Installation and Start-up Manual 04.2004 Edition

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SINAMICS S120

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SINAMICS S120

Installation and Start-up Manual

Manufacturer/service documentation

Valid for

Drive	*Firmware release*
SINAMICS S120	2.1

04.2004 Edition

SINAMICS® Documentation

Printing History

Brief details of this edition and previous editions are listed below.

The status of each edition is shown by the code in the “Remarks” column.

Status code in the “Remarks” column:

A New documentation
B Unrevised reprint with new order no.
C Revised edition with new status

If factual changes have been made on the page in relation to the same software version, this is indicated by a new edition coding in the header on that page.

Edition	Order No.	Comments
03.03	6SL3 097-0AF00-0BP0	**A**
04.04	6SL3 097-2AF00-0BP0	**C**

This manual is part of the documentation available on the following CD

Edition	Order no.	Remarks
04.04	6SL3 097-2CA00-0BG0	**A**

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The controller may support functions that are not described in this documentation. The customer is not, however, entitled to these functions in the event of the system being replaced or serviced.

We have checked that the contents of this document correspond to the hardware and software described. Since deviations cannot be precluded entirely, we cannot guarantee complete conformance. However, the data in this manual is reviewed regularly and any necessary corrections included in subsequent editions. We are thankful for any recommendations or suggestions.

We reserve the right to make technical changes.

Order no. 6SL3 097-2AF00-0BP0
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Preface

Information on the SINAMICS S120 documentation

The SINAMICS S120 documentation is divided into the following areas:

- General documentation/catalogs
- Manufacturer/service documentation
- Electronic documentation

Table Preface-1 Usage phases and the available documents/tools

Usage phase	Document/tool
Exploratory	Sales documents for SINAMICS S120
Planning/configuration	SIZER configuration tool
Decision/ordering	SINAMICS S120 catalog
Installation/assembly	SINAMICS S120 Equipment Manuals • Control units and additional system components • Booksize power sections • Chassis power sections
Commissioning	• STARTER parameterization and commissioning tool • Getting Started: SINAMICS S120 • SINAMICS S120 Installation and Start–Up Manual • SINAMICS S List Manual
Usage/operation	• SINAMICS S120 Installation and Start–Up Manual • SINAMICS S List Manual
Maintenance/servicing	• SINAMICS S120 Installation and Start–Up Manual • SINAMICS S List Manual

This documentation is part of the technical customer documentation for SINAMICS. All documents can be obtained separately.

You can obtain detailed information about the documents named in the documentation overview and other documents available for SINAMICS from your local Siemens office.

In the interests of clarity, this documentation does not contain all the detailed information for all product types and cannot take into account every possible aspect of installation, operation, or maintenance.

The contents of this documentation are not part of an earlier or existing agreement, a promise, or a legal agreement, nor do they change this. All obligations entered into by Siemens result from the respective contract of sale that contains the complete and sole valid warranty arrangements. These contractual warranty provisions are neither extended nor curbed as a result of the statements made in this documentation.

Audience

This documentation is intended for machine manufacturers, commissioning engineers, and service personnel who use the SINAMICS S drive system.

Objective

The Installation and Start–Up Manual describes all the procedures and operational instructions required for commissioning and servicing SINAMICS S120.

The Installation and Start–Up Manual is structured as follows:

Chapter 1	System Overview
Chapter 2	Preparations for Commissioning
Chapter 3	Commissioning
Chapter 4	PROFIBUS Communication
Chapter 5	Drive Functions
Chapter 6	SINAMICS Safety Integrated
Chapter 7	Diagnostics
Chapter 8	Basic Information About the Drive System

Advice for beginners:
First read Chapters 1 and 8 and then read the relevant chapters.

In addition to the Installation and Start–Up Manual, you need the List Manual.

The List Manual is structured as follows:

Chapter 1	Parameters
Chapter 2	Function Diagrams
Chapter 3	Faults and Alarms

Finding your way around

To help you find information more easily, the following sections have been included in the appendix in addition to the table of contents:

1. List of abbreviations
2. References
3. Glossary
4. Index

Danger and warning symbols – explanations

The following danger and warning notices are used in this document:

Danger

This symbol indicates that death, severe personal injury, or substantial property damage **will** result if proper precautions are not taken.

Warning

This symbol indicates that death, severe personal injury, or substantial property damage **may** result if proper precautions are not taken.

Caution

This symbol indicates that minor personal injury or property damage **may** result if proper precautions are not taken.

Caution

(Without a warning triangle) indicates that material damage **can** result if proper precautions are not taken.

Notice

Indicates that an unwanted result or situation **may** result if the appropriate advice is not taken into account.

Note

This notice indicates that there are further issues to be taken into consideration.

Definition: Qualified personnel

With reference to this manual and the warning labels on the product, a “qualified person” is someone who is familiar with the installation, mounting, start-up, and operation of the equipment and who has certified qualifications for the type of responsibility involved, such as:

- Training and instruction, i.e. authority to switch on and off, to earth and to label circuits and equipment according to safety regulations.
- Trained in the proper care and use of protective equipment in accordance with established safety procedures.
- First aid training.

Technical notes

Technical support

If you have any further questions, please call our hotline:

A&D Technical Supports	Tel.:	+49 (0) 180 5050 – 222
	Fax:	+49 (0) 180 5050 – 223
	email:	adsupport@siemens.com

Please send any questions about the documentation (suggestions for improvement, corrections, and so on) to the following fax number or email address:

	+49 (0) 9131 98 – 2176
Fax form:	see feedback page at the end of this documentation
email:	motioncontrol.docu@erlf.siemens.de

Internet address

Up–to–date information about our products can be found on the Internet at the following address:

http://www.siemens.com/automation/drives

Notation

The following notation and abbreviations are used in this documentation:

Notation for parameters (examples):

- p0918 Adjustable parameter 918
- r1024 Visualization parameter 1024
- p1070[1] Adjustable parameter 1070, index 1
- p0099[0...3] Adjustable parameter 99, indices 0 to 3
- r0945[2](3) Visualization parameter 945, index 2 of drive object 3
- p0795.4 Adjustable parameter 795, bit 4

Notation for faults and alarms (examples):

- F1234 Fault 1234
- A5678 Alarm 5678

General notation:

- The sign “≙” means “is equal to”

ESD notices

Caution

An **e**lectrostatic–**s**ensitive **d**evice (ESD) is an individual component, integrated circuit, or module that can be damaged by electrostatic fields or discharges.

Instructions for handling ESD:

- When handling components, make sure that personnel, workplaces, and packaging are well earthed.
- Personnel in ESD areas with conductive flooring may only handle electronic components if:
  - They are grounded with an ESD wrist band
  - They are wearing ESD shoes or ESD shoe grounding straps
- Electronic boards should only be touched if absolutely necessary. They must only be handled on the front panel or, in the case of printed circuit boards, at the edge.
- Electronic boards must not come into contact with plastics or items of clothing containing synthetic fibers.
- Boards must only be placed on conductive surfaces (work surfaces with ESD surface, conductive ESD foam, ESD packing bag, ESD transport container).
- Electronic modules must be kept at a distance from data display equipment, monitors, and televisions (minimum distance from screen: >10 cm).
- Measurements must only be taken on boards when:
  - The measuring device is grounded (with a protective conductor, for example).
  - The measuring head has been temporarily discharged before measurements are taken on a floating measuring device (e.g. touching a bare metal controller housing).

Safety information

Danger

- Commissioning must not start until you have ensured that the machine in which the components described here are to be installed complies with Directive 98/37/EC.
- SINAMICS devices and AC motors must only be commissioned by suitably qualified personnel.
- Personnel must take into account the information provided in the technical customer documentation for the product, and be familiar with and observe the specified danger and warning notices.
- When electrical equipment and motors are operated, the electrical circuits automatically conduct a dangerous voltage.
- Dangerous mechanical movements may occur in the system during operation.
- All work on the electrical system must be carried out when the system has been disconnected from the power supply.
- SINAMICS devices with AC motors must only be connected to the power supply via an AC–DC residual–current–operated device with selective switching once verification has been provided that the SINAMICS device is compatible with the residual–current–operated device in accordance with EN 50178, Chapter 5.2.11.2.

Warning

- The successful and safe operation of these devices and motors depends on correct transport, proper storage and installation, as well as careful operation and maintenance.
- The specifications in the catalogs and offers also apply to special variants of the devices and motors.
- In addition to the danger and warning information provided in the technical customer documentation, the applicable national, local, and system–specific regulations and requirements must be taken into account.
- Only protective extra–low voltages (PELVs) that comply with EN60204–1 must be connected to all connections and terminals between 0 and 48 V.

Caution

- The surface temperature of the motors can reach over +80 °C.
- For this reason, temperature–sensitive parts (lines or electronic components, for example) must not be placed on or attached to the motor.
- When attaching the connecting cables, you must ensure that:
  - They are not damaged
  - They are not under tension
  - They cannot come into contact with any rotating parts.

Caution

- As part of routine tests, SINAMICS devices with AC motors undergo a voltage test in accordance with EN 50178. Before the voltage test is performed on the electrical equipment of industrial machines to EN 60204–1, Section 19.4, all connectors of SINAMICS equipment must be disconnected/unplugged to prevent the equipment from being damaged.
- Motors must be connected in accordance with the circuit diagram provided. They must not be connected directly to the three–phase supply because this will damage them.

Note

- When operated in dry operating areas, SINAMICS equipment with three–phase motors conforms to low–voltage Directive 73/23/EEC.

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Contents

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System overview

1

1.1 Application

SINAMICS is the new range of drives from Siemens designed for mechanical and plant engineering applications. SINAMICS offers solutions for all drive tasks:

- Simple pump and fan applications in the process industry.
- Complex individual drives in centrifuges, presses, extruders, elevators, as well as conveyor and transport systems.
- Drive line-ups in textile, plastic film, and paper machines, as well as in rolling mill plants.
- Highly dynamic servo drives for machine tools, as well as packaging and printing machines.

Depending on the application, the SINAMICS range offers the ideal version for any drive task.

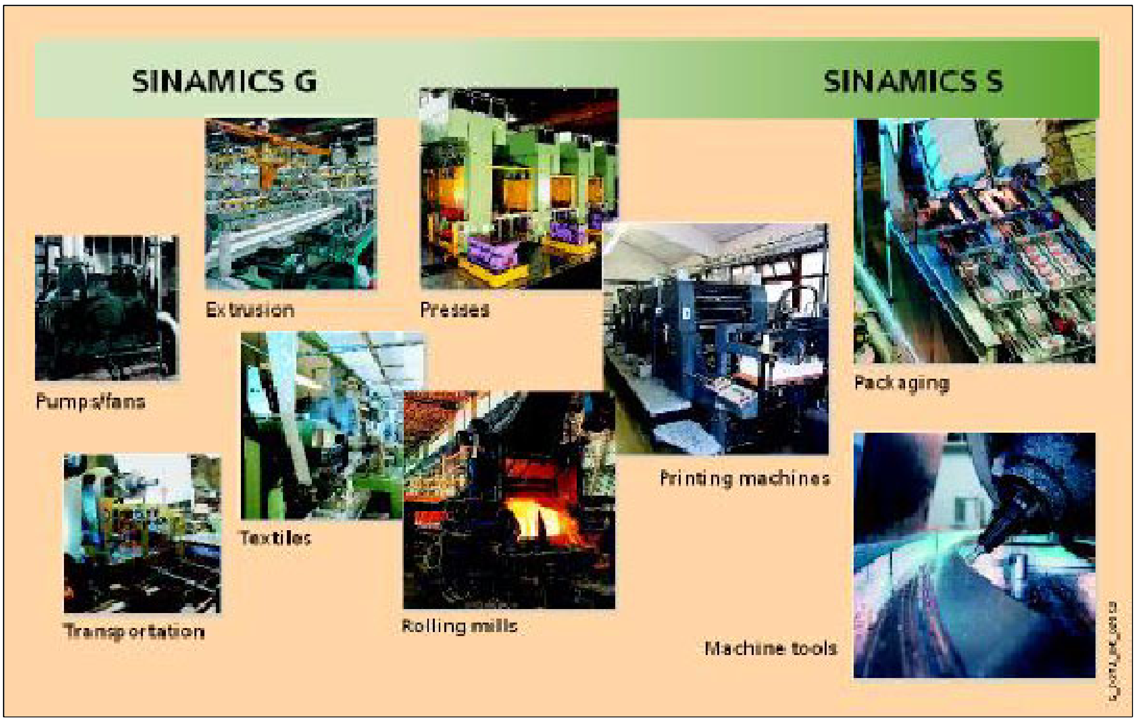


Fig. 1-1 SINAMICS applications

1.2 Versions

SINAMICS offers different versions designed to meet a range of requirements:

- SINAMICS G is designed for standard applications with induction motors. These applications have less stringent requirements regarding the dynamics and accuracy of the motor speed.
- SINAMICS S handles complex drive tasks with synchronous/induction motors and fulfills stringent requirements regarding:
  - Dynamics and accuracy
  - Integration of extensive technological functions in the drive control system

1.3 Platform concept and Totally Integrated Automation

All SINAMICS versions are based on a platform concept. Joint hardware and software components, as well as standardized tools for design, configuration, and commissioning tasks ensure high-level integration across all components. SINAMICS handles a wide variety of drive tasks with no system gaps. The different SINAMICS versions can be easily combined with each other.

SINAMICS is part of the Siemens "Totally Integrated Automation" concept. Integrated SINAMICS systems covering configuration, data storage, and communication at automation level ensure low-maintenance solutions with SIMATIC, SIMOTION, and SINUMERIK.

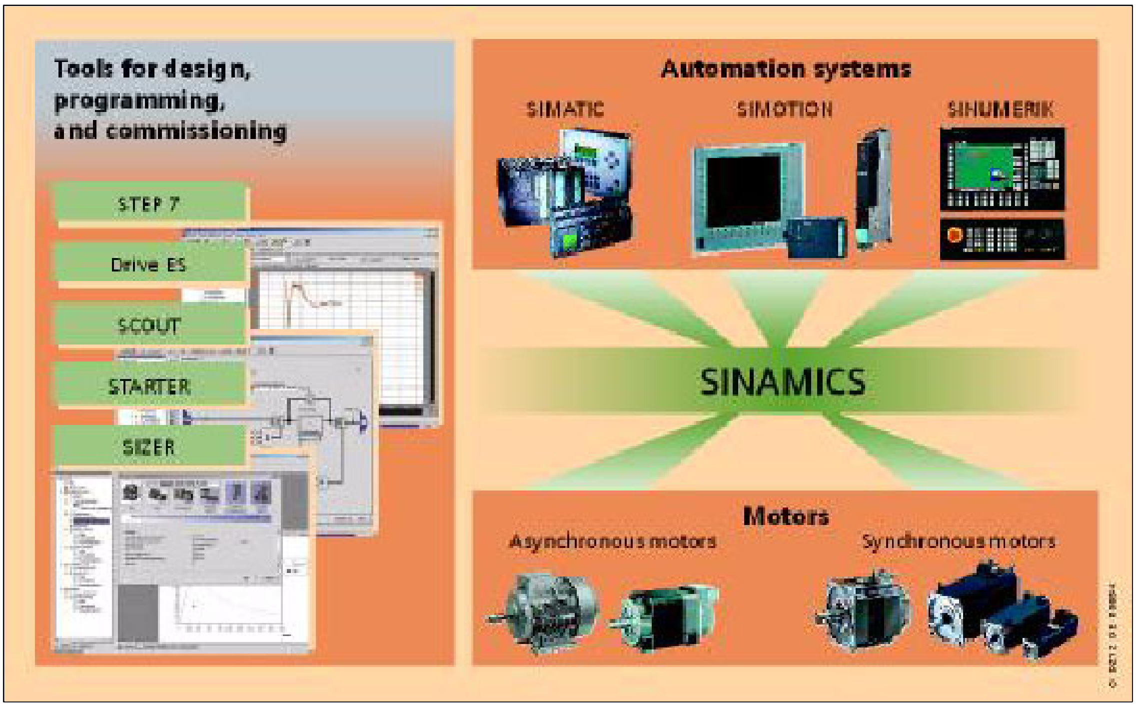


Fig. 1-2 SINAMICS as part of the Siemens modular automation concept

1.4 Introduction

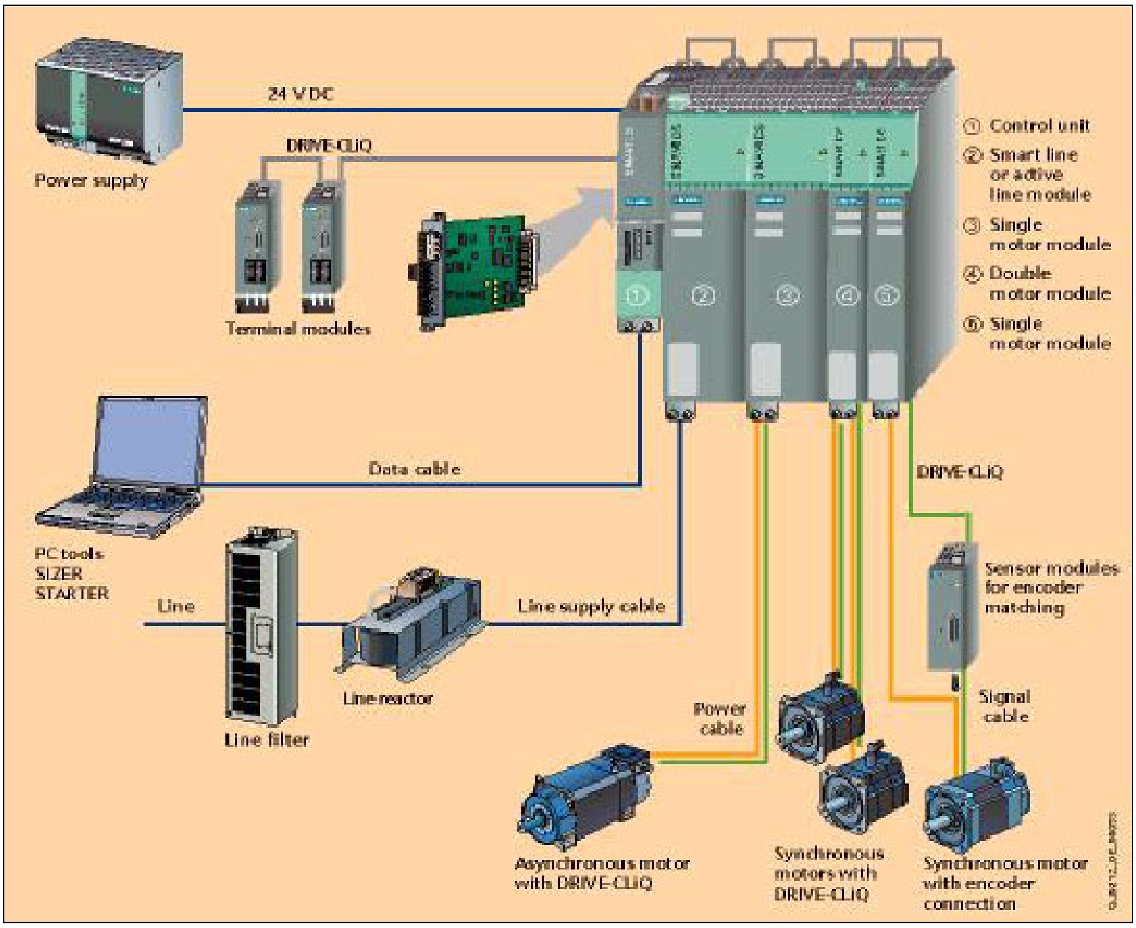


Fig. 1-3 SINAMICS S120 system overview

Modular system for complex drive tasks

SINAMICS S120 solves complex drive tasks for a wide range of industrial applications and is, therefore, designed as a modular system. Users can choose from many different harmonized components and functions to create a solution that best meets their requirements. SIZER, a high-performance configuration tool, makes it easier to choose and determine the optimum drive configuration.

SINAMICS S120 is enhanced by a wide range of motors. Whether synchronous or asynchronous, all motor types are supported by SINAMICS S120.

Drive for multi–axis applications

The trend towards separate axes in mechanical engineering is growing all the time. Where possible, central drives are being replaced by electronically coordinated servo drives. These require drives with a connected DC link, which allows cost–saving energy balancing between braking and driving axes.

SINAMICS S120 features infeeds and inverters that cover a broad power range, are designed for seamless integration, and enable space–saving, multi–axis drive configurations.

New system architecture with a central control unit

Electronically coordinated individual drives work together to perform your drive tasks. Higher–level controllers operate the drives to achieve the required coordinated movement. This requires cyclic data exchange between the controller and all the drives. This exchange always had to take place via a field bus, which required a great deal of time and effort for installation and configuration. SINAMICS S120 takes a different approach. A central control unit controls the drive for all connected axes and also establishes the technological links between the axes. Since all the required data is stored in the central control unit, it does not need to be transferred. Cross–axis connections can be established within a control unit and easily configured in the STARTER commissioning tool using a mouse.

Simple technological tasks can be carried out automatically by the SINAMICS S120 control unit. For complex numerical or motion–control tasks, high–performance SINUMERIK or SIMOTION D modules are used instead.

DRIVE–CLiQ – a digital interface between all components

All SINAMICS S120 components, including the motors and encoders, are interconnected via a joint serial interface called DRIVE–CLiQ. The standardized cables and connectors reduce the variety of different parts and cut storage costs.

Converter boards for converting standard encoder signals to DRIVE–CLiQ are available for third–party motors or retrofit applications.

Electronic type plates in all components

All SINAMICS S120 components have an electronic type plate that contains all the relevant data about that particular component. In the motors, for example, this data includes the parameters of the electric equivalent circuit diagram and characteristic values for the built-in motor encoder. The control unit records this data automatically via DRIVE-CLiQ so that it does not need to be entered during commissioning or if the equipment is replaced.

In addition to the technical data, the type plate includes logistical data (manufacturer ID, order number, and globally unique ID). Since this data can be called up electronically on site or remotely, all the components used in a machine can always be individually identified, which helps simplify servicing.

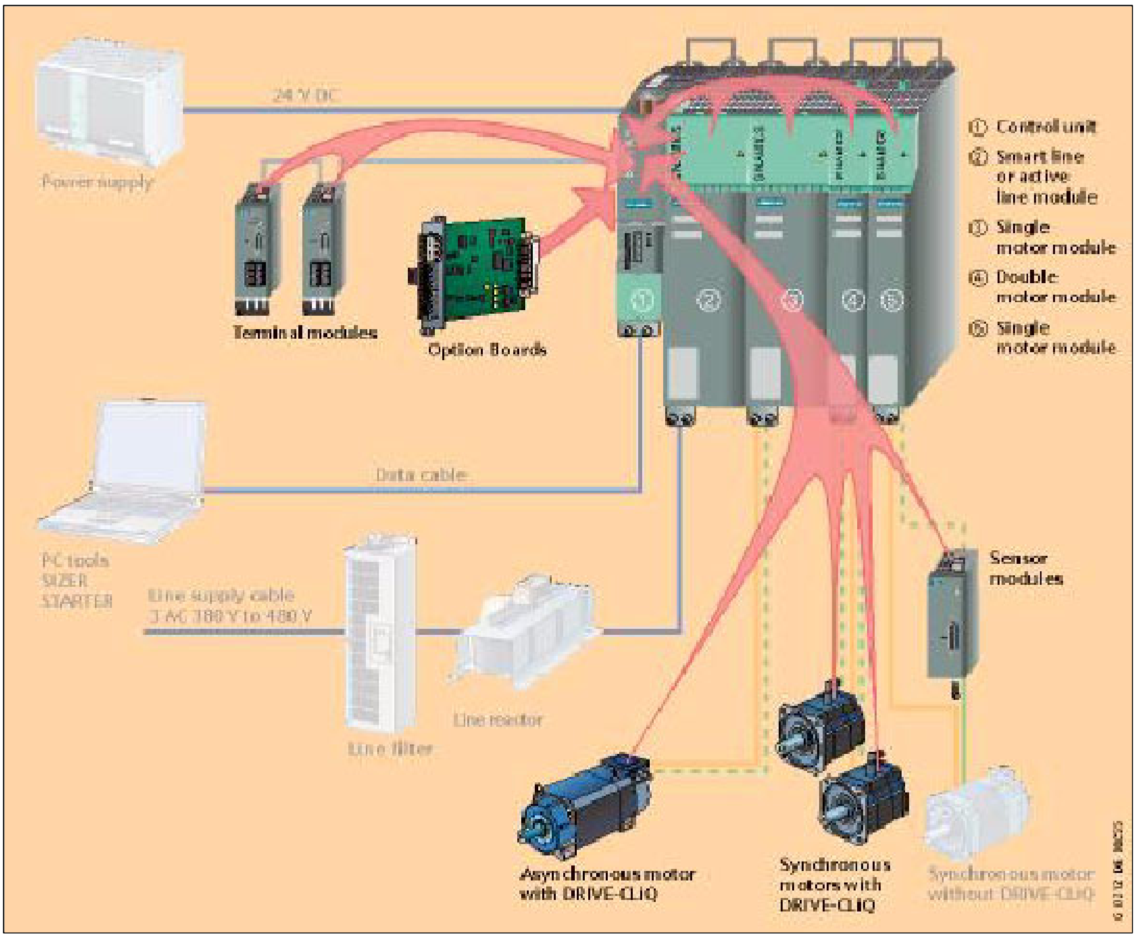


Fig. 1-4 The electronic type plate for SINAMICS S120

1.5 SINAMICS S120 components

This overview features the SINAMICS S120 components that are primarily used for multi-axis drive tasks.

Fig. 1-5 SINAMICS S120 component overview

The following power components are available:

- Line–side power components, such as fuses, contactors, reactors, and filters for switching the power supply and meeting EMC requirements.
- Line modules, which supply power centrally to the DC link.
- DC link components (optional), which stabilize the DC link voltage.
- Motor modules, which act as inverters, receive power from the DC link, and supply the connected motors.

To carry out the required functions, SINAMICS S120 is equipped with:

- A control unit that carries out all drive and technological functions across all axes.
- Additional system components that enhance functionality and offer different interfaces for encoders and process signals.

The SINAMICS S120 components were developed for installation in cabinets. They have the following features and characteristics:

- Easy to handle, simple installation and wiring
- Practical connection system, cable routing in accordance with EMC requirements
- Standardized design, seamless integration
- Internal ventilators (other cooling methods available on request).

1.6 Power sections

Line modules

Convert the three-phase supply into a DC voltage for the DC link.

- Smart line modules

  The smart line modules generate a non-stabilized DC link voltage and are capable of regenerative feedback.
- Active line modules

  The active line modules generate a stabilized DC link voltage and are capable of regenerative feedback.

Motor modules

Convert energy from the DC link for the connected motors with variable voltage and variable frequency.

1.7 Servo versus vector

Table 1-1 Servo versus vector

	Servo	Vector
Typical applications	Drives with highly dynamic motion control. Angular-locked synchronism with isochronous PROFIBUS. For use in production machine tools and clocked production machines.	Speed-controlled drives with high speed and torque stability in general mechanical engineering systems.
Number of drives that can be controlled by one control unit.	1 active line module + 6 motor modules	1 active line module + 2 motor modules
Dynamic response	High	Medium
Scanning frequency of current controller/speed controller Pulse frequency	125 µs / 125 µs ≥ 4 kHz	250 µs / 1000 µs ≥ 2 kHz
Synchronous motors/ induction motors	Yes / yes	No / yes
Position interface via PROFIBUS for higher-level motion control	Yes	No
Sensorless speed control • Direction reversal without model change • Start from standstill without model change	 No No	 Yes Yes
Motor identification (third-party motors) and speed controller optimization	No	Yes
V/f control	Diagnosis mode	Yes (different characteristics)
Sensorless torque control	No	Yes (controlled at low speeds)
Thermal utilization of motor / motor module	Reduction of current setpoint	Reduction of current setpoint or pulse frequency
Speed setpoint channel (ramp-function generator)	Optional (reduces the number of drives)	Standard

■

Preparations for commissioning 2

Before you start commissioning (see Chapter 3), you will need to make the preparations described in this chapter.

- Requirements for commissioning
- Rules for wiring with DRIVE-CLiQ
- PROFIBUS components
- STARTER commissioning tool

2.1 Requirements for commissioning

The following are the basic requirements for commissioning a SINAMICS S drive system:

- STARTER commissioning tool
- PROFIBUS interface
- Wired drive line-up

The diagram below shows a basic sample configuration.

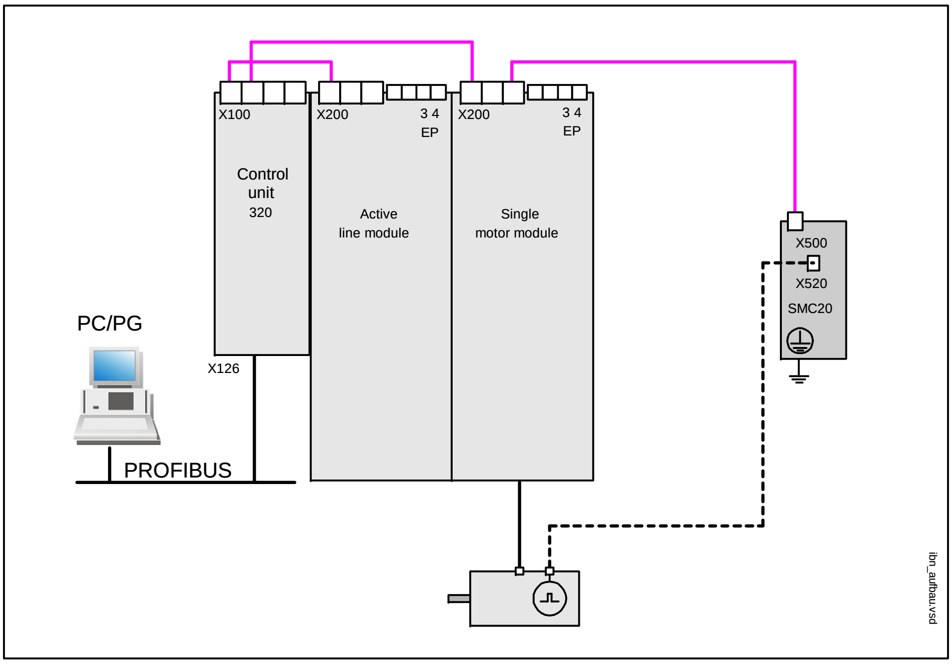


Fig. 2-1 Component configuration (example)

2.2 PROFIBUS components

We recommend the following components for communication via PROFIBUS:

1. Communication modules if PC/PG interface via the **PROFIBUS interface**

   – CP5511 (PROFIBUS interface via PCMCIA card)

     Configuration: PCMCIA type 2 card + adapter with 9–pin SUB–D socket for connection to PROFIBUS.

     Order no.: 6GK1551–1AA00

   – CP5611 (PROFIBUS interface via short PCI card)

     Configuration: Short PCI card with 9–pin SUB–D socket for connection to PROFIBUS.

     Order no.: 6GK1561–1AA00

   – CP5613 (PROFIBUS interface via short PCI card)

     Configuration: Short PCI card with 9–pin SUB–D socket for connection to PROFIBUS, diagnostic LEDs, PROFIBUS controller ASPC2 StepE

     Order no.: 6GK1561–3AA00

2. **Connection cables**

   – between: CP 5xxx <––> PROFIBUS

     Order no.: 6ES7901–4BD00–0XA0

Checklist for commissioning

The checklist in Table 2-1 should be observed and verified before switching on the system for the first time.

Table 2-1 Checklist for commissioning

Check	O. K. ✓
Are all the necessary components of the configured drive line-up installed and available?	
Have the components been installed properly?	
Has all wiring work been successfully completed?	
Is the CompactFlash card plugged into the control unit?	
Are all connectors correctly plugged in and screwed in place?	
Have all the screws been tightened to the specified torque?	
Are all the required 24 V jumpers available and connected?	
Have all the covers for the DC link been closed and latched into place?	
Are the shield connections installed correctly?	
Have the minimum clearances for ventilation been observed above and below the components?	
Offline project Is the data of the installed components known? (e.g. active line module, motor module, motors, encoders, etc.)	

2.3 Rules for wiring with DRIVE-CLiQ

The following rules apply for wiring components with DRIVE-CLiQ. The rules are subdivided into **obligatory rules**, which must be observed, and **optional rules**, which enable automatic topology detection.

Obligatory rules:

- A maximum of 198 DRIVE-CLiQ node components can be connected for each control unit 320.
- Up to 16 nodes can be connected to a DRIVE-CLiQ socket.
- Up to 7 nodes can be connected in a row. A row is always seen from the perspective of the control unit.
- Ring wiring is not permitted.
- The components must not be double-wired.

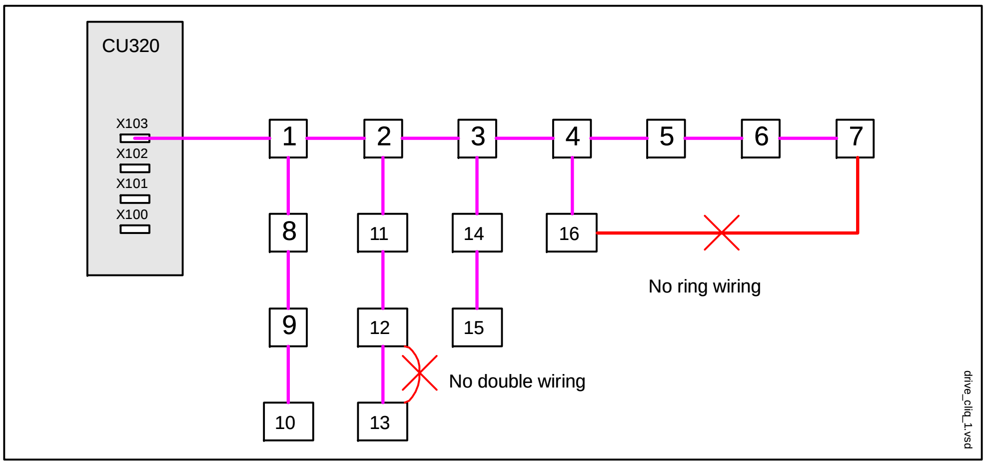


Fig. 2-2 Wiring with DRIVE-CLiQ (example)

Optional rules:

If you follow the optional rules for wiring DRIVE-CLiQ, the components are automatically assigned to the drives as shown below.

- The associated motor encoder can also be connected to a motor module.

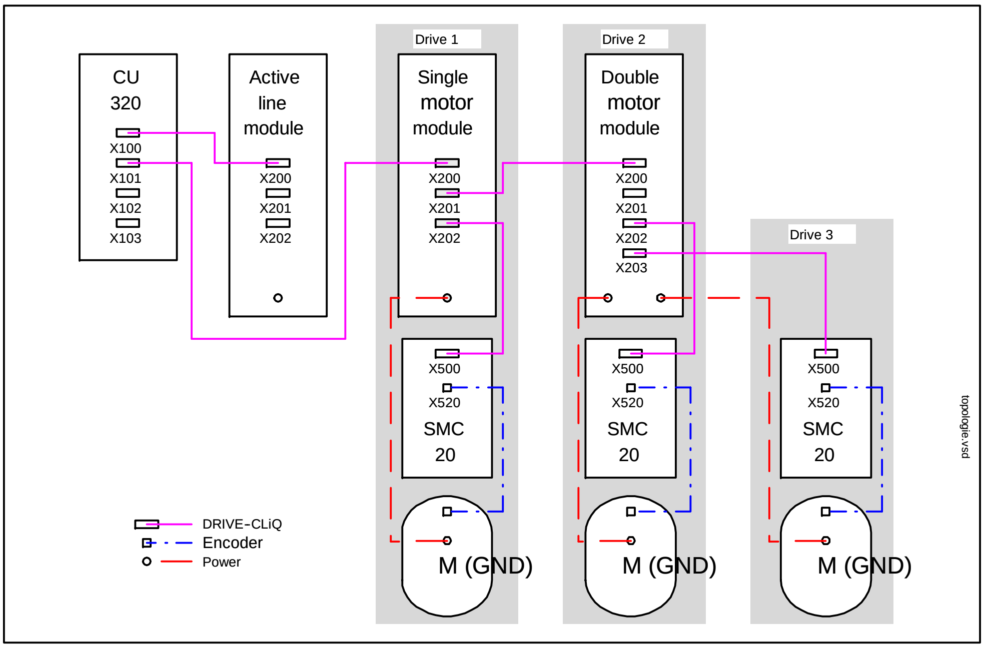


Fig. 2-3 Proposed topology

2.4 STARTER commissioning tool

Brief description

STARTER is a tool for drive units from the MICROMASTER and SINAMICS families.

The tool can be used for the following:

- Commissioning
- Testing
- Diagnostics

Supply format

The STARTER parameterization and commissioning tool is supplied on the New Drive CD.

System requirements

The system requirements for STARTER can be found in the “read me” file in the STARTER installation directory.

2.4.1 Important STARTER functions

Description

STARTER supports the following tools for managing the project:

- Copying from RAM to ROM
- Loading to target system
- Loading to PG
- Restoring the factory settings

Copying from RAM to ROM

You can use this function to save volatile control unit data to the non–volatile CompactFlash card. This ensures that the data is still available after the 24 V control unit supply has been switched off.

This function can be activated as follows:

- Extras –> Setting –> Download –> Activate “Copy from RAM to ROM”
  This means that every time you choose “Load project to target system”, the data is transferred to the non–volatile memory.
- Right–click Drive unit –> Target system –> Copy from RAM to ROM
- Drive unit grayed out –> “Copy from RAM to ROM” button

Loading to target system

You can use this function to load the current STARTER project to the control unit. The data is loaded to the working memory of the control unit. A reset is then triggered.

With the exception of the “Load project to target system” and active “Copy from RAM to ROM” buttons, the data then has to be saved in a non–volatile memory using the “Copy from RAM to ROM” function.

This function can be activated as follows:

- Right–click Drive unit –> Target system –> Load to target system
- Drive unit grayed out –> “Load to target system” button
- All projects to all drives simultaneously:
  “Load project to target system” button

Loading to PG

You can use this function to load the current control unit project to STARTER. You can then enter modified component order numbers offline via the configuration.

This function can be activated as follows:

- Right–click Drive unit –> Target system –> Load to PG
- Drive unit grayed out –> “Load to PG” button

Restoring the factory settings

You can use this function to set all the parameters in the working memory of the control unit to the factory settings. To ensure that the data on the CompactFlash card is also reset to the factory settings, choose the “Copy from RAM to ROM” function.

■

3 Commissioning

This chapter describes the following:

- The sequence of operations during commissioning
- First commissioning using servo controller booksize as an example
- First commissioning using vector controller booksize as an example

3.1 Sequence of operations during commissioning

Once the basic requirements have been met (see Section 2.1), you may proceed as follows to commission the drive:

Table 3-1 Commissioning sequence

Step	Action	Section
1	Create a project with STARTER in offline mode.	3.2.3
2	Configure the drive unit in STARTER.	3.2.3
3	Save the project in STARTER.	3.2.3
4	Switch to online mode with the target system in STARTER.	3.1.2
5	Load the project to the target system.	3.2.3

3.1.1 Safety guidelines

Danger

A hazardous voltage will be present in all components for a further 5 minutes after the system has been shutdown. The protective cover for the DC link must not be opened until this time has elapsed.

Please follow the instructions on the safety cover for the DC link!

Caution

For safety reasons, Safety Integrated must be commissioned using STARTER in online mode.

Reason:

STARTER should only be used to store the safety parameters of a project monitoring channel. As a result, downloading a project with active Safety Integrated results in safety problems (see Chapter 6).

Note

Before switching on the drive for the first time, check that the screws of the DC link busbars are tightened to the specified torque (see SINAMICS S120 Equipment Manual).

3.1.2 Activating online operation: STARTER via PROFIBUS

Description

The following options are available for online operation via PROFIBUS:

- Online operation with direct connection to the field bus via CP 5511 / CP 5611 / CP 5613

  PG/PC <––> PROFIBUS interface card (CP) <––> PROFIBUS

STARTER via PROFIBUS (example with 3 control units)

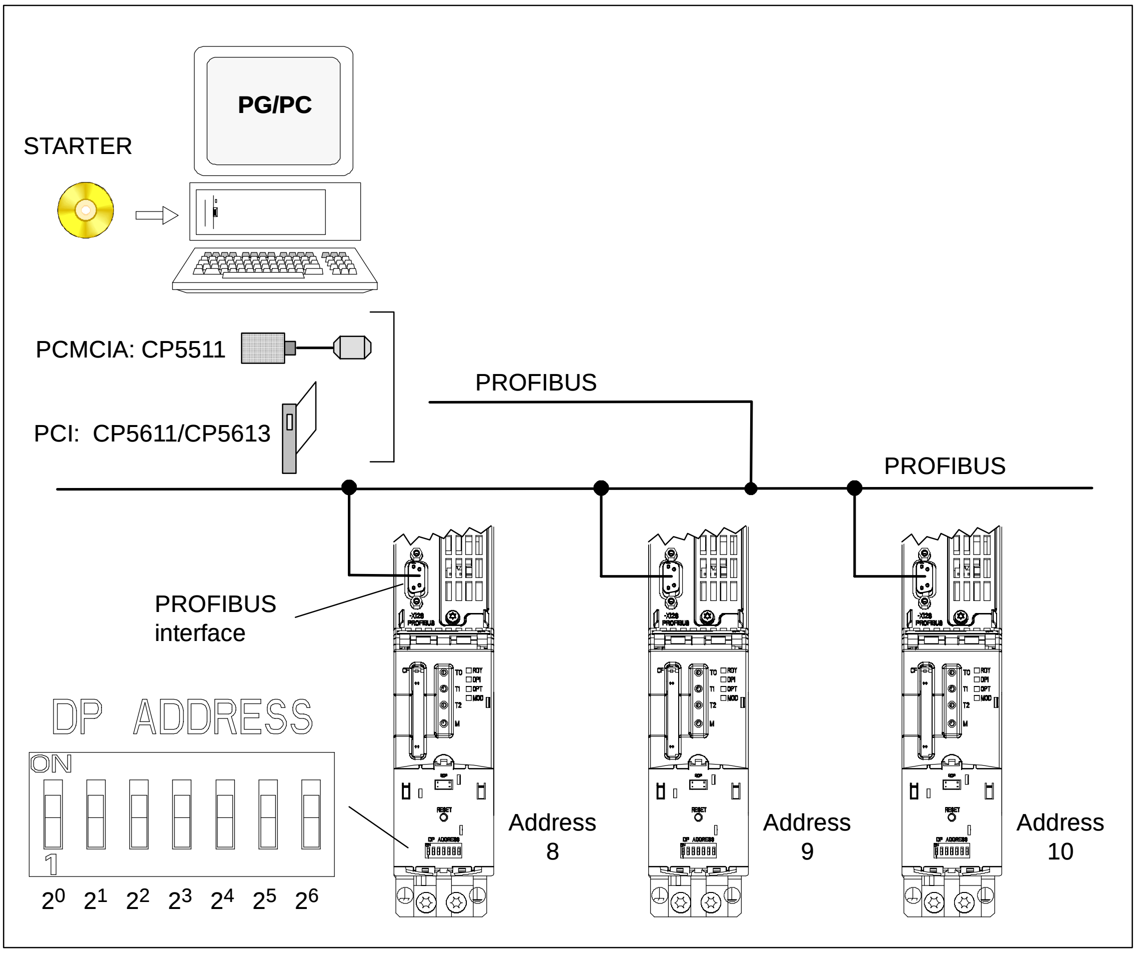


Fig. 3-1 STARTER via PROFIBUS (example with 3 control units)

Settings in STARTER for direct online connection via PROFIBUS

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

- Set Extras – PG/PC interface...

  Install/uninstall interface
- Set Extras – PG/PC interface... – Properties “

  Activate “PG/PC is only master on bus”

Note

- Baud rate

  Switching STARTER to a working PROFIBUS:

  STARTER automatically detects the baud rate used by SINAMICS for the PROFIBUS.

  Switching the STARTER for commissioning:

  The control unit automatically detects the baud rate set in STARTER.
- PROFIBUS addresses

  The PROFIBUS addresses for the individual drive units must be specified in the project and must match the address settings on the devices.

3.2 First commissioning: servo

The commissioning example described in this section shows all the necessary configuration and parameter settings and testing routines. The commissioning procedure is performed using the STARTER commissioning tool.

Requirements for commissioning

1. The commissioning requirements have been met

   ––> see Section 2.1
2. The checklist for commissioning has been completed and all items are O.K.

   ––> see Section 2.1
3. STARTER is installed and ready to run

   ––> see Section 2.4

Procedure

1. Create a project offline with STARTER.
2. In STARTER, switch the control unit to online mode.
3. Load the entire project to the control unit.

3.2.1 Task

1. Commission a drive system with the following components:

Table 3-2 Component overview

Description	Component	Order number
Closed-loop control and infeed		
Control unit 1	Control unit 320	6SL3040-0MA00-0AAx
Active line module 1	Active line module 16 kW	6SL3130-7TE21-6AAx
Line filter package 16 kW	Line filter and line reactor	6SL3000-0FE21-6AAx
Drive 1		
Motor module 1	Single motor module 9 A	6SL3120-1TE21-0AAx
Sensor module 1.1	SMC20	6SL3055-0AA00-5BAx
Motor 1	Synchronous motor	1FK7061-7AF7x-xxxx
Motor encoder 1	Incremental encoder sin/cos C/D 1Vpp 2048 p/r	1FK7xxx-xxxxx-xAxx
Sensor module 1.2	SMC20	6SL3055-0AA00-5BAx
External encoder	Incremental encoder sin/cos 1Vpp 4096 p/r	–
Drive 2		
Motor module 2	Single motor module 9 A	6SL3120-1TE21-0AAx
Motor 2	Induction motor	1PH7103-xxDxx-xLxx
Sensor module 2	SMC20	6SL3055-0AA00-5BAx
Motor encoder 2	Incremental encoder sin/cos 1Vpp 2048 p/r	1PH7xxx-xMxxx-xxxx

2. The enable signals for the infeed and the two drives must be transmitted via PROFIBUS.
   - Telegram for the active line module

     370: infeed, 1 word
   - Telegram for motor module 1

     4: speed control, 2 position encoders
   - Enable signals for motor module 2

     3: speed control, 1 position encoder

Note

For more information on the telegram types, see Chapter 4 or SINAMICS S120 List Manual.

3.2.2 Component wiring (example)

Fig. 3-2 below shows a possible component configuration and wiring option. The DRIVE-CLiQ wiring is highlighted in **bold**.

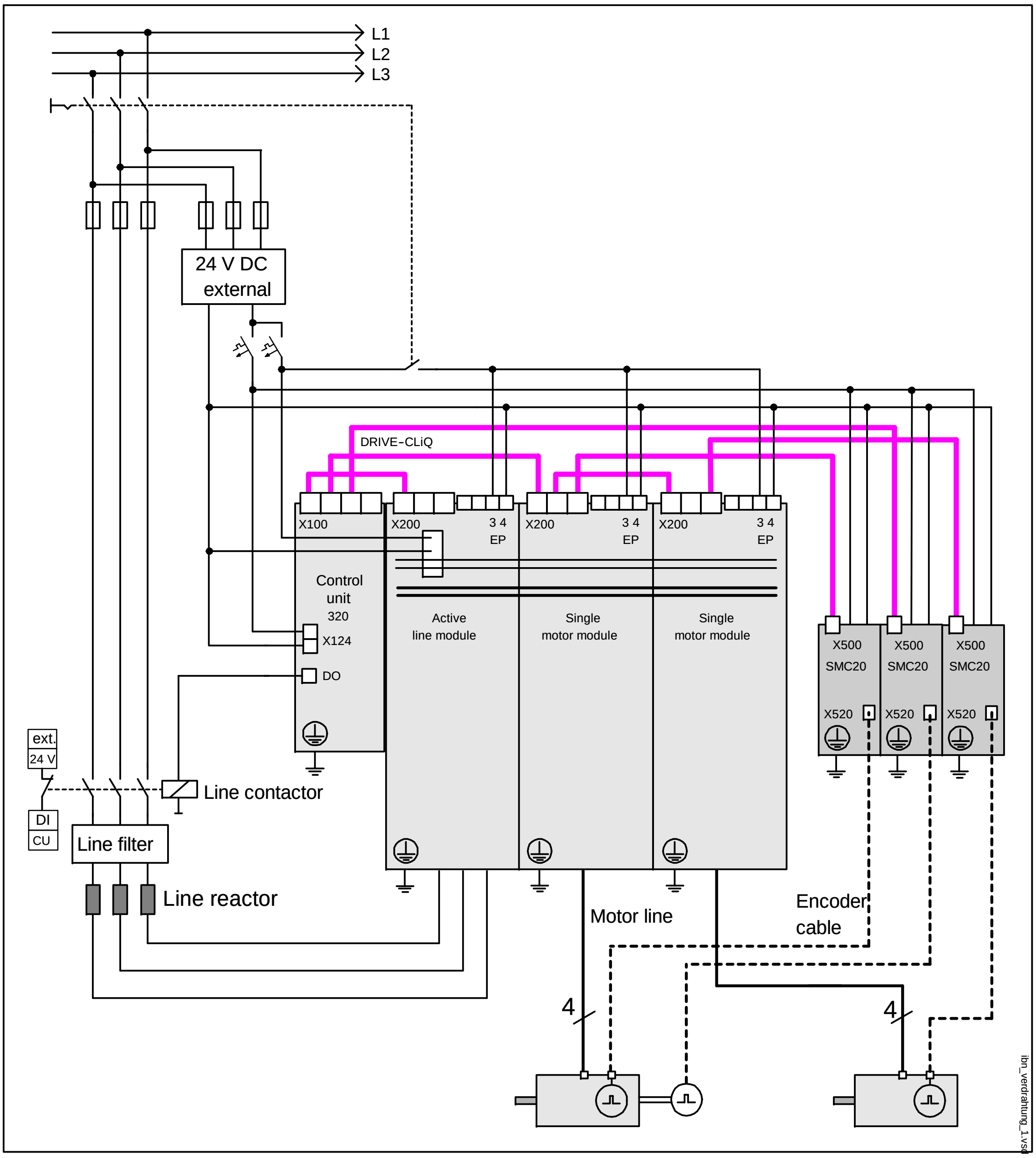


Fig. 3-2 Component wiring (example)

3.2.3 Commissioning with STARTER (example)

Table 3-3 below describes the steps for commissioning the example with STARTER.

Table 3-3 Commissioning sequence with STARTER (example)

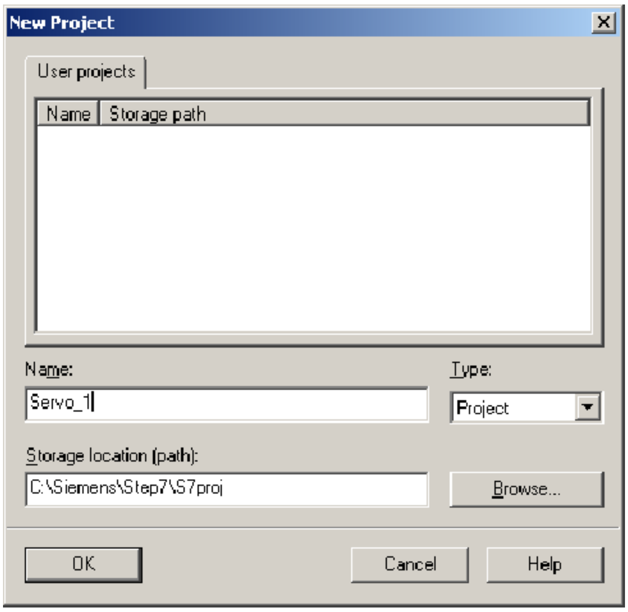
What to do	How to do it	Comments
1. **Create new project**	Operator action: Menu: “Project”––> New ... User projects: Projects already in the target directory Name: Servo_1 (choose any name) Type: Project Storage location (path): Default (can be set as req.)	The project is created offline and loaded to the target system when configuration is complete.
		

Table 3-3 Commissioning sequence with STARTER (example), continued

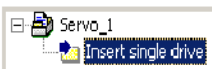
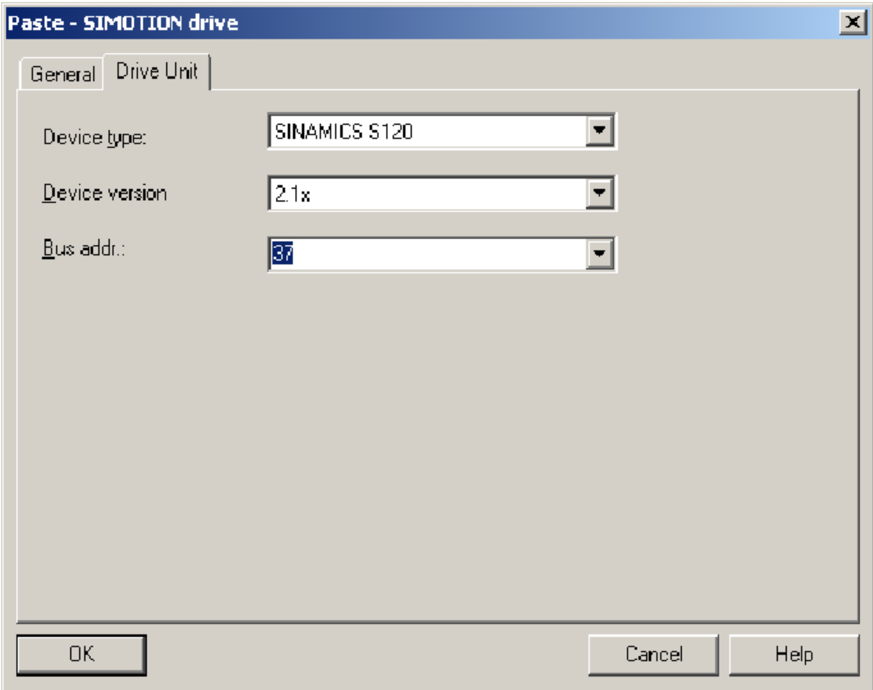
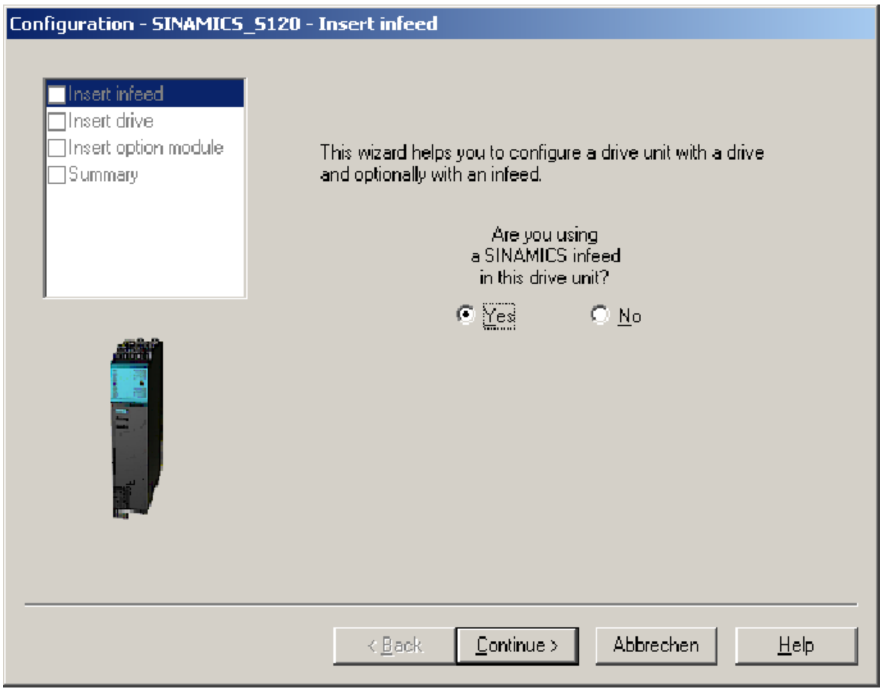
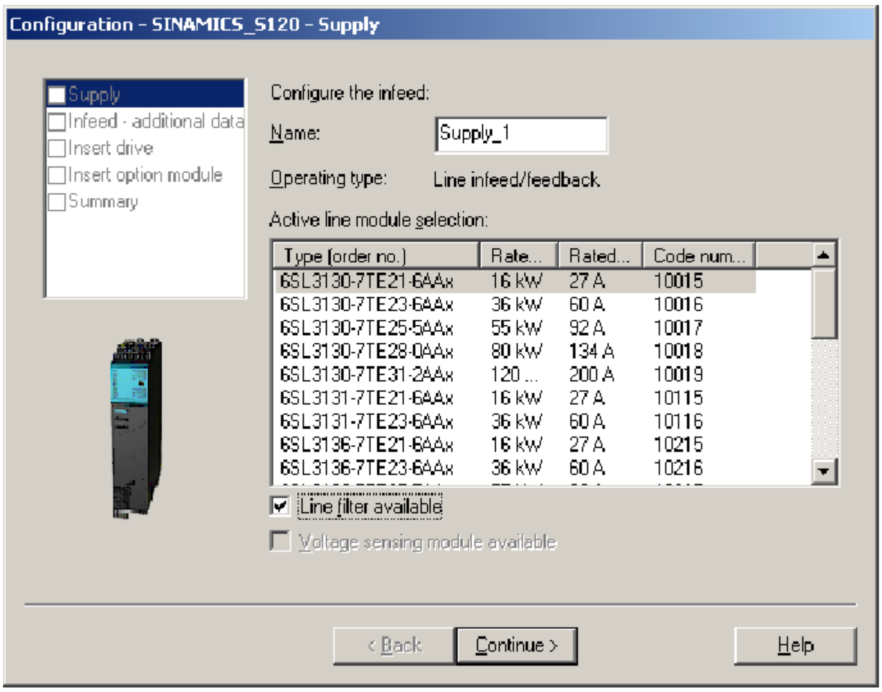
What to do	How to do it	Comments
2. **Add individual drive**	Operator action: --> Double-click "Add individual drive". Device type: SINAMICS S120 Device version: 2.1x Bus address: 37	Information about the bus address: The PROFIBUS address of the control unit must be set here. The address is set via the address switch on the control unit (or via p0918 if the address switch = "all ON" or "all OFF" (factory setting = 126)).
		

Table 3-3 Commissioning sequence with STARTER (example), continued

<table>
<tr><th>What to do</th><th>How to do it</th><th>Comments</th></tr>
<tr><td>3. Configure the drive unit</td><td>Operator action:
--> Double-click “Configure drive”.
“Are you using a regulated supply (active line module)?” = Yes
--> Click “Next”.</td><td></td></tr>
<tr><td>3.1. Add infeed</td><td colspan="2">


</td></tr>
<tr><td>3.2. Infeed</td><td colspan="2">


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

Table 3-3 Commissioning sequence with STARTER (example), continued

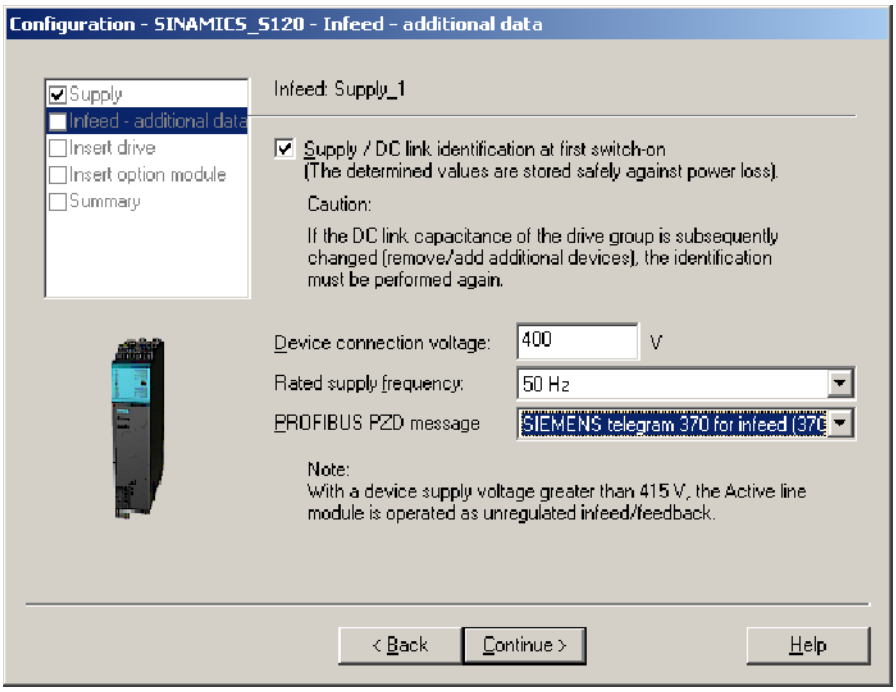
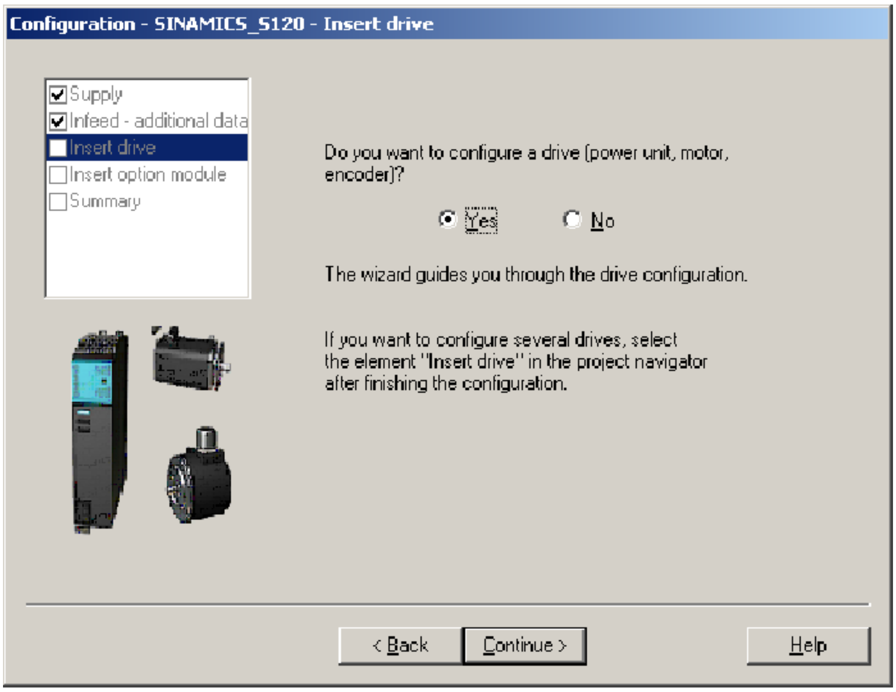
<table>
<tr><th>What to do</th><th>How to do it</th><th>Comments</th></tr>
<tr><td>3.3. Infeed: further data</td><td>
</td><td></td></tr>
<tr><td>3.4. Add drive</td><td>
</td><td></td></tr>
</table>

Table 3-3 Commissioning sequence with STARTER (example), continued

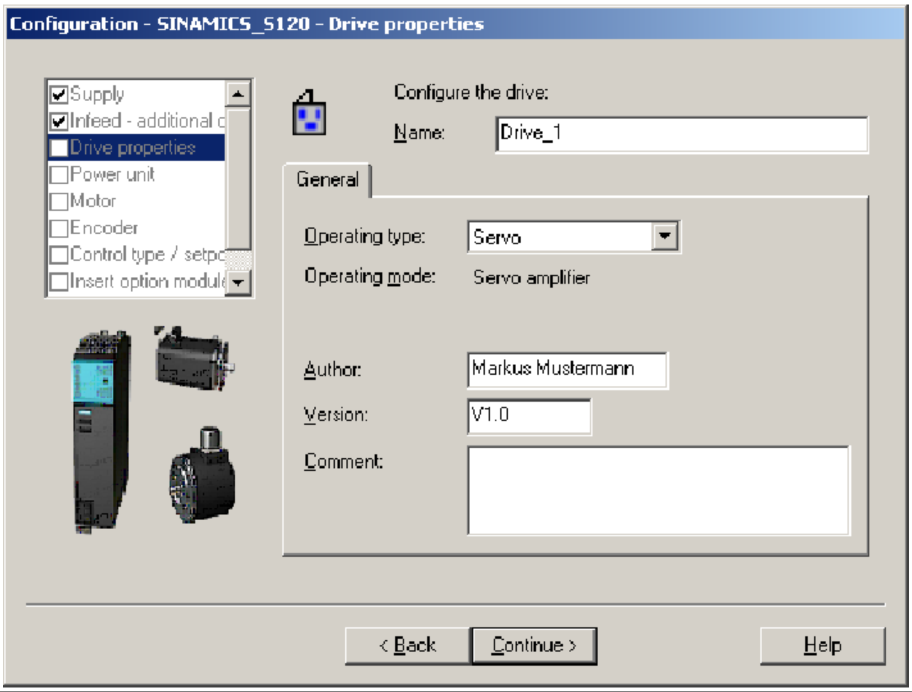
What to do	How to do it	Comments
3.5. Drive properties	Name: Choose any name Operating type: Servo Author: Optional Version: Optional Comment: Optional --> Click “Next”.	
		

Table 3-3 Commissioning sequence with STARTER (example), continued

What to do	How to do it	Comments
3.6. Power section	Name: Choose any name Power section selection: Select type (order no.) (see type plate) --> Click “Next”.	

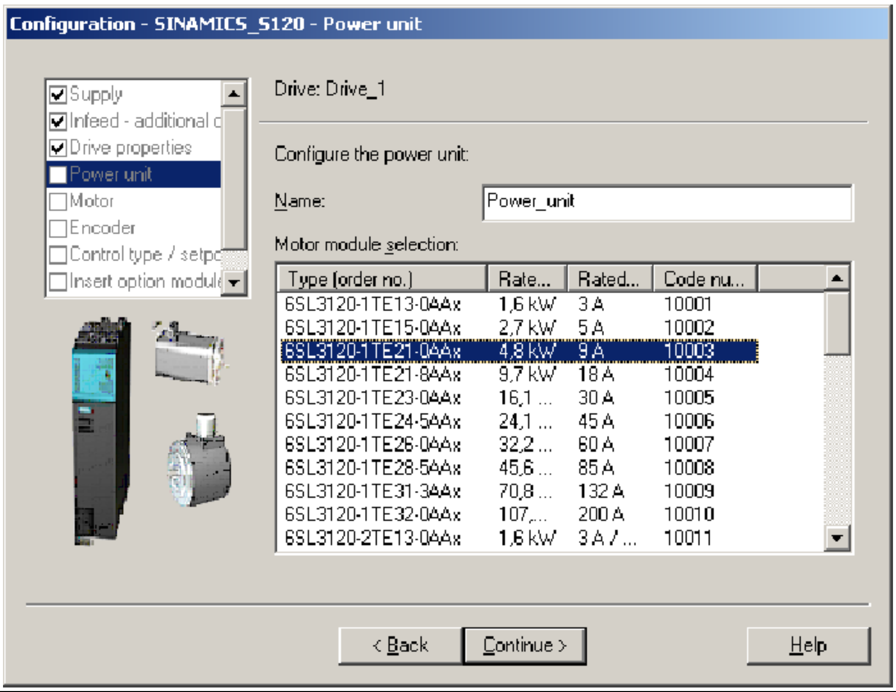


Table 3-3 Commissioning sequence with STARTER (example), continued

What to do	How to do it	Comments
3.7. Motor	Name: Choose any name Select standard motor from list: yes Enter motor data: no Select motor type Brake present: no Select motor (see motor rating plate) --> Click “Next”.	

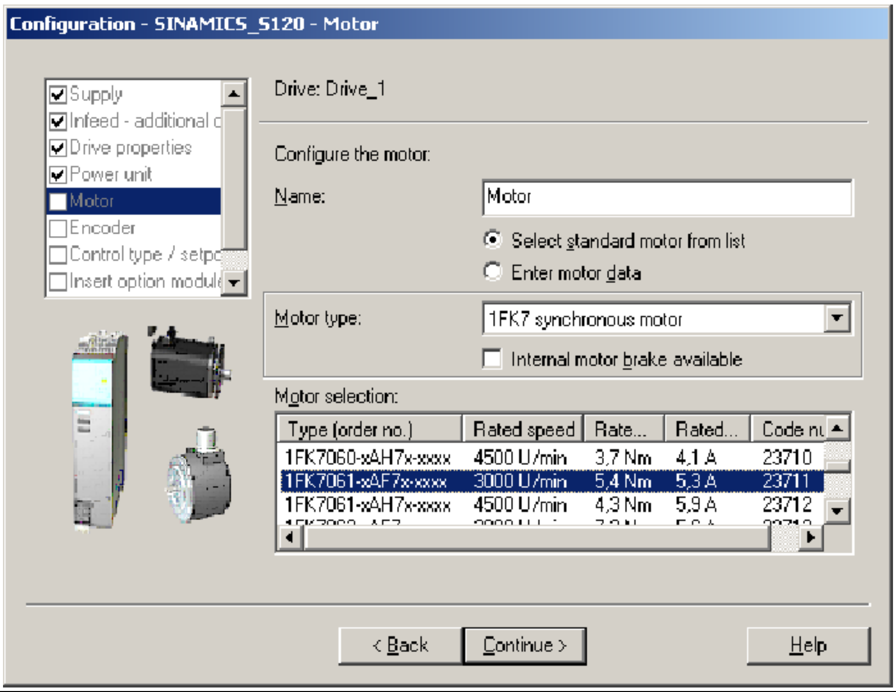


Table 3-3 Commissioning sequence with STARTER (example), continued

What to do	How to do it	Comments
3.8. Encoder 1	Which encoder do you want to use? Encoder 1 Select motor encoder from list: yes Enter data: no Select motor encoder: (see motor rating plate) --> Click “Next”.	

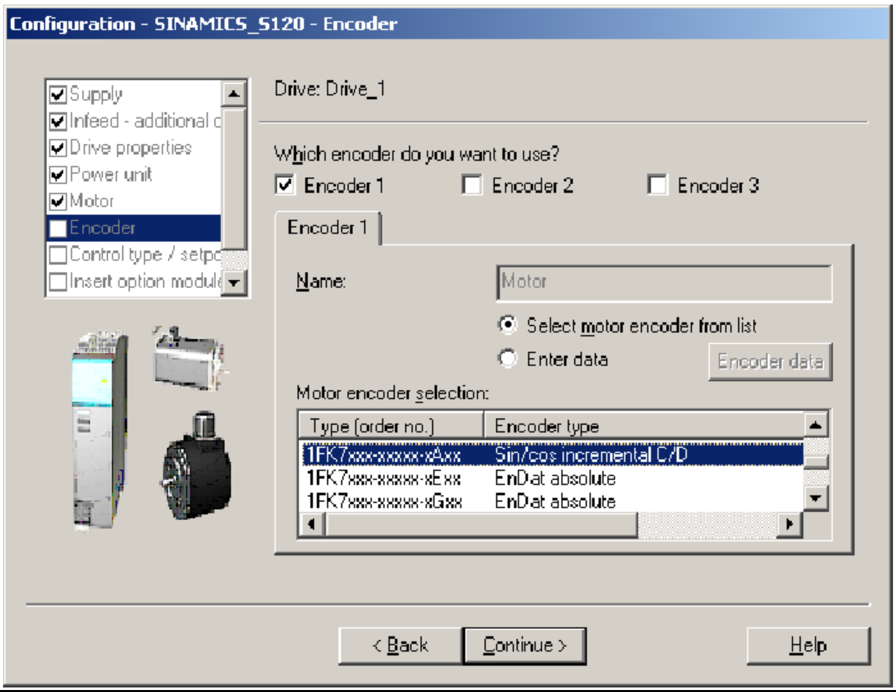
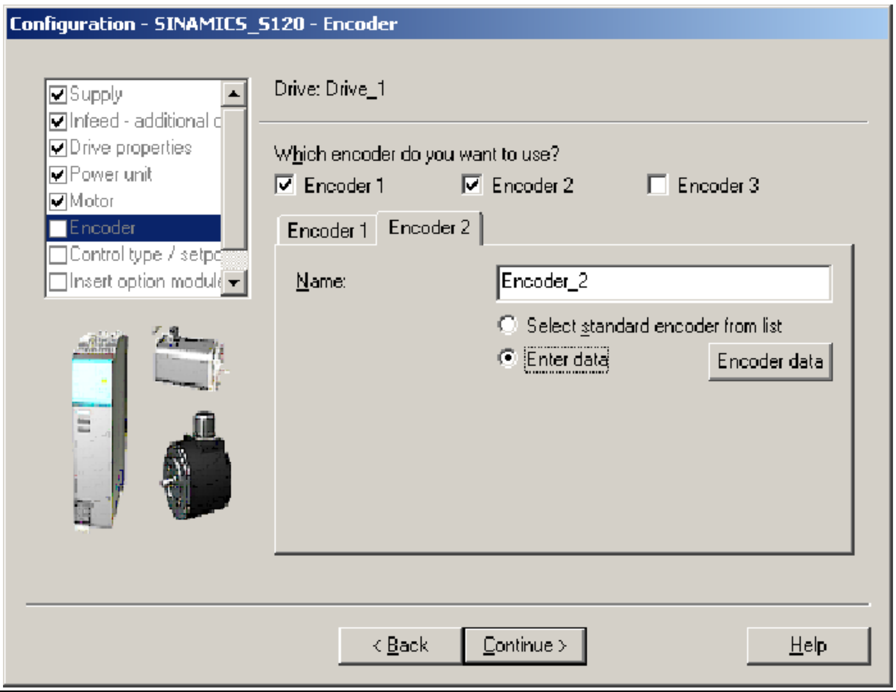


Table 3-3 Commissioning sequence with STARTER (example), continued

What to do	How to do it	Comments
3.9. Encoder 2	Which encoder do you want to use? Encoder 2 Enter data: yes Click “Encoder data”. Enter encoder data. Click “OK”. --> Click “Next”.	The sensor module (encoder evaluator) is set in accordance with the connected encoder.



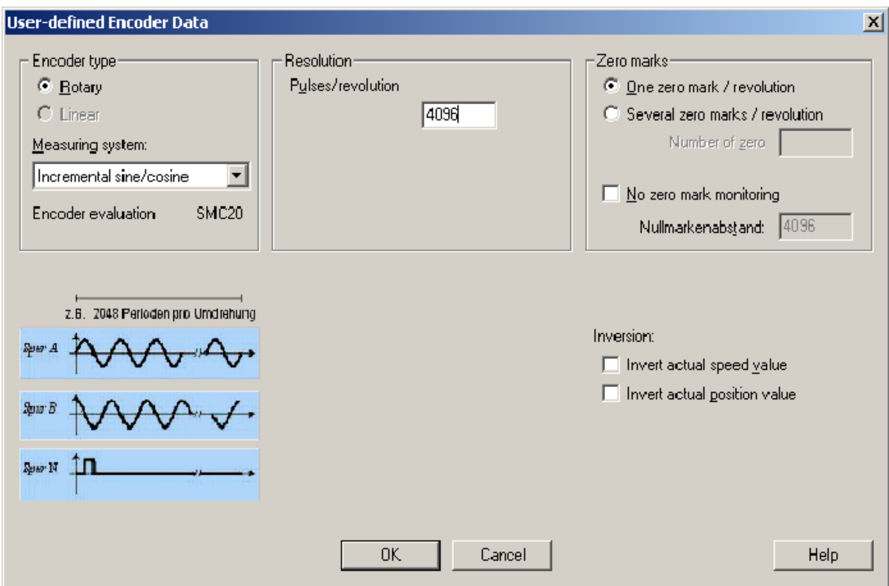


Table 3-3 Commissioning sequence with STARTER (example), continued

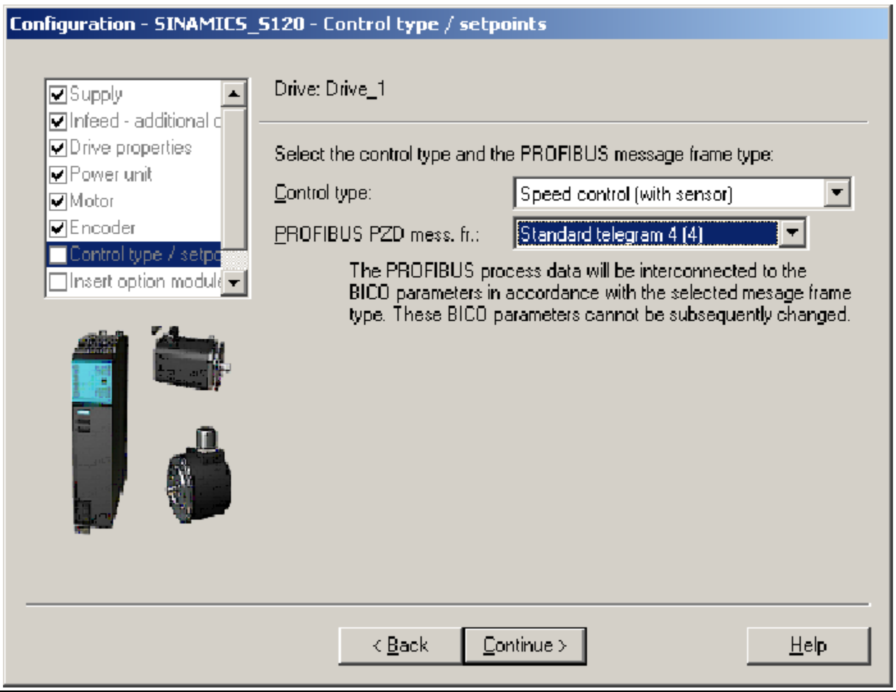
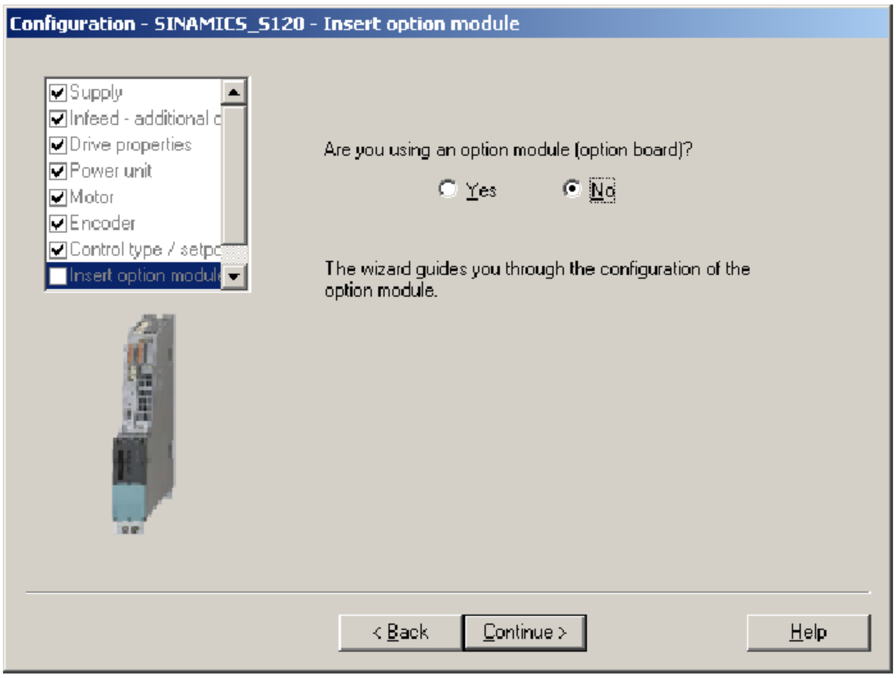
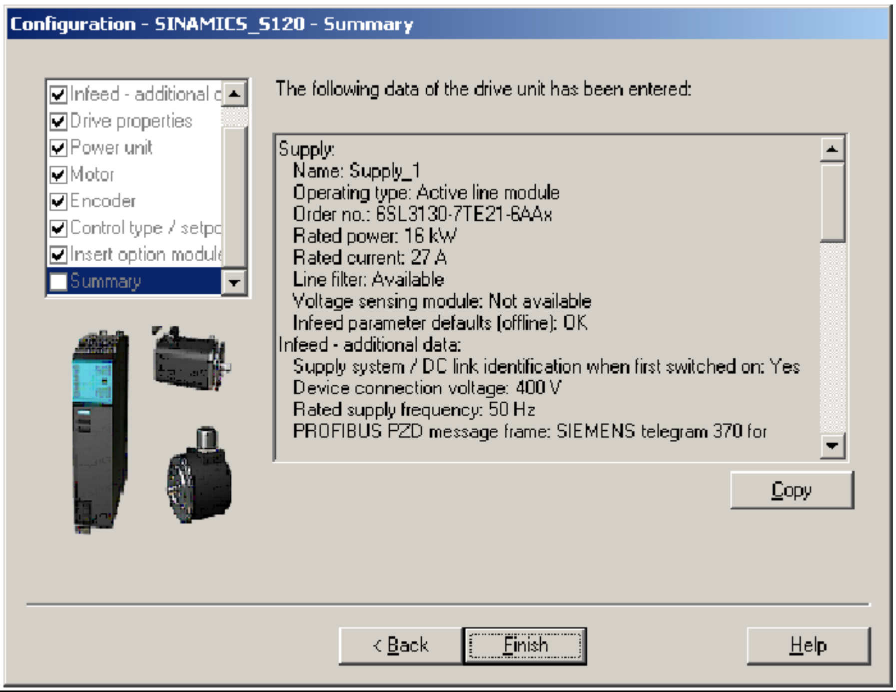
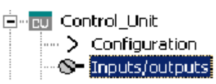
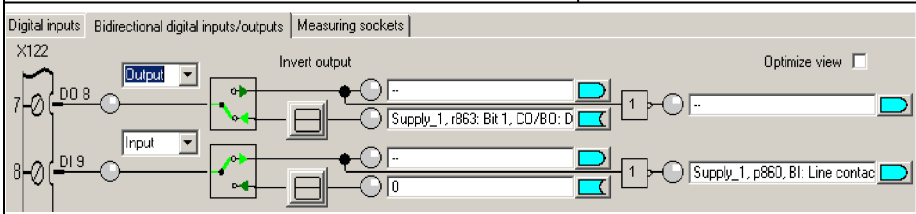
<table>
<tr><th>What to do</th><th>How to do it</th><th>Comments</th></tr>
<tr><td>3.10. Control type/ setpoints</td><td>
</td><td></td></tr>
<tr><td>3.11. Add option board</td><td>Are you using an option board?
--> Click “No”.</td><td></td></tr>
<tr><td></td><td>
</td><td></td></tr>
</table>

Table 3-3 Commissioning sequence with STARTER (example), continued

What to do	How to do it	Comments
3.12. Summary	Check the listed data. --> Click “Complete”.	
		
4. **Add drive 2**	Operator action: --> Double-click “Add drive”.	Further steps described as of Chapter 3.5.
5. **Line contactor**	Line contactor p0728.8 = 1 Set DI/DO as output p0738 = 863.1 Line contactor on p0860 = 723.9 Line contactor feedback	The line contactor must be controlled by the infeed_1 drive object. See function diagram [8934].
		
6. **Save parameters on device**	• Connect with target system (go online) • Target system -> Load to target system • Target system -> Copy from RAM to ROM (save the data on the CF card)	Position cursor on drive unit (SINAMICS S120) and right-click.

STARTER diagnosis options

Under “Component” –> Diagnosis –> Control / status words

- Control / status words
- Status parameters
- Missing enable signals

3.3 First commissioning: vector

The commissioning example described in this section shows all the necessary configuration and parameter settings and testing routines. The commissioning procedure is performed using the STARTER commissioning tool.

Requirements for commissioning

1. The commissioning requirements have been met.

   ––> see Section 2.1
2. The checklist for commissioning has been completed and all items are O.K.

   ––> see Section 2.1
3. STARTER is installed and ready to run.

   ––> see Section 2.4

Procedure

1. Create a project offline with STARTER.
2. Go online with the device in STARTER.
3. Load the entire project to the target system.

3.3.1 Task

1. Commission a drive system with the following components:

Table 3-4 Component overview

Description	Component	Order number
Closed–loop control and infeed		
Control unit	Control unit 320	6SL3040–0MA00–0AAx
Active line module	Active line module 16 kW	6SL3130–7TE21–6AAx
Line filter package 16 kW	Line filter and line reactor	6SL3000–0FE21–6AAx
Drive		
Motor module	Single motor module 9 A	6SL3120–1TE21–0AAx
Motor	Induction motor	1LA

2. The enable signals for the infeed and drive are to be transmitted via terminals.

3.3.2 Component wiring (example)

Fig. 3-2 below shows a possible component configuration and wiring option. The DRIVE-CLiQ wiring is highlighted in **bold**.

