  r1242 (r1282) = Vdc_max - 50 V (Vdc_max: overvoltage threshold of the converter)

Function diagram

FP 6220 (FP 6320) Vdc_max controller and Vdc_min controller

Parameters

- p1240 (p1280) Vdc controller configuration
- r1242 (r1282) Vdc_min controller switch-in level
- p1243 (p1283) Vdc_max controller dynamic factor
- p1245 (p1285) Vdc_min controller switch-in level
- r1246 (r1286) Vdc_min controller switch-in level
- p1247 (p1287) Vdc_min controller dynamic factor
- (p1288) Vdc_max controller ramp-function generator feedback factor (V/f)
- p1249 (p1289) Vdc_max controller speed threshold
- p1250 (p1290) Vdc controller proportional gain

• p1251 (p1291)	Vdc controller integral action time
• p1252 (p1292)	Vdc controller derivative-action 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
• p1257 (p1297)	Vdc_min controller speed threshold
• r1258 (r1298)	Vdc controller output

9.2.6 Automatic restart function

Description

The automatic restart function automatically restarts the cabinet unit after an undervoltage or a power failure. The alarms present are acknowledged and the drive is restarted automatically.

The drive can be restarted using:

- The standard procedure starting from standstill, or
- The flying restart function.
  For drives with low moments of inertia and load torques facilitating the stopping of the drive within a matter of seconds (e.g., pump drives with water gauges), starting from standstill is recommended.

Note

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

If p1210 is set to values >1, the motor can be restarted automatically without the need to issue the ON command.

In the event of prolonged power failures and 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 cause death, serious injury, or considerable material damage.

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 acknowledgement 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 power 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 power failure after manual acknowledgement	As for p1210 = 4. But pending faults must be acknowledged manually.
16	Restart after fault after manual acknowledgement	As for p1210 = 6. But 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 acknowledgement (line supply voltage must be restored or the infeed signals that it is ready). Fault F07320 is output when the number of parameterized startup attempts is reached.

If p1211 = x, x + 1 startup attempts will be made.

Note

A startup attempt starts immediately when the fault occurs.

The faults are acknowledged automatically at intervals of half the waiting time p1212.

Following successful acknowledgement 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 acknowledgement 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 restart

  The monitoring time starts when the faults are detected. If the automatic acknowledgements 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.

  For p1210 = 14, 16 manual acknowledgement of the pending fault must take place within the time in p1213 index 0. Otherwise the fault F07320 is generated after the time set.

- p1213[1] = Monitoring time for resetting the starting counter

  The starting counter (see r1214) is only reset to starting value p1211 once the time in p1213 index[1] has expired after a successful restart. The delay time is not effective for 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 starting counter is reset to the starting value p1211, if F07320 occurred, the switch-on command is recalled and the fault acknowledged.

  If starting value p1211 or mode p1210 is changed, the starting counter is immediately updated.

Set fault number without automatic restart (p1206)

Up to 10 fault numbers for which the automatic restart should not be effective can be selected via p1206[0...9].

The parameter is only effective if p1210 = 6 and p1210 = 16.

Parameters

- p1206 [0...9] Set fault number 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 inverter is enabled and the motor is supplied with power.

9.2.7 Flying restart

Description

The "Flying restart" function (enabled via p1200) allows the converter to switch to a motor that is still rotating. Switching on the converter 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 converter and motor frequency can be synchronized.

During the standard start-up procedure for the converter, the motor must be at a standstill. The converter 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

The flying restart function must be used when the motor may still be running or is being driven by the load to prevent shutdowns due to overcurrent (F7801).

Note

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 low moment of inertia, the flying restart function can cause the drive to accelerate slightly.

In group drives, the flying restart function should not be activated due to the different coasting properties of the individual motors.

9.2.7.1 Flying restart without 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 parameterizable 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 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 parameterized in p0346.

Once the excitation build-up time (p0346) has elapsed, the ramp-function generator is set to the actual speed value and the motor ramped up to the current setpoint frequency.

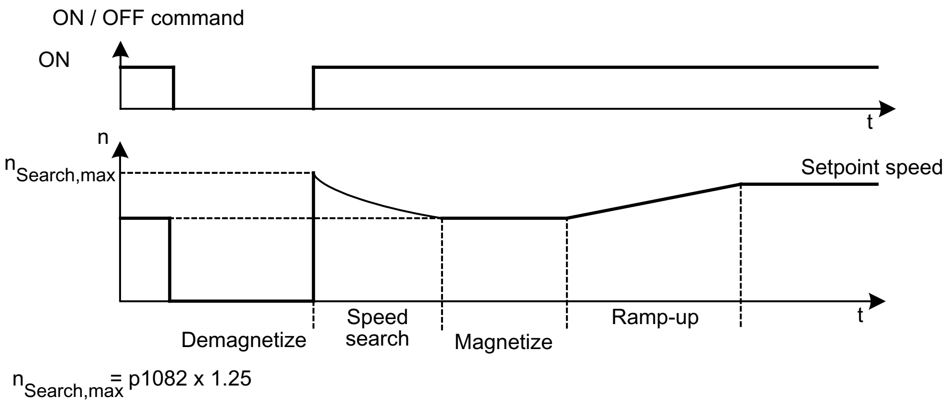


Figure 9-6 Flying restart

> **⚠ WARNING**
>
> When the flying restart (p1200) function is active, the drive may still be accelerated by the detection current despite the fact that it is at standstill and the setpoint is 0!
>
> For this reason, entering the area around the drive when it is in this condition can cause death, serious injury, or considerable material damage.

9.2.7.2 Flying restart with encoder

Description

The flying restart function behaves differently with V/f control and vector control:

- V/f characteristic (p1300 < 20):
  Flying restart without encoder (see "Flying restart without encoder")
- Vector control with 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**
>
> When the flying restart (p1200) function is active, the drive may still be accelerated by the detection current despite the fact that it is at standstill and the setpoint is 0.
>
> For this reason, entering the area around the drive when it is in this condition can cause death, serious injury, or considerable material damage.

9.2.7.3 Parameters

- p1200 Flying restart operating mode
  - 0: Flying restart inactive
  - 1: Flying restart always active (start in setpoint direction)
  - 2: Flying restart active after On, error, OFF2 (start in setpoint direction)
  - 3: Flying restart active after error, OFF2 (start in setpoint direction)
  - 4: Flying restart always active (start only in setpoint direction)
  - 5: Flying restart active after On, error, OFF2 (start only in setpoint direction)
  - 6: Flying restart active after error, OFF2 (start only in setpoint direction)
- p1202 Flying restart search current
- p1203 Flying restart search speed factor
- r1204 Flying restart, V/f control status
- r1205 Flying restart, vector control status

Note

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.

9.2.8 Motor changeover/selection

9.2.8.1 Description

The motor data set changeover is, for example, used for:

- Changing over between different motors
- Motor data adaptation

Note

To switch to a rotating motor, the "flying restart" function must be activated.

9.2.8.2 Example of changing over between two motors

Prerequisites

- The drive has been commissioned for the first time.
- 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 contacts (1 NO contact)
- 2 motor contactors with positively-driven auxiliary contacts (1 NC contact, 1 NO contact)

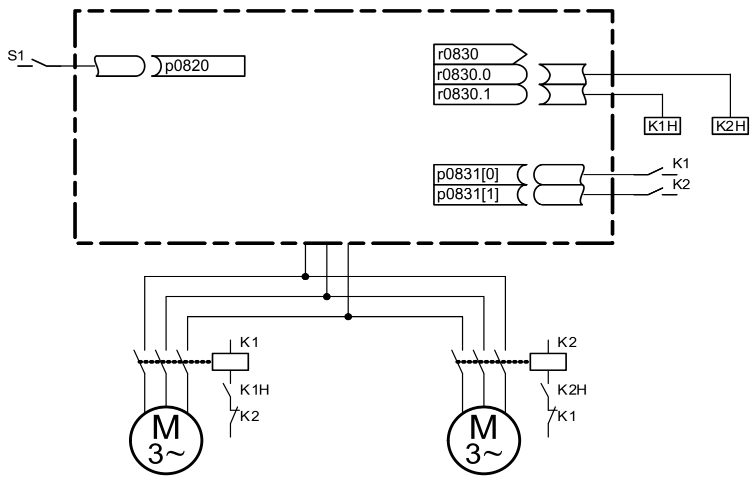


Figure 9-7 Example of motor changeover

Table 9- 3 Settings for the motor changeover example

Parameters	Settings	Comment
p0130	2	Configure 2 MDS
p0180	2	Configure 2 DDS
p0186[0..1]	0, 1	The MDS are assigned to the DDS.
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 suppression:
   The pulses are suppressed 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.

9.2.8.3 Function diagram

FP 8565 Drive Data Set (DDS)
FP 8575 Motor Data Sets (MDS)

9.2.8.4 Parameters

- r0051 Drive data set DDS effective
- p0130 Motor data sets (MDS) number
- p0180 Drive data set (DDS) number
- p0186 Motor data sets (MDS) number
- p0819[0...2] Copy drive data set DDS
- p0820 BI: Drive data set selection DDS, bit 0
- p0821 BI: Drive data set selection DDS, bit 1
- 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
- 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

9.2.9 Friction characteristic curve

Description

The friction characteristic is used to compensate for the frictional torque of the motor and driven load. A friction characteristic allows the speed controller to be pre-controlled and improves the control response..

10 points along the characteristic are used for the friction characteristic. The coordinates of every point along the characteristic are defined by a speed parameter (p382x) and a torque parameter (p383x) (point 1 = p3820 and p3830).

Features

- There are 10 points along the characteristic 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

p3847 (friction characteristic plot warm-up period) can be used to set a time for the drive to warm up to the specified operating temperature. During this time, the drive is brought up to and kept at the greatest speed set for plotting the friction characteristic, so that the drive warms up to the operating temperature. Then measurement is started with the highest speed.

DANGER

When the friction characteristic is plotted, the drive can cause the motor to move. As a result, the motor may reach maximum speed.

When commissioning the drive, the EMERGENCY STOP functions must function perfectly. To protect the machines and personnel, the relevant safety regulations must be observed.

Function diagram

FD 7010 Friction characteristic curve

Parameters

- p3820 Friction characteristic, value n0
- ...
- p3839 Friction characteristic, value M9
- r3840 Friction characteristic status word
- r3841 Friction characteristic, output
- p3842 Activate friction characteristic
- p3845 Activate friction characteristic plot
- p3846 Friction characteristic plot ramp-up/ramp-down time
- p3847 Friction characteristic plot warm-up period

9.2.10 Armature short-circuit brake, internal voltage protection, DC brake

9.2.10.1 General

The "External armature short-circuit" function for permanent-magnet synchronous motors initiates an external contactor which short-circuits the motor via resistors when the pulses are canceled. This reduces the kinetic energy of the motor.

The "Internal armature short-circuit braking" function for permanent-magnet synchronous motors short-circuits a half-bridge in the power unit to control the motor power consumption, thus braking the motor.

The "Internal voltage protection" function for permanent-magnet synchronous motors protects the DC link capacitors when the pulses are cancelled by short-circuiting a half-bridge in the power unit.

The "DC braking" function for induction motors injects a direct current into the motor, thus braking the motor.

9.2.10.2 External armature short-circuit brake

Description

External armature short-circuit braking is only available for synchronous motors. It is mainly required when braking in a hazardous situation, if controlled braking using the drive converter is no longer possible, (e.g. in the case of power failure, 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 means that an additional resistance is inserted in the motor circuit that supports reducing 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 canceled.

This function controls an external contactor via output terminals, which then short-circuits the motor through resistors when the pulses are canceled.

A permanent-magnet synchronous motor (p0300 = 2xx) is required in order to use the external armature short-circuit.

CAUTION
Only short-circuit proof motors may be used, or suitable resistances must be used for short-circuiting the motor.

Note

In case of incorrect parameterization (e.g. induction motor and external armature short-circuit selected), the fault F07906 "Armature short-circuit / internal voltage protection: parameterization error" is generated.

Function diagram

FP 7014 Technology functions - External armature short circuit

Parameters

- p0300: Mot type selection
- p1230 BI: Armature short-circuit/DC brake activation
- p1231 Armature short-circuit/DC brake 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, delay time when opening
- r1238 CO: External armature short-circuit state
- r1239 CO/BO: Armature short-circuit / DC brake status word

9.2.10.3 Internal armature short-circuit brake

Description

Internal armature short-circuit braking is only available for synchronous motors. It is mainly required when braking in a hazardous situation, if controlled braking using the drive converter is no longer possible, (e.g. in the case of power failure, 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 unit. This means that an additional resistance is inserted in the motor circuit that supports reducing the kinetic energy of the motor.

The internal armature short-circuit is configured p1231 = 4 and activated via p1230. It is initiated when the pulses are canceled.

A permanent-magnet synchronous motor (p0300 = 2xx) is required in order to use the internal armature short-circuit.

⚠DANGER
When the armature short-circuit is active, after the pulses have been cancelled all the motor terminals are at half the DC-link potential.

CAUTION
Only short-circuit proof motors may be used. The Power Module / Motor Module must be designed to handle 1.8 times the short-circuit current of the motor.

Function diagram

FP 7016 Technology functions - Internal armature short circuit

Parameters

- p0300: Mot type selection
- p1230 BI: Armature short-circuit/DC brake activation
- p1231 Armature short-circuit/DC brake configuration
  - 4: Internal armature short-circuit/DC brake
- r1239 CO/BO: Armature short-circuit / DC brake status word

9.2.10.4 Internal voltage protection

Description

The internal voltage protection prevents the DC link capacitance from being loaded into a field weakening operated motor if the energy regeneration capability from the source voltage is missing.

Depending on the DC link voltage, the Power Module / Motor Module automatically decides whether the armature short-circuit is to be engaged. In this case, the protection remains operative even if the DRIVE-CLiQ connection between the Control Unit and the Power Module / Motor Module is interrupted.

The internal armature short-circuit is configured and activated via p1231 = 3 and activated when a device-specific DC link voltage threshold is reached. It is initiated when the pulses are canceled.

A permanent-magnet synchronous motor (p0300 = 2xx) is required in order to use the internal voltage protection.

DANGER

When the internal voltage protection is active, after the pulses have been cancelled all the motor terminals are at half the DC-link potential.

CAUTION

Only short-circuit proof motors may be used.

The Power Module / Motor Module must be designed to handle 1.8 times the short-circuit current of the motor.

The internal voltage protection function cannot be interrupted by a fault response. If an overcurrent occurs while internal voltage protection is active, the Power Module / Motor Module and/or the motor may sustain irreparable damage!

With the internal voltage protection active, the motor must not be powered by an external source for an extended period of time (e.g. by pulling loads or another coupled motor).

Note

In case of incorrect parameterization (e.g. induction motor and internal voltage protection selected), the fault F07906 "Armature short-circuit / internal voltage protection: parameterization error" is generated.

Parameters

- p0300: Mot type selection
- p1231 Armature short-circuit/DC brake configuration
  - 3: Internal voltage protection

9.2.10.5 DC brake

Description

DC braking is only supported for induction motors. It is mainly required when braking in a hazardous situation, if controlled braking using the drive converter is no longer possible, (e.g. in the case of power failure, EMERGENCY OFF etc.) or if no regenerative infeed is used. .

The DC brake is activated via p1231 = 4 or via p1231 = 14. It can be triggered via an input signal p1230 (signal = 1) or a fault response.

Activation of the DC brake via input signal

p1231 = 4

If the DC brake is activated by the digital input signal, the first step is that the pulses are blocked for the demagnetization time (p0347) of the motor in order to demagnetize the motor - the parameter p1234 (Speed at the start of DC braking) is ignored.

Then the braking current (p1232) is applied as long as the input is initiated in order to brake the motor or hold it at standstill.

p1231 = 14

The DC brake is released, if during operation a 1-signal is pending at the binector input p1230 and the actual speed is below the starting speed (p1234).

After the preceding demagnetization (p0347) of the motor for the period set in p1233, the braking current p1232 is applied and subsequently switched off automatically.

Cancellation of the input signal for DC braking

If the DC brake is removed, the drive returns to its selected operating mode.

The following applies:

- With vector control (closed-loop controlled with or without encoder):
  The drive is synchronized with the motor frequency if the "Flying restart" function is activated, and then returns to closed-loop controlled mode. If the "Flying restart" function is not active, the drive can only be restarted from standstill without overcurrent fault.
- In V/f mode:
  With the "Flying restart" function activated, the converter frequency is synchronized with the motor frequency, and the drive will then return to V/f mode. If the "Flying restart" function is not activated, the drive can only be restarted from standstill without overcurrent fault.

DC brake as a fault response

If the DC brake is activated as a fault response, the motor is initially braked in field-oriented mode along the braking ramp up to the threshold set in p1234 (DC brake starting speed). The slope of the ramp is identical with that of the OFF1 ramp (parameterized using p1082, p1121). Subsequently, the pulses are disabled for the period in p0347 (demagnetizing time) in order to demagnetize the motor. The DC braking will start for the duration set in p1233 (DC braking period).

- If an encoder is present, braking will continue until the speed drops to below standstill threshold p1226.
- If no encoder is present, only the period in p1233 is effective.

Function diagram

FP 7017	Technology functions - DC braking

Parameters

- p0300: Mot type selection
- p1226 Standstill recognition speed threshold
- p1230 BI: Armature short-circuit/DC brake activation
- p1231 Armature short-circuit/DC brake configuration
  - 4: Internal armature short-circuit/DC brake
  - 14: DC braking under starting speed
- p1232 DC braking braking current
- p1233 DC braking period
- p1234 DC braking start speed
- r1239 CO/BO: Armature short-circuit / DC brake status word
- p1345 I_max voltage controller proportional gain
- p1346 I_max voltage controller integral time

9.2.11 Increasing the output frequency

9.2.11.1 Description

In applications that require higher output frequencies, the pulse frequency of the converter 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.

Note

Use of a sine-wave filter must be selected using p0230 = 3/4 when carrying out commissioning. This setting fixes the output frequency to 4 kHz or 2.5 kHz (this cannot be changed).

9.2.11.2 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

Converter rating [kW]	Default pulse frequency [kHz]	Maximum output frequency [Hz]
Supply voltage 380 – 480 V 3 AC		
110 – 250	2	160
315 – 560	1.25	100
Supply voltage 500 – 600 V 3 AC		
110 – 560	1.25	100
Supply voltage 660 – 690 V 3 AC		
75 – 800	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 block TM31 are set in the factory to 4000 µs. This is also the minimum limit.

9.2.11.3 Maximum output frequency achieved by increasing the pulse frequency

Maximum output frequencies achieved by increasing the pulse frequency

By multiplying the basis 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)]
5	300 [1)]

[1)] The maximum output frequency is limited to 300 Hz due to the closed-loop control.

9.2.11.4 Parameters

- p0009 Device commissioning parameter filter
- p0112 Sampling times pre-setting p0115
- p0113 Selects the minimum pulse frequency
- p0115 Sampling times
- p1800 Pulse frequency

9.2.12 Pulse frequency wobbling

Description

Pulse frequency wobbling is when the pulse frequency is varied slightly according to a statistical process. The average pulse frequency value is still the value set; the statistical variation of the instantaneous value results in a modified noise spectrum.

This procedure reduces the subjectively noticeable motor noise, especially for the relatively low pulse frequencies set in the factory.

Pulse frequency wobbling is activated with p1810.2 = 1. The amplitude of the static wobbling signal can be set in the range from 0% to 20% via p1811.

Restrictions

- Pulse frequency wobbling can only be activated under the following conditions (p1810.2 = 1):
  - The drive is pulse suppressed.
  - p1800 < 2 x 1000 / p0115[0]
- p1811 (Pulse frequency wobbling amplitude) can only be set under the following conditions:
  - p1802.2 = 1
  - p0230 (output filter) < 3 (no sine-wave filter)
- When pulse frequency wobbling is activated and impulses are enabled, the maximum pulse frequency (p1800) can be set as follows:
  - For p1811 = 0: p1800 ≤ 2 x 1000 / p0115[0]
  - For p1811 > 0: p1800 ≤ 1000 / p0115[0]
- When pulse frequency wobbling is activated and impulses are enabled, if the maximum pulse frequency (p1800) is set to be greater than 1000 / p0115[0], then p1811 is set to 0.
- When pulse frequency wobbling is activated and impulses are suppressed, if the maximum pulse frequency (p1800) is set to be greater than 2 x 1000 / p0115[0], then p1811 and p1810.2 are set to 0.

Note

If pulse frequency wobbling is deactivated (p1810.2 = 0), then 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 system is switched off.
Once the drive unit has been switched on, the counter continues to run with the value that was saved the last time the drive 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.

Actual 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.

To store the value, you need a CONTROL UNIT with order number 6SL3040-....-0AA1 and version C or higher.

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 maintained, the maintenance interval must be reset.

Operating hours counter for the fan

The operating hours of the fan in the power unit are displayed in p0251 (drive).

The number of hours operated can only be reset to 0 in this parameter (e.g. 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.

9.2.14 Simulation operation

Description

The simulation function 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, the simulation mode is reset, and a fault message F07826 is issued.

Communications with a higher-level automation system can be tested using the 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.

Another application is to test the correct functioning of the Power Module. Especially for drive units with higher power ratings 75 kW (690 V) and 110 kW (400 V), after repairs, it is necessary to test the gating of the power semiconductors. This is done by injecting a low DC voltage as DC link voltage (e.g. 12 V). The drive unit is then powered-up and the pulses enabled. It must be possible to run through all of the pulse patterns of the gating unit software.

This means that the software must allow the pulses to be switched-in and various frequencies approached. If a speed encoder is not being used, then this is generally implemented using V/f control or sensorless closed-loop speed control.

Note

The following functions are de-activated in the simulation mode:

- Motor data identification
- Motor data identification, rotating without encoder
- Pole position identification

No flying restart is carried-out for V/f control and sensorless closed-loop vector control.

Commissioning

Simulation is activated using p1272 = 1; the following pre-requisites must be fulfilled:

- The drive unit must have been commissioned for the first time (default: Standard induction motors).
- The DC link voltage must lie below 40 V (observe the tolerance of the DC link voltage sensing).

Alarm A07825 (simulation mode activated) must be output during simulation operation.

Parameters

- p1272 Simulation operation

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, torque setpoint and actual value remain unchanged, as does the relative position change.

A pulse inhibit must be set prior to attempting reversal.

Reversing can be set differently for each drive data set.

Note

When changing over the drive data set to differently set reversing and with pulse approval, fault F7434 is issued.

Reversing can be observed by checking parameters r0069 (phase currents) and r0089 (phase voltage). The absolute position reference is lost on reversal.

Function diagram

FD 4704, 4715	Encoder evaluation
FD 6730, 6731	Current control

Parameters

- r0069 Phase currents actual value
- r0089 Phase voltage actual value
- p1820 Reverse output phase sequence
- p1821 Direction of rotation

9.2.16 Einheitenumschaltung

Description

Parameters and process variables for input and output can be switched to a suitable units 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 rating plate of the drive converter or the motor rating plate can be changed over between SI/US units; however, a per unit 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 referenced variables and the reference variable is subsequently changed, the % value entered in a parameter will not change.

  Example:

  – With a reference speed of 1500 1/min, a fixed speed of 80 % corresponds to a value of 1200 1/min.

  – If the reference speed is changed to 3000 1/min, the value of 80 % is retained and is now 2400 1/min.

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 the 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.

Changing over the units

The units can be changed over 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 Selection of units system, motor equivalent circuit diagram data
- p0505 Selection of units system
- p0595 Selection of technological unit
- p0596 Reference variable of technological unit
- p2000 Reference frequency/speed
- p2001 Reference voltage
- p2002 Reference current
- p2003 Reference torque
- p2004 Reference power
- p2005 Reference angle
- p2007 Reference acceleration

9.2.17 Derating behavior at 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").

When commissioning the converter the behavior at overload is adjusted in such a manner that the pulse frequency is variably reduced so that the required power can be obtained.

Characteristics:

- 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)
- For p0290 = 2 at overload first reduce the pulse frequency (and consequently the output frequency) until it has dropped to rated pulse frequency, then reduce the output frequency if overload continues to persist.
  The rated pulse frequency is half the inverse value of the current controller clock 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 entering 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.
  At overload, then also for p0290 = 2 or 3, this new pulse frequency will no longer be underranged, the downstream reaction (reduce output voltage or switch off) will be triggered.

Exceptions:

- With an activated sinus filter (p0230 = 3, 4), this behavior is not permitted because the factory set pulse frequency (2.5 kHz or 4 kHz) should 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

At commissioning the parameter p 0290 is automatically set to the value "2". This activates pulse frequency reduction at 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 unit

Parameter

- r0036 Power unit overload I2t
- r0037 CO: Power unit temperatures
- p0115 Sampling times for internal control loops
- p0230 Drive filter type, motor side
- p0290 Power unit overload response
- p1082 Maximum speed
- r2135.13 Fault thermal overload power unit
- r2135.15 Thermal overload in power unit alarm

9.3 Extended functions

9.3.1 Technology controller

Description

The "technology controller" function module allows simple control functions to be implemented, e.g.:

- 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 differentiator can be switched to the control deviation channel or the actual value channel (factory setting). The P, I, and D components can be set separately.

A value of 0 deactivates the corresponding component. Setpoints can be specified via two connector inputs. The setpoints can be scaled via parameters p2255 and p2256.

A ramp-function generator in the setpoint channel can be used to set the setpoint ramp-up/ramp-down time via parameters p2257 and p2258. The setpoint and actual value channel each have a smoothing element. The smoothing time can be set via parameters p2261 and p2265.

The setpoints can be specified via separate fixed setpoints (p2201 to p2215), the motorized potentiometer, or via the field bus (e.g. PROFIBUS).