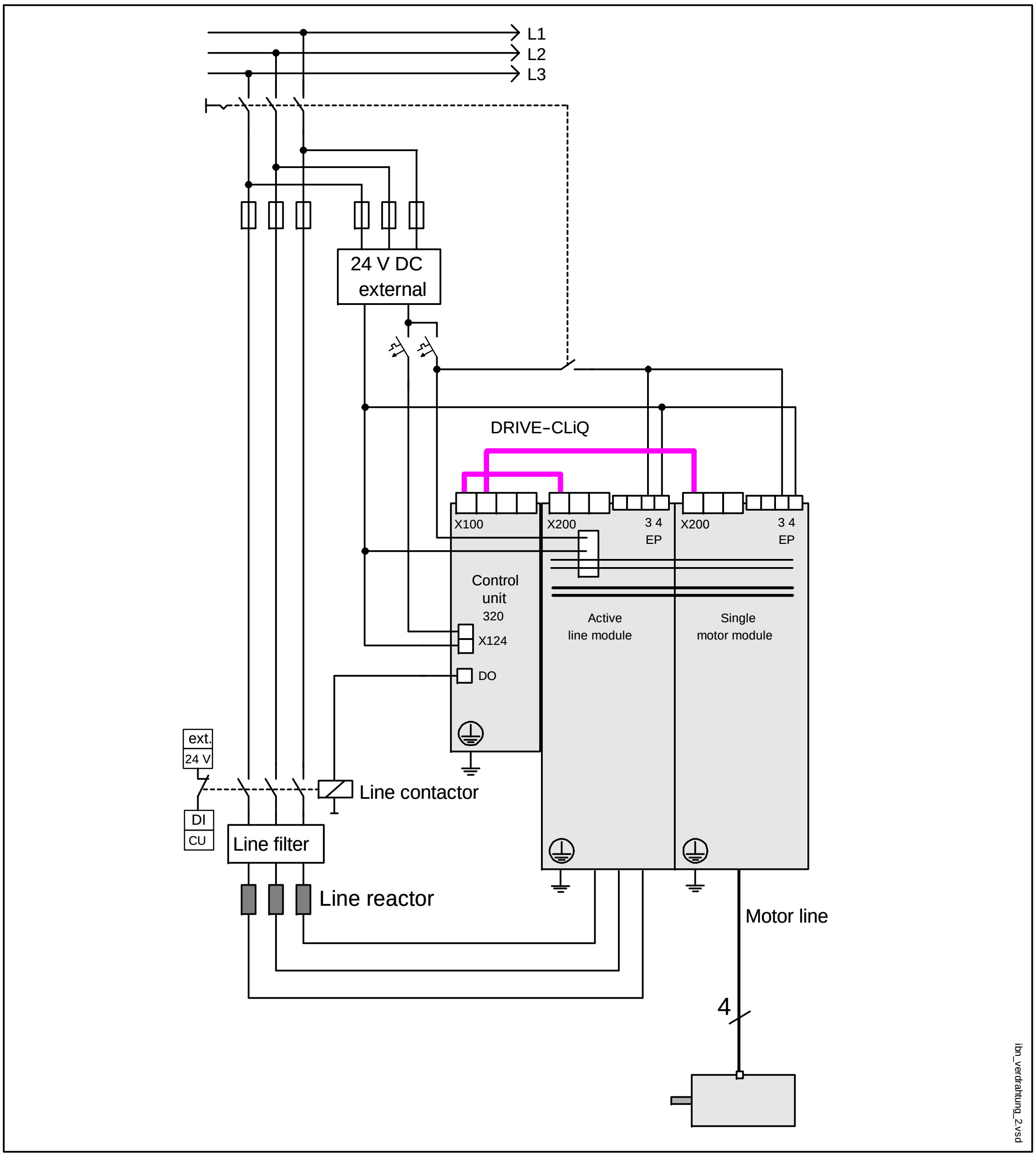


Fig. 3-3 Component wiring (example)

3.3.3 Commissioning with STARTER (example)

Table 3-3 below describes the steps for commissioning the example with STARTER.

Table 3-5 Commissioning sequence with STARTER (example)

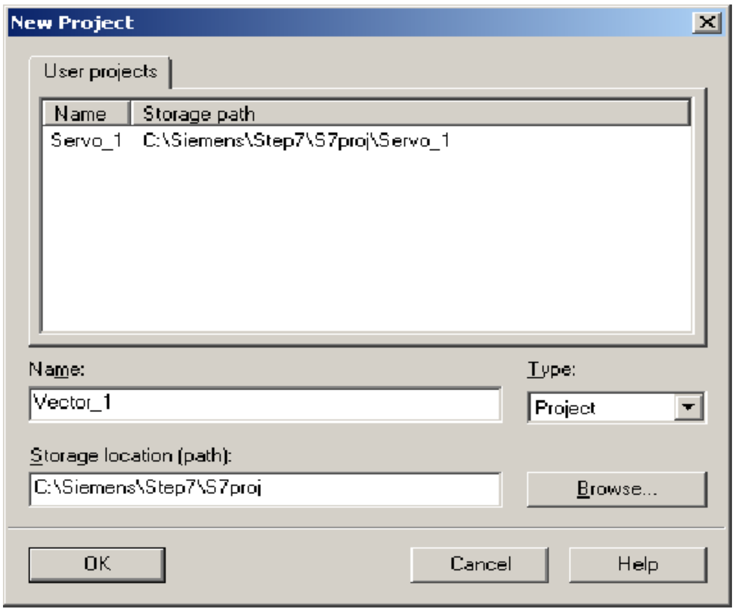
What to do	How to do it	Comments
1. **Create new project**	Operator action: Menu: “Project”––> New ... User projects: Projects already in the target directory Name: Vector_1 (choose any name) Type: Project Storage location (path): Default (can be set as req.)	The project is created offline and loaded to the target system when configuration is complete.
		

Table 3-5 Commissioning sequence with STARTER (example), continued

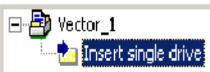
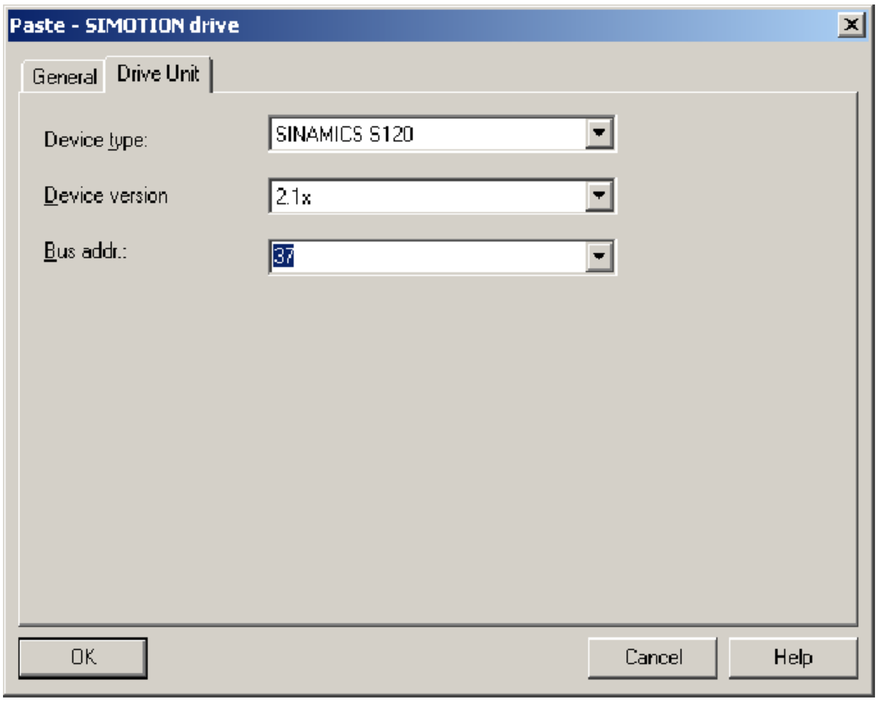
What to do	How to do it	Comments
2. **Add individual drive**	Operator action: --> Double-click "Add individual drive". Device type: SINAMICS S120 Device version: 2.1x Bus address: 37	Information about the bus address: The PROFIBUS address of the control unit must be set here. The address is set via the address switch on the control unit (or via p0918 if the address switch = "all ON" or "all OFF" (factory setting = 126)).
		

Table 3-5 Commissioning sequence with STARTER (example), continued

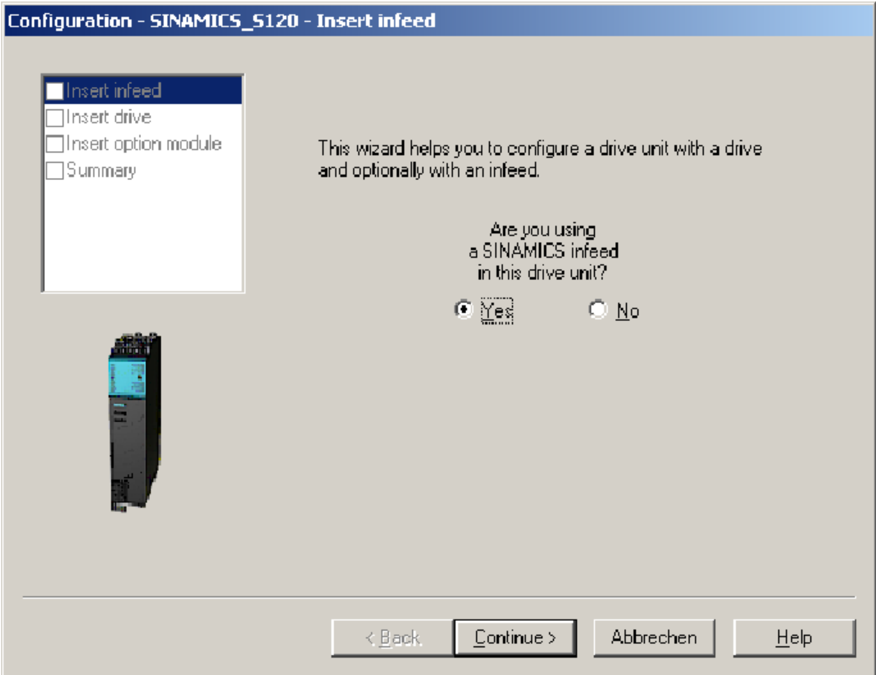
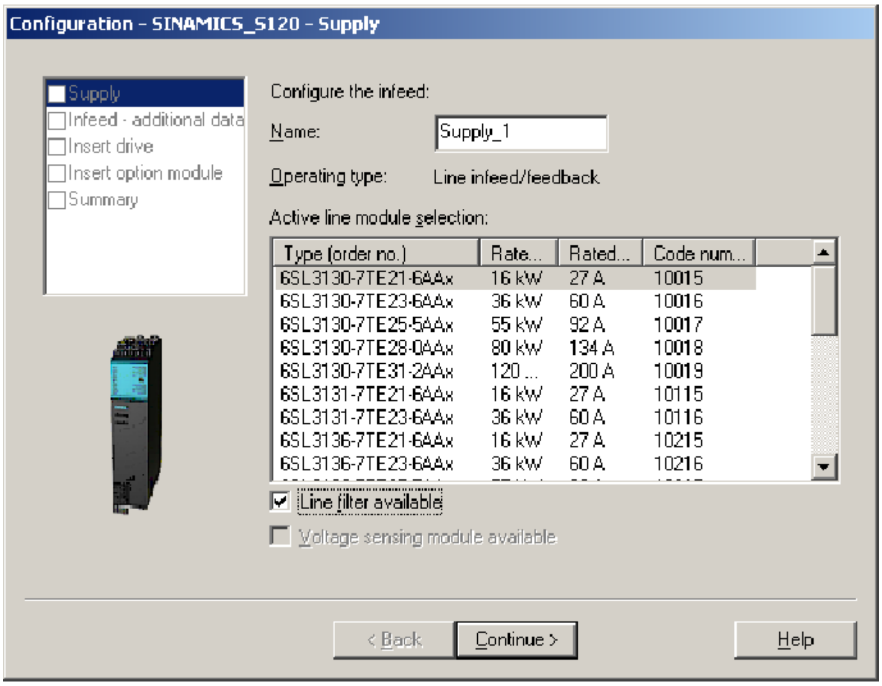
<table>
<tr><th>What to do</th><th>How to do it</th><th>Comments</th></tr>
<tr><td>3. Configure the drive unit</td><td>Operator action:
-->Double-click “Configure drive”.
“Are you using a regulated supply (active line module)?” = Yes
--> Click “Next”.</td><td></td></tr>
<tr><td>3.1. Add infeed</td><td colspan="2">
</td></tr>
<tr><td>3.2. Infeed</td><td colspan="2">
</td></tr>
</table>

Table 3-5 Commissioning sequence with STARTER (example), continued

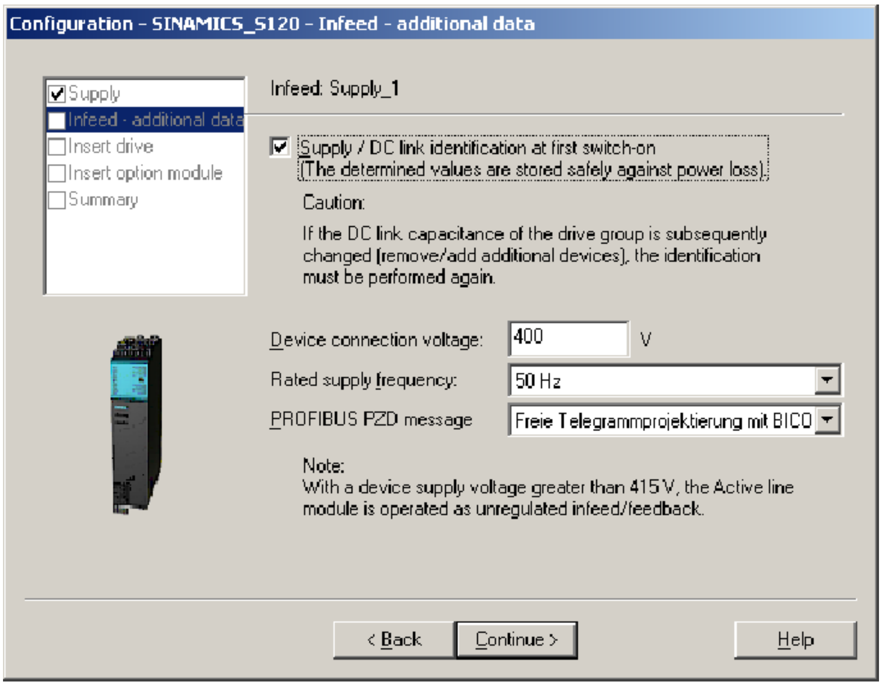
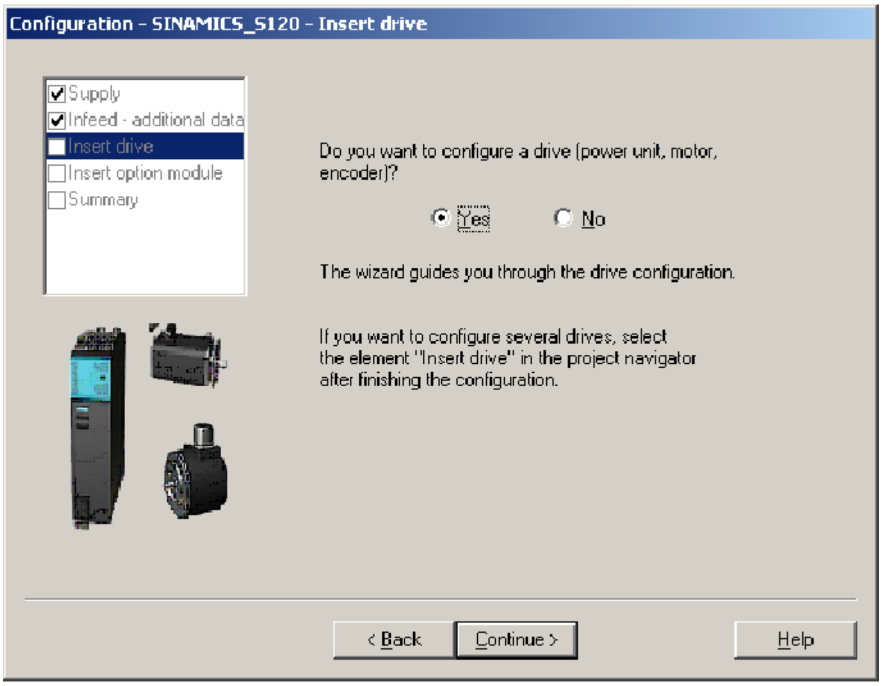
What to do	How to do it	Comments
3.3. Infeed: further data		
3.4. Add drive		

Table 3-5 Commissioning sequence with STARTER (example), continued

What to do	How to do it		Comments
3.5. Drive properties	Name:	Choose any name	
	Operating type:	Vector	
	Author:	Optional	
	Version:	Optional	
	Comment:	Optional	
	--> Click “Next”.		

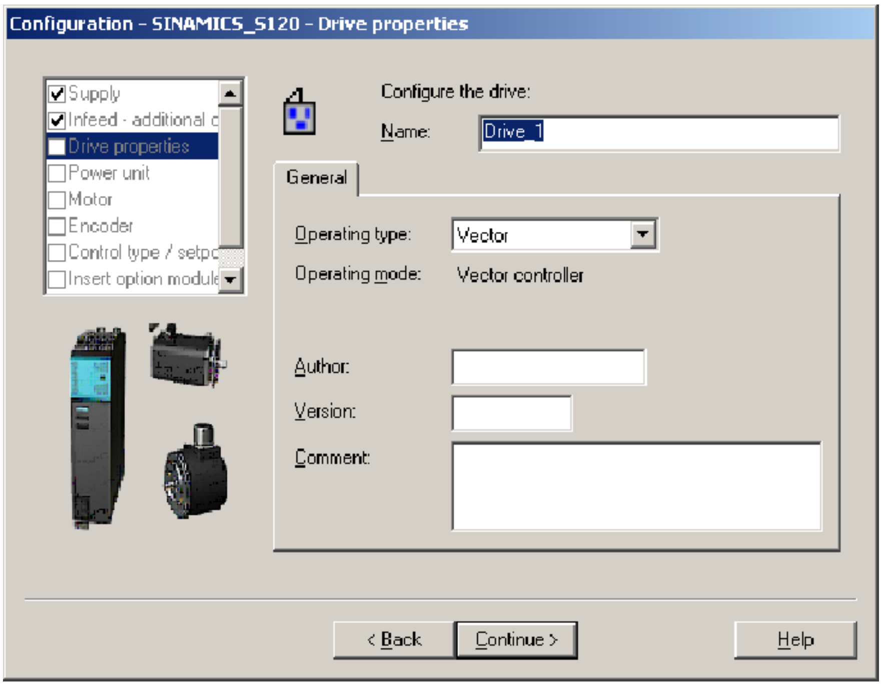


Table 3-5 Commissioning sequence with STARTER (example), continued

What to do	How to do it	Comments
3.6. Power section	Name: Choose any name Power section selection: Select type (order no.) (see type plate) --> Click “Next”.	

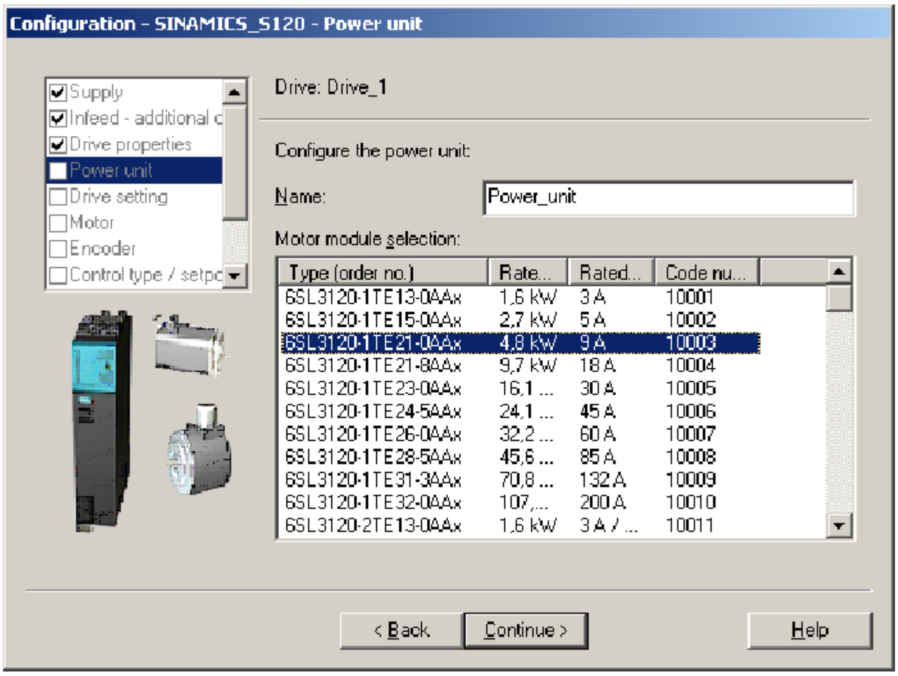


Table 3-5 Commissioning sequence with STARTER (example), continued

What to do	How to do it	Comments
3.7. Drive setting	Standard: IEC motor (50 Hz / kW) NEMA motor (60 Hz / kW) Power section / application: CT duty cycle for vector VT duty cycle for vector --> Click “Next”.	These settings do not affect the motor control in firmware version 2.1.

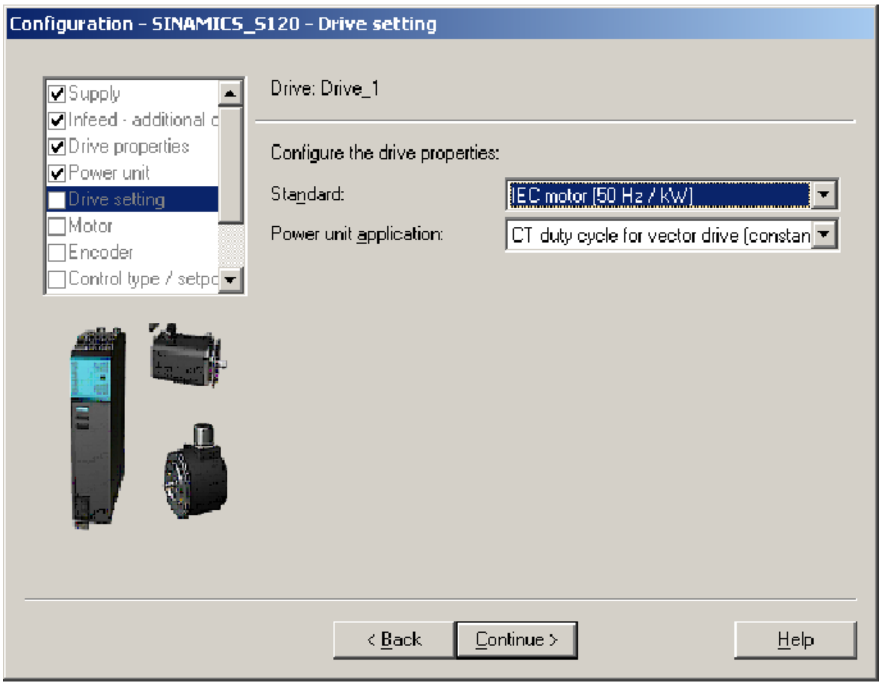


Table 3-5 Commissioning sequence with STARTER (example), continued

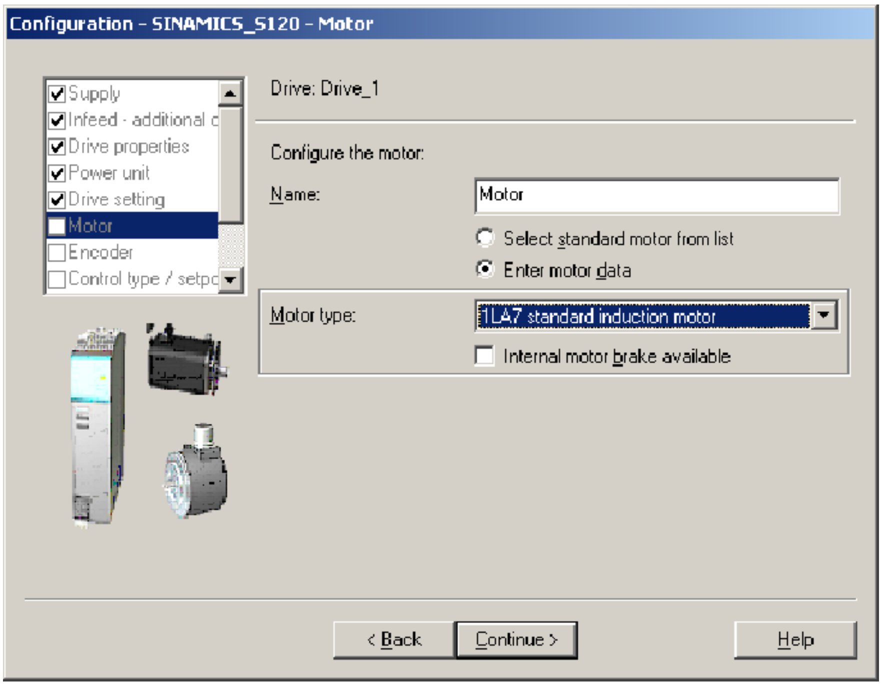
<table>
<tr><th>What to do</th><th>How to do it</th><th>Comments</th></tr>
<tr><td>3.8. Motor</td><td>Name: Choose any name
Select standard motor from list: no
Enter motor data: yes
Select motor type
Brake present: no
Select motor
(see motor rating plate)
--> Click “Next”.</td><td></td></tr>
<tr><td></td><td colspan="2">
</td></tr>
</table>

Table 3-5 Commissioning sequence with STARTER (example), continued

What to do	How to do it	Comments
3.9. Motor data	Enter the motor data: p0304[0]: Rated motor voltage = 400 V p0305[0]: Rated motor current = 4.70 A p0307[0]: Rated motor power = 2.20 kW p0308[0]: Rated motor power factor = 0.82 p0310[0]: Rated motor frequency = 50.00 Hz p0311[0]: Rated motor speed = 1420 1/min p0355[0]: Motor cooling method = self-cooling	The controller settings are calculated using the motor data entered. The equivalent circuit diagram data can be entered here or it can be determined automatically by calculating all the motor/controller data.

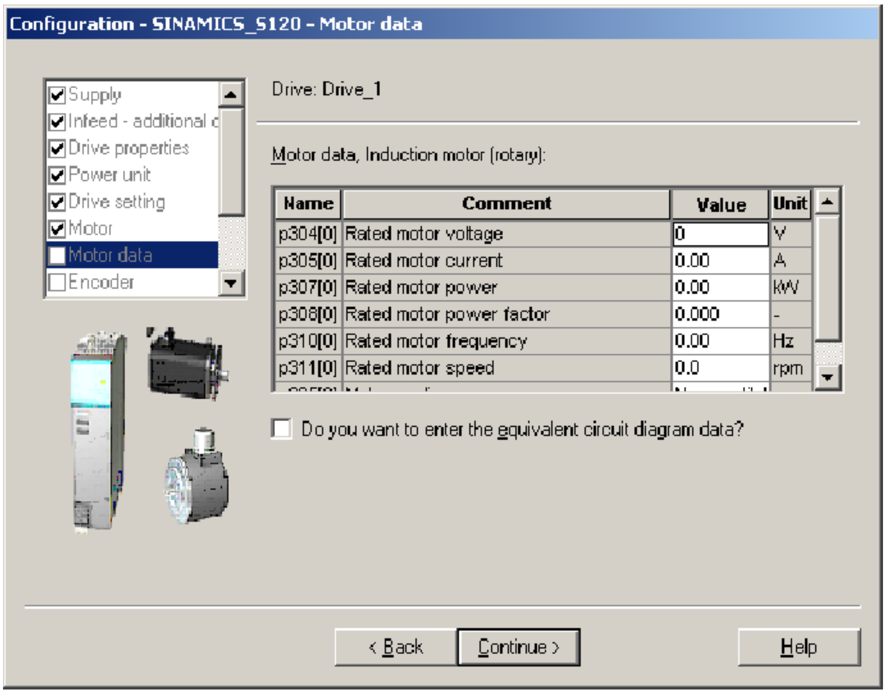


Table 3-5 Commissioning sequence with STARTER (example), continued

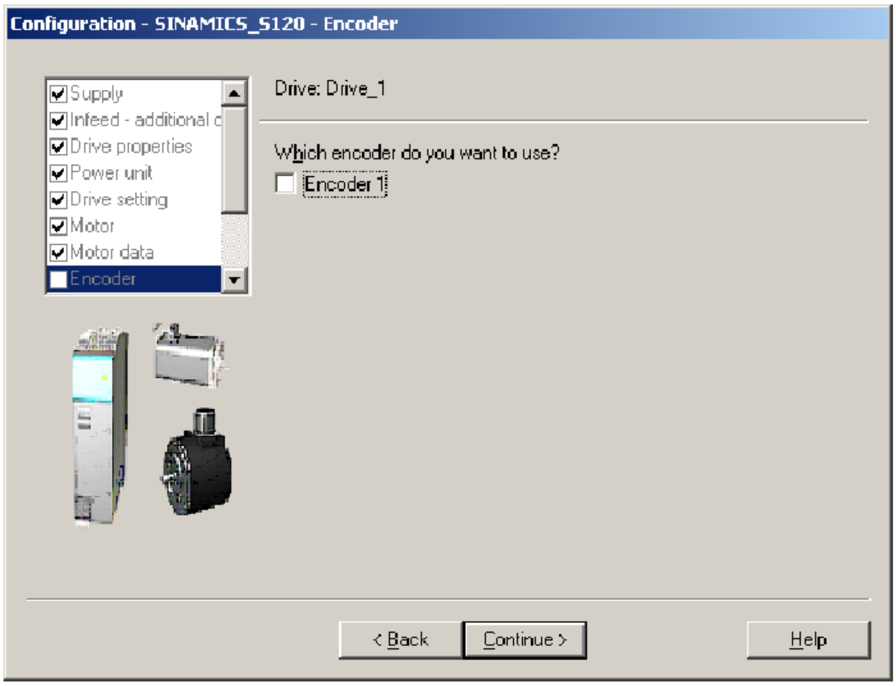
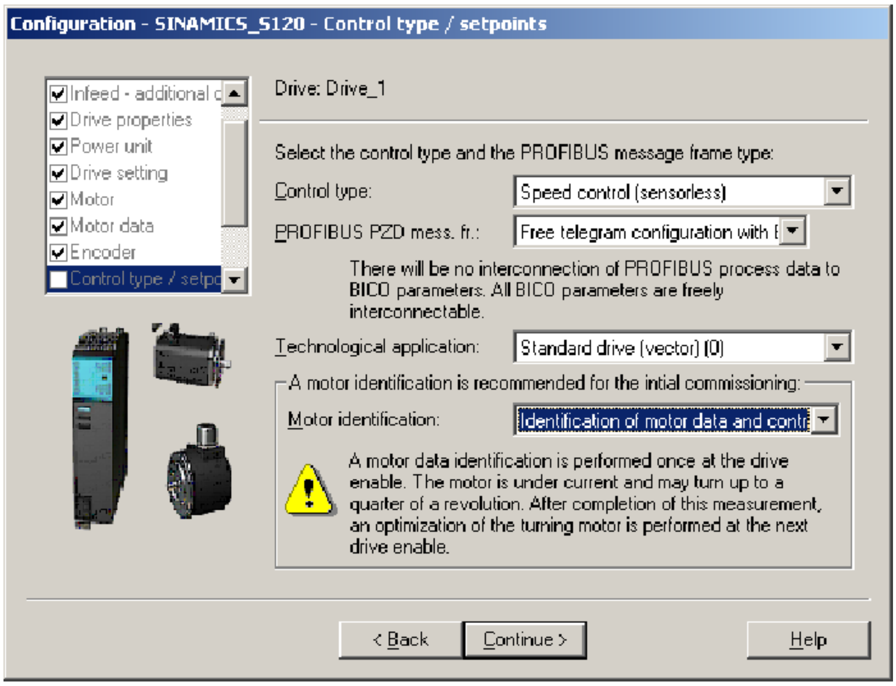
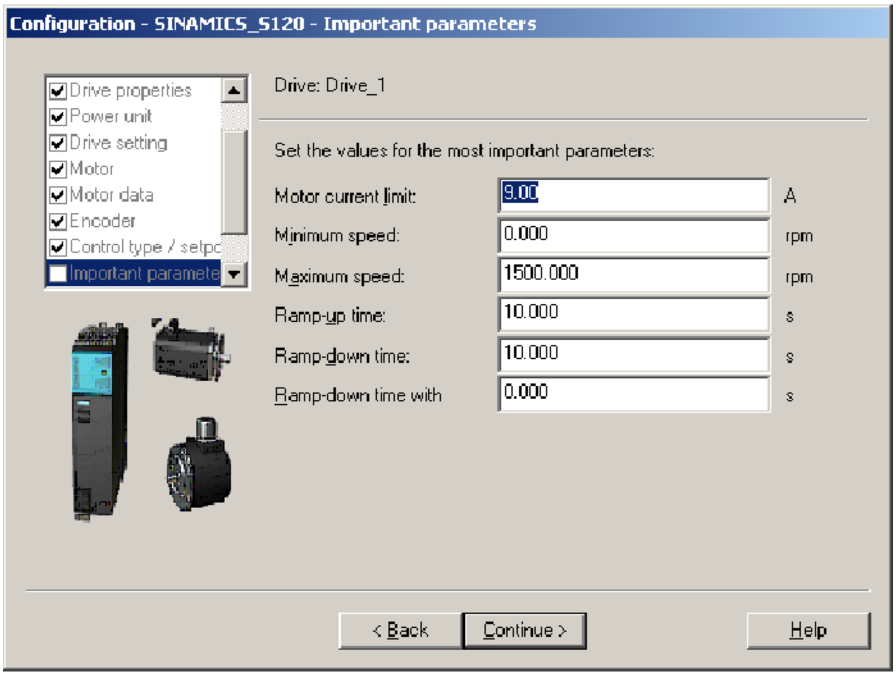
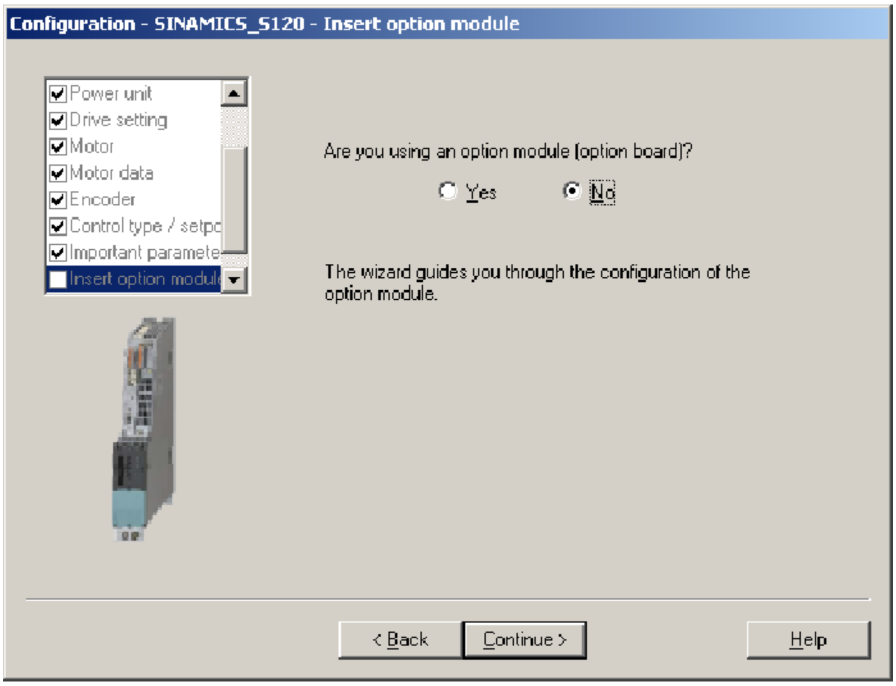
What to do	How to do it	Comments
3.10. Encoder	Which encoder do you want to use? Encoder 1: no	
		
3.11. Control type / setpoints		

Table 3-5 Commissioning sequence with STARTER (example), continued

<table>
<tr><th>What to do</th><th>How to do it</th><th>Comments</th></tr>
<tr><td>3.12. Important parameters</td><td colspan="2">


</td></tr>
<tr><td>3.13. Add option board</td><td>Are you using an option board?
--> Click “No”.</td><td></td></tr>
<tr><td></td><td colspan="2">


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

Table 3-5 Commissioning sequence with STARTER (example), continued

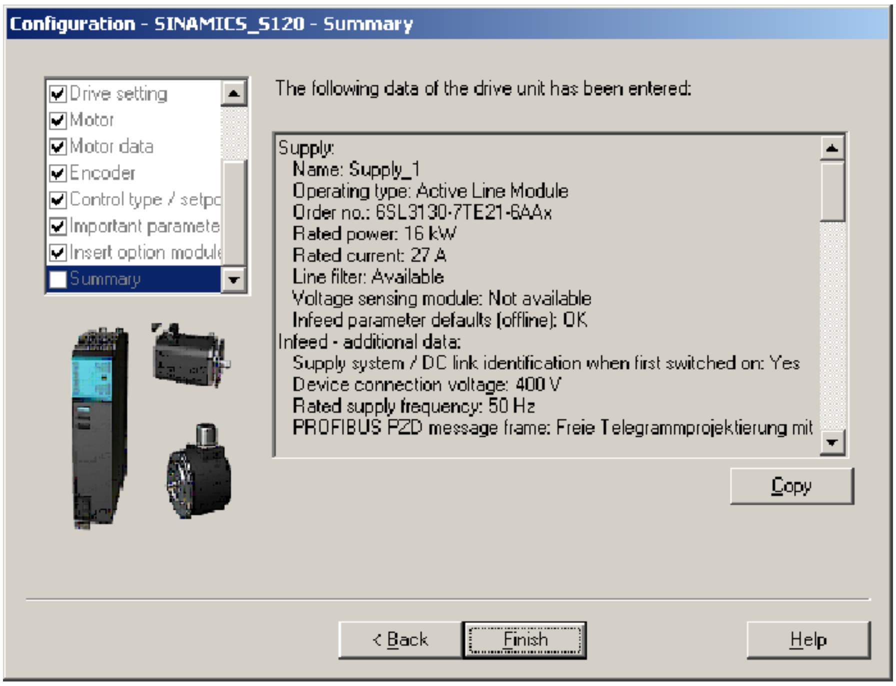
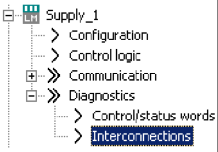
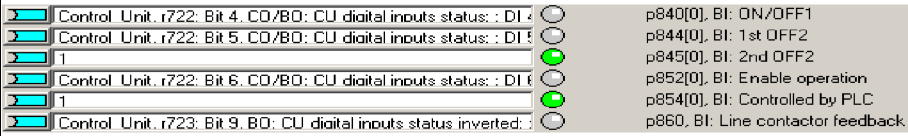
What to do	How to do it	Comments
3.14. Summary	Check the listed data. --> Click “Complete”.	
		

Table 3-5 Commissioning sequence with STARTER (example), continued

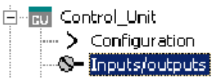
<table>
<tr><th>What to do</th><th>How to do it</th><th>Comments</th></tr>
<tr><td>4. Enable signals and BICO interconnections</td><td>The enable signals for the infeed and the two drives must be transmitted via the digital input on control unit 320.</td><td>Note:
If an active line module is installed, the same signal source must not be used to enable both the infeed and the drive.</td></tr>
<tr><td>4.1. Active line module</td><td>• Enable signals for the active line module
p0840 = 722.4 ON/OFF1
p0844 = 722.5 OFF2
p0852 = 722.6 Enable operation</td><td></td></tr>
<tr><td>



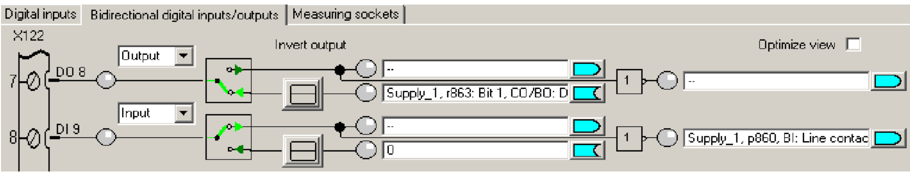
</td><td colspan="2">



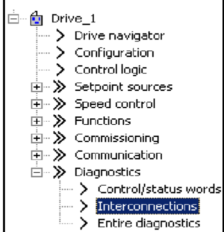
</td></tr>
<tr><td>4.2. Line contactor</td><td>• Line contactor
p0728.8 = 1 Set DI/DO as output
p0738 =863.1 Line contactor on
p0860 = 723.9 Line contactor feedback</td><td>The line contactor must be controlled by the infeed_1 drive object. The inputs/outputs are located on the control unit.
See function diagram [8934]</td></tr>
<tr><td>



</td><td colspan="2">



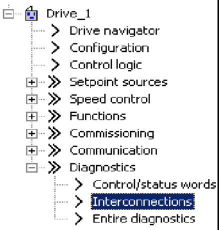
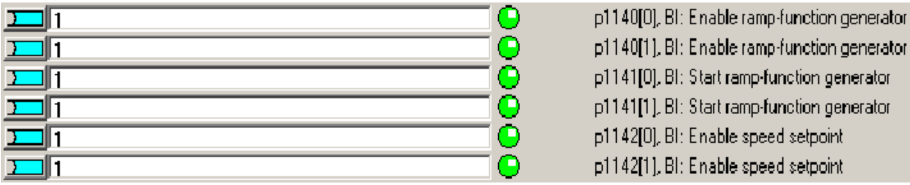
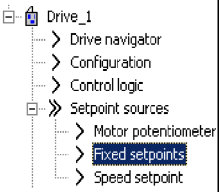
</td></tr>
<tr><td>4.3. Enable motor module</td><td>• Enable signals for the motor module (drive_1)
p0840 = 722.0 ON/OFF1
p0844 = 722.1 OFF2
p0848 = 722.2 OFF3
p0852 = 722.3 Enable operation
p0864 = 863.0 Infeed operation</td><td>See function diagram [2501]</td></tr>
<tr><td>



</td><td colspan="2">

</td></tr>
<tr><td>4.4. Ramp-function generator</td><td>Ramp-function generator
p1140 = 1 Enable ramp-function generator
p1141 = 1 Start ramp-function generator
p1142 = 1 Enable speed setpoint</td><td>See function diagram [3060]</td></tr>
</table>

Table 3-5　　Commissioning sequence with STARTER (example), continued

What to do	How to do it	Comments
		
4.5. Setpoint	Specify setpoint p1001 = 40　　Fixed speed setpoint 1	See function diagram [3010]
		
5. **Save parameters on device**	• Connect with target system (go online) • Target system −> Load to target system • Target system −> Copy from RAM to ROM	Position cursor on drive unit (SINAMICS S120) and right-click.

STARTER diagnosis options

Under "Component" −> Diagnosis −> Control / status words

- Control / status words
- Status parameters
- Missing enable signals

■

Notes

Communication via PROFIBUS 4

This chapter looks at the following aspects of communication via PROFIBUS:

- General information about PROFIBUS
- Commissioning PROFIBUS
- Cyclic communication
- Acyclic communication
- Motion control with PROFIBUS

4.1 General information about PROFIBUS

4.1.1 General information about PROFIBUS for SINAMICS

General

PROFIBUS is an open international field bus standard for a wide range of production and process automation applications.

The following standards ensure open, multi-vendor systems:

- International standard EN 50170
- International standard IEC 61158

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

Note

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

/PPA/ PROFIdrive Profile Drive Technology

Master and slave

- Master and slave properties

Table 4-1 Master and slave properties

Properties	Master	Slave
Bus node	Active	Passive
Send messages	Permitted without external request	Only possible on request by master
Receive messages	Possible with no restrictions	Only receive and acknowledge permitted

- Master

  Masters are categorized into the following classes:

  - Master class 1 (DPMC1):

    Central automation stations that exchange data with the slaves in cyclic and acyclic mode. Communication between the masters is also possible.

    Examples: SIMATIC S5, SIMATIC S7

- Master class 2 (DPMC2):

  Devices for configuration, commissioning, operator control and monitoring during bus operation. Devices that only exchange data with the slaves in acyclic mode.

  Examples: programming devices, human machine interfaces

- Slaves

  Slaves can only acknowledge received messages or transfer messages to a master at the request of the master.

Bus access method

PROFIBUS uses the token passing method, i.e. the active stations (masters) are arranged in a logical ring in which the authorization to send is received within a defined time frame.

Within this time frame, the master with authorization to send can communicate with other masters or handle communication with the assigned slaves in a master/slave procedure.

PROFIBUS telegram for cyclic data transmission and acyclic services

To transmit process data in cyclic mode and carry out acyclic services, telegrams with the following structure are used:

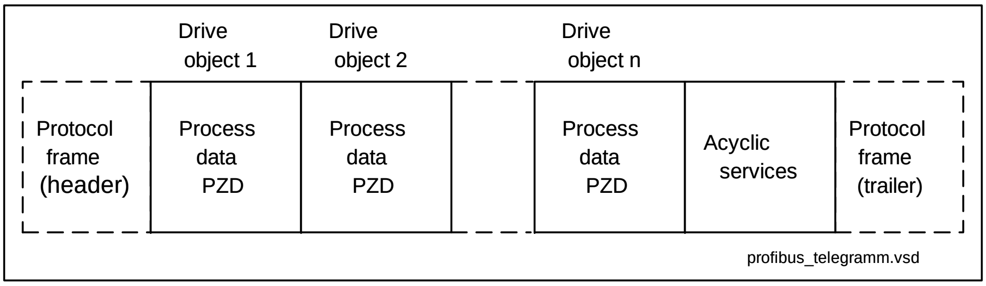


Fig. 4-1 Telegram structure for data transmission

Each drive unit uses one telegram to send and receive all the process data and carry out all the acyclic services under a single PROFIBUS address.

The overall length of the telegram increases with the number of drive objects.

Sequence of drive objects in the telegram

The following drive objects can exchange process data:

	Components	Drive objects
1.	Active line module	A_INFEED
2.	Motor module	SERVO
3.	Motor module	VECTOR
4.	Terminal module 31	TM31
5.	Terminal board 30	TB30
6.	Control unit	CU

On the drive side, the sequence of drive objects in the telegram is displayed via a list in p0978[0...15] where it can also be changed.

You can use the STARTER commissioning tool to display the sequence of drive objects for a commissioned drive system in online mode by choosing --> “Drive unit” --> “Configuration”.

When you create the configuration on the master side (e.g. HWConfig), the process-data-capable drive objects for the application are added to the telegram in this sequence.

Note

The sequence of drive objects in the configuration must be the same as that in the drive system.

The structure of the telegram depends on the drive objects taken into account during configuration. Configurations that do not take into account all of the drive objects in the drive system are permitted.

Example:

Assumption: The hardware set-up is as described in Section 4.1.2.

The following configurations, for example, are possible:

--> Configuration with SERVO, SERVO, SERVO

--> Configuration with A_INFEED, SERVO, SERVO, SERVO, TB30

4.1.2 Example: telegram structure for cyclic data transmission

Task

The drive system comprises the following components and drive objects:

• Active line module	A_INFEED
• Single motor module	SERVO
• Double motor module 1	SERVO
• Double motor module 2	SERVO
• Control unit with terminal board 30 (TB30)	TB30

The process data for all of these components is to be exchanged with the higher-level automation system.

- Telegrams to be used:
  - Telegram 370 for the active line module
  - Standard telegram 6 for the motor modules
  - User defined for terminal board 30

Component and telegram structure

The predefined component structure results in the telegram structure shown in the following diagram.

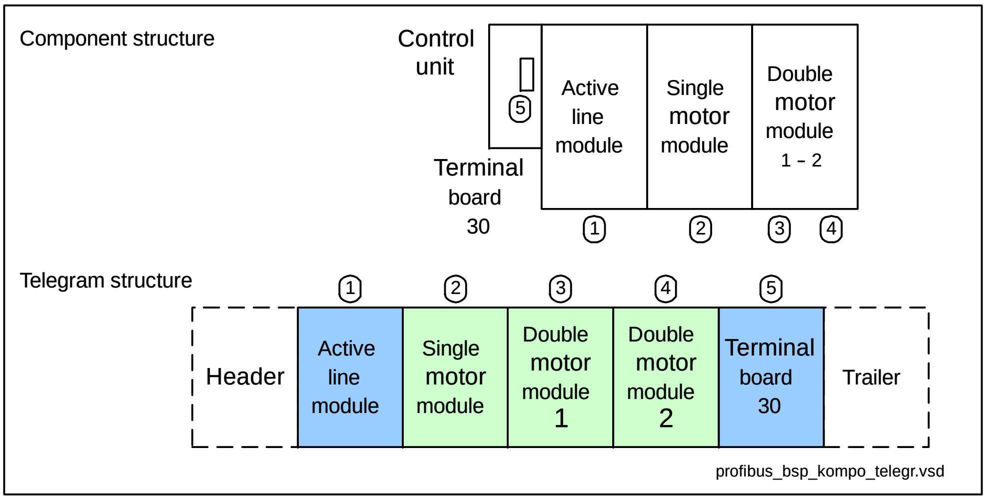


Fig. 4-2 Component and telegram structure

The sequence of components/objects can be checked using p0978[0...15].

Configuration settings (e.g. HWConfig for SIMATIC S7)

The components are mapped to objects for configuration.

Due to the telegram structure shown in Fig. 4-2, the objects in the “DP slave properties” overview must be configured as follows:

- Active line module: Telegram 370
- Single motor module: Standard telegram 6
- Double motor module, drive 1: Standard telegram 6
- Double motor module, drive 2: Standard telegram 6
- Terminal board: User defined

DP slave properties: overview

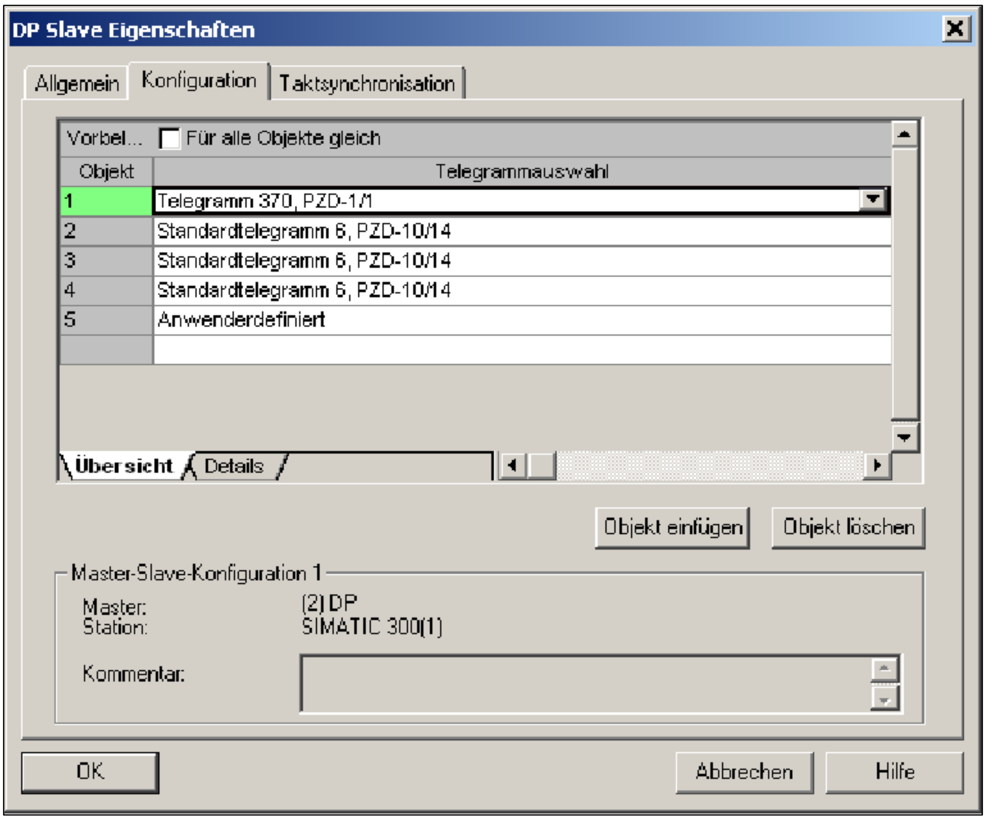


Fig. 4-3 Slave properties: overview

When you press the “Details” soft key, the properties of the configured telegram structure are displayed (e.g. I/O addresses, axis separator).

DP slave properties: details

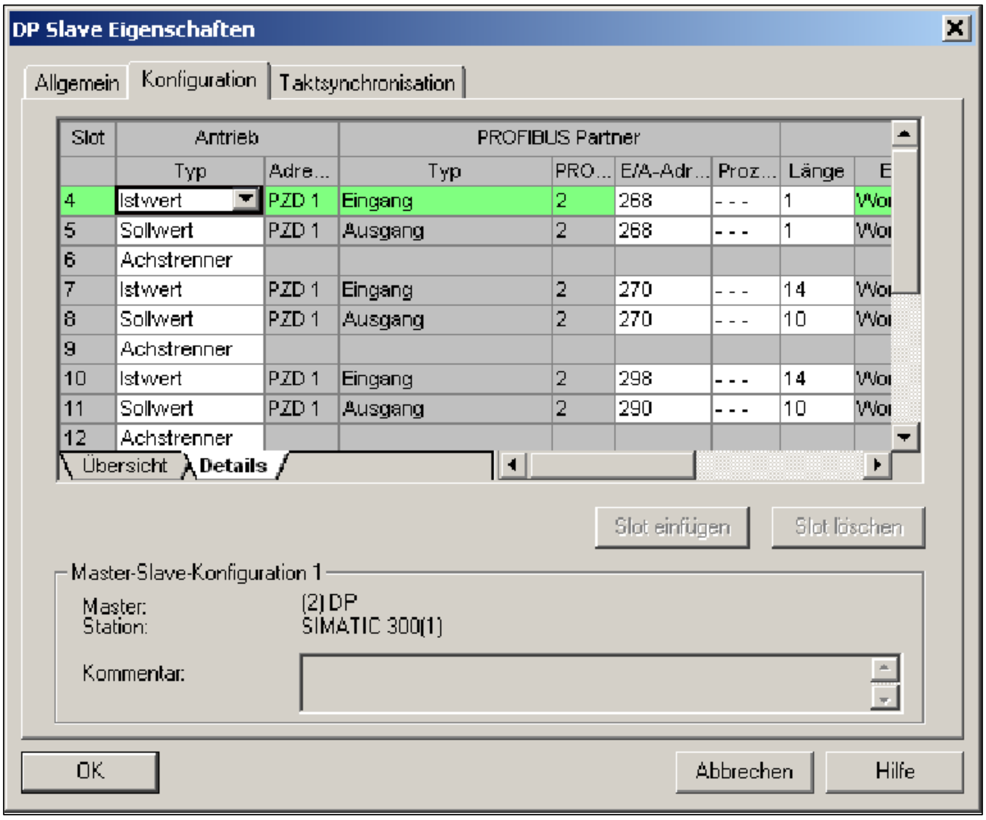


Fig. 4-4 Slave properties: details

The axis separator separates the objects in the telegram as follows:

- Slot 4 and 5: Object 1 --> active line module component
- Slot 7 and 8: Object 2 --> single motor module component
- Slot 10 and 11: Object 3 --> double motor module component, drive 1

  etc.

4.2 Commissioning PROFIBUS

4.2.1 General information about commissioning

Interfaces and diagnostic LEDs

A PROFIBUS interface with LEDs and address switches is available as standard on the control unit.

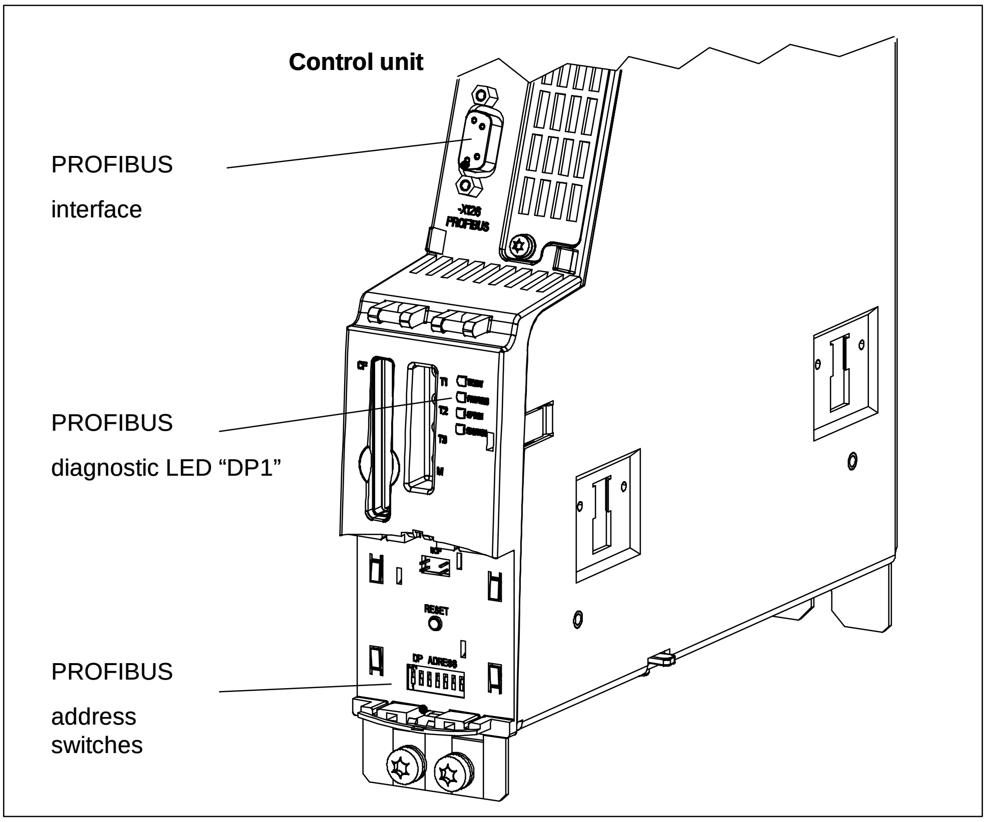


Fig. 4-5 Interfaces and diagnostic LED

- PROFIBUS interface

  The PROFIBUS interface is described in the following documentation:

  /GH1/ SINAMICS S120 Equipment Manual
  Control Units and Additional System Components

- PROFIBUS diagnostic LED

  For a description of the diagnostic LED, see 7.1.1.

Note

A teleservice adapter can be connected to the PROFIBUS interface (X126) for remote diagnosis purposes.

Setting the PROFIBUS address

Two methods are available for setting the PROFIBUS address:

1. Via the PROFIBUS address switches on the control unit
   - In this case, p0918 is read-only and simply displays the set address.
   - A change is not effective until POWER ON.
2. Via p0918
   - You can only use this method when all the PROFIBUS address switches from S1 to S7 are set to ON or OFF.
   - A change is effective immediately.

Example:

Setting the PROFIBUS address using the PROFIBUS address switches on the control unit

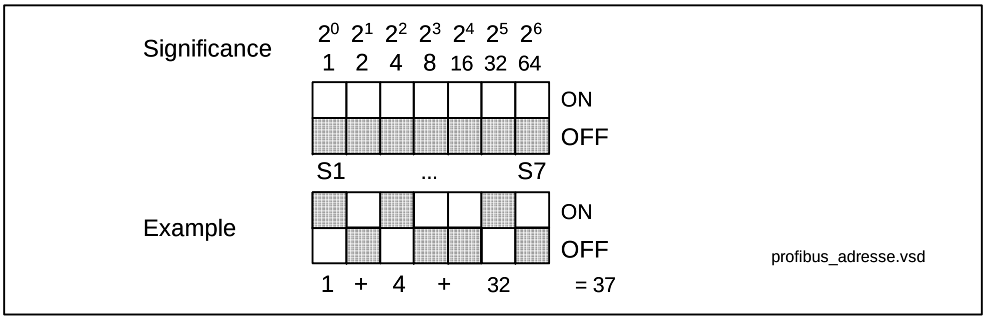


Fig. 4-6 Example: setting the PROFIBUS address using the PROFIBUS address switch on the control unit

Note

Parameter p0918 is unique to the control unit (see control unit). The factory setting is 126.

Permitted PROFIBUS addresses are 1 ... 126. Address 126 is used for commissioning.

The address setting on the switch is displayed in p0918.

A change in the switch setting is not effective until POWER ON.

The factory settings are “ON” or “OFF” for all switches. With these two settings, the PROFIBUS address is set by parameterization.

Device master file

A device master file provides a full and clear description of the features of a PROFIBUS slave. The device master files are ASCII files with an accurately defined format.

The following device master files (DMF) for SINAMICS S120 are available:

- si0280e5.gsd GSD Revision 4

  Clock–synchronous mode to standard
  (supported with STEP 7 V5.1 Service Pack 3 or higher).

Device identification

An identification parameter for individual slaves facilitates diagnosis and provides an overview of the nodes on the PROFIBUS.

The information for each slave is stored in the following parameter:

r0964[0...6] Device identification

Bus terminating resistor and shielding

Reliable data transmission via PROFIBUS depends, amongst other things, on the setting for the bus terminating resistors and the shielding for the PROFIBUS cables.

- Bus terminating resistor

  The bus terminating resistors in the PROFIBUS plugs must be set as follows:

  – First and last nodes in the line: switch in terminating resistor

  – Other nodes in the line: switch out terminating resistor

- Shielding for the PROFIBUS cables

  The cable shield in the plug must be connected at both ends with the greatest possible surface area.

  /GH1/ SINAMICS S120 Equipment Manual
  Control Units and Additional
  System Components

4.2.2 Commissioning procedure

Preconditions and assumptions for commissioning

PROFIBUS slave

1. The PROFIBUS address to be set for the application is known.
2. The telegram type for each drive object is known by the application.

PROFIBUS master

1. The communication properties of the SINAMICS S120 slave must be available in the master (DMF or drive ES slave OM).

Commissioning steps (example with SIMATIC S7)

1. Set the PROFIBUS address on the slave.

   See Section 4.2.1
2. Set the telegram type on the slave.

   See Section 4.3.1
3. Perform the following steps in HWConfig:
   - Connect the drive to PROFIBUS and assign an address.
   - Set the telegram type.

     The same telegram type as on the slave must be set for every drive object exchanging process data via PROFIBUS.

     The setting “without PZD” can be defined on a node or object (e.g. infeed control with setpoints/actual values via terminals).
4. Program the automatic allocation of I/O addresses from the user program.

4.2.3 Diagnosis options

Diagnosis via parameters (see List Manual)

- r2053 PROFIBUS diagnostics send PZD word
- r2054 PROFIBUS status
- r2055 PROFIBUS diagnostics standard
- r2063 PROFIBUS diagnostics PZD send double word
- r2064 PROFIBUS diagnostics isochronous mode
- r2065 PROFIBUS diagnostics master sign–of–life
- r2075 PROFIBUS diagnostics telegram offset PZD receive
- r2076 PROFIBUS diagnostics telegram offset send PZD

Diagnosis via LED DP1 (see 7.1)

4.3 Cyclic communication

Cyclic communication is the method used to exchange time–critical process data between master and slave in the Data_Exchange telegram.

4.3.1 Telegrams and process data

General

The selection of a telegram via p0922 determines which process data is transferred between master and slave.

From the perspective of the slave, 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 or setpoints
- Send words: Status words or actual values

What kinds of telegram are used?

1. Standard telegrams

   The standard telegrams are structured in accordance with the PROFIdrive Profile V3.1. The internal process data links are set up automatically in accordance with the telegram number setting.

   The following standard telegrams can be set via p0922:

   - 1 Speed control, 2 words
   - 2 Speed control, 4 words
   - 3 Speed control, 1 position encoder
   - 4 Speed control, 2 position encoders
   - 5 DSC, 1 position encoder
   - 6 DSC, 2 position encoders

2. 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:

   - 102 Speed control with torque reduction, 1 position encoder
   - 103 Speed control with torque reduction, 2 position encoders
   - 105 DSC with torque reduction, 1 position encoder
   - 106 DSC with torque reduction, 2 position encoders
   - 370 Telegram for the infeed

3. Free telegrams (p0922 = 999)

   The send and receive telegrams can be configured as required by using BICO technology to interconnect the send and receive words.

   - Interconnect the receive telegram (see function diagram 2460, 2481)

     The following BICO outputs are available for interconnecting PZD receive words 1 ... 16:

     PZD receive word 1 ... 4

     As connector output in DWORD and WORD format and as binector output.

     PZD receive word 4 ... 16

     As connector output in DWORD and WORD format and as binector output via two connector/binector converters.

   - Interconnect the send telegram (see function diagram 2470, 2483)

     The following BICO inputs are available for interconnecting PZD send words 1 ... 16:

     As connector input in DWORD and WORD format.

     As binector input via two binector/connector converters.

Note

When you reset p0922 = 999 (factory setting) to p0922 $\neq$ 999, the telegrams are interconnected automatically.

When you reset p0922 $\neq$ 999 to p0922 = 999, the previous telegram interconnection is retained.

This is an easy method of interconnecting free telegrams as required on the basis of existing telegrams.

Note

- The following must apply to ensure conformity with the PROFIdrive profile:
  - Interconnect PZD receive word 1 as control word 1 (CTW1)
  - Interconnect PZD send word 1 as status word 1 (STW1)

    Use WORD format for PZD1.
- Each PZD word can either be assigned one word or double word.

  Only one of the interconnection parameters (p2051 or p2061) can have the value $\neq$ 0 for a PZD word.
- Physical word and double word values are inserted in the telegram as referenced variables.

  p200x apply as reference variables (telegram contents = 4000 hex or 4000 0000 hex in the case of double words if the input variable has the value p200x).

Structure of the telegrams

Telegram	PZD1	PZD2	PZD3	PZD4	PZD5	PZD6	PZD7	PZD8	PZD9	PZD10	PZD11	PZD12	PZD13	PZD14	PZD15	PZD16
1	CTW1	NSETP_A														
	STW1	NACT_A														
2	CTW1	NSETP_B		CTW2												
	STW1	NACT_B		STW2												
3	CTW1	NSETP_B		CTW2	G1_CTW											
	STW1	NACT_B		STW2	G1_STW	G1_XACT1		G1_XACT2								
4	CTW1	NSETP_B		CTW2	G1_CTW	G2_CTW										
	STW1	NACT_B		STW2	G1_STW	G1_XACT1		G1_XACT2		G2_STW	G2_XACT1		G2_XACT2			
5	CTW1	NSETP_B		CTW2	G1_CTW	XERR		KPC								
	STW1	NACT_B		STW2	G1_STW	G1_XACT1		G1_XACT2								
6	CTW1	NSETP_B		CTW2	G1_CTW	G2_CTW	XERR		KPC							
	STW1	NACT_B		STW2	G1_STW	G1_XACT1		G1_XACT2		G2_STW	G2_XACT1		G2_XACT2			
102	CTW1	NSETP_B		CTW2	TRQRED	G1_CTW										
	STW1	NACT_B		STW2	MSGW	G1_STW	G1_XACT1		G1_XACT2							
103	CTW1	NSETP_B		CTW2	TRQRED	G1_CTW	G2_CTW									
	STW1	NACT_B		STW2	MSGW	G1_STW	G1_XACT1		G1_XACT2		G2_STW	G2_XACT1		G2_XACT2		
105	CTW1	NSETP_B		CTW2	TRQRED	G1_CTW	XERR		KPC							
	STW1	NACT_B		STW2	MSGW	G1_STW	G1_XACT1		G1_XACT2							
106	CTW1	NSETP_B		CTW2	TRQRED	G1_CTW	G2_CTW	XERR		KPC						
	STW1	NACT_B		STW2	MSGW	G1_STW	G1_XACT1		G1_XACT2		G2_STW	G2_XACT1		G2_XACT2		
370	A_CTW1															
	A_STW1															
999	CTW1	Receive telegram can be interconnected as required using BICO technology														
	STW1	Send telegram can be interconnected as required using BICO technology														

⇐ Receive telegram from PROFIBUS

⇒ Send telegram to PROFIBUS

▭ = PZD for position encoder

profibus_pzd.vsd

Fig. 4-7 Structure of the telegrams

Depending on the drive object, only certain telegrams can be used:

Object	Telegram
• A_INFEED	p0922 = 370, 999
• SERVO	p0922 = 2, 3, 4, 5, 6, 102, 103, 105, 106, 999
• VECTOR	p0922 = 1, 999
• TM31	No predefined telegram
• TB30	No predefined telegram
• CU	No predefined telegram

Depending on the drive object, the following maximum number of process data items can be transmitted for user–defined telegram structures:

Object	Max. no. of PZD items for sending / receiving
• A_INFEED	5
• SERVO	16
• VECTOR	16
• TM31	5
• TB30	5
• CU	5

Interface mode for servo drives

The interface mode is used for adjusting the assignment of the control and status words to suit other SIEMENS drive systems when PROFIBUS is used.

When you set a telegram in the range between 100 and 199, interface mode is set by default (p2038 = 1) and cannot be changed.

The mode can be set as follows:

Value	Interface mode
• p2038 = 0	SINAMICS (factory setting)
• p2038 = 1	SIMODRIVE 611 universal

Procedure:

1. Set p0922 $\neq$ 999
2. Set p2038 = set required interface mode

Function diagram overview (see List Manual)

- 2410 PROFIBUS address, diagnostics
- 2420 Telegrams and process data
- 2440 Standard/manufacturer–specific receive telegram interconnection
- 2442 STW1 control word interconnection (p2038 = 0)
- 2443 STW1 control word interconnection (p2038 = 1)
- 2444 STW2 control word interconnection (p2038 = 0)
- 2445 STW2 control word interconnection (p2038 = 1)
- 2450 Standard/manufacturer–specific send telegrams, interconnection
- 2452 ZSW1 status word interconnection (p2038 = 0)
- 2453 ZSW1 status word interconnection (p2038 = 1)
- 2454 ZSW2 status word interconnection (p2038 = 0)
- 2455 ZSW2 status word interconnection (p2038 = 1)
- 2456 MELDW status word interconnection
- 2460 Receive telegram free interconnection via BICO (p0922 = 999)
- 2470 Send telegram, free interconnection via BICO (p0922 = 999)
- 2472 Status words, free interconnection
- 2481 Receive telegram, free interconnection via BICO (p0922 = 999)
- 2483 Send telegram, free interconnection via BICO (p0922 = 999)

4.3.2 Description of control words and setpoints

Note

This section describes the assignment and meaning of the process data in SINAMICS interface mode (p2038 = 0).

Overview of control words and setpoints

Table 4-2 Overview of control words and setpoints

Abbrevi-ation	Name	Signal no.	Data type 1)	Comments
CTW1	Control word 1	1	U16	
CTW2	Control word 2	3	U16	
NSETP_A	Speed setpoint A (16–bit)	5	I16	
NSETP_B	Speed setpoint B (32–bit)	7	I32	
G1_CTW	Encoder 1 control word	9	U32	
G2_CTW	Encoder 2 control word	13	U32	
G3_CTW	Encoder 3 control word	17	U32	
XERR	Position deviation	25	I32	
KPC	Position controller gain factor	26	I32	
TRQRED	Torque reduction	101	I16	
A_CTW1	Control word for A_INFEED	320	U16	

1) Data type to PROFIdrive Profile V3.1:
I16 = Integer16, I32 = Integer32, U16 = Unsigned16, U32 = Unsigned32

CTW1 (control word 1)

See function diagram [2442]

Table 4-3 Description of CTW1 (control word 1)

Bit	Meaning	Comments		BICO
0	ON / OFF (OFF1)	0/1	ON Operating condition (edge-triggered)	BI: p0840
		0	OFF (OFF1) Stop via ramp-function generator followed by pulse inhibit.	
1	No coast down / coast down (OFF2)	1	No coast down Precondition for “Ready To Start” status.	BI: p0844
		0	Coast down (OFF2) Pulse inhibit, the motor is de-energized and coasts down.	
	Note: Control signal OFF2 is generated by ANDing BI: p0844 and BI: p0845.			
2	No fast stop / fast stop (OFF3)	1	No fast stop Precondition for “Ready To Start” status.	BI: p0848
		0	Fast stop (OFF3) The drive decelerates at the torque limit without the ramp-function generator.	
	Note: Control signal OFF3 is generated by ANDing BI: p0848 and BI: p0849.			
3	Enable operation / disable operation	1	Enable operation Enable inverter, pulse enable, ramp-up with active setpoint	BI: p0852
		0	Disable operation Pulse inhibit. The motor coasts down. The “Ready To Run” status remains set.	
4	Enable ramp-function generator / Set zero ramp-function generator	1	Enable ramp-function generator Any speed setpoint can be specified.	BI: p1140
		0	Set zero ramp-function generator The drive decelerates at the torque limit without the ramp-function generator.	
5	Resume ramp-function generator / freeze ramp-function generator	1	Resume ramp-function generator Ramp-up is resumed via the ramp-function generator.	BI: p1141
		0	Freeze ramp-function generator Ramp-up via the ramp-function generator is stopped and the output value is frozen.	

Table 4-3 Description of CTW1 (control word 1), continued

Bit	Meaning	Comments		BICO
6	Enable speed setpoint / disable speed setpoint	1	Enable speed setpoint The speed setpoint at the input of the ramp-function generator is enabled.	BI: p1142
		0	Disable speed setpoint The speed setpoint at the input of the ramp-function generator is set to zero. The drive decelerates according to the ramp-down time set in p1121.	
7	Acknowledge error	0/1	Acknowledge error Active faults are acknowledged at a 0/1 edge.	BI: p2103
		0	No effect	
	Note: Acknowledgement takes place at a 0/1 edge via BI: p2103, BI: p2104, or BI: p2105.			
8	Jog 1	1	Jog 1 Selection of jog 1. The drive runs with jog setpoint 1 (p1058).	BI: p1055
		0	Jog 1 not selected.	
9	Jog 2	1	Jog 2 Selection of jog 2. The drive runs with jog setpoint 2 (p1059).	BI: p1056
		0	Jog 2 not selected.	
	Note: If Jog 1 and 2 are selected simultaneously, the momentary setpoint is frozen.			
10	Control by PLC	1	Control by PLC This signal must be set so that the process data transferred from the PROFIBUS master to the slave is accepted and activated.	BI: p0852
		0	No control by PLC The process data transferred from the PROFIBUS master is discarded by the slave, i.e. it is assumed to be zero.	
	Note: This bit should not be set to “1” until the PROFIBUS slave has returned an appropriate status via STW1.9 = “1”.			
11	Direction reversal	1	Direction reversal	BI: p1113
		0	No direction reversal	
12	Reserved			

Table 4-3 Description of CTW1 (control word 1), continued

Bit	Meaning	Comments		BICO
13	Motorized potentiometer raise	1	Motorized potentiometer raise	BI: p1035
		0	Motorized potentiometer raise not selected	
14	Motorized potentiometer lower	1	Motorized potentiometer lower	BI: p1036
		0	Motorized potentiometer lower not selected	
	Note: If motorized potentiometer raise and lower are 0 or 1 simultaneously, the current setpoint is frozen.			
15	Command data set selection CDS bit 0	1	Command data set 1 is selected (CDS 1)	BI: p0810
		0	Command data set 0 is selected (CDS 0)	

CTW2 (control word 2)

See function diagram [2444]

Table 4-4 Description of CTW2 (control word 2)

Bit	Meaning	Comments		BICO
0 ... 7	Reserved	–	–	–
8	Travel to fixed stop	1	Select "Travel to fixed stop" The signal must be set before the fixed stop is reached.	BI: p1545
		1/0	Deselect "Travel to fixed stop". The edge is necessary in order to move away from the fixed stop, i.e. upon direction reversal.	
9 10 11	Reserved	–	–	–
12	Master sign-of-life bit 0	–	User data integrity (4-bit counter)	CI: p2045
13	Master sign-of-life bit 1	–		
14	Master sign-of-life bit 2	–		
15	Master sign-of-life bit 3	–		

NSETP_A (speed setpoint A (16-bit))

- Speed setpoint with a 16-bit resolution with sign bit.
- Bit 15 determines the sign of the setpoint:
  - Bit = 0 --> positive setpoint
  - Bit = 1 --> negative setpoint
- The speed is normalized via p2000.

  NSETP_A = 4000 hex or 16384 dec ≙ speed in p2000

NSETP_B (speed setpoint B (32-bit))

- Speed setpoint with a 32-bit resolution with sign bit.
- Bit 31 determines the sign of the setpoint:
  - Bit = 0 --> positive setpoint
  - Bit = 1 --> negative setpoint
- The speed is normalized via p2000.

  NSETP_B = 4000 0000 hex or 1 073 741 824 dec ≙ speed in p2000

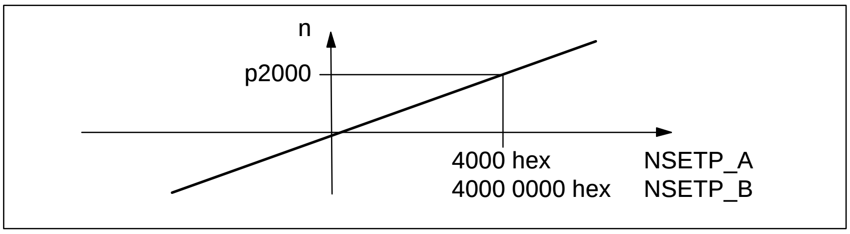


Fig. 4-8 Normalization of speed

Gn_CTW (encoder n control word)

This process data belongs to the encoder interface and is described in Section 4.3.4.

XERR (position deviation)

The position deviation for dynamic servo control (DSC) is transmitted via this setpoint.

The format of XERR is identical to the format of G1_XACT1 (see Section 4.3.4).

KPC (position controller gain factor)

In dynamic servo control (DSC), the position controller gain factor is transmitted via this setpoint.

Transmission format: KPC is transmitted in the unit 0.001 1/s

Value range: 0 to 4000.0

Special case: When KPC = 0, the “DSC” function is deactivated.

Example:

A2C2A hex ≙ 666666 dec ≙ KPC = 666.666 1/s ≙ KPC = 40 1000/min

TRQRED (torque reduction)

This setpoint can be used to reduce the torque limit currently active on the drive.

When you use manufacturer-specific PROFIBUS telegrams with the TRQRED control word, the signal flow is automatically interconnected up to the point where the torque limit is scaled.

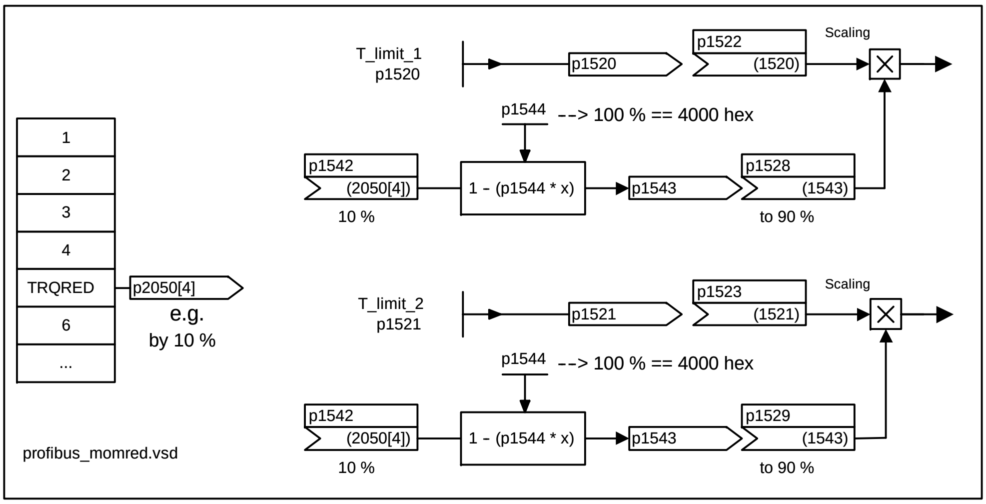


Fig. 4-9 Control word TRQRED

TRQRED specifies the percentage by which the torque limit is to be reduced. This value is converted internally to the amount by which the torque is to be reduced and normalized via p1544.

A_CTW1 (control word for A_INFEED)

See function diagram [8920]

Table 4-5 Description of A_CTW1 (control word for A_INFEED)

Bit	Meaning	Comments		BICO
0	ON / OFF (OFF1)	0/1	ON Operating condition (edge–triggered)	BI: p0840
		0	OFF (OFF1) Reduce DC link voltage via ramp (p3566), then pulse inhibit/line contactor open	
1	Operating condition / immediate OFF (OFF2)	1	Operating condition	BI: p0844
		0	Immediate OFF (OFF2) Pulse inhibit/line contactor open	
	Note: Control signal OFF2 is generated by ANDing BI: p0844 and BI: p0845.			
2	Reserved	–	–	–
3	Enable operation / inhibit operation	1	Enable operation Pulse enable is present	BI: p0852
		0	Inhibit operation Pulse inhibit is present	
4	Reserved	–	–	–
5	Inhibit motoring operation / enable motoring operation	1	Inhibit motoring operation Motoring operation as step–up converter is inhibited.	BI: p3532
		0	Enable motoring operation Motoring operation as step–up converter is enabled.	
	Note: When “Inhibit motoring operation” is present, power can still be taken from the DC link. The DC link voltage is then no longer controlled. The voltage level is the same as the rectified value of the current line voltage.			
6	Inhibit regenerative operation / enable regenerative operation	1	Inhibit regenerative operation Regenerative operation is inhibited.	BI: p3533
		0	Enable regenerative operation. Regenerative operation is enabled.	
	Note: If regenerative operation is inhibited and power is fed to the DC link (e.g. by braking the motor), the DC link voltage increases (F30002).			
7	Acknowledge faults	0/1	Acknowledge faults	BI: p2103
	Note: Faults are acknowledged at a 0/1 edge via BI: p2103, BI: p2104, or BI: p2105.			
8 9	Reserved	–	–	–

Table 4-5 Description of A_CTW1 (control word for A_INFEED), continued

<table>
<tr><th>Bit</th><th>Meaning</th><th colspan="2">Comments</th><th>BICO</th></tr>
<tr><td rowspan="3">10</td><td rowspan="2">Controlled by PLC</td><td>1</td><td>Controlled by PLC
This signal must be set so that the process data transferred from the PROFIBUS master to the slave is accepted and activated.</td><td rowspan="2">BI: p0854</td></tr>
<tr><td>0</td><td>Not controlled by PLC
The process data transferred from the PROFIBUS master is discarded by the slave, i.e. it is assumed to be zero.</td></tr>
<tr><td colspan="4">Note:
This bit should not be set to “1” until the PROFIBUS slave has returned an appropriate status via STW1.9 = “1”.</td></tr>
<tr><td>11
12
13
14
15</td><td>Reserved</td><td>–</td><td>–</td><td>–</td></tr>
</table>

4.3.3 Description of status words and actual values

Note

This chapter describes the assignment and meaning of the process data in SINAMICS interface mode (p2038 = 0).