Pre-control can be integrated via a connector input.

The output can be scaled via parameter p2295 and the control direction reversed. It can be limited via parameters p2291 and p2292 and interconnected as required via a connector output (r2294).

The actual value can be 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

With the entry "0" sec. as 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.

Function diagram

FD 7950	Technology controller – fixed values, binary selection
FP 7951	Technology controller – fixed values, direct selection
FD 7954	Technology controller – motorized potentiometer
FD 7958	Technology controller – closed-loop controller

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 Terminal Module (TM31) is used.

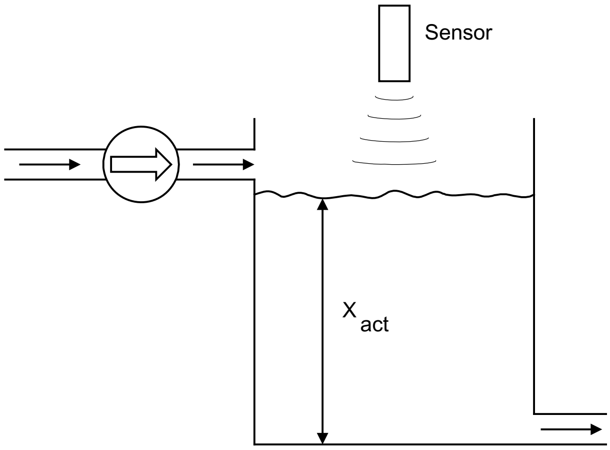


Figure 9-8 Level control: Application

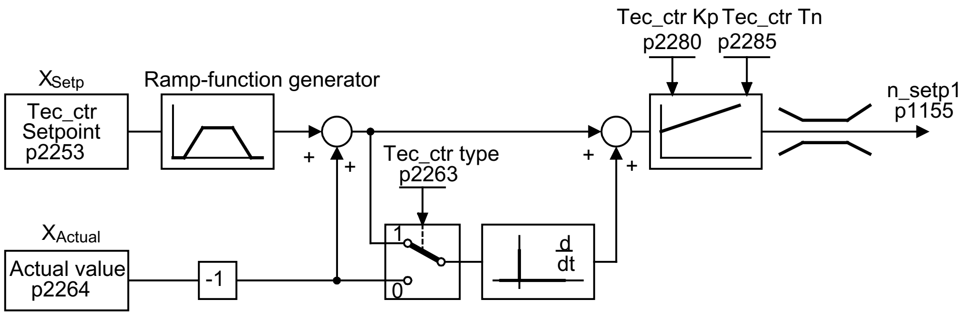


Figure 9-9 Level control: Controller structure

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 bypass function uses digital converter 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 operated using the converter or directly on the supply line. The contactors are activated by the converter. The feedback signals for the contactor positions have to be returned to the converter.

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 when one of the "OFF2" or "OFF3" control word signals is canceled.
- Exception:
  If necessary, the bypass switch can be interlocked by a higher-level controller such that the converter 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 converter is started up again after POWER OFF, the status of the bypass contactors is evaluated. After powering up, the converter 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 converter into "Ready to start and bypass" status after powering up, is of a higher priority than switching back on automatically.
- Monitoring of the motor temperatures using temperature sensors is active while the converter is in one of two statuses "Ready to start and bypass" or "Ready for operation and bypass".
- The two motor contactors must be designed for switching under load.

Note

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.

Prerequisites

The bypass function is only available for sped control without encoders (p1300 = 20) or V/f-control (p1300 = 0...19) and when using an asynchronous 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 Bypass with synchronizer with degree of overlapping (p1260 = 1)

Description

When “Bypass with synchronizer with degree of overlapping (p1260 = 1)” is activated, the synchronized motor is transferred to the supply and retrieved again. During the changeover, both contactors K1 and K2 are closed at the same time for a period (phase lock synchronization).

A reactor is used to de-couple the drive converter from the line supply - the uk value for the reactor is 10 (± 2) %.

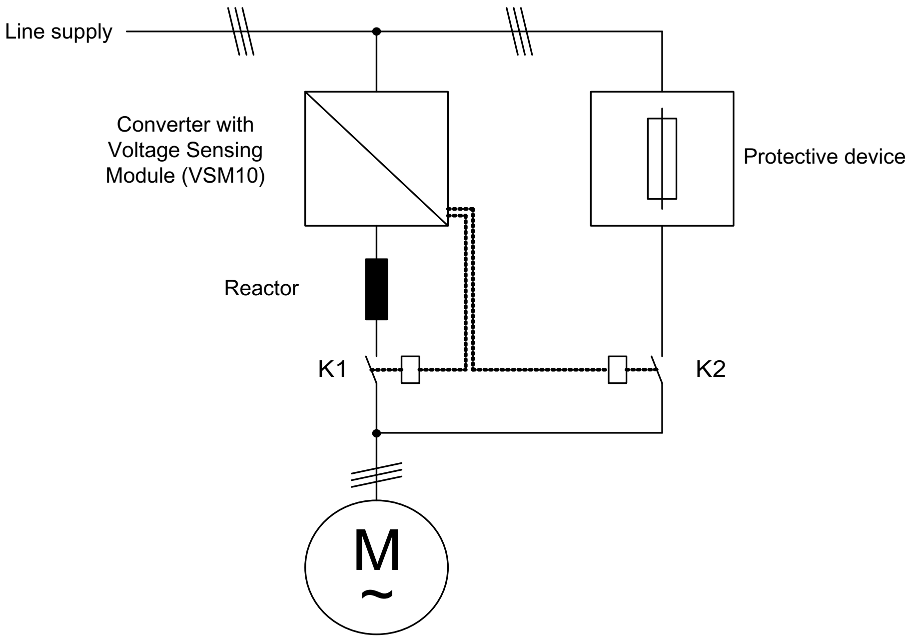


Figure 9-10 Typical circuit diagram for bypass with synchronizer with degree of overlapping

Activation

The function with synchronizer with degree of overlapping (p1260 = 1) function can only be activated using a control signal. It cannot be activated using a speed threshold or a fault.

Parameterization

Once the bypass with synchronizer with degree of overlapping (p1260 = 1) function has been activated, the following parameters must be set:

Table 9- 6 Parameter settings for bypass function with synchronizer with degree of overlapping

Parameters	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	The internal voltages are used for synchronization.
p3802 = r1261.2	Synchronizer activation is triggered by the bypass function.

Transfer process

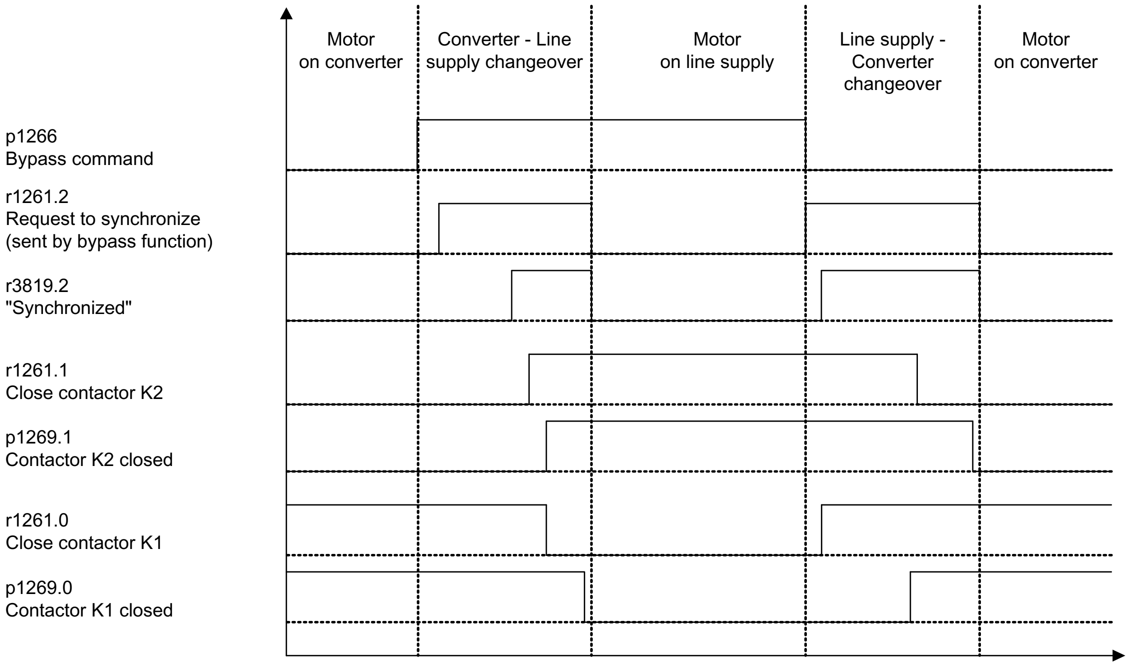


Figure 9-11 Signal diagram, bypass with synchronization with overlap

Transfer of motor to line supply
(contactors K1 and K2 are activated by the converter):

- The initial state is as follows: Contactor K1 is closed, contactor K2 is open and the motor is fed from the converter.
- 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 converter 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 converter inhibits the pulses. The converter is in "Ready for operation and bypass" state.
- If the On command is cancelled in this phase, the converter will change to "Ready to start and bypass" status. If the appropriate contactors are being used, the converter 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 "Command bypass" 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 converter interprets this as a command to retrieve the motor from the line supply.
- Once converter 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 returns to operation on the converter.

9.3.2.2 Bypass with synchronizer without degree of overlapping (p1260 = 2)

Description

When “Bypass with synchronizer without degree of overlapping (p1260 = 2)” is activated, contactor K2 (to be closed) is only closed when contactor K1 is opened (anticipatory type synchronization). Phasing of the motor voltage before synchronization must be set such that there is an "initial jump" upstream of the supply to which synchronization should be carried out. This done by setting the synchronization setpoint (p3809). A phase and frequency difference of around zero is produced when closing contactor K2 by braking the motor in the brief period in which both contactors are open.

In order for the function to run correctly, the moment of inertia must be sufficient.

Due to the expense of determining the synchronization setpoint (p3809), the decoupling restrictor is not needed.

The "flying restart" function must be activated (p1200 = 1).

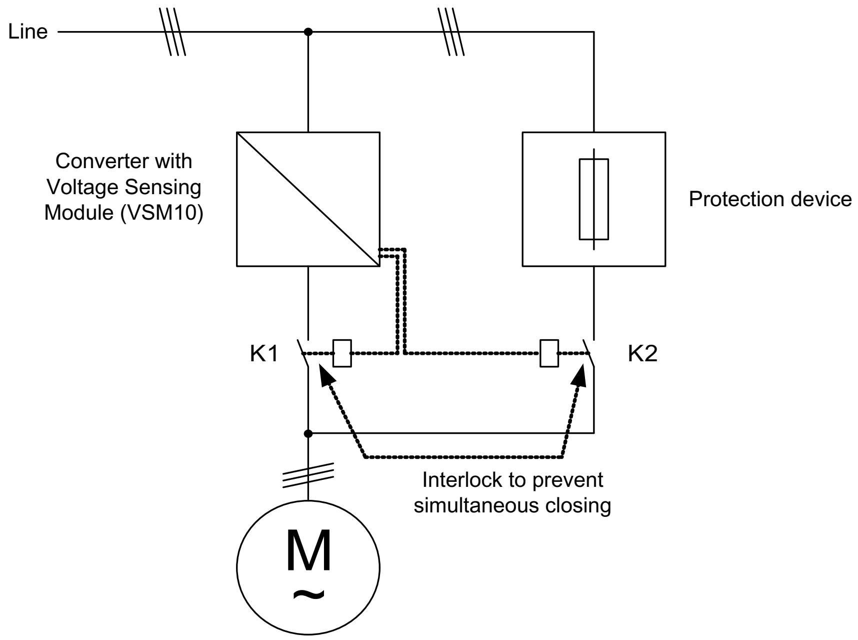


Figure 9-12 Example circuit for bypass with synchronizer without degree of overlapping

Activation

The bypass with synchronizer without degree of overlapping (p1260 = 2) function can only be activated using a control signal. It cannot be activated using a speed threshold or a fault.

Parameterization

Once the bypass with synchronizer without degree of overlapping (p1260 = 2) function has been activated, the following parameters must be set:

Table 9- 7 Parameter settings for bypass function with synchronizer without degree of overlapping

Parameters	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	The internal voltages are used for synchronization.
p3802 = r1261.2	Synchronizer activation is triggered by the bypass function.
p1200 = 1	The "flying restart" function is always active.

9.3.2.3 Bypass without synchronizer (p1260 = 3)

Description

When the motor is transferred to the supply, contactor K1 is opened (following converter's pulse inhibit). The system then waits for the motor excitation time to elapse after which contactor K2 is closed and the motor is run directly on the supply.
If the motor is switched on in a non-synchronized manner, when activated an equalizing current flows and this must be taken into account when designing the protective equipment (see diagram "Circuit bypass without synchronization").

When the motor is being transferred from the supply by the converter, initially contactor K2 is opened and after the excitation time, contactor K1 is closed. The converter then captures the rotating motor and the motor is operated on the converter.

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).

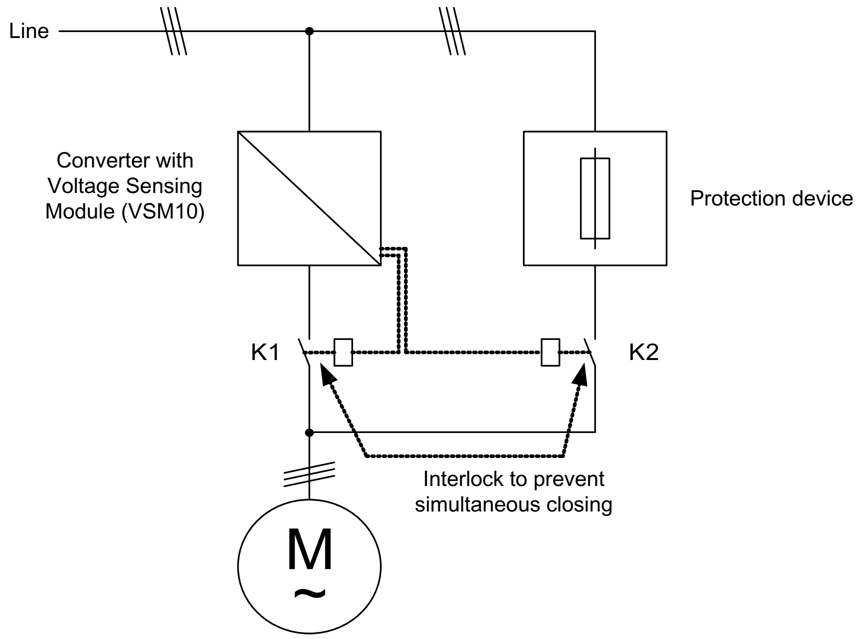


Figure 9-13 Example circuit for bypass without synchronization

Activation

The bypass with synchronizer (p1260 = 3) can be triggered by the following signals (p1267):

- Bypass by means of control signal (p1267.0 = 1):
  The bypass can be activated by means of a digital signal (p1266) (e.g. from a higher-level automation system). If the digital signal is canceled, a changeover to converter operations 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 converter is used as a start-up converter). The bypass cannot be connected until the speed setpoint is greater than the bypass speed threshold (p1265).
  The system reverts to converter mode 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 straight away if the actual speed is still above the bypass speed threshold (p1265) after switching back to converter operations.

The bypass time, debypass time, bypass speed variables and the command source for changing over are set using parameters.

Parameterization

Once the bypass without synchronizer (p1260 = 3) function has been activated, the following parameters must be set:

Table 9- 8 Parameter settings for bypass function with synchronizer without degree of overlapping

Parameter	Description
p1262 =	Bypass dead time setting
p1263 =	Debypass 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 = 1	The internal voltages are used for synchronization.
p3802 = r1261.2	Synchronizer activation is triggered by the bypass function.
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 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 braking control" function module allows complex braking control for motor holding brakes and operational brakes.

The brake is controlled as follows (the sequence reflects the priority):

- Via parameter p1215
- Via binector parameters p1219[0..3] and p0855
- Via zero speed detection
- Via a connector interconnection threshold value

Commissioning

The "extended braking 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 strip TM31.

Function diagram

FD 2704	Zero speed detection
FD 2707	Release/apply brake
FD 2711	Signal outputs

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 starts by generating a torque against the applied brake. The brake is not released until the motor torque or motor current (p1220) has exceeded braking threshold 1 (p1221).

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 is to take place simultaneously. This can be achieved if OFF3 is used as a tripping signal for emergency braking:

p1219[0] = r0898.2 (OFF3 to "apply brake immediately").

To prevent the converter working in opposition to the brake, the OFF3 ramp (p1135) should be set to 0 seconds. Any prevailing regenerative energy must be converted into heat via a braking resistor.

This is often used, for example, in calendar stacks, cutting tools, running gears, and presses.

Example 3: Service brake on crane drives

For cranes with manual control, it is important that the drive responds immediately when the control lever is moved (master switch). To this end, the drive is powered up using the on command (p0840) (the pulses are enabled). Speed setpoint (p1142) and speed controller (p0856) are inhibited. The motor is magnetized. The magnetization time generally applicable for three-phase motors (1-2 seconds) is, therefore, eliminated.

Now, only the brake opening time will delay the motor starting to rotate following activation of the master switch. Movement 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 opening 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 ramp-function generator's ramp-down ramp. 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.

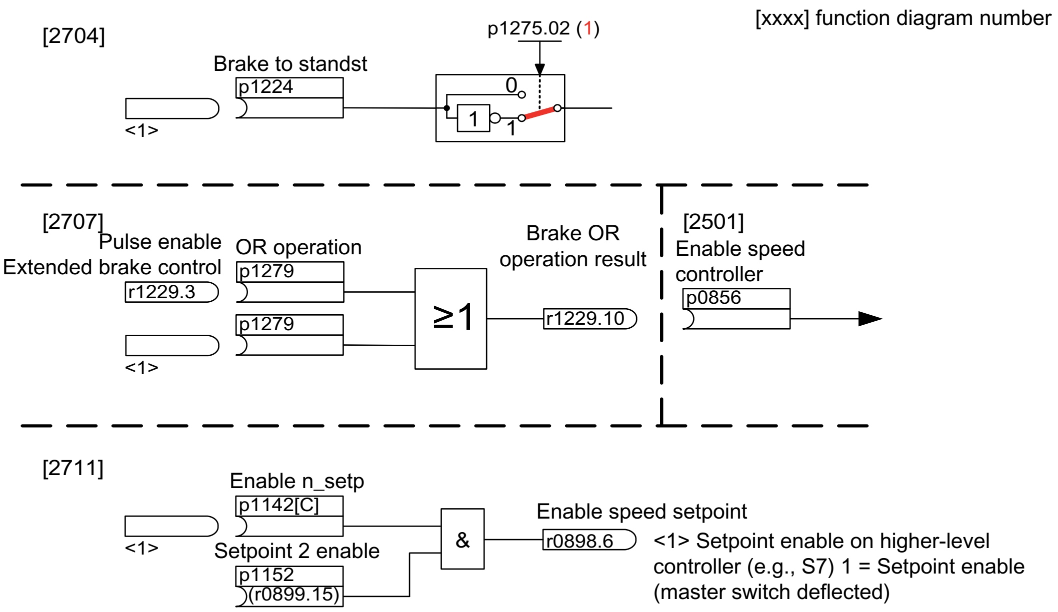


Figure 9-14 Example: Service brake on a crane drive

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 for drive and outgoing shafts and transfer the peripheral speeds and forces. Load monitoring can be used here to identify blockages in the working machine and interruptions to the power transmission.
During load monitoring, the current speed/torque curve is compared with the programmed speed/torque curve (p2182 – 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 message can be delayed by means of parameter p2192 to prevent false alarms caused by brief transitional states.

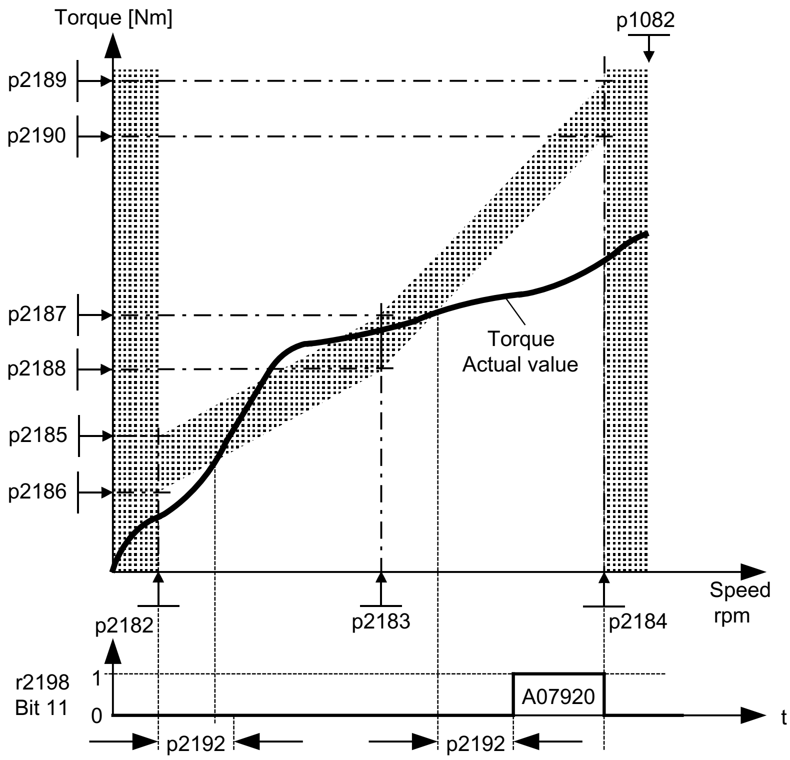


Figure 9-15 Load monitoring (p2181 =1)

Commissioning

The "extended monitoring functions" function module can be activated by running the commissioning wizard. Parameter r0108.17 indicates whether it has been activated.

Function diagram

FD 8010	Speed messages 1
FP 8011	Speed messages 2
FD 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 displays alarm
- r2198.12 Load monitoring displays fault

9.4 Monitoring and protective functions

9.4.1 Protecting power components

Description

SINAMICS power units offer comprehensive functions for protecting power components.

Table 9- 9 General protection for power units

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 for IGBT module	F30001 "Overcurrent" -> OFF2 F30022 "Monitoring Uce" -> OFF2
Ground fault	Monitoring the sum of all phase currents	After threshold in p0287 is exceeded: F30021 "power unit: 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)] The 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 priority of thermal monitoring for power components is to identify critical situations. If alarm thresholds are exceeded, the user can set parameterizable response options that enable continued operation (e.g. with reduced power) and prevent immediate shutdown. The parameterization options, however, only enable intervention below the shutdown thresholds, which cannot be changed by the user.

The following thermal monitoring options are available:

- i^2t monitoring – A07805 – F30005
  i^2t monitoring is used to protect components that have a high thermal time constant compared with semi-conductors. Overload with regard to i^2t is present when the converter load (r0036) is greater than 100% (load in % in relation to rated operation).
- Heatsink temperature – A05000 – F30004
  Monitoring of the heat-sink temperature (r0037) of the power semi-conductor (IGBT).
- Chip temperature – A05001 – F30025
  Significant temperature differences can occur between the barrier layer of the IGBT and the heatsink. These differences are taken into account and monitored by the chip temperature (r0037).

If an overload occurs with respect to any of these three monitoring functions, an alarm is first output. The alarm threshold p0294 (i^2t monitoring) can be parameterized relative to the shutdown (trip) values.

Example

The factory setting for the alarm threshold for chip temperature monitoring is 15 Kelvin (K), and 5 K for the heat sink and inlet air. This means that the "Overtemperature, overload" alarm is triggered at 15 K or 5 K below the shutdown threshold.

The parameterized responses are induced via p0290 simultaneously when the alarm is output. Possible responses include:

- Reduction in pulse frequency (p0290 = 2, 3)
  This is a highly effective method of reducing losses in the power unit, since switching losses account for a high proportion of overall losses. In many applications, a temporary reduction in the pulse frequency can be tolerated to allow the process to continue.
  Disadvantage:
  As a result of the pulse frequency reduction, the current ripple is increased which can mean that the torque ripple is increased at the motor shaft (for low moments of inertia) and also an 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.
- Reducing the output frequency (p0290 = 0, 2)
  This variant is recommended when you do not need to reduce the pulse frequency or the pulse frequency has already been set to the lowest level. 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 converter output current which, in turn, reduces losses in the power unit.
- No reduction (p0290 = 1)
  You should choose this option if it is neither possible to reduce the pulse frequency nor reduce the output current. The converter 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 it reaches its shutdown threshold, the converter switches itself off and the "Overtemperature, overload" fault is output. The time until shutdown, however, is not defined and depends on the degree of overload. To ensure that an alarm can be output earlier or that the user can intervene, if necessary, in the drive process (e.g. reduce load/ambient temperature), only the alarm threshold can be changed.

Function diagram

FP 8014 Thermal monitoring, power unit

Parameters

- r0036 Power Module overload
- r0037 Power Module temperatures
- p0290 Power Module overload response
- r0293 Power unit alarm threshold model temperature
- p0294 Power Module alarm with i²t overload
- r2135.13 Fault: thermal overload in power unit
- r2135.15 Alarm: thermal overload in power unit

9.4.3 Block protection

Description

The fault message "Motor blocked" is only triggered if the speed of the drive is below the variable speed threshold set 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 blocking monitoring enable can be deactivated via p2144.