Overview of status words and actual values

Table 4-6 Overview of status words and actual values

Abbreviation	Name	Signal no.	Data type 1)	Comments
STW1	Status word 1	2	U16	
STW2	Status word 2	4	U16	
NACT_A	Speed setpoint A (16 bit)	6	I16	
NACT_B	Speed setpoint B (32 bit)	8	I32	
G1_STW	Encoder 1 status word	10	U16	
G1_XACT1	Encoder 1 actual position 1	11	U32	
G1_XACT2	Encoder 1 actual position 2	12	U32	
G2_STW	Encoder 2 status word	14	U32	
G2_XACT1	Encoder 2 actual position 1	15	U32	
G2_XACT2	Encoder 2 actual position 2	16	U32	
G3_STW	Encoder 3 status word	18	U32	
G3_XACT1	Encoder 3 actual position 1	19	U32	
G3_XACT2	Encoder 3 actual position 2	20	U32	
MSGW	Message word	102	U16	
A_STW1	Status word for A_INFEED	321	U16	

1) Data type to PROFIdrive Profile V3.1:
I16 = Integer16, I32 = Integer32, U16 = Unsigned16, U32 = Unsigned32

STW1 (status word 1)

See function diagram [2452]

Table 4-7 Description of STW1 (status word 1)

Bit	Meaning	Comments		BICO
0	Ready to power up	1	Ready to power up Power supply on, electronics initialized, line contactor released if necessary, pulses inhibited.	BO: r0899.0
		0	Not ready to power up	
1	Ready	1	Ready Voltage at line module (i.e. line contactor closed (if used)), field being built up.	BO: r0899.1
		0	Not ready Cause: No ON command has been issued.	
2	Operation enabled	1	Operation enabled Enable electronics and pulses, then ramp up to active setpoint.	BO: r0899.2
		0	Operation inhibited	
3	Fault present	1	Fault present The drive is faulty and is, therefore, out of service. The drive switches to Power-on inhibit once the fault has been acknowledged and the cause has been remedied. The active faults are stored in the fault buffer.	BO: r2193.3
		0	No fault present There is no active fault in the fault buffer.	
4	No OFF2 active / coasting active (OFF2)	1	No OFF2 active	BO: r0899.4
		0	Coasting active (OFF2) An OFF2 command is present.	
5	0 = fast stop active (OFF3)	1	No OFF3 active	BO: r0899.5
		0	Fast stop active (OFF3) An OFF3 command is present.	
6	Power-up inhibit active	1	Power-up inhibit active A restart is only possible through OFF1 followed by ON.	BO: r0899.6
		0	No power-up inhibit Power up is possible.	

Table 4-7 Description of STW1 (status word 1), continued

Bit	Meaning	Comments		BICO
7	Alarm present	1	Alarm present The drive is operational again. No acknowledgement necessary. The active alarms are stored in the alarm buffer.	BO: r2139.7
		0	No alarm present No active alarm is present in the alarm buffer.	
8	Speed setpoint–actual value deviation within the tolerance bandwidth	1	Setpoint/actual value monitoring within tolerance band Actual value within tolerance band; dynamic overshoot or shortfall permitted for $t < t_{max}$, e.g. $n = n_{setp} \pm$ $f = f_{setp} \pm$, etc., t_{max} is parameterizable	BO: r2197.7
		0	Setpoint/actual value monitoring not within tolerance band	
9	Control requested	1	Control requested The programmable logic controller is requested to assume control. Condition for applications with isochronous mode: drive synchronized with PLC system.	BO: r0899.9
		0	Local operation Control only possible on device	
10	f or n comparison value reached or exceeded	1	f or n comparison value reached or exceeded	BO: r2199.1
		0	f or n comparison value not reached	
	Note: The message is parameterized as follows: p2141 Threshold value p2142 Hysteresis			
11	I, M or P limit not reached / I, M or P limit reached	1	I, M or P limit not reached	BO: r1407.7
		0	I, M or P limit reached	
12	Holding brake closed	1	Holding brake activated	BO: r0899.12
		0	Holding brake not activated	
13	Alarm, motor overtemperature	1	Motor overtemperature alarm active	BO: r2135.14
		0	Motor overtemperature alarm not active	
14	Motor rotates forwards (n_act >= 0)	1	Motor rotates forwards	BO: r2197.3
		0	Motor not rotating forwards	

Table 4-7 Description of STW1 (status word 1), continued

Bit	Meaning	Comments		BICO
15	0 = Alarm, power module thermal overload	1	No alarm present	BO: r2135.15
		0	Alarm, power module thermal overload The overtemperature alarm for the power module is active.	

STW2 (status word 2)

See function diagram [2454]

Table 4-8 Description of STW2 (status word 2)

Bit	Meaning	Comments		BICO
0 ... 7	Reserved	–	–	–
8	Travel to fixed stop	1	Travel to fixed stop	BO: p1406.8
		0	No travel to fixed stop	
9 10 11	Reserved	–	–	–
12	Slave sign–of–life bit 0	–	User data integrity (4–bit counter)	Implicitly interconnected
13	Slave sign–of–life bit 1	–		
14	Slave sign–of–life bit 2	–		
15	Slave sign–of–life bit 3	–		

NACT_A (actual speed value A (16–bit))

- Actual speed value with 16–bit resolution.
- The actual speed value is normalized in the same way as the setpoint (see NSETP_A).

NACT_B (actual speed value B (32–bit))

- Actual speed value with 32–bit resolution.
- The actual speed value is normalized in the same way as the setpoint (see NSETP_B).

Gn_STW (encoder n status word)
Gn_XACT1 (encoder n actual position value 1)
Gn_XACT2 (encoder n actual position value 2)

This process data belongs to the encoder interface and is described in Section 4.3.4.

MSGW (message word)

See function diagram [2456]

Table 4-9 Description of MSGW (message word)

Bit	Meaning	Comments		BICO
0	Ramp-up/ramp-down completed / ramp-function generator active	1	Ramp-up/ramp-down completed The ramp-up procedure is completed once the speed setpoint has been changed.	BO: r2199.5
		1/0	Ramp-up starts The start of the ramp-up procedure is detected as follows: • The speed setpoint changes and • The defined tolerance bandwidth (p2164) is exited.	
		0	Ramp-function generator active The ramp-up procedure is still active once the speed setpoint has been changed.	
		0/1	Ramp-up procedure completed The ramp-up procedure is complete when: • The speed setpoint is constant and • The actual speed value is within the tolerance bandwidth and has reached the speed setpoint and • The waiting time (p2166) has elapsed.	

Table 4-9 Description of MSGW (message word), continued

<table>
<tr><th>Bit</th><th>Meaning</th><th colspan="2">Comments</th><th>BICO</th></tr>
<tr><td rowspan="3">1</td><td rowspan="2">Torque utilization < p2194</td><td>1</td><td>Torque utilization < p2194
The current torque utilization is less than the set torque utilization threshold (p2194).
or
Ramp-up is not yet complete.</td><td rowspan="2">BO:
r2199.11</td></tr>
<tr><td>0</td><td>Torque utilization > p2194
The current torque utilization is greater than the set torque utilization threshold (p2194).</td></tr>
<tr><td colspan="4">Application:
This message indicates that the motor is overloaded and appropriate measures need to be taken to rectify the situation (e.g. stop the motor or reduce the load).</td></tr>
<tr><td rowspan="3">2</td><td rowspan="2">n_act < p2161</td><td>1</td><td>n_act < p2161
The actual speed value is less than the set threshold value (p2161).</td><td rowspan="2">BO:
r2199.0</td></tr>
<tr><td>0</td><td>n_act ≥ p2161
The actual speed value is greater than or the same as the set threshold value (p2161).</td></tr>
<tr><td colspan="4">Note:
The message is parameterized as follows:
p2161 Threshold value
p2150 Hysteresis
Application:
To protect the mechanics, the gear stages are not switched mechanically until the speed is less than the set threshold value.</td></tr>
<tr><td rowspan="3">3</td><td rowspan="2">n_act ≤ p2155</td><td>1</td><td>n_act ≤ p2155
The actual speed value is less than or the same as the set threshold value (p2155).</td><td rowspan="2">BO:
r2197.1</td></tr>
<tr><td>0</td><td>n_act > p2155
The actual speed value is greater than the set threshold value (p2155).</td></tr>
<tr><td colspan="4">Note:
The message is parameterized as follows:
p2155 Threshold value
p2140 Hysteresis
Application:
Speed monitoring</td></tr>
<tr><td rowspan="2">4</td><td rowspan="2">DC link voltage
≥ p2172</td><td>1</td><td>DC link voltage ≥ p2172
The DC link voltage is greater than or the same as the set threshold value (p2172).</td><td rowspan="2">BO:
r2197.10</td></tr>
<tr><td>0</td><td>DC link voltage > p2172
The DC link voltage is less than the set threshold value (p2172).</td></tr>
</table>

Table 4-9 Description of MSGW (message word), continued

<table>
<tr><th>Bit</th><th>Meaning</th><th colspan="2">Comments</th><th>BICO</th></tr>
<tr><td rowspan="2">5</td><td rowspan="2">Reserved</td><td>1</td><td>–</td><td rowspan="2">–</td></tr>
<tr><td>0</td><td>–</td></tr>
<tr><td rowspan="3">6</td><td rowspan="2">No motor overtemperature alarm</td><td>1</td><td>No motor overtemperature alarm
The temperature of the motor is within the permissible range.</td><td rowspan="2">BO: r2129.14</td></tr>
<tr><td>0</td><td>Motor overtemperature alarm
The temperature of the motor is greater than the set motor temperature threshold (p0604).</td></tr>
<tr><td colspan="4">Note:
• When the motor temperature threshold is exceeded, only an alarm is output initially to warn you of this. The alarm is canceled automatically when the temperature no longer exceeds the alarm threshold.
• If the overtemperature is present for longer than the value set via p0606, a fault is output to warn you of this.
• The motor temperature monitor can be switched on/off via p0600 = 0.
Application:
The user can respond to this message by reducing the load, thereby preventing the motor from shutting down with the “Motor temperature exceeded” fault after the set time has elapsed.</td></tr>
<tr><td rowspan="2">7</td><td rowspan="2">No thermal overload in power section alarm</td><td>1</td><td>No thermal overload in power section alarm
The temperature of the heat sink in the power section is within the permissible range.</td><td rowspan="2">BO: r2129.15</td></tr>
<tr><td>0</td><td>Thermal overload in power section alarm
The temperature of the heat sink in the power section is outside the permissible range.
If the overtemperature remains, the drive switches itself off after approx. 20 s.</td></tr>
<tr><td rowspan="2">8</td><td rowspan="2">Setpoint speed reached</td><td>1</td><td>Setpoint speed reached</td><td rowspan="2">BO: r2199.3</td></tr>
<tr><td>0</td><td>Setpoint speed not reached</td></tr>
<tr><td rowspan="2">9
...
12</td><td rowspan="2">Reserved</td><td>1</td><td>–</td><td rowspan="2">–</td></tr>
<tr><td>0</td><td>–</td></tr>
<tr><td rowspan="3">13</td><td rowspan="2">Enable pulses</td><td>1</td><td>Enable pulses
The pulses for activating the motor are enabled.</td><td rowspan="2">BO: r0899.11</td></tr>
<tr><td>0</td><td>Pulses inhibited</td></tr>
<tr><td colspan="4">Application:
Armature short-circuit protection must only be switched on when the pulses are inhibited.
This signal can be evaluated as one of many conditions when armature short-circuit protection is activated.</td></tr>
</table>

Table 4-9 Description of MSGW (message word), continued

Bit	Meaning	Comments		BICO
14 15	Reserved	1	–	–
		0	–	

A_STW1 (status word for A_INFEED)

See function diagram [8926]

Table 4-10 Description of A_STW1 (status word for A_INFEED)

Bit	Meaning	Comments		BICO
0	Ready to power up	1	Ready to power up	BO: r0899.0
		0	Not ready to power up	
1	Ready	1	Ready DC link pre-charged, pulses inhibited	BO: r0899.1
		0	Not ready	
2	Operation enabled	1	Operation enabled Vdc = Vdc_setp	BO: r0899.2
		0	Operation inhibited	
3	Fault present	1	Fault present	BO: r0899.3
		0	No fault	
4	No OFF2 active	1	No OFF2 active	BO: r0899.4
		0	OFF2 active	
5	Reserved	–	–	–
6	Power-up inhibit active	1	Power-up inhibit Fault present	BO: r0899.6
		0	No power-up inhibit	
7	Alarm present	1	Alarm present	BO: r0899.7
		0	No alarm	
8	Reserved	–	–	–
9	Control requested	1	Control requested The programmable logic controller is requested to assume control. Condition for applications with isochronous mode: drive synchronized with PLC system.	BO: r0899.9
		0	Local operation Control only possible on device	
10	Reserved	–	–	–

Table 4-10 Description of A_STW1 (status word for A_INFEED), continued

Bit	Meaning	Comments		BICO
11	Bypass energized	1	Bypass energized Pre–charging is complete and the bypass relay for the pre–charging resistors is energized.	BO: r0899.11
		0	Bypass not energized Pre–charging not yet complete	
12	Line contactor energized	1	Line contactor energized	BO: r0899.12
		0	Line contactor not energized	
13 14 15	Reserved	–	–	–

4.3.4 Control and status words for encoders

Description

The process data for the encoders is available in various telegrams. For example, telegram 3 is provided for speed control with 1 position encoder and transmits the process data of encoder 1.

The following process data is available for the encoders:

- Gn_CTW Encoder n control word (n = 1, 2, 3)
- Gn_STW Encoder n status word
- Gn_XACT1 Encoder n actual position value 1
- Gn_XACT2 Encoder n actual position value 2

Note

Encoder 1: motor encoder

Encoder 2: direct measuring system

Encoder 3: additional measuring system

Example of encoder interface

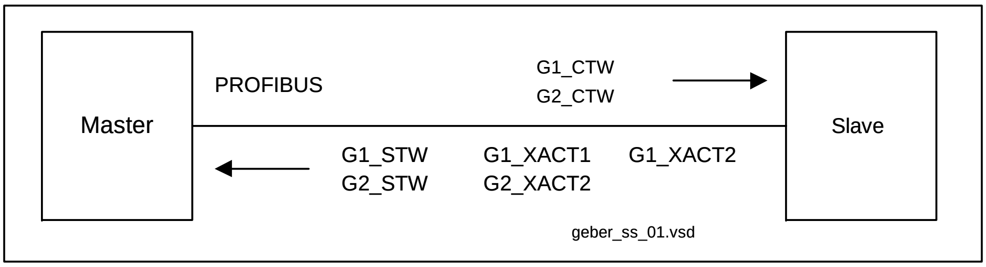


Fig. 4-10 Example of encoder interface (encoder 1: two actual values, encoder 2: one actual value)

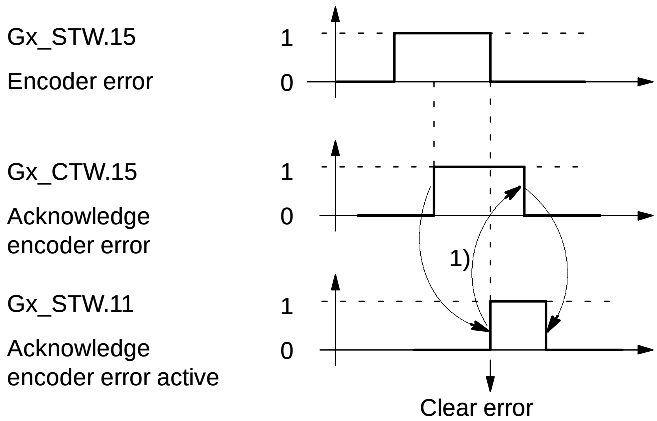
Encoder 1 control word (G1_CTW)

The encoder control word controls the encoder functions.

Table 4-11 Description of the individual signals in Gx_CTW

Bit	Name		Signal state, description
0 1 2 3	Find reference marker or Measure-ment on-the-fly	**Func-tions**	If bit 7 = 0, then find reference marker request applies: Bit Meaning 0 Function 1 Reference marker 1 1 Reserved 2 Reserved 3 Reserved If bit 7 = 1, then measurement on-the-fly request applies: Bit Meaning 0 Function 1 Probe 1 positive edge 1 Function 2 Probe 1 negative edge 2 Function 3 Probe 2 positive edge 3 Function 4 Probe 2 negative edge **Note:** • Bit x = 1 Request function Bit x = 0 Do not request function • The following applies if more than 1 function is activated: The values for all functions cannot be read until each activated function has terminated and this has been confirmed in the corresponding status bit (STW.0/.1/.2/.3 “0” signal again). • Find reference marker It is possible to search for a reference marker. • Equivalent zero mark • Measurement on-the-fly The positive and negative edge can be activated simultaneously.
4 5 6		**Com-mand**	Bit 6, 5, 4 Meaning 000 – 001 Activate function x 010 Read value x 011 Abort function x (x: function selected via bits 0 – 4)
7		**Mode**	1 Measurement on-the-fly 0 Find reference marker
8 ... 12	Reserved		–

Table 4-11 Description of the individual signals in Gx_CTW, continued

Bit	Name	Signal state, description	
13	Request cyclic absolute value	1	Request cyclic transmission of the absolute actual position value in Gx_XACT2. Used for (e.g.): • Additional measuring system monitoring • Synchronization during ramp‑up
		0	No request
14	Reserved	–	–
15	Acknowledge encoder error	0/1	Request to reset encoder errors  1) Signal must be reset by user
		0	No request

Example 1: Measurement on-the-fly

Assumptions for the example:

- Probe with positive edge (function 1)
- Position control with encoder 1

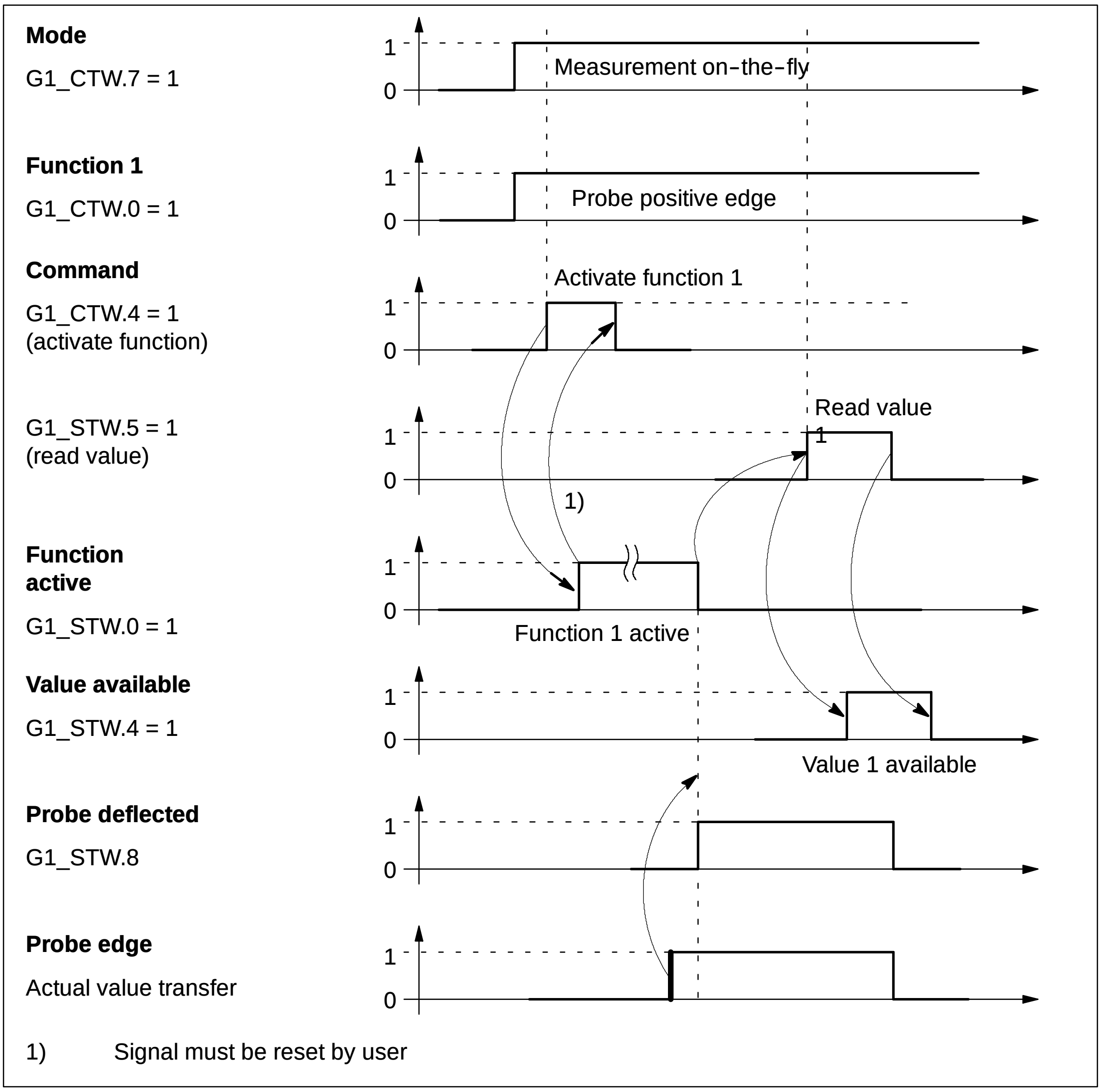


Fig. 4-11 Function chart for “measurement on-the-fly”

Encoder 2 control word (G2_CTW)

- see G1_CTW (Table 4-11)

Encoder 3 control word (G3_CTW)

- see G1_CTW (Table 4-11)

Encoder 1 status word (G1_STW)

The encoder status word is used to display states, errors and acknowledgements.

Table 4-12 Description of the individual signals in Gx_STW

<table>
<tr><th>Bit</th><th colspan="2">Name</th><th colspan="2">Signal state, description</th></tr>
<tr><td>0
1
2
3</td><td rowspan="3">Find reference marker
or
Measure-ment on-the-fly</td><td>Status:
Function 1 - 4 active</td><td colspan="2">Valid for find reference marker and measurement on-the-fly
Bit Meaning
0 Function 1 Reference marker 1
Probe 1 positive edge
1 Function 2 Probe 1 negative edge
2 Function 3 Probe 2 positive edge
3 Function 4 Probe 2 negative edge
Note:
• Bit x = 1 Function active
Bit x = 0 Function inactive</td></tr>
<tr><td>4
5
6
7</td><td>Status:
Value 1 - 4 available</td><td colspan="2">Valid for find reference marker and measurement on-the-fly
Bit Meaning
4 Value 1 Reference marker 1
Probe 1 positive edge
5 Value 2 Probe 1 negative edge
6 Value 3 Probe 2 positive edge
7 Value 4 Probe 2 negative edge
Note:
• Bit x = 1 Value available
Bit x = 0 Value not available
• Only one value can be fetched at a time.
Reason: only one shared status word Gx_XACT2 is available for reading the values.
• The probe must be configured to a “high-speed input” DI/DO on the Control Unit.</td></tr>
<tr><td rowspan="2">8</td><td rowspan="2">Probe 1 deflected</td><td>1</td><td>Probe deflected (high signal)</td></tr>
<tr><td></td><td>0</td><td>Probe not deflected (low signal)</td></tr>
<tr><td rowspan="2">9</td><td rowspan="2"></td><td rowspan="2">Probe 2 deflected</td><td>1</td><td>Probe deflected (high signal)</td></tr>
<tr><td>0</td><td>Probe not deflected (low signal)</td></tr>
<tr><td>10</td><td colspan="2">Reserved</td><td></td><td>–</td></tr>
</table>

Table 4-12 Description of the individual signals in Gx_STW, continued

Bit	Name	Signal state, description	
11	Acknowledge encoder error active	1	Acknowledge encoder error active **Note:** see CTW.15 (acknowledge encoder error)
		0	No acknowledgement active
12	Reserved		–
13	Transmit cyclic absolute value	1	Acknowledgement for Gx_CTW.13 (request cyclic absolute value) **Note:** Cyclic transmission of the absolute value can be interrupted by a function with higher priority. ––> see Fig. 4-13 ––> see Gx_XACT2
		0	No acknowledgement
14	Reserved	1	–
15	Encoder error	1	Error from encoder or actual–value sensing is active. **Note:** The error code is stored in Gx_XACT2
		0	No error is active.

Encoder 1 actual position value 1 (G1_XACT1)

- Resolution: encoder lines • 2^n

  n: fine resolution, no. of bits for internal multiplication

  The fine resolution is specified via p0418.
- Used to transmit the cyclic actual position value to the master.
- The transmitted value is a relative, free-running actual value.
- Any overflows must be evaluated by the master controller.

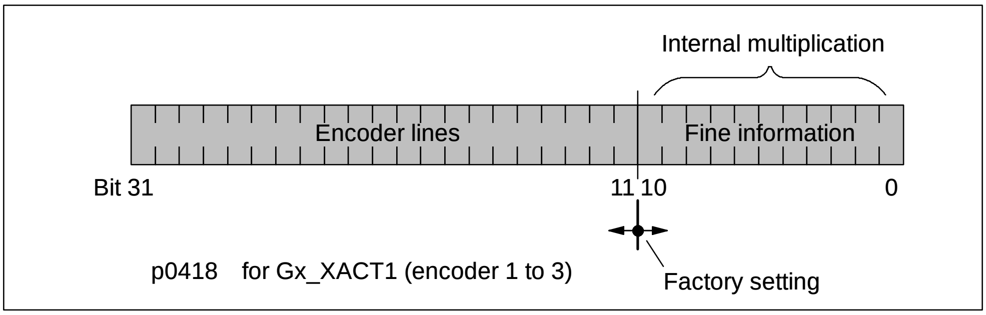


Fig. 4-12 Partitioning and settings for Gx_XACT1

- Encoder lines of incremental encoder
  - For encoders with sin/cos 1Vpp:

    Encoder lines = no. of sinusoidal signal periods
- After power up: Gx_XACT1 = 0
- An overflow in Gx_XACT1 must be trapped by the master controller.
- There is no modulo interpretation of Gx_XACT1 on the drive.

Encoder 1 actual position value 2 (G1_XACT2)

Different values are entered in Gx_XACT2 depending on the function (see Fig. 4-13).

- Priorities for Gx_XACT2

  The following priorities should be considered for values in Gx_XACT2:

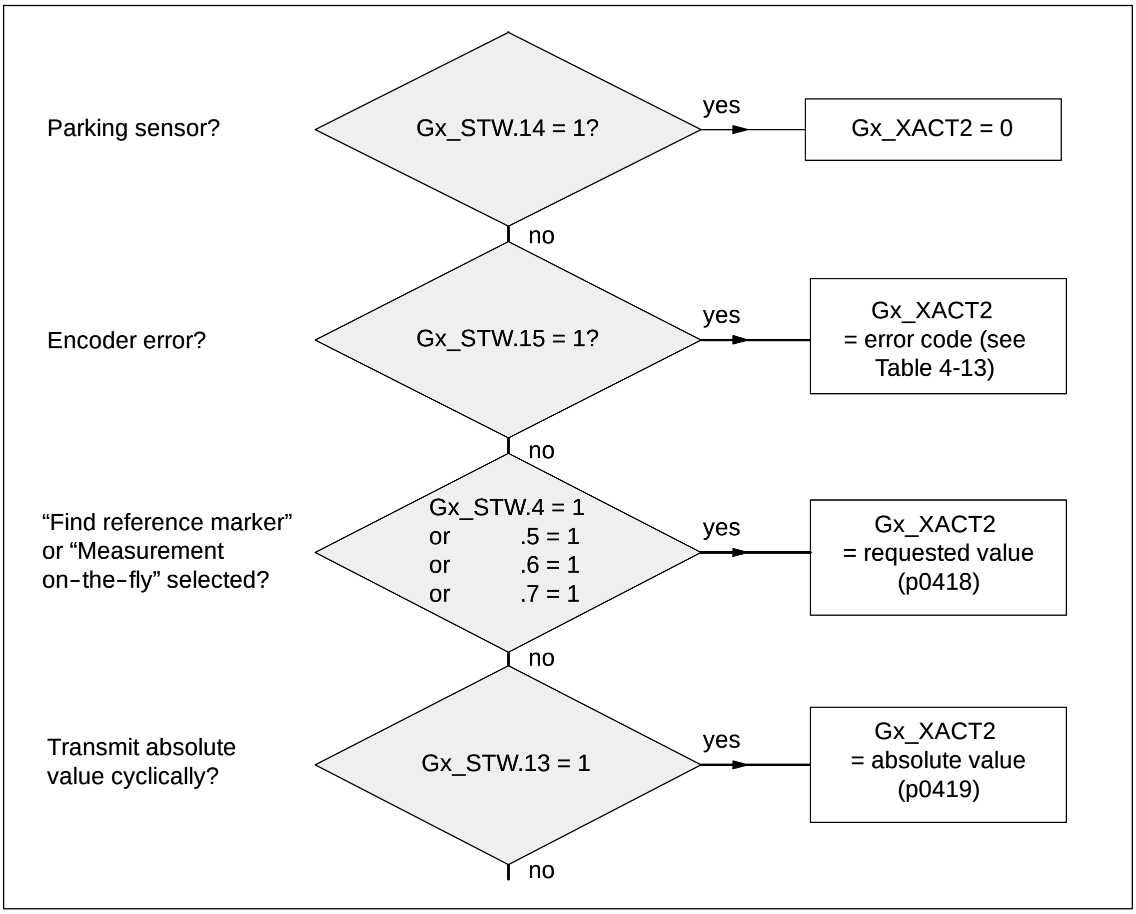


Fig. 4-13 Priorities for functions and Gx_XACT2

- Resolution: encoder lines • 2^n

  n: fine resolution, no. of bits for internal multiplication

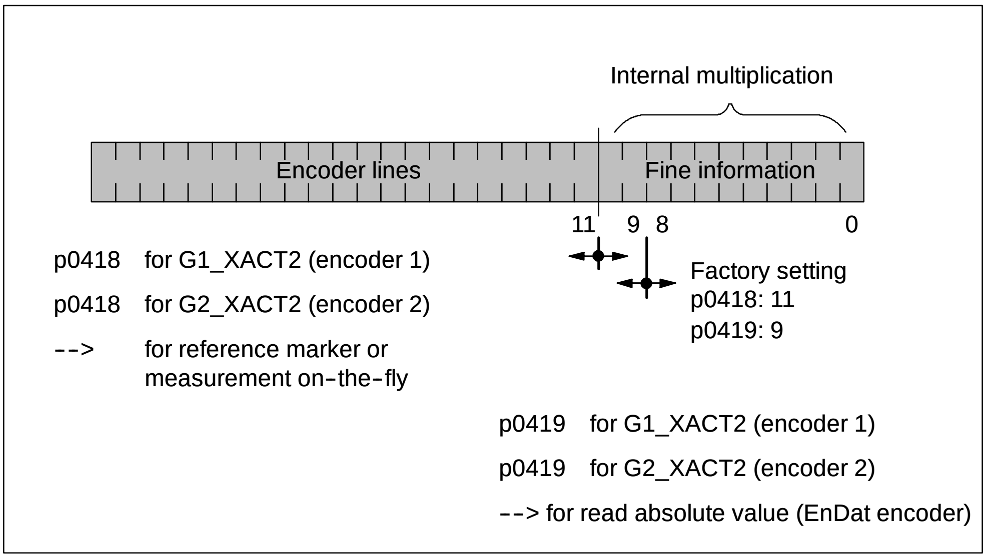


Fig. 4-14 Partitioning and settings for Gx_XACT2

- Encoder lines of incremental encoder
  - For encoders with sin/cos 1Vpp:
    Encoder lines = no. of sinusoidal signal periods

Error code in Gx_XACT2

Table 4-13 Error code in Gx_XACT2

Gx_XACT2	Meaning	Possible causes/description
1	Reserved	Reserved
2	Reserved	Reserved
3	Reserved	Reserved
4	Abort find reference marker	• A fault is active (Gx_STW.15 = 1) • Encoder has no zero marker (reference marker) • Reference marker 2, 3 or 4 is requested • Switchover to “Measurement on-the-fly” during search for reference marker. • Command “Read value x” set during search for reference marker.
5	Abort get reference value	• More than one value requested • No value requested • Requested value not available
6	Measurement on-the-fly abort	• No probe configured p0488, p0489 • Switchover to “Find reference marker” during measurement on-the-fly. • Command “Read value x” set during measurement on-the-fly.

Table 4-13 Error code in Gx_XACT2, continued

Gx_XACT 2	Meaning	Possible causes/description
7	Abort get measured value	• More than one value requested • No value requested • Requested value not available
8	Abort absolute value transmission on	• EnDat encoder not installed

Encoder 2 status word (G2_STW)

- See G1_STW (Table 4-12)

Encoder 2 actual position value 1 (G2_XACT1)

- See G1_XACT1

Encoder 2 actual position value 2 (G2_XACT2)

- See G1_XACT2

Encoder 3 status word (G3_STW)

- See G1_STW (Table 4-12)

Encoder 3 actual position value 1 (G3_XACT1)

- See G1_XACT1

Encoder 3 actual position value 2 (G3_XACT2)

- See G1_XACT2

Function diagram overview (see List Manual)

- 4720 Encoder interface, receive signals, encoders n
- 4730 Encoder interface, send signals, encoders n
- 4740 Measuring probe evaluation, measured value memory, encoders n

Parameter overview (see List Manual)

Adjustable parameters

- p0480[0...2] CI: signal source for encoder control word Gn_CTW
- p0488[0...2] Measuring probe 1 input terminal
- p0489[0...2] Measuring probe 2 input terminal
- p0490 Invert measuring probe
- p0418[0...15] Fine resolution Gx_XACT1
- p0419[0...15] Fine resolution Gx_XACT2

Visualization parameters

- r0481[0...2] CO: encoder status word Gn_STW
- r0482[0...2] CO: encoder actual position value Gn_XACT1
- r0483[0...2] CO: encoder actual position value Gn_XACT2
- r0487[0...2] CO: diagnostic encoder control word Gn_CTW

4.4 Acyclic communication

4.4.1 General information about acyclic communication

Description

With acyclic communication, as opposed to cyclic communication, data transfer takes place only when an explicit request is made (e.g. in order to read and write parameters).

The DPV1 services (read data set/write data set) are available for acyclic communication.

Note

Please refer to the following documentation for a detailed description of acyclic communication via DPV1:

/PPD/ PROFIdrive Profile Drive Technology

The following options are available for reading and writing parameters:

- S7 protocol

  This protocol uses the STARTER commissioning tool, for example, in online mode via PROFIBUS.

- PROFIdrive parameter channel (DPV1) with data set 47

  The DPV1 services are available for master class 1 and class 2.

Properties of the DPV1 parameter channel

- One 16–bit address each for parameter number and subindex.
- Exchange of user data volumes up to 240 bytes.
- Concurrent access by several PROFIBUS masters (master class 2, e.g. commissioning tool).
- Transfer of different parameters in one access (multiple parameter request).
- Transfer of complete arrays or part of an array possible.
- Only one parameter request is processed at a time (no pipelining).
- A parameter request/response must fit into a data set (max. 240 bytes).

4.4.2 Requests and responses according to DPV1

Structure of parameter request and parameter response

	Parameter request			Offset
	Request header	**Request reference**	**Request ID**	0
		Axis	**No. of parameters**	2
	1st parameter address	**Attribute**	**No. of elements**	4
		Parameter number		6
		Subindex		8
	...			
	Parameter address n	**Attribute**	**No. of elements**	
		Parameter number		
		Subindex		
Values for write access only	1st parameter value(s)	**Format**	**No. of values**	
		Values		
		...		
	...			
	parameter value(s) n	**Format**	**No. of values**	
		Values		
		...		

	Parameter response			Offset
	Response header	**Request reference mirrored**	**Response ID**	0
		Axis mirrored	**No. of parameters**	2
Values for read access only Error values for negative response only	1st parameter value(s)	**Format**	**No. of values**	4
		Values or error values		6
		...		
	...			
	Parameter value(s) n	**Format**	**No. of values**	
		Values or error values		
		...		

Description of fields in DPV1 parameter request and response

Table 4-14 Description of fields

Field	Data type	Values	Comments
Request reference	Unsigned8	0x01 ... 0xFF	
	Unique identification of the request/response pair for the master. The master changes the request reference with each new request. The slave mirrors the request reference in its response.		
Request ID	Unsigned8	0x01 0x02	Read request Write request
	Specifies the type of request. In the case of a write request, the changes are made in a volatile memory (RAM). A save operation is needed in order to transfer the data to the non–volatile memory (p0971, p0977).		
Response ID	Unsigned8	0x01 0x02 0x81 0x82	Read request (+) Write request (+) Read request (–) Write request (–)
	Mirrors the request identifier and specifies whether request execution was positive or negative. Negative means: Cannot execute part or all of request. The error values are transferred instead of the values for each subresponse.		
Axis	Unsigned8	0x00 ... 0xFF	Number
	Addresses an axis on a multi–axis drive. Different axes with separate parameter number ranges can be accessed over the same DPV1 connection.		
No. of parameters	Unsigned8	0x01 ... 0x27	No. 1 ... 39 Limited by DPV1 telegram length
	Defines the number of adjoining areas for the parameter address and/or parameter value for multi–parameter requests. The number of parameters = 1 for single requests.		
Attribute	Unsigned8	0x10 0x20 0x30	Value Description (not implemented) Text (not implemented)
	Type of object accessed.		
No. of elements	Unsigned8	0x00 0x01 ... 0x75	Special function No. 1 ... 117 Limited by DPV1 telegram length
	Number of array elements accessed.		
Parameter number	Unsigned16	0x0001 ... 0xFFFF	Number 1 ... 65535
	Addresses the parameter to be accessed.		

Table 4-14 Description of fields, continued

Field	Data type	Values	Comments
Subindex	Unsigned16	0x0000 ... 0xFFFF	Number 0 ... 65535
	Addresses the first array element of the parameter to be accessed.		
Format	Unsigned8	0x02 0x03 0x04 0x05 0x06 0x07 0x08 Other values 0x40 0x41 0x42 0x43 0x44	Data type Integer8 Data type Integer16 Data type Integer32 Data type Unsigned8 Data type Unsigned16 Data type Unsigned32 Data type FloatingPoint See PROFIdrive Profile V3.1 Zero (without values as a positive subresponse to a write request) Byte Word Double word Error
	The format and number specify the adjoining space containing values in the telegram. Data types in conformity with PROFIdrive Profile V3.1 shall be preferred for write access. Bytes, words and double words are also possible as a substitute.		
No. of values	Unsigned8	0x00 ... 0xEA	No. 0 ... 234 Limited by DPV1 telegram length
	Specifies the number of subsequent values.		
Values or error values	Unsigned16	 0x0000 ... 0x00FF	 For meaning of error values ––> see Table 4-15
	The values of the parameter for read or write access. The error values in the event of a negative response. If the values make up an odd number of bytes, a zero byte is appended. This ensures the integrity of the word structure of the telegram.		

Error values in DPV1 parameter responses

Table 4-15 Error values in DPV1 parameter responses

Error value	Meaning	Comments	Add. infor-mation
0x00	Illegal parameter number	Access to a parameter which does not exist.	–
0x01	Parameter value cannot be changed	Modification access to a parameter value which cannot be changed.	Subindex
0x02	Lower or upper value limit exceeded	Modification access with value outside value limits.	Subindex
0x03	Invalid subindex	Access to a subindex which does not exist.	Subindex
0x04	No array	Access with subindex to an unindexed parameter.	–
0x05	Wrong data type	Modification access with a value which does not match the data type of the parameter.	–
0x06	Illegal set operation (only reset allowed)	Modification access with a value not equal to 0 in a case where this is not allowed.	Subindex
0x07	Description element cannot be changed	Modification access to a description element which cannot be changed.	Subindex
0x09	No description data	Access to a description which does not exist (the parameter value exists).	–
0x0B	No operating priority	Modification access with no operating priority.	–
0x0F	No text array exists	Access to a text array which does not exist (the parameter value exists).	–
0x11	Request cannot be executed due to operating status	Access is not possible temporarily for unspecified reasons.	–
0x14	Illegal value	Modification access with a value which is within the limits but which is illegal for other permanent reasons (parameter with defined individual values).	Subindex
0x15	Response too long	The length of the present response exceeds the maximum transfer length.	–
0x16	Illegal parameter address	Illegal or unsupported value for attribute, number of elements, parameter number, subindex or a combination of these.	–
0x17	Illegal format	Write request: illegal or unsupported parameter data format	–
0x18	No. of values inconsistent	Write request: a mismatch exists between the number of values in the parameter data and the number of elements in the parameter address.	–
0x19	Drive object does not exist	You have attempted to access a drive object that does not exist.	–

Table 4-15 Error values in DPV1 parameter responses, continued

Error value	Meaning	Comments	Add. infor-mation
0x65	Presently deactivated.	You have tried to access a parameter that, although available, is currently inactive (e.g. n control set and access to parameter from V/f control).	–
0x68	Illegal value	Modification request with a value that, although within limits, is impermissible for other reasons (e.g. parameter with defined individual values).	–
0x6B	Parameter %s [%s]: No write access for the enabled controller	–	–
0x6C	Parameter %s [%s]: Unit unknown	–	–
0x6D	Parameter %s [%s]: write access only in the commissioning state, encoder (p0010 = 4).	–	–
0x6E	Parameter %s [%s]: write access only in the commissioning state, motor (p0010 = 3).	–	–
0x6F	Parameter %s [%s]: write access only in the commissioning state, power module (p0010 = 2).	–	–
0x70	Parameter %s [%s]: write access only in fast commissioning state (p0010 = 1).	–	–
0x71	Parameter %s [%s]: write access only in the ready state (p0010 = 0).	–	–
0x72	Parameter %s [%s]: write access only in the commissioning state, parameter reset (p0010 = 30).	–	–
0x73	Parameter %s [%s]: write access only in the commissioning state, Safety (p0010 = 95).	–	–
0x74	Parameter %s [%s]: write access only in the commissioning state, technological application/units (p0010 = 5).	–	–
0x75	Parameter %s [%s]: write access only in the commissioning state (p0010 not equal to 0).	–	–
0x76	Parameter %s [%s]: write access only in the commissioning state, download (p0010 = 29).	–	–
0x77	Parameter %s [%s] may not be written in download.	–	–

Table 4-15 Error values in DPV1 parameter responses, continued

Error value	Meaning	Comments	Add. infor-mation
0x78	Parameter %s [%s]: write access only in the commissioning state, drive configuration (device: p0009 = 3).	–	–
0x79	Parameter %s [%s]: write access only in the commissioning state, definition of the drive type (device: p0009 = 2).	–	–
0x7A	Parameter %s [%s]: write access only in the commissioning state, data set basis configuration (device: p0009 = 4).	–	–
0x7B	Parameter %s [%s]: write access only in the commissioning state, device configuration (device: p0009 = 1).	–	–
0x7C	Parameter %s [%s]: write access only in the commissioning state, device download (device: p0009 = 29).	–	–
0x7D	Parameter %s [%s]: write access only in the commissioning state, device parameter reset (device: p0009 = 30).	–	–
0x7E	Parameter %s [%s]: write access only in the commissioning state, device ready (device: p0009 = 0).	–	–
0x7F	Parameter %s [%s]: write access only in the commissioning state, device (device: p0009 not equal to 0).	–	–
0x81	Parameter %s [%s] may not be written in download.	–	–
0x82	Transfer of the control authority (master) is inhibited by BI: p0806.	–	–
0x83	Parameter %s [%s]: Requested BICO interconnection not possible	BICO output does not supply float values. The BICO input, however, requires a float value.	–
0x84	Parameter %s [%s]: Free BICO interconnection inhibited by p0717.	–	–
0x85	Parameter %s [%s]: Access method not defined.	–	–
0xC8	Below the valid values.	Modification request for a value that, although within “absolute” limits, is below the currently valid lower limit.	–

Table 4-15 Error values in DPV1 parameter responses, continued

Error value	Meaning	Comments	Add. infor-mation
0xC9	Above the valid values.	Modification request for a value that, although within “absolute” limits, is above the currently valid upper limit (e.g. governed by the current converter rating).	–
0xCC	Write access not permitted.	Write access is not permitted because an access key is not available.	–

4.4.3 Determining the axis/drive object numbers

Further information about the drive system (e.g. axis numbers) can be determined as follows using parameters p0101, r0102, and p0107/r0107:

1. The value of parameter r0102 (“Number of drive objects”) for drive object/axis 1 is read via a read request.

   Drive object 1 is the control unit (CU), which is a minimum requirement for each drive system.

2. Depending on the result of the initial read request, further read requests for drive object/axis 1 are used to read the indices for parameter p0101 (“Drive object numbers”), as specified by parameter r0102.

   Example:

   If the number of drive objects is “5”, the values for indices 0 to 4 for parameter p0101 are read.

Note

The first two points provide you with the following information:

- The number of drive objects in the drive system
- The numbers of the existing drive objects

---

3. Following this, parameter r0107/p0107 (“Drive object type”) is read for each drive object/axis (indicated by the drive object number).

   Depending on the drive object, parameter 107 can be either an adjustable or visualization parameter.

   The value of parameter r0107/p0107 indicates the drive object type.

   The following drive object types are available:

   0: No type

   1: SINAMICS S (control unit, always available)

   2: SINAMICS G (control unit)

   3: SINAMICS I (control unit integrated in SIMOTION D4xx)

   4: SINAMICS CX32

   10: Active line module

   11: Servo (servo drive object type)

   12: Vector (vector drive object type)

   100: TB30 (terminal board)

   200: TM31 (terminal module)

   201: TM41 (terminal module)

   202: TM17 high feature (terminal module)

   203: TM15 (terminal module)

   254: CU link

4. From here, refer to the parameter list for each drive object.

4.4.4 Example 1: read parameters

Prerequisites

1. The PROFIBUS master has been commissioned and is fully operational.
2. PROFIBUS communication between master and slave is operational.
3. The master can read and write data sets in conformance with PROFIBUS DPV1.

Task description

Following the occurrence of at least one fault (STW1.3 = “1”) on drive 2, the active fault codes must be read from the fault buffer r0945[0] ... r0945[7].

The request is to be handled using a request and response data block.

Basic procedure

1. Create a request to read the parameters.
2. Invoke the request.
3. Evaluate the response.

Procedure

1. Create the request.

Parameter request			Offset
Request header	Request reference = 25 hex	Request ID = 01 hex	0 + 1
	Axis = 02 hex	No. of parameters = 01 hex	2 + 3
Parameter address	Attribute = 10 hex	No. of elements = 08 hex	4 + 5
	Parameter no. = 945 dec		6
	Subindex = 0 dec		8

Information about the parameter request:

- Request reference:

  The value is selected at random from the valid value range. The request reference establishes the relationship between request and response.

- Request ID:

  01 hex --> This identifier is required for a read request.

- Axis:

  02 hex --> Drive 2, fault buffer with drive and device-specific faults
- No. of parameters:

  01 hex --> One parameter is read.
- Attribute:

  10 hex --> The parameter values are read.
- No. of elements:

  08 hex --> The current fault incident with 8 faults is to be read.
- Parameter number:

  945 dec --> p0945 (fault code) is read.
- Subindex:

  0 dec --> Read access starts at index 0.

2. Invoke the parameter request.

   If STW1.3 = “1” --> Invoke parameter request.
3. Evaluate the parameter response.

Parameter response			Offset
Response header	Request reference mirrored = 25 hex	Response ID = 01 hex	0 + 1
	Axis mirrored = 02 hex	No. of parameters = 01 hex	2 + 3
Parameter value	Format = 06 hex	No. of values = 08 hex	4 + 5
	1st value = 1355 dec		6
	2nd value = 0 dec		8
	...		...
	8th value = 0 dec		20

Information about the parameter response:

- Request reference mirrored:

  This response belongs to the request with request reference 25.
- Response ID:

  01 hex --> Read request positive, values stored as of 1st value
- Axis mirrored, no. of parameters:

  The values correspond to the values from the request.
- Format:

  06 hex --> Parameter values are in Unsigned16 format.

- No. of values:

  08 hex --> 8 parameter values are available.
- 1st value ... 8th value

  A fault is only entered in value 1 of the fault buffer for drive 2.

4.4.5 Example 2: write parameters (multi-parameter request)

Prerequisites

1. The PROFIBUS master has been commissioned and is fully operational.
2. PROFIBUS communication between master and slave is operational.
3. The master can read and write data sets in conformance with PROFIBUS DPV1.
4. Control type: Vector controller

Task description

Jog 1 and 2 are to be set up for drive 2 via the input terminals of the control unit. A parameter request is to be used to write the corresponding parameters as follows:

- BI: p1055 = r0722.4 Jog bit 0
- BI: p1056 = r0722.5 Jog bit 1
- p1058 = 300 rpm Jog 1 speed setpoint
- p1059 = 600 rpm Jog 2 speed setpoint

The request is to be handled using a request and response data block.

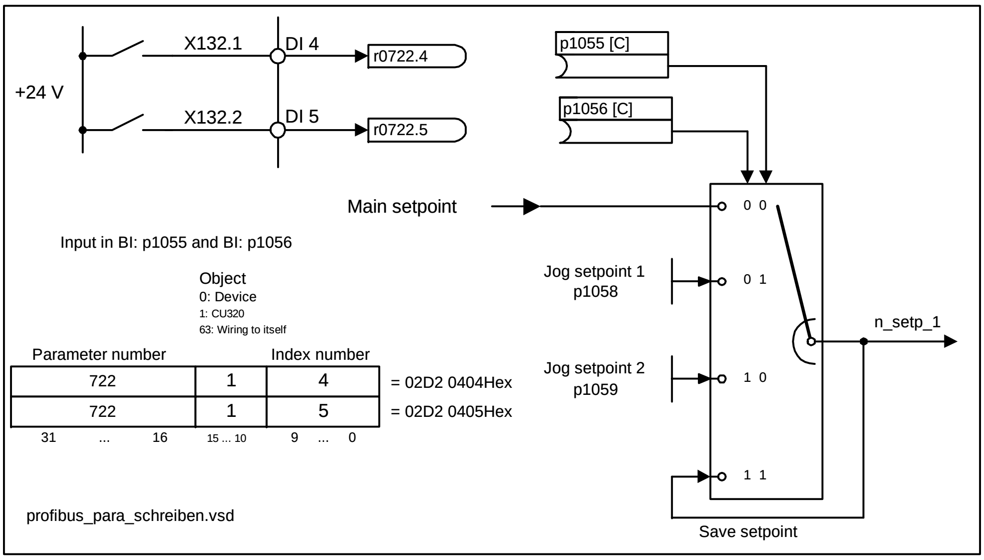


Fig. 4-15 Task description for multi-parameter request (example)

Basic procedure

1. Create a request to write the parameters.
2. Invoke the request.
3. Evaluate the response.

Procedure

1. Create the request.

Parameter request			Offset
Request header	Request reference = 40 hex	Request ID = 02 hex	0 + 1
	Axis = 02 hex	No. of parameters = 04 hex	2 + 3
1st parameter address	Attribute = 10 hex	No. of elements = 01 hex	4 + 5
	Parameter no. = 1055 dec		6
	Subindex = 0 dec		8
2nd parameter address	Attribute = 10 hex	No. of elements = 01 hex	10 + 11
	Parameter no. = 1056 dec		12
	Subindex = 0 dec		14
3rd parameter address	Attribute = 10 hex	No. of elements = 01 hex	16 + 17
	Parameter no. = 1058 dec		18
	Subindex = 0 dec		20
4th parameter address	Attribute = 10 hex	No. of elements = 01 hex	22 + 23
	Parameter no. = 1059 dec		24
	Subindex = 0 dec		26
1st parameter value(s)	Format = 07 hex	No. of values = 01 hex	28 + 29
	Value = 02D2 hex		30
	Value = 0204 hex		32
2nd parameter value(s)	Format = 07 hex	No. of values = 01 hex	34 + 35
	Value = 02D2 hex		36
	Value = 0205 hex		38
3rd parameter value(s)	Format = 08 hex	No. of values = 01 hex	40 + 41
	Value = 4396 hex		42
	Value = 0000 hex		44
4th parameter value(s)	Format = 08 hex	No. of values = 01 hex	46 + 47
	Value = 4416 hex		48
	Value = 0000 hex		50

Information about the parameter request:

- Request reference:

  The value is selected at random from the valid value range. The request reference establishes the relationship between request and response.

- Request ID:

  02 hex --> This identifier is required for a write request.

- Axis:

  02 hex --> The parameters are written to drive 2.

- No. of parameters

  04 hex --> The multi-parameter request comprises 4 individual parameter requests.

1st parameter address ... 4th parameter address

- Attribute:

  10 hex --> The parameter values are to be written.

- No. of elements

  01 hex --> 1 array element is written.

- Parameter number

  Specifies the number of the parameter to be written (p1055, p1056, p1058, p1059).

- Subindex:

  0 dec --> ID for the first array element.

1st parameter value ... 4th parameter value

- Format:

  07 hex --> Unsigned32 data type

  08 hex --> FloatingPoint data type

- No. of values:

  01 hex --> A value is written to each parameter in the specified format.

- Value:

  BICO input parameter: enter signal source (see Fig. 4-15)

  Adjustable parameter: enter value

2. Invoke the parameter request.

3. Evaluate the parameter response.

Parameter response			Offset
Response header	Request reference mirrored = 40 hex	Response ID = 02 hex	0
	Axis mirrored = 02 hex	No. of parameters = 04 hex	2

Information about the parameter response:

- Request reference mirrored:

  This response belongs to the request with request reference 40.
- Response ID:

  02 hex --> Write request positive
- Axis mirrored:

  02 hex --> The value matches the value from the request.
- No. of parameters:

  04 hex --> The value matches the value from the request.

4.5 Motion control with PROFIBUS

Description

The “Motion control with PROFIBUS” function can be used to implement an isochronous drive link between a master and one or more slaves via the PROFIBUS field bus.

Note

The isochronous drive link is defined in the following documentation:

/PPD/ PROFIdrive Profile Drive Technology

Properties

- No additional parameters have to be entered in addition to the bus configuration in order to activate this function. All that is necessary is to initialize the master and slave for the function.
- Fixed sampling times are used for all data communication.
- The Global Control (GC) clock information is transmitted before the beginning of each cycle.
- The length of the clock cycle depends on the drive configuration:
  - Large number of drives -> long cycle
  - Large number of slaves -> long cycle
- A sign-of-life counter is used to monitor user data transfer and clock pulse failures.

Overview of closed-loop control

- Sensing of the actual position value on the slave can be performed using:
  - An indirect measuring system (motor encoder)
  - An additional direct measuring system
- The encoder interface must be configured in the process data.
- The control loop is closed via the PROFIBUS.
- The position controller is located on the master.
- The current and speed control systems and actual value sensing (encoder interface) are located on the slave.
- The position controller clock cycle is transmitted across the field bus to the slaves.
- The slaves synchronize their speed and/or current controller cycle with the position controller cycle on the master.
- The speed setpoint is specified by the master.

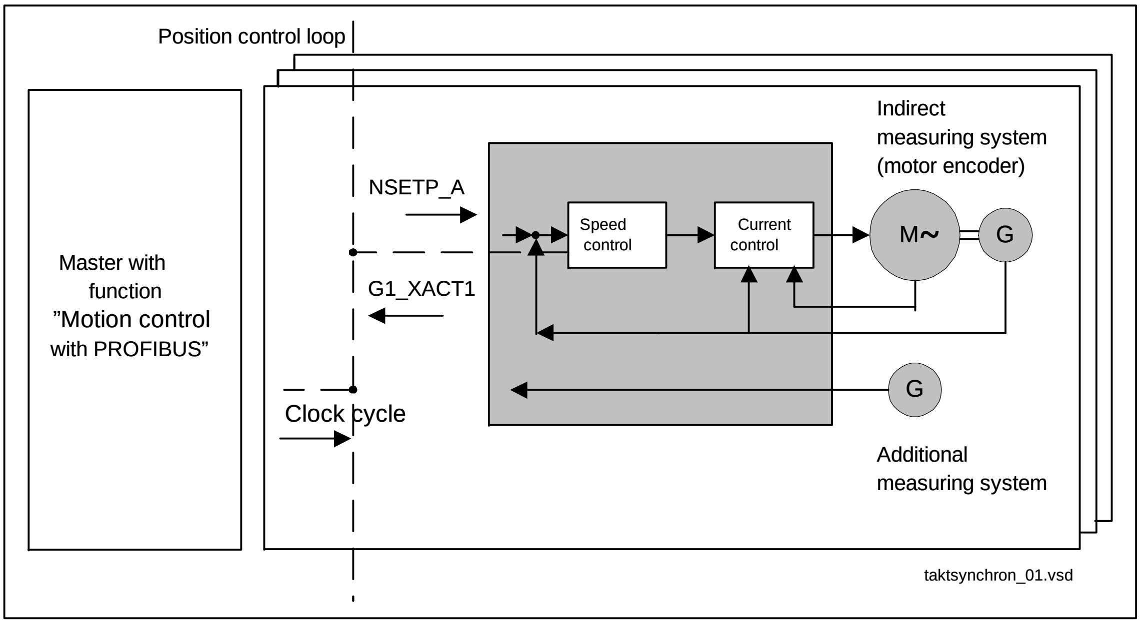


Fig. 4-16 Overview of “Motion control with PROFIBUS” (example: master and 3 slaves)

Structure of the data cycle

The data cycle comprises the following elements:

1. Global control telegram
2. Cyclic part
   - Setpoints and actual values
3. Acyclic part
   - Parameters and diagnostic data
4. Reserved part
   - Transmission of token
   - For searching for a new node in the drive line-up
   - Waiting time until next cycle

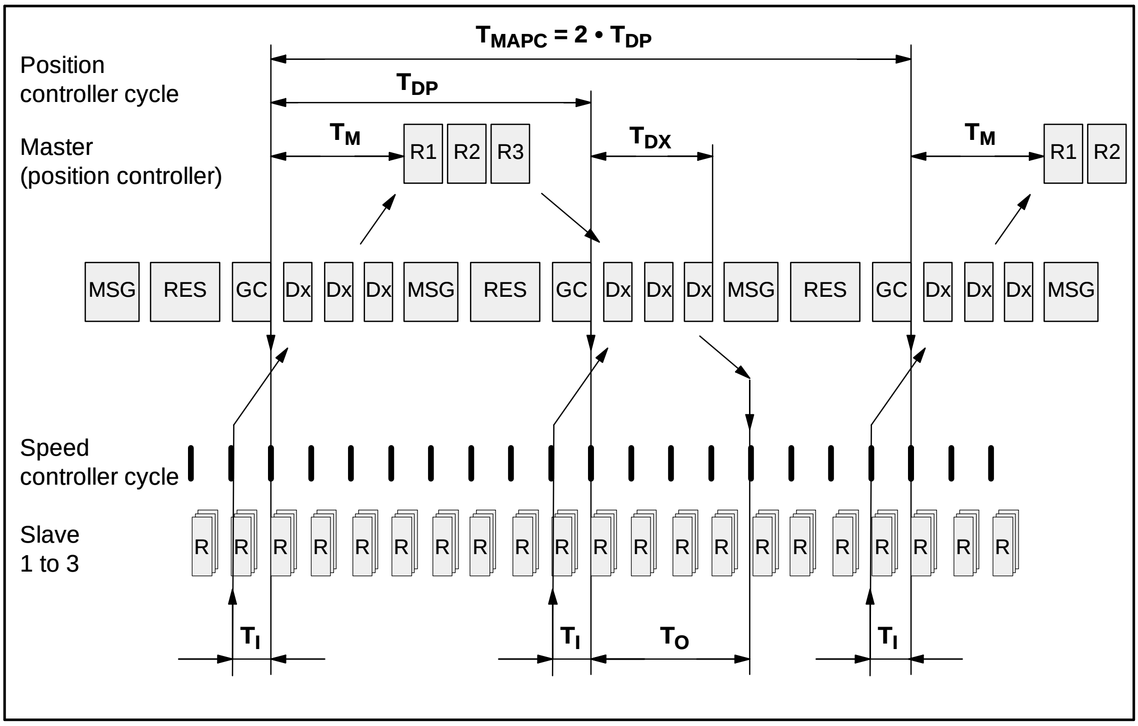


Fig. 4-17 Example: Optimized cycle with $T_{MAPC} = 2 \cdot T_{DP}$

Sequence of data transfer to closed-loop control system

1. Actual position value G1_XACT1 is read into the telegram image at time T_I before the start of each cycle and transferred to the master in the next cycle.
2. Closed-loop control on the master starts at time T_M after each position controller cycle and uses the current actual values read previously from the slaves.
3. In the next cycle, the master transmits the calculated setpoints to the telegram image of the slaves. The speed setpoint command NSETP_A is issued to the closed-loop control system at time T_O after the beginning of the cycle.

Designations and descriptions for Motion Control

Table 4-16 Time settings and meanings

Name	Value[1)]	Limit value	Description
T_{BASE_DP}	5DC hex ≐ 1500 dec	–	Time base for T_{DP} Calculation: $T_{BASE\_DP} = 1500 \cdot T_{Bit} = 125\ \mu s$ $T_{Bit} = 1/12\ \mu s$ at 12 Mbaud
T_{DP}	8	$T_{DP} \geq T_{DP\_MIN}$	Cycle time T_{DP} = integer multiple • T_{BASE_DP} Calculation: $T_{DP} = 8 \cdot T_{BASE\_DP} = 1$ ms

Table 4-16 Time settings and meanings, continued

Name	Value[1)]	Limit value	Description
		$T_{DP\_MIN} = 8$	Minimum DP cycle time Calculation: $T_{DP\_MIN} = 8 \bullet T_{BASE\_DP} = 1$ ms
T_{MAPC}	1	$n \bullet T_{DP}$ n = 1 – 14	Master application cycle time This is the time frame in which the master application generates new setpoints (e.g. in the position controller cycle). Calculation: $T_{MAPC} = 1 \bullet T_{DP} = 1$ ms
T_{SAPC}			Slave application cycle time
T_{BASE_IO}	5DC hex ≐ 1500 dec	–	Time base for T_I, T_O Calculation: $T_{BASE\_IO} = 1500 \bullet T_{Bit} = 125\ \mu s$ $T_{Bit} = 1/12\ \mu s$ at 12 Mbaud
T_I	2	$T_{I\_MIN} \leq T_I < T_{DP}$ $T_{I\_MIN} = 1$	Time of actual–value sensing This is the time at which the actual position value is captured before the start of each cycle. T_I = integer multiple of T_{BASE_IO} Calculation: $T_I = 2 \bullet 125\ \mu s = 250\ \mu s$ For $T_I = 0$: $T_I = T_{DP}$ Minimum T_I Calculation: $T_{I\_MIN} = 1 \bullet T_{BASE\_IO} = 125\ \mu s$
T_O	4	$T_{DX} + T_{O\_MIN}$ $\leq T_O \leq T_{DP}$ $T_{O\_MIN} = 1$	Time of setpoint transfer This is the time at which the transferred setpoints (speed setpoint) are accepted by the closed–loop control system after the start of the cycle. T_O = integer multiple of T_{BASE_IO} Calculation: $T_O = 4 \bullet 125\ \mu s = 500\ \mu s$ For $T_O = 0$: $T_O \doteq T_{DP}$ Minimum time interval between T_O and T_{DX} $T_{O\_MIN} = 1 \bullet T_{BASE\_IO} = 125\ \mu s$
T_{DX}	E10 hex ≐ 3600 dec	$T_{DX} < T_{DP}$	Data exchange time This is the time required within one cycle for transferring process data to all available slaves. T_{DX} = integer multiple of T_{Bit} $T_{Bit} = 1/12\ \mu s$ at 12 Mbaud Calculation: $T_{DX} = 3600 \bullet T_{BIT} = 300\ \mu s$

Table 4-16 Time settings and meanings, continued

Name	Value[1)]	Limit value	Description
T_{PLL_W}	0	–	PLL window (half the width of the GC synchronization window) The following applies to the setting: • Small window --> minimization of synchronization fluctuations on the drive • Large window --> higher tolerance of GC fluctuations Calculation: (assumption: T_{PLL_W} = A hex ≙ 10 dec) $T_{PLL\_W} = 10 \bullet T_{BIT} = 0.833\ \mu s$ $T_{Bit} = 1/12\ \mu s$ at 12 Mbaud
T_{PLL_D}	0	–	PLL dead time The PLL dead time can be used to compensate for different data transfer times to the slaves (e.g. due to repeaters). The slaves with faster transfer times are delayed with a corresponding PLL dead time. Calculation: $T_{PLL\_D} = 0 \bullet T_{BIT} = 0\ \mu s$ $T_{Bit} = 1/12\ \mu s$ at 12 Mbaud
GC			Global control telegram (broadcast telegram)
T_{TH}			Token hold time This time is calculated by the engineering system.
Dx			Data_Exchange This service is used to implement user data exchange between master and slave 1 – n.
MSG			Acyclic service After cyclic transmission, the master checks whether the token hold time has already expired. If not, another acyclic DPV1 service is transmitted.
RES			Reserve: “Active pause” until expiry of the isochronous cycle
R			Processing time for speed or position controller
T_M			Master time This is the time from the start of the position controller cycle to the start of master closed-loop control.
GAP			Attempt to open connection with new node. This attempt takes place every xth cycle.
T_J			T_J returns the duration of the cycle jitter. The cycle jitter is the delay of the GC telegram.

1) The values correspond to device master file si0280e5.gsd

Setting criteria for times

- Cycle (T_{DP})
  - T_{DP} must be set to the same value for all bus nodes.
  - $T_{DP} > T_{DX}$ and $T_{DP} \geqq T_O$

    T_{DP} is thus large enough to enable communication with all bus nodes.

Notice

After T_{DP} has been changed on the PROFIBUS master, the drive system must be switched on (POWER ON).

- T_I and T_O
  - Setting the times in T_I and T_O as small as possible reduces the dead time in the position control loop.
  - $T_O > T_{DX} + T_{Omin}$
- A tool is available for settings and optimization.
  - Allow a reserve.

    Further class 2 masters can be connected.

    Non-cyclic communication can take place.

Minimum time for reserve

Table 4-17 Minimum time for reserve

Data	**Time required** [µs]
Basic load	300
Per slave	20
Per byte of user data	1.5
One additional class 2 master	500

User data integrity

User data integrity is verified in both transfer directions (master <--> slave) by a sign-of-life (4-bit counter).

The sign-of-life counters are incremented from 1 to 15 and then start again at 1.

- Master sign-of-life
  - CTW2.12 ... CTW2.15 are used for the master sign-of-life.
  - The master sign-of-life counter is incremented on each master application cycle (T_{MAPC}).
  - The number of sign-of-life errors tolerated can be set via p0925.
  - p0925 = 65535 deactivates sign-of-life monitoring on the slave.
  - Monitoring

    The master sign-of-life is monitored on the slave and any sign-of-life errors are evaluated accordingly.

    The maximum number of tolerated master sign-of-life errors with no history can be set via p0925.

    If the number of tolerated sign-of-life errors set in p0925 is exceeded, the response is as follows:

    --> A corresponding message is output.

    --> The value zero is output as the slave sign-of-life.

    --> Synchronization with the master sign-of-life is started.
- Slave sign-of-life
  - STW2.12 ... STW2.15 are used for the slave sign-of-life.
  - The slave sign-of-life counter is incremented in each DP cycle (T_{DP}).

■

Drive functions

5

5.1 Active infeed

5.1.1 Active infeed closed-loop control

Description

Active infeed closed-loop control works together with the line reactor as a step-up converter. The level of the DC link voltage can be set by parameterization.

The open and closed-loop control firmware for the active line module runs on the control unit assigned to it. The active line module and control unit communicate via DRIVE-CLiQ.

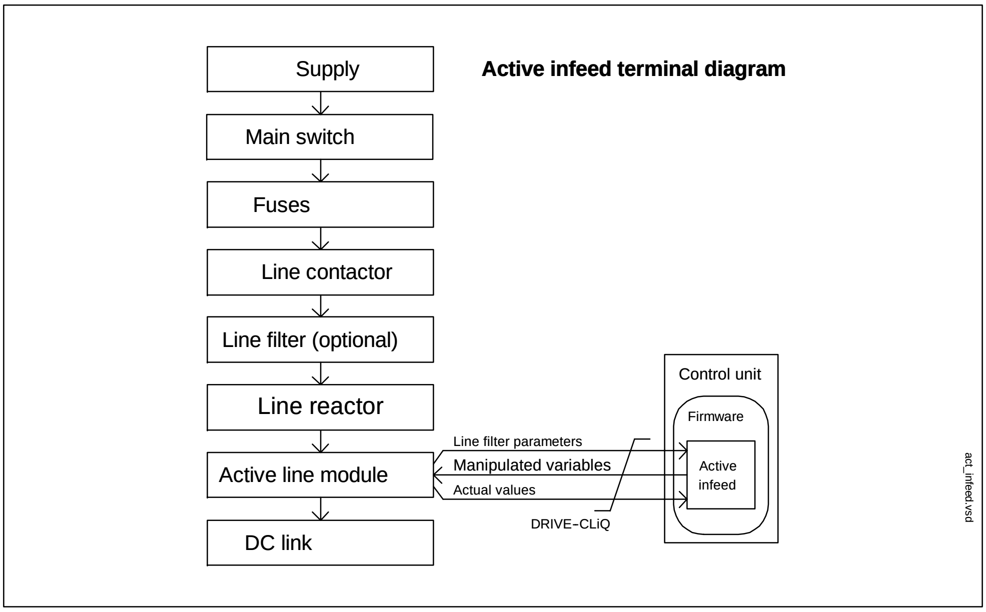


Fig. 5-1 Terminal diagram for active infeed booksize

Properties

- Regulated DC link voltage
- Level of DC link voltage adjustable
- Low phase effect

Control types

The active line module can be operated in two different control modes depending on the parameterized line supply voltage (p0210):

- Active mode

  In the active mode, the DC link voltage is regulated to a settable value.

  Step–up converter with regulated DC link voltage and sinusoidal line supply voltage.

- Smart mode

  In the smart mode, the DC link voltage is not regulated but is, instead, derived from the rectified line supply voltage.

Simple commissioning

The rated line supply voltage (p0210) and rated line frequency must be parameterized during commissioning.

The DC link voltage setpoint (p3510) is preset as follows during commissioning in line with the rated line supply voltage (p0210):

Table 5-1 Presetting the control type and DC link voltage

Line voltage p0210 [V]	380–400	401–415	416–440	460	480
Control type p3400.0	Active mode		Smart mode		
Vdc_setp p3510 [V]	600	625	562–594[1)]	621[1)]	648[1)]

1) Voltages specified for the smart mode are derived from the rectified line supply voltage. The DC link voltage setpoint (p3510) has no effect in this control mode.

In the active mode, the DC link voltage (p3510) can be set within the following limits:

- Upper limit: maximum DC link voltage (p0280)
- Lower limit: rated line supply voltage (p0210) multiplied by 1.42

Note

In a supply system without regenerative feedback capability (e.g. generators), the regenerative operation must be inhibited via the binector input p3533.

Function diagram overview (see List Manual)

- 1774 Overviews – active infeed

Parameter overview (see List Manual)

Adjustable parameters

- p0210 Rated line supply voltage
- p0280 DC link voltage maximum steady-state
- p3400 Infeed configuration word
- p3510 Infeed DC link voltage setpoint
- p3533 BI: Infeed, inhibit regenerative operation

5.1.2 Line and DC link identification

Automatic parameter identification is used to determine all the line and DC link parameters, thereby enabling the controller setting for the line module to be optimized.

Note

If the line environment or DC link components are changed, automatic identification should be repeated with p3410 = 4 (e.g. once the system has been installed or the drive line-up extended).

When the identification function is activated, alarm A06400 is output.

Identification methods

- p3410 = 1 triggers the identification function for the total inductance and DC link capacitance the next time a pulse is enabled. The results are displayed in r3411 and r3412.

  This identification method can be used to check the data in parameters p3421 and p3422 active for closed-loop control.
- p3410 = 2 copies the data (r3411 und r3412) determined during identification (p3410 = 1) to p3421 und p3422 (volatile). The controller is then recalculated. p0977 = “1” can be used to store the parameters in a non-volatile memory.
- p3410 = 3 triggers the identification function for the total inductance and DC link capacitance the next time a pulse is enabled. The data determined during identification is copied to p3421 and p3422 and the controller is recalculated. All the infeed parameters are then automatically stored in a non-volatile memory.

- In addition to p3410 = 3, p3410 = 4 determines the parameters for adapting the current controller (p3620 and p3622).

Note

You are advised to use this identification method.

- p3410 = 5 recalculates the controller before identification is carried out on the basis of standard values (p0223 and p0227). Identification is then started in the same way as with p3410 = 4.

  Closed-loop control may have to be reset to the factory setting if the identification process is unsuccessful.

Parameter overview (see List Manual)

- p3410 Infeed identification method
- p3421 Infeed inductance
- p3422 Infeed DC link capacity
- p3620 Infeed current controller adaptation lower application threshold
- p3622 Infeed current controller adaptation reduction factor
- r3411 Infeed identified inductance
- r3412 Infeed DC-link capacitance identified

5.1.3 Line contactor control

Description

This function can be used to control an external line contactor. Opening and closing the line contactor can be monitored by evaluating the feedback contact in the line contactor.

The line contactor can be controlled using two drive objects:

- Via bit r0863.1 of drive object A_INFEED
- Via bit r0863.1 of drive object SERVO/VECTOR

Example of commissioning line contactor control

Assumption:

- Line contactor control via a digital output of the control unit (DI/DO 8)
- Line contactor feedback via a digital input of the control unit (DI/DO 9)
- Line contactor switching time less than 100 ms

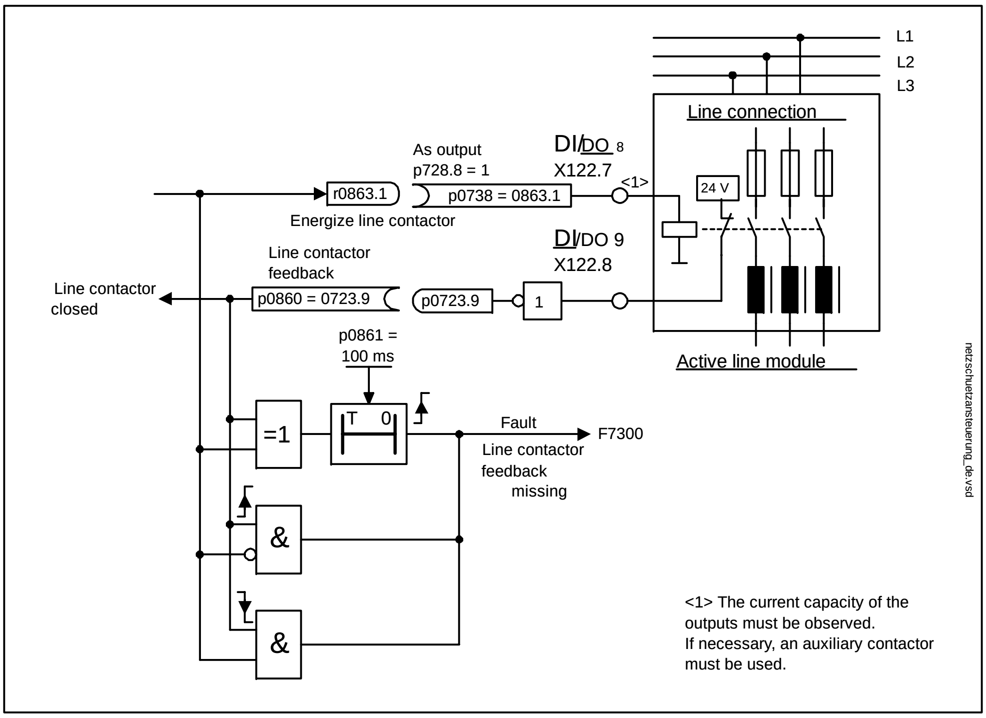


Fig. 5-2 Line contactor control

Commissioning steps:

- Connect the line contactor control contact to DI/DO 8.

Note

Note the current capacity of the digital output (see Equipment Manual); if necessary, use an auxiliary contactor.

- Parameterize DI/DO 8 as an output (p728.8 = 1).
- Assign p0738 the control signal for the line contactor r0863.1.
- Connect the line contactor feedback contact to DI/DO 9.
- Assign p0860 an inverted input signal p0723.9.
- Enter the monitoring time for the line contactor (100 ms) in p0861.

Function diagram overview (see List Manual)

- 8934 Missing enable signals, line contactor control

Parameter overview (see List Manual)

- r0863.1 CO/BO: Drive coupling status word/control word
- p0860 BI: Line contactor feedback

5.1.4 Active infeed open-loop control

Description

The active line module can be controlled via terminals and a field bus. The operating status is indicated on the operating display r0002. The missing enable signals for operation (r0002 = 00) are mapped in parameter r0046. The EP terminals (enable pulses) must be connected in accordance with the Equipment Manual.

Display/acknowledge error

Errors, the causes of which have been rectified, that are still present can be acknowledged by means of a 0 –> 1 edge at the “Acknowledge error” (p2103.5) signal.

Switching on the active line module:

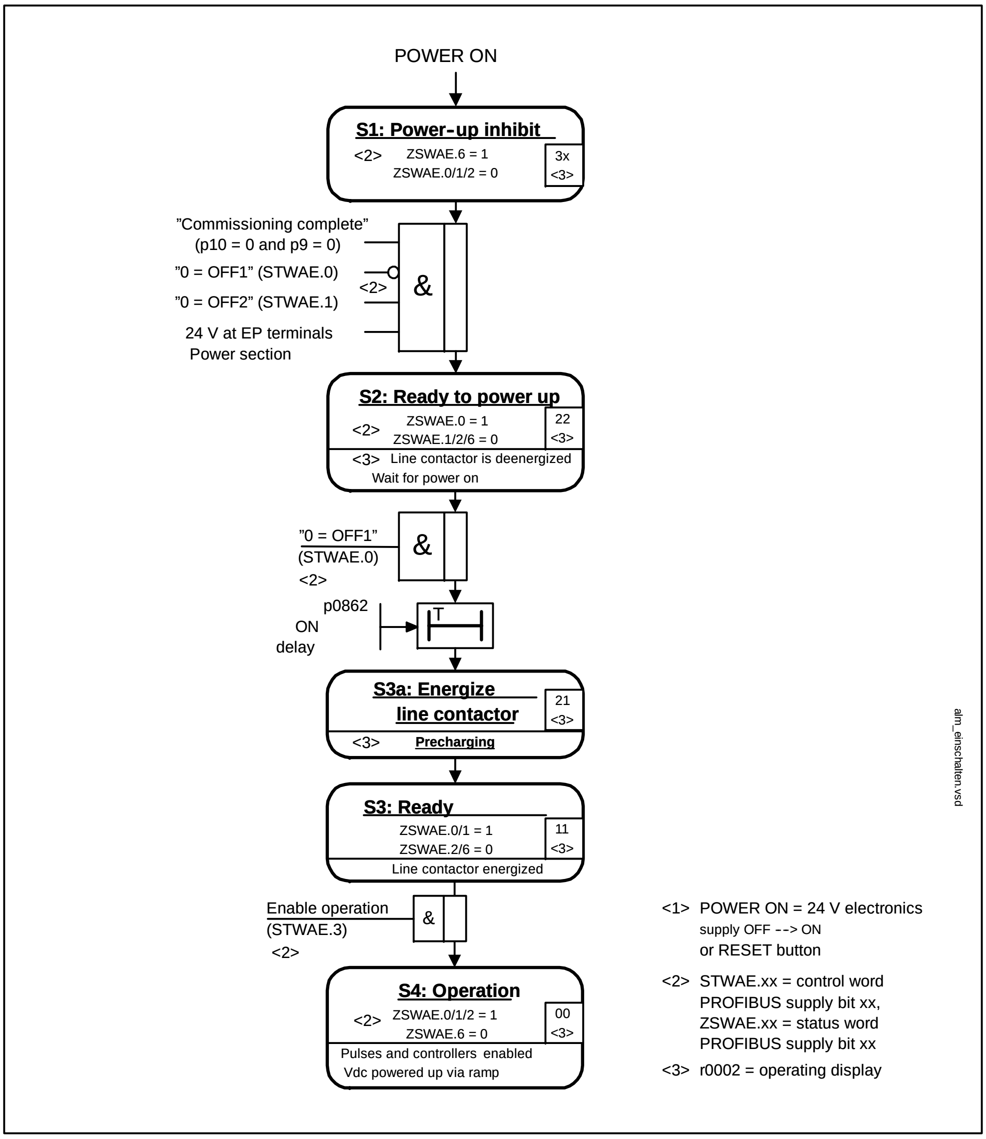


Fig. 5-3 Active infeed ramp-up

Switching off the active line module

To switch off the active line module, carry out the steps for switching it on in reverse order.

Switching off the controller with the OFF signal is delayed by the time entered in p3490 allowing the connected drives to be decelerated in a controlled manner.

Control and status messages

Table 5-2 Active infeed open-loop control

Signal name	Internal control word	Binector input	PROFIBUS telegram 370
OFF (OFF1)	STWAE.0	p0840 ON/OFF2	A_STW1.0
Immediate OFF (OFF2)	STWAE.1	p0844 1 OFF2 and p0845 2 OFF2	A_STW1.1
Enable operation	STWAE.3	p0852 Enable operation	A_STW1.3
Inhibit motoring operation	STWAE.5	p3532 Inhibit motoring operation	A_STW1.5
Inhibit regenerative operation	STWAE.6	p3533 Inhibit regenerative operation	A_STW1.6
Acknowledge error	STWAE.7	p2103 1 Acknowledge or p2104 2 Acknowledge or p2105 3 Acknowledge	A_STW1.7
Control requested by PLC	STWAE.10	p0854 Controlled by PLC	A_STW1.10

Table 5-3 Active infeed status message

Signal name	Internal status word	Parameter	PROFIBUS telegram 370
Ready to power up	ZSWAE.0	r0899.0	A_ZSW1.0
Ready	ZSWAE.1	r0899.1	A_ZSW1.1
Enable operation	ZSWAE.2	r0899.2	A_ZSW1.2
Fault active	ZSWAE.3	r2139.3	A_ZSW1.3
No OFF2 active	ZSWAE.4	r0899.4	A_ZSW1.4
Power-up inhibit	ZSWAE.6	r0899.6	A_ZSW1.6
Warning active	ZSWAE.7	r2139.7	A_ZSW1.7
Controlled by PLC	ZSWAE.9	r0899.9	A_ZSW1.9
Precharging complete	ZSWAE.11	r0899.11	A_ZSW1.11
Line contactor energized feedback	ZSWAE.12	r0899.12	A_ZSW1.12

5.1.5 Harmonics controller

Description

Harmonics in the line voltage cause harmonics in the line currents. By activating the harmonics controller, you can reduce current harmonics.

Example: setting the harmonics controller

The 5th and 7th harmonic are to be compensated:

Table 5-4 Example parameters for the harmonics controller

Index	p3624 harmonics controller order	p3625 scaling
[0]	5	100 %
[1]	7	100 %

The phase currents in parameter p0069[0...2] (U, V, W) can be checked using the STARTER trace function.

Parameter overview (see List Manual)

- p3624 Infeed harmonics controller order
- p3625 Infeed harmonics controller scaling
- r0069[0...6] Phase current, actual value

5.2 Servo setpoint channel

Description

In the servo operating mode, the setpoint channel is deactivated by default. If a setpoint channel is required, it has to be activated.

Properties of the servo without setpoint channel configuration

- The setpoint value is connected directly to p1155[D]
- Deceleration ramp for OFF 1 and OFF 3
- A higher number of motors can be controlled with one control unit by moving the ramp-function generator to the higher-level controller.
- Dynamic Servo Control (DSC) only
- Deceleration ramp OFF1 via p1121[D]
- Deceleration ramp OFF3 via p1135[D]
- Only for PROFIBUS telegrams 2 to 106 and 999 (free assignment)
- STW 1 bit 5 (freeze ramp-function generator), no function

5.2.1 Dynamic Servo Control (DSC)

Description

Dynamic Servo Control (DSC) enables the actual position value to be evaluated in a fast speed controller cycle directly in the drive. The position setpoint is predefined in the position control cycle by the higher-level controller, e.g. SIMOTION, via the isochronous PROFIBUS with PROFIdrive telegrams (not telegram type 1 or 999).

DSC enables high position controller gain, and as a result minimizes following errors and provides a high level of noise immunity.

Function diagram overview (see List Manual)

- 3090 Dynamic Servo Control (DSC)

Parameter overview (see List Manual)

- p1190 CI: DSC position deviation XERR
- p1191 CI: DSC position controller gain KPC
- p1192[D] DSC encoder selection
- p1193[D] DSC encoder adaption factor

5.2.2 Activating the setpoint channel in the servo operating mode

In the servo operating mode, the setpoint channel can be activated via a pull-down menu in STARTER. The pull-down menu is only visible offline in the expert list.

The following configurations can be set.

- BASIS (factory setting)
- CAN
- Setpoint channel
- CAN + setpoint channel

The current configuration can be checked in parameter r0108.

After the configuration has been set, it has to be loaded to the control unit and stored in a non-volatile memory via p0971 or p0977 (copy RAM to ROM).

Fig. 5-4 Pull-down menu configuration

Note

When the setpoint channel for servo is activated, the number of motors that can be controlled with one control unit is reduced.

5.3 Setpoint channel

5.3.1 Description

The setpoint from the setpoint source passes through the setpoint channel to motor control.

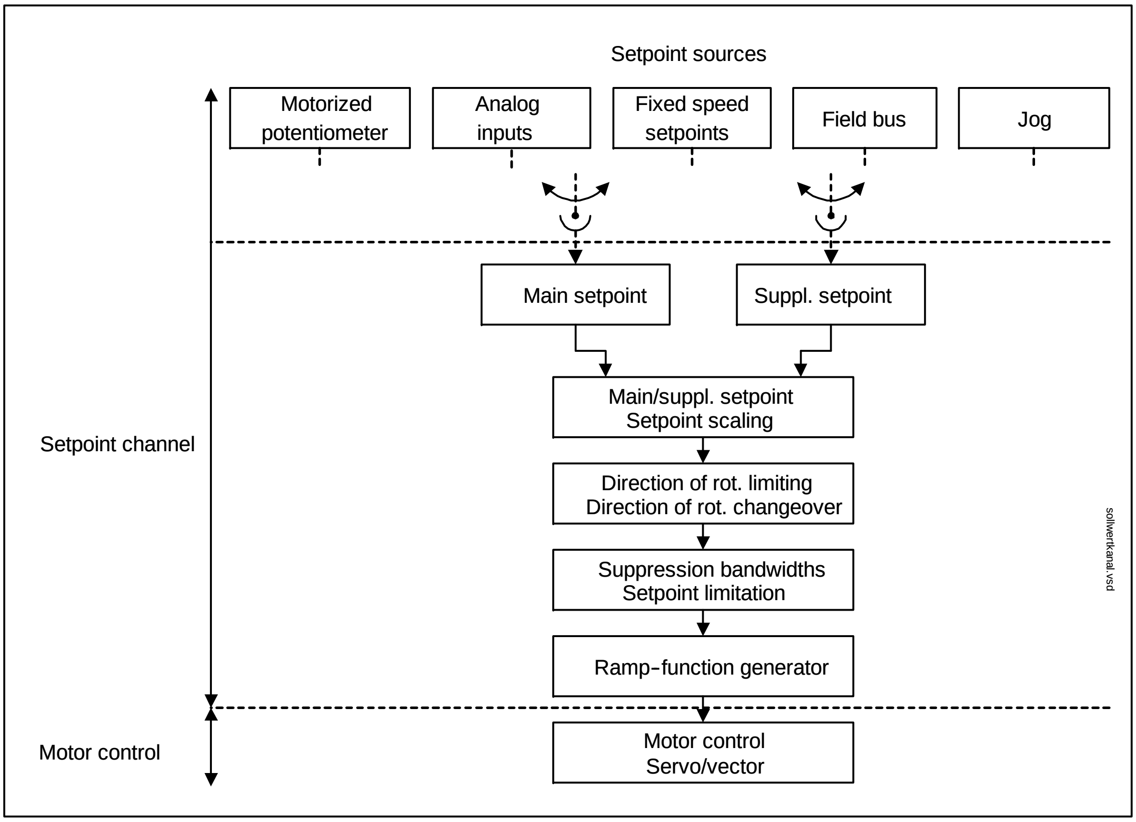


Fig. 5-5 Setpoint channel

Properties of the setpoint channel

- Main/supplementary setpoint, setpoint scaling
- Direction of rotation limiting and direction of rotation changeover
- Suppression bandwidths and setpoint limitation

Setpoint sources

The closed-loop control setpoint can be interconnected from various sources using BICO technology, e. g. to p1070 CI: main setpoint (see function diagram 3030).

There are various options for setpoint input:

- 3010 Fixed speed setpoints
- 3020 Motorized potentiometer
- 3030 Jog
- Field bus
  - PROFIBUS control word, see "Communication via PROFIBUS" chapter
- Via analog inputs using the modules listed below:
  - Terminal board 30 (TB30)
  - Terminal module 31 (TM31)

5.3.2 Jogging

Description

This function can be selected via digital inputs or via a field bus (e.g. PROFIBUS). The setpoint is, therefore, predefined via p1058[D] and p1059[D].

When a jog signal is present, the motor is accelerated to the jog setpoint with the acceleration ramp of the ramp-function generator (referred to the maximum speed p1082; see following diagram). After the jog signal has been deselected, the motor is decelerated via the set ramp of the ramp-function generator.

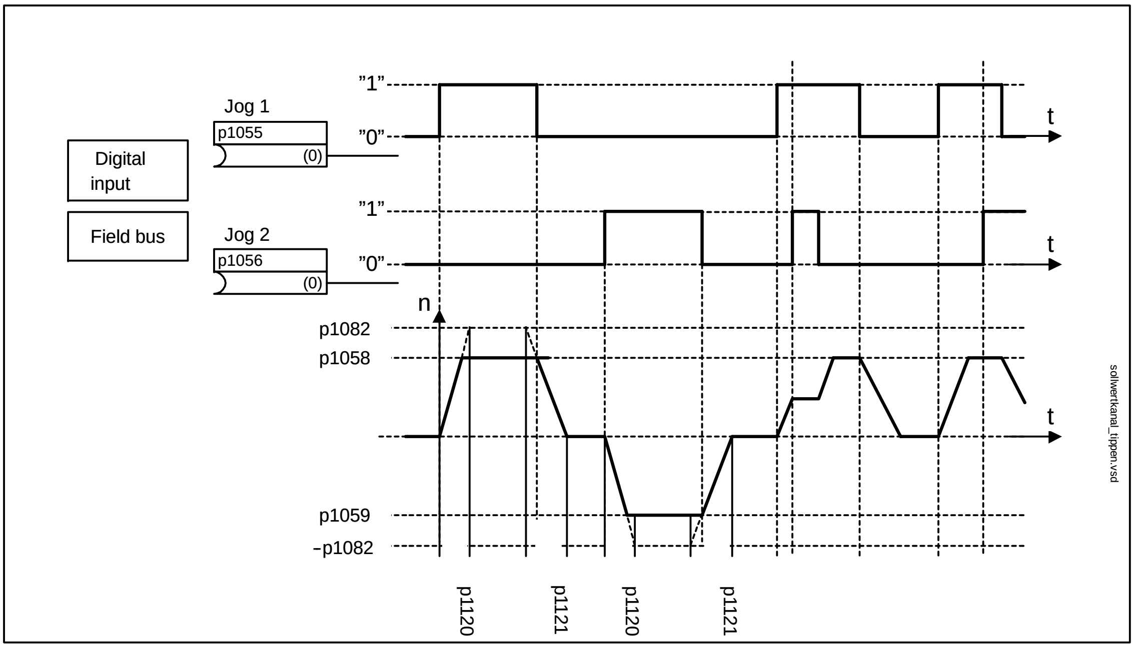


Fig. 5-6 Jog

Jog properties

- If both jog signals are issued at the same time, the current speed is maintained (constant velocity phase).
- Jog setpoints are approached and exited via the ramp-function generator.
- The jog function can only be activated from the “ready to start” status.
- A positive jog signal edge only causes the motor module to be powered up if no ON command is present (i.e. if OFF/ON = 0) and the motor module is not set to the “power-up inhibit” status.
- The jog function can also be activated from the OFF deceleration ramp.
- OFF2 and OFF3 have priority over jogging.
- If the ON command is present after the jog signal has been removed (OFF/ON = 1), the normal speed setpoint will be activated via the ramp-function generator.
- In jog mode, the main speed setpoints (r1078) and the supplementary setpoints 1 and 2 (p1155 and p1160) are inhibited.
- The suppression bandwidths (p1091 ... p1094) and the minimum limit (p1080) in the setpoint channel are also active in jog mode.
- If OFF/ON and jog are selected at the same time, OFF/ON has priority.
- In jog mode, ZSWA.02 (operation enabled) is set to “0” because the speed setpoint has not been enabled for control.

Jog sequence

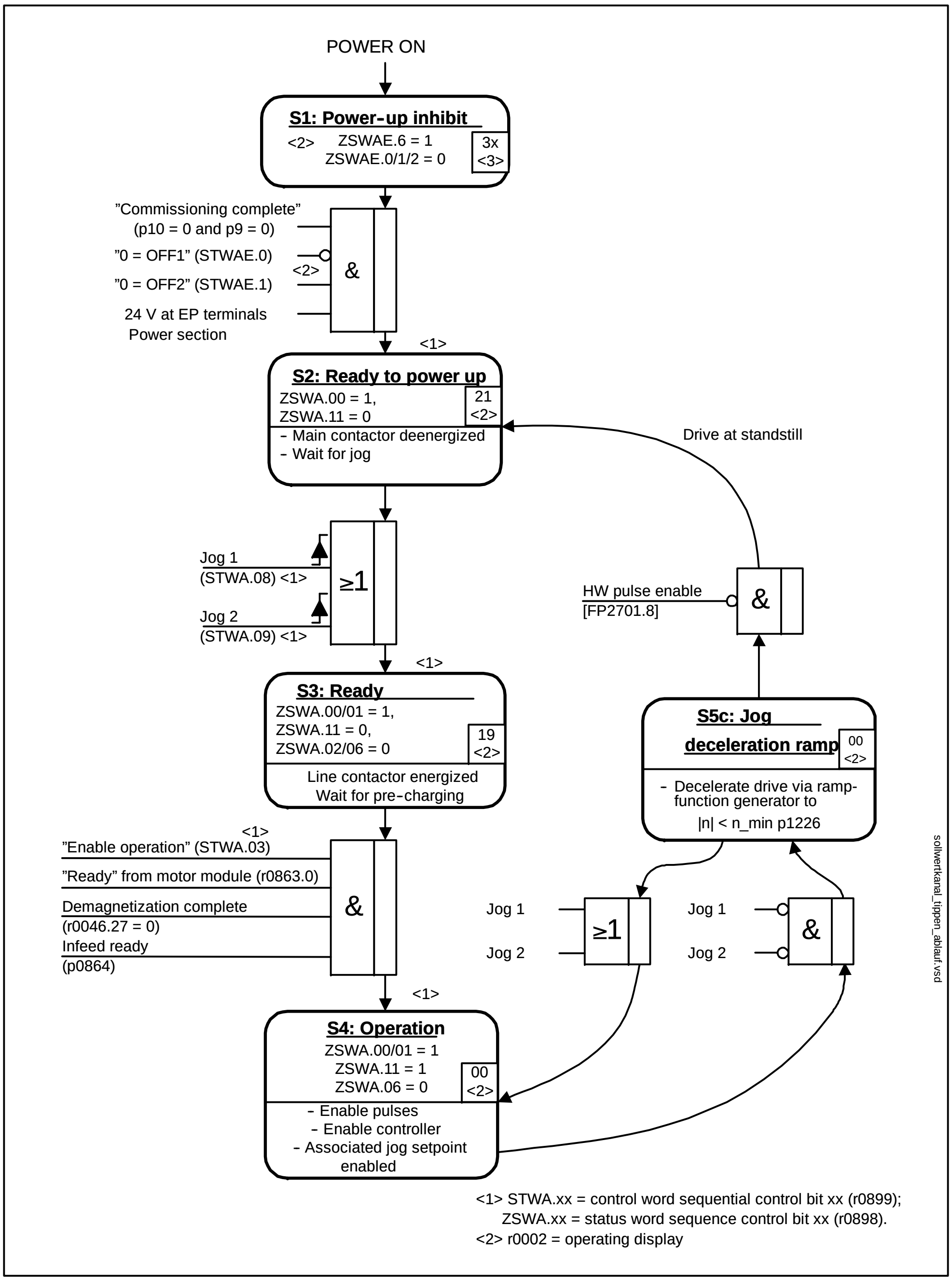


Fig. 5-7 Jog sequence

Control and status messages

Table 5-5 Jog control

Signal name	Internal control word	Binector input	PROFIBUS telegram 2 ... 106
0 = OFF	STWA.00	p0840 ON/OFF1	STW1.0
Enable operation	STWA.03	p0852 Enable operation	STW1.3
Jog 1	STWA.08	p1055 Jog bit 0	STW1.8
Jog 2	STWA.09	p1056 Jog bit 1	STW1.9

Table 5-6 Jog status message

Signal name	Internal status word	Parameter	PROFIBUS telegram 2 ... 106
Ready to power up	ZSWA.00	r0899.0	ZSW1.0
Ready	ZSWA.01	r0899.1	ZSW1.1
Operation enabled	ZSWA.02	r0899.2	ZSW1.2
Power-up inhibit	ZSWA.06	r0899.6	ZSW1.6
Pre-charging completed	ZSWA.11	r0899.11	ZSW1.11

Function diagram overview (see List Manual)

- 2610 Sequence control - control unit
- 3030 Main/added setpoint, setpoint scaling, jogging

Parameter overview (see List Manual)

- p1055[C] BI: Jog bit 0
- p1056[C] BI: Jog bit 1
- p1058[D] Jog 1 speed setpoint
- p1059[D] Jog 2 speed setpoint
- p1082[D] Maximum speed
- p1120[D] Ramp-function generator ramp-up time
- p1121[D] Ramp-function generator ramp-down time

5.3.3 Fixed speed setpoints

Description

This function can be used to specify preset speed setpoints. The fixed setpoints are defined in parameters and selected via binector inputs. Both the individual fixed setpoints and the effective fixed setpoint are available for further interconnection via a connector output (e. g. to connector input p1070 – CI: main setpoint).

Properties

- Number of fixed setpoints: Fixed setpoint 1 to 15
- Selection of fixed setpoints: Binector input bits 0 to 3
  - Binector input bits 0, 1, 2 and 3 = 0 ––> setpoint = 0 active
  - Unused binector inputs have the same effect as a "0" signal

Function diagram overview (see List Manual)

- 1550 Overviews – setpoint channel
- 2503 Status word sequence control
- 3010 Fixed speed setpoints

Parameter overview (see List Manual)

Adjustable parameters

- p1001[D] CO: Fixed speed setpoint 1
- ...
- p1015[D] CO: Fixed speed setpoint 15
- p1020[C] BI: Fixed setpoint selection bit 0
- p1021[C] BI: Fixed setpoint selection bit 1
- p1022[C] BI: Fixed setpoint selection bit 2
- p1023[C] BI: Fixed speed setpoint selection bit 3

Visualization parameters

- r1024 CO: Fixed speed setpoint effective
- r1197 Fixed speed setpoint current number

5.3.4 Motorized potentiometer

Description

This function is used to simulate an electromechanical potentiometer for setpoint input.

You can switch between manual and automatic mode for setpoint input. The specified setpoint is routed to an internal ramp–function generator.

The output of the ramp–function generator for the motorized potentiometer is available for further interconnection via a connector output (e.g. interconnection to connector input p1070 – CI: main setpoint).

Properties for manual mode (p1041)

- Separate binector inputs, e.g. PROFIBUS control signals, for Raise and Lower are used to adjust the input setpoint.
  - p1035 BI: Motorized potentiometer, setpoint, raise (STW1.13)
  - p1036 BI: Motorized potentiometer, lower setpoint (STW1.14)
- Invert setpoint (p1039)

  Inversion is effective only during “Motorized potentiometer raise” or “Motorized potentiometer lower”.
- Configurable ramp–function generator, e.g.:
  - Ramp–up/ramp–down time (p1047/p1048)
  - Setting value (p1047/p1048)
  - Initial rounding–off active/not active (p1030.2)
- Configurable starting value for Power On (p1040)

Properties for automatic mode (p1041)

- The input setpoint is specified via a connector input (p1042).
- The motorized potentiometer acts like a “normal” ramp–function generator.
- Configurable ramp–function generator, e.g.:
  - Switch on/off (p1030.1)
  - Ramp–up/ramp–down time (p1047/p1048)
  - Setting value (p1047/p1048)
  - Initial rounding–off active/not active (p1030.2)
- Configurable setpoint for Power On (p1030)
  - Starting value is the value in p1040 (p1030.0 = 0)

Function diagram overview (see List Manual)

- 1550 Setpoint channel
- 2501 Control word sequence control
- 3020 Motorized potentiometer

Parameter overview (see List Manual)

Adjustable parameters

- p1030[D] Motorized potentiometer, configuration
- p1035[C] BI: Motorized potentiometer, setpoint, raise
- p1036[C] BI: Motorized potentiometer, lower setpoint
- p1037[D] Motorized potentiometer, maximum speed
- p1038[D] Motorized potentiometer, minimum speed
- p1039[C] BI: Motorized potentiometer, inversion
- p1040[D] Motorized potentiometer, starting value
- p1041[C] BI: Motorized potentiometer, manual/automatic
- p1042[C] CI: Motorized potentiometer, automatic setpoint
- p1043[C] BI: Motorized potentiometer, accept setpoint
- p1044[C] CI: Motorized potentiometer, setting value
- p1047[D] Motorized potentiometer, ramp-up time
- p1048[D] Motorized potentiometer, ramp-down time
- p1082[D] Maximum speed

Visualization parameters

- r1045 CO: Motorized potentiometer, speed setpoint in front of ramp-function generator
- r1050 CO: Motorized potentiometer, setpoint after the ramp-function generator

5.3.5 Main/supplementary setpoint and setpoint modification

Description

Fine tuning (correction variable) often needs to be carried out on site for applications in which the command variables are generated by central control systems. With SINAMICS S120, this can be easily carried out using the addition point for the main and supplementary setpoint in the setpoint channel. Both variables are imported simultaneously via two separate or one setpoint source and added in the setpoint channel.

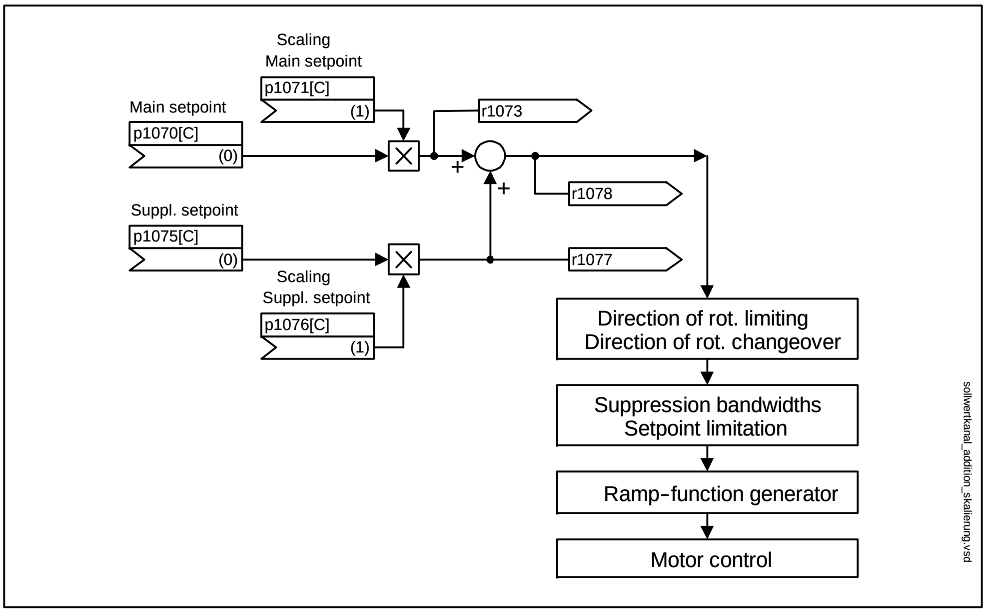


Fig. 5-8 Setpoint addition, setpoint scaling

Function diagram overview (see List Manual)

- 1550 Setpoint channel
- 3030 Main/added setpoint, setpoint scaling, jogging

Parameter overview (see List Manual)

Adjustable parameters

- p1070[C] CI: Main setpoint
- p1071[C] CI: Main setpoint scaling
- p1075[C] CI: Supplementary setpoint
- p1076[C] CI: Supplementary setpoint scaling

Visualization parameters

- r1073[C] CO: Main setpoint effective
- r1077[C] CO: Supplementary setpoint effective
- r1078[C] CO: Total setpoint effective

5.3.6 Direction of rotation limiting and direction of rotation changeover

Description

A reverse operation involves a forwards and backwards movement. Direction of rotation changeover in the setpoint channel can be carried out after the end point has been reached by selecting the direction of rotation changeover parameter p1113[C].

If, on the other hand, a negative or positive setpoint is not to be preselected via the setpoint channel, this can be prevented via parameter p1110[C] and p1111[C].

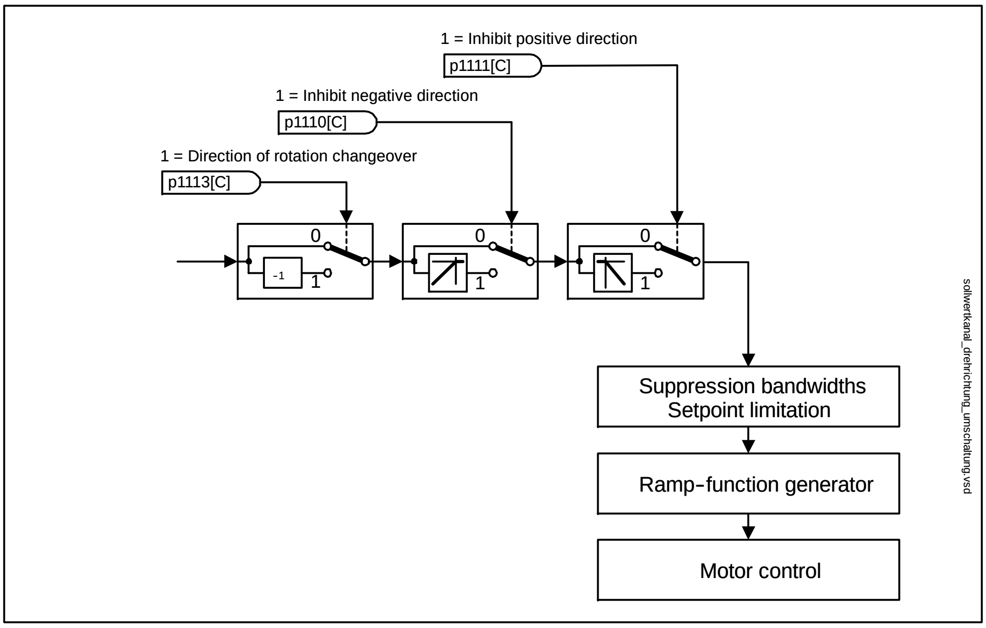


Fig. 5-9 Direction of rotation limiting and direction of rotation changeover

Function diagram overview (see List Manual)

- 1550 Setpoint channel
- 3040 Direction of rotation limiting and direction of rotation changeover

Parameter overview (see List Manual)

Adjustable parameters

- p1110[C] BI: Inhibit negative direction
- p1111[C] BI: Inhibit positive direction
- p1113[C] BI: Direction of rotation changeover

5.3.7 Suppression bandwidths and setpoint limitation

Description

In the range 0 rpm – setpoint speed, machines can have one or more points of resonance. These points of resonance result in vibrations, which, in a worst case scenario, can damage the machine. SINAMICS S120 uses suppression bandwidths to bypass these resonance frequencies as quickly as possible, thereby prolonging the service life of the machine in the long term.

The limit frequencies can be set via p1080[D] and p1082[D]. These limits can be changed during operation with the connectors p1085[C] and p1088[C].

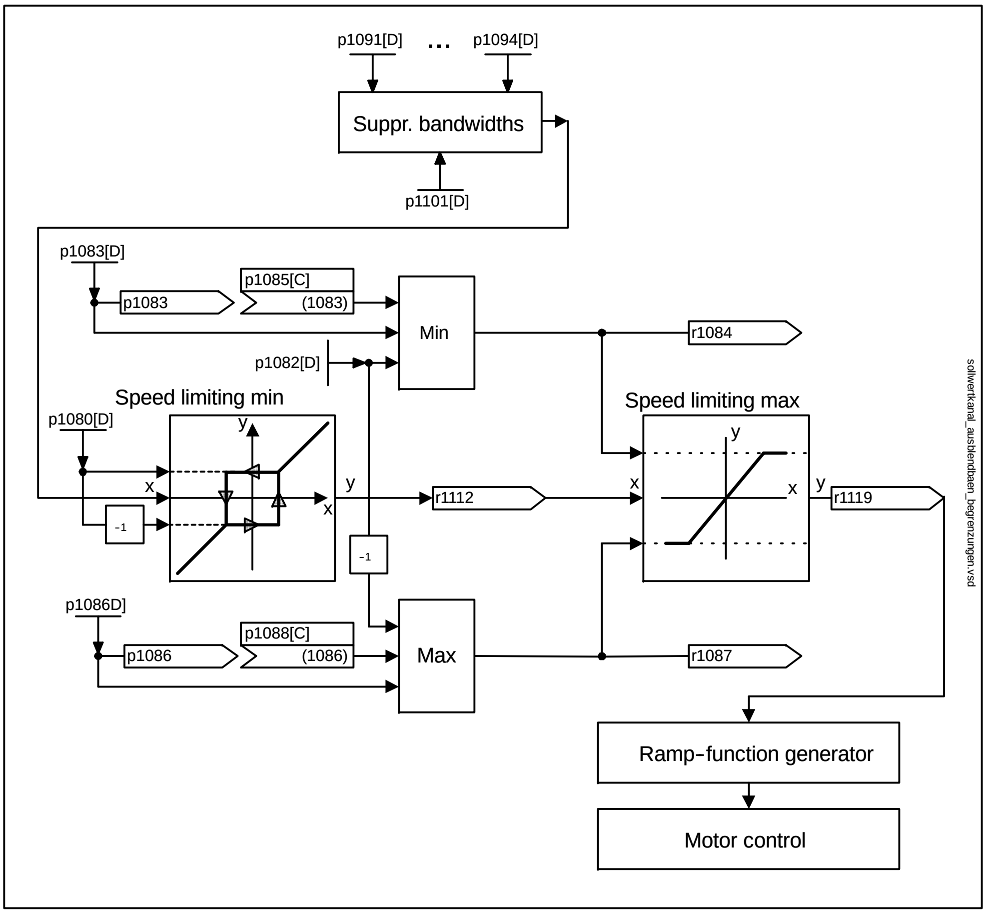


Fig. 5-10 Suppression bandwidths and setpoint limitation

Function diagram overview (see List Manual)

- 1550 Setpoint channel
- 3050 Suppression bandwidth and speed limiting

Parameter overview (see List Manual)

Adjustable parameters

Setpoint limitation

- p1080[D] Minimum speed
- p1082[D] Maximum speed
- p1083[D] CO: Speed limit in positive direction of rotation
- p1085[C] CI: Speed limit in positive direction of rotation
- p1086[D] CO: Speed limit in negative direction of rotation
- p1088[C] DI: Speed limit in negative direction of rotation

Suppression bandwidths

- p1091[D] Suppression speed 1
- ...
- p1094[D] Suppression speed 4
- p1101[D] Suppression speed bandwidth

Visualization parameters

- r1084 Speed limit positive effective
- r1087 Speed limit negative effective
- r1119 Ramp-function generator setpoint at the input

5.3.8 Ramp-function generator

Description

The ramp-function generator is used to limit acceleration in the event of abrupt setpoint changes. This helps reduce the impact on the mechanics of the connected machines. The ramp-up time p1120[D] and ramp-down time p1121[D] can be used to set an acceleration ramp and a deceleration ramp independently of each other. This allows a controlled transition to be made in the event of setpoint changes.

The maximum speed p1082[D] is used as a reference value for calculating the ramps from the ramp-up and ramp-down times. A special adjustable ramp can be set via p1135 for fast stop (OFF3), e.g. for rapid controlled deceleration when an emergency stop button is pressed.

There are two types of ramp-function generator:

- Simple ramp-function generator with
  - Acceleration and deceleration ramps
  - Ramp for fast stop (OFF 3)
  - Tracking can be selected via a binector input
- Extended ramp-function generator with
  - Initial and final rounding off
  - Setting values for the ramp-function generator

Properties of the simple ramp-function generator

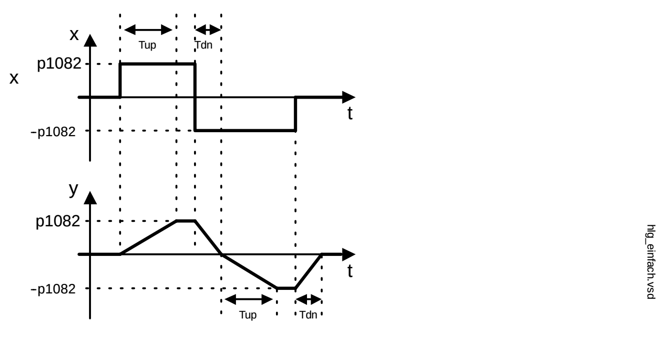


Fig. 5-11 Ramp-up and ramp-down with the simple ramp-function generator

- RFG ramp-up time Tup p1120[D]
- RFG ramp-down time Tdn p1121[D]
- OFF 3 deceleration ramp
  - OFF3 ramp-down time p1135[D]

Properties of the extended ramp-function generator

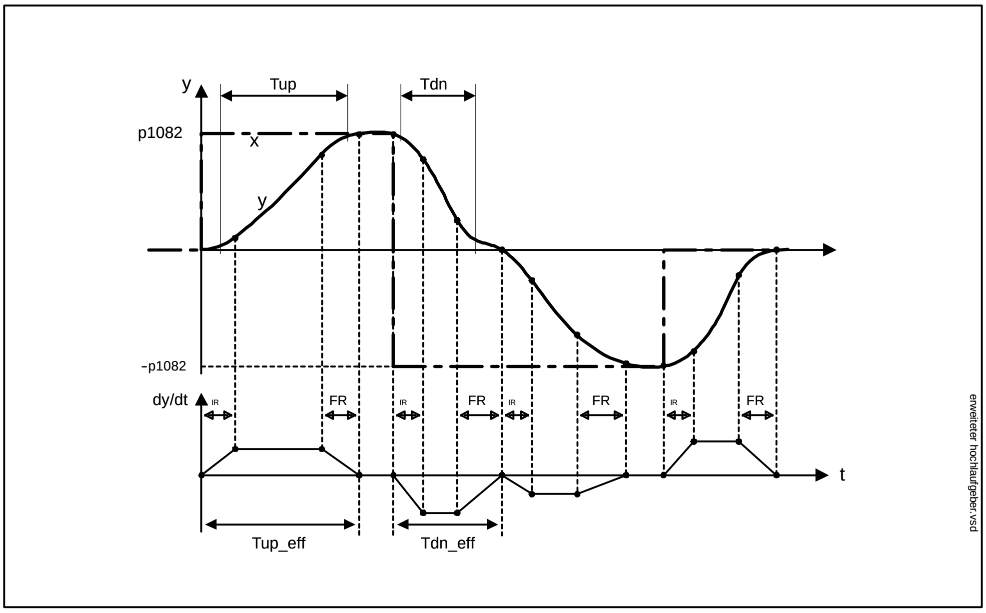


Fig. 5-12 Extended ramp-function generator

- RFG ramp-up time Tup p1120[D]
- RFG ramp-down time Tdn p1121[D]
- Initial rounding-off time IR p1130[D]
- Final rounding-off time FR p1131[D]
- Effective ramp-up time
  Tup_eff = Tup + (IR/2 + FR/2)
- Effective ramp-down time
  Tdn_eff = Tdn + (IR/2 + FR/2)
- OFF 3 deceleration ramp
  - OFF3 ramp-down time p1135[D]
  - OFF3 initial rounding-off time p1136[D]
  - OFF3 final rounding-off time p1137[D]
- Set ramp-function generator
  - Ramp-function generator setting value p1144[C]
  - Set ramp-function generator signal p1143[C]
- Ramp-function generator rounding-off type p1134[D]
  - p1134 = “0”: Rounding is always active. Can result in overshoot.
  - p1134 = “1”: Final rounding-off is not active if the input word is reduced abruptly during ramp-up.

Ramp-function generator tracking

Ramp-function generator tracking allows the speed setpoint to be corrected in line with the actual speed value, thereby speeding up response times in the event of a change in direction.

Ramp-function generator tracking can be activated for both ramp-function generators.

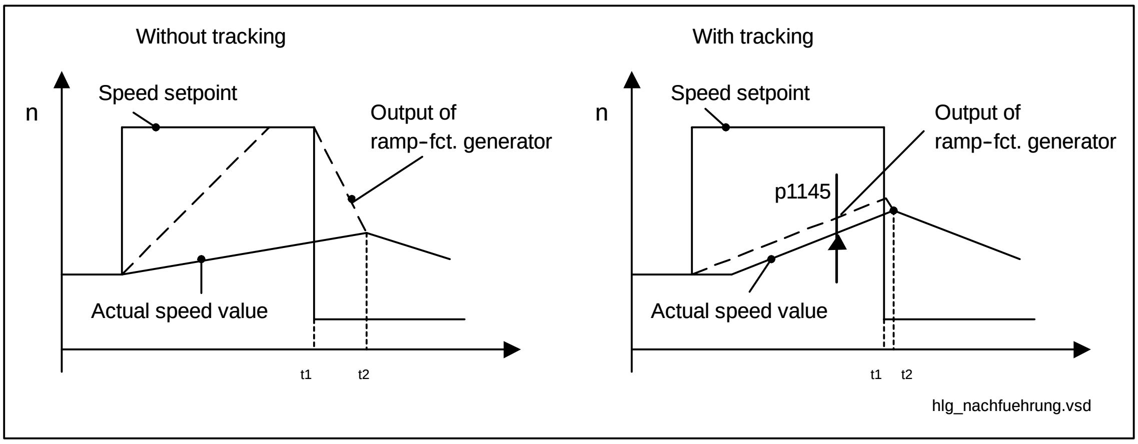


Fig. 5-13 Ramp-function generator tracking

Without ramp-function generator tracking

- p1145 = 0
- Drive accelerates until t2 although setpoint < actual value

With ramp-function generator tracking

- p1145 > 0
- Ramp-function generator output leads setpoint by only a small margin
- t1 and t2 almost identical

Function diagram overview (see List Manual)

- 1550 Setpoint channel
- 3060 Simple ramp-function generator
- 3070 Extended ramp-function generator
- 3080 Ramp-function generator selection, status word, tracking

Signal overview (see List Manual)

- Control signal STW1.2 OFF3
- Control signal STW1.4 Enable ramp-function generator
- Control signal STW1.5 Start/stop ramp-function generator
- Control signal STW1.6 Enable setpoint
- Control signal STW2.1 Bypass ramp-function generator

Parameterization with STARTER

The “ramp–function generator” parameter screen is selected via the following icon in the toolbar of the STARTER commissioning tool:

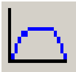


Fig. 5-14 STARTER icon for “ramp–function generator”

Parameter overview (see List Manual)

Adjustable parameters

- p1115 Ramp–function generator selection
- p1120[D] Ramp–function generator ramp–up time
- p1121[D] Ramp–function generator ramp–down time
- p1122[C] BI: Bypass ramp–function generator
- p1130[D] Ramp–function generator initial rounding–off time
- p1131[D] Ramp–function generator final rounding–off time
- p1134[D] Ramp–function generator rounding–off type
- p1135[D] OFF3 ramp–down time
- p1136[D] OFF3 initial rounding–off time
- p1137[D] OFF3 final rounding–off time
- p1140[C] BI: Enable ramp–function generator
- p1141[C] BI: Start ramp–function generator
- p1143[C] BI: Ramp–function generator transfer setting value
- p1144[C] CI: Ramp–function generator setting value
- p1145[D] Ramp–function generator tracking

Visualization parameters

- r1119 CO: Ramp–function generator setpoint at the input
- r1150 CO: Ramp–function generator speed setpoint at the output

5.3.9 Speed setpoint interpolators

The speed setpoint interpolator is used, for example, if an external position encoder is installed.

The position controller normally operates with a substantially slower cycle frequency than the speed controller.

- The output signal of the position controller, which changes in “coarse” steps, is smoothed with the aid of the interpolator.
- This enables continuous–action control.
- Steady operation of the drive without constant acceleration and braking.
- Only with isochronous PROFIBUS.

Parameterization

The “speed setpoint” parameter screen is selected via the following icon in the toolbar of the STARTER commissioning tool:

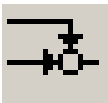


Fig. 5-15 STARTER icon for “setpoint addition”

5.4 Servo control

This type of control enables operation with an extremely high dynamic response and precision for a motor with a motor encoder.

5.4.1 Speed controller

The speed controller controls the motor speed using the actual values from the encoder (operation with encoder) or the calculated actual speed value from the electric motor model (operation without encoder).

Properties

- Speed setpoint filter
- Speed controller adaptation

Note

Speed and torque cannot be controlled simultaneously. If speed control is activated, this has priority over torque control.

Limitations

Speed limitation p1082[D] is initialized with default values for the selected motor and becomes active during commissioning.

5.4.2 Speed setpoint filter

The two speed setpoint filters are identical in structure and can be used as follows:

- Band-stop
- Low-pass 1st order (PT1) or
- Low-pass 2nd order (PT2) or

Both filters are activated via parameter p1414.x. Parameters p1415 and p1421 are used to select the filter elements.

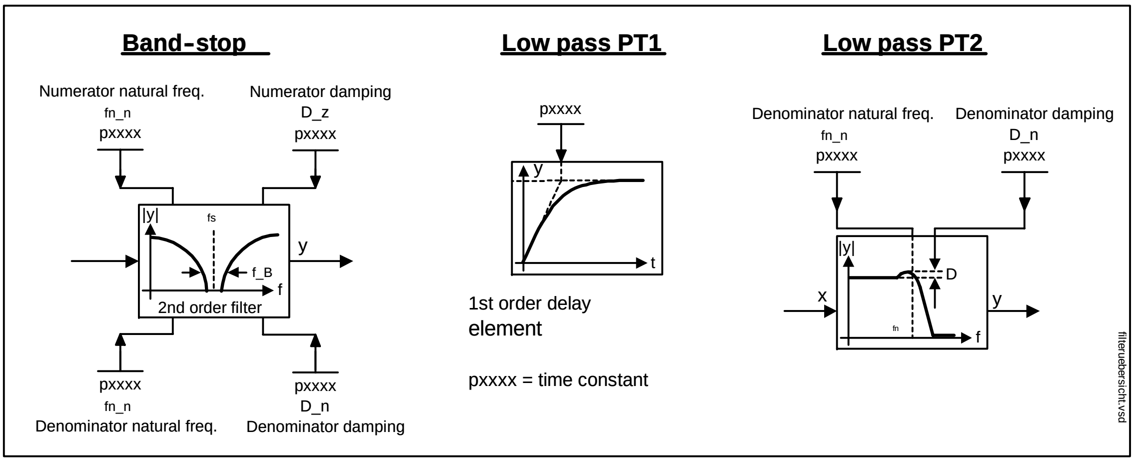


Fig. 5-16 Filter overview for speed setpoint filters

Parameter overview for speed setpoint filter (see List Manual)

Adjustable parameters

- p1414[D] Speed setpoint filter activation
- p1415[D] Speed setpoint filter 1 type
- p1416[D] Speed setpoint filter 1 time constant
- p1417[D] Speed setpoint filter 1 denominator natural frequency
- p1418[D] Speed setpoint filter 1 denominator damping
- p1419[D] Speed setpoint filter 1 numerator natural frequency
- p1420[D] Speed setpoint filter 1 numerator damping
- p1421[D] Speed setpoint filter 2 type
- p1422[D] Speed setpoint filter 2 time constant
- p1423[D] Speed setpoint filter 2 denominator natural frequency
- p1424[D] Speed setpoint filter 2 denominator damping
- p1425[D] Speed setpoint filter 2 numerator natural frequency
- p1426[D] Speed setpoint filter 2 numerator damping

Parameterization

The “speed setpoint filter” parameter screen is selected via the following icon in the toolbar of the STARTER commissioning tool:

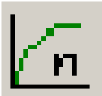


Fig. 5-17 STARTER icon for “speed setpoint filter”

5.4.3 Speed controller adaptation

Description

Two adaptation methods are available, namely free Kp_n adaptation and speed-dependent Kp_n/Tn_n adaptation.

Free Kp_n adaptation is also active in “operation without encoder” mode and is used in “operation with encoder” mode as an additional factor for speed-dependent Kp_n adaptation.

Speed-dependent Kp_n/Tn_n adaptation is only active in “operation with encoder” mode and also affects the Tn_n value.

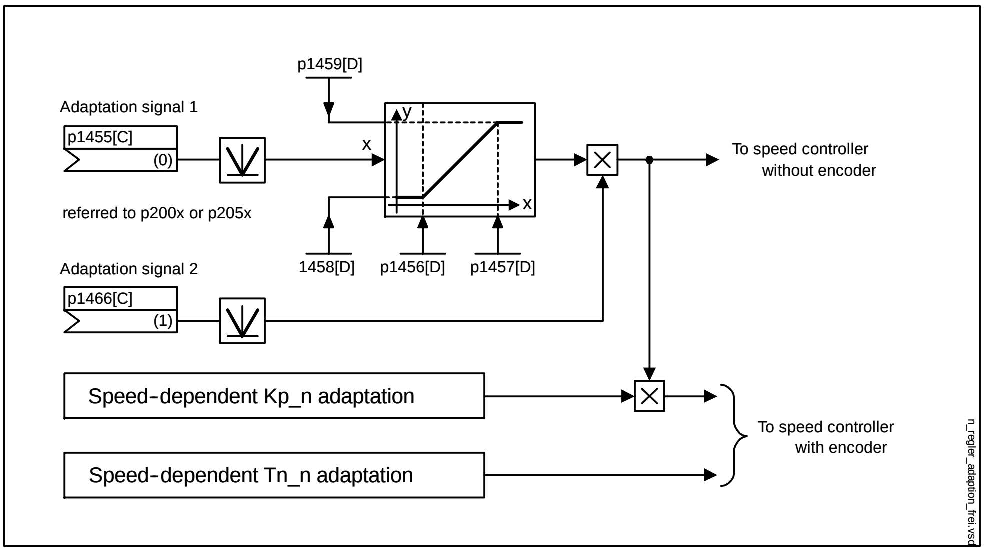


Fig. 5-18 Free Kp_n adaptation

Example of speed-dependent adaptation

Note

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

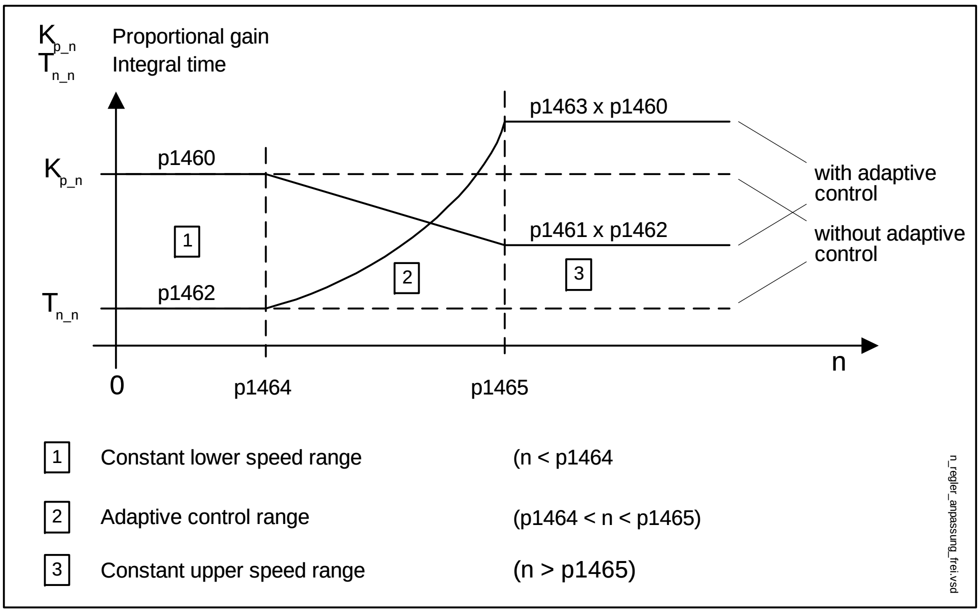


Fig. 5-19 Speed controller Kp_n/Tn_n adaptation

Parameterization

The “speed controller” parameter screen is selected via the following icon in the toolbar of the STARTER commissioning tool:

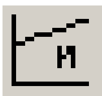


Fig. 5-20 STARTER icon for “speed controller”

Parameter overview for speed controller adaptation (see List Manual)

Free Kp_n adaptation

- p1455[C] CI: Speed controller P gain adaptation signal
- p1456[D] Speed controller P gain adaptation application point lower
- p1457[D] Speed controller P gain adaptation application point upper
- p1458[D] Adaptation factor, lower
- p1459[D] Adaptation factor, upper

Speed-dependent Kp_n/Tn_n adaptation

- p1460[D] Speed controller P gain adaptation speed, lower
- p1461[D] Speed controller P gain adaptation speed, upper
- p1462[D] Speed controller integral action time adaptation speed, lower
- p1463[D] Speed controller integral action time adaptation speed, upper
- p1464[D] Speed controller adaptation speed, lower
- p1465[D] Speed controller adaptation speed, upper
- p1466[C] CI: Speed controller P-gain scaling

Function diagram overview (see List Manual)

- 5050 Kp_n and Tn_n adaptation

5.4.4 Torque control mode

Description

A control word is used to switch from speed control to torque control mode. All torque setpoints from the speed control system are rendered inactive. The setpoints for torque control mode are selected by parameterization.

Properties

- Switchover to torque control mode via control word
- Torque setpoint definition:
  - Selection of source for torque setpoint possible
  - Torque setpoint scalable
  - Input of an additional torque setpoint possible
- Display of the overall torque

Commissioning torque control mode

1. Set p1406.12 = "1"
2. Torque setpoint definition:
   - Select source
   - Scale setpoint
   - Select additional setpoint
3. Activate enable signals

Function diagram overview (see List Manual)

- 5060 Torque setpoint, changeover control type
- 5610 Torque limiting/reduction/interpolator

Signal overview (see List Manual)

- Control signal p1406.12 Torque control

Parameterization

The "torque setpoint" parameter screen is selected via the following icon in the toolbar of the STARTER commissioning tool:

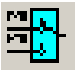


Fig. 5-21 STARTER icon for "torque setpoint"

Parameter overview (see List Manual)

Adjustable parameters

- p1501[C] BI: Changeover closed-loop speed and torque control
- p1511[C] CI: Supplementary torque 1
- p1512[C] CI: Harmonic torque 1 scaling
- p1513[C] CI: Supplementary torque 2

Visualization parameters

- r1515 Supplementary torque total

5.4.5 Torque setpoint limitation

Description

The steps involved in limiting the torque setpoint are as follows:

1. Definition of the torque setpoint and an additional torque setpoint
2. Generation of torque limits

Limitation of the torque setpoint to a maximum value is possible in all four quadrants. Different limits can be parameterized for motor and regenerative modes.

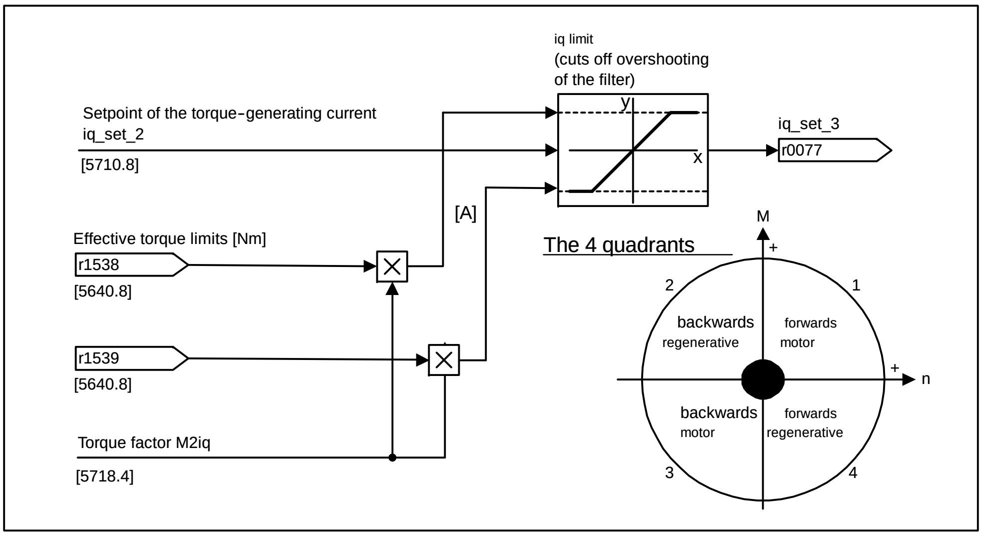


Fig. 5-22 Current setpoint limiting

Note

This function is effective immediately without any settings. In addition, the user can define further settings in order to limit the torque.

Properties

The connector inputs of the function are initialized with fixed torque limits. If required, the torque limits can also be defined dynamically.

- A control bit can be used to select the torque limitation mode. The following alternatives are available:
  - Upper and lower torque limit
  - Motor and regenerative torque limit
- Additional power limitation configurable
  - Motor mode power limit
  - Regenerative mode power limit
- The following factors are monitored by the current controller and thus always apply in addition to torque limitation:
  - Stall power
  - Maximum torque–generating current
- Offset of the setting values also possible (see Fig. 5-23)
- The following torque limits are displayed via parameters:
  - Lowest of all upper torque limits with and without offset
  - Highest of all lower torque limits with and without offset

Fixed and variable torque limit settings

Table 5-7 Fixed and variable torque limit settings

Selection	Torque limitation mode			
Mode	Maximum upper or lower torque limits p1400.4 = 0		Maximum motor or regenerative mode torque limits p1400.4 = 1	
Fixed torque limit	Upper torque limit (as positive value)	p1520	Motor mode torque limit (as positive value)	p1520
	Lower torque limit (as negative value)	p1521	Regenerative mode torque limit (as negative value)	p1521
Source for variable torque limit	Upper torque limit	p1522	Motor mode torque limit	p1522
	Lower torque limit	p1523	Regenerative mode torque limit	p1523
Source for variable scaling factor of torque limit	Upper torque limit	p1528	Motor mode torque limit	p1528
	Lower torque limit	p1529	Regenerative mode torque limit	p1529
Torque offset for torque limit	Shifts the upper or lower torque limits together	p1532	Shifts the motor or regenerative mode torque limits together	p1532

Variants of torque limitation

The following variants are available:

1. No settings entered:

   The preset torque limits are valid.

2. Fixed limits are required for the torque:

   - The fixed upper and lower limits or alternatively the fixed motor and regenerative limits can be specified separately by different sources.

3. Dynamic limits are required for the torque:

   - The dynamic upper and lower limits or alternatively the dynamic motor and regenerative limits can be specified separately by different sources.
   - Parameters are used to select the source of the current limit.

4. A torque offset can be parameterized.

5. In addition, the power limits can be parameterized separately for motor and regenerative mode.

Notice

Negative values at r1534 or positive values at r1535 represent a minimum torque for the other torque directions and can cause the drives to rotate if no load torque is generated to counteract this (see List Manual SINAMICS S FUP5630).

Example: Torque limits with or without offset

The signals selected via p1522 and p1523 include the torque limits parameterized via p1520 and p1521.

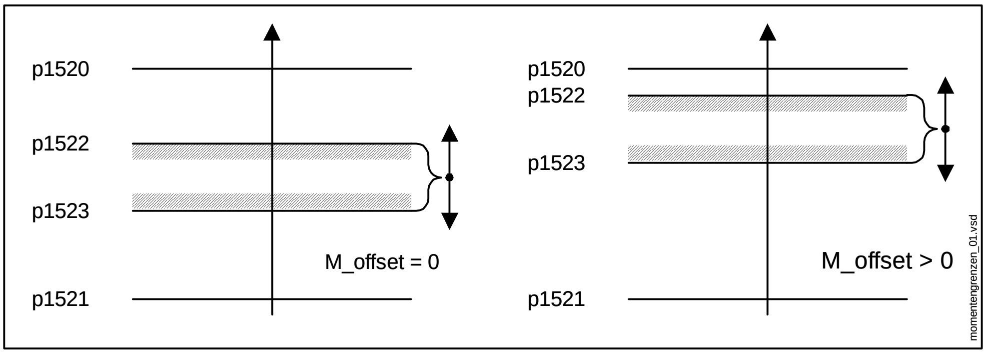


Fig. 5-23 Example: Torque limits with or without offset

Activating the torque limits

1. Use parameters to select the source for torque limitation
2. Use a control word to specify the torque limitation mode
3. Also possible if necessary:
   - Select and activate additional limitations
   - Set the torque offset

Examples

- Travel to fixed stop (see Section 5.4.11)
- Tension control for continuous goods conveyors and winders

Function diagram overview (see List Manual)

- 5610 Torque limiting/reduction/interpolator
- 5620 Torque limits when motoring/regenerating (p1400.4 = 1)
- 5630 Upper/lower torque limits (p1400.4 = 0)
- 5640 Mode changeover, power/current limiting

Parameterization

The “torque limit” parameter screen is selected via the following icon in the toolbar of the STARTER commissioning tool:

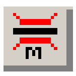


Fig. 5-24 STARTER icon for “torque limit”

Parameter overview (see List Manual)

Adjustable parameters

- p0640[D] Current limit
- p1400[D] Speed control configuration
- p1520[D] CO: Upper or motor–mode torque limit
- p1521[D] CO: Lower or regenerative torque limit
- p1522[C] CI: Upper or motor–mode torque limit
- p1523[C] CI: Lower or regenerative torque limit
- r1526 Upper torque limit of all torque limits without offset
- r1527 CO: Lower torque limit of all torque limits without offset

• p1528[C]	CI: Upper or motoring torque limit scaling
• p1529[C]	CI: Lower or regenerative torque limit scaling
• p1530[D]	Power limit, motor mode
• p1531[D]	Power limit, regenerative mode
• p1532[D]	Torque offset torque limit

Visualization parameters

• r1508	CO: Torque setpoint before supplementary torque
• r1509	CO: Torque setpoint before torque limiting
• r1515	Supplementary torque total
• r1526	Upper torque limit of all torque limits without offset
• r1527	Lower torque limit of all torque limits without offset
• r1533	Maximum torque–generating current of all current limits
• r1534	CO: Upper torque limit of all torque limits
• r1535	Lower torque limit of all torque limits
• r1536	Maximum motor–mode torque–generating current limit
• r1537	Maximum regenerative mode torque–generating current limit
• r1538	CO: Upper torque limit effective
• r1539	CO: Lower torque limit effective

5.4.6 Current controller

Properties

- PI controller for current control
- Four identical current setpoint filters
- Current and torque limitation
- Current controller adaptation
- Flux control

Current control

No settings are required for operating the current controller. The controller can be optimized for special applications (see Section 5.4.8).

Current and torque limitation

The current and torque limitations are initialized when the system is commissioned for the first time and should be adjusted according to the application.

Current controller adaptation

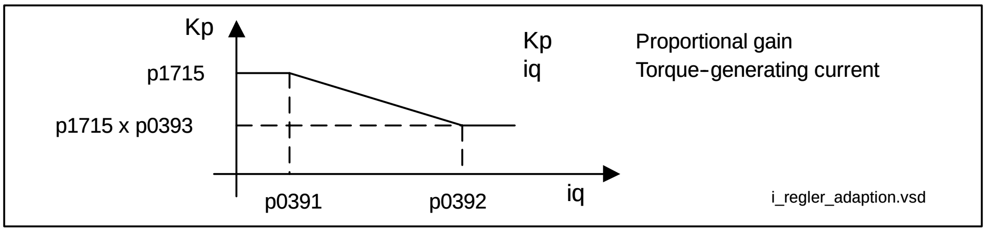


Fig. 5-25 Current controller adaptation

Flux controller (for induction motor)

The parameters for the flux controller are initialized when the system is commissioned for the first time and do not usually need to be adjusted.

Function diagram overview (see List Manual)

- 5710 Current setpoint filter
- 5714 Iq and Id controllers
- 5718 Interface to the motor module (gating signals, current actual values)
- 5722 Field current input, flux controller

Parameter overview (see List Manual)

Current control

- p1701[D] Current controller reference model deadtime
- p1703[D] Isq current controller precontrol scaling
- p1715[D] Current controller P gain
- p1717[D] Current controller integral action time

Current and torque limitation

- p1520[D] CO: Upper or motor-mode torque limit
- p1521[D] CO: Lower or regenerative torque limit
- p1522[C] CI: Upper or motor-mode torque limit
- p1523[C] CI: Lower or regenerative torque limit
- p1524[D] CO: Upper or motoring torque limit scaling
- p1525[D] CO: Lower or regenerative torque limit scaling
- p1528[C] CI: Upper or motoring torque limit scaling
- p1529[C] CI: Upper or motoring torque limit scaling
- p1530[D] Power limit, motor mode
- p1531[D] Power limit, regenerative mode
- p1532[D] Torque offset torque limit
- p0323[M] Maximum motor current
- p0326[M] Stall torque correction factor
- p0640[D] Current limit

Visualization parameters

- r1526 Upper torque limit of all torque limits without offset
- r1527 Lower torque limit of all torque limits without offset
- r1533 Maximum torque-generating current of all current limits
- r1534 CO: Upper torque limit of all torque limits
- r1535 Lower torque limit of all torque limits
- r1536 Maximum motor-mode torque-generating current limit
- r1538 CO: Upper torque limit effective
- r1539 CO: Lower torque limit effective

Current controller adaptation

- p0391[M] Current controller adaptation, lower starting point
- p0392[M] Current controller adaptation, upper starting point
- p0393[M] Current controller adaptation upper P gain
- p1590[D] Flux controller P gain
- p1592[D] Flux controller integral action time

5.4.7 Current setpoint filter

The four current setpoint filters connected in series can be parameterized as follows:

- Low-pass 2nd order (PT2: -40dB/decade)
- General filter 2nd order
  Band-stop and low-pass with reduction are converted to the parameters of the general filter 2nd order via STARTER.
  - Band-stop
  - Low-pass with reduction by a constant value

The phase frequency curve is shown alongside the amplitude log frequency curve. A phase shift results in a control system delay and should be kept to a minimum.

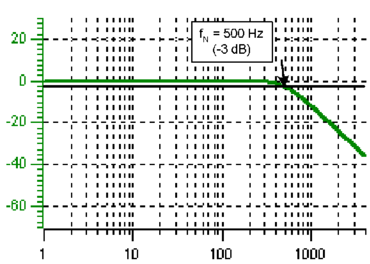
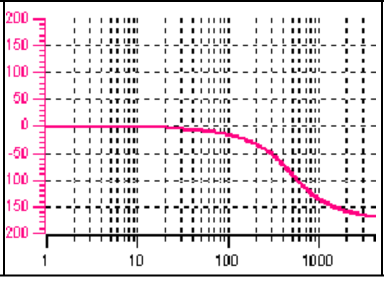
General 2nd-order filter

Transfer function:

$$H_{(s)} = \frac{1}{\left(\frac{s}{2\pi f_N}\right)^2 + \frac{2D_N}{2\pi f_N} \cdot s + 1}$$

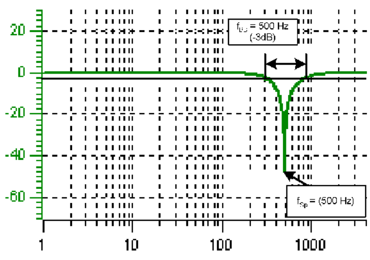
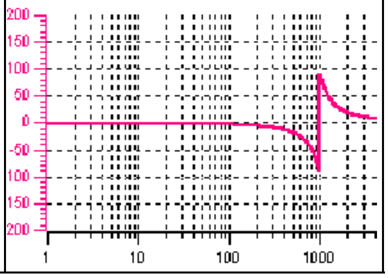
Characteristic frequency f_N
Damping D_N

Table 5-8 Example of a PT2 filter

STARTER filter parameters	Amplitude log frequency curve	Phase frequency curve
Characteristic frequency f_N 500 Hz Damping D_N 0.7 dB		

Band-stop with infinite notch depth

Table 5-9 Example of band-stop with infinite notch depth

STARTER filter parameters	Amplitude log frequency curve	Phase frequency curve
Blocking frequency f_{Sp} = 500 Hz Bandwidth (−3dB) f_{BB} = 500 Hz Notch depth K = infinite dB Reduction Abs = 0 dB		

Simplified conversion to parameters for general order filters:

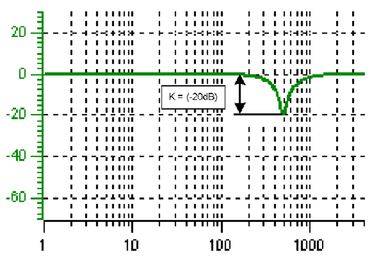
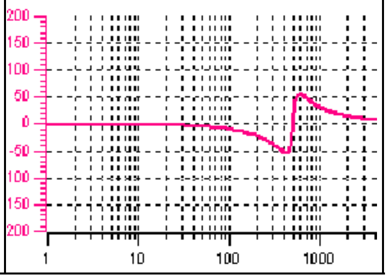
Reduction or increase after the blocking frequency (Abs)

Infinite notch depth at the blocking frequency

- Numerator frequency $f_Z = f_{Sp}$
- Numerator damping 0
- Denominator frequency $f_N = f_{Sp}$
- Denominator damping $D_N = \dfrac{f_{BB}}{2 \cdot f_{Sp}}$

Band-stop with defined notch depth

Table 5-10 Example of band-stop with defined notch depth

STARTER filter parameters	Amplitude log frequency curve	Phase frequency curve
Blocking frequency $f_{Sp} = 500$ Hz Bandwidth $f_{BB} = 500$ Hz Notch depth K = infinite dB Reduction Abs = 0 dB		

Simplified conversion to parameters for general order filters:

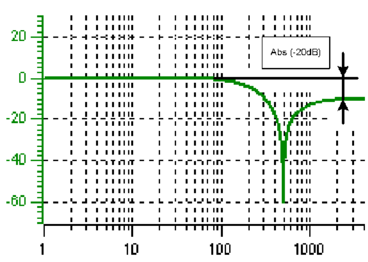
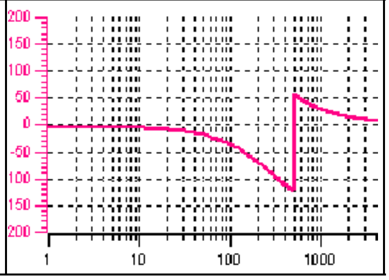
No reduction or increase after the blocking frequency

Defined notch at the blocking frequency K[dB] (e.g. –20 dB)

- Numerator frequency $f_Z = f_{Sp}$
- Numerator damping $D_Z = \dfrac{f_{BB}}{2 \cdot f_{Sp} \cdot 10^{\frac{K}{20}}}$
- Denominator frequency $f_N = f_{Sp}$
- Denominator damping $D_N = \dfrac{f_{BB}}{2 \cdot f_{Sp}}$

Band-stop with defined reduction

Table 5-11 Example of band-stop

STARTER filter parameters	Amplitude log frequency curve	Phase frequency curve
Blocking frequency 500 Hz Bandwidth 500 Hz Notch depth infinite dB Reduction −10 dB		

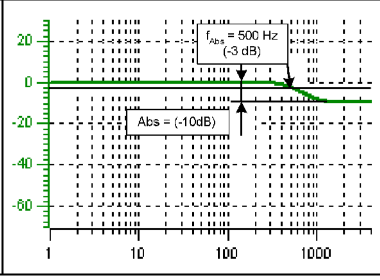
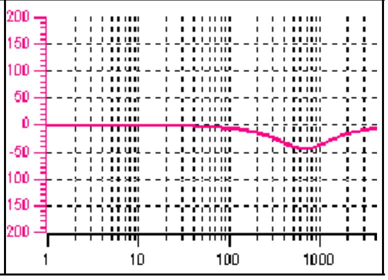
General

Conversion to parameters for general order filters:

- Numerator frequency $f_Z = \frac{\omega_Z}{2\pi} = f_{Sp}$
- Numerator damping $D_Z = 10^{\frac{K}{20}} \cdot \frac{1}{2} \cdot \sqrt{\left(1 - \frac{1}{10^{\frac{Abs}{20}}}\right)^2 + \frac{f_{BB}^2}{f_{Sp}^2 \cdot 10^{\frac{Abs}{10}}}}$
- Denominator frequency $f_N = \frac{\omega_N}{2\pi} = f_{Sp} \cdot 10^{\frac{Abs}{40}}$
- Denominator damping $D_N = \frac{f_{BB}}{2 \cdot f_{Sp} \cdot 10^{\frac{Abs}{40}}}$

General low-pass with reduction

Table 5-12 Example of general low-pass with reduction

STARTER filter parameters	Amplitude log frequency curve	Phase frequency curve
Characteristic frequency f_{Abs} = 500 Hz Damping D = 0.7 Reduction Abs = –10 dB		

Conversion to parameters for general order filters

- Numerator frequency $f_Z = f_{Abs}$ (start of reduction)
- Numerator damping $f_Z = \dfrac{f_{Abs}}{10^{\frac{Abs}{40}}}$
- Denominator frequency D
- Denominator damping D

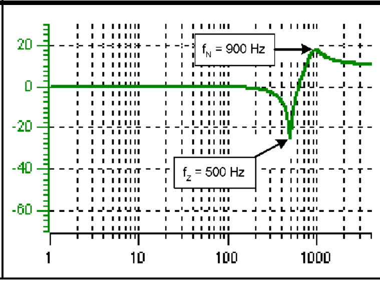
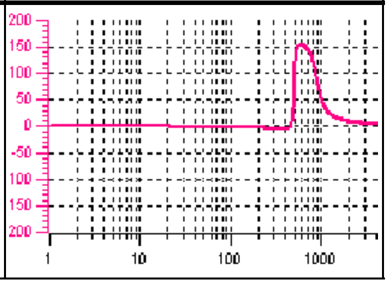
Transfer function general 2nd-order filter

$$H_{(s)} = \frac{\left(\frac{s}{2\pi f_Z}\right)^2 + \frac{2D_Z}{2\pi f_Z} \cdot s + 1}{\left(\frac{s}{2\pi f_N}\right)^2 + \frac{2D_N}{2\pi f_N} \cdot s + 1}$$

$$s = j\omega = j \cdot 2\pi f$$

- Numerator frequency f_Z
- Numerator damping D_Z
- Denominator frequency f_N
- Denominator damping D_N

Table 5-13 Example of general 2nd-order filter

STARTER filter parameters	Amplitude log frequency curve	Phase frequency curve
Numerator frequency f_Z = 500 Hz Numerator damping D_Z = 0.02 dB Denominator frequency f_N = 900 Hz Denominator damping D_N = 0.15 dB		

Parameterization

The "current setpoint filter" parameter screen is selected via the following icon in the toolbar of the STARTER commissioning tool:

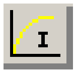


Fig. 5-26 STARTER icon for "current setpoint filter"

Parameter overview (see List Manual)

- p1656[D] Activates current setpoint filter
- p1657[D] Current setpoint filter 1 type
- p1658[D] Current setpoint filter 1 denominator natural frequency
- p1659[D] Current setpoint filter 1 denominator damping
- p1660[D] Current setpoint filter 1 numerator natural frequency
- p1661[D] Current setpoint filter 1 numerator damping
- ...
- p1676[D] Current setpoint filter 4 numerator damping

5.4.8 Optimizing the current and speed controllers

General

Caution

Controller optimization may only be performed by skilled personnel with a knowledge of control engineering.

The following tools are available for optimizing the controllers:

- “Function generator” (see Section 7.2.1) in STARTER
- “Trace” (see Section 7.2.2) in STARTER
- “Measuring function” in STARTER
- Measuring sockets (see Section 7.2.4) on the CU320

Optimizing the current controller

The current controller is initialized when the system is commissioned for the first time and is adequately optimized for most applications.

Optimizing the speed controller

The speed controller is set in accordance with the motor moment of inertia when the motor is configured for the first time. The calculated proportional gain is set to approximately 30 % of the maximum possible gain in order to minimize vibrations when the controller is mounted on the mechanics of the machine for the first time.

The integral time of the speed controller is always preset to 10 ms.

- The following optimization measures are necessary in order to achieve the full dynamic response:
  - Increase the proportional gain Kp_n (p1460[D])
  - Change the integral action time TN_n (p1462[D])

Example of measuring the speed controller frequency response

By measuring the speed controller frequency response and the control system, critical resonance frequencies can, if necessary, be determined at the stability limit of the speed control loop and dampened using one or more current setpoint filters. This normally enables the proportional gain to be increased (e.g. Kp_n = 3* default value).

After the Kp_n value has been set, the ideal integral action time Tn_n (e.g. lowered from 10 ms to 5 ms) can be determined.

Example of speed setpoint step change

A rectangular step change can be applied to the speed setpoint via the speed setpoint step change measuring function. The measuring function has preselected the measurement for the speed setpoint and the torque–generating current.

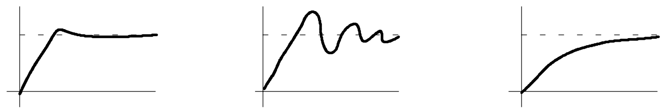


Fig. 5-27 Setting the proportional gain K_p

Parameter overview

See “Speed controller” section.

5.4.9 V/f control for diagnostics

Description

With V/f control, the motor is operated with an open control loop and does require speed control or actual current sensing, for example. Operation is possible with a small amount of motor data.

V/f control can be used to check the following:

- Motor module
- Power cable between the motor module <––> motor
- Motor
- DRIVE–CLiQ cable between the motor module <––> motor
- Encoder and actual encoder value

The following motors can be operated with V/f control:

- Induction motors
- Synchronous motors

Caution

V/f control must only be used as a diagnostic function, e.g. to check that the motor encoder is functioning correctly.

Note

In “operation with encoder” mode, the actual speed is displayed by the measuring system; in “operation without encoder” mode, a calculated actual speed value is displayed.

Note

The operation of synchronous motors with V/f control is allowed only at up to 25 % of the rated motor speed.

Structure of V/f control

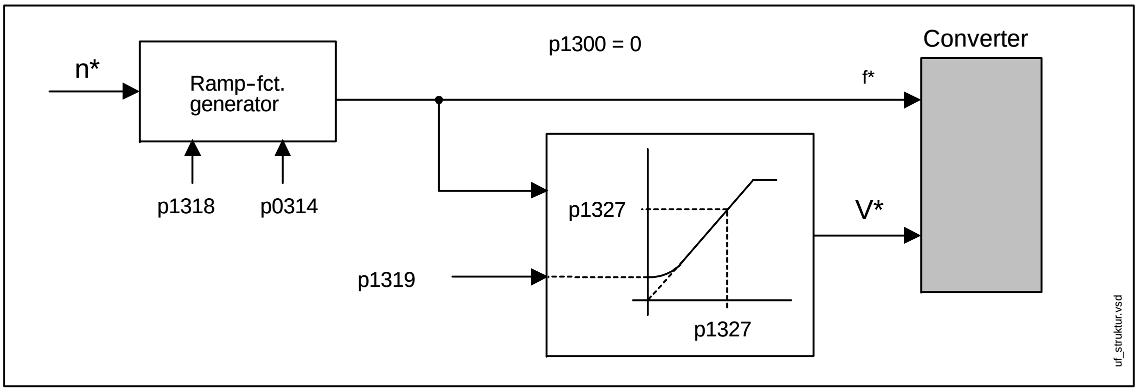


Fig. 5-28 Structure of V/f control

Preconditions for V/f control

1. Initial commissioning has been performed:

   The parameters for V/f control have been initialized with appropriate values.

2. Initial commissioning has not been performed:

   The following relevant motor data must be checked and corrected:

   - r0313 Motor pole pair number
   - p0314 Number of motor pole pairs
   - p1318 V/f control ramp-up time
   - p1319 V/f control voltage at zero frequency
   - p1326 V/f control programmable characteristic frequency
   - p1327 V/f control programmable characteristic voltage

V/f control can now be commissioned.

Commissioning V/f control

1. Verify the preconditions for V/f control mode.
2. Set p0311 --> rated motor speed
3. Set p1300 = 0 --> activates the function
4. Activate the enable signals for operation
5. Specify the speed setpoint --> evaluate the diagnostic function

V/f characteristic

Conversion of the speed setpoint to the frequency specification is performed allowing for the number of pole pairs. The synchronous frequency associated with the speed setpoint is output (no slip compensation).

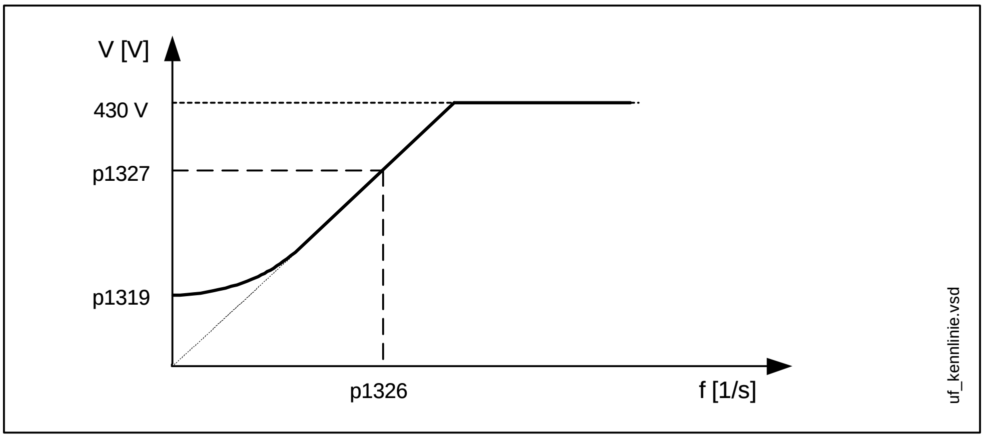


Fig. 5-29 V/f characteristic

Function diagram overview (see List Manual)

- 5020 Speed setpoint filter and speed pre-control
- 5300 V/f control for diagnostics

Parameter overview (see List Manual)

Adjustable parameters

- p0304[M Rated motor voltage
- p0310[M Rated motor frequency
- p0311[M Rated motor speed
- p0314[M Number of motor pole pairs
- p0317[M Motor voltage constant
- p0322[M] Maximum motor speed
- p0323[M] Maximum motor current
- p0640[D] Current limit
- p1082[D] Maximum speed
- p1300[D] Open-loop/closed-loop control operating mode
- p1318[D] V/f control ramp-up/ramp-down time
- p1319[D] V/f control voltage at zero frequency

Visualization parameters

- r0313[M] Motor pole pair number, actual (or calculated)

5.4.10 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.
- 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 for the existing losses, thereby stabilizing the voltage in the DC link (kinetic buffering).

Properties

- Vdc control
  - This comprises Vdc_max control and Vdc_min control (kinetic buffering), which are independent of each other.
  - Joint P controller. Suggested setting:

    p1250 = 0.5 * DC link capacitance [mF]
- Vdc_max control
  - This function can be used to control momentary regenerative load without shutdown with “overvoltage in the DC link“.
  - Vdc_max control is only recommended with a supply without active closed-loop control for the DC link and without feedback or if feedback is not possible (e.g. in the event of a power failure).
- 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.

Description of Vdc_min control

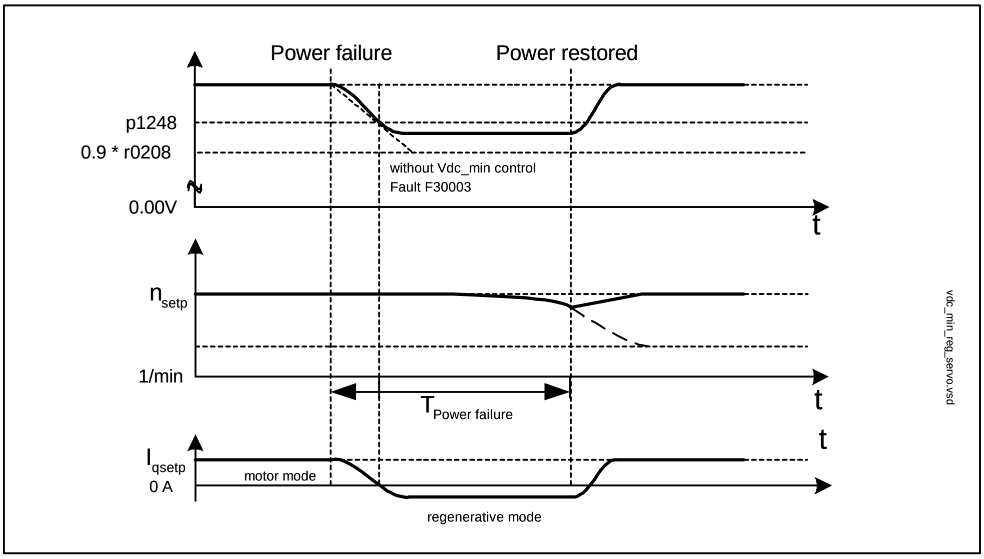


Fig. 5-30 Switching Vdc_min control on/off (kinetic buffering)

The DC link voltage threshold (p1248) is the limit setpoint for Vdc_min control. The DC link energy is maintained by means of the kinetic energy of the drive.

Description of Vdc_min monitoring

Once the DC link voltage threshold has been undershot (p1248), Vdc_min monitoring triggers a fault (F07403), which can be parameterized as required (factory setting: OFF1).

Description of Vdc_max control (p1240 = 1, 3)

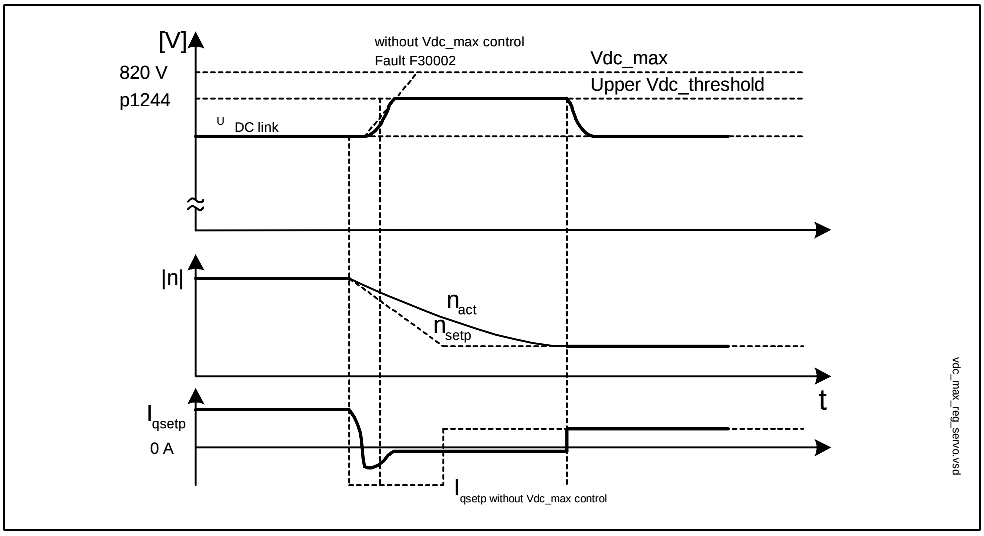


Fig. 5-31 Switching Vdc_max control on/off

The DC link voltage threshold (p1244) is the limit setpoint for Vdc_max control; the current setpoint (Iqsetp) is reduced to the extent that this value is not overshot.

Description of Vdc_max monitoring (p1240 = 4, 6)

Once the DC link voltage threshold has been overshot (p1244), Vdc_max monitoring triggers a fault (F07404), which can be parameterized as required (factory setting: OFF2).

Parameter overview (see List Manual)

Adjustable parameters

- p1240 Vdc controller or Vdc monitoring configuration (control)
- p1243[D] Vdc_max controller dynamic factor (control)
- p1245[D] Vdc_min controller switch-in level (kinetic buffering) (control)
- p1246[D] Vdc_min controller switch-in level (kinetic buffering) (control)
- p1247[D] Vdc_min controller dynamic factor (kinetic buffering) (control)
- p1250[D] Vdc controller proportional gain
- p1251[D] Vdc controller integral-action time (control)
- p1252[D] Vdc controller derivative-action time (control)
- p1254 Vdc_max controller automatic detection ON level (control)
- p1256[D] Vdc_min controller response (kinetic buffering) (control)
- p1257[D] Vdc_min controller speed threshold (control)

Visualization parameters

- r1242 Vdc_max controller switch-in level
- r1258 CO: Vdc controller output

5.4.11 Travel to fixed stop

Description

This function can be used to move a motor to a fixed stop at a specified torque without a fault being signaled. When the stop is reached, the specified torque is built up and remains applied.

The desired torque derating is brought about by scaling the upper/motor-mode torque limit and the lower/regenerative-mode torque limit.

Application examples

- Screwing parts together with a defined torque.
- Moving to a mechanical reference point.

Signals

When PROFIBUS telegrams 101 to 106 are used, the following are automatically interconnected:

- Process data T_Der to the torque limit scaling factor
- Control word 2, bit 8
- Status word 2, bit 11 and message word, bit 1

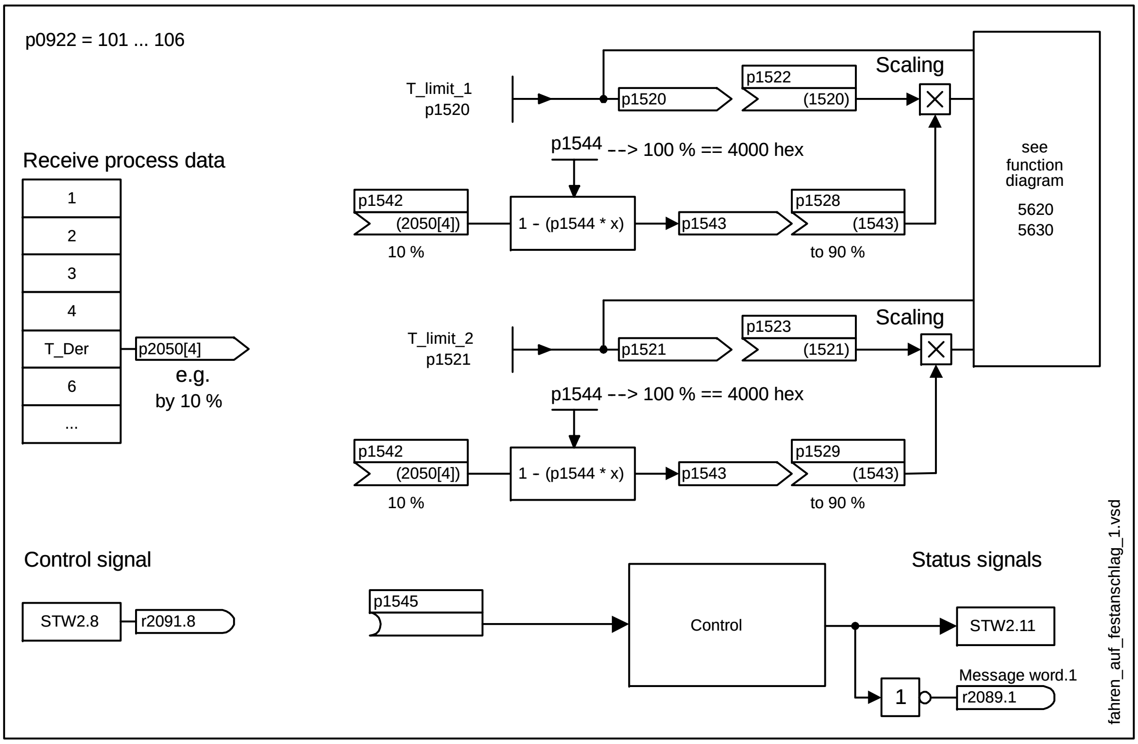


Fig. 5-32 Signals for “Travel to fixed stop”

Signal chart

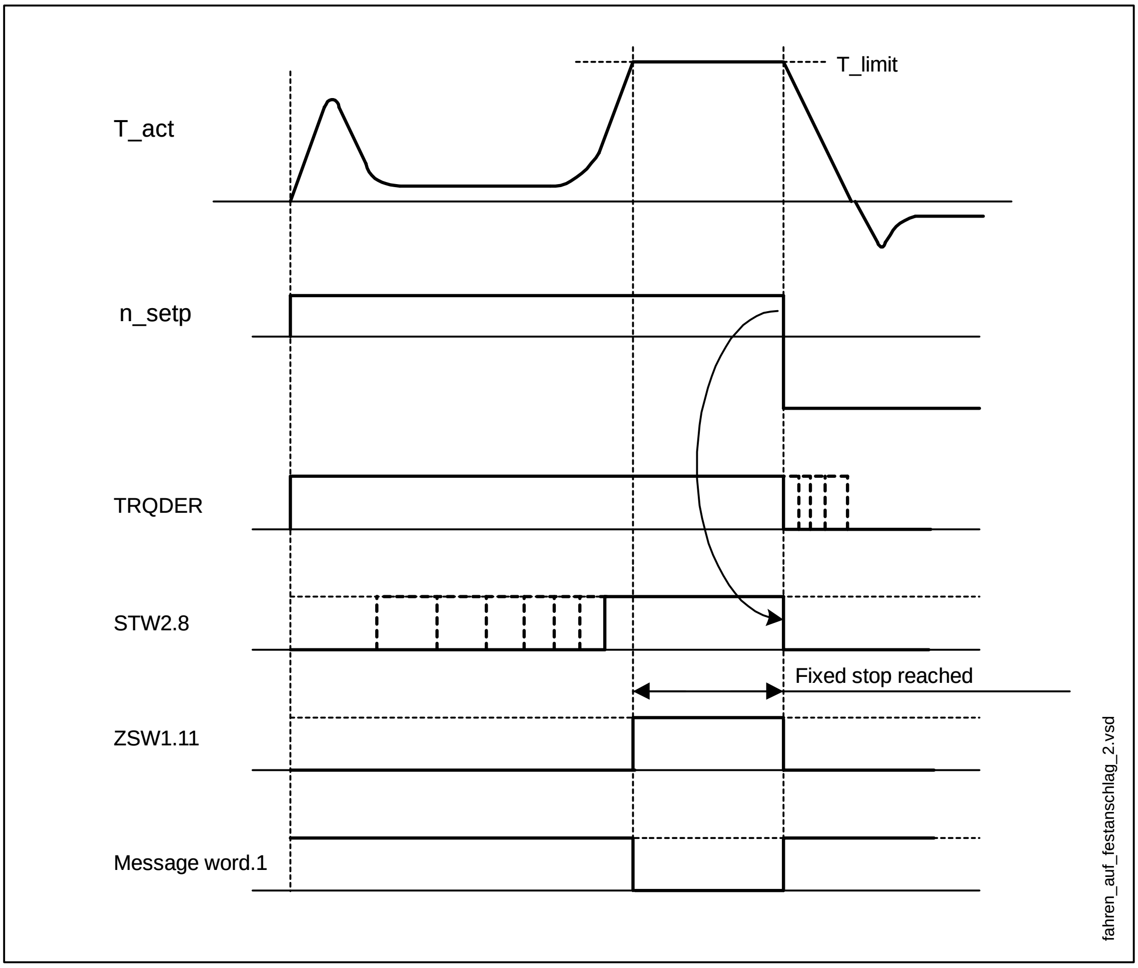


Fig. 5-33 Signal chart for “Travel to fixed stop”

STW2.8

- 1 signal

  The “Motor blocked” message is suppressed.