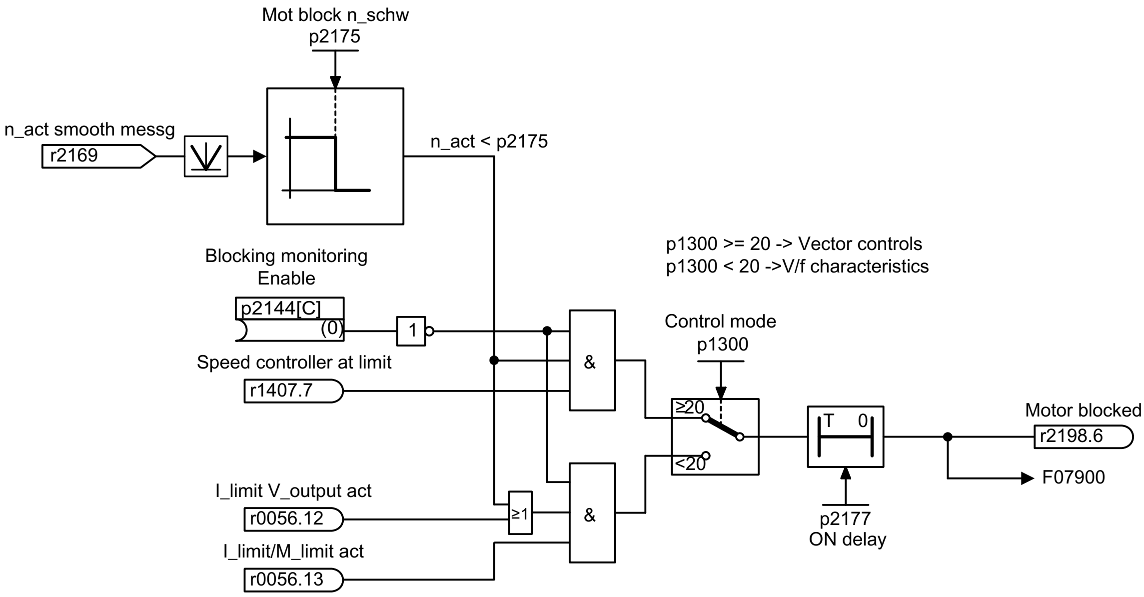


Figure 9-16 Blocking protection

Function diagram

FP 8012 Messages and monitoring - Torque messages, motor blocked/stalled

Parameters

- p2144 BI: Motor stall monitoring enable (negated)
- p2175 Motor locked speed threshold
- p2177 Motor locked delay time

9.4.4 Stall protection (only for vector control)

Description

If, for closed-loop speed control with encoder, the speed threshold set in p1744 for stall detection is exceeded, then r1408.11 (speed adaptation, speed deviation) is set.

If the fault 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 after the delay time in p2178, fault F07902 (motor stalled) is returned.

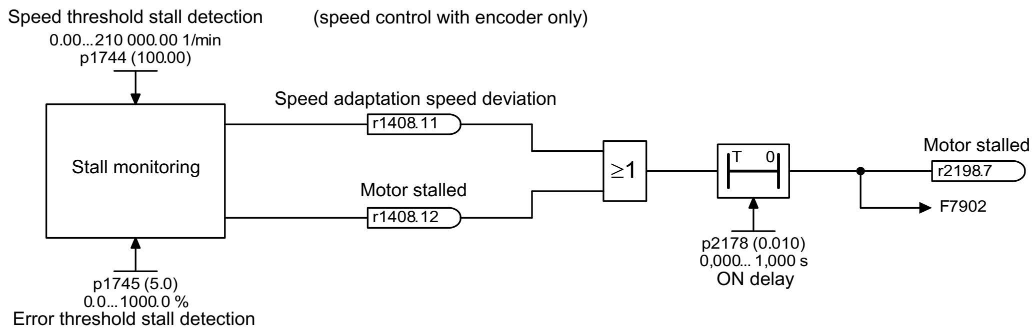


Figure 9-17 Stall protection

Function diagram

FP 6730 Current control
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. If alarm thresholds are exceeded, the user can set parameterizable response options (p0610) that enable continued operation (e.g. with reduced power) and prevent immediate shutdown.

- Effective protection is also possible without a temperature sensor (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 connection at the customer terminal block TM31

Temperature measurement via KTY

The device is connected to terminals X522:7 (Temp+) and X522:8 (Temp-) on the customer terminal block (TM31) in the forward direction of the diode. The measured temperature is limited to between –140 °C and +248 °C and is made available for further evaluation.

- Set the KTY temperature sensor type: p4100 = 2
- Activate motor temperature measurement via the external sensor: p0600 = 10
  If a customer terminal block TM31 is present and on completion of commissioning, the source for the external sensor is set to the customer terminal block (p0603 = (TM31) r4105).

Temperature measurement via PTC

The device is connected to terminal X522:7/8 on the customer terminal block (TM31). The threshold for switching to an alarm or fault is 1650 Ω. If the threshold is exceeded, the system switches internally from an artificially-generated temperature value of -50 °C to +250°C and makes it available for further evaluation.

- Set the PTC temperature sensor type: p4100 = 1
- Activate motor temperature measurement via the external sensor: p0600 = 10
  If a customer terminal block TM31 is present and on completion of commissioning, the source for the external sensor is set to the customer terminal block (p0603 = (TM31) r4105).

9.4.5.3 Temperature connection to a Sensor Module

Temperature measurement via KTY

The device is connected to the appropriate terminals Temp- and Temp+ on the Sensor Module in the forward direction of the diode (see corresponding section in chapter "Electrical installation").

- Activate motor temperature measurement via encoder 1: p0600 = 1.
- Set the KTY temperature sensor type: p0601 = 2

Temperature measurement via PTC

The device is connected to the appropriate terminals Temp- and Temp+ on the Sensor Module (see corresponding section in chapter "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 connection directly to the Control Interface Module

Temperature measurement via KTY

The device 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 device 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 via PT100

The device is connected to terminals X41:3 (Temp-) and X41:4 (Temp+) on the Control Interface Module. p0624 can be used to set the temperature offset for the PT100 measured value.

- 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; delivery state 130 °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
- When the fault threshold is reached (set via p0605, delivery state 145 °C), fault F07011 is triggered in conjunction with the setting in p0610.

Temperature measurement via PTC

- Alarm A07910 is triggered once the PTC responds.
- Fault F07011 is triggered once the waiting time defined in p0606 has elapsed.

Sensor monitoring for wire breakage/short-circuit

If the temperature of the motor temperature monitor is outside the range -140 °C to +250 °C, the sensor cable is broken or has short-circuited. Alarm A07015 ("Drive: Motor temperature sensor alarm") is triggered. Fault F07016 (“Drive: Motor temperature sensor fault”) is triggered once the waiting time defined in p0607 has elapsed.

Fault F07016 can be suppressed by p0607 = 0. If an induction motor is connected, the drive continues operating with the data calculated in 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 Function diagram

FP 8016	Thermal monitoring motor
FP 9576	TM31 -temperature evaluation KTY/PTC
FP 9577	TM31 -sensor monitoring KTY/PTC

9.4.5.7 Parameters

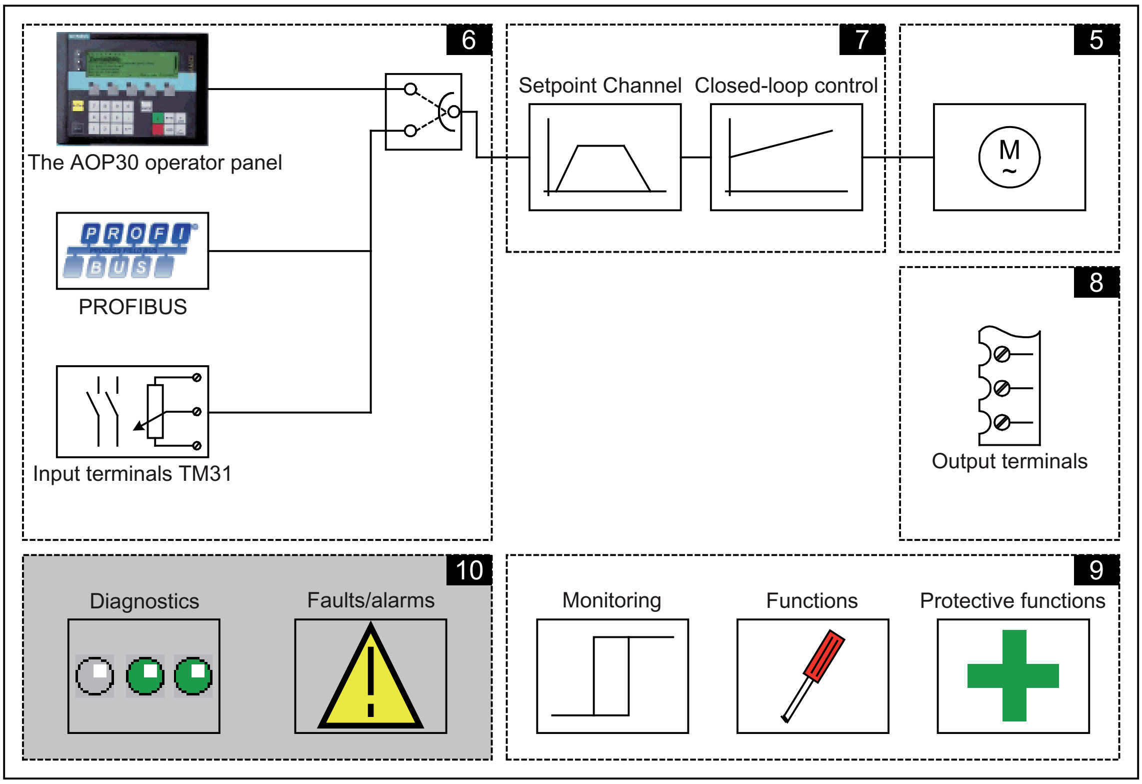
- p0600 Motor temperature sensor for monitoring
- p0601 Motor temperature sensor type
- p0604 Motor overtemperature fault threshold
- p0605 Motor overtemperature alarm threshold
- p0606 Motor overtemperature timer
- p0607 Temperature sensor fault timer
- p0610 Motor overtemperature response
- p4100 TM31 temperature evaluation sensor type
- r4105 CO: TM31 temperature evaluation actual value

Diagnosis / faults and alarms 10

10.1 Chapter content

This chapter provides information on the following:

- Troubleshooting
- Service and support offered by Siemens AG



10.2 Diagnosis

Description

This section describes procedures for identifying the causes of problems and the measures you need to take to rectify them.

Note

If errors 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.

10.2.1 Diagnostics via LEDs

Control Unit

Table 10- 1 Description of the Control Unit LEDs

LED	Color	Status	Description
RDY (ready)	---	OFF	No electronics power supply or electronics power supply is outside permissible tolerance range.
	Green	Continuous	The component is ready to operate and cyclic DRIVE-CLiQ communication is taking place. The Control Unit is awaiting first commissioning.
		2 Hz flashing light	Writing to CompactFlash card.
	Red	Continuous	At least one fault is present in this component.
		0.5 Hz flashing light	CompactFlash Card has not been inserted. Boot error (e.g., firmware cannot be loaded to the RAM).
	Green/red	Flashing light 0.5 Hz	Control Unit is ready for operation. However there are no software licenses.
	Orange	Continuous	System is booting and DRIVE-CLiQ communication is being established.
		0.5 Hz flashing light	DRIVE-CLiQ component firmware update in progress.
		2 Hz flashing light	Component firmware update complete. Waiting for POWER ON of relevant components.
DP1 (PROFIdrive cyclic transmission)	---	OFF	Cyclic communication is not (yet) taking place. Note: The PROFIdrive is ready for communication when the Control Unit is ready to operate (see RDY LED).
	Green	Continuous	Cyclic communication is taking place.
		0.5 Hz flashing light	Cyclic communication is not fully underway yet. Possible causes: - The controller is not transmitting any setpoints. - In isochronous mode, the controller did not send a Global Control or it sent a defective Global Control (GC).
	Red	Continuous	Cyclic communication has been interrupted.
	Orange	2 Hz flashing light	Firmware checksum error (CRC error).
OPT (option)	---	OFF	Electronics power supply outside permissible tolerance range. The component is not ready to operate. The Option Board is missing or an associated drive object has not been created.
	Green	Continuous	Option board is ready.
		0.5 Hz flashing light	Depends on the option board used.
	Red	Continuous	At least one fault is present in this component. The option board is not ready (e.g., after power ON).
MOD	---	OFF	Reserved

Customer terminal block TM31

Table 10- 2 Description of the LEDs on the TM31

LED	Color	Status	Description
RDY	---	OFF	The electronics power supply is missing or lies outside permissible tolerance range.
	Green	On permanently	The component is ready to operate and cyclic DRIVE-CLiQ communication is taking place.
	Orange	On permanently	DRIVE-CLiQ communication is being established.
	Red	On permanently	At least one fault is pending on this component. Note: LED is driven irrespective of the corresponding messages being reconfigured.
	Green/red	0.5 Hz flashing light	Firmware is being downloaded.
		2 Hz flashing light	Firmware download is complete. Waiting for POWER ON.
	Green/orange or red/orange	2 Hz flashing light	Detection of the components via LED is activated (p0154). Note: Both options depend on the LED status when module recognition is activated via p0154 = 1.

Control Interface Module – Interface module in the Power Module

Table 10- 3 Description of the LEDs "READY" and "DC LINK" on the Control Interface Module

LED state		Description
READY	DC LINK	
Off	Off	The electronics power supply is missing or out of tolerance.
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 on this component. Note: LED is driven irrespective of the corresponding messages being reconfigured.
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- 4 Meaning of the LED "POWER OK" on the Control Interface Module

LED	Color	State	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

Hazardous DC link voltages may be present at any time regardless of the status of the "DC LINK" LED.
The warning information on the components must be carefully observed!

SMC30 – encoder evaluation

Table 10- 5 Description of the LEDs on the SMC30

LED	Color	State	Description
RDY	---	OFF	The electronics power supply is missing or lies outside the permissible tolerance range.
	Green	Steady light	The component is ready for operation and cyclic DRIVE-CLiQ communication is taking place.
	Orange	Steady light	DRIVE-CLiQ communication is being established.
	Red	Steady light	At least one fault is pending on this component. Note: LED is driven irrespective of the corresponding messages being 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	Detection of the components via LED is activated (p0144). Note: Both options depend on the LED status when module recognition is activated via p0144 = 1.
OUT>5 V	---	OFF	Electronics power supply is missing or outside permissible tolerance range. Power supply ≤ 5 V.
	Orange	Steady light	Electronic power supply for measuring system present. Supply voltage > 5 V. Notice: You must ensure that the connected encoder can be operated with a 24 V supply. Operating an encoder designed for a 5 V supply with a 24 V supply can damage the encoder electronics beyond repair.

10.2.2 Diagnostics via parameters

All Objects: key diagnostic parameters (details in List Manual)

Parameters	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.
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)

Parameters	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. For the display parameters for the firmware version of the other connected components, see the parameter description in the List Manual.
r0721	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	Status of digital inputs (CU)
	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.
r0747	Status of digital outputs (CU)
	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.

Parameters	Name Description
r9976[0..7]	System load
	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. Further, the degree of memory utilization of the data and program memory is displayed.

VECTOR: key diagnostic parameters (details in List Manual)

Parameters	Name Description
r0002	Operating display
	The value provides information about the current operating status and the conditions necessary to reach the next status.
r0020	Speed setpoint smoothed
	Displays the actual smoothed speed/velocity setpoint at the input of the speed/velocity controller or V/f characteristic (after the interpolator).
r0021	Actual speed value smoothed
	Displays the smoothed actual value of the motor speed/velocity.
r0026	DC link voltage smoothed
	Displays the smoothed actual value of the DC link.
r0027	Absolute actual current smoothed
	Displays the smoothed actual value of the current.
r0031	Actual torque smoothed
	Displays the smoothed actual torque.
r0035	Motor temperature
	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). • An PTC sensor is connected. If using a synchronous motor, the thermal motor model is activated (p0600 = 0 or p0601 = 0).
r0037	Power Module temperatures
	Displays the measured temperatures in the Power Module.
r0046	Missing drive enable signals
	Displays missing enable signals that are preventing the closed-loop drive control from being commissioned.
r0049	Motor/encoder data set effective (MDS, EDS)
	Displays the effective motor data set (MDS) and the effective encoder data sets (EDS).
r0050	Command data set effective (CDS)
	Displays the effective command data set (CDS)
r0051	Drive data set (DDS) effective

Parameters	Name Description
	Effective drive data set (DDS) display.
r0206	Rated power module power Displays the rated power module power for various load duty cycles.
r0207	Rated power module current Displays the rated power module power for various load duty cycles.
r0208	Rated power module line supply voltage Displays the rated line supply voltage of the power module.

TM31: key diagnostic parameters (details in List Manual)

Parameters	Name Description
r0002	TM31 operating display Operating display for terminal board 31 (TB31).
r4021	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	Status of digital inputs 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	Status of digital outputs 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 warnings 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 acknowledgement after it has been rectified

Note

The list of faults and alarms is included on the CD.

It also contains descriptions of the responses (OFF1, OFF2, etc.).

10.4 Service and Support

Technical support

We offer technical support in both German and English for deploying products, systems, and solutions in drive and automation technology.

In special cases, help is available from professional, trained, and experienced specialists via teleservice and video conferencing.

If you have any questions, please contact our hotline:

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

Time zone America	
Phone	+1 423 262 2522
Fax	+1 423 262 2200
Internet	techsupport.sea@siemens.com

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

10.4.1 Spare parts

Ask your local Siemens office for details of spare parts available for your built-in unit.

Maintenance and servicing 11

11.1 Chapter content

This chapter 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 devices.
- Exchanging device components when the unit is serviced
- Forming the DC link capacitors
- Upgrading the device firmware

DANGER

Five safety rules

When carrying out any kind of work on electrical devices, the "five safety rules" must always be observed:

1. Disconnect the system
2. Protect against reconnection.
3. Make sure that the equipment has zero potential
4. Ground and short-circuit.
5. Cover or fence off adjacent components that are still live.

DANGER

Before carrying out any maintenance or repair work on the de-energized built-in unit, wait for 5 minutes after switching off the supply voltage. This allows the capacitors to discharge to a harmless level (< 25 V) after the supply voltage has been switched off.

Before starting work, you should also measure the voltage after the 5 minutes have elapsed. The voltage can be measured on DC link terminals DCP and DCN.

11.2 Maintenance

The chassis unit comprises mostly electronic components. Apart from the fan(s), the unit, therefore, contains hardly any components that are subject to wear or that require maintenance or servicing. The purpose of maintenance is to preserve the specified condition of the chassis unit. 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 chassis unit must be removed at regular intervals (or at least once a year) by qualified personnel in line with the relevant safety regulations. The unit must be cleaned using a brush and vacuum cleaner, and dry compressed air (max. 1 bar) for areas that cannot be easily reached.

Ventilation

When installing the devices in a cabinet, make sure that the cabinet ventilation slots are not obstructed. The fan must be checked to make sure that it is functioning correctly.

Cable and screw terminals

Cable and screw terminals must be checked regularly to ensure that they are secure in position, and if necessary, retightened. Cabling must be checked for defects. Defective parts must be replaced immediately.

Note

The actual intervals at which maintenance procedures are to be performed depend on the installation conditions 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 Maintenance

11.3.1 Maintenance

Servicing involves activities and procedures for maintaining and restoring the specified condition of the device.

Required tools

The following tools are required for replacing components:

- Spanner or socket spanner (w/f 10)
- Spanner or socket spanner (w/f 13)
- Spanner or socket spanner (w/f 16/17)
- Spanner or socket spanner (w/f 18/19)
- Hexagon-socket spanner (size 8)
- Torque wrench from 5 Nm to 50 Nm
- Screwdriver size 1 / 2
- Screwdriver Torx T20
- Screwdriver Torx T30

Tightening torques for current-carrying parts

When securing connections for current-conducting parts (DC link/motor connections, busbars), you must observe the following tightening torques.

Table 11- 1 Tightening torques for connecting current-carrying parts

Screw	Torque
M6	6 Nm
M8	13 Nm
M10	25 Nm
M12	50 Nm

11.3.2 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.

11.3.3 Using crane lifting lugs to transport power blocks

Crane lifting lugs

The power blocks are fitted with crane lifting lugs for transportation on a lifting harness in the context of replacement.

The positions of the crane lifting lugs are illustrated by arrows in the figures below.

⚠ WARNING
A lifting harness with vertical ropes or chains must be used to prevent any risk of damage to the housing.

CAUTION
The power block busbars must not be used to support or secure lifting harnesses for the purpose of transportation.

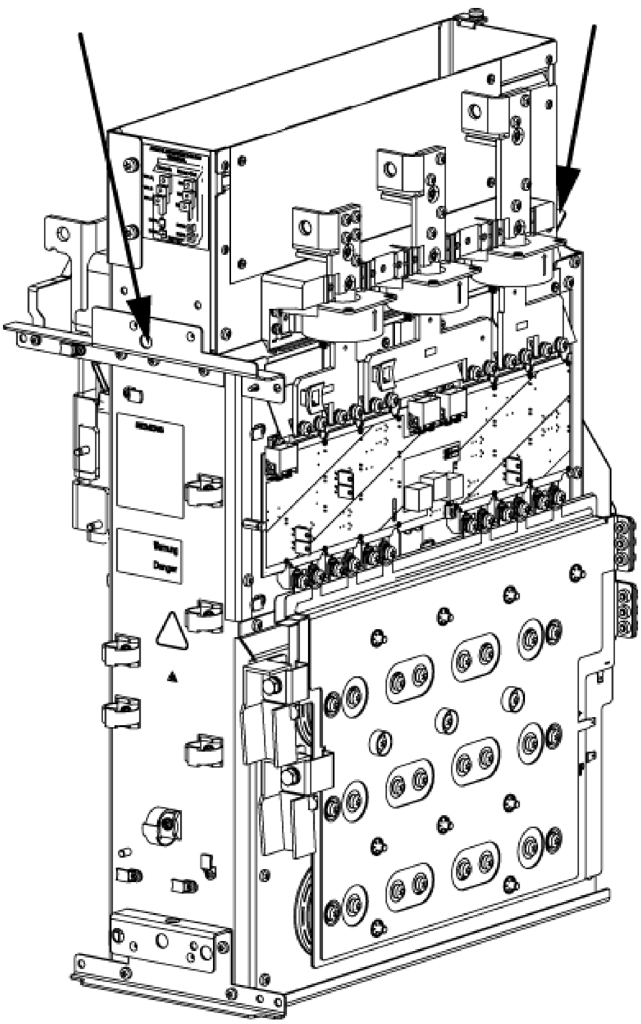


Figure 11-2 Crane lifting lugs on FX, GX power block

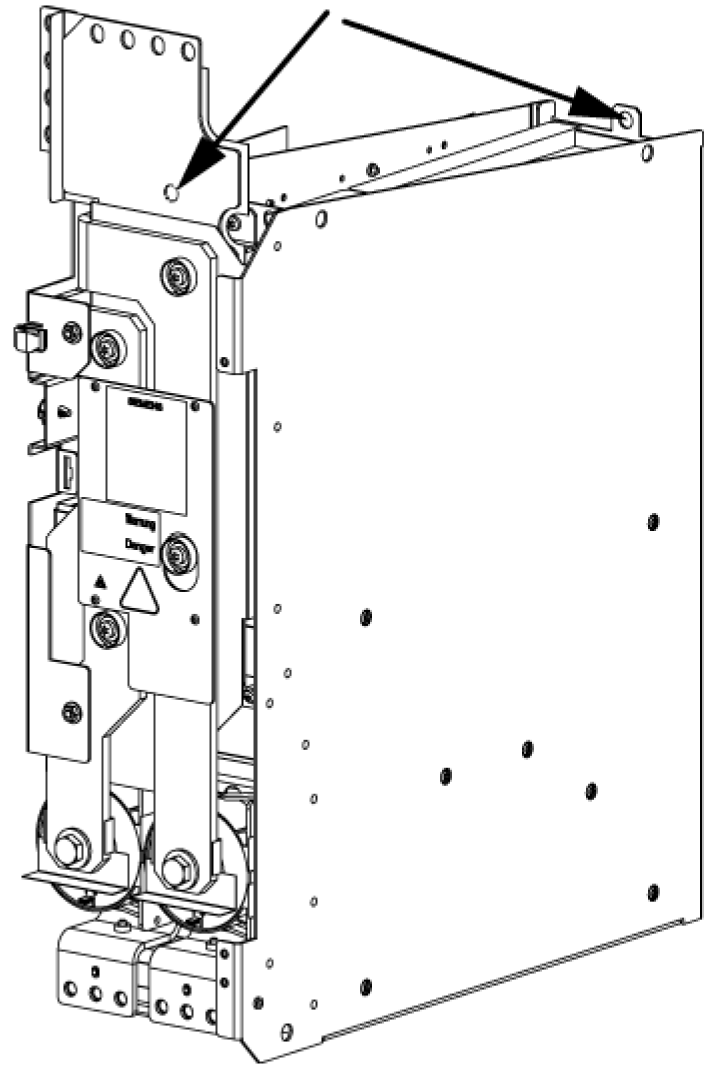


Figure 11-3 Crane lifting lugs on HX, JX power block

Note

On HX and JX power blocks, the front crane lifting lug is located behind the busbar.

11.4 Replacing components

WARNING

The following must be taken into account when the devices are transported:

- Some of the devices are heavy or top heavy.
- Due to their weight, the devices must be handled with care by trained personnel.
- Serious injury or even death and substantial material damage can occur if the devices are not lifted or transported properly.

WARNING

The devices are operated with high voltages.

All connection work must be carried out when the cabinet is de-energized!

All work on the device must be carried out by trained personnel only. Non-observance of these warnings can result in death, serious personal injury, or substantial property damage.

Work on an open device must be carried out with extreme caution because external supply voltages may be present. The power and control terminals may be live even when the motor is not running.

Dangerously high voltage levels are still present in the device up to five minutes after it has been disconnected due to the DC link capacitors. For this reason, the unit should not be opened until a reasonable period of time has elapsed.

DANGER

Five safety rules

When carrying out any kind of work on electrical devices, the "five safety rules" according to EN 50110 must always be observed:

1. Disconnect the system
2. Protect against reconnection.
3. Make sure that the equipment has zero potential
4. Ground and short-circuit.
5. Cover or fence off adjacent components that are still live.

11.4.1 Replacing the Control Interface Module, frame size FX

Replacing the Control Interface Module

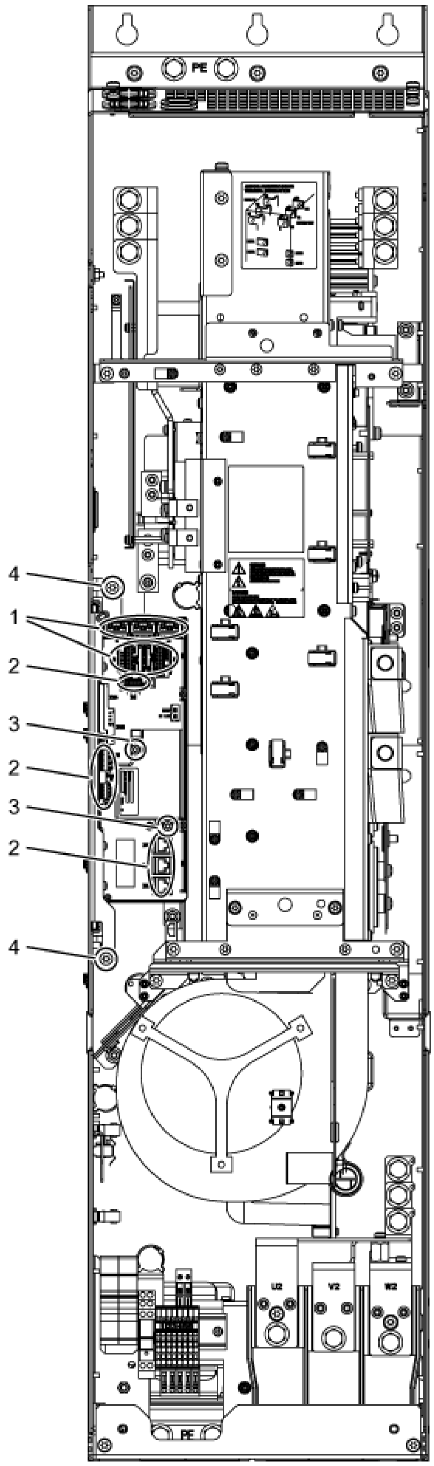


Figure 11-4 Replacing the Control Interface Module, frame size FX

Preparatory steps

- Disconnect the built-in unit from the power supply.
- Allow unimpeded access.
- Remove the protective cover.

Removal steps

The removal steps are numbered in accordance with the figure.

1. Disconnect the plug-in connections for the fiber-optic cables and signal cables (5 plugs).
2. Remove the DRIVE-CLiQ cables and connections on -X41, -X42, -X46 (6 plugs).
3. Take out the retaining screws for the IPD card (2 screws) and remove the IPD card from plug -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 have to disconnect 5 further plugs one after the other (2 at the top, 3 below).

CAUTION
When removing the unit, ensure that you do not damage any signal cables.

Installation steps

For installation, carry out the above steps in reverse order.

CAUTION
The tightening torques specified in the table "Tightening torques for connecting current-conducting parts" must be observed. Carefully establish the plug connections and then ensure that they are secure. The fiber optic cable plugs must be remounted at their original slot. Fiber optic cables and sockets are accordingly labeled for correct assignment (U11, U21, U31). The screw connections for the protective covers must only be tightened finger-tight.

11.4.2 Replacing the Control Interface Module, frame size GX

Replacing the Control Interface Module

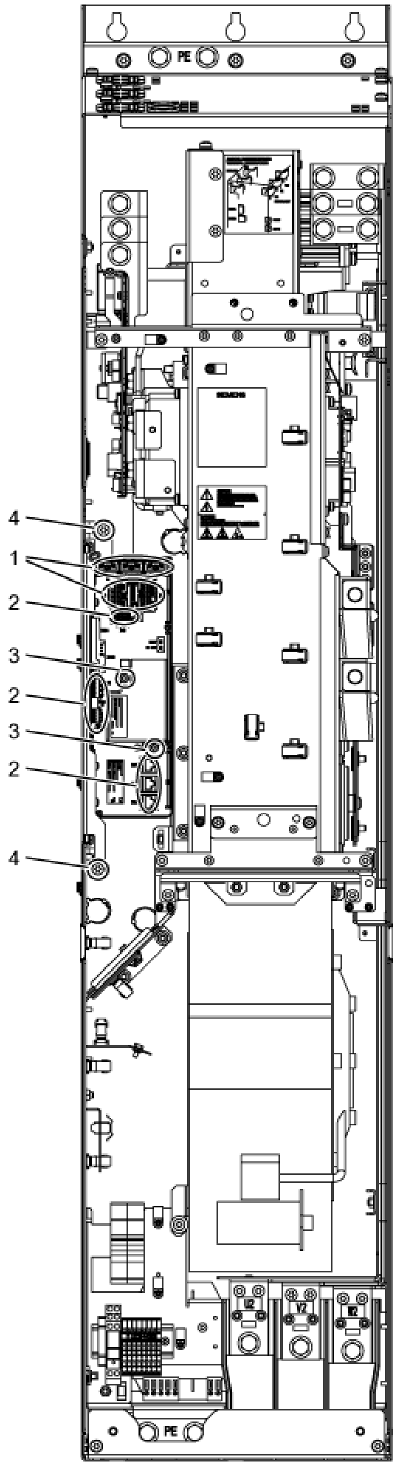


Figure 11-5 Replacing the Control Interface Module, frame size GX

Preparatory steps

- Disconnect the built-in unit from the power supply.
- Allow unimpeded access.
- Remove the protective cover.

Removal steps

The removal steps are numbered in accordance with the figure.

1. Disconnect the plug-in connections for the fiber-optic cables and signal cables (5 plugs).
2. Remove the DRIVE-CLiQ cables and connections on -X41, -X42, -X46 (6 plugs).
3. Take out the retaining screws for the IPD card (2 screws) and remove the IPD card from plug -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 have to disconnect 5 further plugs one after the other (2 at the top, 3 below).

CAUTION
When removing the unit, ensure that you do not damage any signal cables.

Installation steps

For installation, carry out the above steps in reverse order.

CAUTION
The tightening torques specified in the table "Tightening torques for connecting current-conducting parts" must be observed. Carefully establish the plug connections and then ensure that they are secure. The fiber optic cable plugs must be remounted at their original slot. Fiber optic cables and sockets are accordingly labeled for correct assignment (U11, U21, U31). The screw connections for the protective covers must only be tightened finger-tight.

11.4.3 Replacing the Control Interface Module, frame size HX

Replacing the Control Interface Module

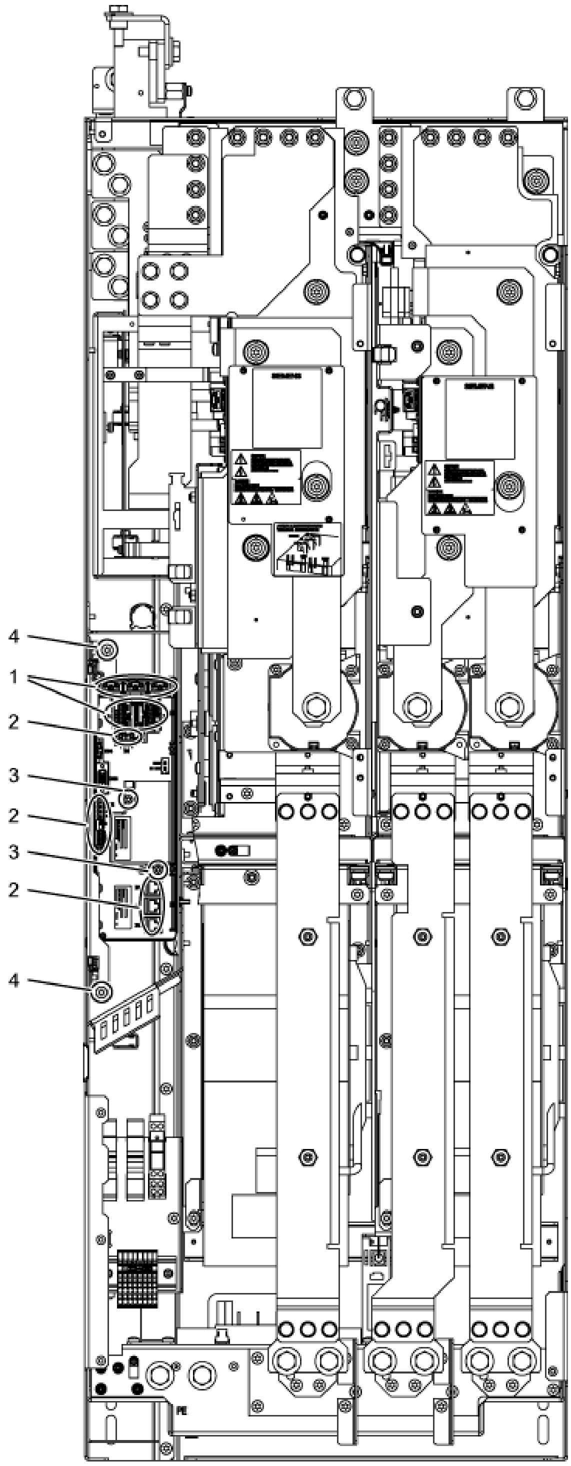


Figure 11-6 Replacing the Control Interface Module, frame size HX

Preparatory steps

- Disconnect the built-in unit from the power supply.
- Allow unimpeded access.
- Remove the protective cover.

Removal steps

The removal steps are numbered in accordance with the figure.

1. Disconnect the plug-in connections for the fiber-optic cables and signal cables (5 plugs).
2. Remove the DRIVE-CLiQ cables and connections on -X41, -X42, -X46 (6 plugs).
3. Take out the retaining screws for the IPD card (2 screws) and remove the IPD card from plug -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 have to disconnect 5 further plugs one after the other (2 at the top, 3 below).

CAUTION
When removing the unit, ensure that you do not damage any signal cables.

Installation steps

For installation, carry out the above steps in reverse order.

CAUTION
The tightening torques specified in the table "Tightening torques for connecting current-conducting parts" must be observed. Carefully establish the plug connections and then ensure that they are secure. The fiber optic cable plugs must be remounted at their original slot. Fiber optic cables and sockets are accordingly labeled for correct assignment (U11, U21, U31). The screw connections for the protective covers must only be tightened finger-tight.

11.4.4 Replacing the Control Interface Module, frame size JX

Replacing the Control Interface Module

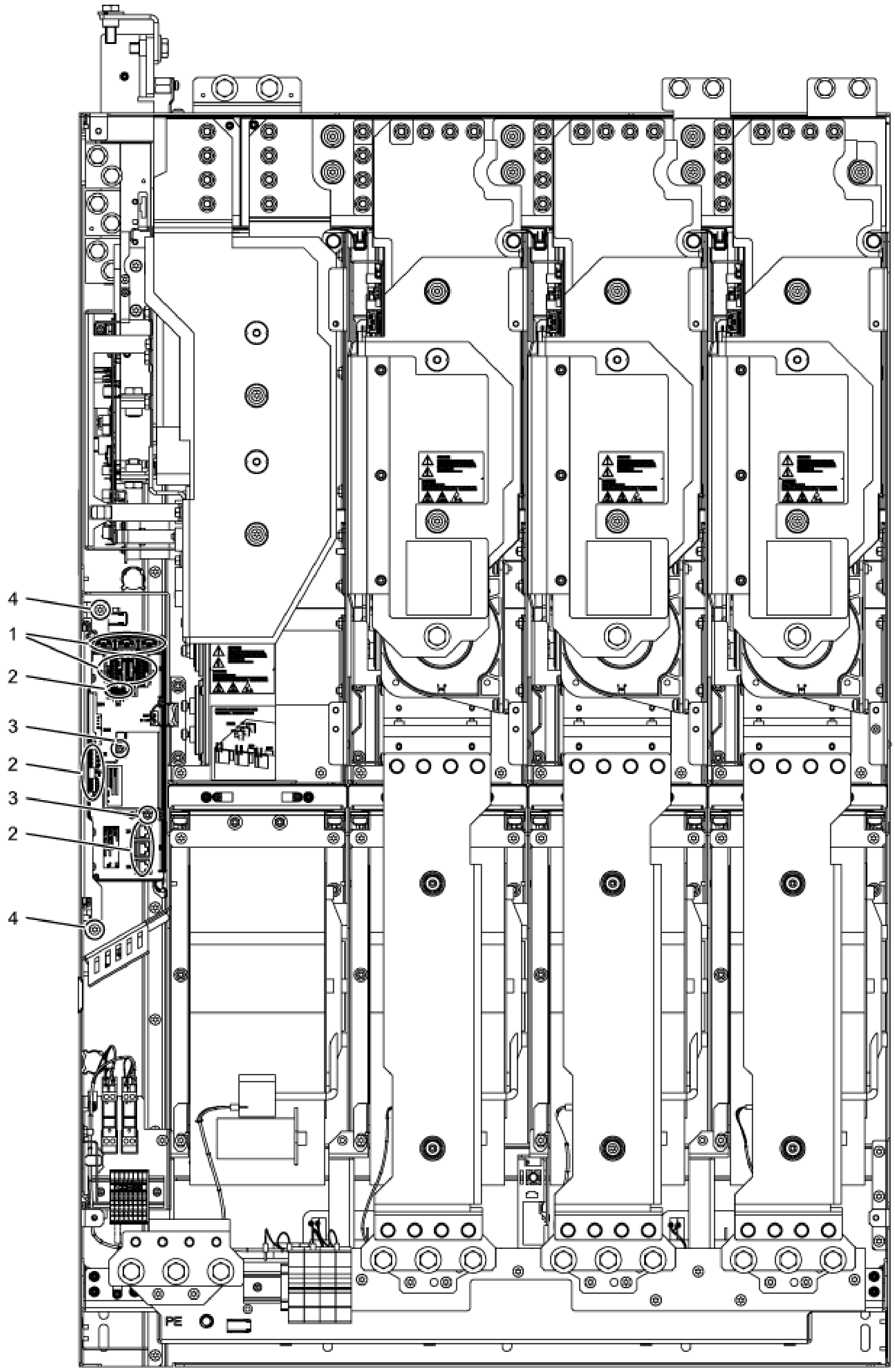


Figure 11-7 Replacing the Control Interface Module, frame size JX

Preparatory steps

- Disconnect the built-in unit from the power supply.
- Allow unimpeded access.
- Remove the protective cover.

Removal steps

The removal steps are numbered in accordance with the figure.

1. Disconnect the plug-in connections for the fiber-optic cables and signal cables (5 plugs).
2. Remove the DRIVE-CLiQ cables and connections on -X41, -X42, -X46 (6 plugs).
3. Take out the retaining screws for the IPD card (2 screws) and remove the IPD card from plug -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 have to disconnect 5 further plugs one after the other (2 at the top, 3 below).

CAUTION
When removing the unit, ensure that you do not damage any signal cables.

Installation steps

For installation, carry out the above steps in reverse order.

CAUTION
The tightening torques specified in the table "Tightening torques for connecting current-conducting parts" must be observed. Carefully establish the plug connections and then ensure that they are secure. The fiber optic cable plugs must be remounted at their original slot. Fiber optic cables and sockets are accordingly labeled for correct assignment (U11, U21, U31). The screw connections for the protective covers must only be tightened finger-tight.

11.4.5 Replacing the power block, frame size FX

Replacing the power block

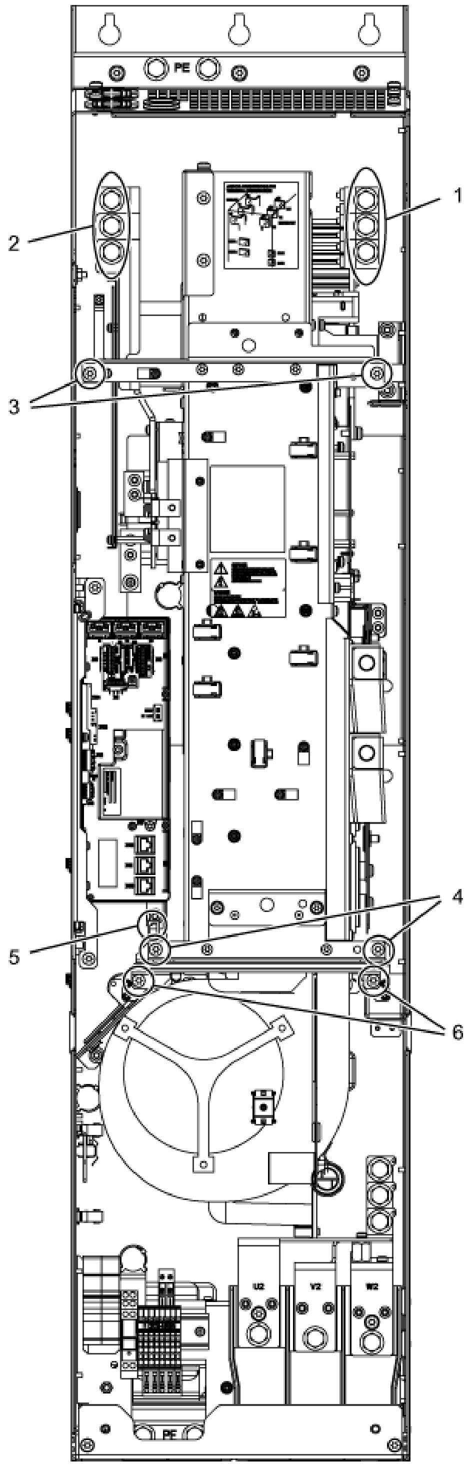


Figure 11-8 Replacing the power block, frame size FX

Preparatory steps

- Disconnect the built-in unit from the power supply.
- Allow unimpeded access to the power block.
- Remove the protective cover.
- Removing the Control Interface Module (see corresponding section)

Removal steps

The removal steps are numbered in accordance with 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 two retaining screws for the fan and attach the equipment for assembling the power block at this position.

You can now remove the power block.

CAUTION
When removing the power block, ensure that you do not damage any signal cables.

Installation steps

For installation, carry out the above steps in reverse order.

CAUTION
The tightening torques specified in the table "Tightening torques for connecting current-conducting parts" must be observed. Carefully establish the plug connections and then ensure that they are secure. The screw connections for the protective covers must only be tightened finger-tight.

11.4.6 Replacing the power block (frame size GX)

Replacing the power block

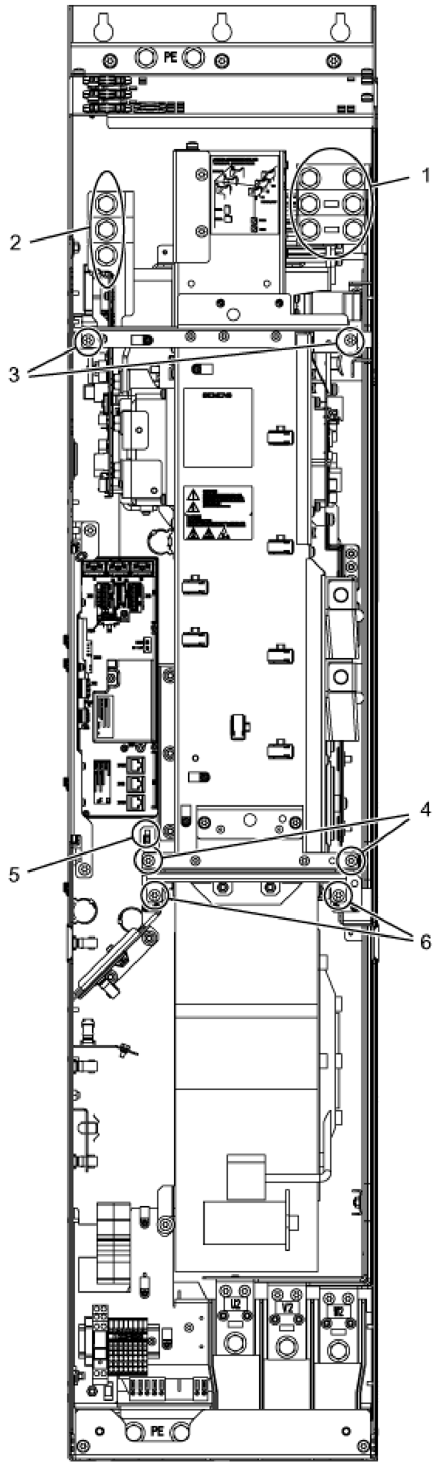


Figure 11-9 Replacing the power block, frame size GX

Preparatory steps

- Disconnect the built-in unit from the power supply.
- Allow unimpeded access to the power block.
- Remove the protective cover.
- Removing the Control Interface Module (see corresponding section)

Removal steps

The removal steps are numbered in accordance with 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 two retaining screws for the fan and attach the equipment for assembling the power block at this position.

You can now remove the power block.

CAUTION
When removing the power block, ensure that you do not damage any signal cables.

Installation steps

For installation, carry out the above steps in reverse order.

CAUTION
The tightening torques specified in the table "Tightening torques for connecting current-conducting parts" must be observed. Carefully establish the plug connections and then ensure that they are secure. The screw connections for the protective covers must only be tightened finger-tight.

11.4.7 Replacing the power block (frame size HX)

Replacing the left power block

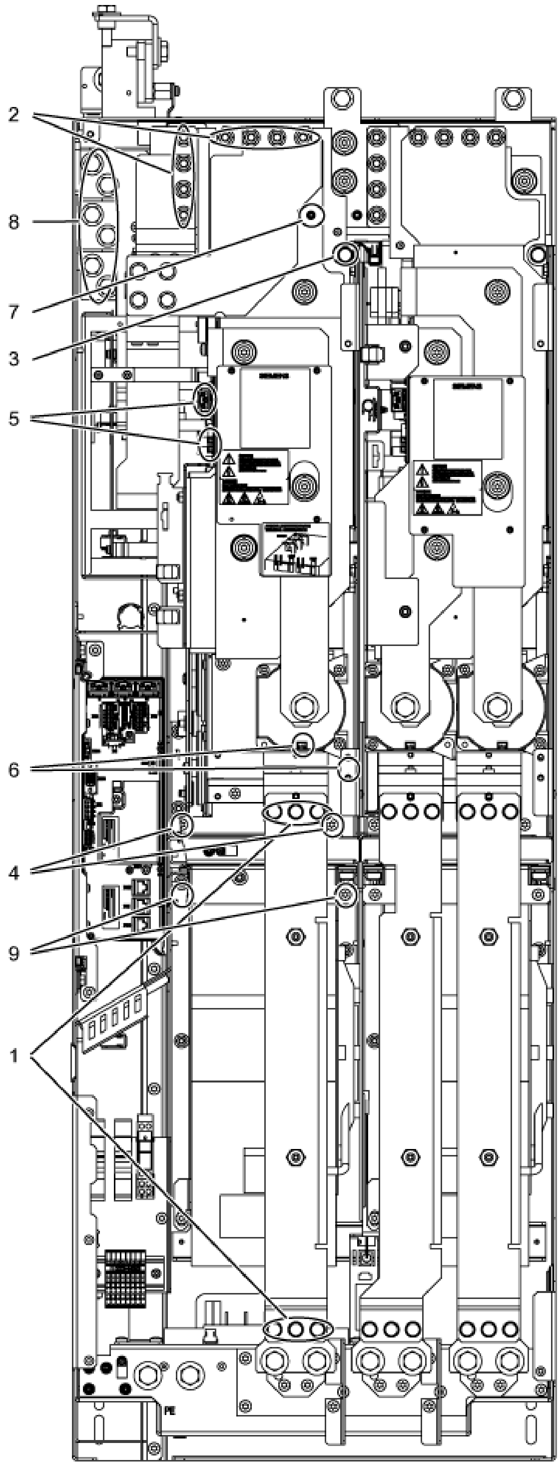


Figure 11-10 Replacing the power block, frame size HX, left power block

Preparatory steps

- Disconnect the built-in unit from the power supply.
- Allow unimpeded access to the power block.
- Remove the protective cover.

Removal steps

The removal steps are numbered in accordance with 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-in connections for the fiber-optic cables and signal cables (3 plugs).
6. Remove the connection for the current transformer and associated 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 two retaining screws for the fan and attach the tool for de-installing the power block at this position.

You can now remove the power block.

CAUTION
When removing the power block, ensure that you do not damage any signal cables.

Installation steps

For installation, carry out the above steps in reverse order.

CAUTION
The tightening torques specified in the table "Tightening torques for connecting current-conducting parts" must be observed. Carefully establish the plug connections and then ensure that they are secure. The screw connections for the protective covers must only be tightened finger-tight.