  The I component of the speed controller is set to limitation upon torque limitation.

- 1/0 signal

  The speed setpoint filters and the interpolators are set to the speed setpoint input.

Commissioning

1. Deactivate fault

   Set STW2.3 = “1”

2. Set the desired torque limit

   Example:

   p1400.4 = “0” --> upper or lower torque limit

   p1520 = 100 Nm --> effective in upper positive torque direction

   p1521 = -1500 Nm --> Effective in lower negative torque direction

3. Run motor to fixed stop

   The motor runs at the set torque until it reaches the stop and continues to work against the stop until the torque limit has been reached, this status being indicated in status bit ZSW2.11 “Torque limit reached”.

Function diagram overview (see List Manual)

- 5610 Torque limiting/reduction/interpolator
- 5620 Torque limits when motoring/regenerating (p1400.4 = 1)
- 5630 Upper/lower torque limits (p1400.4 = 0)

Parameter overview (see List Manual)

Adjustable parameters

- p1400[D] Speed control configuration
- p1520[D] CO: Upper or motor-mode torque limit
- p1521[D] CO: Lower or regenerative torque limit
- p1522[C] CI: Upper or motor-mode torque limit
- p1523[C] CI: Lower or regenerative torque limit
- p1542[C] CI: Travel to a fixed endstop, torque derating
- p1544 Travel to a fixed endstop, evaluate torque reduction
- p1545[C] BI: Activates of travel to a fixed endstop

Visualization parameters

- r1526 Upper torque limit of all torque limits without offset
- r1527 Lower torque limit of all torque limits without offset
- r1543 CO: Travel to fixed endstop, torque scaling

5.5 Vector speed/torque control

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 available torque
- Motor protection due to variable torque limitation in motor and regenerative mode
- Drive and braking torque controlled independently of the speed
- Maximum holding torque possible at speed 0

In some cases, these benefits are available without speed feedback.

Vector control can be used with or without a speed sensor.

The following criteria indicate when a speed sensor is required:

- High speed accuracy is required
- High dynamic response requirements
  - Better command behavior
  - Better disturbance characteristic
- Torque control in a range greater than 1:10 is required
- A defined and/or variable torque for speeds below approx. 10 % of the rated motor frequency (p0310) needs to be maintained.

With regard to setpoint input, vector control is divided into:

- Speed control
- Torque control/current control (torque control for short)

5.5.1 Vector control without encoder

In vector control without an encoder, 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. 0 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 switchover is governed via time and frequency conditions (p1755, p1756, and p1758). The system does not wait for the time condition to elapse when the setpoint frequency at the ramp–function generator input and the actual frequency are below p1755 x p1756 simultaneously.

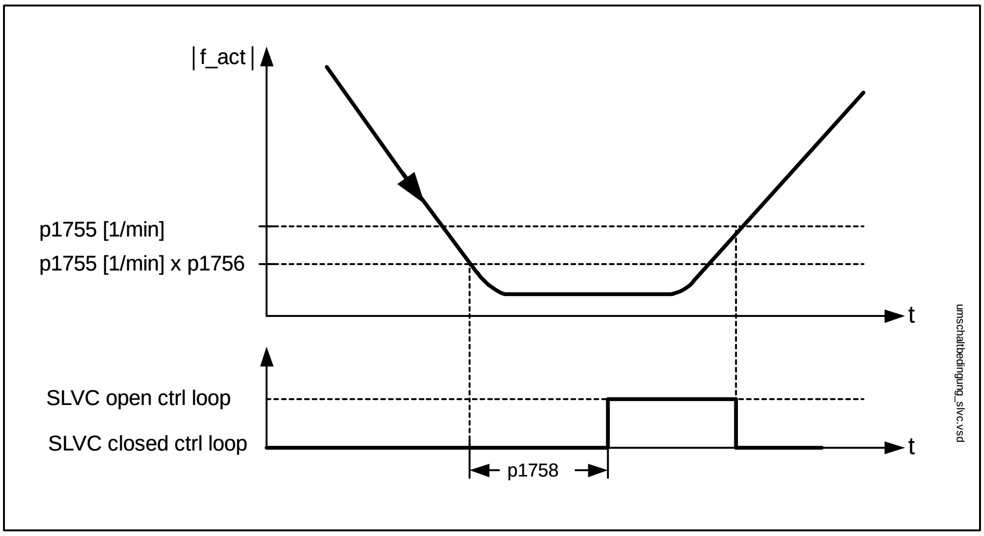


Fig. 5-34 Switchover conditions for SLVC

In open-loop operation, the actual speed value is the same as the setpoint value. For vertical loads and acceleration, parameters p1610 (constant torque boost) and p1611 (acceleration torque boost) must be modified in order to generate the static or dynamic load torque of the drive. If p1610 is set to 0 %, only the magnetizing current (r0331) is injected; when the value is 100 %, the rated motor current (p0305) is injected. 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 an encoder has the following characteristics at low frequencies:

- Closed-loop operation up to approx. 1 Hz output frequency
- Start-up in closed-loop operation (directly after drive is energized)
- Passes through low frequency range (0 Hz) in closed-loop operation

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Note

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

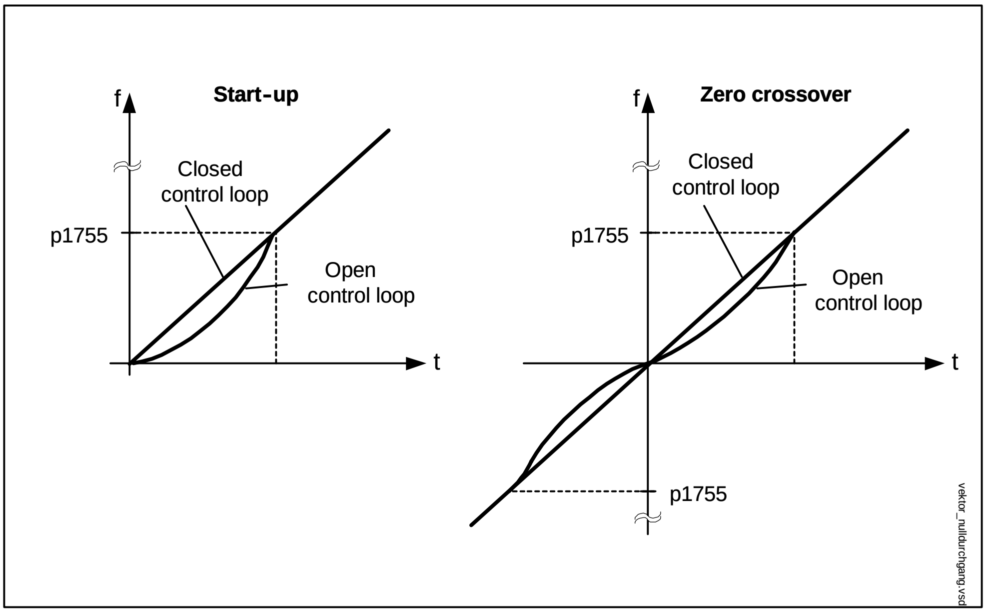


Fig. 5-35 Start-up and passing through 0 Hz in closed-loop operation

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

Note

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

Function diagram overview (see List Manual)

- 6718 Interface to the motor module (gating signals, current actual values)

Parameter overview (see List Manual)

- p0305[M Rated motor current
- r0331[M] Motor magnetizing current/short-circuit current (actual)
- p1610[D] Torque setpoint static (SLVC)
- p1611[D] Supplementary accelerating torque (SLVC)
- p1750[D] Motor model configuration
- p1755[D] Motor model without encoder
- p1756 Motor model changeover speed hysteresis
- p1758[D] Motor model changeover delay time, open/closed-loop control

5.5.2 Vector control with encoder

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
- Constant torque in the rated speed range
- 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.

5.5.3 Speed controller

Both closed-loop control procedures (SLVC, VC) have the same speed controller structure, which contains the following components:

- PI controller
- Speed controller pre-control
- Droop function

The total of the output variables result in the torque setpoint, which is reduced to the permissible magnitude by means of torque setpoint limitation.

Speed controller

The speed controller receives its setpoint (r0062) from the setpoint channel and its actual value (r0063) either directly from the speed sensor (VC) or indirectly via the motor model (SLVC). The system deviation 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.

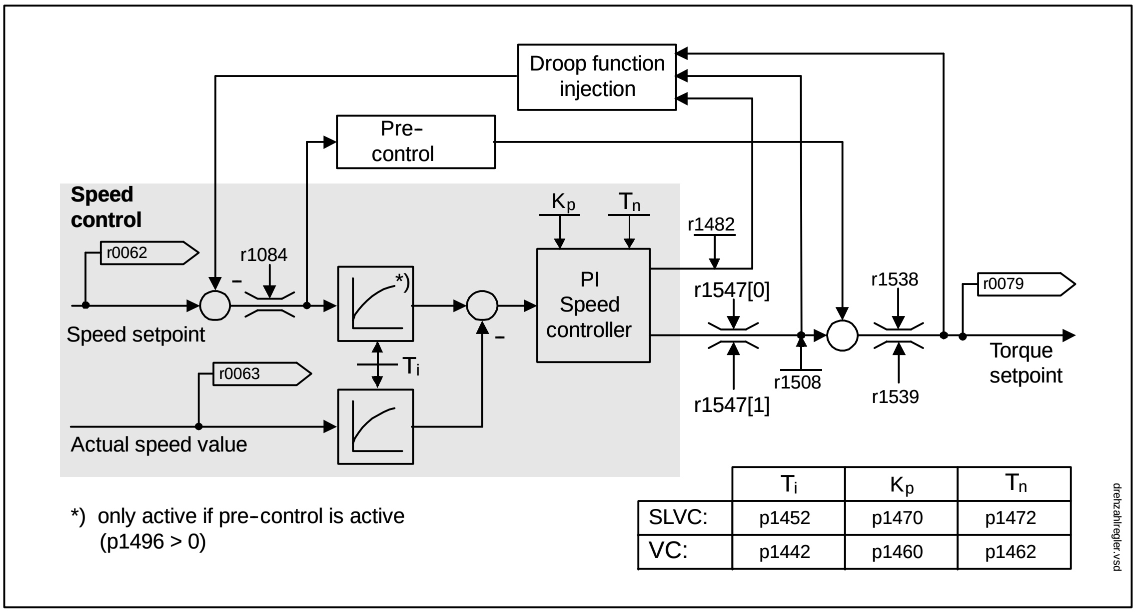


Fig. 5-36 Speed controller

The optimum speed controller setting can be determined via the automatic speed controller optimization function (p1960).

If the inertia load 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 = total of the short delay times (contains p1442 and p1452)

If vibrations occur with these settings, the speed controller gain Kp must be reduced manually. Actual speed value smoothing can also be increased (standard procedure for gearless or high-frequency torsion vibrations) and the controller calculation called up again, since the value is used for calculating Kp and Tn.

The following relationships apply for optimization:

- If Kp is increased, the controller becomes faster, although overshoot is reduced. Signal ripples und vibrations in the speed control loop, however, increase.
- If Tn is decreased, the controller still becomes faster, although overshoot is increased.

When speed control is set manually, it is easiest to define the possible dynamic response via Kp (and actual speed value smoothing) first before reducing the integral time as much as possible. When doing so, closed-loop control must remain stable in the field-weakening range too.

To suppress any vibrations that occur in the speed controller, it is usually only necessary to increase the smoothing time in p1452 for SLVC or p1442 for VC 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

Compared with speed control with an encoder, the dynamic response of drives without an encoder is significantly reduced because the speed can only be derived from the converter output variables for current and voltage that have a corresponding interference level.

Parameter overview (see List Manual)

- p0340[D] Automatic calculation of control parameters
- p1442[D] Actual speed smoothing time
- p1452[D] Speed actual value smoothing time (SLVC)
- p1460[D] Speed controller P gain adaptation speed, lower
- p1462[D] Speed controller integral action time adaptation speed, lower
- p1470[D] Speed controller sensorless operation P–gain
- p1472[D] Speed controller sensorless operation integral–action time
- p1960 Speed controller optimization selection
- r0062 CO: Speed setpoint after filter
- r0063 CO: Actual speed smoothed
- r0345[M] CO: Nominal motor starting time
- r1482 CO: Speed controller I torque output
- r1508 CO: Torque setpoint before supplementary torque

5.5.4 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.

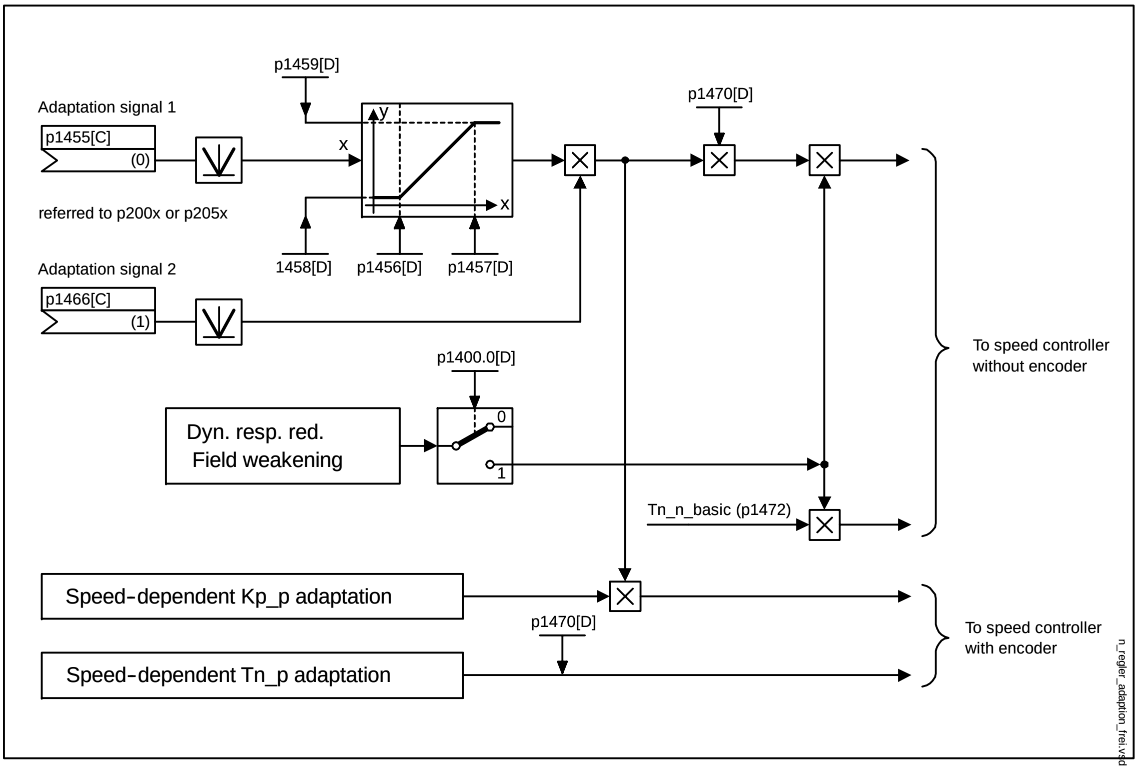


Fig. 5-37 Free KP adaptation

Dynamic response reduction in the field–weakening range can be activated (p1400.0) with sensorless operation. This is activated when the speed controller is optimized in order to achieve a greater dynamic response in the basic speed range.

Example of speed-dependent adaptation

Note

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

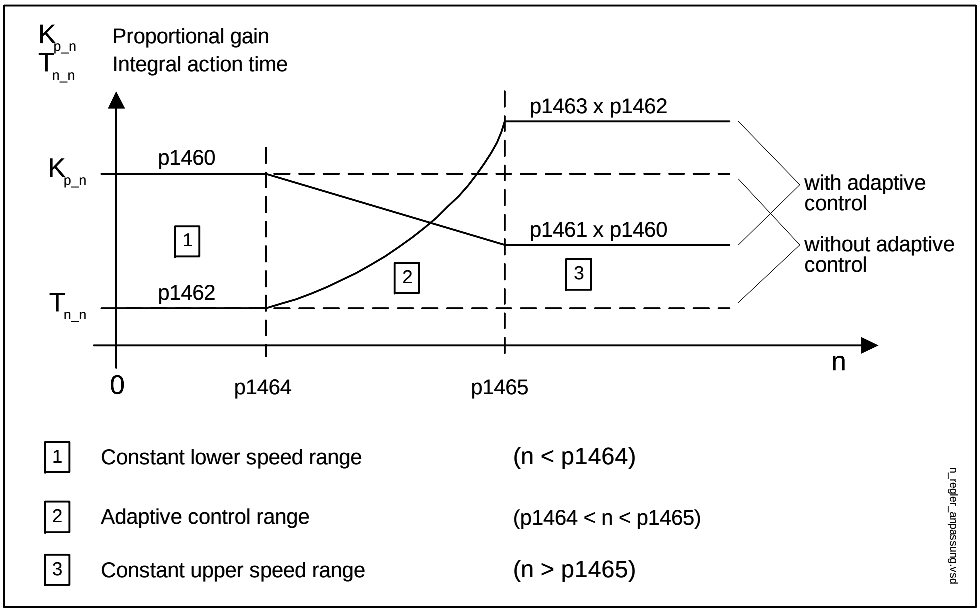


Fig. 5-38 Speed controller Kp_n/Tn_n adaptation

Parameterization

The “speed controller” parameter screen is selected via the following icon in the toolbar of the STARTER commissioning tool:

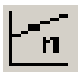


Fig. 5-39 STARTER icon for “speed controller”

Parameter overview for speed controller adaptation (see List Manual)

- p1400.5[D] Speed control configuration

Free Kp_n adaptation

- p1455[C] CI: Speed controller P gain adaptation signal
- p1456[D] Speed controller P gain adaptation application point lower
- p1457[D] Speed controller P gain adaptation application point upper
- p1458[D] Adaptation factor, lower
- p1459[D] Adaptation factor, upper
- p1470[D] Speed controller sensorless operation P–gain

Speed–dependent Kp_n/Tn_n adaptation (VC only)

- p1460[D] Speed controller P gain adaptation speed, lower
- p1461[D] Speed controller P gain adaptation speed, upper
- p1462[D] Speed controller integral action time adaptation speed, lower
- p1463[D] Speed controller integral action time adaptation speed, upper
- p1464[D] Speed controller adaptation speed, lower
- p1465[D] Speed controller adaptation speed, upper
- p1466[C] CI: Speed controller P–gain scaling

Dynamic response reduction field weakening (SLVC only)

- p1400.0[D] Speed control configuration

Function diagram overview (see List Manual)

- 6050 Kp_n and Tn_n adaptation

5.5.5 Speed controller pre-contol

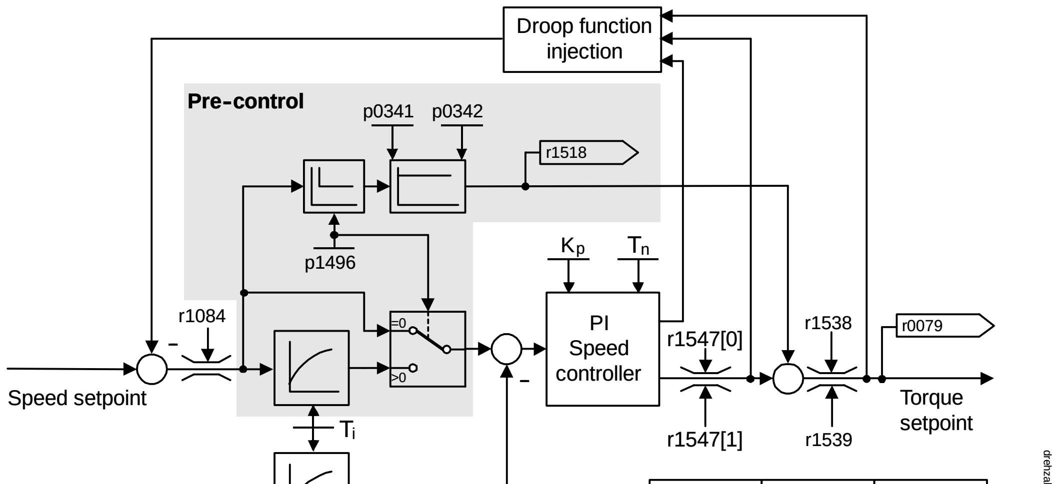
The command behavior of the speed control loop can be improved by calculating the accelerating torque from the speed setpoint and connecting it on the line side of the speed controller. This torque setpoint (mv) is calculated as follows:

$$mv = p1496 \times J \times \frac{dn}{dt} = p1496 \times p0341 \times p0342 \times \frac{dn}{dt}$$

The motor moment of inertia p0341 is calculated directly during quick commissioning or when the entire set of parameters is calculated (p0340 = 1; complete calculation). The factor p0342 between the total moment of inertia J and the motor moment of inertia must be determined manually or by means of speed controller optimization. The acceleration is calculated from the speed difference over the time dn/dt.

Note

When speed controller optimiziation 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 %.



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

Fig. 5-40 Speed controller with pre-control

If the speed controller has been correctly adjusted, it only has to compensate for disturbance variables in its own control loop, which can be achieved by means of a relatively small change to the correcting variables. Speed setpoint changes, on the other hand, are carried out without involving the speed controller and are, therefore, performed more quickly.

The effect of the pre–control variable can be adapted according to the application via the evaluation factor p1496. If p1496 = 100 %, pre–control is calculated in accordance with the motor and load moment of inertia (p0341, p0342). A balancing filter is used automatically in order to prevent the speed controller from acting against the injected torque setpoint. The time constant of the balancing filter corresponds to the equivalent delay time of the speed control loop. Speed controller pre–control is correctly set (p1496 = 100 %, calibration via p0342) when the I component of the speed controller (r1482) does not change during a ramp–up or ramp–down in the range n > 20 % x p0310. Pre–control, therefore, also allows a new speed setpoint to be approached without overshoot (precondition: torque limiting does not intervene and the moment of inertia remains constant).

If the speed controller is pre–controlled through 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 analog signal p0753 or activating ramp–function generator rounding–off p1130 – p1133.

The starting time r0345 (T_{start}) 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 ($n_{Mot,rated}$).

$$r0345 = T_{Start} = J \times \frac{(2\pi \times n_{mot,rated})}{(60 \times M_{mot,rated})} = p0341 \times p0342 \times \frac{(2\pi \times p0311)}{(60 \times r0333)}$$

If these basic conditions are in line with the application, the starting time can be used as the lowest value for the ramp–up or ramp–down 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 ensures that speed controller pre–control is functioning optimally.

Function diagram overview (see List Manual)

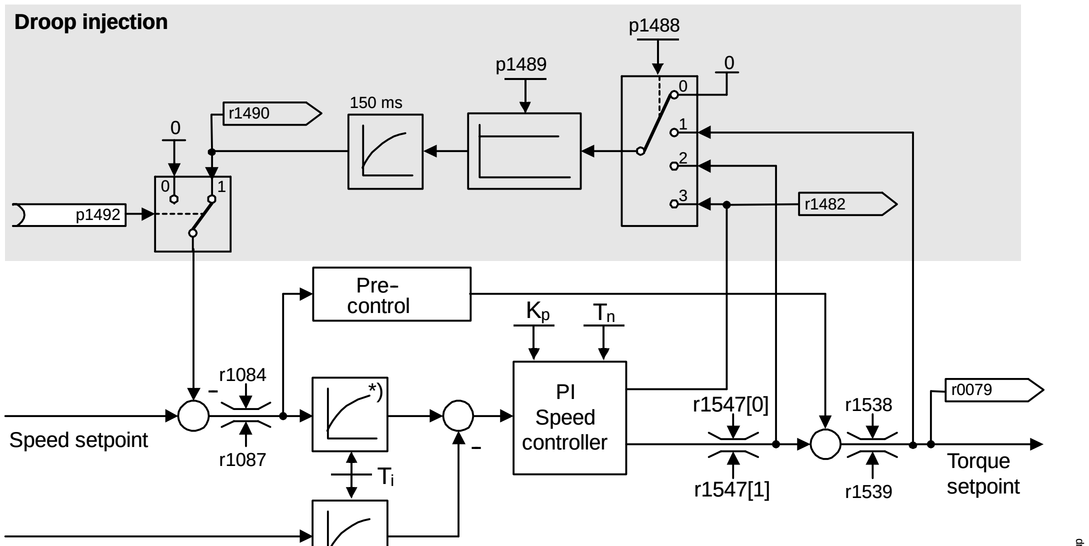
- 6040 Speed controller

Parameter overview (see List Manual)

- p0311[M Rated motor speed
- r0333[M] Rated motor torque
- p0341[M] Motor moment of inertia
- p0342[M] Ratio between the total moment of inertia and that of the motor
- r0345[M] Nominal motor starting time
- p1496[D] Acceleration precontrol scaling
- r1518 CO: Accelerating torque

5.5.6 Droop function

The droop function (enabled via p1492) ensures that the speed setpoint is reduced proportionally as the load torque increases.



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

Fig. 5-41 Speed controller with droop function

Drooping is the most straightforward way of controlling load balancing. This type of control can only be applied, however, if the drives are operated in motor mode and the speed is steady state. This method is only suitable to a limited extent for drives that are accelerated and braked with significant changes in speed.

This simple type of load balancing control 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. The droop function compensates for 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).

Preconditions

- All connected drives must be operated with vector control and speed control (with or without an encoder).
- The ramp-function generator ramp-up and ramp-down times must be the same for all drives.

Function diagram overview (see List Manual)

- 6030 Speed setpoint, droop, acceleration model

Parameter overview (see List Manual)

- p1488[D] Droop input source
- p1489[D] Droop feedback scaling
- p1492[C] BI: Droop feedback enable
- r1490 CO: Droop feedback speed reduction
- r1482 CO: Speed controller I torque output

5.5.7 Torque control mode

With sensorless speed control SLVC (p1300 = 20) or speed control with sensor VC (p1300 = 21), a switchover can be made to torque control (slave drive) via BICO parameter p1501. A switchover cannot be made between speed and torque control if torque control is selected directly with p1300 = 22 or 23. The torque setpoint and supplementary setpoint can be set via BICO parameter p1503 (CI: torque setpoint) or p1511 (CI: supplementary torque). The supplementary torque is active both with torque and speed control. This particular feature with the supplementary torque setpoint allows a pre–control torque to be applied for speed control.

Note

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

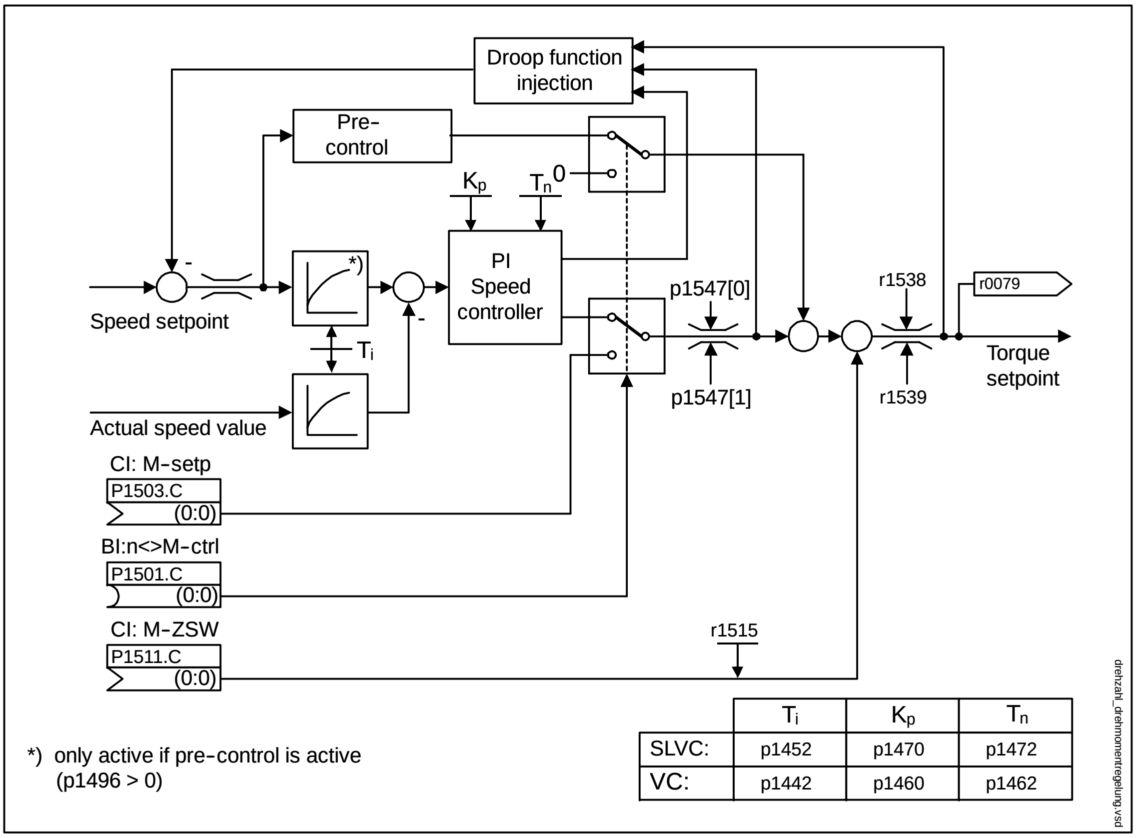


Fig. 5-42 Speed/torque control

The total of the two torque setpoints is limited in the same way as the speed control torque setpoint. At speeds in excess of the maximum speed (p1182), a speed limiter reduces the torque limits to prevent the drive from being accelerated further.

True torque control (with self-adjusting speed) is only possible in closed-loop but not open-loop control for sensorless vector control (SLVC). In open-loop control, the torque setpoint adjusts the setpoint speed via a ramp-function generator (integration time ~ p1499 x p0341 x p0342). For this reason, sensorless torque control at standstill is only suitable for applications that require an accelerating torque but no load torque (e.g. traction drives). This restriction does not apply to torque control with sensor.

If a quick stop command (OFF3) is issued when torque control is active, a switchover is made automatically to speed control and the drive is decelerated. No switchover takes place with a stop command (OFF1) as a slave drive (p1501). Instead, the system waits until a higher-level closed-loop control decelerates the drive to a standstill so that the pulses can be inhibited. This is necessary to ensure that the main and slave drives are stopped together.

If p1300 = 22 or 23 (no slave drive), shutdown takes place directly with OFF1 (as with OFF2).

Function diagram overview (see List Manual)

- 6060 Torque setpoint

Parameter overview (see List Manual)

- p0341[M] Motor moment of inertia
- p0342[M] Ratio between the total moment of inertia and that of the motor
- p1300[D] Open–loop/closed–loop control operating mode
- p1611[D] Acceleration for torque control (SLVC) scaling
- p1501[C] BI: Changeover closed–loop speed and torque control
- p1503[C] CI: Torque setpoint
- p1511[C] CI: Supplementary torque 1

5.5.8 Torque limiting

Description

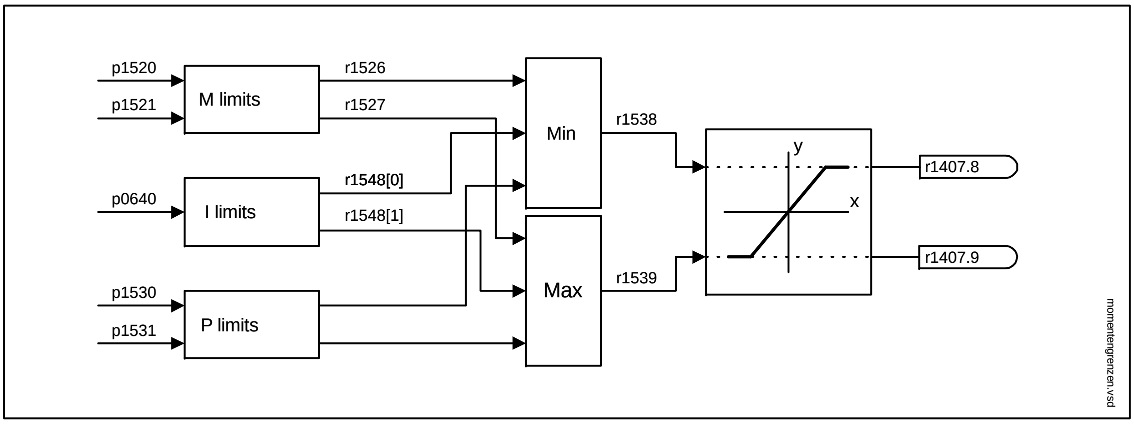


Fig. 5-43 Torque limiting

The value specifies the maximum permissible torque whereby different limits can be parameterized for motor and regenerative mode.

- p0640[D] Current limit
- p1520[D] CO: Upper or motor–mode torque limit
- p1521[D] CO: Lower or regenerative torque limit
- p1522[C] CI: Upper or motor–mode torque limit
- p1523[C] CI: Lower or regenerative torque limit
- p1524[D] CO: Upper or motoring torque limit scaling
- p1525[D] CO: Lower or regenerative torque limit scaling
- p1530[D] Power limit, motor mode
- p1531[D] Power limit, regenerative mode

The current active torque limit values are displayed in the following parameters:

- r0067 CO: Maximum drive output current
- r1526 CO: Upper torque limit of all torque limits without offset
- r1527 CO: Lower torque limit of all torque limits without offset

The following limits all apply to the torque setpoint, which is present either at the speed controller output in the case of speed control, or at the torque input in the case of torque control. The minimum value of the different limits is used in each case. This minimum value is calculatd cyclically in the converter and displayed in parameters r1538 and r1539.

- r1538 Upper torque limit effective

- r1539 Lower torque limit effective

These cyclical values, therefore, limit the torque setpoint at the speed controller output/torque input and indicate the maximum torque currently possible. If the torque setpoint is limited in the motor module, this is indicated via the following diagnostic parameters:

- r1407. 8 Upper torque limit active
- r1407.9 Lower torque limit active

5.5.9 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.
- 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 for the existing losses, thereby stabilizing the voltage in the DC link (kinetic buffering).

Properties

- Vdc control
  - This comprises Vdc_max control and Vdc_min control (kinetic buffering).
  - Joint PI controller. The dynamic factor is used to set Vdc_min and Vdc_max control independently of each other.
- Vdc_max control
  - This function can be used to control momentary regenerative load without shutdown with “overvoltage in the DC link“.
  - Vdc_max control is only recommended with a supply without active closed-loop control for the DC link and without feedback.
- 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.

Description of Vdc_min control

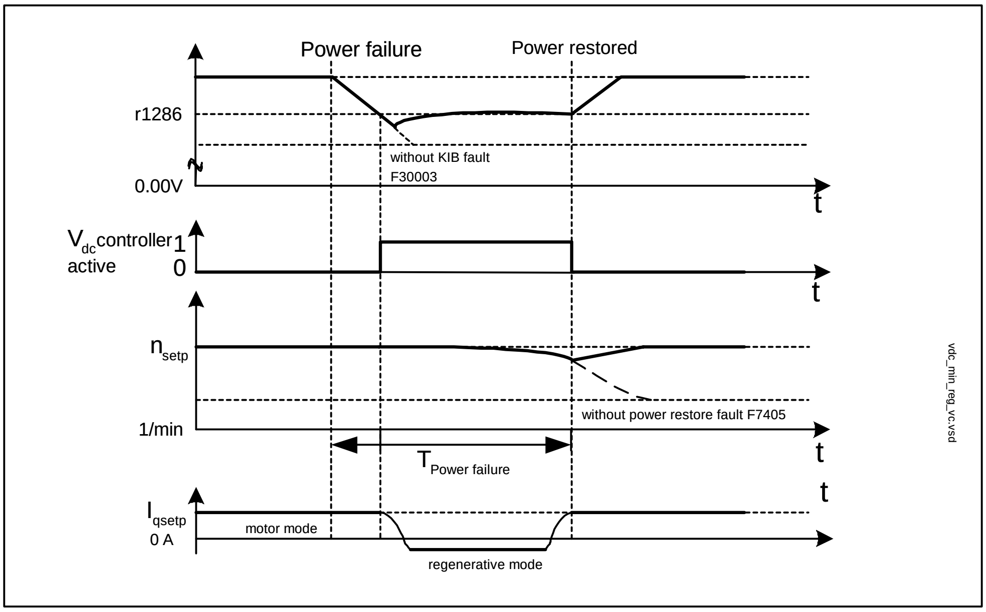


Fig. 5-44 Switching Vdc_min control on/off (kinetic buffering)

In the event of a power failure, Vdc_min control is activated when the Vdc_min switch-in level is undershot. This controls the DC link voltage and maintains it at a constant level. The motor speed is reduced.

When the power supply is restored, the DC link voltage increases again and Vdc_min control is deactivated at 5% above the Vdc_min switch-on level. The motor continues operating normally.

If the power supply is not reestablished, the motor speed continues to drop. When the threshold in p1257 is reached, this results in a response in accordance with p1256.

Once the time threshold (p1255) has elapsed without the line voltage being re-established, a fault is triggered (F07406), which can be parameterized as required (factory setting: OFF3).

Description of Vdc_max control

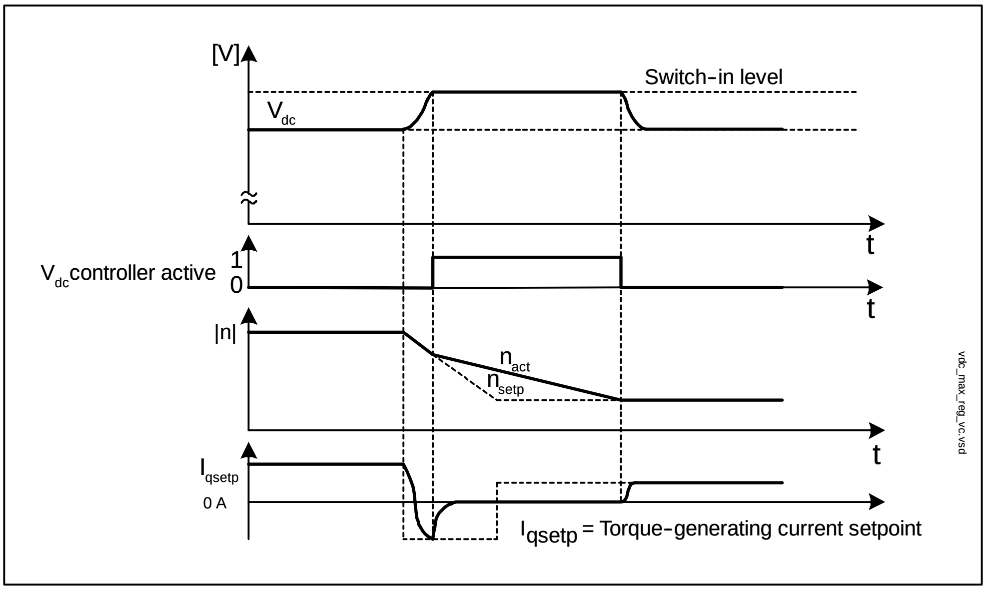


Fig. 5-45 Switching Vdc_max control on/off

The switch-in level for Vdc_max control (r1242) is calculated as follows:

- Automatic detection of ON level deactivated (p1254 = 0)

  r1242 = 1.15 x p0210 (device supply voltage, DC link)

- Automatic detection of ON level activated (p1254 = 1)

  r1242 = Vdc_max – 50 V (Vdc_max: overvoltage threshold of the motor module)

Function diagram overview (see List Manual)

- 6220 Vdc_max controller and Vdc_min controller

Parameter overview (see List Manual)

Adjustable parameters

- p1240[D] Vdc controller or Vdc monitoring configuration
- p1243[D] Vdc_max controller dynamic factor (control)
- p1245[D] Vdc_min controller switch-in level (kinetic buffering) (control)
- p1246 Vdc_min controller switch-in level (kinetic buffering) (control)
- p1247[D] Vdc_min controller dynamic factor (kinetic buffering) (control)
- p1250[D] Vdc controller proportional gain (control)
- p1251[D] Vdc controller integral-action time (control)
- p1252[D] Vdc controller derivative-action time (control)
- p1254 Vdc_max controller automatic detection ON level (control)
- p1256[D] Vdc_min controller response (kinetic buffering) (control)
- p1257[D] Vdc_min controller speed threshold (control)

Visualization parameters

- r1242 Vdc_max controller switch-in level
- r1258 CO: Vdc controller output (control)

5.5.10 Flying restart

Description

After power ON, the “flying restart” function switches automatically to a motor module, which may be coasting. During the switchover to the rotating motor, –>magnetization must first be carried out for an –> induction motor.
In “operation without encoder” mode, a –> “search” is first of all made for the current speed. The current speed setpoint in the ramp–function generator is then set to the current actual speed value. The ramp–up to the final speed setpoint starts with this value. The “flying restart” function can help to shorten the ramp–up procedure after the power has been switched on (when the load is still coasting down).

Application example: After a power failure, a fan drive can be quickly reconnected to the running fan motor by means of the “flying restart” function.
See also: Automatic restart

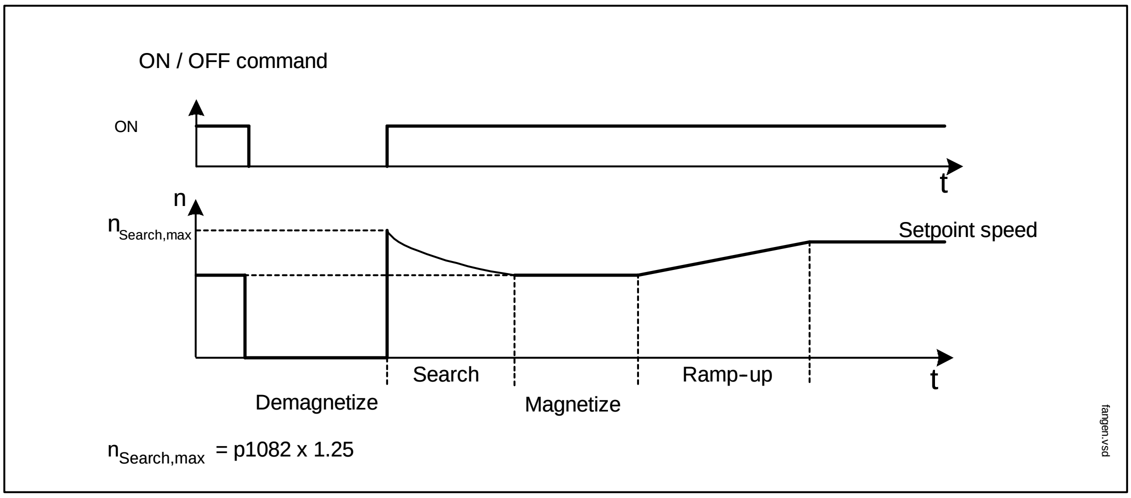


Fig. 5-46 Flying restart

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.

Properties of the flying restart function

- p1082 Maximum speed
- p1200 Flying restart operating mode
  - 0: Flying restart is inactive
  - 1: Flying restart is always active. Start in setpoint direction.
  - 2: Flying restart is active after: switch–on, fault, OFF2. Start in setpoint direction.
  - 3: Flying restart is active after: fault, OFF2. Start in setpoint direction.
  - 4: Flying restart is always active. Start in setpoint direction **only**.
  - 5: Flying restart is active after: switch–on, fault, OFF2. Start in setpoint direction **only**.
  - 6: Flying restart is active after: fault, OFF2, start in setpoint direction **only**.
- p1202 Flying restart search current
- p1203 Flying restart search rate factor

5.5.11 Motor identification and 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; p1900 = 1 sets p1910 = 1 and p1960 in accordance with the current control type (p1300).

Parameter p1960 is set depending on p1300:

- p1960 = 1, when p1300 = 20 or 22
- p1960 = 2, when p1300 = 21 or 23

Parameter p1900 is also available for quick commissioning (p0010 = 1). Motor identification is not started until all the enable signals are set and the next switch–on command is issued. This is indicated using appropriate alarms (A07991 for the standstill measurement and A07980 for the rotating measurement).

When the standstill measurement is complete, the drive switches itself off automatically and p1910 is automatically reset to 0. To start the rotating measurement, you have to switch the drive back on. The drive also switches itself off automatically when this measurement is complete and p1960 (and p1900) is reset to 0. The measurements can be aborted by canceling the enable signals (e.g. OFF) or by resetting the parameters.

Note

To set the new controller setting permanently, the data must be saved with p0977 or p0971 on the non–volatile CompactFlash card.

Danger

During motor identification, the drive may cause the motor to move. The emergency OFF functions must be fully operational during commissioning. To protect the machines and personnel, the relevant safety regulations must be observed.

Standstill measurement (p1910)

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 in the V/f curve 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):

- Equivalent circuit diagram data
- Total resistance of:
  - Power cable resistance (R_{cable}) and
  - Stator resistance (R_S)
- IGBT on-state voltage or compensation for the IGBT lockout times

Since the type plate data contains the initialization values for identification, you must ensure that it is entered correctly and consistently to enable the above data to be determined.

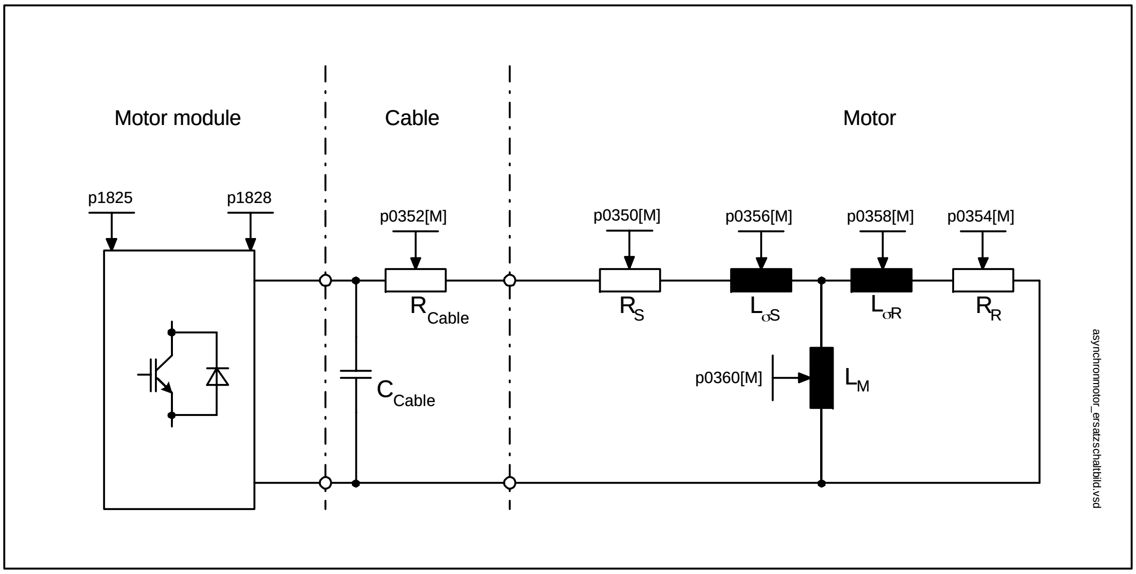


Fig. 5-47 Equivalent circuit diagram for induction motor and cable

In addition to the equivalent circuit diagram data, motor data identification (p1910 = 3) can be used to determine the magnetization characteristic for motors of less than 11 kW. If the motor power is greater than 11 kW, the magnetization characteristic can only be determined with p1960 and a rotating measurement.
If the motor–motor module combination 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-producing current in the field-weakening range more accurately, thereby increasing torque accuracy.

Note

Speed controller optimization (p1960) allows the rated magnetization current and saturation characteristic to be determined more accurately.

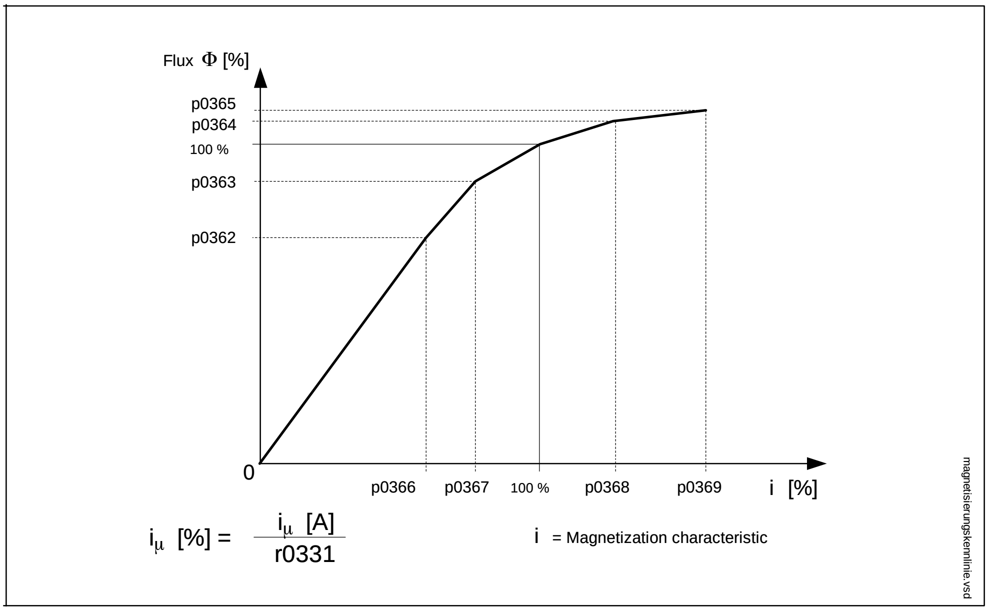


Fig. 5-48 Magnetization characteristic

Note

To set the new controller setting permanently, the data must be saved with p0977 or p0971 on the non-volatile CompactFlash card.

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.

The following parameters are determined by means of motor identification

- p1910 = 1: p0350, p0354, p0356, p0358, p0360, p1825, p1828, p1829, p1830
- p1910 = 3: p0362... p0366

Rotating measurement

Speed controller optimization determines the data required (e.g. moment of inertia) for setting the speed controller. It also measures the saturation characteristic and rated magnetization current of the motor.

Speed control can be activated via p1960 or p1900 = 1.

If the rotating measurement is not to be carried out using the speed set in p1965, this parameter can be changed before the measurement is started.

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 any problems occur during the measurement, the dynamic response is reduced automatically and the result displayed in r1969. The drive must also be checked to ensure that it is stable across the entire range. If necessary, the dynamic response may have to be reduced or Kp/Tn adaptation for the speed controller parameterized accordingly.

Carrying out the rotating measurement (p1960 > 0):

The following measurements are carried out when the enable signals are set and a switch-on command is issued.

- Measurement of the saturation characteristic (p0362 to p0369)
- Measurement of the magnetization current (p0320))
- Speed controller optimization
  - p1470 and p1472, when p1960 = 1 (operation without encoder)
  - p1460 and p1462, when 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 on the non-volatile CompactFlash card.

Danger

During speed controller optimization, the drive may cause the motor to move. The emergency OFF functions must be fully operational during commissioning. To protect the machines and personnel, the relevant safety regulations must be observed.

Parameter overview (see List Manual)

- p1959 Speed controller optimization configuration
- p1960 Speed controller optimization selection
- p1961 Saturation characteristic speed for calculation
- p1965 Speed controller optimization speed
- p1967 Speed controller optimization dynamics factor
- r1969 Speed controller optimization inertia identified

5.6 Vector V/f control

The simplest solution for a control procedure is the V/f curve, 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

and other similar processes.

V/f control aims to maintain a constant flux ϕ in the motor, whereby the flux is proportionate to the magnetization current $I\mu$ or the ratio of voltage (U) to frequency (f).

$\phi \sim I\mu \sim U/f$

The torque (M) generated by the induction motors is, in turn, proportionate to the product (or, more precisely, the vector product $\underline{\phi}$ x $\underline{I}$) 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 (U) must be changed in proportion to the frequency (f) to ensure that a constant magnetization current Im $I\mu$ flows. V/f characteristic control is derived from these basic premises.

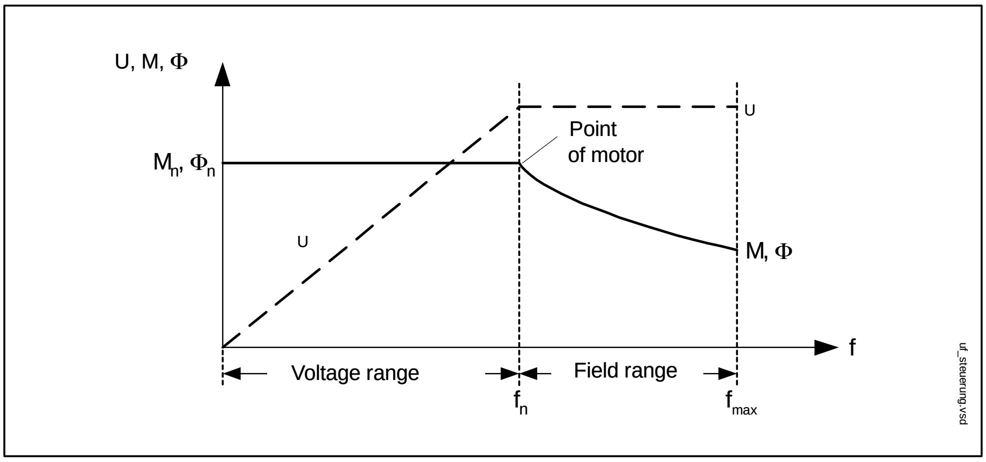


Fig. 5-49 Operating areas and characteristic curves for the induction motor with converter supply

Several variations of the V/f characteristic exist, which are shown in the following table.

Table 5-14 V/f characteristic (p1300)

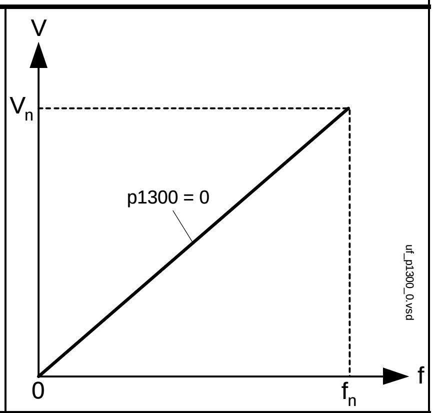
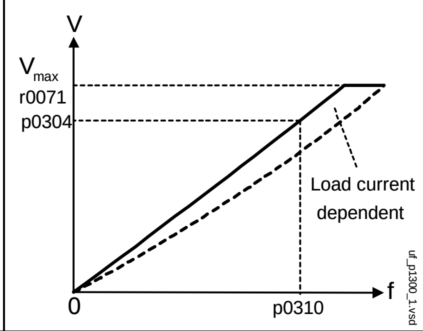
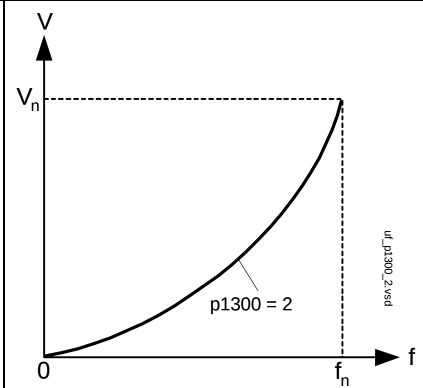
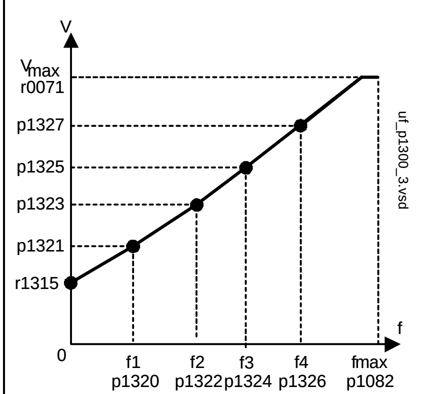
Parameter values	Meaning	Application / Property	
0	Linear characteristic	Standard (w/o voltage boost)	
1	Linear characteristic with flux current control (FCC)	Characteristic that compensates for voltage drops in the stator resistance for static / dynamic loads (flux current control FCC). This is particularly useful for small motors, since they have a relatively high stator resistance.	
2	Parabolic characteristic	Characteristic that takes into account the motor torque characteristic (e.g. fan/pump). a) Quadratic characteristic (n^2 characteristic) b) Energy saving because the low voltage also results in small currents and drops.	
3	Programmable characteristic	Characteristic that takes into account the motor / machine torque characteristic (e.g. synchronous motor).	

Table 5-14 V/f characteristic (p1300), continued

Parameter values	Meaning	Application / Property
5	Precise frequency drives	Characteristic that takes into account the technological particularity of an application (e.g. textile applications): a) whereby current limitation (Imax controller) only affects the output voltage and not the output frequency, or b) by disabling slip compensation
6	Precise frequency drives with flux current control (FCC)	Characteristic that takes into account the technological particularity of an application (e.g. textile applications): a) whereby current limitation (Imax controller) only affects the output voltage and not the output frequency, or b) by disabling slip compensation Voltage drops 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.
19	Independent voltage setpoint	The user can define the output voltage of the motor module independently of the frequency using BICO parameter p1330 via the interfaces (e.g. analog input AI0 of a terminal board 30 –> p1330 = r4055[0]).

5.6.1 Voltage boost

With an output frequency of 0 Hz, the V/f characteristics yield an output voltage of 0 V. The voltage boost must be entered to:

- Magnetize the induction motor
- Maintain the load
- Compensate for the losses (ohmic losses in the winding resistors) in the system
- Generate a breakaway/acceleration/braking torque.

The voltage boost can be increased permanently (p1310) or during acceleration (p1311).

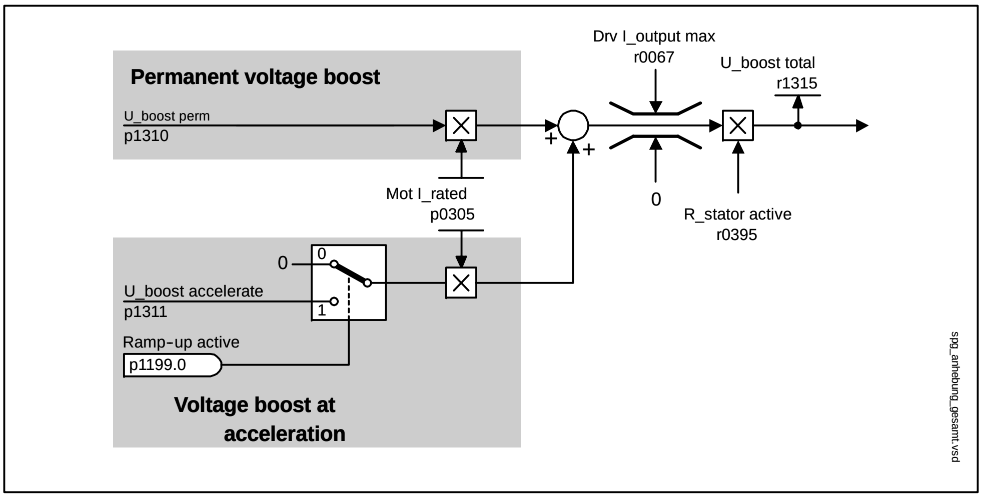


Fig. 5-50 Total voltage boost

Note

The voltage boost affects all V/f characteristics (p1300) from 0 to 19.

Notice

If the voltage boost value is too high, this can result in a thermal overload of the motor winding.

Permanent voltage boost (p1310)

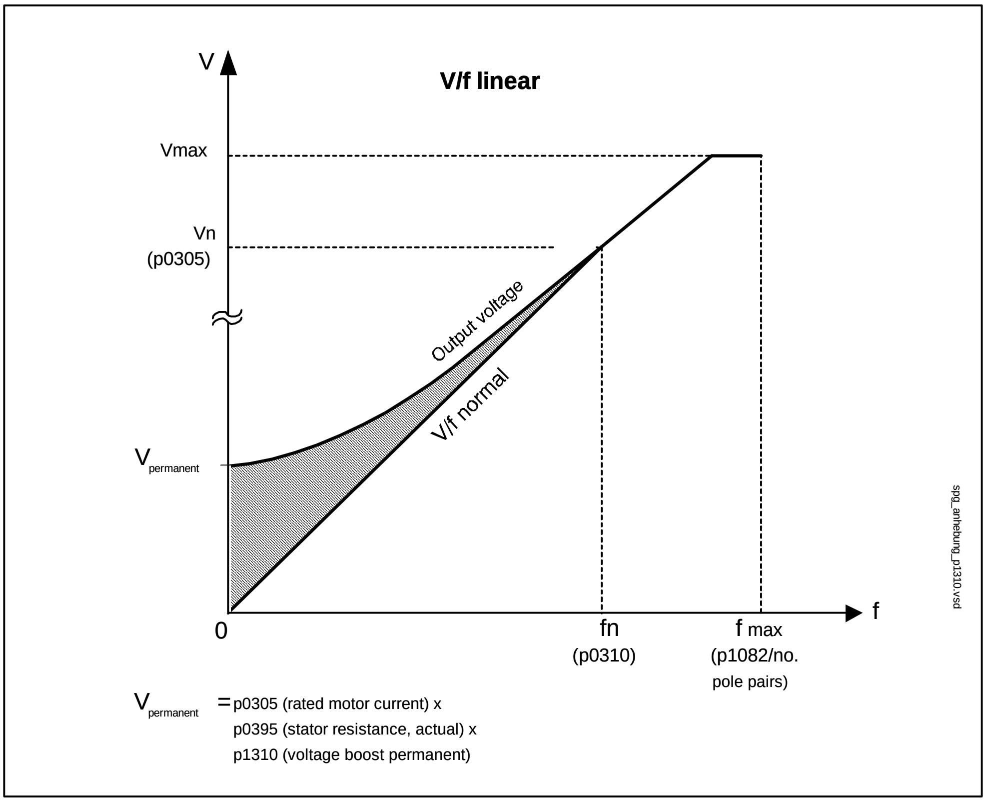


Fig. 5-51 Voltage boost at acceleration (example: p1300 and p1311 = 0)

Voltage boost at acceleration (p1311)

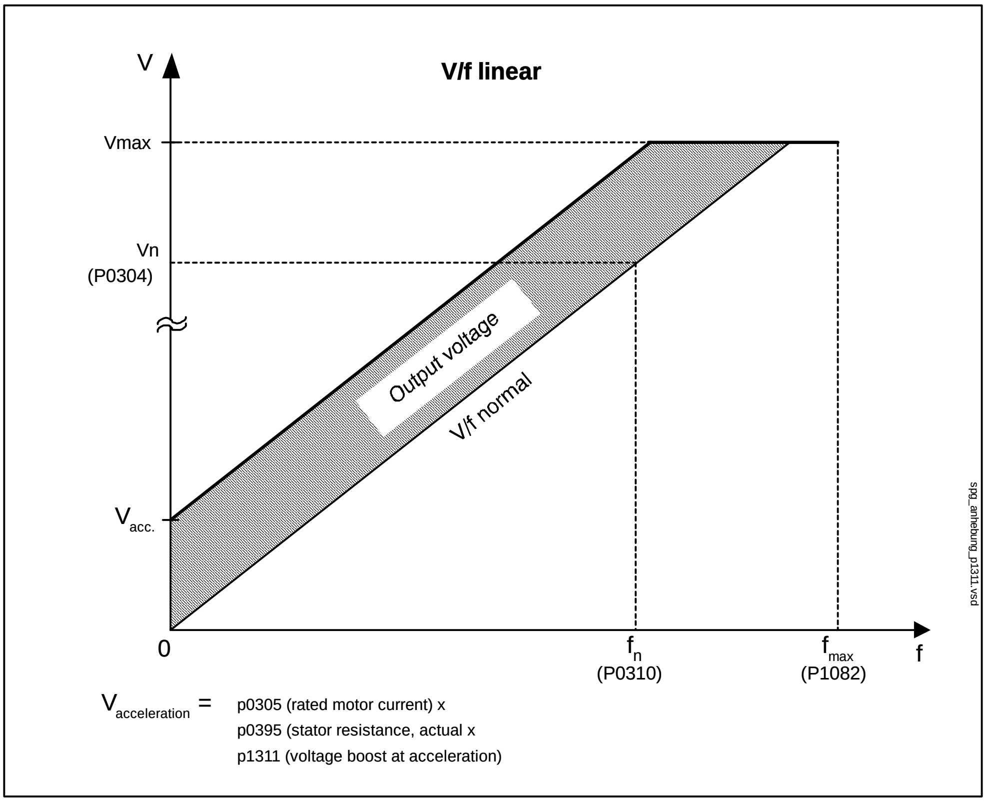


Fig. 5-52 Permanent voltage boost (example: p1300 and p1311 = 0)

Function diagram overview (see List Manual)

- 6300 V/f characteristic and voltage boost

Parameters

- p0305[M Rated motor current
- p0395[M] Stator resistance, actual
- p1310[D] Voltage boost permanent
- p1311[D] Voltage boost at acceleration
- r1315 Voltage boost total

5.6.2 Slip compensation

Description

Slip compensation is an additional V/f control function. It ensures that the speed of induction motors is maintained at a constant level irrespective of the load.

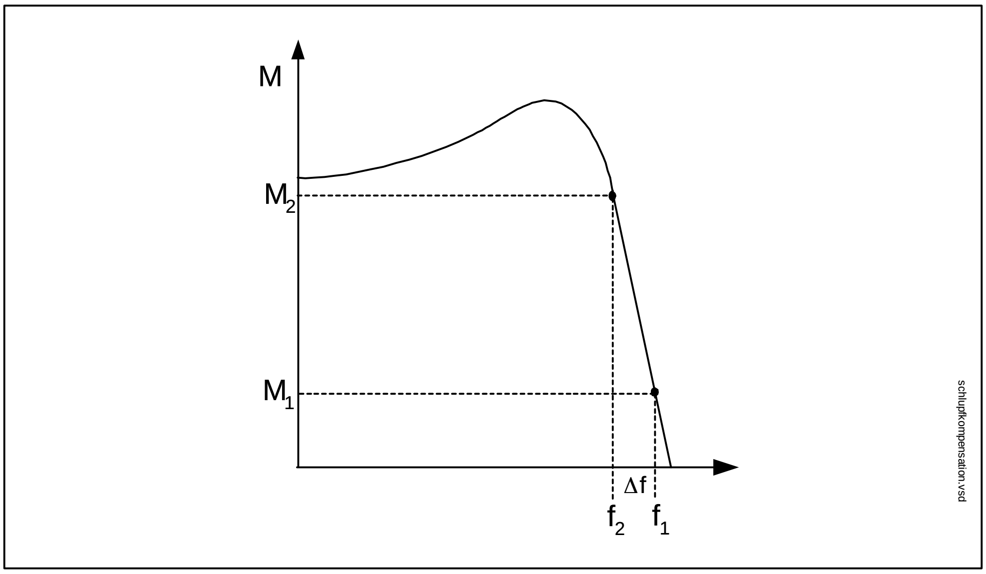


Fig. 5-53 Slip compensation

Properties of slip compensation

- p1335[D] Slip compensation
  - p1335 = 0.0 %: slip compensation is deactivated.
  - p1335 = 100.0 %: slip is fully compensated.
- p1336[D] Slip compensation limit value
- p1337[D] Actual slip compensation

5.6.3 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.
- 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 for the existing losses, thereby stabilizing the voltage in the DC link (kinetic buffering).

Properties

- Vdc control
  - This comprises Vdc_max control and Vdc_min control (kinetic buffering), which are independent of each other.
  - Joint PI controller. The dynamic factor is used to set Vdc_min and Vdc_max control to a smoother or harder setting 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 with “overvoltage in the DC link“.
  - Vdc_max control is only recommended with a supply without active closed-loop control for the DC link and without feedback.

Description of Vdc_min control

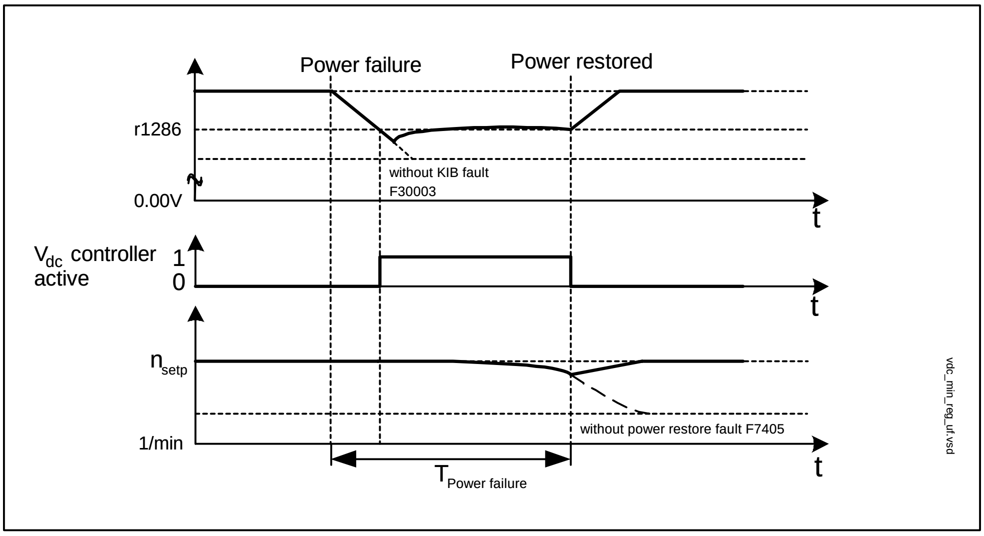


Fig. 5-54 Switching Vdc_min control on/off (kinetic buffering)

In the event of a power failure, Vdc_min control is activated when the Vdc_min switch-in level is undershot. This controls the DC link voltage and maintains it at a constant level. The motor speed is reduced.

When the power supply is restored, the DC link voltage increases again and Vdc_min control is deactivated at 5 % above the Vdc_min switch-on level. The motor continues operating normally.

If the power supply is not reestablished, the motor speed continues to drop. When the threshold in p1257 is reached, this results in a response in accordance with p1256.

Once the time threshold (p1255) has elapsed without the line voltage being re-established, a fault is triggered (F07406), which can be parameterized as required (factory setting: OFF3).

Description of Vdc_max control

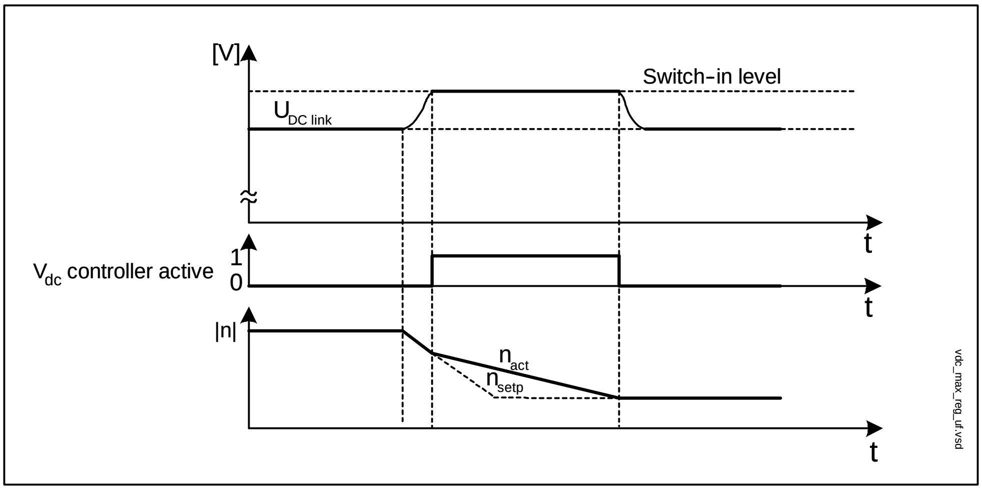


Fig. 5-55 Switching Vdc_max control on/off

The switch-in level for Vdc_max control (r1282) is calculated as follows:

- Automatic detection of ON level deactivated (p1294 = 0)

  r1282 = 1.15 x p0210 (device supply voltage, DC link)

- Automatic detection of ON level activated (p1294 = 1)

  r1282 = Vdc_max – 50 V (Vdc_max: overvoltage threshold of the motor module)

Function diagram overview (see List Manual)

- 6320 Vdc_max controller and Vdc_min controller

Parameter overview (see List Manual)

Adjustable parameters

- p1280[D] Vdc controller configuration
- p1283[D] Vdc_max controller dynamic factor
- p1285[D] Vdc_min controller switch-in level (kinetic buffering) (V/f)
- p1286 Vdc_min controller switch-in level (kinetic buffering) (V/f)
- p1287[D] Vdc_min controller dynamic factor (kinetic buffering) (V/f)
- p1290[D] Vdc controller proportional gain (V/f)
- p1291[D] Vdc controller integral action time (V/f)
- p1292[D] Vdc controller derivative action time (V/f)
- p1294 Vdc_max controller automatic detection ON signal level (V/f)
- p1296[D] Vdc_min controller response (kinetic buffering) (V/f)
- p1297[D] Vdc_min controller speed threshold (V/f)

Visualization parameters

- r1242 Vdc_max controller switch-in level
- r1258[0...15] CO:Vdc controller output

■

SINAMICS Safety Integrated 6

This chapter describes the following aspects of SINAMICS Safety Integrated:

- General information about SINAMICS Safety Integrated
- Safe standstill (SH)
- Safe brake control (SBC)
- Commissioning the safe standstill (SH) and safe brake control (SBC) functions
- Overview of parameters and function diagrams
- Acceptance test and certificate

6.1 General information about SINAMICS Safety Integrated

6.1.1 Explanations, standards, and terminology

Safety Integrated

The "Safety Integrated" functions, which have been prototype tested, provide highly-effective application-oriented protection for personnel and machinery.

This innovate safety technology offers the following benefits:

- Increased safety
- More economic operation
- Greater flexibility
- Higher level of plant availability

The following Safety Integrated (SI) functions are available:

- Safe stop (SH) Safe standstill (SH)

  "Safe stop (SH)" is a function that helps prevent the drive from restarting unexpectedly (to EN 60204-1, Section 5.4.).
- Safe Brake Control (SBC)

Note

These functions are drive autonomous, that is, no higher-level controller is required.

Standards and guidelines

Various standards and guidelines for safety technology must be observed.

Guidelines are binding for both the manufacturer and operator of machines.

Standards generally reflect the state of the art and act as a basis for implementing safety concepts. Unlike guidelines, however, they are not binding.

Below is a list of standards and guidelines for safety technology.

- EC 98/37/EG machinery directive

  This guideline defines basic protection measures for safety technology.
- EN 292–1

  Basic terminology and general principles for design
- EN 954–1

  Safety–related parts of control systems
- EN 1050

  Risk assessment
- IEC 61508

  Functional reliability of electrical and electronic systems

  This standard defines “safety integrity levels” (SIL), which not only describe a certain degree of integrity with regard to safety–oriented software but also defined, quantitative error probability ranges with regard to the hardware.

Note

The safety functions for SINAMICS S120 fulfill the following requirements:

- Category 3 to EN 954–1.
- Safety integrity level 2 (SIL 2) to IEC 61508.

Expectations

The monitoring functions in each monitoring channel work on the principle that a defined status must prevail before each action is carried out and a specific acknowledgement made after each action.

If these expectations of a monitoring channel are not fulfilled, the drive coasts to a standstill (two channel) and an appropriate message is output.

Switch-off signal paths

Two independent switch-off signal paths are available. All switch-off signal paths are low active, thereby ensuring that the system is always switched to a safe status if a component fails or in the event of cable breakage.

If an error is discovered in the switch-off signal paths, the “Safe standstill” function is activated and a system restart inhibited.

Two-channel monitoring structure

All the main hardware and software functions for Safety Integrated are implemented in two independent monitoring channels (e.g. switch-off signal paths, data management, data comparison).

The two drive monitoring channels are implemented using the following components:

- Control unit
- The motor module belonging to a drive

Forced dormant error detection or test for the switch-off signal paths

Forced dormant error detection for the switch-off signal paths is used for detecting errors in the software/hardware of the two monitoring channels as quickly as possible and is carried out automatically when the “Safe standstill” function is activated/deactivated.

To fulfill the requirements of EN 954-1 regarding timely error detection, the two switch-off signal paths must be tested at least once within a defined time to ensure that they are functioning properly. For this purpose, forced dormant error detection must be triggered manually by the user or automatically.

A timer ensures that forced dormant error detection is carried out as quickly as possible.

- p9659 Safety Integrated timer for forced checking procedure

Forced dormant error detection must be carried out at least once during the time set in this parameter.

Once this time has elapsed, an alarm is output and remains present until forced dormant error detection is carried out.

The timer returns to the set value each time the “Safe standstill” function is deactivated.

When the appropriate safety devices are implemented (e.g. protective doors), it can be assumed that running machinery will not pose any risk to personnel. For this reason, only an alarm is output to inform the user that a forced dormant error detection run is due and request that this be carried out at the next available opportunity. This alarm does not affect machine operation.

The user must set the time interval for carrying out forced dormant error detection to between 0.00 and 9000.00 hours depending on the application (factory setting: 8.00 hours).

When to carry out forced dormant error detection:

- When the drives are at a standstill after the system has been switched on.
- When the protective door is opened.
- At defined intervals (e.g. every 8 hours).
- In automatic mode (time and event dependent)

Safety-related input signals (SGE)

Safety-relevant input signals act as an interface with the process. These digital signals are transmitted to the system (two channel) and are used for selecting/ deselecting safety functions.

Example: Selecting/deselecting “Safe standstill” (SH)

Crosswise data comparison

A cyclic crosswise comparison of the safety-relevant data in the two monitoring channels is carried out.

In the event of inconsistencies, the following occurs:

1. Fault F01611 or F30611 (STOP F) is output and the time in p9658 or p9858 triggered.
2. Once the time has elapsed, a further fault (F01600 or F30600 (STOP A)) is output and the safe pulse disable activated.

The stop reaction is transferred to the other monitoring channel so that two-channel standstill can be carried out.

Monitoring clock cycle

The safety-oriented drive functions are executed cyclically in the monitoring clock cycle.

The safety monitoring clock cycle lasts a minimum of 4 ms (factory setting for V02.01). Increasing the basic DRIVE-CLiQ sampling time (p0110) also increases the safety monitoring clock cycle.

Parameter overview (see List Manual)

- r9780 Safety Integrated monitoring clock cycle (control unit)
- r9880 Safety Integrated monitoring clock cycle (motor module)

6.1.2 Parameter, Checksum, Version, Password

Properties of Safety Integrated parameters

The following applies to Safety Integrated parameters:

- They are kept separate for each monitoring channel.
- They are password-protected against accidental or unauthorized changes.
- During ramp-up, a checksum (cyclic redundancy check: CRC) is generated and checked via the safety parameters, which have undergone a checksum check.
- Data management
  - Safety parameters for control unit

    These parameters are stored on the non-volatile CompactFlash card.
  - Safety parameters for motor module

    These parameters are stored on the non-volatile CompactFlash card in a separate file and format.
- Factory settings for safety parameters

  You can only reset the safety parameters to the factory setting on a drive-specific basis using p0970 or p3900 when the safety functions are not enabled (p9601 = p9801 = 0).

Checking the checksum

For each monitoring channel, the safety parameters include one parameter for the actual checksum for the safety parameters that have undergone a checksum check.

During commissioning, the actual checksum must be transferred to the corresponding parameter for the specified checksum.

- r9798 Safety Integrated actual checksum SI parameters (control unit)
- p9799 Safety Integrated specified checksum SI parameters (control unit)
- r9898 Safety Integrated actual checksum SI parameters (motor module)
- p9899 Safety Integrated specified checksum SI parameters (motor module)

During each ramp-up procedure, the actual checksum is calculated via the safety parameters and then compared with the specified checksum.

If the actual and specified checksums are different, fault F01650 or F30650 is output and an acceptance test requested.

Safety Integrated versions

The safety software has a separate version ID for the control unit and motor module.

- r9770[0...2] Safety Integrated version (control unit)
- r9870[0...2] Safety Integrated version (motor module)

Password

The safety password protects the safety parameters against unauthorized write access.

In commissioning mode for Safety Integrated (p0010 = 95), you cannot change safety parameters until you have entered the valid safety password in p9761.

- When Safety Integrated is commissioned for the first time, the following applies:
  - Safety password = 0
  - Default setting for p9761 = 0

  This means:

  The safety password does not need to be set during initial commissioning.
- Changing the password
  - p0010 = 95 commissioning mode (see Section 6.4)
  - p9761 = Enter “old safety password”.
  - p9762 = Enter “new password”.
  - p9763 = Confirm “new password”.
  - The new and confirmed safety password is valid immediately.

If you need to change safety parameters but you do not know the safety password, proceed as follows:

1. Set the entire drive unit to the factory setting (see Section 8.2).
2. Recommission the drive unit and drives.
3. Recommission Safety Integrated.

Parameter overview (see List Manual)

- p9761 Safety Integrated password input
- p9762 Safety Integrated new password
- p9763 Safety Integrated, confirm password

6.2 Safe standstill (SH)

General description

In conjunction with a machine function or in the event of an error, the “Safe standstill (SH)” function is used to safely disconnect the torque-generating motor power supply.

When the function is selected, the drive unit is in a “safe status”. The power-on disable function prevents the drive unit from being restarted.

The pulse disable integrated in the motor modules is a prerequisite for this function.

Features of “safe standstill”

- This function is drive autonomous, that is, no higher-level controller is required.
- The function is drive specific, that is, it must be commissioned individually on a drive-by-drive basis.
- The terminals for the “safe standstill” function can be grouped together.
- When the “safe standstill” function is selected:
  - The motor cannot be started accidentally.
  - The pulse disable safely disconnects the torque-generating motor power supply.
  - The motor module and motor are not electrically isolated.

Caution

Appropriate measures must be taken to ensure that the motor does not move once the motor power supply has been disconnected (“coast down”) (e.g. enable the “Safe brake control” function with a vertical axis).