Replacing the right power block

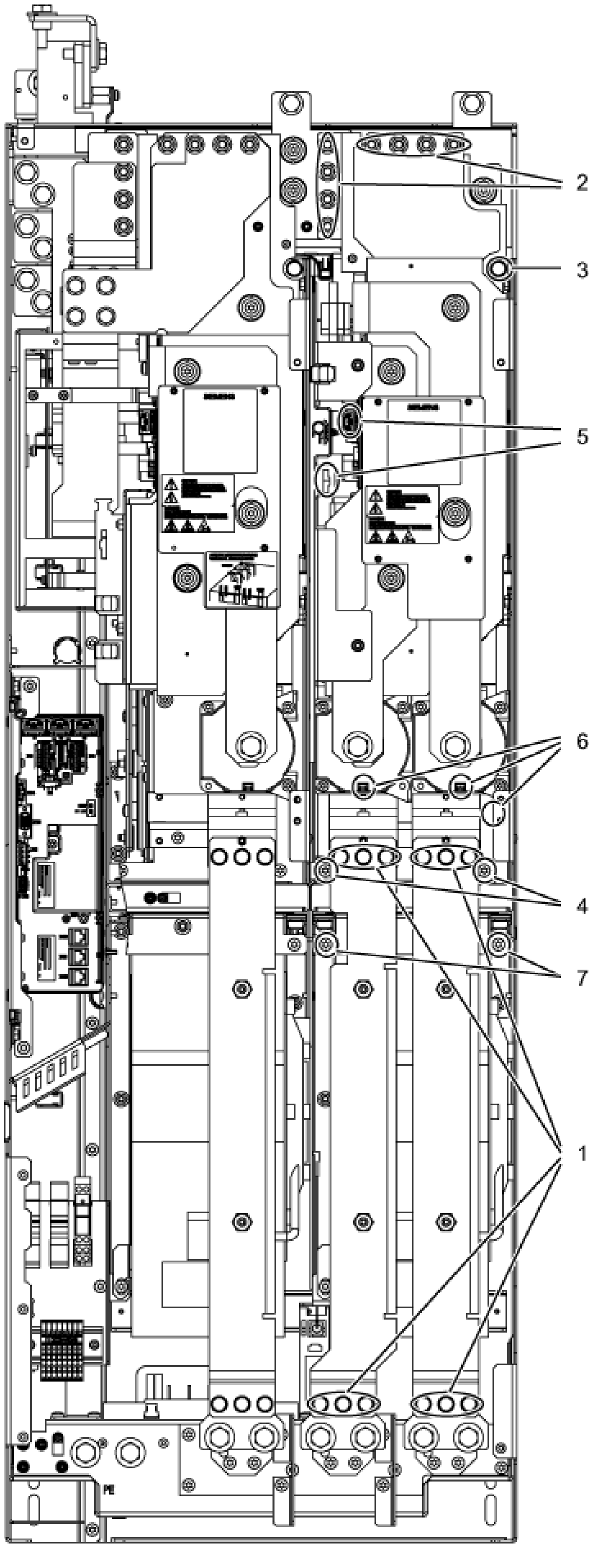


Figure 11-11 Replacing the power block, frame size HX, right power block

Preparatory steps

- Disconnect the built-in unit from the power supply.
- Allow unimpeded access to the power block.
- Remove the protective cover.

Removal steps

The removal steps are numbered in accordance with 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-in connections for the fiber-optic cables and signal cables (3 plugs).
6. Remove the connection for the current transformer and associated PE connection (2 plugs).
7. Unscrew the two retaining screws for the fan and attach the tool for de-installing the power block at this position.

You can now remove the power block.

CAUTION
When removing the power block, ensure that you do not damage any signal cables.

Installation steps

For installation, carry out the above steps in reverse order.

CAUTION
The tightening torques specified in the table "Tightening torques for connecting current-conducting parts" must be observed. Carefully establish the plug connections and then ensure that they are secure. The screw connections for the protective covers must only be tightened finger-tight.

11.4.8 Replacing the power block (frame size JX)

Replacing the left power block

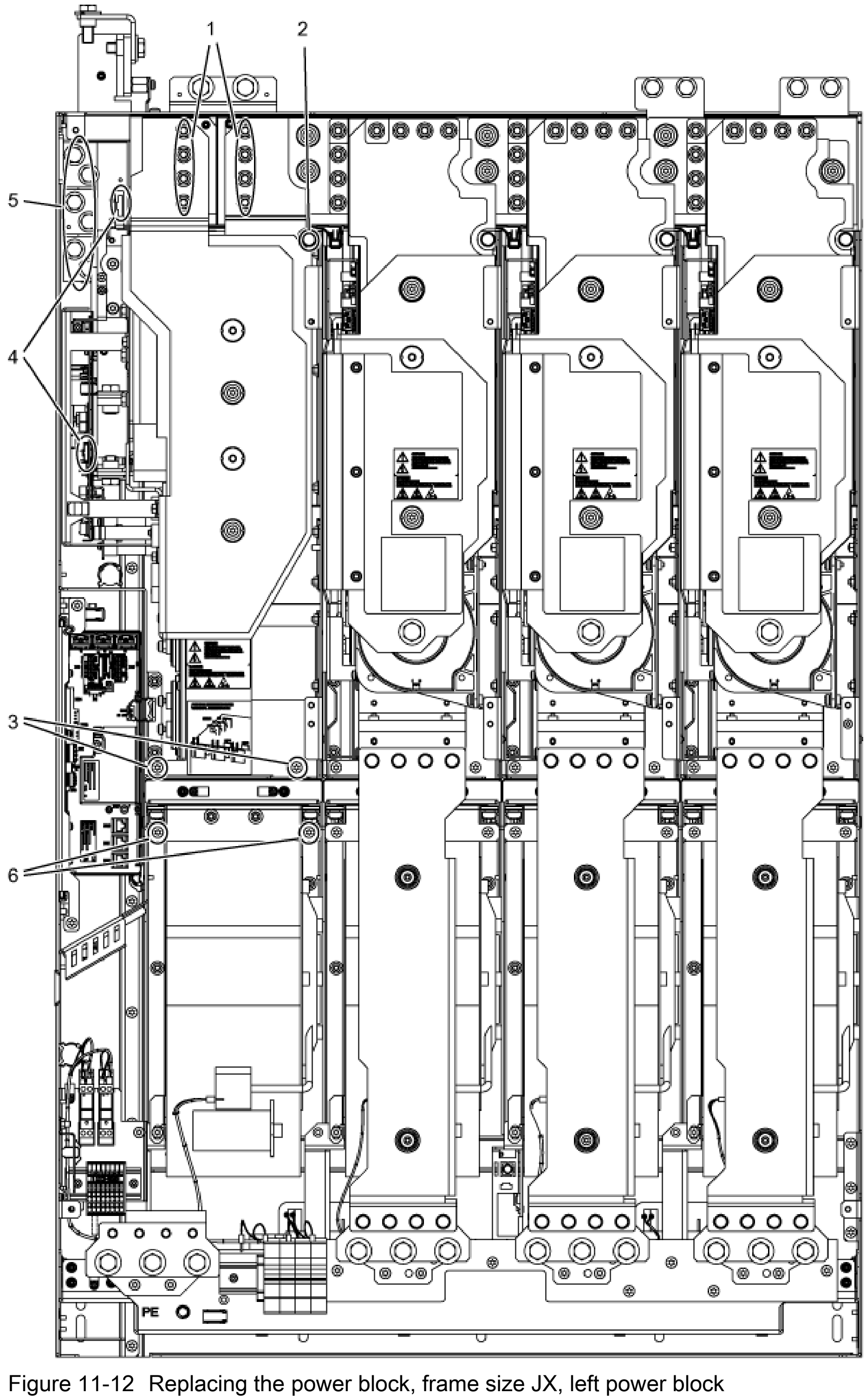


Figure 11-12 Replacing the power block, frame size JX, left power block

Preparatory steps

- Disconnect the built-in unit from the power supply.
- Allow unimpeded access to the power block.
- Remove the protective cover.

Removal steps

The removal steps are numbered in accordance with 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-in connections for the fiber-optic cables and signal cables (2 plugs).
5. Remove the connections to the mains supply (6 screws).
6. Unscrew the two retaining screws for the fan and attach the tool for de-installing the power block at this position.

You can now remove the power block.

CAUTION
When removing the power block, ensure that you do not damage any signal cables.

Installation steps

For installation, carry out the above steps in reverse order.

CAUTION
The tightening torques specified in the table "Tightening torques for connecting current-conducting parts" must be observed. Carefully establish the plug connections and then ensure that they are secure. The screw connections for the protective covers must only be tightened finger-tight.

Replacing the right power block

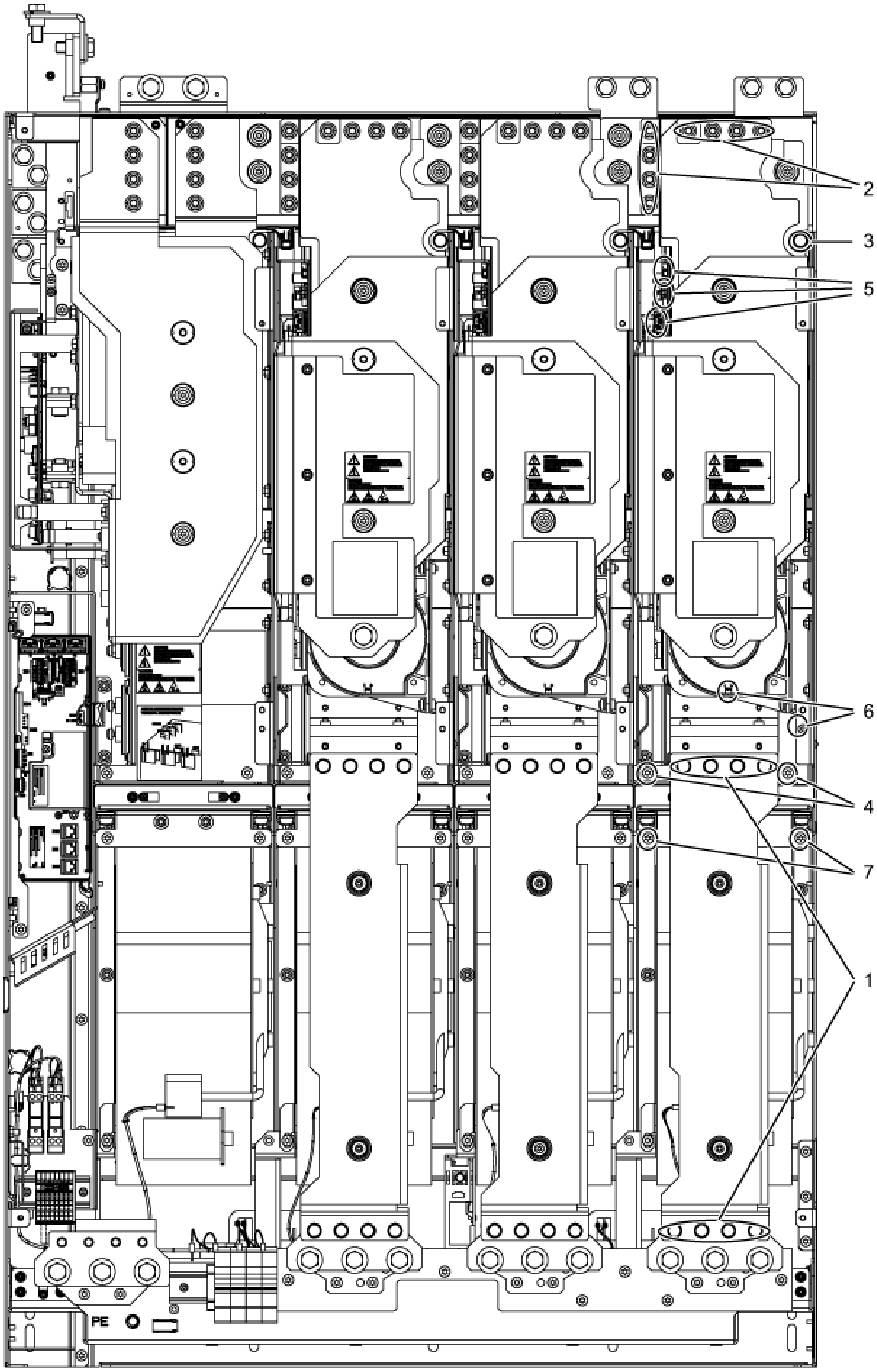


Figure 11-13 Replacing the power block, frame size JX, right power block

Preparatory steps

- Disconnect the built-in unit from the power supply.
- Allow unimpeded access to the power block.
- Remove the protective cover.

Removal steps

The removal steps are numbered in accordance with 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-in connections for the fiber-optic cables and signal cables (2 plugs).
6. Remove the connection for the current transformer and associated PE connection (1 plug).
7. Unscrew the two retaining screws for the fan and attach the tool for de-installing the power block at this position.

You can now remove the power block.

CAUTION
When removing the power block, ensure that you do not damage any signal cables.

Installation steps

For installation, carry out the above steps in reverse order.

CAUTION
The tightening torques specified in the table "Tightening torques for connecting current-conducting parts" must be observed. Carefully establish the plug connections and then ensure that they are secure. The screw connections for the protective covers must only be tightened finger-tight.

11.4.9 Replacing the fan, frame size FX

Replacing the fan

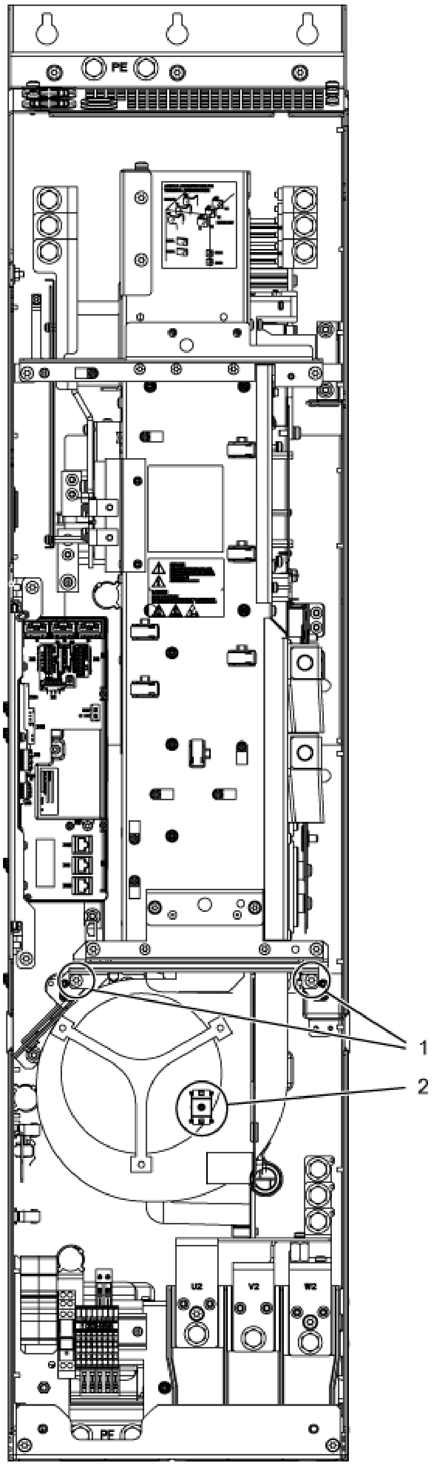


Figure 11-14 Replacing the fan, frame size FX

Description

The average service life of the device fans is 50,000 hours. In practice, however, the service life depends on other variables (e.g., ambient temperature, degree of cabinet protection, etc.) and, therefore, may deviate from this value.

The fans must be replaced in good time to ensure that the cabinet unit is available.

Preparatory steps

- Disconnect the built-in unit from the power supply.
- Allow unimpeded access.
- Remove the protective cover.

Removal steps

The removal steps are numbered in accordance with 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.

CAUTION
When removing the unit, ensure that you do not damage any signal cables.

Installation steps

For installation, carry out the above steps in reverse order.

CAUTION
The tightening torques specified in the table "Tightening torques for connecting current-conducting parts" must be observed. Carefully establish the plug connections and then ensure that they are secure. The screw connections for the protective covers must only be tightened finger-tight.

11.4.10 Replacing the fan (frame size GX)

Replacing the fan

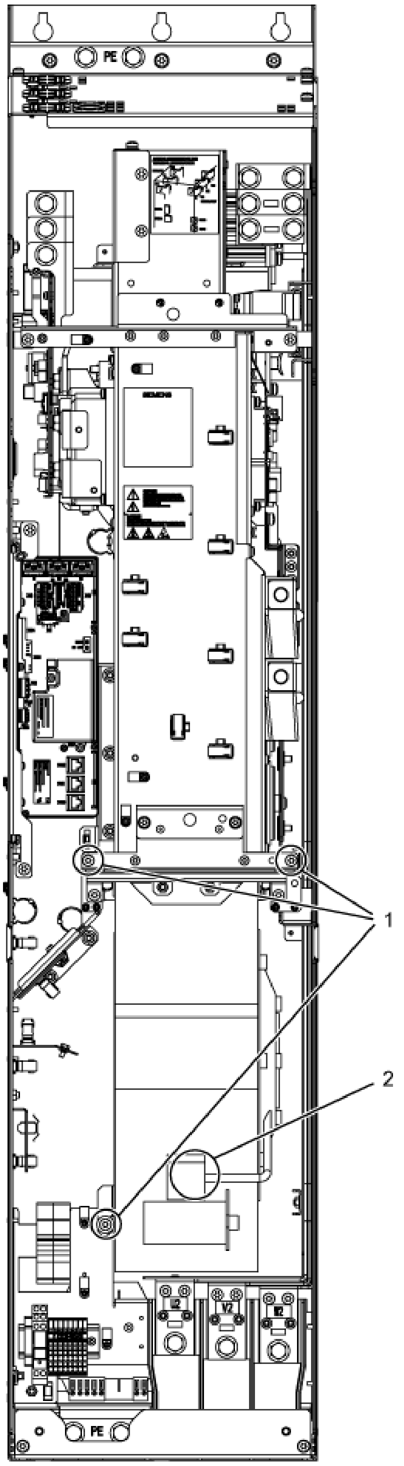


Figure 11-15 Replacing the fan, frame size GX

Description

The average service life of the device fans is 50,000 hours. In practice, however, the service life depends on other variables (e.g., ambient temperature, degree of cabinet protection, etc.) and, therefore, may deviate from this value.

The fans must be replaced in good time to ensure that the built-in unit is available.

Preparatory steps

- Disconnect the built-in unit from the power supply.
- Allow unimpeded access.
- Remove the protective cover.

Removal steps

The removal steps are numbered in accordance with 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.

CAUTION
When removing the unit, ensure that you do not damage any signal cables.

Installation steps

For installation, carry out the above steps in reverse order.

CAUTION
The tightening torques specified in the table "Tightening torques for connecting current-conducting parts" must be observed. Carefully establish the plug connections and then ensure that they are secure. The screw connections for the protective covers must only be tightened finger-tight.

11.4.11 Replacing the fan (frame size HX)

Replacing the fan (left-hand power block)

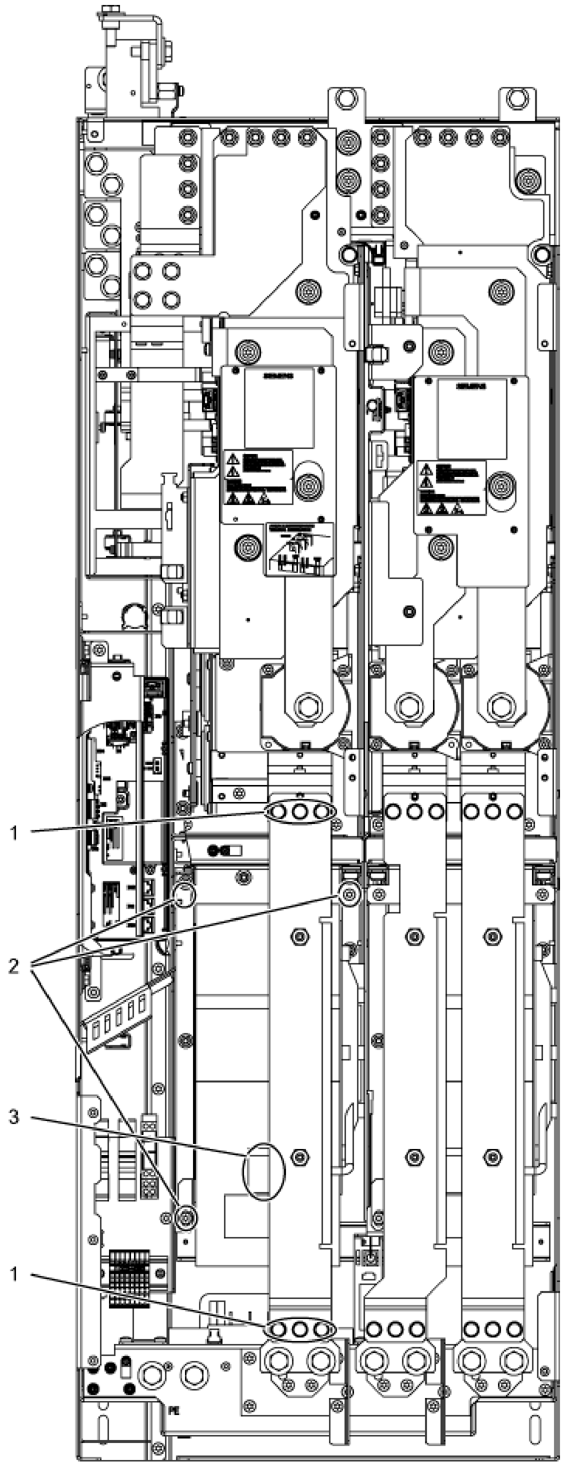


Figure 11-16 Replacing the fan, frame size HX: left power block

Description

The average service life of the device fans is 50,000 hours. In practice, however, the service life depends on other variables (e.g., ambient temperature, degree of cabinet protection, etc.) and, therefore, may deviate from this value.

The fans must be replaced in good time to ensure that the built-in unit is available.

Preparatory steps

- Disconnect the built-in unit from the power supply.
- Allow unimpeded access.
- Remove the protective cover.

Removal steps

The removal steps are numbered in accordance with the figure.

1. Remove the copper bar (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.

CAUTION
When removing the unit, ensure that you do not damage any signal cables.

Installation steps

For installation, carry out the above steps in reverse order.

CAUTION
The tightening torques specified in the table "Tightening torques for connecting current-conducting parts" must be observed. Carefully establish the plug connections and then ensure that they are secure. The screw connections for the protective covers must only be tightened finger-tight.

Replacing the fan (right-hand power block)

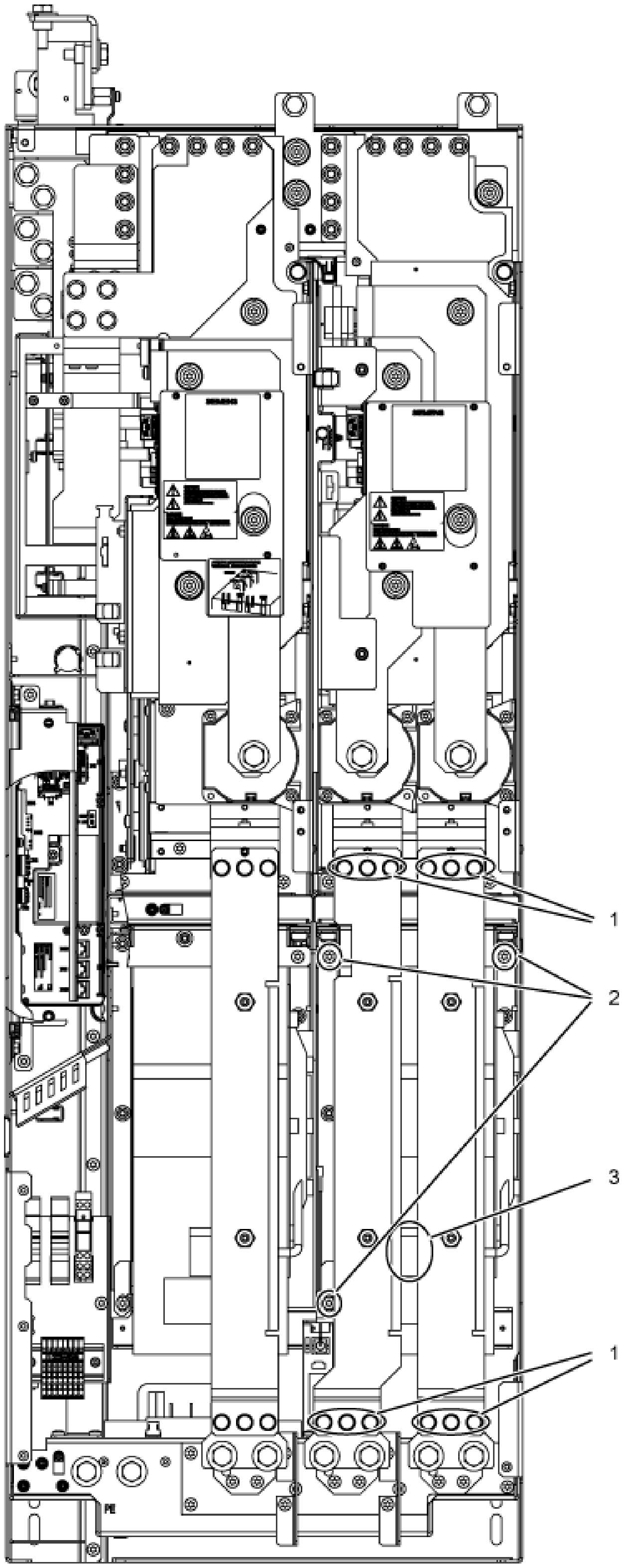


Figure 11-17 Replacing the fan, frame size HX: right power block

Description

The average service life of the device fans is 50,000 hours. In practice, however, the service life depends on other variables (e.g., ambient temperature, degree of cabinet protection, etc.) and, therefore, may deviate from this value.

The fans must be replaced in good time to ensure that the built-in unit is available.

Preparatory steps

- Disconnect the built-in unit from the power supply.
- Allow unimpeded access.
- Remove the protective cover.

Removal steps

The removal steps are numbered in accordance with the figure.

1. Remove the copper bar (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.

CAUTION
When removing the unit, ensure that you do not damage any signal cables.

Installation steps

For installation, carry out the above steps in reverse order.

CAUTION
The tightening torques specified in the table "Tightening torques for connecting current-conducting parts" must be observed. Carefully establish the plug connections and then ensure that they are secure. The screw connections for the protective covers must only be tightened finger-tight.

11.4.12 Replacing the fan (frame size JX)

Replacing the fan (left-hand power block)

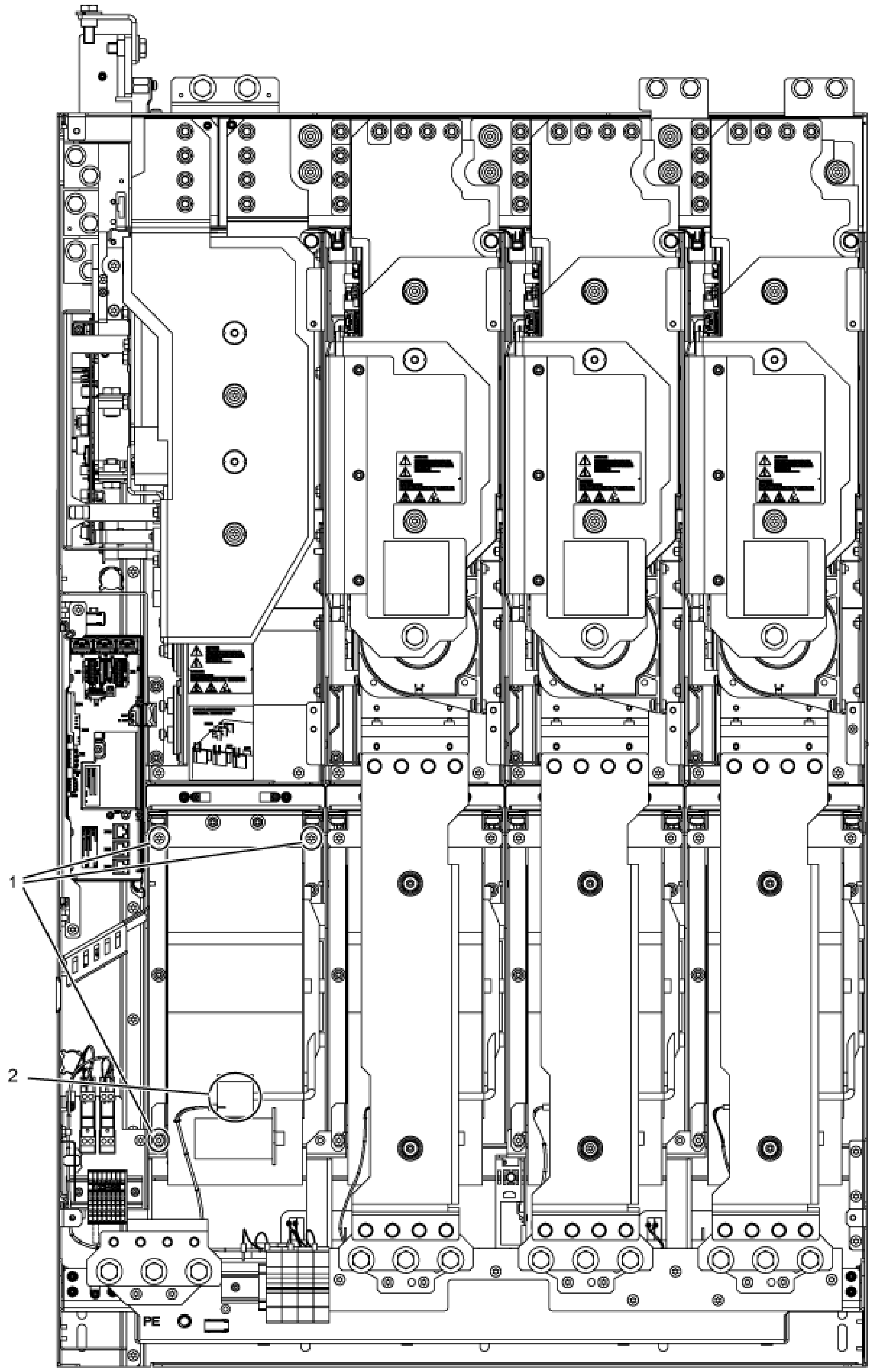


Figure 11-18 Replacing the fan, frame size JX, left power block

Description

The average service life of the device fans is 50,000 hours. In practice, however, the service life depends on other variables (e.g., ambient temperature, degree of cabinet protection, etc.) and, therefore, may deviate from this value.

The fans must be replaced in good time to ensure that the built-in unit is available.

Preparatory steps

- Disconnect the built-in unit from the power supply.
- Allow unimpeded access.
- Remove the protective cover.

Removal steps

The removal steps are numbered in accordance with 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.

CAUTION
When removing the unit, ensure that you do not damage any signal cables.

Installation steps

For installation, carry out the above steps in reverse order.

CAUTION
The tightening torques specified in the table "Tightening torques for connecting current-conducting parts" must be observed. Carefully establish the plug connections and then ensure that they are secure. The screw connections for the protective covers must only be tightened finger-tight.

Replacing the fan (right-hand power block)

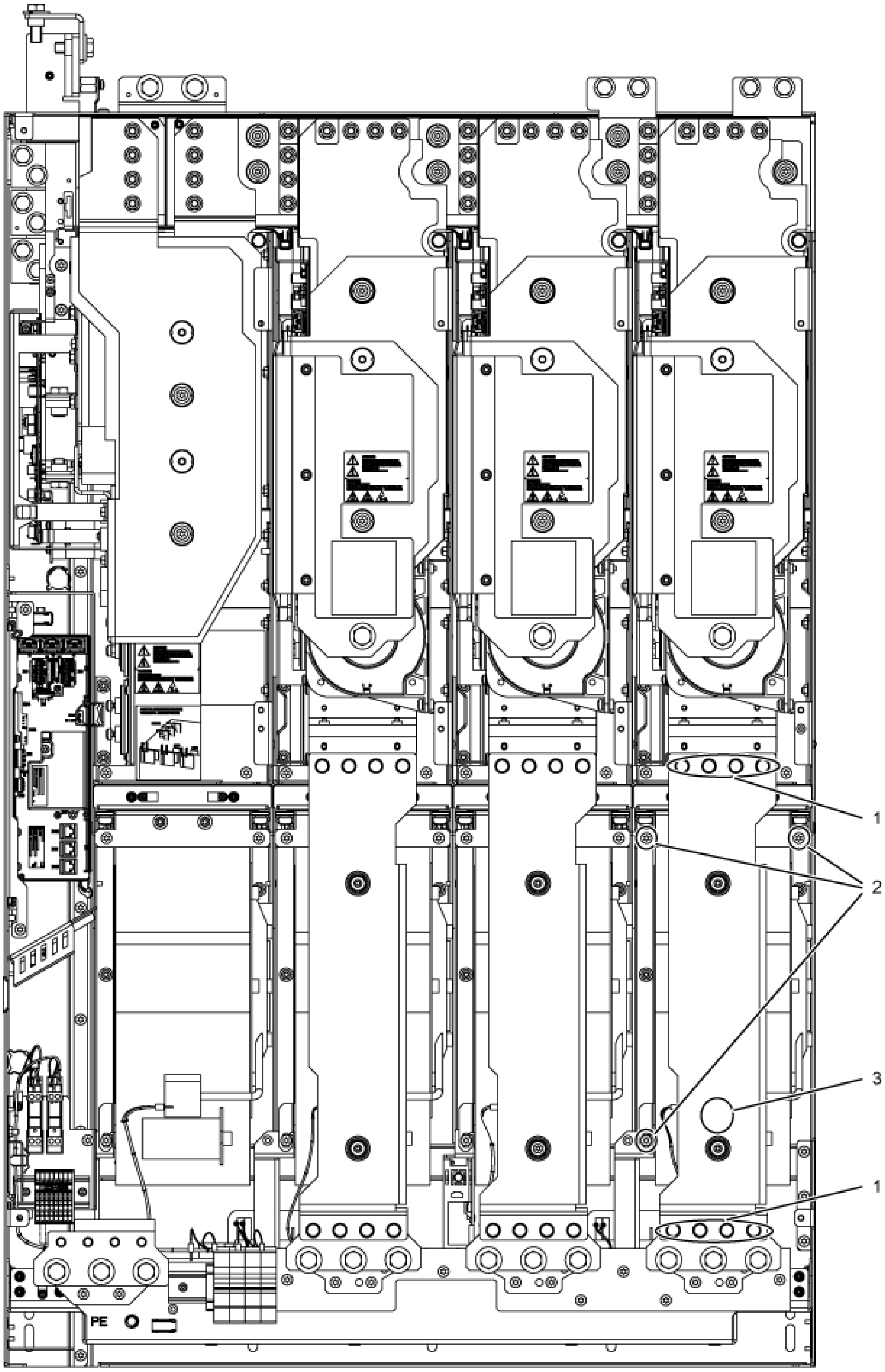


Figure 11-19 Replacing the fan, frame size JX, right power block

Description

The average service life of the device fans is 50,000 hours. In practice, however, the service life depends on other variables (e.g., ambient temperature, degree of cabinet protection, etc.) and, therefore, may deviate from this value.

The fans must be replaced in good time to ensure that the built-in unit is available.

Preparatory steps

- Disconnect the built-in unit from the power supply.
- Allow unimpeded access.
- Remove the protective cover.

Removal steps

The removal steps are numbered in accordance with 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.

CAUTION
When removing the unit, ensure that you do not damage any signal cables.

Installation steps

For installation, carry out the above steps in reverse order.

CAUTION
The tightening torques specified in the table "Tightening torques for connecting current-conducting parts" must be observed. Carefully establish the plug connections and then ensure that they are secure. The screw connections for the protective covers must only be tightened finger-tight.

11.5 Forming the DC link capacitors

Description

If the device is kept in storage for more than 2 years, the DC link capacitors have to be re-formed. If this is not done, the unit could be damaged when it is operated under load.

If the cabinet is commissioned within two years of its date of manufacture, the DC link capacitors do not need to be re-formed. The date of manufacture is indicated in the serial number on the type plate (see "Device Overview").

Note

It is important that the storage period is 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 converter by means of an ON signal (bit 0 of the control word); all the other bits must be set in such a way that the converter can be operated.
  - Once the delay time has elapsed, switch off the converter and restore the original PROFIBUS setting.
- Operation via terminal block:
  - Set p0852 to "0" (factory setting is "1").
  - Switch on the converter (via digital input 0 on the customer terminal block).
  - Once the delay time has elapsed, switch off the converter and restore the original setting for p0852.

Note

Reforming cannot be carried out in LOCAL mode via the AOP30.

11.6 Messages after replacing DRIVE-CLiQ components

After DRIVE-CLiQ components are replaced (Control Interface Module, TM31, SMCxx) when service is required, generally no message is output after power-up, since an identical component is identified and accepted as component when the system boots.

The reason for this is that an identical component is detected and accepted as spare part when running-up. If, unexpectedly, a fault message of the "topology fault" category is displayed, then when replacing a component, one of the following faults/errors should have occurred:

- A Control Interface Module with different firmware data was installed.
- When connecting-up DRIVE-CLiQ cables, connections were interchanged.

Automatic firmware update

As of firmware 2.5, an automatic firmware update can be carried out once the electronics have been powered up on replacement DRIVE-CLiQ components.

- 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).

CAUTION
The drive converter must not be shut down during this process!

- Once the automatic firmware update is complete, the "RDY" LED on the Control Unit will flash quickly (orange, 2 Hz) along with an LED on the relevant DRIVE-CLiQ component (green/red, 2 Hz).
- To complete the automatic firmware update process, a POWER ON is required (switch the device off and back on again).

11.7 Upgrading the chassis unit firmware

When you upgrade the built-in unit firmware (by installing a new CompactFlash Card with a new firmware version, for example), you might also have to upgrade the firmware for the DRIVE-CLiQ components in the built-in unit.

If the system detects that the firmware in the DRIVE-CLiQ components needs to be updated, it will trigger this process automatically when the automatic firmware update is performed.

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 automatically and in sequence on the DRIVE-CLiQ components; during the update process, an LED on the component whose firmware is being updated will flash slowly (green/red, 0.5 Hz).
3. Once the firmware update on an individual DRIVE-CLiQ component is complete, the LED on that component will flash quickly (green/red, 2 Hz).
4. Once the firmware update on all components is complete, the LED on the Control Unit will flash quickly (orange, 2 Hz).
5. To complete the automatic firmware update process, a POWER ON is required (switch the device off and back on again).

CAUTION
The power supply to the components must not be interrupted while the firmware is being upgraded.

CAUTION
New firmware should only be installed if there is a problem with the unit.

12 Technical specifications

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 ambient conditions (derating)

12.2 General specifications

Table 12- 1 General technical specifications

Electrical data			
Line system configurations	TN/TT supplies or insulated supplies (IT supplies)		
Line frequency	47 Hz to 63 Hz		
Output frequency	0 Hz to 300 Hz		
Line power factor total fundamental factor	 ≥ 0.98 0.93 to 0.96		
Converter efficiency	> 98 %		
Short-circuit current rating SCCR in accordance with UL508C (up to 600 V)	• 1.1 kW – 447 kW: 65 kA • 448 kW – 671 kW: 84 kA • 672 kW – 1193 kW: 170 kA • >1194 kW: 200 kA		
Switching at input	Once every 3 minutes		
Mechanical data			
Degree of protection	IP20 (frame sizes FX and GX) IP00 (frame sizes HX and JX)		
Class of protection	I acc. to EN 61800-5-1		
Cooling method	Forced air cooling AF to EN 60146		
Sound pressure level L_{pA} (1 m)	≤ 73 dB(A) at 50 Hz line frequency ≤ 75 dB(A) at 60 Hz line frequency		
Touch protection	EN 50274 and BGV A3 when used as intended		
Compliance with standards			
Standards	EN 60146-1, EN 61800-2, EN 61800-3, EN 61800-5-1, EN 60204-1, EN 60529 [2)]		
CE mark	To EMC directive No. 2004/108/EC and low-voltage directive No. 2006/95/EC		
RI suppression	In accordance with the EMC product standard for variable-speed drives EN 61800-3, "second environment". Application in "first environment" possible with line filters [1)].		
Approval	cULus (File No.: E192450) (only up to 600 V 3 AC)		
Ambient conditions	**Storage**	**Transport**	**Operation**
Ambient temperature	-25 ... +55 °C	-25 ... +70°C as of *–40 °C* for 24 hours	*0* ... +40 °C up to +50 °C with derating
Humidity range [2)] (non-condensing) corresponds to class	*5 to 95 %* 1K4 to EN 60721-3-1	5 ... 95 % at 40 °C 2K3 to EN 60721-3-2	5 ... *95 %* 3K3 to EN 60721-3-3
Environmental class/harmful chemical substances [2)]	1C2 to EN 60721-3-1	2C2 to EN 60721-3-2	3C2 to EN 60721-3-3
Organic/biological influences [2)]	1B1 to EN 60721-3-1	2B1 to EN 60721-3-2	3B1 to EN 60721-3-3
Installation altitude	Up to 2000 m above sea level without derating, > 2000 m above sea level with derating (see "Derating data")		

Mechanical stability	Storage	Transport	Operation
Vibrational load [2] - Displacement - Acceleration corresponds to class	 1.5 mm at *5* to 9 Hz 5 m/s² at > 9 to 200 Hz 1M2 to EN 60721-3-1	 *3.1 mm* at *5* ... 9 Hz 10 m/s² at > 9 ... 200 Hz 2M2 to EN 60721-3-2	 0.075 mm at 10 ... 58 Hz 10 m/s² at >58 ... 200 Hz -
Shock load [2] - Acceleration corresponds to class	 40 m/s² at 22 ms 1M2 to EN 60721-3-1	 100 m/s² at 11 ms 2M2 to EN 60721-3-2	 100 m/s² at 11 ms 3M4 to EN 60721-3-3

Deviations from the defined classes are shown in *italics*.

[1] Applies to cable lengths of up to 100 m.

[2] The EN standards specified are the European editions of the international IEC standards with the same designations.

12.2.1 Derating data

Permissible output current as a function of the ambient temperature

The cabinet devices and the associated system components are rated for an ambient temperature of 40 °C and installation altitudes up to 2000 m above sea level. The output current must be reduced if the cabinet devices are operated at ambient temperatures above 40 °C. Ambient temperatures above 50 °C are not permissible. The following table specifies the permissible output current as a function of the ambient temperature.

Table 12- 2 Current derating as a function of the ambient temperature (air intake temperature)

Installation altitude above sea level in m	Current derating factor at an ambient temperature (air intake temperature) of						
	20 °C	25 °C	30 °C	35 °C	40 °C	45 °C	50 °C
0 ... 2000	100 %	100 %	100 %	100 %	100 %	93.3 %	86.7 %

Installation altitudes between 2000 m and 5000 m above sea level

If the SINAMICS G130 converter units are operated at an installation altitude >2000 m above sea level, it must be taken into account that the air pressure and, consequently, the air density decreases. The lower air density also reduces the cooling efficiency and the insulation capacity of the air.

Installation altitudes between 2000 m and 5000 m can be achieved by applying the following measures.

Reduce 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, to lower heat loss in the converter unit by reducing the output current, whereby ambient temperatures lower than 40 °C may be offset to compensate. The following table specifies the permissible output currents as a function of the installation altitude and ambient temperature. The specified values already include a permitted correction in respect of installation altitude and ambient temperatures less than 40 °C(incoming air temperature at the inlet to the converter unit). The values apply under the precondition that the cabinet layout ensures a cooling air flow though the units as stated in the technical specifications.

Table 12- 3 Current derating as a function of ambient temperature and installation altitude

Installation altitude above sea level in m	Current derating factor at an ambient temperature (air intake temperature) of						
	20 °C	25 °C	30 °C	35 °C	40 °C	45 °C	50 °C
0 ... 2000	100 %	100 %	100 %	100 %	100 %	93.3 %	86.7 %
... 2500	100 %	100 %	100 %	100 %	96.3 %		
... 3000	100 %	100 %	100 %	98.7 %			
... 3500	100 %	100 %	100 %				
... 4000	100 %	100 %	96.3 %				
... 4500	100 %	97.5 %					
... 5000	98.2 %						

Using an isolating transformer to reduce transient overvoltages according to IEC 61800-5-1

This drops overvoltage category III to overvoltage category II, thereby reducing the requirements for insulation capacity of the air. Additional voltage derating (reduction of the input voltage) is not required if the following framework conditions are observed:

- The isolating transformer must be fed from a low-voltage or medium-voltage network and must not be power directly from a high-voltage supply system.
- The isolating transformer may be connect to one or more converter units.
- The cables between the isolating transformer and the converter unit(s) must be routed in such a manner as to rule out direct lightening strike, i.e. overland lines must not be used.
- The following types of system are permissible:
  – TN systems with grounded star point (no grounded outer conductor).
  – IT systems (operation with a ground fault must be restricted to the shorted possible time).

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.

Table 12- 4 Derating factor of the output current as a function of the pulse frequency for devices with a rated pulse frequency of 2 kHz

Order number 6SL3310-...	Power [kW]	Output current at 2 kHz [A]	Derating factor at 4 kHz
Supply voltage 380 – 480 V 3 AC			
1GE32-1AAx	110	210	82 %
1GE32-6AAx	132	260	83 %
1GE33-1AAx	160	310	88 %
1GE33-8AAx	200	380	87 %
1GE35-0AAx	250	490	78 %

Table 12- 5 Derating factor of the output current as a function of the pulse frequency for units with a rated pulse frequency of 1.25 kHz

Order number 6SL3310-...	Power [kW]	Output current at 1.25 kHz [A]	Derating factor at 2.5 kHz	Derating factor at 5 kHz
Supply voltage 380 – 480 V 3 AC				
1GE36-1AAx	315	605	72 %	60 %
1GE37-5AAx	400	745	72 %	60 %
1GE38-4AAx	450	840	79 %	60 %
1GE41-0AAx	560	985	87 %	60 %
Supply voltage 500 – 600 V 3 AC				
1GF31-8AAx	110	175	87 %	60 %
1GF32-2AAx	132	215	87 %	60 %
1GF32-6AAx	160	260	88 %	60 %
1GF33-3AAx	200	330	82 %	55 %
1GF34-1AAx	250	410	82 %	55 %
1GF34-7AAx	315	465	87 %	55 %
1GF35-8AAx	400	575	85 %	55 %
1GF37-4AAx	500	735	79 %	55 %
1GF38-1AAx	560	810	72 %	55 %

Order number 6SL3310-...	Power [kW]	Output current at 1.25 kHz [A]	Derating factor at 2.5 kHz	Derating factor at 5 kHz
Supply voltage 660 – 690 V 3 AC				
1GH28-5AAx	75	85	89 %	60 %
1GH31-0AAx	90	100	88 %	60 %
1GH31-2AAx	110	120	88 %	60 %
1GH31-5AAx	132	150	84 %	55 %
1GH31-8AAx	160	175	87 %	60 %
1GH32-2AAx	200	215	87 %	60 %
1GH32-6AAx	250	260	88 %	60 %
1GH33-3AAx	315	330	82 %	55 %
1GH34-1AAx	400	410	82 %	55 %
1GH34-7AAx	450	465	87 %	55 %
1GH35-8AAx	560	575	85 %	55 %
1GH37-4AAx	710	735	79 %	55 %
1GH38-1AAx	800	810	72 %	55 %

For pulse frequencies in the range between the fixed values, the relevant derating factors can be determined by means of linear interpolation.

The following formula applies for this: $Y_2 = Y_0 + \frac{Y_1 - Y_0}{X_1 - X_0}(X_2 - X_0)$

Example:
The derating factor is required for when X_2 = 2 kHz for 6SL3310-1GE41-0AAx.

X_0 = 1.25 kHz, Y_0 = 100%, X_1 = 2.5 kHz, Y_1 = 87%, X_2 = 2 kHz, Y_2 = ??

$$Y_2 = 100\ \% + \frac{87\ \% - 100\ \%}{2.5\ \text{kHz} - 1.25\ \text{kHz}}(2\ \text{kHz} - 1.25\ \text{kHz}) =$$

$$100\ \% + \frac{-13\ \%}{1.25\ \text{kHz}}(0.75\ \text{kHz}) = 100\ \% - 7.8\ \% = \underline{\underline{92.2\ \%}}$$

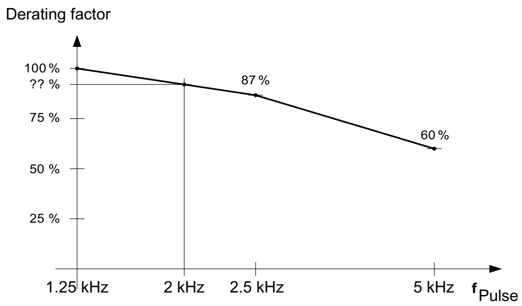


Figure 12-1 Calculating derating factors by means of linear interpolation

12.2.2 Overload capability

The converter is equipped with an overload reserve to deal with breakaway torques, for example.

In drives with overload requirements, the appropriate base load current must, therefore, be used as a basis for the required load.

The criterion for overload is that the drive is operated with its base load current before and after the overload occurs on the basis of a duty cycle duration of 300 s.

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.

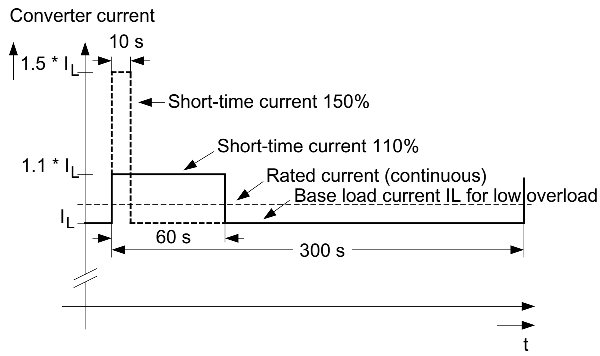


Figure 12-2 Low overload

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.

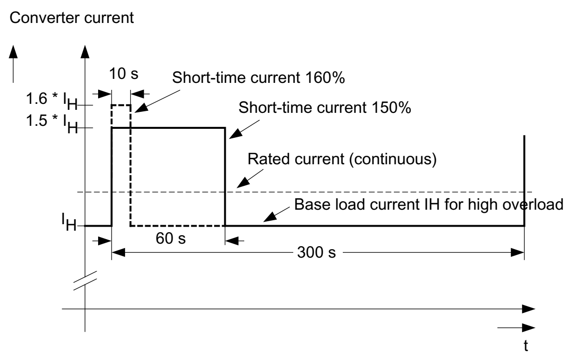


Figure 12-3 High overload

12.3 Technical specifications

Note

Current, voltage and power figures in these tables are rated values.

The cables to the device are protected by fuses of operating class gG.

The cable cross-sections have been determined for three-core copper cables routed horizontally in air at 40 °C ambient temperature (according to DIN VDE 0276-1000 and IEC 60364-5-52) with a permissible operating temperature of 70°C (e.g. Protodur NYY or NYCWY) and the recommended conductor protection according to DIN VDE 0100 section 430 and IEC 60364-4-43.

CAUTION

When the conditions differ from the above stated (cable routing, cable grouping, ambient temperature), the following instructions for routing the cables must be taken into account:

The required cable cross-section depends on the amperage which flows through the cable. The permissible current loading of cables is defined, for example, in DIN VDE 0276-1000 and IEC 60364-5-52. It depends partly on ambient conditions such as temperature and partly on the type of routing. If the cables are routed individually, they will be cooled relatively well. If several cables are routed together, they may heat each other up. Please note the corresponding derating factors for these supplementary conditions in DIN VDE 0276-1000 and IEC 60364-5-52.