- The status of the “Safe standstill” function is displayed via the appropriate parameters.

Terminals for “Safe standstill” and grouping

The “Safe standstill” function is selected/deselected on a drive–specific basis via the terminals on the control unit and motor module.

- Control unit

  The required input terminal for “Safe standstill (SH)” is selected via the BICO interconnection (BI: p9620).

  Digital input DI 0 ... DI 7 on the control unit can be used as a signal source.

- Motor module

  The input terminal for “Safe standstill (SH)” is terminal “EP” (“Enable pulses”).

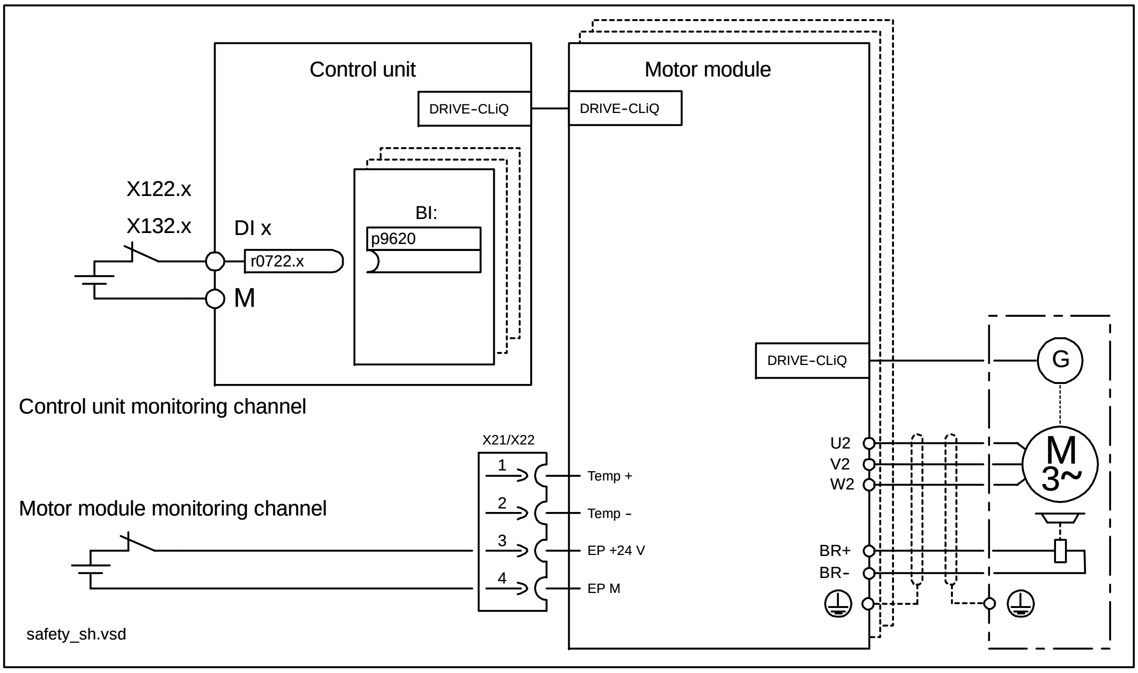


Fig. 6-1 Terminals for “Safe standstill”

To ensure that the function works for more than one drive, the terminals for the corresponding drives must be grouped together as follows:

- Control unit

  By connecting the binector input to the joint input terminal on the drives in one group.

- Motor module

  By wiring the “EP” terminal on the individual motor modules in the group.

Note

The grouping must be identical in both monitoring channels.

The assignment is checked during the test for the switch-off signal paths, whereby the operator selects “Safe standstill” for each group. The check is drive specific.

Example: terminal grouping for “Safe standstill (SH)”

It must be possible to select/deselect “Safe standstill” separately for group 1 (drive 1 and 2) and group 2 (drive 3 and 4).

In addition, the same grouping for “Safe standstill” must be assigned on both the control unit and the motor modules.

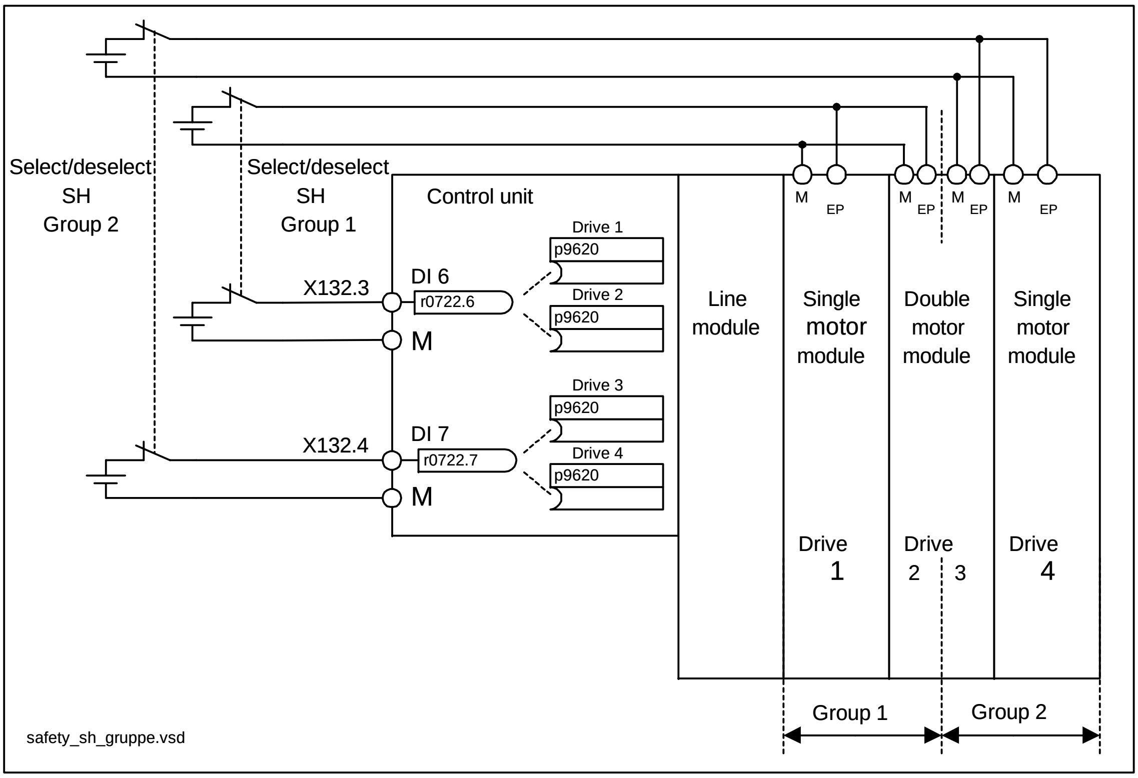


Fig. 6-2 Example: terminal grouping for “Safe standstill (SH)”

Enabling the “Safe standstill (SH)” function

The “Safe standstill” function is enabled via the following parameters:

- p9601.0 SH via terminals (control unit)
- p9801.0 SH via terminals (motor module)

Selecting/deselecting “Safe standstill”

The “Safe standstill” function must be selected/deselected “simultaneously” in both monitoring channels via the input terminals.

1 signal: Deselect function

0 signal: Select function

“Simultaneously” means:

The changeover must be complete in both monitoring channels within the parameterized tolerance time.

- p9650 Safety Integrated tolerance time SGE changeover (control unit)
- p9850 Safety Integrated tolerance time SGE changeover (motor module)

If the “Safe standstill” function is not selected/deselected within the tolerance time, this is detected by the crosswise data comparison and fault F01611 or F30611 (STOP F) is output.

The following occurs when “Safe standstill” is selected:

- Each monitoring channel triggers the safe pulse disable via its switch–off signal path.
- A motor holding brake is applied (if connected and configured).

The following occurs when “Safe standstill” is deselected:

- Each monitoring channel cancels the safe pulse disable via its switch–off signal path.
- The safety prompt “Apply motor holding brake” is canceled.

Note

If the two input signals for selecting/deselecting “Safe standstill” differ momentarily (i.e. within the tolerance time in p9650/p9850), the drive is stopped although no message is output.

If you want a message to be displayed in this case, however, you have to reconfigure N01620/N30620 as an alarm or fault.

Restart once the “Safe standstill” function has been selected

1. Deselect the function in each monitoring channel via the input terminals.
2. Issue drive enable signals.
3. Cancel the power–on inhibit and switch the drive back on.
   - 1/0 edge at input signal “ON/OFF1” (cancel power–on inhibit)
   - 0/1 edge at input signal “ON/OFF1” (switch on drive)
4. Run the drives again.

Status with “Safe standstill”

The status of the “Safe standstill (SH)” function is indicated via the following parameters:

Parameter overview (see List Manual)

- r9772 CO/BO: Safety Integrated status (control unit)
- r9872 CO/BO: Safety Integrated status (motor module)
- r9773 CO/BO: Safety Integrated status (control unit + motor module)
- r9774 CO/BO: Safety Integrated status (group safe standstill)

Response time for “Safe standstill” function

The response time when you select/deselect the function via input terminals is max. 2 monitoring clock cycles (8 ms, V02.01).

In the event of a fault in a monitoring channel or with DRIVE–CLiQ communication, the response time is max. 6 monitoring clock cycles (25 ms, V02.01).

Parameter overview (see List Manual)

- r9780 Safety Integrated monitoring clock cycle (control unit)
- r9880 Safety Integrated monitoring clock cycle (motor module)

6.3 Safe brake control (SBC)

Description

Safe brake control is used to activate holding brakes that function according to the standby current principle (e.g. motor holding brake).

The command for releasing or applying the brake is transmitted to the motor module via DRIVE-CLiQ. The motor module then carries out the action and activates the outputs for the brake.

Brake activation via the brake connection on the motor module is carried out using a safe, two-channel method.

Warning

"Safe brake control" does not detect faults in the brake itself (e.g. brake winding short-circuit, worn brakes, and so on).

"Safe brake control" only detects faults in the brake cables (e.g. breakage) when the status changes (when the brakes are released or applied).

Features of "Safe brake control (SBC)"

- When "Safe standstill" is selected or when safety monitors are triggered, "SBC" is triggered by means of safe pulse disable.
- Unlike conventional brake control, "SBC" is triggered via p1215 with two channels.
- "SBC" is triggered independently of the brake control mode set in p1215.
- Each time "Safe standstill" is selected, the holding brake is applied immediately with forced dormant error detection.

Enabling the "Safe brake control (SBC)" function

The "Safe brake control" function is enabled via the following parameters:

- p9602 Safety Integrated enable safe brake control (control unit)
- p9802 Safety Integrated enable safe brake control (motor module)

The "Safe brake control" function is not activated until at least one safety monitoring function is enabled (i.e. p9601 = p9801 $\neq$ 0).

Two-channel brake control

The brake is controlled from the control unit. Two signal paths are available for applying the brake.

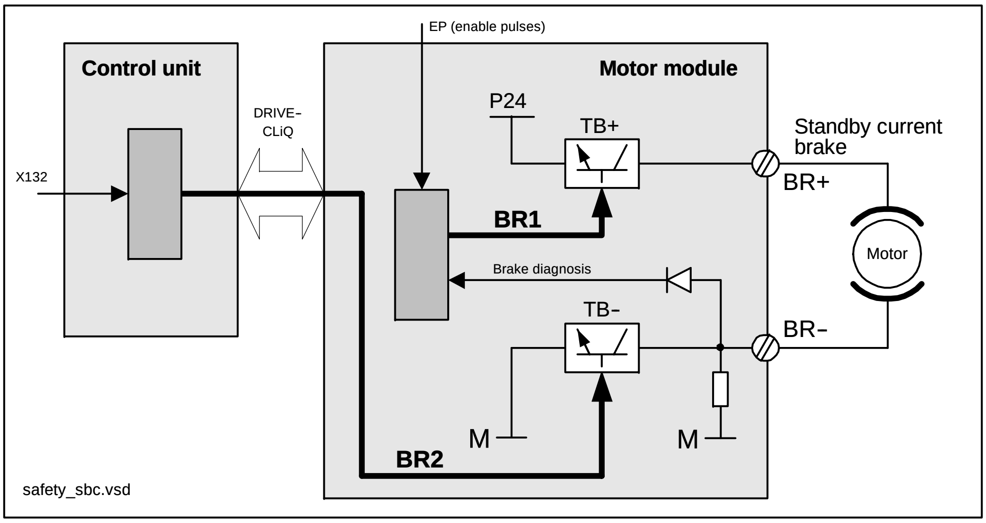


Fig. 6-3 Two-channel brake control

The motor module carries out a check to ensure that the “Safe brake control” function is working properly and ensures that if the control unit fails or is faulty, the brake current is interrupted and the brake applied.

The brake diagnosis can only reliably detect a malfunction in either of the switches (TB+, TB–) when the status changes (when the brake is released or applied).

If the motor module or control unit detects a fault, the brake current is switched off and the safe status is reached.

6.4 Commissioning the “SH” and “SBC” functions

6.4.1 General information about commissioning safety functions

Commissioning notes

Caution

For safety reasons, Safety Integrated must be commissioned using STARTER in online mode.

Reason:

STARTER should only be used to store the safety parameters of a project monitoring channel. As a result, downloading a project with active Safety Integrated results in safety problems.

What to do if you download a project when Safety Integrated is active:

- Switch to online mode and compare the safety parameters between the two monitoring channels in safety commissioning mode.
- Exit safety commissioning mode.
- Switch the power on.

Note

- The “SH” and “SBC” functions are only available for the SERVO drive projects (r0107 = 11, V02.01).
- The “SH” and “SBC” functions are drive specific, that is, the functions must be commissioned individually for each drive.
- To support the “SH” and “SBC” functions, the following (minimum) safety versions are required:

  Control unit: V02.01.01 (r9770[0...2])

  Motor module: V02.01.01 (r9870[0...2])
- If the version in the motor module is incompatible, the control unit responds as follows during the switchover to safety commissioning mode (p0010 = 95):
  - Fault F01655 (Safety Integrated control unit: align monitoring functions) is output. The fault triggers stop reaction OFF2.

    The fault cannot be acknowledged until safety commissioning mode (p0010 $\neq$ 95) is exited.
  - The control unit triggers a safe pulse disable via its own safety switch-off signal path.
  - If parameterized (p1215), the motor holding brake is applied.
  - The safety functions cannot be enabled (p9601/p9801 and p9602/p9802).

Prerequisites for commissioning the safety functions

1. Commissioning of the drives must be complete.
2. Non-safe pulse disable must be present.

   e.g. via OFF1 = “0” or OFF2 = “0”

   If the motor holding brake is connected and parameterized, the holding brake is applied.
3. The terminals for “Safe standstill” must be wired.
   - Control unit: Digital input DI 0 ... DI 7
   - Motor module: Terminal “EP” (X21.3 and X21.4)
4. For operation with SBC, the following applies:

   A motor with motor holding brake must be connected to the appropriate terminal of the motor module.

6.4.2 Procedure for commissioning “SH” and “SBC”

To commission the “SH” and “SBC” functions, carry out the following steps:

Table 6-1 Commissioning the “SH” and “SBC” functions

No.	Parameter	Description / comments
1	p0010 = 95	**Safety Integrated: set commissioning mode** • The following alarms and faults are output: – A01698 (Safety Integrated control unit: Commissioning mode active) During initial commissioning only: – F01650 (Safety Integrated control unit: Acceptance test required) with fault value = 130 (no safety parameters exist for the motor module). – F30650 (Safety Integrated motor module: Acceptance test required) with fault value = 130 (no safety parameters exist for the motor module). For information on the acceptance test and certificate, see Step 12. • The pulses are reliably disabled and monitored by the control unit and motor module. • The safety sign–of–life is monitored by the control unit and motor module. • The function for exchanging stop reactions between the control unit and motor module is active. • An existing and parameterized motor holding brake has already been applied. • In this mode, fault F01650 or F30650 with fault value = 2003 is output after a safety parameter is changed for the first time. This behavior applies for the entire duration of safety commissioning, that is, the “Safe standstill” function cannot be selected/deselected while safety commissioning mode is active because this would constantly force safe pulse disable.
2	p9761 = “Value”	**Set the safety password** When Safety Integrated is commissioned for the first time, the following applies: • Safety password = 0 • Default setting for p9761 = 0 This means that the safety password does not need to be set during initial commissioning.
3	 p9601.0 p9801.0	**Enable the “Safe standstill” function** SH via control unit terminals SH via motor module terminals • The parameters are not changed until safety commissioning mode has been exited (i.e. when p0010 ≠ 95 is set). • Both parameters are contained in the crosswise data comparison and must, therefore, be identical.

Table 6-1 Commissioning the “SH” and “SBC” functions, continued

No.	Parameter	Description / comments
4	 p9602 = 1 p9802 = 1	**Enable the “Safe brake control” function** Enable “SBC” on the control unit Enable “SBC” on the motor module • The parameters are not changed until safety commissioning mode has been exited (i.e. when p0010 ≠ 95 is set). • Both parameters are contained in the crosswise data comparison and must, therefore, be identical. • The “Safe brake control” function is not active until at least one safety monitoring function is enabled (i.e. p9601 = p9801 ≠ 0).
5	 p9620 = “Value” Terminal “EP”	**Set terminals for “Safe standstill”** Set the signal source for “Safe standstill” on the control unit. Wire terminal “EP” (enable pulses) on the motor module. • Control unit monitoring channel: By connecting BI: p9620 accordingly for the individual drives, the following is possible: – Select/deselect “Safe standstill” – Group the terminals for “Safe standstill” Digital input DI 0 ... DI 7 on the control unit can be used as a signal source. • Motor module monitoring channel: By wiring the “EP” terminal accordingly on the individual motor modules, the following is possible: – Select/deselect “Safe standstill” – Group the terminals for “Safe standstill” **Note:** The “Safe standstill” terminals must be grouped identically in both monitoring channels.
6	 p9650 = “Value” p9850 = “Value”	**Set the tolerance time for the SGE changeover** Tolerance time for the SGE changeover on the control unit Tolerance time for the SGE changeover on the motor module • The parameters are not changed until safety commissioning mode has been exited (i.e. when p0010 ≠ 95 is set). • Due to the different runtimes in the two monitoring channels, an SGE changeover (e.g. selection/deselection of SH) does not take immediate effect. After an SGE changeover, a crosswise comparison of the dynamic data is not carried out during this tolerance time. • Both parameters are contained in the crosswise data comparison and must, therefore, be identical. A difference of one safety monitoring clock cycle is tolerated for the values.

Table 6-1 Commissioning the “SH” and “SBC” functions, continued

No.	Parameter	Description / comments
7	 p9658 = “Value” p9858 = “Value”	**Transition period from STOP F to STOP A.** Transition period from STOP F to STOP A on the control unit Transition period from STOP F to STOP A on the motor module • The parameters are not changed until safety commissioning mode has been exited (i.e. when p0010 $\neq$ 95 is set). • STOP F is the stop reaction triggered by fault F01611 or F30611 (Safety Integrated: Defect in a monitoring channel) when the crosswise data comparison is infringed. STOP F normally triggers “No stop reaction”. • Once the parameterized time has elapsed, STOP A (immediate Safety pulse disable) is triggered by fault F01600 or F30600 (Safety Integrated: STOP A initiated). The default setting for p9658 and p9858 is 0 (i.e. STOP F immediately results in STOP A). • Practical use for STOP F: Reconfigure the stop reaction for fault F01611 from NONE to OFF1 or OFF3, for example, (p2100, p2101) and set a sufficient transition period (e.g. p9658 = p9858 = 500 ms). In this way, STOP F can be used to trigger a standstill via the ramp-function generator (OFF1) or a fast stop (OFF3) before STOP A disables the pulses. • Both parameters are contained in the crosswise data comparison and must, therefore, be identical. A difference of one safety monitoring clock cycle is tolerated for the values.
8	p9659 = “Value”	**Time for carrying out forced checking procedure and testing the Safety switch-off signal paths** • Once this time has elapsed, alarm A01699 (Safety Integrated control unit: Shutdown path test required) prompts the user to test the switch-off signal paths (select/deselect SH). • The commissioning engineer can change the time required for carrying out the forced checking procedure and testing the Safety switch-off signal paths.
9	 p9799 = “r9798” p9899 = “r9898”	**Adjust specified checksum** Specified checksum on the control unit Specified checksum on the motor module The current checksums for the Safety parameters that have undergone a checksum check are displayed as follows: • Actual checksum on the control unit: r9798 • Actual checksum on the motor module: r9898 By setting the actual checksum in the parameter for the specified checksum, the commissioning engineer confirms the Safety parameters in each monitoring channel. This procedure is performed automatically when STARTER and the commissioning Wizard for SINAMICS Safety Integrated are used.

Table 6-1 Commissioning the “SH” and “SBC” functions, continued

No.	Parameter	Description / comments
10	 p9762 = “Value” p9763 = “Value”	**Set the new Safety password** Enter a new password Confirm the new password • The new password is not valid until it has been entered in p9762 and confirmed in p9763. • As of now, you must enter the new password in p9761 so that you can change Safety parameters. • Changing the Safety password does not mean that you have to change the checksums in p9799 and p9899.
11	p0010 = Value not equal to 95	**Safety Integrated: exit commissioning mode** • If at least one Safety monitoring function is enabled (p9601 = p9801 $\neq$ 0), the checksums are checked: If the specified checksum on the control unit has not been correctly adjusted, fault F01650 (Safety Integrated control unit: Acceptance test required) with fault code 2000 is output, thereby preventing Safety commissioning mode from being exited. If the specified checksum on the motor module has not been correctly adjusted, fault F01650 (Safety Integrated control unit: Acceptance test required) with fault code 2001 is output, thereby preventing Safety commissioning mode from being exited. • If a Safety monitoring function has not been enabled (p9601 = p9801 = 0), Safety commissioning mode is exited without the checksums being checked. When Safety commissioning mode is exited, the following is carried out: • All the drive parameters are stored on the CompactFlash card. • The Safety parameters on the motor module are loaded by the control unit and stored on the CompactFlash card. • The new Safety parameters are active on the control unit and motor module.
12	–	**Carrying out the acceptance test and creating the test certificate** Once Safety commissioning is complete, the commissioning engineer must carry out an acceptance test for the enabled Safety monitoring functions. The results of the acceptance test must be documented in an acceptance certificate (see Section 6.6).

6.4.3 Safety faults

Stop reaction

When Safety Integrated faults occur, the following stop reactions can be triggered:

Table 6-2 Safety Integrated stop reactions

<table>
<tr><th>Stop reaction</th><th>Action</th><th>Effect</th><th>Triggered when...</th></tr>
<tr><td>STOP A
Cannot be acknow-ledged</td><td rowspan="2">Trigger safe pulse disable via the switch-off signal path for the relevant monitoring channel.
During operation with SBC: apply motor holding brake.</td><td rowspan="2">The motor coasts to a standstill or is braked by the holding brake.</td><td>For all non-acknowledgeable Safety faults with pulse disable.</td></tr>
<tr><td>STOP A</td><td>For all acknowledgeable Safety faults with pulse disable.
As a follow-up reaction of STOP F.</td></tr>
<tr><td></td><td colspan="3">STOP A is identical to stop category 0 to EN 60204-1.
With STOP A, the motor is switched directly to zero torque via the “Safe standstill (SH)” function.
A motor at standstill cannot be started again accidentally.
A moving motor coasts to standstill. This can be prevented by using external braking mechanisms (e.g. armature short-circuiting, holding or operational brake).
When STOP A is present, “Safe standstill (SH)” is effective.</td></tr>
<tr><td>STOP F</td><td>Transition to STOP A</td><td>None</td><td>If an error occurs in the crosswise data comparison.</td></tr>
<tr><td></td><td colspan="3">STOP F is permanently assigned to the crosswise data comparison (CDC). In this way, errors are detected in the monitoring channels.
After STOP F, STOP A is triggered.
When STOP A is present, “Safe standstill (SH)” is effective.</td></tr>
</table>

Warning

With a vertical axis or pulling load, there is a risk of uncontrolled axis movements when STOP A/F is triggered. This can be prevented by using “Safe brake control (SBC)” and a holding brake with sufficient retention force (non-safe).

Acknowledging the Safety faults

Safety Integrated faults must be acknowledged as follows:

1. Remove the cause of the fault.
2. Deselect “Safe standstill (SH)”.
3. Acknowledge the fault.

If Safety commissioning mode is exited when the Safety functions are switched off (p0010 = value not equal to 95 when p9601 = p9801 = 0), all the Safety faults can be acknowledged.

Once Safety commissioning mode has been reset (p0010 = 95), all the faults that were previously present reappear.

Description of faults and alarms

Note

The faults and alarms for SINAMICS Safety Integrated are described in the following documentation:

/LH1/ SINAMICS S List Manual – Section 3.2

6.5 Overview of parameters and function diagrams

Parameter overview (see List Manual)

Table 6-3 Safety Integrated parameters

No. Control unit (CU)	Name	No. Motor module (MM)	Can be changed in
p9601	Enable safety functions	p9801	Safety Integrated commissioning (p0010 = 95)
p9602	Enable safe brake control	p9802	
p9620	Signal source for safe standstill	–	
p9650	Tolerance time SGE changeover	p9850	
p9658	Transition period STOP F to STOP A	p9858	
p9659	Timer for forced checking procedure	–	
p9761	Password input	–	In every operating mode
p9762	New password	–	Safety Integrated commissioning (p0010 = 95)
p9763	Confirm password	–	
r9770[0...2]	Version	r9870[0...2]	–
r9771	Shared functions	r9871	–
r9772	Status	r9872	–
r9773	Status (control unit + motor module)	–	–
r9774	Status (group safe standstill)	–	–
r9780	Monitoring clock cycle	r9880	–
r9794	Cross monitoring list	r9894	–
r9795	Diagnostics for STOP F	r9895	–
r9798	Actual checksum SI parameters	r9898	–
p9799	Specified checksum SI parameters	p9899	Safety Integrated commissioning (p0010 = 95)

Description of the parameters

Note

The SINAMICS Safety Integrated parameters are described in the following documentation:

/LH1/ SINAMICS S List Manual – Section 1.2

Function diagram overview (see List Manual)

- 2800 Safety parameter manager
- 2802 Monitoring functions and faults/alarms
- 2804 Status words
- 2810 Safe standstill (SH)
- 2814 Safe brake control (SBC)

6.6 Acceptance test and certificate

6.6.1 General information about acceptance

Acceptance test

The machine manufacturer must carry out an acceptance test for the activated Safety Integrated functions (SI functions) on the machine.

During the acceptance test, all the limit values entered for the enabled SI functions must be exceeded to check and verify that the functions are working properly.

Authorized persons, acceptance certificate

Each SI function must be tested and the results documented and signed in the acceptance certificate by an authorized person. The acceptance certificate must be stored in the machine logbook.

Authorized in this sense refers to a person who has the necessary technical training and knowledge of the safety functions and is authorized by the machine manufacturer to carry out the test.

Note

- Please read the commissioning notes and descriptions in Sections 6.1 to 6.5 in this Installation and Start-Up Manual.
- If any parameters are altered by SI functions, the acceptance test must be carried out again and documented in the acceptance certificate.
- Template for the acceptance certificate

  A printed form is available in this chapter of the Installation and Start-Up Manual as an example/suggestion.

Scope of a complete acceptance test

Documentation (see Section 6.6.2)

Machine documentation (including the SI functions)

1. Machine description and overview diagram (see Tables 6-4 and 6-5)
2. SI functions for each drive (see Table 6-6)
3. Description of safety equipment (see Table 6-7)

Functional test (see Section 6.6.3)

Check the individual SI functions used

4. “Safe standstill” function, part 1 (see Table 6-8)
5. “Safe standstill” function, part 2 (see Table 6-9)
6. “Safe brake control” function (see Table 6-10)

Completion of certificate (see Section 6.6.4)

Record the commissioning procedure and provide countersignatures.

7. Check the Safety parameters.
8. Record the checksums.
9. Verify the data backups.
10. Countersignatures

Appendix

Measurement records for functional test parts 1 and 2.

- Alarm logs
- Trace recordings

6.6.2 Documentation

Table 6-4 Machine description and overview diagram

Designation	
Type	
Serial no.	
Manufacturer	
End customer	
Electrical axes	
Other axes	
Spindles	
Overview diagram of machine	

Table 6-5 Values from relevant machine data

<table>
<tr><td rowspan="2">FW version
Control unit</td><td></td><td>FW version</td><td>SI version</td></tr>
<tr><td></td><td>r0018 =</td><td>r9770 =</td></tr>
<tr><td rowspan="7">FW versions
Motor modules</td><td>Drive number</td><td>FW version</td><td>SI version</td></tr>
<tr><td></td><td>r0128 =</td><td>r9870 =</td></tr>
<tr><td></td><td>r0128 =</td><td>r9870 =</td></tr>
<tr><td></td><td>r0128 =</td><td>r9870 =</td></tr>
<tr><td></td><td>r0128 =</td><td>r9870 =</td></tr>
<tr><td></td><td>r0128 =</td><td>r9870 =</td></tr>
<tr><td></td><td>r0128 =</td><td>r9870 =</td></tr>
<tr><td>System clock cycles
Control unit</td><td colspan="3">p0110[0] =
p0110[1] =
p0110[2] =</td></tr>
<tr><td rowspan="7">Basic axial clock cycles of control unit
=
System clock cycles of motor modules</td><td>Drive number</td><td colspan="2">Clock cycle selection</td></tr>
<tr><td></td><td colspan="2">p0111 =</td></tr>
<tr><td></td><td colspan="2">p0111 =</td></tr>
<tr><td></td><td colspan="2">p0111 =</td></tr>
<tr><td></td><td colspan="2">p0111 =</td></tr>
<tr><td></td><td colspan="2">p0111 =</td></tr>
<tr><td></td><td colspan="2">p0111 =</td></tr>
<tr><td></td><td>Drive number</td><td>SI monitoring clock cycle
Control unit</td><td>SI monitoring clock cycle
Motor module</td></tr>
<tr><td rowspan="6">SI monitoring clock cycle</td><td></td><td>r9780 =</td><td>r9880 =</td></tr>
<tr><td></td><td>r9780 =</td><td>r9880 =</td></tr>
<tr><td></td><td>r9780 =</td><td>r9880 =</td></tr>
<tr><td></td><td>r9780 =</td><td>r9880 =</td></tr>
<tr><td></td><td>r9780 =</td><td>r9880 =</td></tr>
<tr><td></td><td>r9780 =</td><td>r9880 =</td></tr>
</table>

Table 6-6 SI functions for each drive

Drive number	SI function

Table 6-7 Description of safety equipment

Examples: Wiring of SH terminals (protective door, emergency OFF), grouping of SH terminals, holding brake for vertical axis, etc.

6.6.3 Functional test

The functional test must carried out individually for each drive (as far as the machine allows).

Carrying out the test

Initial commissioning	
Serial commissioning	
	Please tick

“Safe standstill” (SH) function, part 1

This test comprises the following steps:

Table 6-8 “Safe standstill” (SH) function, part 1

No.	Description	Status
1.	Initial state	
	• Drive in “Ready” status (p0010 = 0)	
	• Enable SH function (p9601.0 = 1, p9801.0 = 1)	
	• No Safety faults or alarms (r0945, r2122)	
	• r9772.0 = r9772.1 = 0 (SH deselected and inactive – CU)	
	• r9872.0 = r9872.1 = 0 (SH deselected and inactive – MM)	
	• r9773.0 = r9773.1 = 0 (SH deselected and inactive – drive)	
	• For terminal grouping for “Safe standstill”: r9774.0 = r9774.1 = 0 (SH deselected and inactive – group)	
2.	Run the drive.	
3.	Ensure that the correct drive is running.	
4.	Select SH when you issue the run command.	
5.	Check the following:	
	• The drive coasts to a standstill or is braked and stopped by the mechanical brake (if available and configured (p1215, p9602, p9802)).	
	• No Safety faults or alarms (r0945, r2122)	
	• r9772.0 = r9772.1 = 1 (SH selected and active – CU)	
	• r9872.0 = r9872.1 = 1 (SH selected and active – MM)	
	• r9773.0 = r9773.1 = 1 (SH selected and active – drive)	
	• For terminal grouping for “Safe standstill”: r9774.0 = r9774.1 = 1 (SH selected and active – group)	
6.	Deselect SH.	

Table 6-8 “Safe standstill” (SH) function, part 1, continued

No.	Description	Status
7.	Check the following:	
	• No Safety faults or alarms (r0945, r2122)	
	• r9772.0 = r9772.1 = 0 (SH deselected and inactive – CU)	
	• r9872.0 = r9872.1 = 0 (SH deselected and inactive – MM)	
	• r9773.0 = r9773.1 = 0 (SH deselected and inactive – drive)	
	• For terminal grouping for “Safe standstill”: r9774.0 = r9774.1 = 0 (SH deselected and inactive – group)	
	• r0046.0 = 1 (drive in “Power-on inhibit” state)	
8.	Acknowledge “Power-on inhibit” and run the drive.	
9.	Ensure that the correct drive is running.	
	The following is tested: • Correct DRIVE-CLiQ wiring between control unit and motor modules • Correct drive no. – motor module – motor assignment • The hardware is functioning properly. • The switch-off signal paths are wired correctly. • Correct SH terminal assignment on the control unit • Correct SH grouping (if available) • The SH function is parameterized correctly. • Routine for forced dormant error detection of switch-off signal paths	

“Safe standstill” (SH) function, part 2

This test comprises the following steps:

Table 6-9 “Safe standstill” (SH) function, part 2

No.	Description	Status
1.	Initial state	
	• A channel for selecting SH is permanently connected to HIGH level. (e.g.: SH wiring for motor module)	
	• Drive in “Ready” status (p0010 = 0)	
	• Enable SH function (p9601.0 = 1, p9801.0 = 1)	
	• No Safety faults or alarms (r0945, r2122)	
	• r9772.0 = r9772.1 = 0 (SH deselected and inactive – CU)	
	• r9872.0 = r9872.1 = 0 (SH deselected and inactive – MM)	
	• r9773.0 = r9773.1 = 0 (SH deselected and inactive – drive)	
2.	Run the drive.	
3.	Ensure that the correct drive is running.	

Table 6-9 “Safe standstill” (SH) function, part 2, continued

No.	Description	Status
4.	Select SH when you issue the run command.	
5.	Check the following:	
	• The drive coasts to a standstill or is braked and stopped by the mechanical brake (if available and configured (p1215, p9602, p9802)).	
	• The following Safety faults are output (r0945, r2122): – F01611, fault value = 2000 – F01600, fault value = 9999 – F30611, fault value = 2000 – F30600, fault value = 9999	
	• r9772.0 = r9772.1 = 1 (SH selected and active – CU)	
	• r9872.0 = 0, r9872.1 = 1 (SH deselected but active – MM)	
	• r9773.0 = 0, r9773.1 = 1 (SH deselected but active – drive)	
	The following is tested: • The switch-off signal paths are wired correctly. • Crosswise comparison of SH terminals • Routine for forced dormant error detection of switch-off signal paths	

"Safe brake control" (SBC) function

This test comprises the following steps:

Table 6-10 "Safe brake control" (SBC) function

No.	Description	Status
1.	Initial state	
	• Drive in "Ready" status (p0010 = 0)	
	• Enable SH function (p9601.0 = 1, p9801.0 = 1)	
	• Enable SBC function (p9602 = 1, p9802 = 1)	
	• Vertical axis: Brake as in sequential control (p1215 = 1) • No vertical axis: Brake always released (p1215 = 2)	
	• Vertical axis: Mechanical brake is applied • No vertical axis: Mechanical brake is released	
	• No Safety faults or alarms (r0945, r2122)	
	• r9772.0 = r9772.1 = 0 (SH deselected and inactive – CU)	
	• r9872.0 = r9872.1 = 0 (SH deselected and inactive – MM)	
	• r9773.0 = r9773.1 = 0 (SH deselected and inactive – drive)	
	• r9772.4 = r9872.4 = 0 (SBC not requested – CU and MM)	
2.	Run drive (applied brake is released)	
3.	Ensure that the correct drive is running.	
4.	Select SH when you issue the run command.	
5.	Check the following:	
	• Drive is braked and stopped by the mechanical brake.	
	• No Safety faults or alarms (r0945, r2122)	
	• r9772.0 = r9772.1 = 1 (SH selected and active – CU)	
	• r9872.0 = r9872.1 = 1 (SH selected and active – MM)	
	• r9773.0 = r9773.1 = 1 (SH selected and active – drive)	
	• r9772.4 = r9872.4 = 1 (SBC requested – CU and MM)	
6.	Deselect SH.	

Table 6-10 “Safe brake control” (SBC) function, continued

No.	Description	Status
7.	Check the following:	
	• Vertical axis: Mechanical brake remains applied • No vertical axis: Mechanical brake is released	
	• No Safety faults or alarms (r0945, r2122)	
	• r9772.0 = r9772.1 = 0 (SH deselected and inactive – CU)	
	• r9872.0 = r9872.1 = 0 (SH deselected and inactive – MM)	
	• r9773.0 = r9773.1 = 0 (SH deselected and inactive – drive)	
	• r9772.4 = r9872.4 = 0 (SBC not requested – CU and MM)	
	• r0046.0 = 1 (drive in “Power-on inhibit” state)	
8.	Acknowledge “Power-on inhibit” and run the drive. (vertical axis: mechanical brake is released)	
9.	Ensure that the correct drive is running.	
	The following is tested: • The brake is connected properly. • The hardware is functioning properly. • The SBC is parameterized correctly. • Routine for forced dormant error detection of brake control	

6.6.4 Completion of certificate

SI parameters

	Specified values checked?	
	Yes	No
Control unit		
Motor module		

Checksums

Axis/spindle		Checksum (8 hex)	
Name	Drive number	Control unit	Motor module

Data backup

	Storage medium			Storage location
	Type	Description	Date	
Parameter				
PLC program				
Circuit diagrams				

Countersignatures

Commissioning engineer

This confirms that the tests and checks have been carried out properly.

Date	Name	Company / dept.	Signature

Machine manufacturer

This confirms that the parameters recorded above are correct.

Date	Name	Company / dept.	Signature

■

7 Diagnosis

This chapter describes the following diagnostic features of the SINAMICS S120 drive system:

- Diagnostics using LEDs
- Diagnostics using STARTER
- Fault and alarm messages

7.1 Diagnostics using LEDs

Overview of the module LEDs

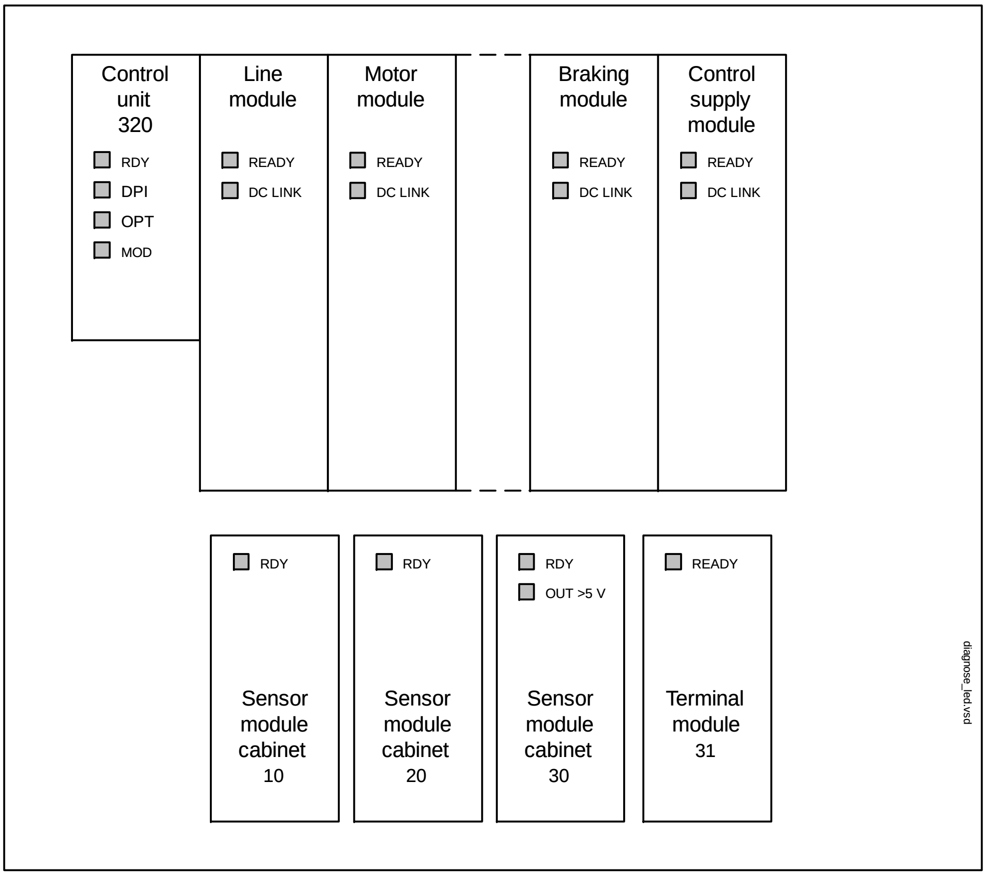


Fig. 7-1 Overview of the module LEDs

7.1.1 Control unit 320 (CU320)

LEDs while the control unit is booting

The individual statuses during the booting procedure are indicated by means of the LEDs on the control unit.

- The duration of the individual statuses varies.
- If an error occurs, the booting procedure is terminated and the cause is inidicated accordingly via the LEDs.
- Once the unit has been successfully booted, all the LEDs are switched off briefly.
- Once the unit has been booted, the LEDs are driven via the loaded software.

  Refer to the description of the LEDs after booting (see table 7-2).

Table 7-1 Control unit 320 – description of the LEDs during booting

	Load software 1		Load software 2					Firmware	
LED	**Reset**	**Error**	**Loaded**	**Running**	**Error file**	**Error crc**	**FW loaded**	**Initia-lizing**	**Running**
RDY	Red	Red 2 Hz	OFF	OFF	OFF	OFF	OFF	OFF	See table 7-2
DP1	Red	Red	Red	Orange	Red 2 Hz	Red 0.5 Hz	OFF	OFF	
OPT	Red	Red	Red	Red	Red	Red	Red	OFF	
MOD	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	

Possible causes:

- CompactFlash Card not installed.
- Load software 2 has not been installed on the CompactFlash card or is defective.
- Software on the CompactFlash card is incomplete or defective.
- CRC invalid.

Remedy:

Plug the appropriate CompactFlash card with the correct software and parameters into the unit.

LEDs after the control unit has booted

Table 7-2 Control unit 320 – description of the LEDs after booting

LED	Color	Status	Description, cause	Remedy
RDY (READY)	–	OFF	Electronics power supply is missing or outside permissible tolerance range.	–
	Green	Continuous	The module is ready for operation and cyclic DRIVE–CLiQ communication is taking place.	–
		Flashing 2 Hz	Writing to CompactFlash card.	–
	Red	Continuous	At least one fault is present in this module.	Remedy and acknowledge fault
		Flashing 0.5 Hz	Boot error (e.g. firmware cannot be loaded to RAM).	Check whether CompactFlash card is plugged in correctly Replace CompactFlash card Replace control unit POWER ON
	Green/ Red	Flashing 0.5 Hz	Control unit 320 is ready. No software licenses.	Obtain licenses
	Orange	Continuous	DRIVE–CLiQ communication is being established.	–
		Flashing 0.5 Hz	Unable to load firmware to RAM.	Check whether CompactFlash card is plugged in correctly Replace CompactFlash card Replace control unit POWER ON
		Flashing 2 Hz	Firmware CRC error.	Check whether CompactFlash card is plugged in correctly Replace CompactFlash card Replace control unit POWER ON

Table 7-2 Control unit 320 – description of the LEDs after booting, continued

LED	Color	Status	Description, cause	Remedy
DP1 (PROFIBUS cyclic operation)	–	OFF	Cyclic communication has not (yet) taken place. Note: PROFIBUS is ready for communication when the control unit is ready (see LED RDY).	–
	Green	Continuous	Cyclic communication is taking place.	–
		Flashing 0.5 Hz	Full cyclic communication is not yet taking place. Possible causes: • The master is not transmitting setpoints. • No global control (GC) or master sign–of–life is transmitted during isochronous operation.	–
	Red	Continuous	Cyclic communication has been interrupted.	Remedy fault
OPT (OPTION)	–	OFF	Electronics power supply is missing or outside permissible tolerance range. Module is not ready. Option board not installed or no associated drive object has been created.	–
	Green	Continuous	Option board is ready.	–
		Flashing 0.5 Hz	Depends on the option board used.	–
	Red	Continuous	At least one fault is present in this module. Option board not ready (e.g. after power–on).	Remedy and acknowledge fault
MOD	–	OFF	Reserved	–
	Green	Continuous	Reserved	–

7.1.2 Active line module

Table 7-3 Active line module – description of LEDs

LED	Color	Status	Description, cause	Remedy
READY	–	OFF	Electronics power supply is missing or outside permissible tolerance range.	–
	Green	Continuous	The module is ready for operation and cyclic DRIVE–CLiQ communication is taking place.	–
	Orange	Continuous	DRIVE–CLiQ communication is being established.	–
	Red	Continuous	At least one fault is present in this module. Note: LED is driven irrespective of the corresponding messages being reconfigured.	Remedy and acknowledge fault
	Green Red	Flashing 2 Hz	Firmware is being downloaded.	–
	Green/ Orange or Red/ Orange	Flashing 2 Hz	Module recognition via LED is activated (p0124). Note: Both options depend on the LED status when module recognition is activated via p0124 = 1.	
DC LINK	–	OFF	Electronics power supply is missing or outside permissible tolerance range.	–
	Orange	Continuous	DC link voltage within permissible tolerance range.	–
	Red	Continuous	DC link voltage outside permissible tolerance range.	Check supply voltage

7.1.3 Smart line module 5 kW and 10 kW

Table 7-4 Smart line module 5 kW and 10 kW – description of LEDs

LED	Color	Status	Description, cause	Remedy
READY	–	OFF	Electronics power supply is missing or outside permissible tolerance range.	–
	Green	Continuous	Module is ready.	–
	Red	Continuous	Overtemperature. Overcurrent switch off.	Diagnose fault (via output terminals) and acknowledge (via input terminal)
DC LINK	–	OFF	Electronics power supply is missing or outside permissible tolerance range.	–
	Yellow	Continuous	DC link voltage within permissible tolerance range.	–
	Red	Continuous	DC link voltage outside permissible tolerance range. Supply failure.	Check supply voltage

7.1.4 Single motor module / double motor module

Table 7-5 Motor module – description of LEDs

LED	Color	Status	Description, cause	Remedy
READY	–	OFF	Electronics power supply is missing or outside permissible tolerance range.	–
	Green	Continuous	The module is ready for operation and cyclic DRIVE–CLiQ communication is taking place.	–
	Orange	Continuous	DRIVE–CLiQ communication is being established.	–
	Red	Continuous	At least one fault is present in this module. Note: LED is driven irrespective of the corresponding messages being reconfigured.	Remedy and acknowledge fault
	Green/ Red	Flashing 2 Hz	Firmware is being downloaded.	–
	Green/ Orange or Red/ Orange	Flashing 2 Hz	Module recognition via LED is activated (p0124). Note: Both options depend on the LED status when module recognition is activated via p0124 = 1.	–
DC LINK	–	OFF	Electronics power supply is missing or outside permissible tolerance range.	–
	Orange	Continuous	DC link voltage within permissible tolerance range.	–
	Red	Continuous	DC link voltage outside permissible tolerance range.	Check supply voltage and DC link connections when module is disconnected from power supply

7.1.5 Braking module

Table 7-6 Braking module – description of LEDs

LED	Color	Status	Description, cause	Remedy
READY	–	OFF	Electronics power supply is missing or outside permissible tolerance range. Module deactivated via terminal.	–
	Green	Continuous	Module is ready.	–
	Red	Continuous	Overtemperature. Overcurrent switch off. I^2t monitoring activated. Ground fault/short-circuit. Note: In the event of an overtemperature, the fault cannot be acknowledged until a cooling time has elapsed.	Diagnose fault (via output terminals) and acknowledge (via input terminal)
DC LINK	–	OFF	Electronics power supply is missing or outside permissible tolerance range. Module not active.	–
	Green	Flashing	Module active (DC link discharge via braking resistor in progress).	–

7.1.6 Control supply module

Table 7-7 Control supply module – description of LEDs

LED	Color	Status	Description, cause	Remedy
READY	–	OFF	Electronics power supply is missing or outside permissible tolerance range.	–
	Green	Continuous	Module is ready.	–
DC LINK	–	OFF	Electronics power supply is missing or outside permissible tolerance range.	–
	Orange	Continuous	DC link voltage within permissible tolerance range.	–
	Red	Continuous	DC link voltage outside permissible tolerance range.	–

7.1.7 Sensor module cabinet 10 / 20 (SMC10 / SMC20)

Table 7-8 Sensor module cabinet 10 / 20 – description of LEDs

LED	Color	Status	Description, cause	Remedy
RDY READY	–	OFF	Electronics power supply is missing or outside permissible tolerance range.	–
	Green	Continuous	The module is ready for operation and cyclic DRIVE–CLiQ communication is taking place.	–
	Orange	Continuous	DRIVE–CLiQ communication is being established.	–
	Red	Continuous	At least one fault is present in this module. Note: LED is driven irrespective of the corresponding messages being reconfigured.	Remedy and acknowledge fault
	Green/ Red	Flashing 2 Hz	Firmware is being downloaded.	–
	Green/ Orange or Red/ Orange	Flashing 2 Hz	Module recognition via LED is activated (p0144). Note: Both options depend on the LED status when module recognition is activated via p0144 = 1.	–

7.1.8 Sensor module cabinet 30 (SMC30)

Table 7-9 Sensor module cabinet 30 – description of LEDs

LED	Color	Status	Description, cause	Remedy
RDY READY	–	OFF	Electronics power supply is missing or outside permissible tolerance range.	–
	Green	Continuous	The module is ready for operation and cyclic DRIVE–CLiQ communication is taking place.	–
	Orange	Continuous	DRIVE–CLiQ communication is being established.	–
	Red	Continuous	At least one fault is present in this module. Note: LED is driven irrespective of the corresponding messages being reconfigured.	Remedy and acknowledge fault
	Green/ Red	Flashing 2 Hz	Firmware is being downloaded.	–
	Green/ Orange or Red/ Orange	Flashing 2 Hz	Module recognition 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 $\leq$5 V.	–
	Orange	Continuous	Electronics power supply for measuring system available. Power supply >5 V.	–

7.1.9 Terminal module 31 (TM31)

Table 7-10 Terminal module 31 – description of LEDs

LED	Color	Status	Description, cause	Remedy
READY	–	OFF	Electronics power supply is missing or outside permissible tolerance range.	–
	Green	Continuous	The module is ready for operation and cyclic DRIVE–CLiQ communication is taking place.	–
	Orange	Continuous	DRIVE–CLiQ communication is being established.	–
	Red	Continuous	At least one fault is present in this module. Note: LED is driven irrespective of the corresponding messages being reconfigured.	Remedy and acknowledge fault
	Green/ Red	Flashing 2 Hz	Firmware is being downloaded.	–
	Green/ Orange or Red/ Orange	Flashing 2 Hz	Module recognition via LED is activated (p0154). Note: Both options depend on the LED status when module recognition is activated via p0154 = 1.	–

7.2 Diagnostics using STARTER

Description

The diagnostic functions support commissioning and service personnel during commissioning, troubleshooting, diagnostics and service activities.

General

Prerequisite: STARTER is online.

The following diagnostic functions are available in STARTER:

- PROFIBUS diagnostics buffer

  The message output window shows the states of the control/status words, parameters and drive enable signals for the selected drive/device.

- Fault/alarm display in the alarms output window

  The faults and alarms for one or more drives/devices can be displayed. The fault/alarm description is called up by selecting “Help –> Context” or by pressing the SHIFT + F1 keys.

- Diagnostics overview

  An overview table is displayed containing all the drives available in the project.

  – Device: the available devices and drives are displayed with names; the device status is output in the “device diagnostics” window.

  – Operating status: the current operating status (e.g. OFFLINE, ONLINE, COMMISSIONING, STOP, STOP U, RUN) of the device or drive is displayed and can be controlled by means of the mode selection switch.

- Specifying signals with the ramp–function generator

  See Section 7.2.1

- Signal recording with the trace function

  See Section 7.2.2

- Analyzing the control response with the measuring function

  See Section 7.2.3

- Outputting voltage signals for external measuring devices via measuring sockets

  See Section 7.2.4

7.2.1 Ramp-function generator

Description

The ramp-function generator can be used, for example, for the following tasks:

- To measure and optimize control loops.
- To compare the dynamic response of coupled drives.
- To specify a simple traversing profile without a traversing program.

The ramp-function generator can be used to generate different signal shapes. Depending on the mode setting, this setpoint can then be fed into the control system, for example as a current setpoint, disturbing torque or speed setpoint. The impact of superimposed control loops is automatically suppressed.

Parameterizing and operating the ramp-function generator

The ramp-function generator is parameterized and operated via the parameterization and commissioning tool STARTER (see Section 2.4).

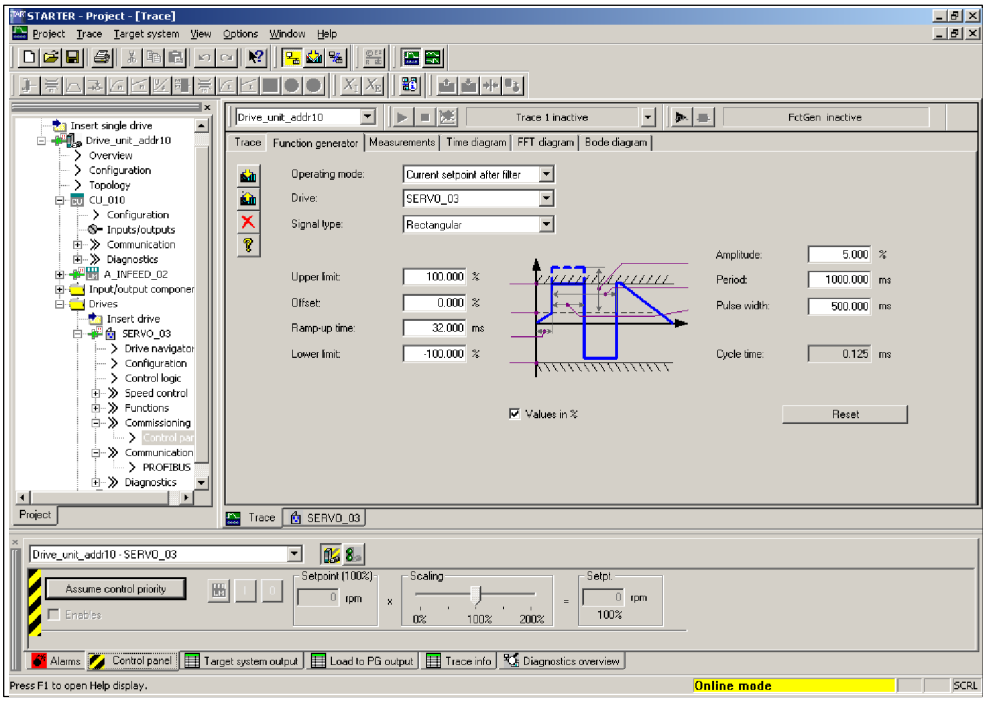


Fig. 7-2 “Ramp-function generator” initial screen

Note

Please refer to the online help for more information about parameterizing and operating the ramp-function generator.

Properties

- Concurrent injection to several drives possible.
- The following parameterizable signal shapes can be set:
  - Square-wave
  - Staircase
  - Triangular
  - PRBS (pseudo random binary signal, white noise)
  - Sinusoidal
- An offset is possible for each signal. The ramp-up to the offset is parameterizable. Signal generation begins after the ramp-up to the offset.
- Restriction of the output signal to the minimum and maximum value settable.
- Operating modes of the ramp-function generator
  - Connector output
  - Current setpoint downstream of filter (current setpoint filter)
  - Disturbing torque (downstream of current setpoint filter)
  - Speed setpoint downstream of filter (speed setpoint filter)
  - Current setpoint upstream of filter (current setpoint filter)
  - Speed setpoint upstream of filter (speed setpoint filter)

Injection points of the ramp-function generator

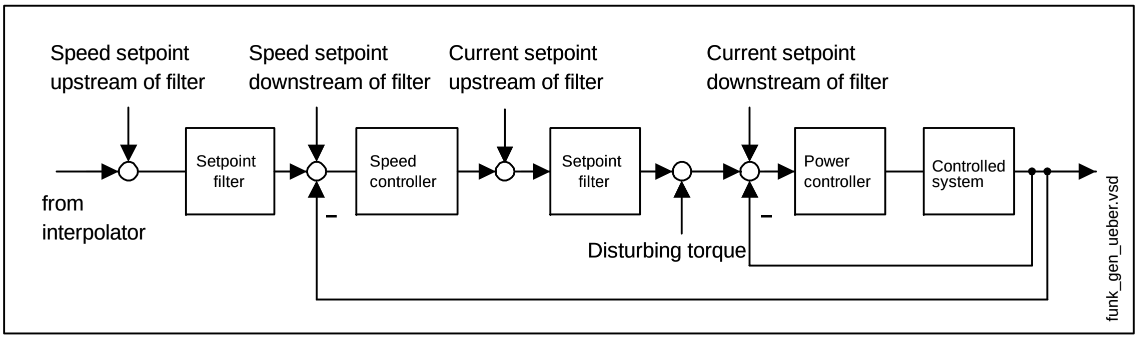


Fig. 7-3 Injection points of the ramp-function generator

Further signal shapes

Further signal shapes can be parameterized.

Example:

The “triangular” signal shape can be parameterized with “upper limitation” to produce a triangle with no peak.

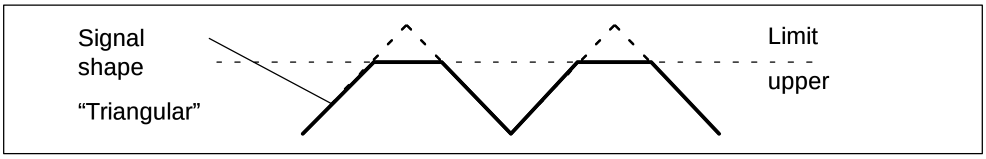


Fig. 7-4 “Triangular” signal without peak

Starting/stopping the ramp-function generator

Caution

With the corresponding ramp-function generator parameter settings (e.g. offset), the motor can “drift” and travel to its end stop.

The movement of the drive is not monitored while the ramp-function generator is active.

To start the ramp-function generator:

1. Meet the conditions for starting the ramp-function generator
   - Activate the control board

     Drives -> Drive_x -> Commissioning -> Control board
   - Switch on the drive

     Control board -> Issue enable signals -> Switch on
2. Select the operating mode

   e.g. speed setpoint downstream of filter
3. Select the drive (as control board)
4. Set the signal shape

   e.g. square-wave
5. Load the settings to the target system (“Download parameters” pushbutton)
6. Start the ramp-function generator (“Start FctGen” pushbutton)

To stop the ramp-function generator:

“Stop FctGen” pushbutton

Parameterization

The “function generator” parameter screen is selected via the following icon in the toolbar of the STARTER commissioning tool:

Fig. 7-5 STARTER icon for “trace function/ramp-function generator”

7.2.2 Trace function

Description

The trace function can be used to record measured values over a defined period depending on trigger conditions.

Note

The following tool is available for using the trace function and plotting the recorded measurements:

STARTER parameterization and commissioning tool --> see Section 2.4

For further information about the trace function, see Section 7.2 and online help.

Parameterizing and using the trace function

The parameterization and commissioning tool STARTER (see Section 2.4) will help you parameterize and use the trace function properly.

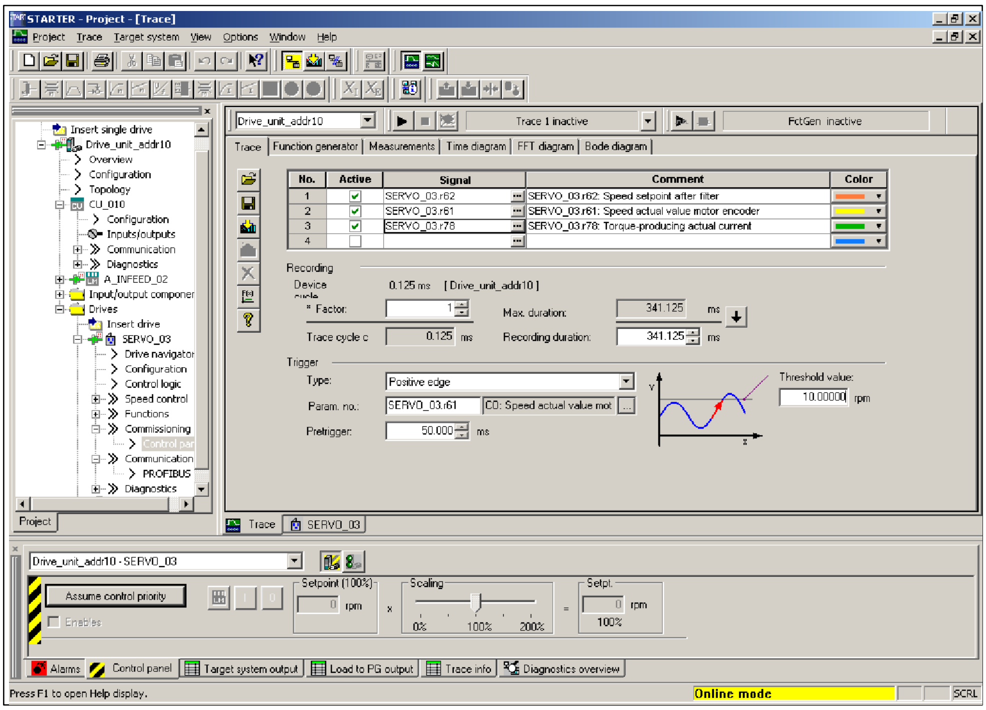


Fig. 7-6 “Trace function” initial screen

Note

Please refer to the online help for more information about parameterizing and using the trace function.

Properties

- Four recording channels per recorder
- Two independent trace recorders per control unit
- Triggering
  - Without triggering (recording immediately after start)
  - Triggering on signal with edge or on level
  - Trigger delay and pretrigger possible
- STARTER parameterization and commissioning tool
  - Automatic or adjustable scaling of display axes
  - Signal measurement via cursor
- Settable trace cycle: Integers of the basic system cycle

  (see also Clock cycles in the system in Section 8.6)

Parameterization

The “trace function” parameter screen is selected via the following icon in the tool-bar of the STARTER commissioning tool:

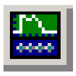


Fig. 7-7 STARTER icon for “trace function/ramp-function generator”

7.2.3 Measuring function

Description

The measuring function is used for optimizing the drive controller. By parameterizing the measuring function, the impact of superimposed control loops can be suppressed selectively and the dynamic response of the individual drives analyzed. The ramp-function generator and trace function are linked for this purpose. The control loop is supplied with the ramp-function generator signal at a given point (e.g. speed setpoint) and recorded by the trace function at another (e.g. speed actual value). The trace function is parameterized automatically when the measuring function is parameterized. Specific predefined operating modes for the trace function are used for this purpose.

Parameterizing and using the measuring function

The measuring function is parameterized and used via the parameterization and commissioning tool STARTER (see Section 2.4).

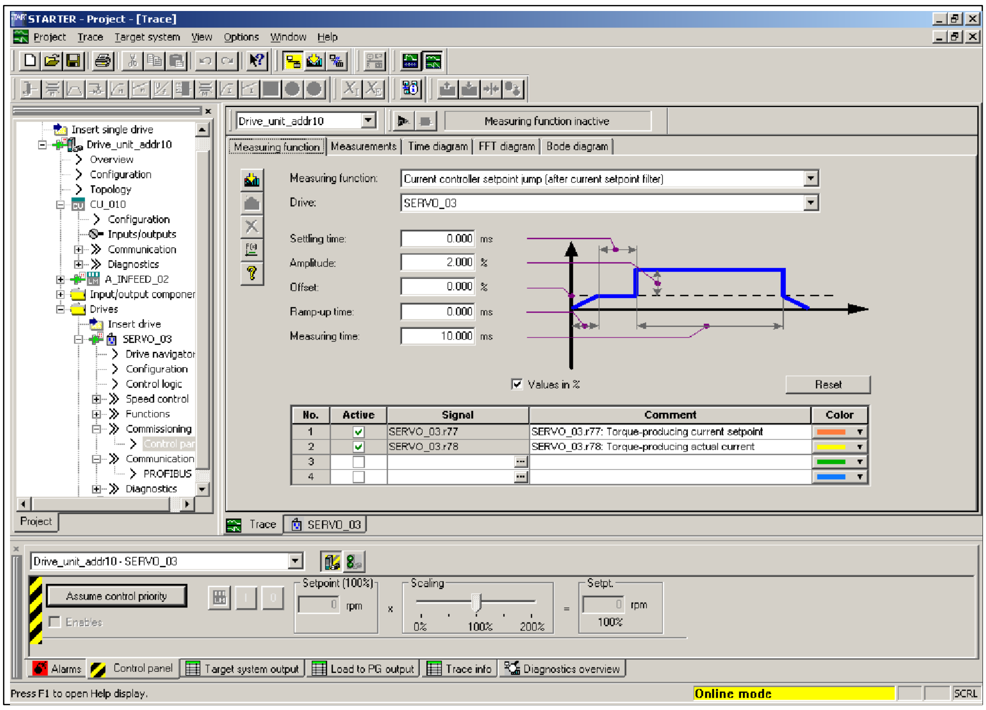


Fig. 7-8 “Measuring function” initial screen

Note

Please refer to the online help for more information about parameterizing and using the measuring function.

Properties

- See the properties for the trace and measuring function
- Measuring functions
  - Current controller setpoint change (downstream of the current setpoint filter)
  - Current controller reference frequency response (downstream of the current setpoint filter)
  - Speed controller setpoint change (downstream of the speed setpoint filter)
  - Speed controller disturbance step change (fault downstream of the current setpoint filter)
  - Speed controller reference frequency response (downstream of the speed setpoint filter)
  - Speed controller reference frequency response (upstream of the speed setpoint filter)
  - Speed controller interference frequency response (fault downstream of the current setpoint filter)
  - Speed-controlled system (excitation downstream of current setpoint filter)

Starting/stopping the measuring function

Caution

With the corresponding measuring function parameter settings (e.g. offset), the motor can “drift” and travel to its end stop.

The movement of the drive is not monitored while the measuring function is active.

To start the ramp–function generator:

1. Meet the conditions for starting the measuring function
   - Activate the control board

     Drives –> Drive_x –> Commissioning –> Control board
   - Switch on the drive

     Control board –> Issue enable signals –> Switch on
2. Select the operating mode

   e.g. speed setpoint downstream of filter
3. Select the drive (as control board)
4. Set the measuring function

   e.g. current controller setpoint change
5. Load the settings to the target system (“Download parameters” pushbutton)
6. Start the measuring function (“Start Measuring Function” pushbutton)

To stop the measuring function:

“Stop Measuring Function” pushbutton

Parameterization

The “measuring function” parameter screen is selected via the following icon in the toolbar of the STARTER commissioning tool:

Fig. 7-9 STARTER icon for “measuring function”

7.2.4 Measuring sockets

Description

The measuring sockets are used to output analog signals. Any interconnectable signal can be output to any measuring socket on the control unit.

Caution

The measuring sockets should be used for commissioning and servicing purposes only.

The measurements may only be carried out by properly trained specialist personnel.

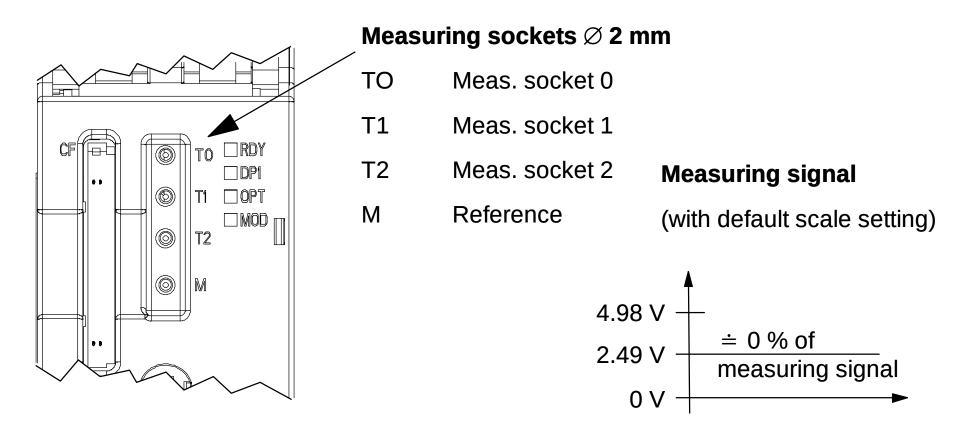


Fig. 7-10 Arrangement of the measuring sockets on the control unit 320

Parameterizing and using the measuring sockets

The measuring sockets are parameterized and used via the parameterization and commissioning tool STARTER (see Section 2.4).

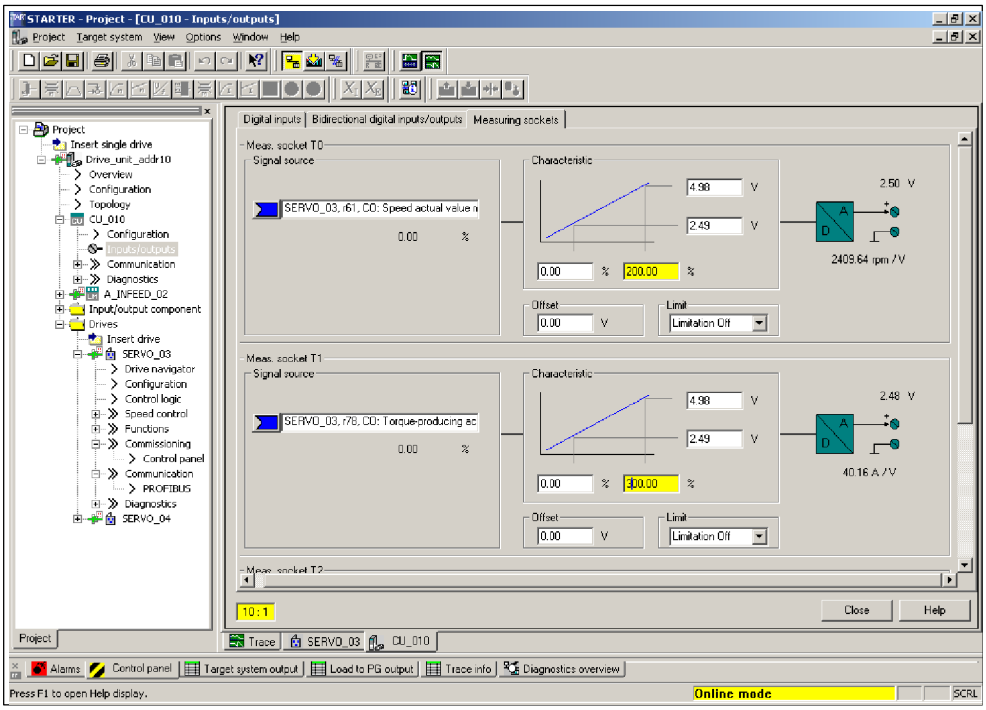


Fig. 7-11 “Measuring sockets” initial screen

Note

Please refer to the online help for more information about parameterizing and using the measuring sockets.

Properties

- Resolution — 8 bits
- Voltage range — 0 V to +4.98 V
- Measuring cycle — Depends on the measuring signal (e.g. actual speed value in speed controller cycle, 125 µs)
- Short–circuit–proof
- Parameterizable scaling
- Adjustable offset
- Adjustable limitation

Signal chart for measuring sockets

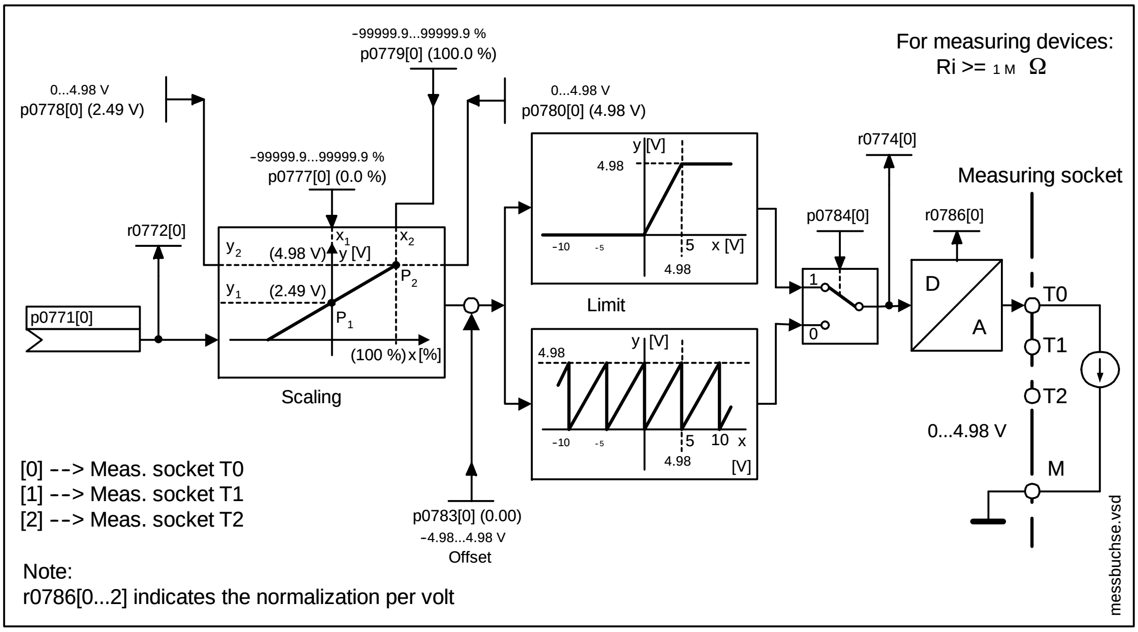


Fig. 7-12 Signal chart for measuring sockets

Which signal can be output via measuring sockets?

The signal to be output via a measuring socket is specified by parameterizing the connector input p0771[0...2].

Important measuring signals (examples):

r0060	CO: Speed setpoint before speed setpoint filter
r0063	CO: Actual speed smoothed
r0069[0...2]	CO: Phase current, actual value
r0075	CO: Field-generating current setpoint
r0076	CO: Field-generating actual current
r0077	CO: Torque-generating current setpoint
r0078	CO: Torque-generating actual current

Scaling

Scaling specifies how the measuring signal is processed. A straight line with 2 points must be defined for this purpose.

Example:

x1 / y1 = 0.0 % / 2.49 V   x2 / y2 = 100.0 % / 4.98 V (default setting)

--> 0.0 % is mapped onto 2.49 V

--> 100.0 % is mapped onto 4.98 V

--> –100.0 % is mapped onto 0.00 V

Offset

The offset is applied additively to the signal to be output. The signal to be output can thus be displayed within the measuring range.

Limit

- Limitation on

  The output of signals outside the permissible measuring range causes the signal to be limited to 4.89 V or 0 V.
- Limitation off

  The output of signals outside the permissible measuring range causes a signal overflow. In the event of an overflow, the signal jumps from 0 V to 4.98 V or from 4.98 to 0 V.

Example of a measurement

Assumption:

The actual speed after smoothing (r0063) is to be output for a drive via measuring socket T1.

How do you do it?

1. Connect and set the measuring device.
2. Interconnect the signal (e.g. STARTER).

   Interconnect the connector input (CI) belonging to the measuring socket with the desired connector output (CO).

   CI: p0771[1] = CO: r0063
3. Parameterize the signal characteristic (scaling, offset, limitation).

Note

r0786[1] indicates the normalization per volt.

A change in the output voltage by 1 volt corresponds to the value in this parameter. The unit is taken from the connected signal.

Example:

r0786 = 1500.0 and the measuring signal is r0063 (CO: Actual speed smoothed).

A change of 1 volt at the output of the measuring socket corresponds to 1500.0 rpm.

Parameter overview (see List Manual)

Adjustable parameters

- p0771[0...2] CI: Test sockets signal source
- p0777[0...2] Test socket characteristic value x1
- P0778[0...2] Test socket characteristic value y1
- p0779[0...2] Test socket characteristic value x2
- p0780[0...2] Test socket characteristic value y2
- p0783[0...2] Test sockets offset
- p0784[0...2] Test socket limit on/off

Visualization parameters

- r0772[0...2] Test sockets output signal
- r0774[0...2] Test sockets output voltage
- r0786[0...2] Test socket normalization per volt

Function diagram overview (see List Manual)

- 8134 Test sockets

7.3 Fault and alarm messages

7.3.1 General information about faults and alarms

Description

The errors and states detected by the individual components of the drive system are indicated by messages.

The messages are categorized into faults and alarms.

Note

The individual faults and alarms are described in detail in:

References: /LH1/ SINAMICS S List Manual

Properties of faults and alarms

- Faults
  - Are identified by Fxxxx.
  - Can lead to a fault reaction.
  - Must be acknowledged once the cause has been remedied.
  - Status via control unit and LED RDY.
  - Status via PROFIBUS status signal STW1.3 (fault active).
  - Entry in the fault buffer (see Section 7.3.2).
- Alarms (identification A4567)
  - Are identified by Axxxx.
  - Have no further effect on the drive.
  - No acknowledgement is required and the alarms are automatically reset once the cause has been remedied.
  - Status via PROFIBUS status signal STW1.7 (alarm active).
  - Entry in the alarm buffer (see Section 7.3.2).
- General properties of faults and alarms
  - Can be configured (e.g. change fault to alarm, fault reaction)
  - Triggering on selected messages possible.
  - Initiation of messages possible via an external signal.

Acknowledging faults

The list of faults and alarms specifies how each fault is acknowledged after the cause has been remedied.

1. Acknowledgement of faults by “POWER ON”
   - Switch the drive on/off (POWER ON)
   - Press the RESET button on the control unit
2. Acknowledgement of faults by “IMMEDIATE”
   - Via PROFIBUS control signal

     STW1.7 (reset fault memory): 0/1 edge

     Set STW1.0 (ON/OFF1) = “0” and “1”
   - Via external input signal

     Binector input and interconnection with digital input

     p2103[0...n] = “desired signal source”

     p2104[0...n] = “desired signal source”

     p2105[0...n] = “desired signal source”

Note

The drive cannot resume operation until all active faults have been acknowledged.

7.3.2 Buffer for faults and alarms

Note

A fault and alarm buffer is provided for each drive.

The drive and device–specific messages are entered in this buffer.

Fault buffer

Faults which occur are entered in the fault buffer as follows:

Table 7-11 Structure of the fault buffer (example)

Fault inci-dent	Index	Fault code r0945	Fault number r0947	Fault time r0948	Fault value r0949	Remedied r2109
1	0 1 ... 7	2 113 ... 0		t_101 t_102 ... 0	w_101 w_102 ... 0	0 0 ... 0
2	8 ... 15	90 ... 0		t_90 ... 0	w_90 ... 0	t_91 ... 0
...	...	...		...	...	...
8	56 ... 63	0 ... 0		0 ... 0	0 ... 0	0 ... 0

Properties of the fault buffer:

- A new fault incident encompasses one or more faults and is entered in fault incident 1.
- The entries are arranged in the buffer according to their time of occurrence.
- If a new fault incident occurs, the fault buffer is reorganized. This history is recorded in fault incidents 2 to 8.
- If the cause of at least one fault in fault incident 1 is remedied and acknowledged, the fault buffer is reorganized. The faults that have not been remedied remain in fault incident 1.
- When 8 faults have been entered in fault incident 1 and a new fault occurs, the fault in the parameters in index 7 is overwritten by the new fault.
- r0944 is incremented each time the fault buffer changes.

- A fault value (r0949) can be output for a fault. The fault value is used to diagnose the fault more accurately; please refer to the fault description for details of the meaning.

Clearing the fault buffer:

- POWER ON clears the entire buffer
- The fault buffer is reset as follows: p0952 = 0

Alarm buffer

Alarms that occur are entered in the alarm buffer as follows:

Table 7-12 Structure of the alarm buffer (example)

Index	Alarm code r2122	Alarm number r2110	Alarm time r2123	Alarm value r2124	Remedied r2125
0	2		t_101	w_101	0
1	113		t_102	w_102	0
...	...		...	...	...
7	10		t_103	w_103	0

A maximum of 8 alarms are displayed. If more than 8 alarms are present, the display is as follows:

Index 0 .. 6 The **first** 7 alarms are displayed

Index 7 The **last** alarm is displayed

Properties of the alarm buffer:

- The entries are arranged in the buffer according to their time of occurrence.
- When 8 alarms have been entered in the alarm buffer and a new alarm occurs, the alarm in the parameters in index 7 are overwritten by the new alarm.
- r2121 is incremented each time the alarm buffer changes.
- An alarm value (r2124) can be output for an alarm. The alarm value is used to diagnose the alarm more accurately; please refer to the alarm description for details of the meaning.

Clearing the alarm buffer:

- POWER ON clears the entire buffer.
- The alarm buffer is reset as follows: p2111 = 0

7.3.3 Configuring messages (faults and alarms)

The properties of the faults and alarms in the drive system are permanently defined.

The following can be configured for some of the messages within a permanently defined framework for the drive system:

- Change message type (example)

Select message	Set message type	
p2118[5] = 95	p2119[5]	= 1: fault (F, fault)
		= 2: alarm (A, alarm)
		= 3: no message (N, no report)

- Change fault reaction (example)

Select message	Set fault reaction	
p2100[3] = 85	p2101[3]	= 0: none
		= 1: OFF1
		= 2: OFF2
		= 3: OFF3
		= 4: STOP1 (being developed)
		= 5: STOP2
		= 6: DCBRAKE (being developed)
		= 7: ENCODER (p0491)

- Change acknowledgement (example)

Select message	Set acknowledgement	
p2126[4] = 105	p2127[4]	= 1: POWER ON
		= 2: IMMEDIATELY

Note

- The associated fault response must be considered when changing the message type to “no message”. If no fault response is required, the fault response should be set to “none” for the corresponding message.
- If BICO interconnections exist between drive objects, all interconnected objects must be configured.

  Example:
  The TM31 has BICO interconnections with drive 1 and 2 and F35207 is to be reconfigured as an alarm.

  --> p2118[n] = 35207 and p2119[n] = 2

  --> This must be set for TM31, drive 1 and drive 2.

Note

Only those messages which are listed in the indexed parameters can be changed as desired. All other message settings retain their factory settings or are reset to the factory settings.

Examples:

- In the case of messages listed via p2128[0...19], the message type can be changed. The factory setting is set for all other messages.
- The fault response of fault F12345 has been changed via p2100[n] and p2101[n]. The factory settings are to be reinstated.
  --> p2100[n] = 0 and p2101[n] = 0

Triggering on messages (example)

Select message	Trigger signal
p2128[0] = 95	BO: r2129.0
or	
p2128[1] = 386	BO: r2129.1

Note

The value of CO: r2129 can be used as a group trigger.

CO: r2129 = 0	No selected message occurred.
CO: r2129 > 0	Group trigger. At least 1 message has occurred. The individual binector outputs BO: r2129 must be examined.

External triggering of messages

If the appropriate binector input is interconnected with an input signal, fault 1, 2 or 3 or alarm 1, 2 or 3 can be triggered via an external input signal.

BI: p2106	--> External fault 1	--> F07860(A)
BI: p2107	--> External fault 2	--> F07861(A)
BI: p2108	--> External fault 3	--> F07862(A)
BI: p2112	--> External fault 1	--> A07850(F)
BI: p2116	--> External fault 2	--> A07851(F)
BI: p2117	--> External fault 3	--> A07852(F)

Note

An external fault or alarm is triggered by a 1/0 signal.

An external fault and alarm do not usually mean that an internal drive message has been generated. The cause of an external fault and warning should, therefore, be remedied outside the drive.

7.3.4 Parameters and function diagrams for faults and alarms

Parameter overview (see List Manual)

- r0944 Counter for fault buffer changes

  ...
- p0952 Fault counter
- p2100[0...19] Sets the fault number for fault response

  ...
- r2130 Sum of fault and alarm buffer changes

Function diagram overview (see List Manual)

- 1710 Overview diagram – Monitoring functions, faults, alarms
- 8060 Faults and alarms – Fault buffer
- 8065 Faults and alarms – Alarm buffer
- 8070 Faults and alarms – Fault/alarm trigger word r2129
- 8075 Faults and alarms – Fault/alarm configuration

■

Basic information about the drive system 8

8.1 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).

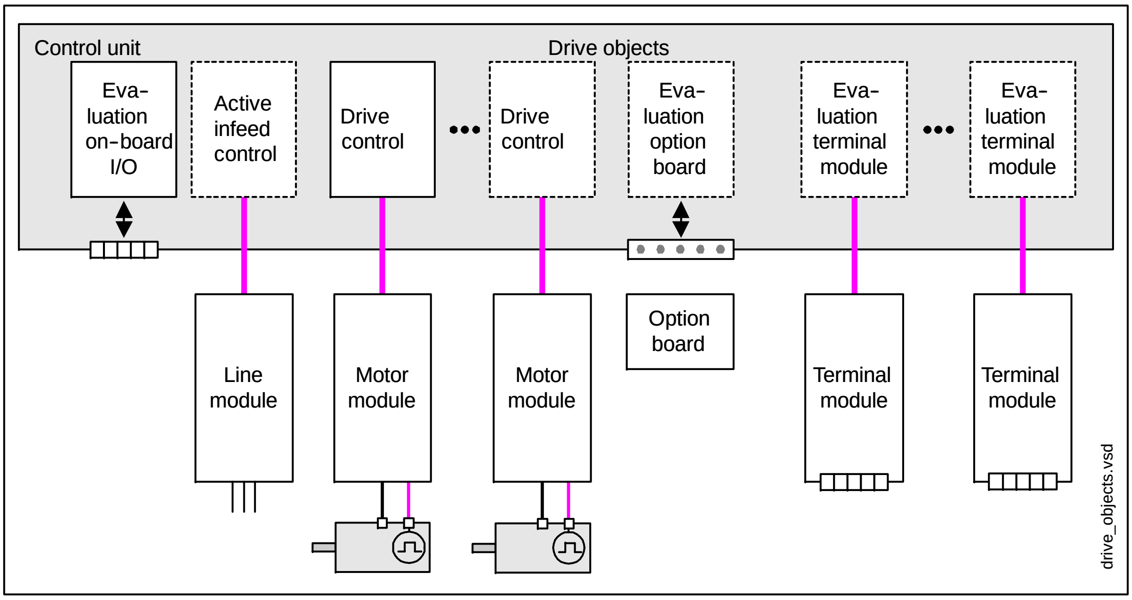


Fig. 8-1 Drive objects

Drive objects installed by default

- Drive control

  The drive control handles closed-loop control of the motor. 1 motor module and at least 1 motor and up to 3 sensors are assigned to the drive control.

  Various types of drive control can be configured (e.g. servo control, vector control, etc.).

  Several drive controls can be configured, depending on the performance of the control unit and the demands made on the drive control system.

- Control unit, inputs/outputs

  The I/Os on the control unit are evaluated within a drive object. High-speed inputs for probes are processed here in addition to bidirectional digital I/Os.

- Properties of a drive object
  - Separate parameter space
  - Separate window in STARTER
  - Separate fault/alarm system (for VECTOR, SERVO, A_INFEED)
  - Separate PROFIBUS telegram for process data (for VECTOR, SERVO, A_INFEED)

Optionally installed drive objects

- Infeed: Active line module infeed control

  If an active line module is used for the infeed in a drive system, the infeed control is implemented on the control unit within a corresponding drive object.
- Infeed: Smart line module infeed control

  If a smart line module is used for the infeed in a drive system, the control unit must handle activation and evaluation of the corresponding signals (RESET, READY).
- 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.

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.

Parameter overview (see List Manual)

Adjustable parameters

- p0101 Drive object numbers
- p0107 Drive object type
- p0108 Drive object configuration

Visualization parameters

- r0102 Number of drive objects

8.2 Parameters

Parameter types

The following adjustable and visualization parameters are available:

- Adjustable parameters (read/write)

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

  Example: Ramp-up and ramp-down time of a ramp-function generator

- Visualization parameters (read-only)

  These parameters are used to display internal variables.

  Example: Current motor current

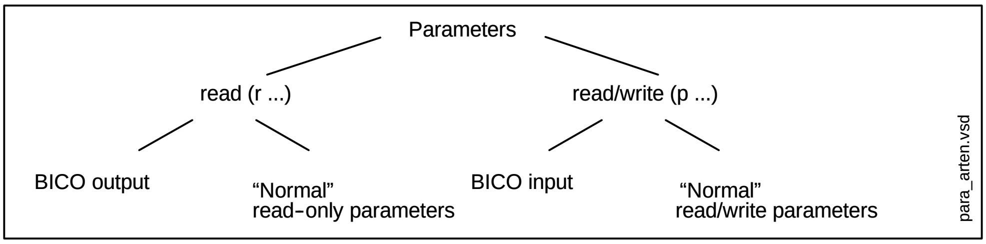


Fig. 8-2 Parameter types

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

Parameter categories

The parameters of the individual drive objects are categorized as follows:

- Data-set-independent parameters

  These parameters exist only once per drive object.

- Data-set-dependent parameters

  These parameters can exist several times for each drive object and can be addressed via the parameter index for reading and writing. A distinction is made between various types of data set:

  - CDS: Command Data Set (see Section 8.8)

    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 (available soon)

    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 switchover.

- EDS Encoder Data Set (available soon)
- MDS Motor Data Set (available soon)

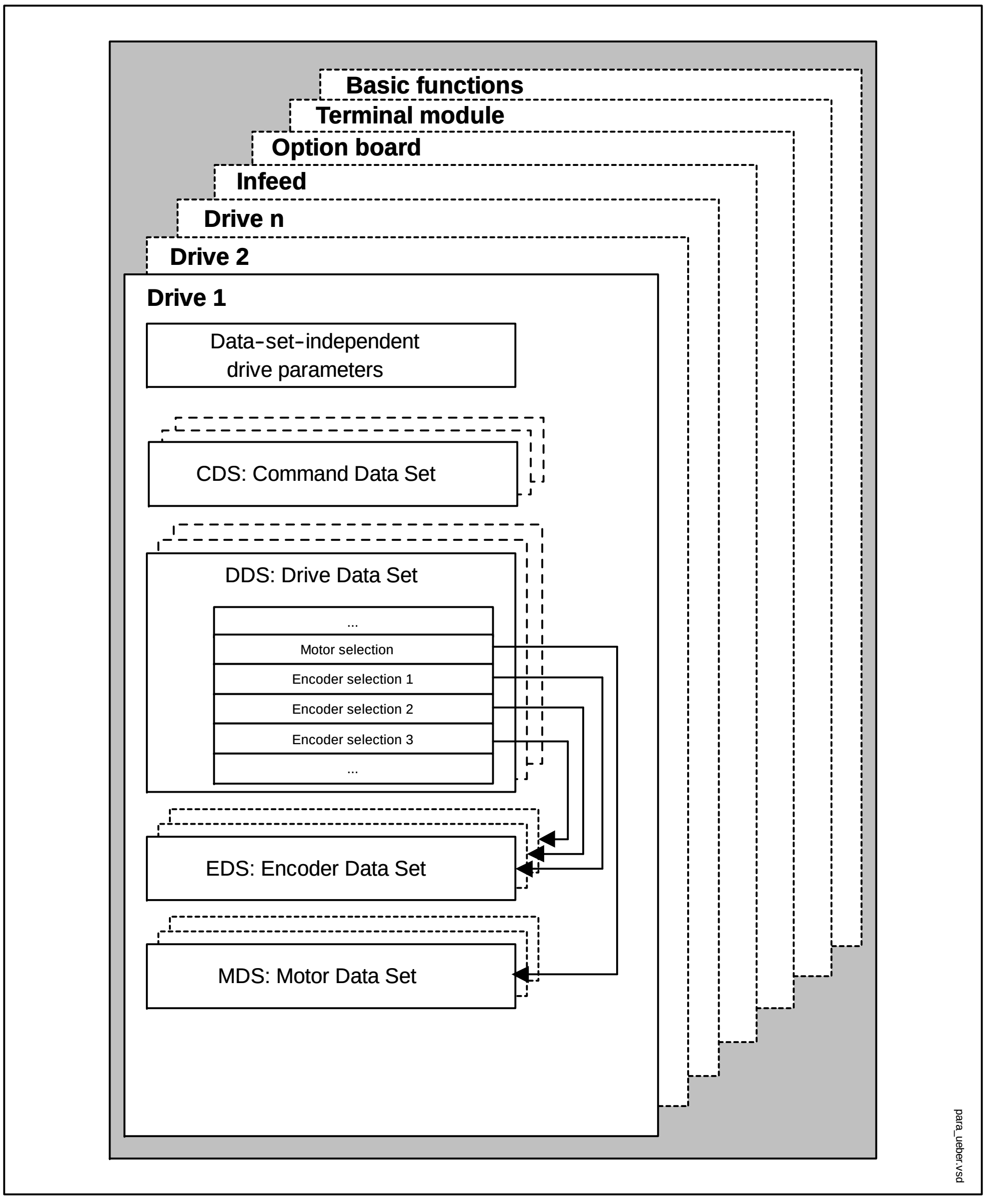


Fig. 8-3 Parameter categories

Saving parameters in a non-volatile memory

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

The data has to be saved as follows in a non-volatile memory so that it is available the next time the drive is switched on.

- Save parameters – device and current drive

  p0971 = 1   Is automatically reset to 0

- Save parameters – device and all drives

  p0977 = 1   Is automatically reset to 0

Resetting parameters

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

- Reset parameters – current drive object

  p0970 = 1   Is automatically reset to 0

- Reset parameters – all parameters

  p0976 = 1   Is automatically reset to 0

8.3 BICO technology: interconnection of 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 and analog 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 (see Section 2.4).

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 8-1 Binectors

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

Connectors, CI: connector input, CO: connector output

A connector is an analog signal. 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 8-2 Connectors

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

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 and index and drive object ID

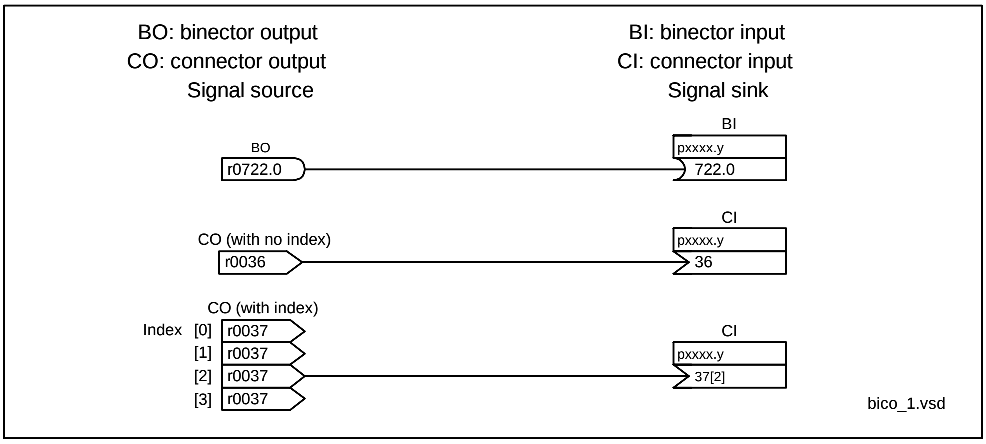


Fig. 8-4 Interconnecting signals using BICO technology

Note

A signal source (BO) can be connected to any number of signal sinks (BI).

A signal sink (BI) can only ever be connected to one signal source (BO).

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

Internal encoding of the binector/connector output parameters

The internal codes are needed, for example, in order to write BICO input parameters via PROFIBUS.

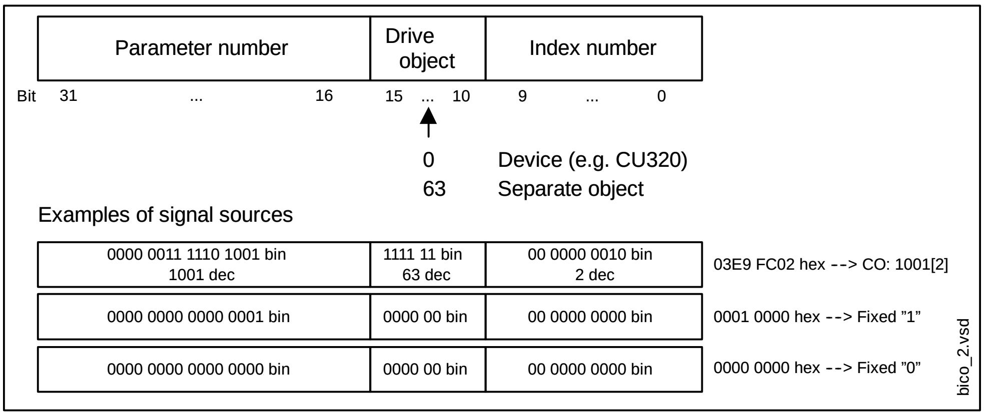


Fig. 8-5 Internal encoding of the binector/connector output parameters

Example 1: Interconnection of 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.

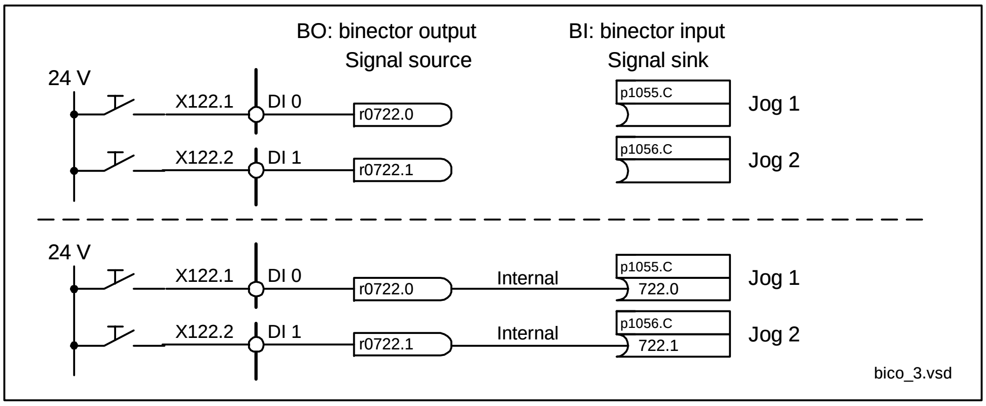


Fig. 8-6 Interconnection of digital signals (example)

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).

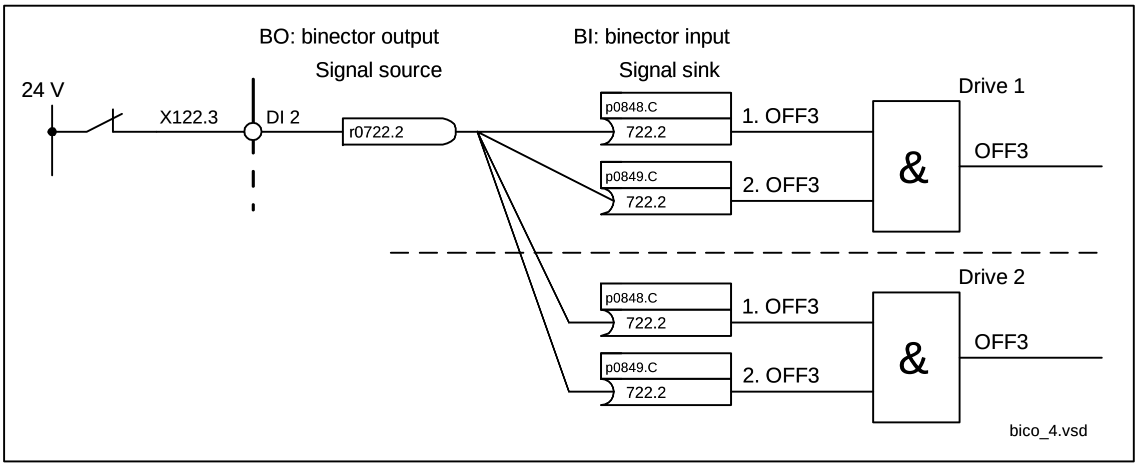


Fig. 8-7 Connection of OFF3 to several drives (example)

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

Copying drives

When a drive is copied, the interconnection is copied with it.

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: PROFIBUS 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: PROFIBUS PZD select 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.

8.4 DRIVE-CLiQ topology

Introduction

The term topology is used in SINAMICS to refer to a wiring harness with DRIVE-CLiQ cables. A unique component number is allocated to each component during the start-up phase.

DRIVE-CLiQ (DRIVE Component Link with IQ) is a communication system for connecting the various components in SINAMICS, e.g. control unit, line module, motor modules and encoders.

DRIVE-CLiQ supports the following:

- Automatic detection of components by the control unit
- Standard interfaces to all components
- Standardized diagnostics down to component level
- Standardized service down to component level

Electronic type plate

The electronic type plate contains the following data:

- Component type (e.g. SMC20)
- Order number (e.g. 6SL3055-0AA0-5BA0)
- Manufacturer (e.g. SIEMENS)
- Hardware version (e.g. A)
- Serial number (e.g. “T-PD3005049)

Actual topology

The actual topology is the actual DRIVE-CLiQ wiring harness.

When the drive system components are started up, the actual topology is detected automatically via DRIVE-CLiQ.

Target topology

The target topology is stored on the CompactFlash card on the control unit and is compared with the actual topology when the control unit is started up.

The target topology can be specified in two ways and saved on the CompactFlash card:

- Via STARTER
  by creating the configuration and loading it to the drive
- Via quick commissioning (automatic configuration)

  The actual topology is read and the target topology written to the CompactFlash card

Comparison of topologies at Power On

Comparing the topologies prevents a component from being controlled/evaluated incorrectly (e.g. drive 1 and 2).

When the drive system is started, the control unit compares the detected actual topology and the electronic type plates with the target topology stored on the CompactFlash card.

You can specify how the electronic type plates are compared for all the components of a control unit via p9906. The type of comparison can be changed subsequently for each individual component. You can use p9908 for this or the right mouse button in the topology view in the STARTER tool. All data on the electronic type plate is compared by default.

The following data in the target and actual topologies is compared depending on the settings made in p9906/9908:

- p9906/9908 = 0: component type, order number, manufacturer, serial number
- p9906/9908 = 1: component type, order number
- p9906/9908 = 2: component type
- p9906/9908 = 3: component class (e.g. sensor module or motor module)

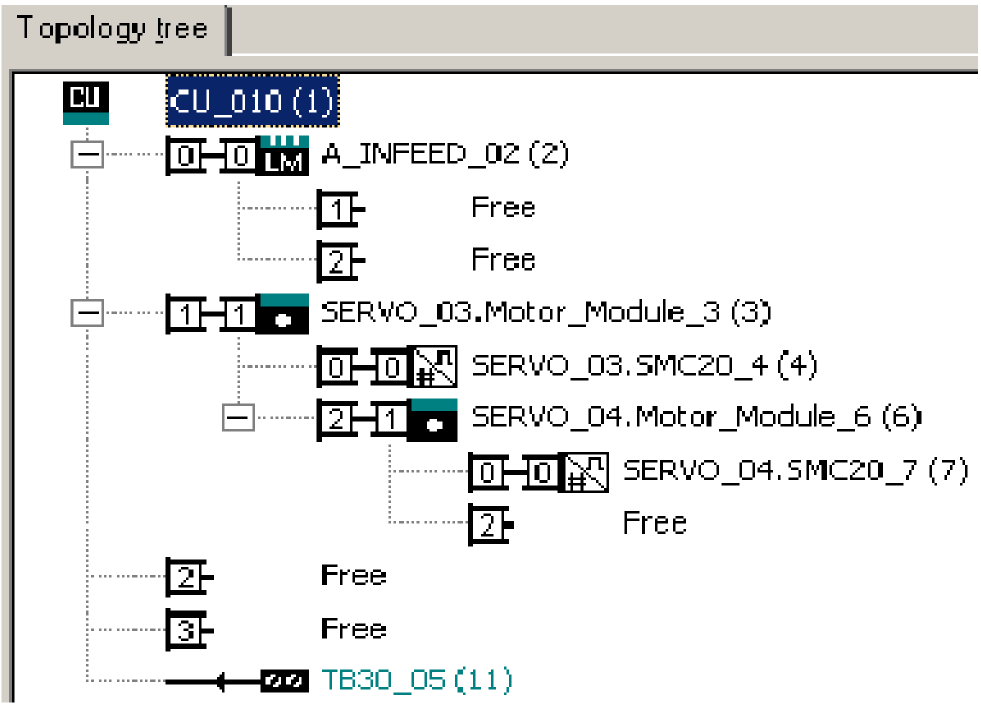


Fig. 8-8   Topology view in the STARTER tool

8.4.1 Examples of replacing components

Note

All the components in a drive line-up should have the same firmware version.

For information on upgrading the firware, see Section 8.10

Description

If the type of comparison is set to the highest setting, the following examples apply.

A distinction is made between the following scenarios:

- Component with an identical order number
- Component with a different order number

Example of replacing a defective component with an identical order number

Prerequisite

- The replaced component has an identical order number

Table 8-3 Example: Replacing a motor module

Action	Response	Remarks
• Switch off the power supply • Replace the defective component and connect the new one • Switch on the power supply	Alarm F1425	
• Set p9905 to “1”	• Alarm disappears • The serial number is copied to the target topology	The serial number is stored in the RAM of the control unit and has to be copied to the non-volatile memory with p0971 or p0977.
The component has been successfully replaced		

Example of replacing a component with a different order number

Prerequisite

- The replaced component has a different order number

Table 8-4 Example of replacing a component with a different order number

Action	Response	Remarks
• Switch off the power supply • Replace the defective component and connect the new one • Switch on the power supply	Alarm F1420	
• Load the project from the control unit to the STARTER (PG) • Configure the replacement drive and select the current component • Load the project to the control unit (target system)	• Alarm disappears	The new order number is stored in the RAM of the control unit and has to be copied to the non-volatile memory with p0971 or p0977.
The component has been successfully replaced		

8.5 DRIVE-CLiQ components

The following sections provide simplified views (in the form of block diagrams) and brief descriptions of the component parts and interfaces of the SINAMICS S120 system.

8.5.1 Control unit 320 (CU320)

Block diagram of the control unit 320

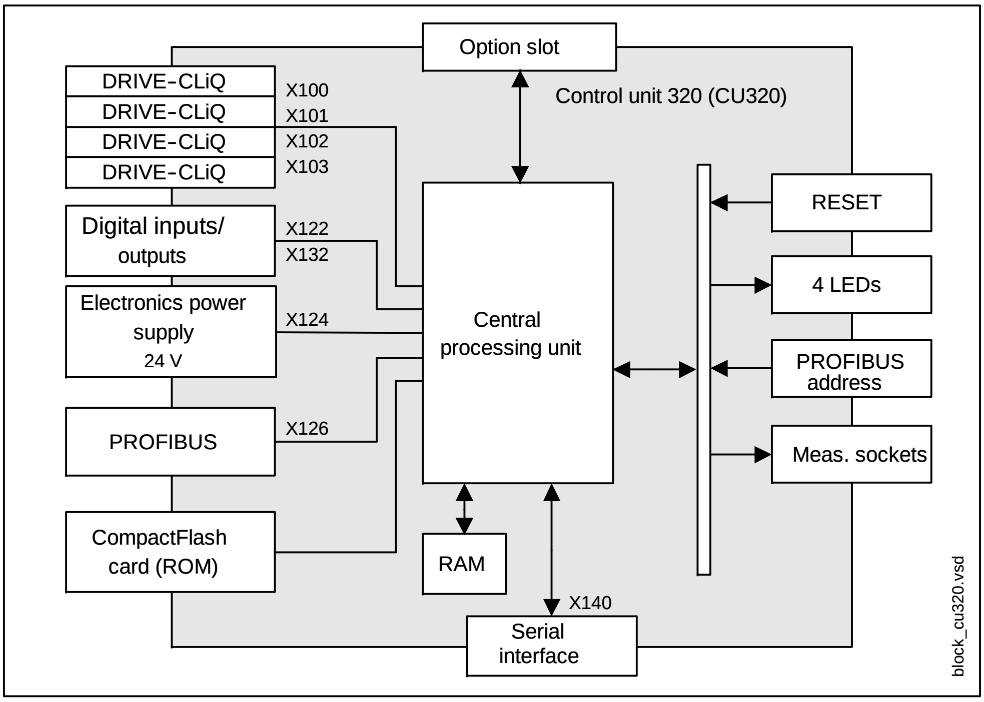


Fig. 8-9 Block diagram of the control unit 320

Central processing unit

The central processing unit (CPU) executes all the closed-loop and open-loop control functions for the drives and the communication tasks of the control unit.

The computing power allows several motor modules and active line modules, which are connected via DRIVECLiQ, to be operated. The number of motor and active line modules that can be operated depends on the control mode (SERVO, VECTOR, etc.) and on the required dynamic response.

CompactFlash card

The CompactFlash card is used as a non-volatile memory for the firmware and user parameters of the central processing unit.

Note

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

When the control unit is switched on, the data is loaded from the CompactFlash card to the RAM.

If any parameters are changed, the "Save data" function has to be executed in order to save the parameters permanently.

For more information about parameters --> see Section 8.2

PROFIBUS

The PROFIBUS interface is installed as standard and is used for communicating with a higher-level control system (e.g. SIMATIC, SIMOTION) and with the engineering system (e.g. STARTER).

The address for the PROFIBUS interface can be set by parameter or using an address switch on the control unit.

For more information about PROFIBUS

->see Chapter 4 Communication via PROFIBUS

24 V electronics power supply

An external 24 V DC power supply must be connected to X124 in order to operate the control unit.

References: /GH1/ SINAMICS S120 Equipment Manual

Digital inputs/outputs

The following types of digital I/O are used:

- Digital inputs
- Bidirectional digital inputs/outputs

The assignment of I/Os to functions can be parameterized freely by the user. Special functions, such as probe input and cam output, can also be assigned to the I/Os.

For more information about inputs/outputs --> see Section 8.9

References: /GH1/ SINAMICS S120 Booksize Equipment Manual

DRIVE–CLiQ

The components assigned to the control unit (e.g. active line modules, motor modules, terminal modules, sensor modules) are connected via the DRIVE–CLiQ interfaces.

DRIVE–CLiQ is a serial communications link between SINAMICS components.

For more information about DRIVE–CLiQ --> see Section 8.4

Option slot

This slot is used to expand the functionality of the control unit by adding option boards (e.g. terminal board 30 (TB30), communication board CAN 10 (CBC10)).

RESET button

The RESET button is located behind the blanking plate.

Pressing the RESET button resets the complete system and induces a new ramp–up. It is similar to a "Power On Reset" except that the 24 V power supply does not have to be switched on. It is only necessary in special situations when an error has occured.

LEDs

The four LEDs on the front of the control unit indicate ramp–up and error states. This diagnostics feature encompasses the control unit itself, the option board and PROFIBUS communication.

For more information about LEDs --> see Section 7.1

Measuring sockets

The three measuring sockets are used to output analog signals for diagnostic purposes.

For more information about measuring sockets --> see Section 7.2.4

Basic operator panel 20 (BOP20, optional)

BOP20 is used to indicate faults and alarms and to display and change parameters without the need for any additional tools.

The operator panel must only be removed or plugged in when the control unit is disconnected from the power supply.

Serial interface (RS232)

The serial interface can be used to establish an online connection between the drive and a PC/PG running the STARTER parameterization and commissioning tool.

For more information about STARTER --> see Section 2.4

8.5.2 Active line module

Active line module block diagram

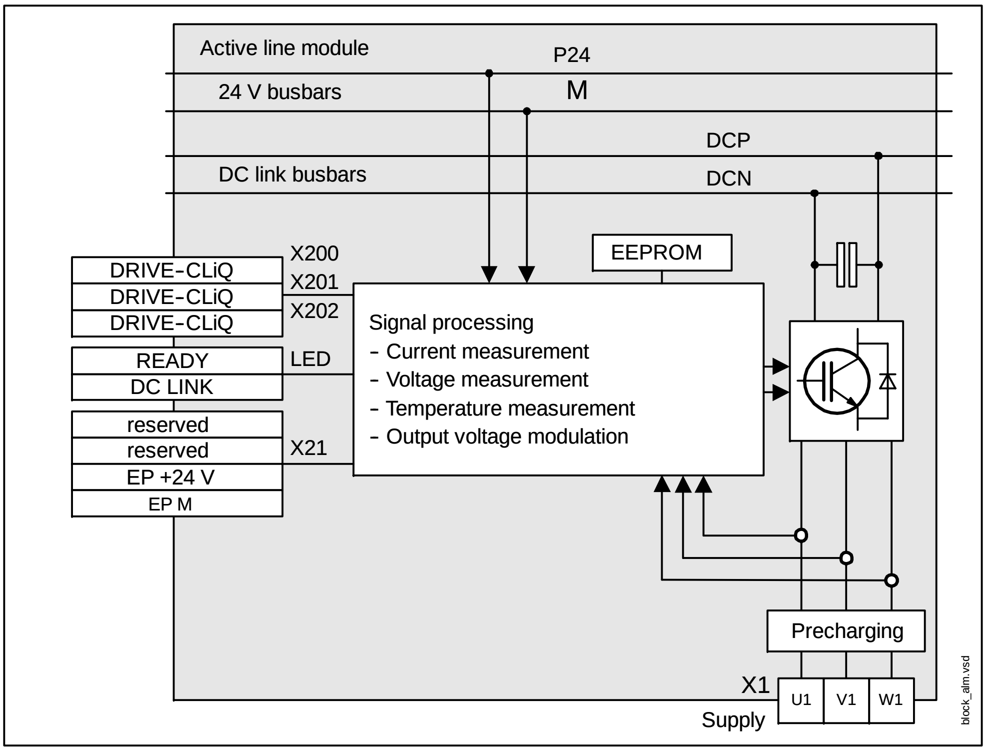


Fig. 8-10 Active line module block diagram

24 V electronics power supply

An external 24 V DC power supply, which is connected to the integrated 24 V busbars via a 24 V terminal adapter, is required to operate the active line modules. The busbars are located underneath the top safety cover.

These busbars can be used to feed further modules from the 24 V DC power supply.

DC link

The DC link voltage is fed via an integrated busbar (DCP, DCN). This busbar supplies the DC link voltage to the motor modules. The busbar is located underneath the top safety cover.

LEDs

The two LEDs on the front indicate operating and error states on the active line module.

For more information about LEDs --> see Section 7.1

DRIVE-CLiQ

The active line module communicates with the assigned control unit via a DRIVE-CLiQ socket. The other DRIVE-CLiQ sockets can be used to connect motor modules, for example.

For more information about DRIVE-CLiQ --> see Section 8.4

Enable terminals EP 24 V, EP M (X21.3, X21.4)

These terminals are used to enable the power transistors of the active line module.

The signal must be wired to the leading breaking contacts of the main switch.

Infeed ready signal

The infeed ready signal is made available to the control unit via DRIVE-CLiQ.

The signal is activated when the following conditions have been met:

- Electronics power supply available
- Supply voltage available
- Active line module in operation

Notice

The Ready signal from the infeed (r0863 bit 0) must be used to enable the motor modules (p0864).

8.5.3 Smart line module (5 kW and 10 kW)

Smart line module block diagram (5 kW and 10 kW)

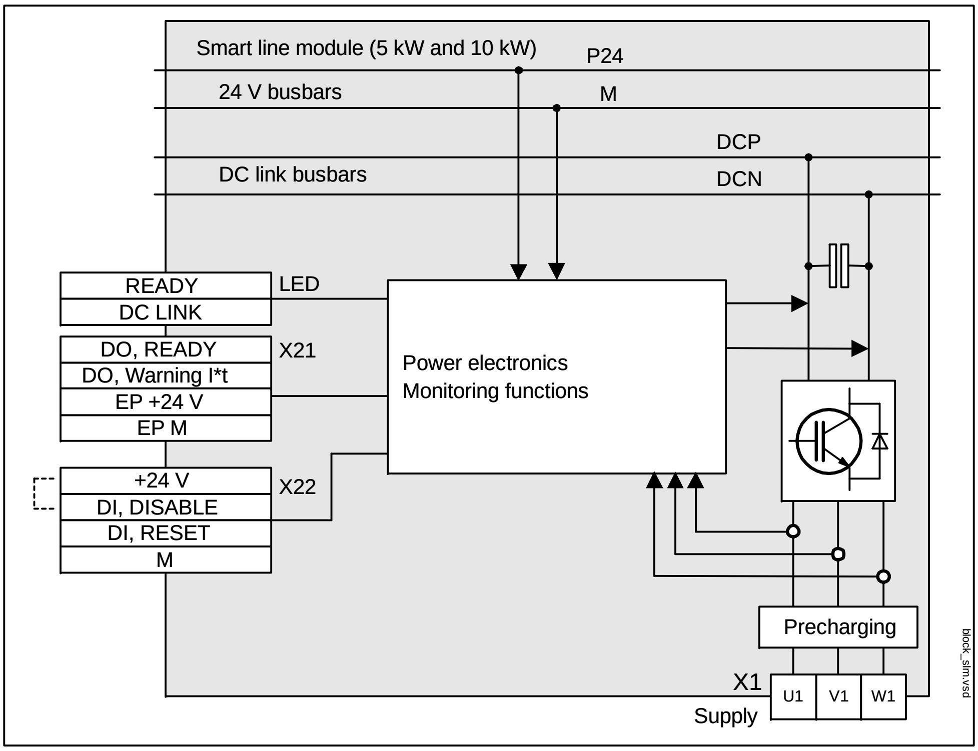


Fig. 8-11 Smart line module block diagram (5 kW and 10 kW)

24 V electronics power supply

An external 24 V DC power supply, which is connected to the integrated 24 V busbars via a 24 V terminal adapter, is required to operate the smart line modules. The busbars are located underneath the top safety cover.

These busbars can be used to feed further modules from the 24 V DC power supply.

DC link

The DC link voltage is fed via an integrated busbar (DCP, DCN). This busbar supplies the DC link voltage to the motor modules. The busbar is located underneath the top safety cover.

LEDs

The two LEDs on the front indicate operating and error states on the active line module.

For more information about LEDs --> see Section 7.1

Terminals X21/X22

- X21.1 DO, Ready

  This terminal reports that the smart line module is in operation. The DC link is available to the motor modules.

- X21.2 DO, Warning I*t

  This terminal outputs a warning to prevent the component from overheating.

- X22.2 DI, Disable

  This terminal is used to enable the power transistors of the smart line module. Feedback is deactivated; the DC link continues to be supplied via diodes (Vdc = 1.35 x U_{supply}).

- X22.3 DI, Reset

  This terminal can be used to reset a fault message, the cause of which has been remedied.

Notice

The Ready signal from the infeed (X21.1) must be used via a digital input/binectors to enable the motor module (p0864) (e.g. digital input 7 on the control unit: p0864 = p0722.7).

8.5.4 Motor module

Motor module block diagram

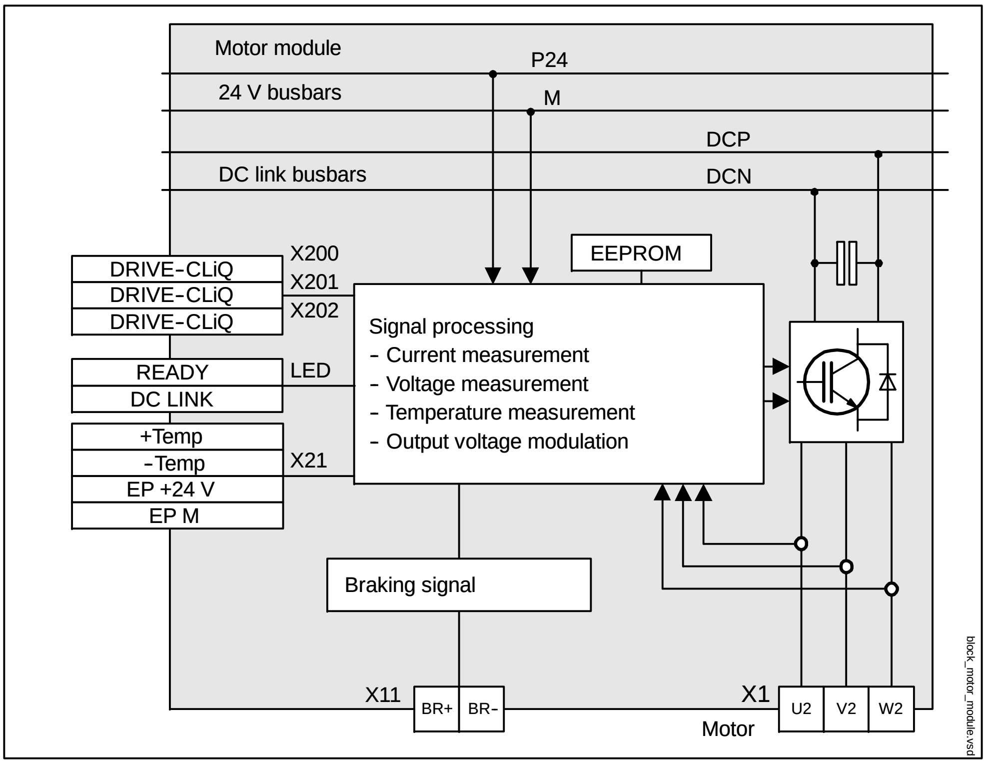


Fig. 8-12 Motor module block diagram

24 V electronics power supply

An external 24 V DC power supply is required for operating the motor modules. Infeed is via the integrated 24 V busbars. The busbars are located underneath the top safety cover.

These busbars can be used to feed further modules from the 24 V DC power supply.

DC link

The DC link voltage is fed via integrated busbars (DCP, DCN). The busbar is located underneath the top safety cover.

DRIVE-CLiQ

The motor module communicates with the control unit via a DRIVE-CLiQ socket. Further modules can be connected on the communication line between the motor module and the control unit.

Sensor modules or further motor modules can be connected to free DRIVE-CLiQ sockets.

For more information about DRIVE-CLiQ --> see Section 8.4

LEDs

The two LEDs on the front indicate operating and error states on the motor module.

For more information about LEDs --> see Section 7.1

Motor temperature measurement (X21.1, X21,2)

These terminals can be used to connect a temperature sensor for measuring the motor temperature in sensorless operation.

If a motor encoder is used, the motor temperature is normally evaluated via the encoder cable, the sensor module and DRIVE-CLiQ.

Enable terminals EP 24 V, EP M (X21.3, X21.4)

These terminals are used to enable trigger pulses for the power transistors of the motor module.

These terminals must be supplied with 24 V DC if safe standstill is activated (see Chapter 6) in order to operate the motor.

Motor holding brake control (BR+, BR-)

The motor holding brake can be connected to terminals BR+ and BR either directly or via an intermediate relay.

The open-loop control of the motor holding brake is linked logically with the internal system sequences via DRIVE-CLiQ and monitored by the control unit.

8.5.5 Sensor module cabinet 10 (SMC10)

SMC10 block diagram

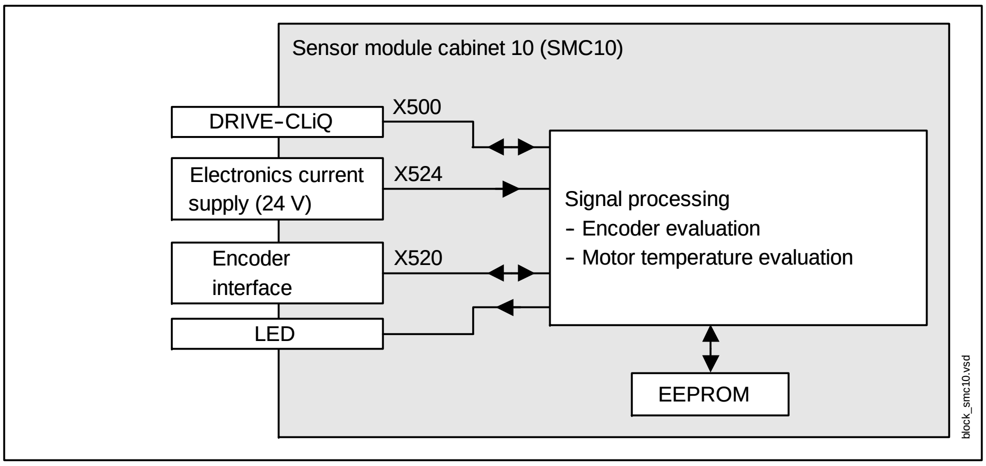


Fig. 8-13 SMC10 block diagram

24 V electronics power supply

An external 24 V power supply via X524 is required for operating the sensor module cabinet.

DRIVE-CLiQ

The sensor module communicates with the assigned control unit via this DRIVE-CLiQ interface. Further modules, e.g. motor modules, can be connected on the communication line between the sensor module and the control unit.

If possible, the DRIVE-CLiQ cable with the encoder signals of the connected motor should be connected to the DRIVE-CLiQ interface.

For more information about DRIVE-CLiQ --> see Section 8.4

LED

The LED on the front indicates operating and error states on the module.

For more information about LEDs --> see Section 7.1

Sensor interface (X520)

The interface can evaluate measuring systems with the following signals:

- Resolver

8.5.6 Sensor module cabinet 20 (SMC20)

SMC20 block diagram

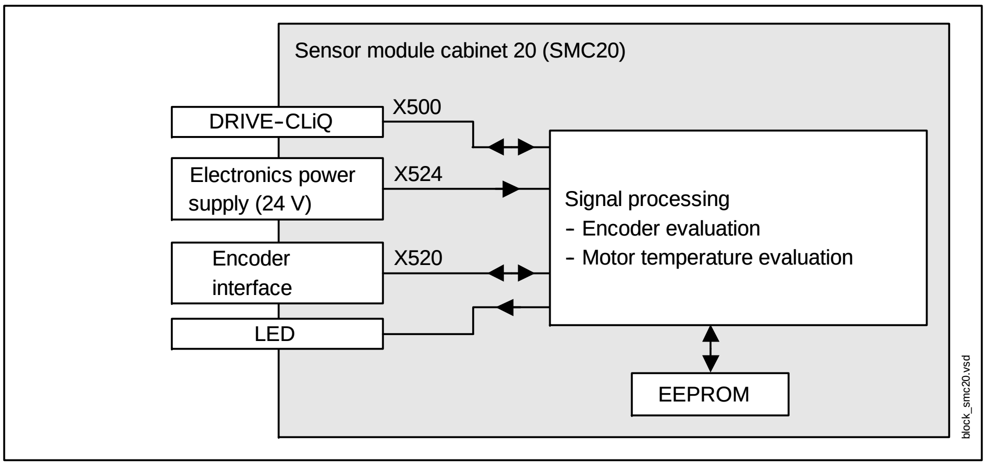


Fig. 8-14 SMC20 block diagram

24 V electronics power supply

An external 24 V power supply via X524 is required for operating the sensor module cabinet.

DRIVE-CLiQ

The sensor module communicates with the assigned control unit via this DRIVE-CLiQ interface. Further modules, e.g. motor modules, can be connected on the communication line between the sensor module and the control unit.

If possible, the DRIVE-CLiQ cable with the encoder signals of the connected motor should be connected to the DRIVE-CLiQ interface.

For more information about DRIVE-CLiQ --> see Section 8.4

LED

The LED on the front indicates operating and error states on the module.

For more information about LEDs --> see Section 7.1

Sensor interface (X520)

The interface can evaluate measuring systems with the following signals:

- Incremental A/B track encoders with voltage signals (sin/cos 1Vpp)
- Zero marker or reference marker R track (1 Vpp)
- C/D tracks with voltage signals (sin/cos 1 Vpp) for rotor position detection
- EnDat signals from absolute value encoders
- Temperature signals (KTY84)

8.5.7 Sensor module cabinet 30 (SMC30)

SMC30 block diagram

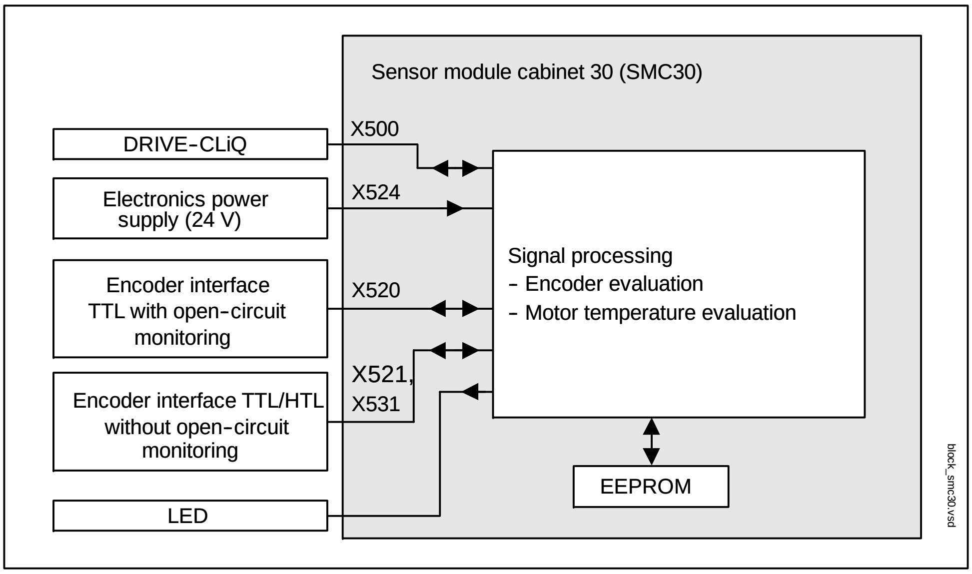


Fig. 8-15 SMC30 block diagram

24 V electronics power supply

An external 24 V power supply via X524 is required for operating the sensor module cabinet.

DRIVE-CLiQ

The sensor module communicates with the assigned control unit via this DRIVE-CLiQ interface. Further modules, e.g. motor modules, can be connected on the communication line between the sensor module and the control unit.

If possible, the DRIVE-CLiQ cable with the encoder signals of the connected motor should be connected to the DRIVE-CLiQ interface.

For more information about DRIVE-CLiQ --> see Section 8.4

LED

The LED on the front indicates operating and error states on the module.

For more information about LEDs --> see Section 7.1

Encoder (X520/X521/X531)

The interfaces can evaluate measuring systems with the following signals:

- Incremental A/B track encoders with voltage signals (TTL / HTL)
- Zero marker or reference marker R track (TTL / HTL)
- Temperature signals (KTY84)

8.5.8 Terminal module 31 (TM31)

TM31 block diagram

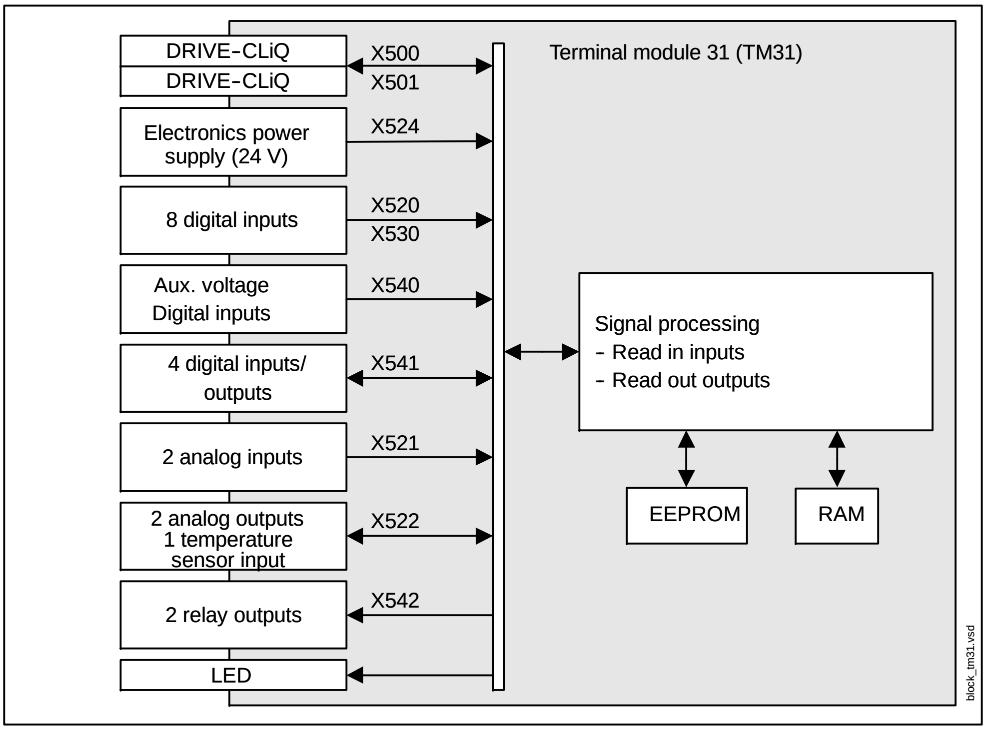


Fig. 8-16 Terminal module 31 (TM31) block diagram

24 V electronics power supply

An external 24 V DC power supply via X524 is required for operating the terminal module.

DRIVE-CLiQ

The terminal module communicates with the assigned control unit via a DRIVE-CLiQ socket.

Further modules, e.g. another terminal module, can be connected to the other DRIVE-CLiQ socket.

For more information about DRIVE-CLiQ --> see Section 8.4

LED

The LED on the front indicates operating and error states on the module.

For more information about LEDs --> see Section 7.1

Interfaces for the inputs/outputs

The following I/Os on the control unit can be connected as required using BICO technology.

- 8 digital inputs (X520 and X530) with auxiliary voltage (X540)
- 4 bidirectional digital inputs/outputs (X541)
- 2 analog inputs (X521)
- 2 analog outputs (X522)
- 2 relay outputs (X542)
- 1 temperature sensor input (KTY84/PTC) (X522)

8.6 Clock cycles in the system

Description

When the drive is being configured, the sampling times of the system clocks are set automatically according to the selected drive performance and do not have to be changed by the user.

The software functions installed in the system are executed in different clock cycles.

The basic clock cycle is normally the fastest current controller cycle.

The scanning frequencies of the cycles are integer multiples of the basic clock cycle in p0111.

Note

The basic clock cycle can be set in steps.

The values of the basic clock cycles depend on the number of drives.

The factory setting should be retained.

Parameter p0110 is used to set the basic clock cycles in the drive; all connected components are governed by this basic clock cycle. This parameter can only be changed when p0009=1.

All the components connected to a control unit DRIVE-CLiQ line must be set to the same basic clock cycle (p0111 when p0009=3).

The clock cycles for:

- Current controller
- Speed controller
- Flux controller
- Setpoint channel

are set by selecting the appropriate values in p0112 for the closed-loop control configuration and are copied to p0115 depending on the performance levels required. The performance levels range from xLow to xHigh. The clock cycles must be integers of the basic clock cycle.

Parameter overview (see List Manual)

Adjustable parameters

- p0111 DRIVE–CLiQ basic sampling times
- p0111 DRIVE–CLiQ basic sampling time selection
- p0112 Sampling times pre–setting p0115
- p0115 Sampling times for internal control loops
- p0118 Current controller computation deadtime

8.7 Units

Description

The unit system is selected when the drive is commissioned for the first time.

- p0505 Unit system selection (available soon)
  - "0" = SI System (**S**ystem **I**nternational Metric System)
  - "1" = US System (**U**nited **S**tates of America)

Default settings

Note

The SI system of units is the default setting for all units.

Characteristics of the units

- The factory settings for units are adequate for standard applications.
- You can use parameters to:
  - switch from one unit to another (available soon)
  - specify user–defined units

Note

Switchable units always have a base unit. The base unit for speeds on motors is one revolution per second (1/s). The parameters are always saved in the base unit.

Units and parameters

Table 8-5 Units and parameters

Unit group	SI unit (metric system)	US unit2)	Adjustable parameter	Possible units
ACCELERATION	m/s^2		–	m/s^2
ANGLE	Degrees		–	Degrees
BAUD	bit/s		–	bit/s
CAPACITANCE_M3	mF		–	mF
CAPACITANCE_M6	μF		–	μF
CURRENT	A		–	A
CURRENT_M3	mA		–	mA
ENERGY	kWh		–	kWh
FLUX	% of rated motor flux		–	% of rated motor flux
FREQUENCY	Hz		–	Hz
FREQUENCY_P3	kHz		–	kHz
INDUCTANCE_M3	mH		p0349 1)2)	0 = mH 1 = % of rated motor impedance
INERTIA	kg m^2		–	kgm
JERK	m/s^3		–	m/s^3
KP_ICTRL	V/A		p0528 1)2)	0 = V/A 1 = –
KP_NCTRL	Nms		p0528 1)2)	0 = Nms 1 = –
KP_FLUX_CTRL	A/Vs		–	A/Vs
LENGTH	m		–	m
MASS_P3	kg		–	kg
PERCENT	%		–	%
POWER_P3	kW		p0100	Vector control only (p0107 = 2): 0 = kW (line frequency 50 Hz) 1 = hp (line frequency 60 Hz) 2 = kW (line frequency 60 Hz)
RESISTANCE	Ω		p0349 1)2)	0 = Ω 1 = % of rated motor impedance

1 Parameter switches several unit groups
2 Available soon

Table 8-5 Units and parameters, continued

Unit group	SI unit (metric system)	US unit2)	Adjustable parameter	Possible units
SPEED	1/min		p05102)	0 = User defined 1 = 1/s 2 = 1/min – preset – 3 = Hz (electrical) 4 = deg/s 5 = deg/min 6 = rad/s 7 = rad /min
			p05112)	Only when p0510 = 0 Conversion factor with reference to base unit 1/s
			p05122)	Only when p0510 = 0 Name of the user–defined unit
TEMPERATURE	°C		–	°C
TEMPERATURE_K	°K		–	°K
TIME	s		–	s
TIME_H	h		–	h
TIME_M3	ms		–	ms
TIME_M6	μs		–	μs
TORQUE	Nm		p05132)	0 = Nm 1 = User defined
			p05142)	Only when p0513 = 1 Conversion factor with reference to base unit Nm
			p05152)	Only when p0513 = 1 Name of the user–defined unit
TORQUE_REL	Nm/A		–	Nm/A
VOLTAGE	V		–	V

1 Parameter switches several unit groups
2 Available soon

Example 1:

- p0349 = 0 All parameters of unit group INDUCTANCE_M3 in “mH” and all parameters of unit group RESISTANCE in “Ω”
- p0349 = 1 All parameters of unit group INDUCTANCE_M3 in “%” and all parameters of unit group RESISTANCE in “%”

Example 2:

- p0528 = 0 All parameters with unit KP_ICTRL in “V/A” and all parameters with unit KP_NCTRL in “Nms”
- p0528 = 1 All parameters with unit KP_ICTRL in “–” and all parameters with unit KP_NCTRL in “–”

Parameter overview (see List Manual)

- p0528 Units system for controller gains
- p2000 Reference speed reference frequency
- p2001 Reference voltage
- p2002 Reference current
- p2003 Reference torque
- r2004 Reference power

8.8 Data sets

Data sets

Parameter sets are stored in data sets

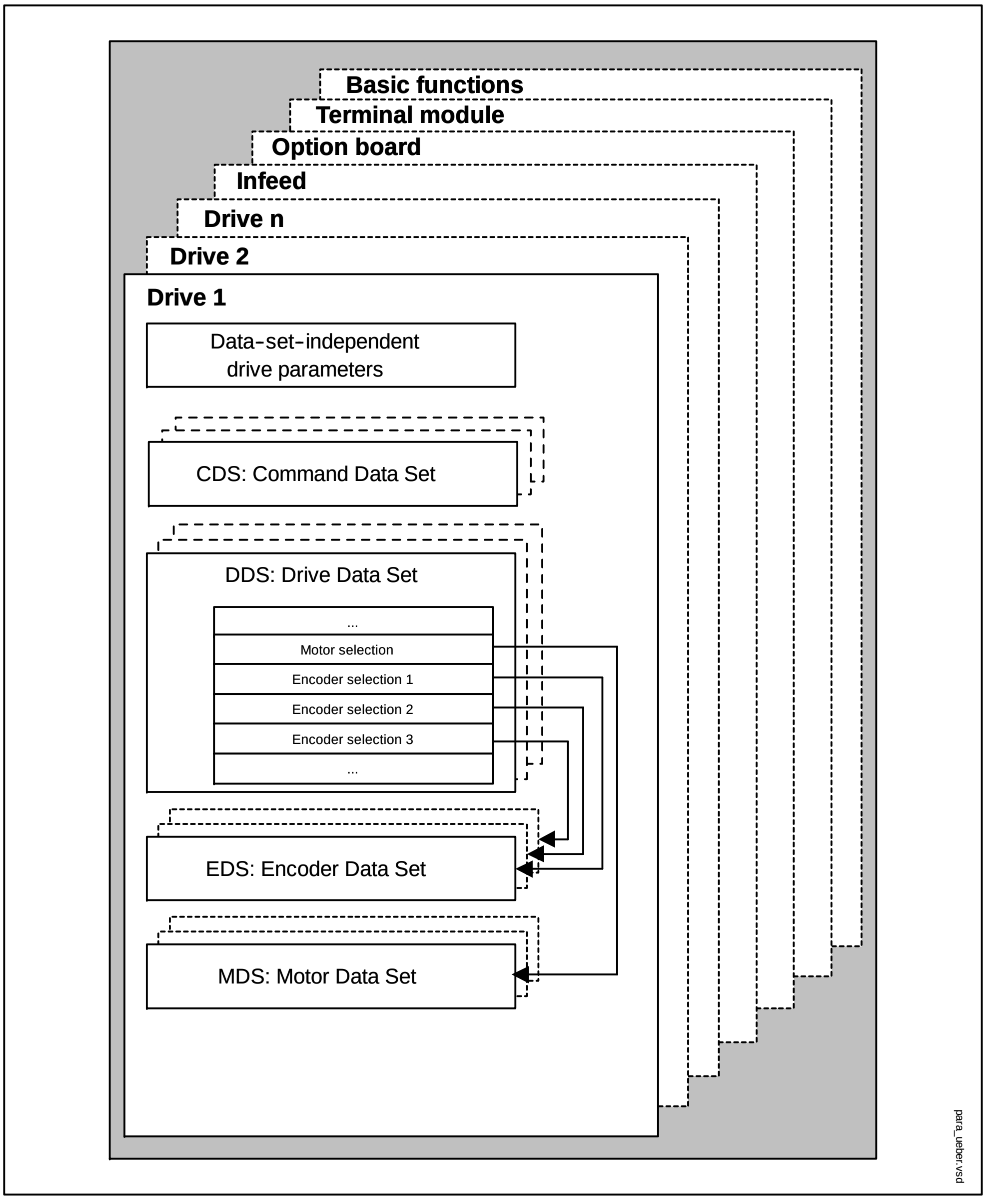


Fig. 8-17 Parameter categories

CDS: Command Data Set (CDS)

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 Section 8.3).

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)

Up to 16 command data sets can be used. p0170 is used to set the desired number of command data sets.

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

Table 8-6 Command data set: selection and display

	Selection				Display	
	Bit 3	**Bit 2**	**Bit 1**	**Bit 0**	**Selected**	**Active**
CDS	**p0813**	**p0812**	**p0811**	**p0810**	**r0836**	**r0050**
0	0	0	0	0	0	0
1	0	0	0	1	1	1
2	0	0	1	0	2	2
3	0	0	1	1	3	3
...	...					
15	1	1	1	1	15	15

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

Example: Switching between command data set 0 and 1

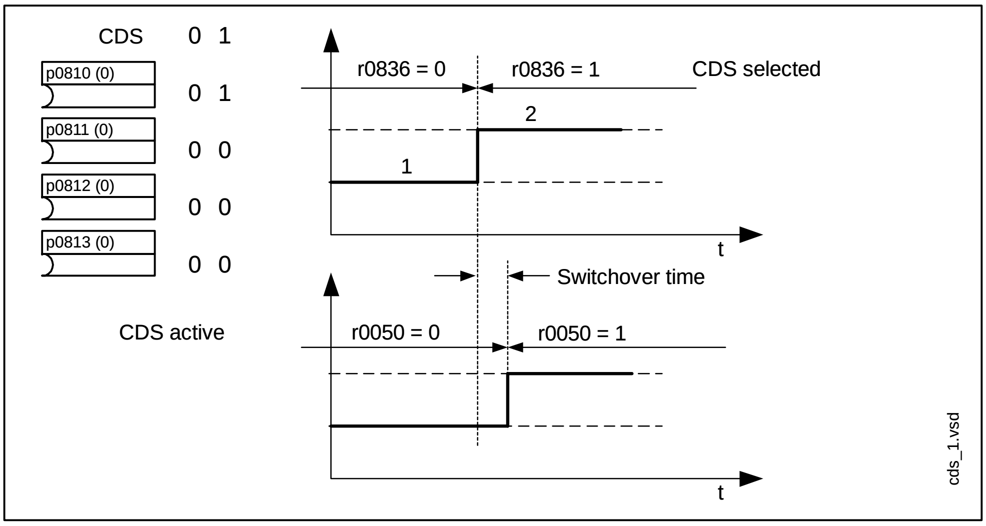


Fig. 8-18 Switching the command data set (example)

DDS: Drive Data Set (available soon)

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:
  - p0176: assigned motor data set (MDS)
  - p0177 to p0179: up to 3 assigned encoder data sets (EDS)
- Various control parameters, e.g.:
  - Fixed speed setpoints (p1001 to p1015)
  - Scaling factors (p1055, p1054)
  - 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.

A control unit can manage up to 16 drive data sets. The number of drive data sets is configured with p0170.

Binector inputs p0820 to p0823 are used to select a drive data set. They represent the number of the drive data set (0 to 15) in binary format (where p0823 is the most significant bit).

- p0810 BI: Command data set selection CDS bit 0
- p0811 BI: Command data set selection CDS bit 1
- p0812 BI: Command data set selection CDS bit 2
- p0813 BI: Command data set selection CDS bit 3

Supplementary conditions and recommendations

- Recommendation for the number of drive data sets for a drive

  The number of drive data sets for a drive should correspond to the options for switchover. The following must therefore apply:

  p0170 (DDS) $\geq$ max (p0120 (PDS), p0130 (MDS))
- Maximum number of drive data sets for a control unit = 16 DDS

  Example:

  Drive 0 has 4 DDS --> 12 DDS are left for further drives

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 p0177, p0178 and p0179.

A control unit 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 visualization parameters with calculated data.

- Adjustable parameters, e.g.:
  - Motor component number (p0131)
  - Motor type selection (p0300)
  - Rated motor data (p0304 ff)
  - ...
- Visualization 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 p0176.

If several motors are operated alternately on a motor module, a matching number of drive data sets must be created. Example: the traveling motor and hoisting gear motor on a hoist are linked to the same motor module and are connected alternately via contactors.

A control unit can manage up to 16 motor data sets. The number of available motor data sets is configured with p0130.

When a drive data set is selected, the assigned motor data set is selected automatically.

Copying a command data set

Set parameter p0809 as follows:

1. p0809[0] = number of the command data set to be copied (source)
2. p0809[1] = number of the command data to which the data is to be copied (target)
3. p0809[2] = 1

Start copying.

Copying is finished when p0809[2] = 0.

Copying a drive data set

Set parameter p0819 as follows:

1. p0819[0] = Number of the drive data set to be copied (source)
2. p0819[1] = Number of the drive data set to which the data is to be copied (target)
3. p0819[2] = 1

Start copying.

Copying is finished when p0809[2] = 0.

Switching over data sets

Example:

Suppose you want to switch between two motors.

How do you do it?

- Configure two drive data sets during commissioning.
- Configure two motor data sets
- Parameterize the required motor data set (MDS) in p0176 in each drive data set.
- Parameterize the motor data set switchover.

When you switch the drive data set, the selected motor data det is activated automatically.

Function diagram overview (see List Manual)

- 2501 Control word, sequence control
- 2503 Status word sequence control

Parameter overview (see List Manual)

Adjustable parameters

- p0120 Power module data set (PDS) number
- p0130 Motor data set (MDS) number
- p0140 Encoder data set (EDS) number
- p0170 Command data set (CDS) number
- p0180 Drive data sets (DDS) number
- p0170 Copy command data set CDS
- p0810 BI: Command data set selection CDS bit 0
- p0811 BI: Command data set selection CDS bit 1
- p0812 BI: Command data set selection CDS bit 2
- p0813 BI: Command data set selection CDS bit 3

8.9 Inputs/outputs

8.9.1 Overview of inputs/outputs

The following types of digital and analog I/O are used:

Table 8-7 Overview of inputs/outputs

Component	Digital			Analog	
	Inputs	Inputs/ outputs bidirectional	Outputs	Inputs	Outputs
CU320	8[1)]	8[2)]	–	–	–
TB30	4	–	4	2	2
TM31	8	4	–	2	2
	Relay outputs: 2 Temperature sensor input: 1				

1) Adjustable: floating or non–floating
2) 6 of these are “high–speed inputs”

Note

For detailed information about the hardware features of I/Os, please refer to:

References: /GH2/ SINAMICS S120 Equipment Manual Booksize Power Sections

For detailed information about the structural relationships between all I/Os of a component and their parameters, please refer to the function diagrams in:

References: /List/ SINAMICS S List Manual

8.9.2 Digital inputs/outputs

Digital inputs

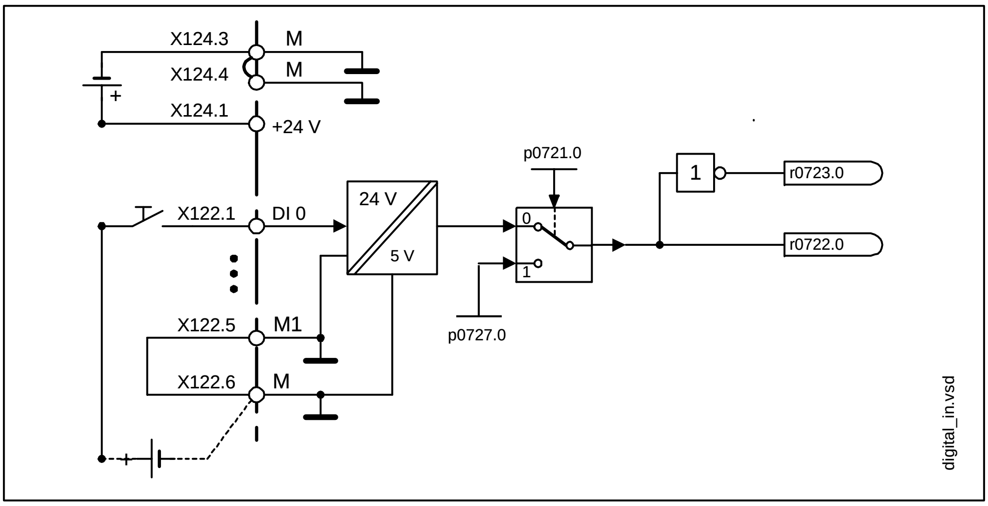


Fig. 8-19 Digital inputs: signal processing using DI 0 of CU320 as an example

Properties

- The digital inputs are “high active”.
- An open input is interpreted as “low”.
- Fixed debouncing setting

  Delay time = 1 to 2 current controller cycles (p0115[0])
- Availability of the input signal for further interconnection
  - inverted and not inverted as a binector output
  - as a connector output
- Simulation mode settable and parameterizable.
- CU 320: Isolation block by block, set by jumper.
  - Jumper open floating

    The digital inputs function only if a reference ground is connected.
  - Jumper closed non-floating

    The digital inputs take their reference ground from the control unit.
- Sampling time for digital inputs/outputs adjustable on CU320 (p0799)

Function diagram overview (see List Manual)

- 2100 Digital inputs, electrically isolated (DI 0 to DI 3)
- 2120 Digital inputs, electrically isolated (DI 4 to DI 7)
- 9100 Electrically isolated digital inputs (DI 0 to DI 3)
- 9550 Digital inputs, electrically isolated (DI 0 to DI 3)
- 9552 Digital inputs, electrically isolated (DI 4 to DI 7)

Digital outputs

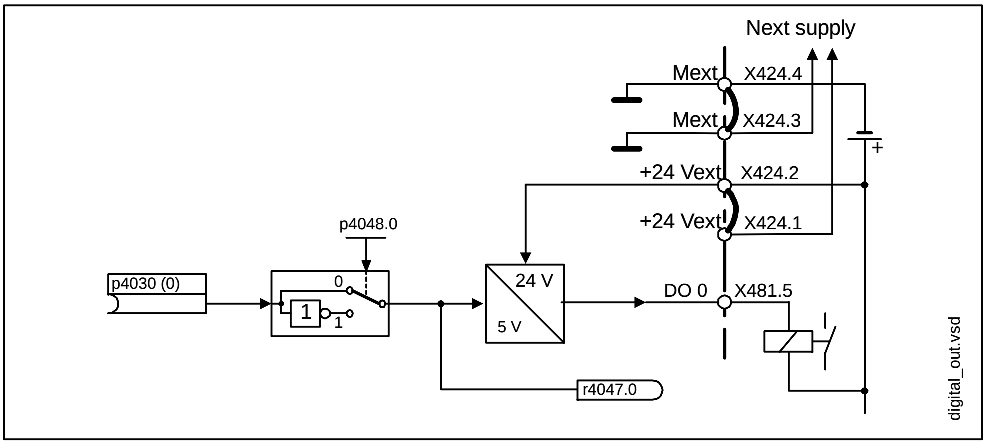


Fig. 8-20 Digital outputs: signal processing using DO 0 of TB30 as an example

Properties

- Separate power supply for digital outputs.
- Source of output signal can be selected by parameter.
- Signal can be inverted by parameter.
- Status of output signal can be displayed
  - as a binector output
  - as a connector output

Note

Before the digital outputs can function, their own electronics power supply must be connected.

Function diagram overview (see List Manual)

- 9102 Electrically isolated digital outputs (DO 0 to DO 3)
- 9556 Digital relay outputs, electrically isolated (DO 0 and DO 1)

Bidirectional digital inputs/outputs

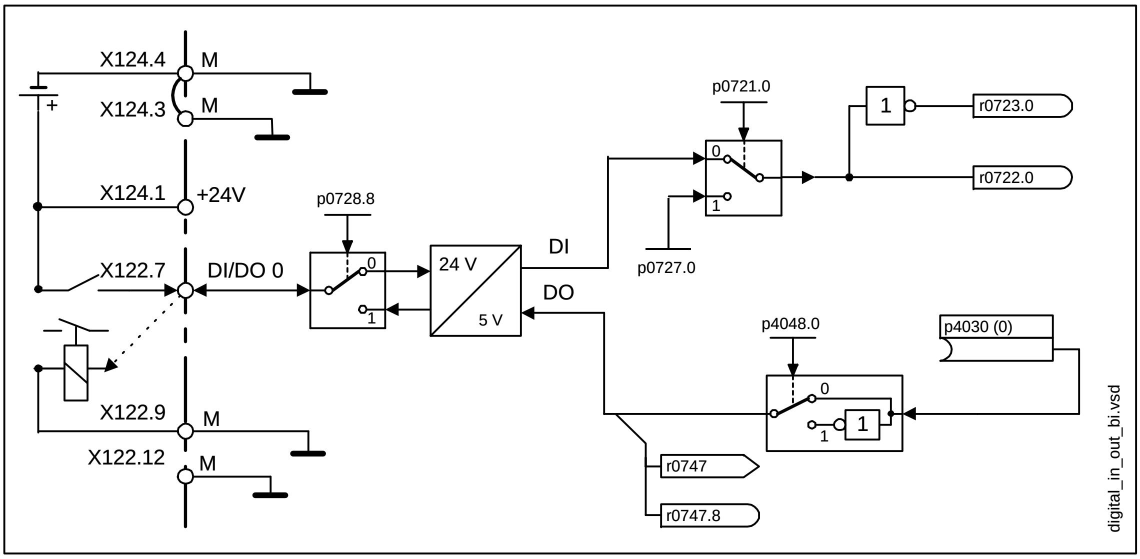


Fig. 8-21 Bidirectional inputs/outputs signal: processing using DI/DO 0 of CU320 as an example

Properties

- Parameterizable as digital input or output.
- If set as digital input:
  - Six “high–speed inputs” on control unit 320

    If these inputs are used, for example, for the “measurement on–the–fly” function, they act as “high–speed inputs” with virtually no time delay when the actual value is saved.
  - The properties of the “pure” digital inputs apply.
- If set as digital output:
  - The properties of the “pure” digital outputs apply.

Function diagram overview (see List Manual)

- 2130 Digital inputs/outputs, bi–directional (DI/DO 8 and DI/DO 9)
- 2131 Digital inputs/outputs, bi–directional (DI/DO 10 and DI/DO 11)
- 2132 Digital inputs/outputs, bi–directional (DI/DO 12 and DI/DO 13)
- 2133 Digital inputs/outputs, bi–directional (DI/DO 14 and DI/DO 15)
- 9560 Digital inputs/outputs, bi–directional (DI/DO 8 and DI/DO 9)
- 9562 Digital inputs/outputs, bi–directional (DI/DO 10 and DI/DO 11)

8.9.3 Analog inputs/outputs

Analog inputs

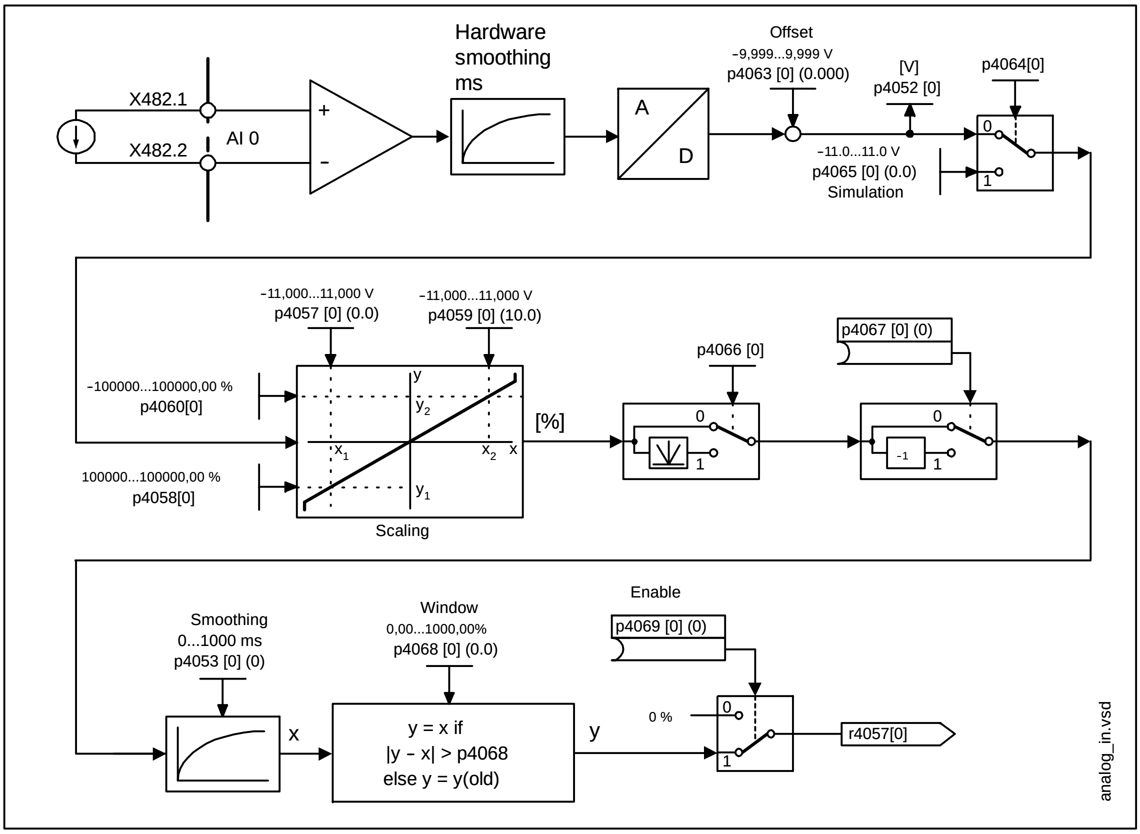


Fig. 8-22 Analog inputs: signal processing using TB30 as an example

Properties

- Differential input with 14−bit resolution
- Hardware input filter set permanently
- Simulation mode parameterizable
- Adjustable offset
- Voltage range: −10.0 V to +10.0 V
- Signal can be inverted via binector input.
- Adjustable absolute−value generation
- Noise suppression (p4068)
- Enabling of inputs via binector input
- Output signal available via connector output
- Scaling
- Smoothing

Function diagram overview (see List Manual)

- 9104 Analog inputs (AI 0 and AI 1)
- 9566 Analog input 0 (AI 0)
- 9568 Analog input 1 (AI 1)

Analog outputs

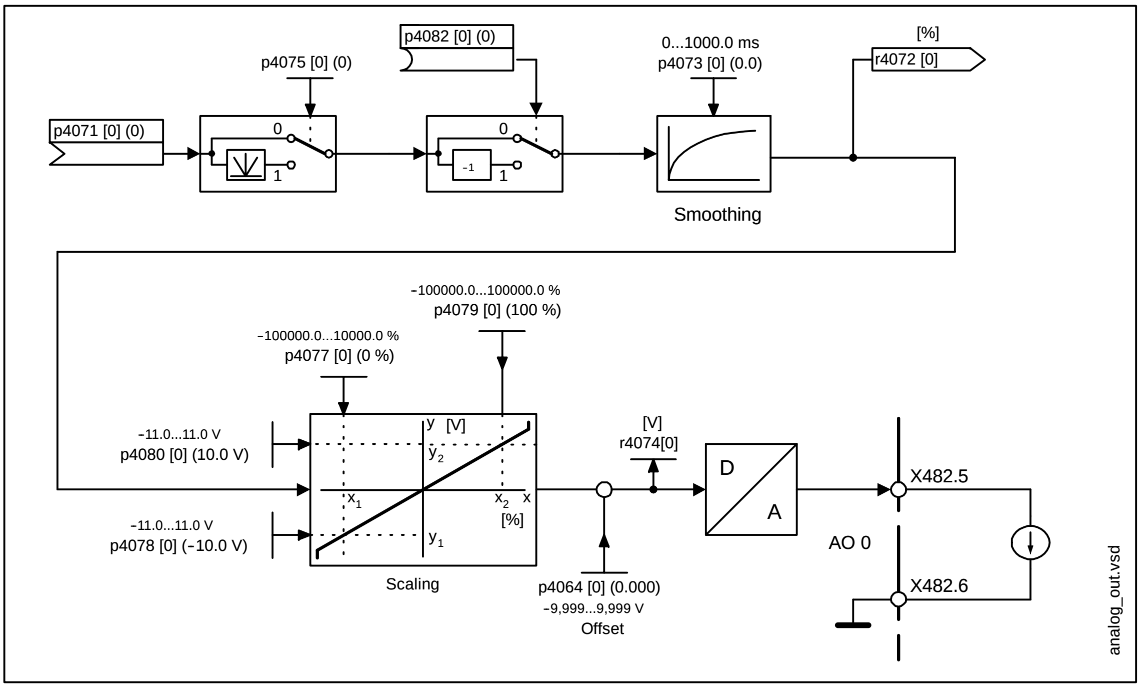


Fig. 8-23 Analog outputs: signal processing using AO 0 of TB30 as an example

Properties

- Voltage range: –10.0 V to +10.0 V
- Resolution: 12 bits
- Adjustable absolute–value generation
- Inversion via binector input
- Adjustable smoothing
- Adjustable transfer characteristic
- Output signal can be displayed via visualization parameter

Function diagram overview (see List Manual)

- 9106 Analog outputs (AO 0 and AO 1)
- 9572 Analog outputs (AO 0 and AO 1)

8.10 Firmware upgrade

The firmware supplied in the DRIVE–CLiQ components is stored in a non–volatile memory on electrically erasable memory chips. If necessary, the firmware can be matched to the version on the CompactFlash card.

New firmware must be loaded if extended functions are made available in a more recent firmware version and these functions are to be used.

Firmware upgrade procedure:

- Enter the component number in parameter p7828
  - p0121 Power module component number
  - p0141 Encoder interface (sensor module) component number
  - p0151 Terminal module component number
- Start the firmware upgrade on the CompactFlash card by entering a “1” in parameter p7829.
  - Upgrade successful > parameter changes back to “0”
  - Error > a negative error code is output
- Perform a reset (e.g. POWER ON) to activate the firmware
- The firmware version can be checked in the following parameters:
  - r0128 Power module firmware version
  - r0148 Voltage sensing module, firmware version
  - r0158 Terminal module firmware version

Note

All the components in a drive line–up should have the same firmware version.

Note

If the upgrade fails, fault F1005 is output with the corresponding fault value in p0949.

8.11 Licensing

Description

If the functions activated in the firmware exceed the scope of the license, the appropriate license key has to be entered.

The license key is an electronic license stamp that indicates that one or more software licenses are owned.

Actual customer verification of the license for the software that is subject to license is called a certificate of license.

Note

Refer to the order documentation (e.g. catalogs) for information on basic functions and functions subject to license.

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

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

Notice

The drive can only be operated with an insufficient license during commissioning and servicing.

The drive requires a sufficient license in order for it to operate normally.

Properties of the license key

- Assigned to a specific CompactFlash card.
- Is stored on the non–volatile CompactFlash card.
- Is not transferrable.
- Can be acquired using the license manager from a license database at:

  http://www.siemens.com/automation/license

  The following information is required:

  – Serial number of the CompactFlash card.
  – Order number of the license.

Entering the license key

Example of a license key:

EACZ–QBCA = 69 65 67 90 45 81 66 67 65 dec (ASCII characters)

Procedure for entering a license key (see example):

- p9920[0] = 69 1st character
- p9920[1] = 65 2nd character

  ...
- p9920[8] = 65 9th character
- p9920[10] = 0 No character

  ...
- p9920[19] = 0 No character

Note

If p9920[x] is changed to 0, all the indexes that follow are also set to 0.