12.3.1 Power Module

Power Module, 380 V - 480 V 3 AC

Table 12- 6 Power Module, 380 V – 480 V 3 AC, part 1

Order number	6SL3310-	1GE32-1AAx	1GE32-6AAx	1GE33-1AAx
Unit rating - for I_L at 50 Hz and 400 V [1)] - for I_H at 50 Hz and 400 V [1)] - for I_L at 60 Hz and 460 V [2)] - for I_H at 60 Hz and 460 V [2)]	 kW kW hp hp	 110 90 150 150	 132 110 200 200	 160 132 250 200
Output current - Rated current I_N - Base load current I_L [3)] - Base load current I_H [4)]	 A A A	 210 205 178	 260 250 233	 310 302 277
Input current - Rated input current - Input current, max. - Current for 24 V DC auxiliary supply [5)]	 A A A	 229 335 0.8	 284 410 0.8	 338 495 0.9
Connection voltages - Line voltage - Electronics power supply - Output voltage	 V_{ACrms} V_{DC} V_{ACrms}	 380 V to 480 V 3 AC ±10 % (-15 % < 1 min) 24 (20.4 – 28.8) 3 AC 0 to line voltage		
Power loss	kW	2.46	3.27	4
Cooling air requirement	m³/s	0.17	0.23	0.36
Max. cable length between Power Module and Motor - shielded - unshielded	 m m	 300 450	 300 450	 300 450
Sound pressure level L_{pA} (1 m) at 50/60 Hz	 dB(A)	 64/67	 64/67	 69/73
Line connection (U1, V1, W1) Connection cross-section, max. (IEC)	 mm²	M10 bolt 2 x 185	M10 bolt 2 x 185	M10 bolt 2 x 240
Motor connection **(U2/T1, V2/T2, W2/T3)** Connection cross-section, max. (IEC)	 mm²	M10 bolt 2 x 185	M10 bolt 2 x 185	M10 bolt 2 x 240
PE1 / GND connection Connection cross section, max. (IEC)	 mm²	M10 bolt 2 x 185	M10 bolt 2 x 185	M10 bolt 2 x 240
PE2 / GND connection Connection cross section, max. (IEC)	 mm²	M10 bolt 2 x 185	M10 bolt 2 x 185	M10 bolt 2 x 240
Degree of protection		IP20	IP20	IP20
Dimensions - Width - Height - Depth	 mm mm mm	 326 1400 356	 326 1400 356	 326 1533 545
Frame size		FX	FX	GX
Weight, approx.	kg	104	104	176

Order number	6SL3310-	1GE32-1AAx	1GE32-6AAx	1GE33-1AAx
Recommended fuses - Line protection without semiconductor protection Rated current frame size to IEC 60269 - Line and semiconductor protection [6] Rated current Frame size to IEC 60269	 A A 	 3NA3144 250 2 3NE1230-2 315 1	 3NA3250 300 3 3NE1331-2 350 2	 3NA3254 355 3 3NE1334-2 500 2

[1] Rated output of a typ. 6-pole standard induction motor based on I_L or I_H at 400 V 3 AC 50 Hz.

[2] Rated output of a typ. 6-pole standard induction motor based on I_L or I_H at 460 V 3 AC 60 Hz.

[3] 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").

[4] 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").

[5] If the auxiliary supply is to be fed in separately from the load supply, e.g., if the control should be able to continue communication if the line voltage fails.

[6] The types of protection specified here are mandatory for installing a UL-approved system.

Table 12- 7 Power Module, 380 V – 480 V 3 AC, part 2

Order number	6SL3310-	1GE33-8AAx	1GE35-0AAx	1GE36-1AAx
Unit rating - for I_L at 50 Hz and 400 V [1)] - for I_H at 50 Hz and 400 V [1)] - for I_L at 60 Hz and 460 V [2)] - for I_H at 60 Hz and 460 V [2)]	 kW kW hp hp	 200 160 300 250	 250 200 400 350	 315 250 500 350
Output current - Rated current I_N - Base load current I_L [3)] - Base load current I_H [4)]	 A A A	 380 370 340	 490 477 438	 605 590 460
Input current - Rated input current - Input current, max. - Current for 24 V DC auxiliary supply [5)]	 A A A	 395 606 0.9	 509 781 0.9	 629 967 1.0
Connection voltages - Line voltage - Electronics power supply - Output voltage	 V_{ACrms} V_{DC} V_{ACrms}	 380 V to 480 V 3 AC ±10 % (-15 % < 1 min) 24 (20.4 – 28.8) 3 AC 0 to line voltage		
Power loss	kW	4.54	5.78	7.8
Cooling air requirement	m³/s	0.36	0.36	0.78
Max. cable length between Power Module and motor - shielded - unshielded	 m m	 300 450	 300 450	 300 450
Sound pressure level L_{pA} (1 m) at 50/60 Hz	 dB(A)	 69/73	 69/73	 70/73
Line connection (U1, V1, W1) Connection cross-section, max. (IEC)	 mm²	M10 bolt 2 x 240	M10 bolt 2 x 240	2 x M12 bolt 4 x 240
Motor connection **(U2/T1, V2/T2, W2/T3)** Connection cross-section, max. (IEC)	 mm²	M10 bolt 2 x 240	M10 bolt 2 x 240	2 x M12 bolt 4 x 240
PE1 / GND connection Connection cross section, max. (IEC)	 mm²	M10 bolt 2 x 240	M10 bolt 2 x 240	M12 bolt 2 x 240
PE2 / GND connection Connection cross section, max. (IEC)	 mm²	M10 bolt 2 x 240	M10 bolt 2 x 240	2 x M12 bolt 4 x 240
Degree of protection		IP20	IP20	IP00
Dimensions - Width - Height - Depth	 mm mm mm	 326 1533 545	 326 1533 545	 503 1506 540
Frame size		GX	GX	HX
Weight, approx.	kg	176	176	294

Order number	6SL3310-	1GE33-8AAx	1GE35-0AAx	1GE36-1AAx
Recommended fuses - Line protection without semiconductor protection Rated current frame size to IEC 60269 - Line and semiconductor protection [6] Rated current Frame size to IEC 60269	 A A 	 3NA3260 400 3 3NE1334-2 450 2	 3NA3372 630 3 3NE1436-2 630 3	 3NA3475 800 4 3NE1438-2 800 3

[1] Rated output of a typ. 6-pole standard induction motor based on I_L or I_H at 400 V 3 AC 50 Hz.

[2] Rated output of a typ. 6-pole standard induction motor based on I_L or I_H at 460 V 3 AC 60 Hz.

[3] 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").

[4] 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").

[5] If the auxiliary supply is to be fed in separately from the load supply, e.g., if the control should be able to continue communication if the line voltage fails.

[6] The types of protection specified here are mandatory for installing a UL-approved system.

Table 12- 8 Power Module, 380 V – 480 V 3 AC, part 3

Order number	6SL3310-	1GE37-5AAx	1GE38-4AAx	1GE41-0AAx
Unit rating - for I_L at 50 Hz and 400 V [1)] - for I_H at 50 Hz and 400 V [1)] - for I_L at 60 Hz and 460 V [2)] - for I_H at 60 Hz and 460 V [2)]	 kW kW hp hp	 400 315 600 450	 450 400 700 600	 560 450 800 700
Output current - Rated current I_N - Base load current I_L [3)] - Base load current I_H [4)]	 A A A	 745 725 570	 840 820 700	 985 960 860
Input current - Rated input current - Input current, max. - Current for 24 V DC auxiliary supply [5)]	 A A A	 775 1188 1.0	 873 1344 1.0	 1024 1573 1.25
Connection voltages - Line voltage - Electronics power supply - Output voltage	 V_{ACrms} V_{DC} V_{ACrms}	 380 V to 480 V 3 AC ±10 % (-15 % < 1 min) 24 (20.4 – 28.8) 3 AC 0 to line voltage		
Power loss	kW	9.1	9.6	13.8
Cooling air requirement	m³/s	0.78	0.78	1.48
Max. cable length between Power Module and Motor - shielded - unshielded	 m m	 300 450	 300 450	 300 450
Sound pressure level L_{pA} (1 m) at 50/60 Hz	 dB(A)	 70/73	 70/73	 72/75
Line connection (U1, V1, W1) Connection cross-section, max. (IEC)	 mm²	2 x M12 bolt 4 x 240	2 x M12 bolt 4 x 240	3 x M12 bolt 6 x 240
Motor connection **(U2/T1, V2/T2, W2/T3)** Connection cross-section, max. (IEC)	 mm²	2 x M12 bolt 4 x 240	2 x M12 bolt 4 x 240	M12 bolt 6 x 240
PE1 / GND connection Connection cross section, max. (IEC)	 mm²	M12 bolt 2 x 240	M12 bolt 2 x 240	2 x M12 bolt 4 x 240
PE2 / GND connection Connection cross section, max. (IEC)	 mm²	2 x M12 bolt 4 x 240	2 x M12 bolt 4 x 240	3 x M12 bolt 6 x 240
Degree of protection		IP00	IP00	IP00
Dimensions - Width - Height - Depth	 mm mm mm	 503 1506 540	 503 1506 540	 909 1510 540
Frame size		HX	HX	JX
Weight, approx.	kg	294	294	530

Order number	6SL3310-	1GE37-5AAx	1GE38-4AAx	1GE41-0AAx
Recommended fuses - Line protection without semiconductor protection Rated current frame size to IEC 60269 - Line and semiconductor protection [6)] Rated current Frame size to IEC 60269	 A A 	 3NA3475 800 4 3NE1448-2 850 3	 3NA3365 2 x 500 3 3NE1436-2 2 x 630 3	 3NA3472 2 x 630 3 3NE1437-2 2 x 710 3

1) Rated output of a typ. 6-pole standard induction motor based on I_L or I_H at 400 V 3 AC 50 Hz.

2) Rated output of a typ. 6-pole standard induction motor based on I_L or I_H at 460 V 3 AC 60 Hz.

3) 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").

4) 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").

5) If the auxiliary supply is to be fed in separately from the load supply, e.g., if the control should be able to continue communication if the line voltage fails.

6) The types of protection specified here are mandatory for installing a UL-approved system.

Power Module, 500 V - 600 V 3 AC

Table 12- 9 Power Module, 500 V – 600 V 3 AC, part 1

Order number	6SL3310-	1GF31-8AAx	1GF32-2AAx	1GF32-6AAx
Unit rating - for I_L at 50 Hz and 500 V [1)] - for I_H at 50 Hz and 500 V [1)] - for I_L at 60 Hz and 575 V [2)] - for I_H at 60 Hz and 575 V [2)]	 kW kW hp hp	 110 90 150 150	 132 110 200 200	 160 132 250 200
Output current - Rated current I_N - Base load current I_L [3)] - Base load current I_H [4)]	 A A A	 175 171 157	 215 208 192	 260 250 233
Input current - Rated input current - Input current, max. - Current for 24 V DC auxiliary supply [5)]	 A A A	 191 279 0.9	 224 341 0.9	 270 410 0.9
Connection voltages - Line voltage - Electronics power supply - Output voltage	 V_{ACrms} V_{DC} V_{ACrms}	 500 V to 600 V 3 AC ±10 % (-15 % < 1 min) 24 (20.4 – 28.8) 3 AC 0 to line voltage		
Power loss	kW	3.0	3.4	3.9
Cooling air requirement	m³/s	0.36	0.36	0.36
Max. cable length between Power Module and Motor - shielded - unshielded	 m m	 300 450	 300 450	 300 450
Sound pressure level L_{pA} (1 m) at 50/60 Hz	 dB(A)	 69/73	 69/73	 69/73
Line connection (U1, V1, W1) Connection cross-section, max. (IEC)	 mm²	M10 bolt 2 x 240	M10 bolt 2 x 240	M10 bolt 2 x 240
Motor connection (U2/T1, V2/T2, W2/T3) Connection cross-section, max. (IEC)	 mm²	M10 bolt 2 x 240	M10 bolt 2 x 240	M10 bolt 2 x 240
PE1 / GND connection Connection cross section, max. (IEC)	 mm²	M10 bolt 2 x 240	M10 bolt 2 x 240	M10 bolt 2 x 240
PE2 / GND connection Connection cross section, max. (IEC)	 mm²	M10 bolt 2 x 240	M10 bolt 2 x 240	M10 bolt 2 x 240
Degree of protection		IP20	IP20	IP20
Dimensions - Width - Height - Depth	 mm mm mm	 326 1533 545	 326 1533 545	 326 1533 545
Frame size		GX	GX	GX
Weight, approx.	kg	176	176	176

Order number	6SL3310-	1GF31-8AAx	1GF32-2AAx	1GF32-6AAx
Recommended fuses - Line protection without semiconductor protection Rated current frame size to IEC 60269 - Line and semiconductor protection [6] Rated current Frame size to IEC 60269	 A A 	 3NA3244-6 250 2 3NE1227-2 250 1	 3NA3252-6 315 2 3NE1230-2 315 1	 3NA3354-6 355 3 3NE1331-2 350 2

[1] Rated output of a typ. 6-pole standard induction motor based on I_L or I_H at 500 V 3 AC 50 Hz.

[2] Rated output of a typ. 6-pole standard induction motor based on I_L or I_H at 575 V 3 AC 60 Hz.

[3] 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").

[4] 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").

[5] If the auxiliary supply is to be fed in separately from the load supply, e.g., if the control should be able to continue communication if the line voltage fails.

[6] The types of protection specified here are mandatory for installing a UL-approved system.

Table 12- 10 Power Module, 500 V – 600 V 3 AC, part 2

Order number	6SL3310-	1GF33-3AAx	1GF34-1AAx	1GF34-7AAx
Unit rating - for I_L at 50 Hz and 500 V 1) - for I_H at 50 Hz and 500 V 1) - for I_L at 60 Hz and 575 V 2) - for I_H at 60 Hz and 575 V 2)	 kW kW hp hp	 200 160 300 250	 250 200 400 350	 315 250 450 450
Output current - Rated current I_N - Base load current I_L 3) - Base load current I_H 4)	 A A A	 330 320 280	 410 400 367	 465 452 416
Input current - Rated input current - Input current, max. - Current for 24 V DC auxiliary supply 5)	 A A A	 343 525 0.9	 426 655 1.0	 483 740 1.0
Connection voltages - Line voltage - Electronics power supply - Output voltage	 V_{ACrms} V_{DC} V_{ACrms}	 500 V to 600 V 3 AC ±10 % (-15 % < 1 min) 24 (20.4 – 28.8) 3 AC 0 to line voltage		
Power loss	kW	4.9	6.4	7.3
Cooling air requirement	m³/s	0.36	0.78	0.78
Max. cable length between Power Module and Motor - shielded - unshielded	 m m	 300 450	 300 450	 300 450
Sound pressure level L_{pA} (1 m) at 50/60 Hz	 dB(A)	 69/73	 70/73	 70/73
Line connection (U1, V1, W1) Connection cross-section, max. (IEC)	 mm²	M10 bolt 2 x 240	2 x M12 bolt 4 x 240	2 x M12 bolt 4 x 240
Motor connection (U2/T1, V2/T2, W2/T3) Connection cross-section, max. (IEC)	 mm²	M10 bolt 2 x 240	2 x M12 bolt 4 x 240	2 x M12 bolt 4 x 240
PE1 / GND connection Connection cross section, max. (IEC)	 mm²	M10 bolt 2 x 240	M12 bolt 2 x 240	M12 bolt 2 x 240
PE2 / GND connection Connection cross section, max. (IEC)	 mm²	M10 bolt 2 x 240	2 x M12 bolt 4 x 240	2 x M12 bolt 4 x 240
Degree of protection		IP20	IP00	IP00
Dimensions - Width - Height - Depth	 mm mm mm	 326 1533 545	 503 1506 540	 503 1506 540
Frame size		GX	HX	HX
Weight, approx.	kg	176	294	294

Order number	6SL3310-	1GF33-3AAx	1GF34-1AAx	1GF34-7AAx
Recommended fuses - Line protection without semiconductor protection Rated current frame size to IEC 60269 - Line and semiconductor protection [6)] Rated current Frame size to IEC 60269	 A A 	 3NA3365-6 500 3 3NE1334-2 500 2	 3NA3365-6 500 3 3NE1334-2 500 2	 3NA3252-6 2 x 315 2 3NE1435-2 560 3

1) Rated output of a typ. 6-pole standard induction motor based on I_L or I_H at 500 V 3 AC 50 Hz.

2) Rated output of a typ. 6-pole standard induction motor based on I_L or I_H at 575 V 3 AC 60 Hz.

3) 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").

4) 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").

5) If the auxiliary supply is to be fed in separately from the load supply, e.g., if the control should be able to continue communication if the line voltage fails.

6) The types of protection specified here are mandatory for installing a UL-approved system.

Table 12- 11 Power Module, 500 V – 600 V 3 AC, part 3

Order number	6SL3310-	1GF35-8AAx	1GF37-4AAx	1GF38-1AAx
Unit rating - for I_L at 50 Hz and 500 V [1] - for I_H at 50 Hz and 500 V [1] - for I_L at 60 Hz and 575 V [2] - for I_H at 60 Hz and 575 V [2]	 kW kW hp hp	 400 315 600 500	 500 450 700 700	 560 500 800 700
Output current - Rated current I_N - Base load current I_L [3] - Base load current I_H [4]	 A A A	 575 560 514	 735 710 657	 810 790 724
Input current - Rated input current - Input current, max. - Current for 24 V DC auxiliary supply [5]	 A A A	 598 918 1.0	 764 1164 1.25	 842 1295 1.25
Connection voltages - Line voltage - Electronics power supply - Output voltage	 V_{ACrms} V_{DC} V_{ACrms}	 500 V to 600 V 3 AC ±10 % (-15 % < 1 min) 24 (20.4 – 28.8) 3 AC 0 to line voltage		
Power loss	kW	8.1	12.0	13.3
Cooling air requirement	m³/s	0.78	1.48	1.48
Max. cable length between Power Module and Motor - shielded - unshielded	 m m	 300 450	 300 450	 300 450
Sound pressure level L_{pA} (1 m) at 50/60 Hz	 dB(A)	 70/73	 73/75	 73/75
Line connection (U1, V1, W1) Connection cross-section, max. (IEC)	 mm²	2 x M12 bolt 4 x 240	3 x M12 bolt 6 x 240	3 x M12 bolt 6 x 240
Motor connection (U2/T1, V2/T2, W2/T3) Connection cross-section, max. (IEC)	 mm²	2 x M12 bolt 4 x 240	3 x M12 bolt 6 x 240	3 x M12 bolt 6 x 240
PE1 / GND connection Connection cross section, max. (IEC)	 mm²	M12 bolt 2 x 240	2 x M12 bolt 4 x 240	2 x M12 bolt 4 x 240
PE2 / GND connection Connection cross section, max. (IEC)	 mm²	2 x M12 bolt 4 x 240	3 x M12 bolt 6 x 240	3 x M12 bolt 6 x 240
Degree of protection		IP00	IP00	IP00
Dimensions - Width - Height - Depth	 mm mm mm	 503 1506 540	 909 1510 540	 909 1510 540
Frame size		HX	JX	JX
Weight, approx.	kg	294	530	530

Order number	6SL3310-	1GF35-8AAx	1GF37-4AAx	1GF38-1AAx
Recommended fuses - Line protection without semiconductor protection Rated current frame size to IEC 60269 - Line and semiconductor protection [6)] Rated current Frame size to IEC 60269	 A A 	 3NA3354-6 2 x 355 3 3NE1447-2 670 3	 3NA3365-6 2 x 500 3 3NE1448-2 850 3	 3NA3365-6 2 x 500 3 3NE1434-2 2 x 500 2

[1)] Rated output of a typ. 6-pole standard induction motor based on I_L or I_H at 500 V 3 AC 50 Hz.

[2)] Rated output of a typ. 6-pole standard induction motor based on I_L or I_H at 575 V 3 AC 60 Hz.

[3)] 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").

[4)] 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").

[5)] If the auxiliary supply is to be fed in separately from the load supply, e.g., if the control should be able to continue communication if the line voltage fails.

[6)] The types of protection specified here are mandatory for installing a UL-approved system.

Power Module, 660 V - 690 V 3 AC

Table 12- 12 Power Module, 660 V – 690 V 3 AC, part 1

Order number	6SL3310-	1GH28-5AAx	1GH31-0AAx	1GH31-2AAx
Unit rating - for I_L at 50 Hz and 690 V [1)] - for I_H at 50 Hz and 690 V [1)]	 kW kW	 75 55	 90 75	 110 90
Output current - Rated current I_N - Base load current I_L [2)] - Base load current I_H [3)]	 A A A	 85 80 76	 100 95 89	 120 115 107
Input current - Rated input current - Input current, max. - Current for 24 V DC auxiliary supply [4)]	 A A A	 93 131 0.8	 109 155 0.8	 131 188 0.8
Connection voltages - Line voltage - Electronics power supply - Output voltage	 V_{ACrms} V_{DC} V_{ACrms}	 660 V to 690 V 3 AC ±10 % (-15 % < 1 min) 24 (20.4 – 28.8) 3 AC 0 to line voltage		
Power loss	kW	1.5	1.8	2.4
Cooling air requirement	m³/s	0.17	0.17	0.17
Max. cable length between Power Module and Motor - shielded - unshielded	 m m	 300 450	 300 450	 300 450
Sound pressure level L_{pA} (1 m) at 50/60 Hz	 dB(A)	 64/67	 64/67	 64/67
Line connection (U1, V1, W1) Connection cross-section, max. (IEC)	 mm²	M10 bolt 2 x 185	M10 bolt 2 x 185	M10 bolt 2 x 185
Motor connection **(U2/T1, V2/T2, W2/T3)** Connection cross-section, max. (IEC)	 mm²	M10 bolt 2 x 185	M10 bolt 2 x 185	M10 bolt 2 x 185
PE1 / GND connection Connection cross section, max. (IEC)	 mm²	M10 bolt 2 x 185	M10 bolt 2 x 185	M10 bolt 2 x 185
PE2 / GND connection Connection cross section, max. (IEC)	 mm²	M10 bolt 2 x 185	M10 bolt 2 x 185	M10 bolt 2 x 185
Degree of protection		IP20	IP20	IP20
Dimensions - Width - Height - Depth	 mm mm mm	 326 1400 356	 326 1400 356	 326 1400 356
Frame size		FX	FX	FX
Weight, approx.	kg	104	104	104

Order number	6SL3310-	1GH28-5AAx	1GH31-0AAx	1GH31-2AAx
Recommended fuses - Line protection without semiconductor protection Rated current frame size to IEC 60269 - Line and semiconductor protection Rated current Frame size to IEC 60269	 A A 	 3NA3132-6 125 1 3NE1022-2 125 00	 3NA3132-6 125 1 3NE1022-2 125 00	 3NA3136-6 160 1 3NE1224-2 160 1

1) Rated output of a typ. 6-pole standard induction motor based on I_L or I_H at 690 V 3 AC 50 Hz.

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) If the auxiliary supply is to be fed in separately from the load supply, e.g., if the control should be able to continue communication if the line voltage fails.

Table 12- 13 Power Module, 660 V – 690 V 3 AC, part 2

Order number	6SL3310-	1GH31-5AAx	1GH31-8AAx	1GH32-2AAx
Unit rating - for I_L at 50 Hz and 690 V [1)] - for I_H at 50 Hz and 690 V [1)]	 kW kW	 132 110	 160 132	 200 160
Output current - Rated current I_N - Base load current I_L [2)] - Base load current I_H [3)]	 A A A	 150 142 134	 175 171 157	 215 208 192
Input current - Rated input current - Input current, max. - Current for 24 V DC auxiliary supply [4)]	 A A A	 164 232 0.8	 191 279 0.9	 224 341 0.9
Connection voltages - Line voltage - Electronics power supply - Output voltage	 V_{ACrms} V_{DC} V_{ACrms}	 660 V to 690 V 3 AC ±10 % (-15 % < 1 min) 24 (20.4 – 28.8) 3 AC 0 to line voltage		
Power loss	kW	2.5	3.8	4.8
Cooling air requirement	m³/s	0.17	0.36	0.36
Max. cable length between Power Module and Motor - shielded - unshielded	 m m	 300 450	 300 450	 300 450
Sound pressure level L_{pA} (1 m) at 50/60 Hz	 dB(A)	 64/67	 69/73	 69/73
Line connection (U1, V1, W1) Connection cross-section, max. (IEC)	 mm²	M10 bolt 2 x 185	M10 bolt 2 x 240	M10 bolt 2 x 240
Motor connection **(U2/T1, V2/T2, W2/T3)** Connection cross-section, max. (IEC)	 mm²	M10 bolt 2 x 185	M10 bolt 2 x 240	M10 bolt 2 x 240
PE1 / GND connection Connection cross section, max. (IEC)	 mm²	M10 bolt 2 x 185	M10 bolt 2 x 240	M10 bolt 2 x 240
PE2 / GND connection Connection cross section, max. (IEC)	 mm²	M10 bolt 2 x 185	M10 bolt 2 x 240	M10 bolt 2 x 240
Degree of protection		IP20	IP20	IP20
Dimensions - Width - Height - Depth	 mm mm mm	 326 1400 356	 326 1533 545	 326 1533 545
Frame size		FX	GX	GX
Weight, approx.	kg	104	176	176

Order number	6SL3310-	1GH31-5AAx	1GH31-8AAx	1GH32-2AAx
Recommended fuses - Line protection without semiconductor protection Rated current frame size to IEC 60269 - Line and semiconductor protection Rated current Frame size to IEC 60269	 A A 	 3NA3240-6 200 2 3NE1225-2 200 1	 3NA3244-6 250 2 3NE1227-2 250 1	 3NA3252-6 315 2 3NE1230-2 315 1

[1)] Rated output of a typ. 6-pole standard induction motor based on I_L or I_H at 690 V 3 AC 50 Hz.

[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)] If the auxiliary supply is to be fed in separately from the load supply, e.g., if the control should be able to continue communication if the line voltage fails.

Table 12- 14 Power Module, 660 V – 690 V 3 AC, part 3

Order number	6SL3310-	1GH32-6AAx	1GH33-3AAx	1GH34-1AAx
Unit rating - for I_L at 50 Hz and 690 V [1)] - for I_H at 50 Hz and 690 V [1)]	 kW kW	 250 200	 315 250	 400 315
Output current - Rated current I_N - Base load current I_L [2)] - Base load current I_H [3)]	 A A A	 260 250 233	 330 320 280	 410 400 367
Input current - Rated input current - Input current, max. - Current for 24 V DC auxiliary supply [4)]	 A A A	 270 410 0.9	 343 525 0.9	 426 655 1.0
Connection voltages - Line voltage - Electronics power supply - Output voltage	 V_{ACrms} V_{DC} V_{ACrms}	 660 V to 690 V 3 AC ±10 % (-15 % < 1 min) 24 (20.4 – 28.8) 3 AC 0 to line voltage		
Power loss	kW	5.0	5.8	7.5
Cooling air requirement	m³/s	0.36	0.36	0.78
Max. cable length between Power Module and motor - shielded - unshielded	 m m	 300 450	 300 450	 300 450
Sound pressure level L_{pA} (1 m) at 50/60 Hz	 dB(A)	 69/73	 69/73	 70/73
Line connection (U1, V1, W1) Connection cross-section, max. (IEC)	 mm²	M10 bolt 2 x 240	M10 bolt 2 x 240	2 x M12 bolt 4 x 240
Motor connection **(U2/T1, V2/T2, W2/T3)** Connection cross-section, max. (IEC)	 mm²	M10 bolt 2 x 240	M10 bolt 2 x 240	2 x M12 bolt 4 x 240
PE1 / GND connection Connection cross section, max. (IEC)	 mm²	M10 bolt 2 x 240	M10 bolt 2 x 240	M12 bolt 2 x 240
PE2 / GND connection Connection cross section, max. (IEC)	 mm²	M10 bolt 2 x 240	M10 bolt 2 x 240	2 x M12 bolt 4 x 240
Degree of protection		IP20	IP20	IP00
Dimensions - Width - Height - Depth	 mm mm mm	 326 1533 545	 326 1533 545	 503 1506 540
Frame size		GX	GX	HX
Weight, approx.	kg	176	176	294

Order number	6SL3310-	1GH32-6AAx	1GH33-3AAx	1GH34-1AAx
Recommended fuses - Line protection without semiconductor protection Rated current frame size to IEC 60269 - Line and semiconductor protection Rated current Frame size to IEC 60269	 A A 	 3NA3354-6 355 3 3NE1331-2 350 2	 3NA3365-6 500 3 3NE1334-2 500 2	 3NA3365-6 500 3 3NE1334-2 500 2

1) Rated output of a typ. 6-pole standard induction motor based on I_L or I_H at 690 V 3 AC 50 Hz.

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) If the auxiliary supply is to be fed in separately from the load supply, e.g., if the control should be able to continue communication if the line voltage fails.

Table 12- 15 Power Module, 660 V – 690 V 3 AC, part 4

Order number	6SL3310-	1GH34-7AAx	1GH35-8AAx	1GH37-4AAx
Unit rating - for I_L at 50 Hz and 690 V [1)] - for I_H at 50 Hz and 690 V [1)]	 kW kW	 450 400	 560 500	 710 560
Output current - Rated current I_N - Base load current I_L [2)] - Base load current I_H [3)]	 A A A	 465 452 416	 575 560 514	 735 710 657
Input current - Rated input current - Input current, max. - Current for 24 V DC auxiliary supply [4)]	 A A A	 483 740 1.0	 598 918 1.0	 764 1164 1.25
Connection voltages - Line voltage - Electronics power supply - Output voltage	 V_{ACrms} V_{DC} V_{ACrms}	 660 V to 690 V 3 AC ±10 % (-15 % < 1 min) 24 (20.4 – 28.8) 3 AC 0 to line voltage		
Power loss	kW	8.5	10.3	12.8
Cooling air requirement	m³/s	0.78	0.78	1.48
Max. cable length between Power Module and Motor - shielded - unshielded	 m m	 300 450	 300 450	 300 450
Sound pressure level L_{pA} (1 m) at 50/60 Hz	 dB(A)	 70/73	 70/73	 73/75
Line connection (U1, V1, W1) Connection cross-section, max. (IEC)	 mm²	2 x M12 bolt 4 x 240	2 x M12 bolt 4 x 240	3 x M12 bolt 6 x 240
Motor connection **(U2/T1, V2/T2, W2/T3)** Connection cross-section, max. (IEC)	 mm²	2 x M12 bolt 4 x 240	2 x M12 bolt 4 x 240	3 x M12 bolt 6 x 240
PE1 / GND connection Connection cross section, max. (IEC)	 mm²	M12 bolt 2 x 240	M12 bolt 2 x 240	2 x M12 bolt 4 x 240
PE2 / GND connection Connection cross section, max. (IEC)	 mm²	2 x M12 bolt 4 x 240	2 x M12 bolt 4 x 240	3 x M12 bolt 6 x 240
Degree of protection		IP00	IP00	IP00
Dimensions - Width - Height - Depth	 mm mm mm	 503 1506 540	 503 1506 540	 909 1510 540
Frame size		HX	HX	JX
Weight, approx.	kg	294	294	530

Order number	6SL3310-	1GH34-7AAx	1GH35-8AAx	1GH37-4AAx
Recommended fuses - Line protection without semiconductor protection Rated current frame size to IEC 60269 - Line and semiconductor protection Rated current Frame size to IEC 60269	 A A 	 3NA3252-6 2 x 315 2 3NE1435-2 560 3	 3NA3354-6 2 x 355 3 3NE1447-2 670 3	 3NA3365-6 2 x 500 3 3NE1448-2 850 3

[1] Rated output of a typ. 6-pole standard induction motor based on I_L or I_H at 690 V 3 AC 50 Hz.

[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] If the auxiliary supply is to be fed in separately from the load supply, e.g., if the control should be able to continue communication if the line voltage fails.

Table 12- 16 Power Module, 660 V – 690 V 3 AC, part 5

Order number	6SL3310-	1GH38-1AAx		
Unit rating - for I_L at 50 Hz and 690 V [1)] - for I_H at 50 Hz and 690 V [1)]	 kW kW	 800 710		
Output current - Rated current I_N - Base load current I_L [2)] - Base load current I_H [3)]	 A A A	 810 790 724		
Input current - Rated input current - Input current, max. - Current for 24 V DC auxiliary supply [4)]	 A A A	 842 1295 1.25		
Connection voltages - Line voltage - Electronics power supply - Output voltage	 V_{ACrms} V_{DC} V_{ACrms}	 660 V to 690 V 3 AC ±10 % (-15 % < 1 min) 24 (20.4 – 28.8) 3 AC 0 to line voltage		
Power loss	kW	13.9		
Cooling air requirement	m³/s	1.48		
Max. cable length between Power Module and motor - shielded - unshielded	 m m	 300 450		
Sound pressure level L_{pA} (1 m) at 50/60 Hz	 dB(A)	 73/75		
Line connection (U1, V1, W1) Connection cross-section, max. (IEC)	 mm²	3 x M12 bolt 6 x 240		
Motor connection **(U2/T1, V2/T2, W2/T3)** Connection cross-section, max. (IEC)	 mm²	3 x M12 bolt 6 x 240		
PE1 / GND connection Connection cross section, max. (IEC)	 mm²	2 x M12 bolt 4 x 240		
PE2 / GND connection Connection cross section, max. (IEC)	 mm²	3 x M12 bolt 6 x 240		
Degree of protection		IP00		
Dimensions - Width - Height - Depth	 mm mm mm	 909 1510 540		
Frame size		JX		
Weight, approx.	kg	530		

Order number	6SL3310-	1GH38-1AAx		
Recommended fuses - Line protection without semiconductor protection Rated current frame size to IEC 60269 - Line and semiconductor protection Rated current Frame size to IEC 60269	 A A 	 3NA3365-6 2 x 500 3 3NE1334-2 2 x 500 2		

1) Rated output of a typ. 6-pole standard induction motor based on I_L or I_H at 690 V 3 AC 50 Hz.

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) If the auxiliary supply is to be fed in separately from the load supply, e.g., if the control should be able to continue communication if the line voltage fails.

12.3.2 Control Unit CU320-2 DP

Table 12- 17 CU320-2 DP

Max. current requirements (at 24 V DC) (not taking into account digital outputs, option slot extension)	1.0 A
Max. connectable cross section	2.5 mm ^{2}
digital inputs	12 isolated digital inputs 8 bidirectional non-isolated digital inputs/digital outputs
Voltage	-3 V to +30 V
Low level (an open digital input is interpreted as "low")	-3 V to +5 V
High level	15 V to 30 V
Typical current consumption (at 24 V DC)	9 mA
Max. connectable cross section	1.5 mm ^{2}
Digital outputs (continuous short-circuit proof)	8 bidirectional non-floating digital outputs/digital inputs
Voltage	24 V DC
Max. load current per digital output	500 mA
Max. connectable cross section	1.5 mm ^{2}
Power loss	24 W
PE connection	On housing with M5 screw
Ground connection	On housing with M5 screw
Width	50 mm
Height	300 mm
Depth	226 mm
Weight, approx.	2.3 kg

12.3.3 TM31 Terminal Module

Table 12- 18 Technical specifications TM31

Max. current requirement (at 24 V DC), not taking into account digital outputs	0.5 A
Max. connectable cross section	2.5 mm²
Digital inputs	
Voltage	-3 V to 30 V
Low level (an open digital input is interpreted as "low")	-3 V to 5 V
High level	15 V to 30 V
Current consumption (at 24 V DC)	10 mA
Signal propagation times of the digital inputs	L -> H: 50 µs H->L: 100 µs
Max. connectable cross section	1.5 mm²
Digital outputs (continued-short-circuit-proof)	
Voltage	24 V DC
Max. load current per digital output	External/internal 24 V supply 100 mA / 20 mA
Max. connectable cross section	1.5 mm²
Analog inputs (switching between the voltage and current input via the switch)	
As voltage input	
- Voltage range	-10 V to 10 V
- Internal resistance Ri	70 kΩ
As current input	
- Current range	4 mA to 20 mA, -20 mA to 20 mA, 0 mA to 20 mA
- Internal resistance Ri	250 Ω
- Resolution	12 bits
Max. connectable cross section	1.5 mm²
Analog outputs (continued-short-circuit-proof)	
Voltage range	-10 V to 10 V
Max. load current	-3 mA to 3 mA
Current range	4 mA to 20 mA, -20 mA to 20 mA, 0 mA to 20 mA
Max. load resistance	500 Ω for outputs in the range -20 mA to 20 mA
Resolution	12 bits
Max. connectable cross section	1.5 mm²
Relay outputs (two-way contacts)	
Max. load current	8 A
Max. switching voltage	250 V AC, 30 V DC
Max. switching power (at 250 V AC)	2000 VA
Max. switching power (at 30 V DC)	240 W (ohmic load)
Required minimum current	100 mA

Max. connectable cross section	2.5 mm^2
Power loss	< 10 W
PE connection	On housing with M4 screw
Width	50 mm
Height	150 mm
Depth	119 mm
Weight, approx.	0.87 kg

12.3.4 SMC30 Sensor Module

Table 12- 19 Technical specifications SMC30

Electronics power supply	
Voltage	24 V DC (20.4 – 28.8)
Current	max. 0.6 A
Max. ambient temperature up to an altitude of 2000 m	55 °C
Note: As of an altitude of 2000 m, the max. ambient temperature decreases by 7°C every 1000 m.	
PE/ground connection	On housing with M4/1.8 Nm screw
Weight	0.45 kg

Appendix A

A.1 List of 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/output bidirectional
DO	Digital output
E	
ESD	Electrostatic devices
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 electrical engineering standard
IGBT	Insulated gate bipolar transistor
J	
JOG	Jog mode
L	
L	Inductance
LED	Light-emitting diode
M	
M	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
PROFIBUS	Serial data bus
PTC	Positive temperature coefficient
R	
r...	Visualization parameter (read-only)
RAM	Read and write memory
RS 232	Serial interface
RS 485	Standard. Describes 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 = G130 built-in unit

This macro is used to make default settings for operating the built-in unit.

Table A- 1 Parameter macro p0015 = G130 built-in unit

Sink			Source		
Parameters	Description	DO	Parameters	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[0]	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	70001	PROFIdrive	Vector
p0864	BI: Infeed operation	Vector	1		Vector
p1000[0]	Macro connector inputs (CI) for speed setpoints	Vector	10001	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		
Parameters	Description	DO	Parameters	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 for switching on	Vector
p2080[1]	BI: PROFIBUS send status word 1	Vector	r0899.1	Ready for operation	Vector
p2080[2]	BI: PROFIBUS send status word 1	Vector	r0899.2	Operation	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	No OFF2	Vector
p2080[5]	BI: PROFIBUS send status word 1	Vector	r0899.5	No OFF3	Vector
p2080[6]	BI: PROFIBUS send status word 1	Vector	r0899.6	Switching on inhibited	Vector
p2080[7]	BI: PROFIBUS send status word 1	Vector	r2139.7	Alarm active	Vector
p2080[8]	BI: PROFIBUS send status word 1	Vector	r2197.7	No setpoint/actual value deviation	Vector
p2080[9]	BI: PROFIBUS send status word 1	Vector	r0899.9	Control request	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	M/I/P limiting not active	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	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	Time constant revolutions actual value filter	Vector	20	20 ms	Vector
p4053[0]	TM31 analog inputs, smoothing time constant	TM31	0	0 ms	TM31
p4056[0]	Type of analog inputs	TM31	0	Voltage 0 to 10 V	TM31
p4056[1]	Type of analog inputs	TM31	0	Voltage 0 to 10 V	TM31
p4076[0]	Type of analog outputs	TM31	1	Voltage 0 to 10 V	TM31

Sink			Source		
Parameters	Description	DO	Parameters	Description	DO
p4076[1]	Type of analog outputs	TM31	1	Voltage 0 to 10 V	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]	Alarm threshold, temperature sensing	TM31	251 °C	When this value is exceeded, alarm A35211 is triggered.	TM31
p4102[1]	Fault threshold for temperature sensing	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 = 1: PROFIdrive (70001)

This macro is used to set the PROFIdrive interface as the default command source.

Table A- 2 Parameter macro p0700 = 1: 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	r0722.4	CU DI4	CU
p0848[0]	No OFF3_1	Vector	r2090.2	PZD 1 bit 2	Vector
p0849[0]	No OFF3_2	Vector	r0722.5	CU DI5	CU
p0806	Inhibit LOCAL mode	Vector	0		Vector
p0810	Changeover CDS bit 0	Vector	0		Vector
p0852	Enable operation	Vector	r2090.3	PZD 1 bit 3	Vector
p0854	Control request	Vector	r2090.10	PZD 1 bit 10	Vector
p0922	Profibus PZD telegram selection	Vector	999	Free telegram configuration	
p1020	FSW bit 0	Vector	0		Vector
p1021	FSW bit 1	Vector	0		Vector
p1035	MOP raise	Vector	r2090.13	PZD 1 bit 13	Vector
p1036	MOP lower	Vector	r2090.14	PZD 1 bit 14	Vector
p1113	Direction of rotation reversal	Vector	r2090.11	PZD 1 bit 11	Vector
p1140	Enable RFG	Vector	r2090.4	PZD 1 bit 4	Vector
p1141	Start RFG	Vector	r2090.5	PZD 1 bit 5	Vector
p1142	Enable nsetp	Vector	r2090.6	PZD 1 bit 6	Vector
p2103	Acknowledge fault 1	Vector	r2090.7	PZD 1 bit 7	Vector
p2104	Acknowledge fault 2	Vector	r0722.3	CU DI3	TM31
p2106	Ext. fault_1	Vector	r0722.6	CU DI6	CU
p2107	Ext. fault_2	Vector	1		Vector
p2112	Ext. alarm_1	Vector	r0722.11	CU DI11	CU
p2116	Ext. alarm_2	Vector	1		Vector
p0738	DI/DO8	CU	r0899.11	Pulses enabled	Vector

Sink			Source		
Parameter	Description	DO	Parameter	Description	DO
p0748.8	Invert DI/DO8	CU	0	Not inverted	
p0728.8	Set DI/DO8 input or output	CU	1	Output	
p0739	DI/DO9	CU	r2139.3	Fault active	Vector
p0748.9	Invert DI/DO9	CU	1	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	0		CU
p0748.11	Invert DI/DO11	CU	0	Not inverted	
p0728.11	Set DI/DO11 input or output	CU	0	Input	
p0742	DI/DO12	CU	r2138.7	Ack. Fault	Vector
p0748.12	Invert DI/DO12	CU	0	Not inverted	
p0728.12	Set DI/DO12 input or output	CU	1	Output	
p0743	DI/DO13	CU	1	+24 V	CU
p0748.13	Invert DI/DO13	CU	0	Not 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	1	+24 V	CU
p0748.15	Invert DI/DO15	CU	0	Not inverted	
p0728.15	Set DI/DO15 input or output	CU	1	Output	

Parameter macro p0700 = 2: Terminal TM31 (70002)

This macro is used to set terminal block TM31 as the command source.

Table A- 3 Parameter macro p0700 = 2: TM31 terminals

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		Vector
p0845[0]	No OFF2_2	Vector	r4022.4	TM31 DI4	TM31
p0848[0]	No OFF3_1	Vector	1		Vector
p0849[0]	No OFF3_2	Vector	r4022.5	TM31 DI5	TM31
p0806	Inhibit LOCAL mode	Vector	0		Vector
p0810	Changeover CDS bit 0	Vector	0		Vector
p0852	Enable operation	Vector	1		Vector
p0854	Control request	Vector	1		Vector
p0922	Profibus PZD telegram selection	Vector	999	Free telegram configuration	
p1020	FSW bit 0	Vector	r4022.1	TM31 DI1	TM31
p1021	FSW bit 1	Vector	r4022.2	TM31 DI2	TM31
p1035	MOP raise	Vector	r4022.1	TM31 DI1	TM31
p1036	MOP lower	Vector	r4022.2	TM31 DI2	TM31
p1113	Direction of rotation reversal	Vector	0		Vector
p1140	Enable RFG	Vector	1		Vector
p1141	Start RFG	Vector	1		Vector
p1142	Enable nsetp	Vector	1		Vector
p2103	Acknowledge fault_1	Vector	0		Vector
p2104	Acknowledge faults_2	Vector	r4022.3	TM31 DI3	TM31
p2106	Ext. fault_1	Vector	r4022.6	TM31 DI6	TM31
p2107	Ext. fault_2	Vector	1		Vector
p2112	Ext. alarm_1	Vector	r4022.11	TM31 DI11	TM31
p2116	Ext. alarm_2	Vector	1		Vector
p0738	DI/DO8	CU	0		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	0		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	0		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	0		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	r2138.7	Ack. fault	Vector

Sink			Source		
Parameter	Description	DO	Parameter	Description	DO
p0748.12	Invert DI/DO12	CU	0	Not inverted	
p0728.12	Set DI/DO12 input or output	CU	1	Output	
p0743	DI/DO13	CU	0		CU
p0748.13	Invert DI/DO13	CU	0	Not inverted	
p0728.13	Set DI/DO13 input or output	CU	1	Output	
p0744	DI/DO14	CU	0		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	0		CU
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 for switching on	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 = 3: CU terminals (70003)

This macro is used to set the CU320 terminals as the command source.

Table A- 4 Parameter macro p0700 = 3: CU terminals

Sink			Source		
Parameter	Description	DO	Parameter	Description	DO
p0840[0]	ON/OFF1	Vector	r0722.0	CU DI0	CU
p0844[0]	No OFF2_1	Vector	1		Vector
p0845[0]	No OFF2_2	Vector	r0722.4	CU DI4	CU
p0848[0]	No OFF3_1	Vector	1		Vector
p0849[0]	No OFF3_2	Vector	r0722.5	CU DI5	CU
p0806	Inhibit LOCAL mode	Vector	0		Vector
p0810	Changeover CDS bit 0	Vector	0		Vector
p0852	Enable operation	Vector	1		Vector
p0854	Control request	Vector	1		Vector
p0922	Profibus PZD telegram selection	Vector	999	Free telegram configuration	
p1020	FSW bit 0	Vector	r0722.1	CU DI1	CU
p1021	FSW bit 1	Vector	r0722.2	CU DI2	CU
p1035	MOP raise	Vector	r0722.1	CU DI1	CU
p1036	MOP lower	Vector	r0722.2	CU DI2	CU
p1113	Direction of rotation reversal	Vector	0		Vector
p1140	Enable RFG	Vector	1		Vector
p1141	Start RFG	Vector	1		Vector
p1142	Enable nsetp	Vector	1		Vector
p2103	Acknowledge fault 1	Vector	0		Vector
p2104	Acknowledge fault 2	Vector	r0722.3	CU DI3	CU
p2106	Ext. fault_1	Vector	r0722.6	CU DI6	CU
p2107	Ext. fault_2	Vector	1		Vector
p2112	Ext. alarm_1	Vector	r0722.11	CU DI11	CU
p2116	Ext. alarm_2	Vector	1		Vector
p0738	DI/DO8	CU	r0899.11	Pulses enabled	Vector
p0748.8	Invert DI/DO8	CU	0	Not inverted	
p0728.8	Set DI/DO8 input or output	CU	1	Output	
p0739	DI/DO9	CU	r2139.3	Fault active	Vector
p0748.9	Invert DI/DO9	CU	1	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	0		CU
p0748.11	Invert DI/DO11	CU	0	Not inverted	
p0728.11	Set DI/DO11 input or output	CU	0	Input	
p0742	DI/DO12	CU	r2138.7	Ack. Fault	Vector

Sink			Source		
Parameter	Description	DO	Parameter	Description	DO
p0748.12	Invert DI/DO12	CU	0	Not inverted	
p0728.12	Set DI/DO12 input or output	CU	1	Output	
p0743	DI/DO13	CU	1	+24 V	CU
p0748.13	Invert DI/DO13	CU	0	Not 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	1	+24 V	CU
p0748.15	Invert DI/DO15	CU	0	Not inverted	
p0728.15	Set DI/DO15 input or output	CU	1	Output	

Parameter macro p0700 = 4: PROFIdrive+TM31 (70004)

This macro is used to set the PROFIdrive interface and terminal block TM31 as the command source.

Table A- 5 Parameter macro p0700 = 4: PROFIdrive+TM31

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	r4022.4	TM31 DI4	TM31
p0848[0]	No OFF3_1	Vector	r2090.2	PZD 1 bit 2	Vector
p0849[0]	No OFF3_2	Vector	r4022.5	TM31 DI5	TM31
p0806	Inhibit LOCAL mode	Vector	0		Vector
p0810	Changeover CDS bit 0	Vector	0		Vector
p0852	Enable operation	Vector	r2090.3	PZD 1 bit 3	Vector
p0854	Control request	Vector	r2090.10	PZD 1 bit 10	Vector
p0922	Profibus PZD telegram selection	Vector	999	Free telegram configuration	
p1020	FSW bit 0	Vector	0		Vector
p1021	FSW bit 1	Vector	0		Vector
p1035	MOP raise	Vector	r2090.13	PZD 1 bit 13	Vector
p1036	MOP lower	Vector	r2090.14	PZD 1 bit 14	Vector
p1113	Direction of rotation reversal	Vector	r2090.11	PZD 1 bit 11	Vector
p1140	Enable RFG	Vector	r2090.4	PZD 1 bit 4	Vector
p1141	Start RFG	Vector	r2090.5	PZD 1 bit 5	Vector
p1142	Enable nsetp	Vector	r2090.6	PZD 1 bit 6	Vector
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	r4022.6	TM31 DI6	TM31
p2107	Ext. fault_2	Vector	1		Vector
p2112	Ext. alarm_1	Vector	r4022.11	TM31 DI11	TM31
p2116	Ext. alarm_2	Vector	1		Vector
p0738	DI/DO8	CU	0		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	0		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	0		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	0		CU
p0748.11	Invert DI/DO11	CU	0	Not inverted	
p0728.11	Set DI/DO11 input or output	CU	1	Output	

Sink			Source		
Parameter	Description	DO	Parameter	Description	DO
p0742	DI/DO12	CU	r2138.7	Ack. Fault	Vector
p0748.12	Invert DI/DO12	CU	0	Not inverted	
p0728.12	Set DI/DO12 input or output	CU	1	Output	
p0743	DI/DO13	CU	0		CU
p0748.13	Invert DI/DO13	CU	0	Not inverted	
p0728.13	Set DI/DO13 input or output	CU	1	Output	
p0744	DI/DO14	CU	0		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	0		CU
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 1	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 for switching on	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 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		
Parameters	Description	DO	Parameters	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: Terminal TM31 (100002)

This macro is used to set analog input 0 on customer terminal block 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		
Parameters	Description	DO	Parameters	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		
Parameters	Description	DO	Parameters	Description	DO
p1070	Main setpoint	Vector	r1024	Active fixed setpoint	Vector
p1071	Main setpoint scaling	Vector	1	100 %	Vector
p1075	Supplementary setpoint	Vector	0		Vector
p1076	Supplementary setpoint scaling	Vector	1	100 %	Vector

Index

K

L

M

N

O

P

Q

R

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