After the license key has been entered, it has to be activated as follows:

- p9921 = 1 Licensing, activate license key

  The parameter is automatically reset to 0

Parameter overview (see List Manual)

- p9920 Licensing, enter license key
- p9921 Licensing, activate license key

■

List of Abbreviations

Abbreviation	German	English
A		
A ...	Warnung	Alarm
AC	Wechselstrom	Alternating Current
ADC	Analog–Digital–Konverter	Analog Digital Converter
AI	Analogeingang	Analog Input
AO	Analogausgang	Analog Output
AOP	Advanced Operator Panel	Advanced Operator Panel
ASCII	Amerikanische Code–Norm für den Informationsaustausch	American Standard Code for Information Interchange
B		
BERO	Firmenname für einen Näherungsschalter	Tradename for a type of proximity switch
BI	Binektoreingang	Binector Input
BIA	Berufsgenossenschaftliches Institut für Arbeitssicherheit	Berufsgenossenschaftliches Institut für Arbeitssicherheit (German Institute for Occupational Safety)
BICO	Binektor–Konnektor–Technologie	Binector Connector Technology
BOP	Basic Operator Panel	Basic Operator Panel
C		
C	Kapazität	Capacitance
CAN	Serielles Bussystem	Controller Area Network
CBC	Kommunikationsbaugruppe CAN	Communication Board CAN
CD	Compact Disc	Compact Disc
CDS	Befehlsdatensatz	Command Data Set
CI	Konnektoreingang	Connector Input
CNC	Computerunterstützte numerische Steuerung	Computer Numerical Control
CO	Konnektorausgang	Connector Output
CO/BO	Konnektor–/Binektorausgang	Connector Output/Binector Output
COM	Mittelkontakt eines Wechselkontaktes	Mid–position contact of a changeover contact

Abbreviation	German	English
CP	Kommunikationsprozessor	Communications Processor
CPU	Zentralbaugruppe	Central Processing Unit
CRC	Checksummenprüfung	Cyclic Redundancy Check
CT	Konstantes Drehmoment	Constant Torque
CU	Control Unit	Control Unit
D		
DAC	Digital–Analog–Konverter	Digital Analog Converter
DC	Gleichstrom	Direct Current
DCN	Gleichstrom negativ	Direct Current Negative
DCP	Gleichstrom positiv	Direct Current Positive
DDS	Antriebsdatensatz	Drive Data Set
DI	Digitaleingang	Digital Input
DI/DO	Digitaleingang/–ausgang bidirektional	Bidirectional Digital Input/Output
DMC	DRIVE–CLiQ Module Cabinet (Hub)	DRIVE–CLiQ Module Cabinet (Hub)
DO	Digitalausgang	Digital Output
DO	Antriebsobjekt	Drive Object
DPRAM	Speicher mit beidseitigem Zugriff	Dual–Port Random Access Memory
DRAM	Dynamischer Speicher	Dynamic Random Access Memory
DRIVE–CLiQ	Drive Component Link with IQ	Drive Component Link with IQ
DSC	Dynamic Servo Control	Dynamic Servo Control
E		
EDS	Geberdatensatz	Encoder Data Set
ESD	Elektrostatisch gefährdete Baugruppen	Electrostatic Sensitive Devices
EMK	Elektromagnetische Kraft	Electromagnetic Force (EMF)
EMC	Elektromagnetische Verträglichkeit	Electromagnetic Compatibility
EN	Europäische Norm	European Standard
EnDat	Geber–Schnittstelle	Encoder–Data–Interface
EP	Impulsfreigabe	Enable Pulses
ES	Engineering System	Engineering System
F		
F ...	Störung	Fault
FAQ	Häufig gestellte Fragen	Frequently Asked Questions
FCC	Function Control Chart	Function Control Chart
FCC	Flussstromregelung	Flux Current Control
FEPROM	Schreib– und Lesespeicher nichtflüchtig	Flash–EPROM
FG	Funktionsgenerator	Function Generator

Abbreviation	German	English
FI	Fehlerstrom–Schutzschalter	Residual–Current Circuit–Breaker (RCCB)
FP	Funktionsplan	Function diagram
FW	Firmware	Firmware
G		
GC	Global–Control–Telegramm (Broadcast–Telegramm)	Global control telegram (broadcast telegram)
GSD	Gerätestammdatei: beschreibt die Merkmale eines PROFIBUS–Slaves	Device master file: describes the features of a PROFIBUS slave
H		
HF	Hochfrequenz	High Frequency
HFD	Hochfrequenzdrossel	High frequency reactor
RFG	Hochlaufgeber	Ramp–Function Generator
HMI	Mensch–Maschine–Schnittstelle	Human Machine Interface
HTL	Logik mit hoher Störschwelle	High–Threshold Logic
HW	Hardware	Hardware
I		
i. V.	In Vorbereitung: diese Eigenschaft steht zur Zeit nicht zur Verfügung	In preparation: this feature is currently not available
IBN	Inbetriebnahme	Commissioning
I/O	Eingang/Ausgang	Input/Output
ID	Identifizierung	Identifier
IEC	Internationale Norm in der Elektrotechnik	International Electrotechnical Commission
IGBT	Bipolartransistor mit isolierter Steuerelektrode	Insulated Gate Bipolar Transistor
IT	Drehstromversorgungsnetz ungeerdet	Three–phase supply network ungrounded
J		
JOG	Jog	Jogging
K		
KDV	Kreuzweiser Datenvergleich	Data cross–checking
KIP	Kinetische Pufferung	Kinetic buffering
Kp	Proportionalverstärkung	Proportional gain
KTY	Spezieller Temperatursensor	Special temperature sensor
L		
L	Induktivität	Inductance
LED	Leuchtdiode	Light Emitting Diode
LSB	Niederwertigstes Bit	Least Significant Bit

Abbreviation	German	English
M		
M (GND)	Masse	Reference potential, zero potential
MB	Megabyte	Megabyte
MCC	Motion Control Chart	Motion Control Chart
MDS	Motordatensatz	Motor Data Set
MLFB	Maschinenlesbare Fabrikatebezeichnung	Machine–readable product designation
MMC	Mensch Maschine Kommunikation	Man–Machine Communication
MSB	Höchstwertigstes Bit	Most Significant Bit
MSCY_C1	Zyklische Kommunikation zwischen Master (Klasse 1) und Slave	Master Slave Cycle Class 1
N		
N. C.	Nicht angeschlossen	Not Connected
NC	Öffner	Normally Closed (contact)
NC	Numerische Steuerung	Numerical Control
NEMA	Normengremium in USA (United States of America)	National Electrical Manufacturers Association
NM	Nullmarke	Zero mark
NO	Schließer	Normally Open (contact)
O		
OC	Betriebsbedingung	Operating Condition
OEM	Original Equipment Manufacturer	Original Equipment Manufacturer
OLP	Busstecker für Lichtleiter	Optical Link Plug
OMI	Option Module Interface	Option Module Interface
P		
p ...	Einstellparameter	Adjustable parameter
PDS	Leistungsteildatensatz	Power Module Data Set
PE	Schutzerde	Protective Earth
PELV	Schutzkleinspannung	Protective Extra Low Voltage
PG	Programmiergerät	Programming terminal
PI	Proportional Integral	Proportional Integral
PLC	Speicherprogrammierbare Steuerung (SPS)	Programmable Logic Controller
PLL	Baustein zur Synchronisierung	Phase Locked Loop
PNO	PROFIBUS Nutzerorganisation	PROFIBUS user organisation
PRBS	Weißes Rauschen	Pseudo Random Binary Signal
PROFIBUS	Serieller Datenbus	Process Field Bus
PS	Stromversorgung	Power Supply

Abbreviation	German	English
PTC	Positiver Temperaturkoeffizient	Positive Temperature Coefficient
PTP	Punkt zu Punkt	Point To Point
PWM	Pulsweitenmodulation	Pulse Width Modulation
PZD	PROFIBUS Prozessdaten	PROFIBUS process data
Q		
R		
r ...	Beobachtungsparameter (nur lesbar)	Visualization parameter (read only)
RAM	Speicher zum Lesen und Schreiben	Random Access Memory
RCCB	Fehlerstrom-Schutzschalter	Residual-Current Circuit-Breaker
RCD	Fehlerstrom-Schutzschalter	Residual Current Device
RJ45	Norm. Beschreibt eine 8-polige Steckverbindung mit Twisted-Pair Ethernet.	Standard. Describes an 8-pole plug connector with twisted pair Ethernet.
RO	Nur lesbar	Read Only
RS232	Serielle Schnittstelle	Serial interface
RS485	Norm. Beschreibt die Physik einer digitalen seriellen Schnittstelle.	Standard. Describes the physical characteristics of a digital serial interface.
S		
S1	Dauerbetrieb	Continuous operation
S3	Aussetzbetrieb	Periodic duty
SBC	Sichere Bremsenansteuerung	Safe Brake Control
SGE	Sicherheitsgerichtetes Eingangssignal	Safe input signal
SH	Sicherer Halt	Safe standstill
SI	Safety Integrated	Safety Integrated
SIL	Sicherheitsintegritätsgrad	Safety Integrity Level
SLVC	Geberlose Vektorregelung	Sensorless Vector Control
SM	Sensor Module	Sensor Module
SMC	Sensor Module Cabinet	Sensor Module Cabinet
SPC	Sollwertkanal	Setpoint Channel
SPS	Speicherprogrammierbare Steuerung	Programmable Logic Controller (PLC)
STW	PROFIBUS Steuerwort	PROFIBUS control word
T		
TB	Terminal Board	Terminal Board
TIA	Totally Integrated Automation	Totally Integrated Automation
TM	Terminal Module	Terminal Module
TN	Drehstromversorgungsnetz geerdet	Grounded three-phase supply network
Tn	Nachstellzeit	Integral time
TT	Drehstromversorgungsnetz geerdet	Grounded three-phase supply network

Abbreviation	German	English
TTL	Transistor-Transistor-Logik	Transistor-Transistor-Logic
U		
UL	Underwriters Laboratories Inc.	Underwriters Laboratories Inc.
V		
VC	Vektorregelung	Vector Control
Vdc	Zwischenkreisspannung	DC link voltage
VDE	Verband Deutscher Elektrotechniker	Association of German Electrical Engineers
VDI	Verein Deutscher Ingenieure	Association of German Engineers
Vpp	Volt Spitze zu Spitze	Volt peak to peak
VSM	Voltage Sensing Module	Voltage Sensing Module
VT	Variables Drehmoment	Variable Torque
W		
WZM	Werkzeugmaschine	Machine tool
X		
XML	Erweiterbare Auszeichnungssprache (Standardsprache für Web-Publishing und Dokumentenmanagement)	Extensible Markup Language
Y		
Z		
DCL	Zwischenkreis	DC Link
ZSW	PROFIBUS Zustandswort	PROFIBUS status word

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0.12 – 3 kW
Ordering information
Order no.: E86060–K5511–A111–A1 Edition 12.2003

/D11/ **SINAMICS G150 Converters**
75 – 800 kW cabinet units
Order no.: E86060–K5511–A101–A1 Edition 11.2002

/D21.2/ **SINAMICS S120 Servo Control**
Drive system (incl. servo motors)
This catalog is only available in PDF format. Edition: 04.2004

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/ST70/ **SIMATIC Products for Totally Integrated Automation, Catalog ST70**
Ordering information
Order no.: E86060–K4670–A111–A8–7600

/PM10/ **SIMOTION Motion Control System, Catalog PM10**
Ordering information
Order no.: E86060–K4910–A101–A3–7600 Edition: 2003

Interactive catalogs

/CA01/ **The Offline Mall from Automation and Drives**
CD–ROM
Order no.: E86060–D4001–A100–C1–7600 Edition: 10.2003

/Mall/ **A&D Mall, Catalog and Online Ordering System**
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Electronic documentation

/CD2/ **SINAMICS**
The SINAMICS system
Order no.: 6SL3097–2CA00–0BG0 Edition 04.2004

User documentation

/BA1/ **SINAMICS G150**
Operating instructions
Order no.: Available on request Edition 04.2004

/BA2/ **SINAMICS G130**
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Order no.: Available on request Edition 04.2004

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Equipment Manual for Control Units and Additional System Components
Order no.: 6SL3097–2AH00–0BP0 Edition 04.2004

/GH2/ **SINAMICS S120**
Equipment Manual for Booksize Power Sections
Order no.: 6SL3097–2AC00–0BP0 Edition 04.2004

/GH3/ **SINAMICS S120**
Equipment Manual for Power Section Chassis
Order no.: 6SL3097–2AE00–0BP0 Edition 04.2004

/GH4/ **SINAMICS S120**
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Order no.: 6SL3097–2AJ00–0BP0 Edition 04.2004

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Order no.: 6SL3097–2AP00–0BP0 Edition 04.2004

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1 **Drive ES Basic V5.1**
Function description
Engineering system for drives from the SIEMENS A&D product range
Order no.: 6SW1700–0JA00–0BA0 Edition 08.2001

2 **SIMOTION Engineering System**
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Planning guide
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/P1/ **PROFIBUS–DP/DPV1 IEC 61158**
Basic Information, Tips and Tricks for Users
Hüthig; Manfred Popp, 2nd Edition
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/P2/ **PROFIBUS–DP, Getting Started**
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Order no.: 4.071

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SIEMENS; Publics MCD Verlag; Josef Weigmann, Gerhard Kilian
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Order no.: 6GK1970–5CA10–0AA0

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PROFIBUS Nutzerorganisation e. V.
Haid–und–Neu–Straße 7, 76131 Karlsruhe
Order no.: 3.171 Version 3, September 2000

/IKPI/ **SIMATIC NET, Industrial Communication and Field Devices**
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Draft PROFIBUS Profile
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Haid–und–Neu–Straße 7, 76131 Karlsruhe
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/PPD/ **PROFIBUS, Profile for Variable–Speed Drives, PROFIDRIVE**
PROFIBUS Nutzerorganisation e. V.
Haid–und–Neu–Straße 7, 76131 Karlsruhe
Order no.: 3.071 Edition: September 1997

/PDP/ **PROFIBUS Installation Guidelines**
Installation Guideline for PROFIBUS–FMS/DP
Installation and wiring recommendation for RS 485 Transmission
Order no.: 2.111 (German)
2.112 (English) Version 1.0

Documentation for Safety Equipment

Note

For more information about technical documentation for Safety Integrated, visit the following address:

http://www.siemens.de/safety

The following list contains some of the safety–related documentation available.

/LVP/ **Low–Voltage Switchgear**
Catalog
Order no.: E86060–K1002–P101–A4–7600 Edition: 2004

/LV10/ **Controlgear for Industry**
Catalog
Order no.: E86060–K1002–A101–A4–7600 Edition: 2004

/LV20/ **BERO – Sensors for Automation**
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Order no.: E86060–K1803–A101–A3–7600 Edition: 2004

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Order no.: E86060–K1801–A101–A4–7600 Edition: 2004

/MRL/ **Directive 98/37/EG of the European Parliament and Council**
Machine directive
Bundesanzeiger–Verlags GmbH Edition 06/22/1998

/SIAH/ **Safety Integrated**
Application manual
Order no.: 6ZB5000–0AA01–0BA0 4th edition

/SICD/ **Safety Integrated**
CD–ROM
Order no.: E20001–D10–M103–X–7400

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Glossary

24 V terminal adapter

Mechanical adapter from terminal to rail, which is supplied in –> “Booksize” format with the –> “Line module”s. The external 24 V is connected to the terminals on the 24 V terminal adapter.

Absolute encoder

After the supply voltage is switched on, the position encoder immediately provides the position of the –> Drive as an absolute actual value. For –> Single–turn encoders, the detection range is one turn, while –> Multi–turn encoders have a detection range of several turns (e.g. 4096 turns).

Access level

Access levels protect the –> “Drive unit” against access. The –> “Parameter”s are divided into different access levels.

Accuracy

According to VDE/VDI 2185, the term “accuracy” in the field of control engineering refers to the deviation of the –> “Actual value” of a controlled variable from the predefined setpoint value.

Active infeed

Overall functionality of an infeed with –> “Active line module”, including the required additional components (filter, switching devices, computing power portion of a –> “Control unit”, voltage detection, and so on).

Active line module

Controlled, self–commutating feed/feedback unit (with –> “IGBT”s in feed/feedback device), which supplies the DC link voltage for the –> “Motor module”s.

Actual topology

The actual topology refers to the existing physical –> “Topology” of the drive components (e. g. via –> “DRIVE–CLiQ”). Once the –> “Actual topology” has been –> “Download”ed, it is recognized in the drive.

Actual value

Actual value of a measuring variable measured at a defined moment.

Example: Current position value of a –> "Drive"

Adjustable parameter **p...**

These parameters are write/read parameters.

See –> "Visualization parameter"

Alarm

An alarm is the response to a potential or expected fault condition detected by the drive that does not cause the drive to switch off and does not have to be acknowledged. The alarm mechanism is specified in the –> PROFIdrive profile. The drive transmits a pending alarm to the control system via a bit in the status word.

Alarm buffer

The drive stores alarms in an alarm buffer. The alarm buffer can be read via parameters.

See –> "Fault buffer"

Alarm code

Codes for –> "Alarm"s entered in the –> "Alarm buffer".

See –> "Message" –> "Fault code"

Analog input

Terminal to which an external analog voltage signal (e. g. –10 V ... +10 V) or current signal (e. g. 0 ... 20 mA) can be connected. An A/D converter forms an internal software signal from this signal.

In SINAMICS, analog inputs are provided by, for example, –> "Terminal board" TB30 and –> "Terminal modules" TMxx.

Analog output

Terminal to which an analog voltage signal (e. g. –10 V ... +10 V) or current signal (e. g. 0 ... 20 mA) is transmitted. The signal is formed by converting an internal software signal using an A/D converter.

In SINAMICS, analog outputs are provided by, for example, –> "Terminal board" TB30 and –> "Terminal modules" TMxx.

Backlash

The term backlash (dead travel on reversing) designates the distance/angle which a spindle or a motor must travel in the case of a speed reversal until the axis (cradle, machine table, tool carrier) is moved in the other direction again.

Base load current **Ib**

After a –> “Limiting short–time current” load of the required reduced current (e. g. 0.95 x or 1.0 + –> “Rated current”). This current must not be exceeded for the time tb.

Basic infeed

Overall functionality of an infeed with –> “Basic line module”, including the required additional components (filters, switching devices, and so on).

Basic line module

Unregulated line infeed unit (diode bridge or thyristor bridge, without feedback) for rectifying the line voltage of the –> DC Link.

BICO parameter

A distinction is made between BICO input parameters and BICO output parameters.

A BICO input parameter is used for selecting the digital or “analog signal” (–> “Signal sink”) to be transmitted to a signal input.

A BICO output parameter is a freely interconnectable digital or “analog signal” (–> “Signal sink”).

To connect a signal via –> “BICO technology”, the number of the BICO output parameter to be connected is entered in the BICO input parameter.

BICO technology

Abbreviation for “binector/connector technology”.

The BICO technology method is used for freely interconnecting process data via “standard” drive parameterization. All freely interconnectable word, double–word, and floating point signals are defined as “connectors”; all freely interconnectable binary signals are defined as “binectors”.

Bidirectional digital input/output **DI/DO x**

Depending on the parameters set, the terminal can be used as a –> “Digital input” or –> “Digital output”.

Binector

Freely connectable binary signal e. g. –> “Digital input”, control bit from PROFIBUS, and so on.

The –> “Signal source” is called the –> “Binector output”, and the –> “Signal sink” is called the –> “Binector output”.

Binector input **BI**

–> “Signal sink” to which a –> “Binector output” (a freely connectable binary signal) can be connected by means of –> “BICO technology”.

See –> Connector Input

Binector output **BO**

–> “Signal source”, that is, a freely connectable binary signal that can be connected via a –> “Binector input” by means of –> “BICO technology”.

See –> “Connector output”

Blackout

Power failure that affects not only the power supply but also the –> “Electronics power supply” (24 V).

See –> “Blackstart” –> “Brownstart”

Blackstart

Automatic restart after a –> “Blackout”.

See –> “Blackout” –> “Brownout”

Blocksize

Volume–optimized cubic –> “Drive unit”. Mostly used for operating a –> “Motor”.

See –> “Booksize” –> “Chassis unit”

Booksize

Book–shaped construction type of the components of a –> “Drive unit” appropriate for butt–mounting. Mostly used for operating several –> Motors.

See –> “Blocksize” –> “Chassis unit”

Braking control

Software function that specifies when an existing mechanical holding brake or operational brake is to be applied, either within the framework of a load cycle in the case of a momentary standstill or when a –> “Fault” occurs

Braking module

Electronic switch or chopper (braking chopper) that connects a –> “Braking resistor” with a specific pulse/pause ratio to the DC link voltage to convert regenerative (braking) energy to heat energy and to finally restrict the DC link voltage to permissible values. For SINAMICS, no braking resistor is integrated in the braking module. This must be mounted outside the braking module.

Braking resistor

Resistor that reduces the excess energy in the DC link. The resistor is connected to a –> “Braking module”.

In this way, the resulting thermal loss is displaced outside the control cabinet.

Braking signal

Signal generated by –> “Braking control” for opening and closing a mechanical brake.

Broadcast telegram

Simultaneous send procedure to more than one node. The transmitter does not require a confirmation of receipt from the nodes.

See –> “Global control telegram” –> “PROFIBUS”

Brownout

Power failure that only affects the power supply and not the –> “Electronics power supply” (24 V).

See –> “Brownstart” –> “Blackstart”

Brownstart

Automatic restart after a –> “Brownout”.

See –> “Brownout” –> “Blackout”

Cabinet unit

A SINAMICS cabinet unit is a complete, ready–to–connect, and function–tested unit (e. g. an –> “AC drive” for which all the components are installed in a cabinet). Cabinet units can be ordered using an order number and are available with a –> “Degree of protection” ranging from IP20 to IP54.

CAN bus **CAN**

The abbreviation CAN stands for “controller area network”. CAN is a serial bus system compliant with ISO 11898. CAN was originally developed for applications in automotive technology (ISO 11519–1) but has since been implemented in a wide range of mechanical engineering applications (e. g. in textile and plastic film processing machines). For CAN applications in industrial automation, a range of device profiles has been defined in –> “CANopen” to enable standardized communication at application level.

CANopen

CANopen is an extension of the –> “CAN bus” to support standardized communication for different types of automation device at application level.

Capacitor module

This module is used for increasing and buffering the DC link capacity.

In this way, it not only compensates a short–time power failure but also allows the braking energy to be buffered.

CE marking **CE**

This product marking comprises the letters “CE” and indicates compliance with all the EU guidelines valid for this product. This marking confirms that the product meets all the EU guidelines to ensure total compliance and has been subject to all prescribed conformity tests.

Certificate of License **CoL**

The certificate of license acts as a verification for the licensee that the use of Siemens software is licensed. Each usage must be assigned a certificate of license, which must be kept in a safe place.

See –> “License key”

Chassis unit

In the upper output power range, chassis units are normally used for installation in cabinet units. The components are mounted on frame plates or in supporting structures.

See –> “Booksize” –> “Blocksize” –> “Chassis unit”

Coast down

The –> Drive is de–energized and the connected –> Motor is allowed to run down without the brakes being applied. The speed reduces in accordance with the load torque and the effective centrifugal mass.

See –> “Pulse enable”

Cold plate

The cold plate is a flat aluminum cooling plate that is used as a thermal interface for SINAMICS power components and uses the -> “Cooling method” -> “Cold plate cooling”.

Cold plate connection adapter

Cold plate connection adapters are mechanical adapter components that allow cooling water hoses to be connected to the -> “Cold plate”. A cold plate connection adapter with an integrated captive seal is screwed onto the top and bottom of the cold plate. The cold plate connection adapter has threads for attaching conventional hose connections.

Cold plate cooling

Cold plate cooling is a -> “Cooling method” for SINAMICS power components, which is currently only available for -> “Booksize” devices. The cold plate is located on the rear of the device instead of the “standard” ribbed heat sink. The cold plate is a flat aluminum cooling plate that contains several perpendicular drill holes. The cold plate acts as a “neutral” interface for cooling variants that are to be implemented on the customer side. The following options, amongst others, are available for cooling the power component by means of cold plate cooling:

1. Using built-on connecting pieces, which are available from Siemens as accessories, the cold plate can be upgraded to a water cooler. With this set-up, the cooling water flows through the perpendicular drill holes. The Siemens specifications for water quality, volume flow rate (quantity of water per time unit), and water pressure are applicable.
2. An external customer-specific water cooler can be screwed flat onto the cold plate.
3. An external customer-specific ribbed heat sink or other heat sink type can be screwed flat onto the cold plate. A wide-ribbed heat sink, for example, can also be used, which can help avoid blockages caused by fiber fly (e. g. in the textiles and paper industry).

Cold plate with external air cooling

Liquid cooling via an external air cooler.

The external air cooler is normally mounted outside the -> “Cabinet unit” and only part of the power loss remains in the cabinet unit.

Cold plate with external liquid cooling

Liquid cooling with an external liquid cooler, which is mounted on the -> “Cold plate”.

If the external liquid cooler is mounted outside the -> “Cabinet unit”, only part of the power loss remains in the cabinet unit.

Cold plate with internal liquid cooling

Liquid cooling via the cold plate connection adapter.

The liquid is fed through integrated channels in the cold plate and cooled externally. The –> “Cold plate” normally extends out of the cabinet unit and only part of the power loss remains in the –> “Cabinet unit”.

Command data set **CDS**

Parameter –> “Data set” containing –> “Binector input”s (e. g for control commands) and –> “Connector input”s (e. g. for setpoints).

The individual data sets are represented as –> “Indexed parameters”. Switchover is carried out via input signals.

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

Commissioning

All measures and actions (required configuration, parameterization, optimization, and tests) that must be taken to prepare a machine or system for operation.

See –> “STARTER” –> “Initial commissioning”

Commissioning tool

Software tool for commissioning a system.

See –> “STARTER” –> “Commissioning” –> “Initial commissioning”

Communication board CAN **CBC10**

This board is used for extending the range of –> “SINAMICS” communication options and is plugged into the –> “Option slot” on the –> “Control unit”.

CompactFlash card

Memory card for non–volatile storage of the drive software and corresponding –> Parameters. The memory card can be plugged into the –> “Control unit” from outside.

Component number

The component number is a standardized ID number for a –> “Drive component” within a –> “Drive unit” connected via –> “DRIVE–CLiQ” or by another method.

The component number can be a value between 1 and 199.

Configuration parameter

These –> “Parameter”s are used to make basic –> “Drive unit” settings (e. g. the number of –> “Drive”s and –> “Data sets”).

Connector

Freely interconnectable “analog signal” based on –> “BICO technology”.

An “analog signal”, for example, is the value of an –> “Analog input” or an item of PROFIBUS process data.

The –> “Signal source” is called the –> “Connector output”, and the –> “Signal sink” is called the –> “Connector input”.

Connector input **CI**

–> “Signal sink” to which a –> “Connector output” (a freely connectable “analog signal”) can be connected by means of –> “BICO technology”.

An “analog signal”, for example, is the value of an –> “Analog input” or an item of PROFIBUS process data.

See –> “Binector input”

Connector output **CO**

–A > “Signal source”, that is, a freely connectable “analog signal” that can be connected via a –> “Connector input” by means of –> “BICO technology”.

An “analog signal”, for example, is the value of an –> “Analog input” or an item of PROFIBUS process data.

See –> “Binector output”

Control stability

Long–term fluctuations in the actual value of a controlled variable caused by drift effects (e. g. fluctuations in the long–term mean value of the actual speed value caused by temperature and long–term influences).

Control supply module

24 V power supply module for the component electronics in a SINAMICS –> “Drive line–up”.

The control supply module is supplied via two inputs: the –> “Network” and the –> “DC link”. The DC link connection ensures that the electronics power supply is buffered in the event of a power failure or voltage dip, thereby enabling –> “Emergency retraction” and “Kinetic buffering”.

Example: grounding rail in a control cabinet.

Control unit **CUxxx**

Central control module in which the closed–loop and open–loop functions for one or more –> “SINAMICS” –> “Line module”s and/or –> “Motor module”s are implemented.

The following control unit types exist:

- SINAMICS control units (e. g. –> “CU320”)
- SIMOTION control units (e. g. –> “SIMOTION D435”)

Control word **CW**

Bit–coded –> “Process data” word. –> “PROFIdrive” transmits this word at cyclic intervals to control the drive states.

Converter

This component contains the control and power modules for operating –> “Motor”s.

See –> “Drive unit”

Cooling method

Cooling method for SINAMICS power units in accordance with EN 60146–1.

The following cooling methods are available in SINAMICS:
–> “Internal air cooling”
–> “External air cooling”
–> “Cold plate cooling”
–> “Liquid cooling”

CU320

SINAMICS –> “Control unit” with 4 –> “DRIVE–CLiQ socket”s,
1 –> “PROFIBUS” interface, 16 digital inputs/outputs.

Cyclic redundancy check **CRC**

Procedure whereby a certain number of bits is added to binary data so that the integrity of the binary data can be checked.

Used when data is transmitted and stored.

See –> “Cyclic redundancy check error”

Cyclic redundancy check error **CRC error**

Error detected during a –> “Cyclic redundancy check”.

Data set

Parameters are grouped together in a data set. This allows a range of application scenarios to be implemented by parameterizing and switching between the data sets.

The individual data sets are entered as –> “Indexed parameters”. Switchover is carried out via input signals.

See –> “Drive data set”
See –> “Command data set”
See –> “Encoder data set”
See –> “Power module data set”
See –> “Motor data set”

Data set 47

Acyclic parameter access via PROFIdrive profile V3 is realized via the DPV1 services (read/write data set) with data set 47.

DC link

The component of the converter (or converter system) that connects the input converter (rectifier) and the output converter (one or more inverters).

With voltage source DC link converters (–> “SINAMICS”), a constant DC voltage is present in the DC link (rectified line voltage).

DC link adapter

Mechanical adapter for –> “Booksize” components that establishes a connection between the integrated busbars and the terminals in the adapter.

DC link capacitor

Capacitor for supporting the DC link voltage.

Notice:

Note the discharge time when switching off the drive unit.

DC link components

Power components that are connected to the DC link (e. g. –> “Capacitor module”, –> “Braking module”, and –> “Control supply module”).

Degree of protection **IPxx**

The degree of protection prevents the damaging effects of water, foreign bodies, and dust, as well as parts inside the motor or energized parts coming into contact with each other. The degrees of protection for electrical machines are indicated by an abbreviation comprising two letters and two identification numbers (e.g. IP55).

Derating

Derating means a rating reduction of components caused by internal or external conditions. For motors and drive components, these conditions are installation altitude and ambient temperature. Drive components can also be derated with regard to –> "Pulse frequency".

Diagnosis

Detecting, signaling, and localizing faults, as well as determining appropriate corrective measures.

See –> "Fault" –> "Alarm" –> "Diagnostic function"

Diagnostic function

Diagnostic functions available in a –> "Drive unit" to facilitate and support commissioning and service tasks.

Examples: Trace, function generator, measuring sockets, LEDs.

See –> "Diagnosis"

Digital input **DI x**

Input terminal for a +24 V control signal.

Digital output **DO x**

Output terminal for a +24 V control signal or –> "Relay output".

Direct measuring system

Position encoder that is directly connected to the machine component that is moved (–> "External encoder") and the corresponding evaluation electronics. With linear axes, linear scales can also be used for this purpose.

In many cases, a direct position sensing system must be used because the –> "Motor encoder" for position sensing and control is not suitable for this purpose (e. g. because the elasticities and backlash in the drive train are too great).

Direction of rotation

When looking at the front of the outgoing motor shaft:

- Shaft rotates clockwise –> positive direction of rotation
- Shaft rotates counter–clockwise –> negative direction of rotation

Display filter

Filtering display objects by means of software. With the display filter, the user can select the desired or predefined filter criteria from all the objects.

Double motor module

Two motors can be connected to and operated with a double motor module.

See –> “Motor module” –> “Single motor module”

Download

Downloading data (e. g. a project or firmware) from a PC/PG to the –> “Control unit” using the –> “STARTER” commissioning tool.

Drive

The drive includes the motor (electric or hydraulic), the actuator (converter, valve), the control unit, measuring system, and supply components (line infeed module, pressure reservoir).

Drive component

Hardware component connected to a –> “Control unit” via –> “DRIVE–CLiQ”, for example.

Drive components include: –> “Motor module”s, –> “Line module”s, –> “Motor”s, –> “Sensor module”s, and –> “Terminal module”s.

The overall arrangement of a control unit including the connected drive components is called a –> “Drive unit”.

Drive data set **DDS**

The – –> “Data set” parameter includes the characteristic drive parameters (number of the assigned –> “Motor data set”, number of the assigned –> “Encoder data set”, various control parameters).

The individual data sets are entered as –> “Indexed parameters”. Switchover is carried out via input signals.

By parameterizing several drive data sets accordingly, you can preconfigure several drive variants and switch between them.

Example: The traveling motor and hoisting–gear motor on a hoist are linked to the same –> “Motor module” and are connected alternately via contactors.

Drive line–up

A drive line–up comprises a –> “Control unit” and the –> “Motor module”s and –> “Line module”s connected via –> “DRIVE–CLiQ”.

Drive object

A drive object is an autonomous, individual software function with its own –> Parameters. It may also have its own –> Faults and –> Alarms. The drive objects may exist by default (e. g. On–board I/O) and may be easy to create (e. g. –> “Terminal board” 30, TB30). It may also be possible to create more than one (e. g. –> “Servo control”). As a rule, each drive object has its own –> STARTER window for parameterization and diagnostic purposes.

Drive parameter

Parameters of a drive axis that include, for example, the parameters of the corresponding controllers, as well as the motor and encoder data.

Drive system

The drive system includes all the components in a product family (such as SINAMICS) that belong to a drive. A drive system comprises, for example, –> “Line module”s, –> “Motor module”s, –> “Encoder”s, –> “Motor”s, –> “Terminal module”s, and –> “Sensor module”s, as well as additional components (reactors, filters, cables, etc.).

Drive unit

The drive unit includes all the components connected via –> “DRIVE–CLiQ” that are required for carrying out drive tasks: –> “Motor module” –> “Control unit” –> “Line module”, and the required –> “Firmware” and –> “Motor”s, but not additional components, such as filters or reactors.

Several –> “Drive”s can be implemented in a drive unit.

See –> “Drive system”

See –> “Drive unit”

DRIVE–CLiQ

Abbreviation for “drive component link with IQ”.

Communication system for connecting the different components of a SINAMICS drive system, such as the –> “Control unit”, –> “Line module”, –> “Motor module”, –> “Motor”, and speed/position encoders.

The DRIVE CLiQ hardware is based on the Industrial Ethernet standard and uses twisted–pair lines. The DRIVE–CLiQ line provides the transmit and receive signals, as well as the +24 V power supply.

DRIVE–CLiQ cable

DRIVE–CLiQ plug–in cable similar to –> “RJ45”.

DRIVE–CLiQ socket

Socket similar to –> “RJ45” on a –> “Drive unit”. A –> “DRIVE–CLiQ cable” can be connected to this socket.

Droop function

The droop function can be used to artificially “soften” the speed controller by switching a variable percentage of the speed controller output signal with a negative sign to the speed controller input. With a high load torque, this has the effect of partially reducing the speed. The droop function is used to soften the response to load surges and for certain load balancing control variants in drives that are interconnected via a continuous goods conveyor. The I component or aggregate output signal can be used as the speed output signal. The droop function can be activated/deactivated using a control command.

Duty cycle

For the duty cycle, a distinction is made between different operating modes (DIN VDE 0530):

- S1: Continuous operation
- S2: Short–time operation
- S3: Intermittent operation (without start–up procedure)
- S4: Intermittent operation (with start–up procedure)
- S5: Intermittent operation (with start–up procedure and electrical braking)
- S6: Continuous operation with intermittent load
- S7: Uninterrupted operation (with start–up and electrical braking)
- S8: Uninterrupted operation with periodic speed variations
- S9: Uninterrupted operation with non–periodic load and speed variations

A duty cycle is described by the following characteristic quantities (see also the relevant standard (IEC 146–1) for converters):

–> “Load duration”
–> “Maximum current”
–> “Limiting short–time current”
–> “Base load current”
–> “Rated current”

dv/dt filter

Motor–side power components. Used for smoothing converter output currents and voltages for the motor.

The –> “Sinus filter” is an even more sophisticated converter output filter.

Dynamic Servo Control **DSC**

Dynamic Servo Control (DSC) enables the actual position value to be evaluated in a fast speed controller cycle directly in the drive. The position setpoint is predefined in the position control cycle by the higher–level controller via the isochronous PROFIBUS with PROFIdrive message frames.

With sophisticated signal filtering and pre–control, DSC ensures optimum dynamics in the position control loop with a low bus bandwidth load.

DSC enables high controller gains and, as a result, a high level of rigidity to be attained (fast compensation of load–dependent path deviations).

Electronic type plate

Each –> "Drive component" of the SINAMICS drive system, which is connected via –> "DRIVE–CLiQ", is equipped with an electronic type plate.

The electronic type plate can be read via the –> "STARTER" commissioning tool and contains the following data:

Type, order number, version, manufacturer, serial number, and technical rated data.

Electronics power supply

Power supply for the electronic SINAMICS components. All SINAMICS components are equipped with terminals or rails for connecting a +24 V power supply unit (e. g. –> "SITOP power" or –> "Control supply module").

Emergency retraction

In dangerous situations, the –> "Drive"s are withdrawn to a safe position without the tool and workpiece colliding.

Dangerous situations include: Power failure, short–time voltage dip, emergency stop.

The –> "Control supply module" supplies the power for the electronics components required for retraction.

Encoder

An encoder is a measuring system that captures actual values for the speed and/ or angular/position values and makes them available for electronic processing. Depending on the mechanical construction, encoders can be integrated in the –> Motor (–> Motor encoder) or mounted on the external mechanics (–> External encoder). Depending on the type of movement, a distinction is made between rotary encoders (also known as “rotary transducers”) and translatory encoders (e. g. –> “Linear encoders”). In terms of measured value provision, a distinction is made between –> Absolute encoders (code sensors) and –> Incremental encoders.

See –> “Incremental encoder TTL/HTL” –> “Incremental encoder sin/cos 1 Vpp” –> “Resolver”

Encoder data set EDS

Parameter –> “Data set” that can be selected using a parameter within the active –> “Drive data set” and that includes the speed/position encoder parameters used by drive control. This means that all the encoder parameters can be switched simultaneously.

The individual data sets are entered via –> “Indexed parameters”.

Encoder interface

Interface for connecting an –> “Encoder”.

In –> “SINAMICS”, a distinction is made between encoders with and without a –> “DRIVE–CLiQ socket”. Encoders with a DRIVE–CLiQ socket can be connected directly, whereas those without a DRIVE–CLiQ socket are connected by means of a –> “Sensor module”.

The term “accuracy” must not be confused with –> “Resolution”. In practice, the resolution must be 2 to 10 times higher than the required accuracy.

Note regarding the precision of speed–controlled drives:

In practice, –> “Control stability” is generally more important than accuracy for speed control (see –> “Resolution”).

EnDat protocol

Serial transmission protocol developed by Heidenhain for transmitting position/ angular actual values from an –> “Absolute encoder” to the drive or positioning control.

The EnDat protocol also allows the encoder to be parameterized and diagnosed.

The –> “SSI protocol” can also be used for serial absolute encoders.

Extended ramp–function generator

See –> “Ramp–function generator”
See –> “Simple ramp–function generator”

External air cooling

External air cooling uses the “through-hole” method. This is a -> Cooling method for SINAMICS power units that is only available for -> Booksize components. The power unit and its heat sink can be inserted in a rectangular knockout at the rear of the switching cabinet and mounted with a seal. The heat sink fins and the fan project beyond the rear of the switching cabinet and the heat is dissipated outside the switching cabinet.

External encoder

Position encoder that is not built in or mounted on the -> “Motor”, but via a mechanical transmission element or mechanical intermediate element.

The external encoder (see -> “Externally-mounted encoder”) is used for -> “Direct position detection”.

Factory setting

-> “Adjustable parameter”s have a factory setting when the drive equipment is delivered. The user does not have to make a special setting.

The factory setting is made using parameter p0970 (in accordance with the -> “PROFIDrive” profile).

Fault

An unwanted status. When the drive control detects this status, it can trigger an -> “Alarm” and indicate this or forward it to a higher-level control unit.

Fault buffer

The drive stores faults in a fault buffer. The fault buffer can be read via parameters.

See -> “Alarm buffer”

Fault code

Codes for -> “Fault”s entered in the -> “Fault buffer”.

See -> “Message” -> “Alarm code”

Fault reaction

A stop reaction is an action initiated when a -> “Fault” occurs.

In -> “SINAMICS”, for example, the following fault reactions can be chosen individually:

OFF1, OFF2, OFF3, ENCODER, “No reaction”, etc.

Field weakening

Field weakening refers to the reduction of the magnetization current for an electric motor so that the speed can be increased further once the rated voltage is reached. Above the threshold speed (or synchronous speed for induction motors) for field weakening, the voltage is maintained at a constant level and the speed can be changed by adjusting the magnetization current. The available torque decreases in the field weakening range with the speed in accordance with the speed/torque characteristic. The Omega ~ EMF / Phi equation is used to calculate field weakening (Omega = angular speed, Phi = flow).

Firmware version

This refers to the software version stored on the –> “CompactFlash card“ of the –> “Control unit”.

The firmware versions of the individual components are displayed via different parameters.

Fixed setpoint

A setpoint that is set to a fixed value in the –> “Drive” (e. g. speed or velocity setpoint).

See –> “Fixed speed setpoint”

Fixed speed setpoint

This function is used for predefining a fixed speed setpoint by means of an –> “Adjustable parameter”.

See –> “Fixed setpoint”

Floating point number

A floating point number is a number with a variable decimal point position. The floating point number comprises two parts. The actual value is stored in the “mantissa” and the position of the decimal point in the “exponent”.

Real numbers can be represented in this way, although infinitely periodic numbers can only be stored and displayed with rounding errors due to the finite length of the mantissa (1/3, for example, is represented as 0.333333330).

Floating point numbers allow you to represent very small and very big numbers with a constant resolution.

In SINAMICS, floating point numbers are represented with 32 bits in accordance with ANSI / IEEE754 (8–bit exponent and 24–bit mantissa), as also specified in the –> “PROFIdrive” profile.

Flux controller

Used with –> “Induction motor”s to control the magnetization flux in the –> “Motor” to the required value.

Flying restart

After power ON, the “flying restart” function automatically switches a converter to a motor, which may be coasting. During the switch to the rotating motor, –> “Magnetization” must first be carried out for an –> “Induction motor”. With drives not equipped with an encoder, a –> “Search” for the current speed is carried out. The current speed setpoint in the ramp–function generator is then set to the current actual speed value. The ramp–up to the final speed setpoint starts with this value. The “flying restart” function can help to shorten the ramp–up procedure after the power has been switched on (when the load is still coasting down).

Application example:

After a power failure, a fan drive can be quickly reconnected to the running fan impeller by means of the flying restart function.

Forced dormant error detection

Forced dormant error detection in –> “Safety Integrated” identifies software/hardware errors in the two transmission channels. For this purpose, the safety–relevant branches of the safety–relevant sections in the two channels must be passed through at least once within a defined time frame.

An error in a transmission channel causes discrepancies and is detected by means of the data cross–comparison.

See –> “Switch–off signal path”

Frequency converter

Frequency converters are electronic devices that form a three–phase system with variable frequency and voltage from the three–phase or AC line. This three–phase system can be used to change the speed of three–phase motors. With the exception of direct converters, frequency converters comprise a current converter on the line side, a DC link (impressed voltage or impressed current), and an inverter on the motor side.

For SINAMICS, the converters are voltage–source DC link converters, with smoothing condensers in the DC link (instead of smoothing chokes in the case of current–source DC link converters).

Function diagram **FD**

Graphical representation of individual functions of a –> “Drive unit” by means of signal paths and control engineering symbols.

The structure of a function and information relating to the hardware and software are represented in a function diagram.

Gating unit

A device for generating the activation pulses for power transistors or firing pulses for thyristors. The gating unit connects the control electronics and the converter power section.

Global control telegram GC

Control telegram sent to the slaves on the –> “PROFIBUS” for synchronization purposes.

It is also known as a –> “Broadcast telegram”.

See –> “PROFIBUS”

Ground reference

A metal part of an electric system or an electric device connected to ground by means of protective ground conductors. The ground reference is the reference potential for measuring electrical quantities.

Heat dissipation

Dissipation of the thermal losses and/or motor to ensure that the permissible temperatures are not exceeded.

The temperature can rise for the following reasons:

- Convection (self cooling)
- Air cooling with internal ventilators (separate cooling)
- Water cooling with internal and/or external cooling circuit

Hysteresis

If a switching function has different response thresholds for –> “Switching on and off”, the difference is called a “hysteresis”. This term is also used for magnetization curves.

I^2t calculation

Calculation of the utilization of a converter or motor, taking into account the converter current or motor current, the speed/frequency, and thermal time constants. It is used for protecting the converter or motor from overtemperature with, if necessary, (pre–)warning and switch–off.

If a temperature encoder is installed on the heat sink of the converter or incorporated in the motor, the I^2t calculation may not be necessary. The I^2t calculation is always an approximation of the actual temperature of the converter or motor.

The actual converter temperature results from the following values (amongst others):

- Forward losses (~ i)
- Switching losses (= f(clock cycle, i, U))
- Ohmic losses (~ i^2 x t)
- Ambient temperature
- The different thermal time constants and thermal resistors

The actual motor temperature results from the following values (amongst others):

- Copper losses (~ i^2 x t)
- Iron losses or magnetic reversal losses
- Ambient temperature
- The different thermal time constants and thermal resistors

See –> "I^2t model"

I^2t model

Simplified software calculation model for calculating the temperature (e. g. of the barrier junction of an –> "IGBT" transistor, the heat sink temperature of a converter, or a motor temperature).

See –> "I^2t calculation"
See –> "I^2t monitoring"

I^2t monitoring

This monitoring function protects a converter or a motor from continuous thermal overload. A (pre–)warning is triggered when the warning function responds. If no countermeasures are taken, a fault trip takes place after a specified time period.

See –> "I^2t calculation"

I^2t motor protection

Calculation of the motor utilization (motor temperature), taking into account the motor current (= converter current), speed, cooling method, and thermal motor time constants. It is used for motor protection with, if necessary, warning and switch–off. I^2t motor protection can be provided by a special protection device or a software –> I^2t Model.

See –> “I^2t calculation”

Identification

Procedure for determining the physical characteristic quantities by evaluating measured quantities (e.g. during a travel procedure or during the infeed of exciting signals).

Example:

Determining the electrical characteristic data of a motor, determining the rotor position, and so on.

See –> “Motor identification”

IGBT technology

Set–up (of the inverter) with IGBT (insulated gate bipolar transistor).

IGBT are high–speed switching (approx. 0.1 μs) power transistors, often with an integrated flywheel diode, and are activated via field effect transistors (MOSFET). This reduces switching and activation losses and is, therefore, suitable for high –> “Pulse frequencies” > 1 kHz to 16 kHz. IGBT are available as individual transistors. For low power values, they are also available as transistor combinations (e. g. as a “six pack” in which a complete inverter is integrated in a module).

Impedance

A/C current resistor in a circuit.

Incremental encoder

Incremental position and speed encoder. Unlike the –> “Absolute encoder”, this encoder does not output an actual position value signal corresponding to the absolute position, but instead outputs incremental “delta position or angular signals”.

A distinction is drawn between –> “Incremental encoder TTL/HTL”, –> “Incremental encoder sin/cos 1 Vpp”, and –> “Resolver”.

Incremental encoder sin/cos 1 Vpp

A high-resolution optical sine/cosine encoder that can be incorporated in 1FK6 motors as a -> "Motor encoder", for example.

The following signals are normally output:

- Two signals displaced by 90 degrees, each with 2048 sinusoidal signal periods per revolution as differential signals with an amplitude of 1 Vpp ("A/B sinusoidal encoder tracks").
- A reference signal (-> "Zero mark") per revolution as a differential signal with an amplitude of 0.5 Vpp.
- With certain types, two additional sinusoidal signal periods displaced by 90 degrees as differential signals with an amplitude of 1 Vpp ("C/D track").

To determine the actual position/angular value, the zero crossings of the sinusoidal encoder tracks are evaluated first (rough evaluation, e. g. in total 4 * 2048 = 8192 zero crossings per revolution). Analog amplitude detection also allows fine evaluation. Combining rough and fine evaluation methods enables -> Resolutions of more than 1,000,000 increments per encoder revolution.

Incremental encoder TTL/HTL

Incremental position and speed measuring encoder (-> Incremental encoder). In most cases, it outputs two pulse chains (-> Tracks) displaced by 90 degrees with rectangular output signals and often one zero mark per revolution respectively. The output signals have TTL levels (in most cases +5 V RS422 differential signals; TTL = Transistor-Transistor Logic) or HTL levels (+15 or +24 V logic level; HTL = High Level Transistor Logic).

Indexed parameter

This parameter has several sub-parameters with the same number that can be initiated by an index.

Induction motor

An AC motor whose speed runs "behind" the synchronous speed.

Induction motors can be connected to the three-phase system either directly in a star/delta connection or via a -> "Frequency converter".

In combination with a frequency converter, the induction motor becomes a "variable-speed drive system".

The terms "squirrel-cage induction motor" and "squirrel-cage rotor" are also commonly used.

See -> "Synchronous motor"

Infeed

Input component of a converter system for generating a DC link voltage to supply one or more –> “Motor module”s, including all the required components, such as –> “Line module”s, fuses, reactors, line filters, and firmware, as well as proportional computing power (if required) in a –> “Control unit”.

Initial commissioning

Initial commissioning of a machine or system.

Initial commissioning involves all the necessary configuration tasks, parameterization, and tests.

Integral time **Tn**

Setting parameters for an integral–action controller (I controller) or an integral component for a proportional–integral–action controller (–> “PI controller”). The smaller the integral time is, the faster the system deviation will be settled.

Internal air cooling

A –> “Cooling method” for SINAMICS power units: Increased air cooling with an integrated fan (based on EN 60146–1).

The actual topology can be used as the target topology in the drive by means of appropriate parameterization.

Inverter

Electronic device with power transistors for converting DC voltages to AC voltages.

See –> “Motor module”

Isochronous mode

This mechanism is specified in the –> “PROFIdrive” profile. It allows the –> “PROFIBUS” participants to synchronize their sampling rates. The synchronization clock pulse rate corresponds to the bus cycle time.

See –> “Isochronous PROFIBUS”

Isochronous PROFIBUS

The isochronous PROFIBUS is an extension of the tried-and-tested PROFIBUS (formerly “PROFIBUS-DP”).

-> “Isochronous mode” is a mechanism specified in the -> “PROFIdrive” profile. This mechanism enables the sampling rates of the connected participants to be synchronized. It also ensures simultaneous transmission or activation of the transmitted process data. The synchronization clock pulse rate corresponds to the bus cycle time.

The new functions are specified in the “Drive Technology” PROFIBUS profile, version 3 issued by the -> “PROFIBUS user organization” (PNO) and are currently being integrated in the PROFIBUS Standard EN 50170, Section 2. To use the new functions, you need a suitable clock-synchronous master interface. The clock-synchronous PROFIBUS is upwards compatible: In a mixed configuration, clock-synchronous slaves and non-clock-synchronous slaves (e. g. intelligent terminal strip ET200) can be operated together on a clock-synchronous PROFIBUS bus line.

Isolated

Electrically separated with an insulation voltage of several 100 V (e.g. via opto-couplers, relays, or transformers).

IT network

In the IT network -> “Line form”, no direct connection exists between active conductors and grounded components. All the electrical equipment is grounded separately.

Relatively high potential differences can occur between the mains circuits and grounded circuits.

Compared to grounded networks (-> “TN networks” and -> “TT networks”), IT networks are less sensitive because no ground-fault current is present in the case of a single-end ground fault, which means that operation can be maintained. For this reason, IT networks are favored in harsh environmental conditions (chemical and rolling mill industries). A single-end ground fault, however, must be detected (by an insulation monitor, for example) and rectified immediately.

The following points must be taken into account with TT and IT networks:

- The effect of standard line filters cannot be predicted due to a missing reference point.

  In addition, interference-suppression capacitors can become overloaded with regard to voltage and current in the event of a ground fault.
- The motor windings may be subject to increased insulation stress due to the phase voltages running counter to ground.

The abbreviation “IT” is derived from the French term “Isolation-Terre” (insulation-to-ground).

Jog mode

This function is used to operate the -> “Drive” in speed control mode. The -> “Jog setpoint” for jog 1 or jog 2 is selected by means of an input signal. The jog setpoints for jog 1 and 2 can be parameterized.

License key

The license key is an electronic license stamp that indicates that one or more software licenses are owned. It allows unrestricted use.

The actual customer verification of the license for the software that is subject to license is called a -> “Certificate of license”.

The license key can be generated using the -> “License Manager” at “//www.siemens.com/automation/license”.

License manager

Software for generating a -> “License key” on the Internet.

Limiting short-time current Is

The “limiting short-time current” is a characteristic quantity for defining a -> “Load cycle”. It refers to the short-time load current from the power section for the time “ts” (taking into account the cooling system). The current then has to be reduced to the -> “Base load current” (Ib) for the time “tb”.

The short-time current is usually less than the -> “Maximum current” although it can be used over a longer period of time.

Line connection module

Connection module for the -> “Basic line module”, -> “Smart line module”, -> “Active line module”, and -> “Power module”.

This module contains the line-side options:

- Line filter (EMC filter)
- Main circuit-breaker or circuit-breakers
- Fuses and load interruptor
- Main contactor

See -> “Active interface module” -> “Smart interface module”

Line contactor

Switching device used for connecting a -> “Line module”, -> “Power module”, or -> “AC drive” to the network.

The line contactor is used if the drive needs to be electrically isolated from the network even if the main circuit-breaker is to remain closed (e. g. replacing a motor without switching off the lights).

Line filter

Line filters are filters in the converter input that are designed to protect the network from harmonic loads and/or interference voltages generated in the converter.

Line filters can be active or passive filters, for the lower-frequency harmonics (line feedback) with 5, 7, 11, 13, etc. times the line frequency, and for high-frequency interference voltages from 10 kHz (RFI suppression filters).

In SINAMICS, the term “line filter” only refers to passive RFI suppression filters.

Line module

A line module is a power component that generates the DC link voltage for one or more -> “Motor module”s from a three-phase mains voltage.

In SINAMICS, the following line module types are used: -> “Basic line module”, -> “Smart line module”, and -> “Active line module”.

The overall function of an infeed, including the required additional components (-> “Line reactor”, proportional computing power in a -> “Control unit”, switching devices, and so on) is called -> “Basic infeed”, -> “Smart infeed”, and -> “Active infeed”.

Line reactor

Line reactors limit low-frequency line harmonics to permissible values. In conjunction with -> “Active line module”s, they are also used as energy stores.

Line-side power components

Power components arranged between the network and converter unit, including -> “Line reactor”s, -> “Line filters”, -> “Line contactor”s, and so on.

Liquid cooling

Water cooling is a -> “Cooling method” for SINAMICS power units that is only available for -> “Chassis units”. With this cooling method, a water cooler with an inlet/outlet connection is permanently integrated in the devices. The Siemens specifications for water quality, volume flow rate (quantity of water per time unit), and water pressure are applicable.

A water cooler installed by the customer can be used for the -> “Cold plate method” method too.

Load balancing control

Load balancing control is designed to ensure that the load torque is distributed in a defined manner across two or more drives, which are interconnected either mechanically or via the goods conveyor.

Load duration tcyc

Total duration of a –> “Load cycle”. If the –> “Maximum current” is not utilized, tcyc = ts + tb.

For ts, see –> “Limiting short–time current”
For tb, see –> “Base load current”

Magnetization

Magnetization involves injecting the rated flux into an induction machine, starting at 0 after the power has been switched on or with –> “Flying restart”.

The rated magnetization times are defined for nearly all of the catalogued Siemens motors in the motor data for the converters. The actual magnetization time can be determined automatically by means of –> “Motor identification”. The magnetization times largely depend on the size of the motor. With small 1 kW motors, magnetization takes approx. 30 ms; with 1 MW motors, it takes approx. 3 s.

A flux controller is available for servo drives that helps accelerate magnetization so that it is no longer dependent on the magnetization time constant.

Manufacturer–specific telegram

For Siemens drives, manufacturer–specific PROFIBUS telegrams are telegrams as of number 101. The telegram numbers are defined in the –> “PROFIdrive profile”.

See –> “Standard telegram”

Marker pulse

The zero pulse is generated by a special track from an –> “Incremental encoder”. With rotary incremental encoders, one zero mark signal is normally output per revolution; with translatory incremental encoders (–> “Linear encoders”), one zero mark signal is output per “axis length”, or more than one at defined intervals.

The manufacturers of encoders call this latter variant the “interval–coded” variant.

The marker pulse is used for the drive –> “Homing procedure” (referencing).

Master control

Master control is usually assigned to a higher-level controller (e. g. PROFIBUS master).

To operate a drive using the -> “STARTER” commissioning tool, master control will have to be occasionally assigned to the PC, after which master control is returned to the higher-level controller.

Maximum current **I_max**

The maximum current is a characteristic value in certain -> “Duty cycles”. It refers to the permissible rms of the peak current for the power semi-conductors (transistors, thyristors).

Measurement on-the-fly

When a hardware signal is received, the instantaneous actual position value is saved and made available via PROFIBUS, for example, for further processing. The hardware signal can originate from a probe or print-mark sensor, for example (mechanical switch, BERO, or optical sensor). The active edge of the hardware signal can be parameterized (rising, falling, or both).

Measuring socket

The structure of the measuring sockets on the -> “Control unit” correspond to an -> “Analog output” with a voltage range of between 0 and 4.98 V.

The measuring sockets should be used exclusively for servicing purposes.

See -> “Analog output” -> “Diagnostic function”

Message

In SINAMICS, a drive issues a message to indicate an error or other exceptional status.

Messages are divided into -> “Fault”s and -> “Alarm”s.

Motion control with PROFIBUS

Application for the -> “Clock-synchronous PROFIBUS”. The bus itself is called the -> “Clock-synchronous PROFIBUS”.

Motor

For the electric motors that can be driven by –> SINAMICS, a basic distinction is made between rotary and linear motors with regard to their direction of motion, and between synchronous and induction motors with regard to their electromagnetic operating principle. In SINAMICS, the motors are connected to a –> "Motor module".

See –> "Synchronous motor" –> "Induction motor" –> "Motor encoder" –> "External encoder" –> "Third–party motor"

Motor data set — MDS

The motor data set parameters are used to configure a –> "Motor".

Several motor data sets exist and control commands can be used to switch between them. This ensures common switching of all –> "Parameter"s that define the motor configuration. A typical application is when several motors are operated on the same –> "Motor module".

The individual data sets are entered as –> "Indexed parameters".

Example: The traveling motor and hoisting–gear motor on a hoist are linked to the same motor module and are connected alternately via contactors.

Motor encoder

An –> "Encoder" (e. g. –> "Resolver", –> "Incremental encoder TTL/HTL", or –> "Incremental encoder sin/cos 1 Vpp"), which is integrated in or attached to the motor.

The encoder detects the motor speed and, in the case of synchronous motors, the rotor position angle (of the commutation angle for the motor currents).

Motor identification

Procedure for determining the physical properties of a motor. For this purpose, the drive control excites the motor with test signals (in the case of a non–rotating or a rotating motor). The parameters are derived from the reaction of the motor.

The term "motor identification" must not be confused with the term –> "Motor recognition".

Motor module

A motor module is a power component (DC–AC inverter) that supplies the power for the connected motor(s).

Power is supplied through the –> “DC link” of the –> “Drive unit”.

A motor module must be connected to a –> “Control unit” via –> “DRIVE–CLiQ”. The open–loop and closed–loop control functions for the motor module are stored in the control unit.

–> “Single motor module”s and –> “Double motor module”s are available.

Motor recognition

Read–out of the data stored in the motor by the –> “Control unit”. The motor data that is stored includes the order number, serial number, and motor parameters. Motors with a suitable digital interface are required for motor recognition (e. g. motors with –> “DRIVE–CLiQ”).

The term “motor recognition” must not be confused with the term –> “Motor identification”.

Motor temperature measurement

The motor temperature can be measured indirectly via the converter–side open–loop and closed–loop control software (–> “I^2t motor protection”, –> “I^2t calculation”) or directly (and, therefore, more accurately) via –> “Motor temperature sensor”s in the motor, which can be evaluated either in the –> “Converter” itself or via additional evaluation units.

Motor temperature sensor

Motor temperature sensors are elements fitted in the motor winding and/or in the motor bearings that measure the relevant temperatures and protect the motor from overtemperature.

The most common sensors are:

- Thermistors (PTC), which are triggered at a certain temperature (–> “Thermistor” motor protection)
- KTY 84 as a (linear) thermistor
- PT 100 for (linear) temperature measurement (mainly for higher power values)

Motorized potentiometer

This function is used to simulate an electromechanical motorized potentiometer for setpoint input. The setpoint is set via a “higher” or “lower” control command.

Motor–side power components

Power components that are arranged between the converter unit and the motor (e. g. output filters, output reactors, etc.).

Multiturn encoder

A multiturn encoder is an –> “Absolute value encoder” that delivers an absolute representation of the angle position across several encoder revolutions (normally 4096 revolutions). The number of revolutions is transmitted in the higher–value bits, while the angle position within a revolution is transmitted in the lower–value bits. Most multiturn encoders include several slotted disks coupled via gear wheels. The angular position value is generally transmitted to the closed–loop control electronics via a serial protocol (e. g. –> “EnDat”, –> “SSI”).

See –> “Single–turn encoder”

NC contact **NC**

Contact that is closed in the “off” position and does not open until it is actuated.
NC: normally closed

See –> “NO contact”
See –> “Two–way contact”

Net data

Useful net data in a telegram, which does not include the data for addressing, data saving, (header and trailer), and so on.

Network

A network is a power supply system to which different electrical consumers (e.g. converters) can be connected. Monophase networks (especially for lower powers) and 3-phase networks are commonly used. A network is generally formed by means of a transformer outlet. Several transformer outlets connected in parallel can also form a common network.

A distinction is made between grounded (TN or TT networks) and ungrounded or isolated (IT) networks.

Compared to grounded networks, IT networks are less sensitive because no ground-fault current is present in the case of a single-end ground fault, which means that operation can be maintained. For this reason, this type of IT network is favored in “rough” environmental conditions (chemical and rolling mill industry). A single-end ground fault, however, must be detected and rectified immediately. For this reason, ground faults must be detected centrally (e. g. using an Iso guardian).

In grounded networks, each ground fault causes a short-circuit current that must be switched off by means of appropriate protective devices. In TT networks, the network starpoint and the individual consumers are grounded by means of a local ground electrode or (ground connection). In the case of TN networks, however, an additional ground connector is laid together with the power cables (as an additional potential compensation).

Normally Open contact **NO**

Contact that is open in the “off” position and does not close until it is actuated.
NC: Normally Open

See -> “NC contact”
See -> “Two-way contact”

Offline

-> “STARTER” is in offline mode when it is not communicating with a -> “Control unit”. In STARTER, offline status is indicated by a white-on-blue display in the status bar.

Blue generally indicates offline mode. In the expert list, the blue value cell in the header, for example, indicates an offline value.

See -> “Online”

Online

-> “STARTER” is in online mode when it is communicating with at least one -> “Control unit”. In STARTER, online status is indicated by a black-on-yellow display in the status bar.

Yellow generally indicates online mode. In the expert list, the yellow value cell in the header, for example, indicates an online value.

See -> “Offline”

Optimized pulse pattern

Complex modulation procedure of a converter gating unit in which the voltage pulses are arranged in such a way that the output current approximates a sinusoidal curve as closely as possible. This is essential for achieving high control factors and minimum torque ripple.

Option

Additional hardware, software, or documentation component that is not included in the standard scope of delivery and is often subject to charge. “Minus options” are also available (e. g. product without documentation).

Option board

PC board inserted in the –> “Control unit” (e. g. a –> “Terminal board” 30, TB30).

Option slot

Slot for an optional module (e. g. in the –> “Control unit”).

P gain

Abbreviation for –> “Proportional gain”.

See –> “Closed–loop PI control”

Parameter

Variable quantity within the drive system that the user can read and, in some cases, write. In –> “SINAMICS”, the specifications defined in the –> “PROFIdrive” profile are defined by a parameter.

See –> “Visualization parameter” –> “Adjustable parameter”

Parameter channel

The parameter channel enables users to read and write –> “Drive” parameters according to the protocol defined in the –> PROFIdrive profile.

Password

Defined sequence of characters that legitimize a user.

A valid password enables the user to access protected data, for example.

PI control

Closed–loop controller that comprises a proportional component (P component) and an integral component (I component). The –> “P gain” and the –> “Integral time” are indicated with –> “Adjustable parameter”s.

PNO **PROFIBUS user organization**

The PNO defines, amongst other things, the -> “PROFIdrive” profile. The “device actions” for certain field device classes are standardized in a PROFIBUS profile.

The PNO can be contacted via “www.profibus.com”.

Power electronics

Electronics that are not used for signal processing, but for processing currents and voltages when higher power values are present.

Power module

In SINAMICS:

A power module is an AC–AC converter with no integrated -> “Control unit”.

In power semi–conductor technology:

A power component with several components in one housing (e. g. an IGBT six pack).

Power module data set **PDS**

Parameter -> “Data set” comprising several -> “Adjustable parameter”s, which is used for configuring a power module (e. g. a -> “Motor module”, -> “Line module”, or -> “Power module”).

The individual data sets are represented as -> “Indexed parameters”.

POWER ON **PO**

Pressing the POWER ON button on the -> “Control unit” resets the entire system and initiates a new ramp–up.

POWER ON can be triggered by switching off and then switching on the power supply for all the drive system components, for example.

See -> “RESET”

Power section

In SINAMICS, “power section” is a generic term for –> “Motor module”, –> “Line module”, and –> “Power module”.

The power section is generally defined as the mechanical construction of the essential power components of a converter, that is, the mechanical construction comprising heat sinks, transistors, diodes (and/or diode modules), and fixings.

In SINAMICS, the term “power section” also designates a (mechanically compact) module comprising the power components for a certain function (e.g. the complete converter (diode rectifier and –> “IGBT” inverter for low powers) or only the inverter, or only the mains rectifier). The power components can be triggered by different –> “Control unit”s.

Power supply

Component that provides electric power for electrical and electronic components.

In –> “SINAMICS”, all the components are connected internally via 24 V terminals or rails.

The power supply can be provided by a conventional power supply unit (e. g. –> “SITOP power”) or a –> “Control supply module”.

Pre–charging

Charging the DC link capacitors via resistors. Pre–charging is normally performed from the feeding supply network, but can also be performed from a pre–charged DC link (DC coupling).

See –> “Pre–charging input circuit”

Pre–charging input circuit

Used for pre–charging the DC link capacitors. The circuit consists of resistors and a bridging device (e. g. relay, contactor, thyristors). A separate pre–charge rectifier may also be implemented.

See –> “Pre–charging”

Process data **PZD**

This data controls an automation procedure and provides information on its status.

Term from the –> “PROFIdrive” profile

PROFIBUS

Field bus to IEC 61158, Sections 2 to 6.

PROFIBUS profile

Application-specific profile (e. g. -> “PROFIdrive”) standardized by the -> “PNO” (PROFIBUS user organization).

PROFIdrive

This -> “PROFIBUS profile” was specified for speed and position-controlled drives by the -> “PNO”.

The latest version is the PROFIdrive V3 profile.

Proportional gain Kp

Indicates the gain factor of the system deviation with a P controller or the proportional component with a PI controller.

Pulse enable

Signal or terminal for activating or deactivating a drive. If the signal is not activated, the activation pulses for the power transistors in the -> “Motor module” are blocked and the -> “Motor” is switched to zero torque. This signal has the highest priority for the drive.

If the pulse enable for the -> “Drive“s is deactivated during operation, the drives coast to a standstill without braking.

See -> “Coast down”

Pulse frequency

The pulse frequency indicates how frequently an inverter phase “pulses”, that is, how often an -> “Inverter” output switches back and forth between the positive and negative -> “DC link” voltage.

A pulse frequency of 2.5 kHz, for example, means that the inverter output switches to the positive and negative DC link voltage an average of 2500 times per second.

Quadrant

The speed/torque coordinate system is normally divided into 4 quadrants:

- 1st quadrant => positive speed, positive torque (motor operation in forward direction of rotation)
- 2nd quadrant => negative speed, positive torque (regenerative operation in reverse direction of rotation)
- 3rd quadrant => negative speed, negative torque (motor operation in reverse direction of rotation)
- 4th quadrant => positive speed, negative torque (regenerative operation in forward direction of rotation)

Quick commissioning

Quick commissioning involves –> “Initial commissioning” of the –> “Motor” and –> “Drive unit”.

When carrying out this type of –> “Commissioning”, you only make the most important settings (e. g. line frequency, motor data, control type).

Ramp–function generator RFG

Ramp–function generators are used to limit the increase of setpoints (e. g. speed setpoints) in controlled drives.

It supplies an output signal with a parameterized steepness if the setpoint at the input changes suddenly, thereby ensuring that the motor can be ramped up in accordance with the technological conditions.

See –> “Simple ramp–function generator”
See –> “Extended ramp–function generator”

Ramping time

The drive accelerates and decelerates a motor by means of the ramp–function generator and the set ramping time. These times can be parameterized separately on the ramp–function generator.

Rated current In

Current for which the converters (and motors) are dimensioned and at which they reach their permissible operating temperature under defined general conditions.

Rated power

Power for which the converters (and –> “Motor”s) are dimensioned and at which they reach their permissible operating temperature under defined general conditions.

Rated speed

Speed at which a motor reaches its –> “Rated power”.

In standard motors, it is the speed at which the motor rotates when connected to the 50/60 Hz line.

In special motors, it is generally the speed at which the full –> “Rated voltage” is reached.

Rated voltage

Voltage for which motors and converters are dimensioned and at which they can supply their full –> “Rated power”.

Reactor

A reactor represents an inductance, as a winding on an iron core, single–phase or three–phase.

Recognition

Automatic detection and determination of a hardware component or the topology, as well as its handling and further use.

Example:

Transfer of the electrical type plate for a component.

See –> “Motor recognition”

Regenerative braking

Braking operation of the –> “Motor” during which the kinetic energy of the mechanical system is converted to electrical energy. This energy is supplied back to the –> “DC link” of the –> “Frequency converter”. Depending on the DC link infeed type, the energy in the DC link can be supplied back to the electrical network or converted to heat by means of a –> “Braking resistor” .

Relay output

–> “Digital output”. A relay contact is used to switch the connected load.

Reluctance motor

Synchronous motor with AC stator winding, without rotor winding and without permanent magnets in the rotor. The design of the rotor, which is normally laminated, ensures that smaller and bigger air gaps (pole and pole gap) are created. This results in a simple structure. The power density, however, is much lower than for a comparable, permanent–magnet –> “Synchronous motor”.

For use with lower power values only (< approx. 1 kW).

RESET

Pressing the RESET button on the –> “Control unit” resets the entire system and initiates a new ramp–up.

A RESET can be initiated by pressing the RESET button or by switching off the power supply and then switching it back on.

See –> “POWER ON”

Resolver

Mechanically and electrically robust and cost–efficient –> “Motor encoder” that does not require any integrated electronics and operates according to a purely electromagnetic principle: One sine and cosine signal are induced in each of the two coils displaced by 90 degrees. The resolver supplies all the signals required for speed–controlled operation of the converter or for position control. The number of sine and cosine periods per revolution is equal to the number of pole pairs of the resolver. With double–pole resolvers, the evaluation electronics may output an additional zero pulse per encoder revolution. This zero pulse ensures a unique assignment of the position information in relation to an encoder revolution. A double–pole resolver can be used as a –> “Single–turn encoder”.

Two–pole resolvers are suitable for motors with any number of poles. With multi–pole resolvers, the pole pair numbers of the motor and the resolver are always identical, which means that multi–pole resolvers ensure a higher resolution than double–pole resolvers.

RI suppression

Measures (e. g. shielding, –> “Line filter”) taken to prevent devices emitting high–frequency electromagnetic signals that interfere with other devices.

RJ45

Standard that describes an 8–pole plug connection for the twisted–pair Ethernet.

Rotor position encoder

Indicates the rotation angle of the rotor in a –> “Synchronous motor”. This information is required for electronic motor commutation.

The speed/position encoder (e. g. –> “Resolver” or –> “Incremental encoder sin/cos 1 Vpp”) integrated in the –> “Motor” is generally used as a position encoder.

Rotor position identification

Procedure for determining the start commutation angle at power on by means of test signals or a test motion. This procedure is applied when no –> “Rotor position encoder” for angle measurement exists.

Safe brake control **SBC**

–> Safety Integrated function.

In SINAMICS –> “Booksize” devices, the motor holding brake is controlled by an electronic switch in the +24 V channel and an electronic switch in the ground channel. Both channels are monitored. If one of the channels fails, this is identified and indicated accordingly. In booksize devices, the brake line is integrated in the power cable.

See –> “Brake control”

Safe stop **SH**

–> Safety Integrated function.

In the event of an error or in conjunction with a machine function, this function is used to safely disconnect the torque–generating motor power supply. This is a drive–specific, non–contact procedure.

Safety equipment

The measures and components required to protect machines, systems and, above all, people during the production process.

See –> “Safety Integrated”

Safety Integrated

These safety functions are integrated in the products and provide effective personal and machine protection according to the EC/98/37 machinery directive.

The integrated safety functions are a simple, cost–effective means of ensuring that the requirements of safety category 3 to EN 954–1 are fulfilled.

The following safety functions exist:

- –> “Safe brake control” (SBC)
- –> “Safe stop” (SH)

SH and SBC are autonomous drive functions.

Safety–related input/output signals **SGE/SGA**

These digital signals act as an interface to the process.

They are sent to the system or received from the system via two channels and via different peripherals (PLC and NC).

Search

A sensorless drive carries out a search to find the current motor speed after a line voltage failure so that it can switch back to the running motor (–> “Flying restart”).

The search procedure is as follows:

- The machine is de–excited.
- The system determines whether or not the machine is at a standstill.
- If the machine is not at a standstill, a search is carried out by outputting a frequency that is decreased starting at the maximum frequency. The main flux is monitored (i.e. the counter EMF) and the current speed determined on the basis of this.

Variable parameters for searches include the search speed and current.

Sensor module **SMCxx**

Hardware module for evaluating speed/position encoder signals and providing detected actual values as numerical values at a -> “DRIVE-CLiQ socket”.

SMCxx = sensor module cabinet-mounted

Sensorless vector control

A variant of -> Vector control (field-oriented control) for -> Induction motors without speed feedback (encoder) that enables high precision and dynamic response in a speed range of approximately 1:10.

Sequencer

Sequential logic for activating the different operating modes when the drive is switched on/off and for the -> “Safety Integrated” functions.

Servo control

For -> “Motor”s equipped with a -> “Motor encoder”, this control type allows operation with a high level of -> “Accuracy” and -> “Dynamic response”.

In addition to speed control, position control can be implemented.

Servo drive

An electric servo drive comprises a motor, a -> “Motor module”, -> “Servo control” and, in most cases, a speed - -> “Encoder”.

Electric servo drives are normally extremely precise with a high dynamic response. They are designed for cycle times to less than 100 ms, and often have a short-time overload capacity, which enables quick acceleration. Servo drives are available as rotary and linear drives and are used for machine tools, handling robots, and packaging machines.

Setpoint channel

In the setpoint channel, the setpoint for closed-loop control (e. g. closed-loop speed control) is conditioned. The setpoint can be defined via -> “PROFIBUS”, -> “Fixed setpoint”s, or the -> “Motorized potentiometer”, for example.

It can be influenced by, for example, the -> “Ramp-function generator”, filters, or additional injections.

Short-circuit-proof

Property of, for example, a -> “Digital output” designed to prevent it from being destroyed.

If the output signal short-circuits, the current is limited to a permissible value.

Signal sink

Sink of an “analog” or binary signal, that is, the position at which the signal is “used”.

In the context of -> “BICO technology”, signal sinks are referred to as the -> “Connector input” or -> “Binector input”.

Signal source

Source of an “analog” or binary signal.

In the context of -> “BICO technology”, signal sources are referred to as the -> “Connector output” or -> “Binector output”.

SIMOTION D435

SIMOTION -> “Control unit” with SINAMICS Integrated and 4 -> “DRIVE-CLiQ socket”s, 2 -> “PROFIBUS” interfaces, 2 Ethernet interfaces, -> “CompactFlash card”, 16 digital inputs/outputs.

Simple ramp-function generator

See -> “Ramp-function generator”
See -> “Extended ramp-function generator”

Single motor module

A single motor module is a -> “Motor module” to which just one motor can be connected.

See -> “Double motor module”

Single-encoder

A single-turn encoder is a rotary “absolute encoder” that can only capture the actual position value during one encoder revolution and stores this value in a non-volatile memory when the power is shutdown. A -> “Multi-turn encoder”, however, captures the actual position value over several revolutions.

SINUMERIK

Siemens AG brand name for numeric controls for equipping tool and production machines.

Sinusoidal filter

The sinusoidal filter is connected to the converter/inverter motor–side output. It is a filter for generating a sinusoidal converter output voltage.

This provides protection for motors whose insulation systems are sensitive to voltage peaks. In many cases too, a shielded motor cable is not needed.

In the chemicals industry, sinusoidal filters are sometimes needed to ensure that the permissible insulation voltage (e. g. in the motor terminal box) is not exceeded.

See –> “dv/dt filter”

Site altitude

Altitude above sea level at which the device or system is installed.

A power derating is often specified for converters due to the reduced quantity of cool air above certain altitudes.

SITOP power

–> “Electronics power supply” component.

Example: 24 V DC

SIZER

The SIZER is a tool for configuring the –> “SINAMICS” and –> “MICROMASTER” drive systems. SIZER assists with the correct technical specifications for the drive systems and selection of the drive components required for the system.

See –> “STARTER”

Slip

The slip in induction machines is the ratio of the difference between synchronous speed n1 and rotor speed n2 in relation to the synchronous speed n1.

$s = (n1 - n2) / n1$

See –> “Slip compensation”

Slip compensation

Slip compensation is an additional –> “V/f control” function. It keeps the speed constant by means of a frequency increase depending on the load current when load changes occur. Slip compensation is effective from approx. 10 % of the rated motor speed.

In this way, a speed accuracy of approx. 0.2 x rated slip can be achieved. The rated slip for motors from 30 kW is approx. <= 1.5 %.

Smart infeed

Overall functionality of an infeed with –> “Smart line module”, including the required additional components (filters, switching devices, and so on).

Smart line module

Unregulated line infeed/feedback with a diode bridge for the infeed and stall–protected, line–commutated feedback via –> “IGBT”s.

The smart line module provides the DC link voltage for the –> “Motor module”.

Smart mode

In smart mode, the –> “DC link” voltage is not controlled. The DC link voltage level is the same as the rectified line voltage.

In smart mode, power can be supplied back to the line.

You can set smart mode during commissioning on the basis of the parameterized rated line voltage.

Speed control

Closed–loop speed control constantly compares the actual motor speed value with the predefined setpoint. These two signals are processed by a closed–loop speed controller that predetermines a torque or motor current as a correcting variable at its output, thereby controlling the setpoint/actual value difference with the highest possible degree of –> Accuracy to zero.

The actual speed value is either captured by means of an –> “Encoder” or calculated from other measured or calculated variables by means of a software motor model.

SSI encoder

An SSI encoder is an –> “Absolute encoder” for recording the absolute position and transmitting the position data to the control electronics via the SSI protocol (synchronous serial interface). The SSI protocol is a common industrial standard for absolute encoders. It involves serial data transmission whereby the control electronics transmit a synchronous shift cycle for the individual data bits to the encoder, thereby ensuring noise–free transmission. The SSI protocol is commonly used for externally–mounted encoders, linear encoders, laser distance measuring systems, and so on. With the SSI encoder, the data in the encoder cable and the shift cycle is transmitted as 5 V differential signals (RS422 standard).

In –> “SINAMICS”, an SSI encoder is evaluated using the –> “Sensor module”.

SSI protocol

The SSI protocol (synchronous serial interface) is a standardized transmission protocol for transmitting –> “SSI encoder” signals.

Standard telegram

The standard telegrams (telegram nos. up to 100) are manufacturer–independent telegrams. These telegrams are specified in the –> "PROFIdrive profile".

STARTER

STARTER assists with the startup and parameterization of the drive units. This tool can also be used to execute the diagnostic functions required during servicing (e.g. PROFIBUS diagnostics, function generator, trace).

See –> "SIZER"

Starting time

Variable–speed drives require the starting time (or ramp–up time) to accelerate to the maximum speed from standstill.

See –> "Ramping time"
See –> "Ramp–up time"

Status word **STW**

Bit–coded –> "Process data" word. –> "PROFIdrive" transmits this word at cyclic intervals to control the drive states.

Suppression bandwidth

A suppression bandwidth is an impermissible speed or frequency setpoint range. The upper and lower limits of the suppression bandwidth can be paramaterized. If a signal value that lies within the skip frequency band is specified by an external or internal setpoint source, it is replaced by one of the suppression bandwidth limits. In this way, unwanted mechanical resonant oscillations can be prevented by suppressing speeds that could cause them.

Switch–off signal path

For –> "Safety Integrated", this designates the signal paths via which a particular response to an event or signal can be transmitted.

These responses always influence the motion control of –> "Drive"s (usually braking and subsequent standstill).

See –> "Forced dormant error detection"x

For cubicle–mounted units, a –> "Motor module" can be used instead of the active line module.

Synchronous motor

Synchronous motors run at the same frequency with which they are operated: They do not have a slip (like –> “Induction motors”). Synchronous motors are built in different ways. They require different feedforward and feedback control concepts depending on their construction to ensure that they can be operated with converters. A distinction is made between permanent–field and separate–field synchronous motors, with/without a damping cage, and with/without a position encoder.

See –> “Induction motor”

Target topology

Drive component wiring predefined by the engineer in –> “SIZER” or by the commissioner in –> “STARTER” (e. g. via –> “DRIVE–CLiQ”).

Terminal board **TBxx**

Terminal extension module for plugging into a –> “Control unit”.

In –> “SINAMICS”, for example, terminal board 30 (TB30) is available with analog and digital I/O terminals.

Terminal expansion

The number of digital and analog I/O terminals available in the basic configuration is increased.

In SINAMICS, the TB30 – “Terminal board” and the TMxxx –> “Terminal modules” can be used to increase the number of terminals.

Terminal module **TMxx**

Terminal extension module for snapping onto the installation rail, for installation in the control cabinet.

In –> “SINAMICS”, terminal module 31 (TM31) is available with analog and digital I/O terminals.

Thermistor

Temperature–dependent resistor.

sSee –> “Motor temperature sensor”

Third–party motor

A motor is designated as an third–party motor if its motor data is not known to the –> “Drive unit”, but can be identified by means of the corresponding –> “Order number”.

The motor data of an external motor is required for commissioning. It must be entered manually in the corresponding parameters.

Time slice

Time grid in which the individual software functions are called up.

TN network

In the TN network –> “Line form”, one point in the network (star point or external conductor) is grounded directly. Each item of electrical equipment is connected to the grounded network point via a protective or PEN conductor.

Three TN network variants are available:

- TN S network: Neutral conductors (N) and protective conductors (PE) are routed separately throughout the entire network.
- TN C network: Neutral conductors (N) and protective conductor functions (PE) throughout the entire network are combined in a single conductor (PEN conductor).
- TN C S network: This term refers to networks in which one section is configured as a TN C network and another section as a TN S network.

The abbreviation TN is derived from the French term “Terre–Neutre” (ground–to–neutral).

See –> “TT network”

Topology

Describes the structure of a drive system with –> “Control unit”, –> “Motor module”, –> “Motor”, –> “Encoder”, –> “Terminal module”, including the –> “DRIVE–CLiQ wiring” and other wiring.

Totally Integrated Automation TIA

Tailored according to customer requirements, Totally Integrated Automation (TIA) can be used to implement industry–specific automation solutions that boost productivity with a high degree of investment security.

Totally Integrated Automation offers an integrated one–stop, end–to–end solution platform for all industries and optimizes company production, process, and plant process.

Totally Integrated Automation is based on Siemens products, services, and application know–how and is continuously enhanced and geared towards future requirements.

Reduced engineering outlay for creating automation solutions, lower life–cycle costs for operating plants, and a significant reduction in time–to–market help boost productivity and investment security.

Trace

Cyclic saving of internal process signals of the –> “Drive” for diagnostic purposes or capturing process data.

See –> “Diagnostic function” –> “STARTER”

Travel to fixed stop

This function can be used to move a motor to a fixed stop at a specified torque without a fault being signaled. When the stop is reached, the parameterized torque is built up and remains applied.

TT network

Two–way contact

Changeover contact comprising an –> “NO contact” and –> “NC contact”.

When the contact is actuated, the contact that was closed opens first and the contact that was open closes.

In the –> “TT network”, one point is grounded directly. Each item of equipment is connected to ground or the central star point. The grounding resistance between the star points of the supply system and the potential of the items of equipment that are grounded individually must be taken into account.

When a converter is used in TT systems, the effect of standard line filters cannot be predicted due to a floating reference point.

The abbreviation “TT” is derived from the French term “terre–terre” (ground–to–ground).

See –> “TN network”

Type plate

A type plate contains the component name, key technical rated data and, in many cases, the serial number.

Underwriters Laboratories Inc. **UL**

Independent, non–profit–oriented organization from the USA for performing tests relevant for public security. Certification authority for testing, certifying, and evaluating products, systems, and services. All components distributed in the USA must be certified by the UL.

Upload

Uploading data (e. g. a project) from the –> “Control unit” to a PC/PG using the –> “STARTER” commissioning tool.

V/f control

Control method for three-phase AC motors. The voltage amplitude (V) is predefined depending on the current motor frequency (f). A rough motor model is used in this context. For this mode, the U/f ratio is proportional to the achievable torque.

- –> "Servo control":
  Simple V/f control used for diagnostic purposes is available for the SINAMICS servo variant.
- –> "Vector control":
  With the vector model of SINAMICS, V/f control for induction motors can be used for controlling the single and group drives (several motors on one converter) with low to medium requirements with regard to the dynamic response, speed setting range, and precision. The V/f characteristic can be set. Common characteristic forms include a characteristic with constant torque or the quadratic characteristic for pumps and fans.

Varistor

Voltage-dependent resistor.

Vdc_max control

The Vdc_max controller flattens the brake ramp automatically during braking when the maximum permissible –> "DC link voltage" is reached, thereby enabling the drive to continue running without shutting down.

See –> "Vdc_min control"

Vdc_min control

Vdc_min control (kinetic buffering) is a software function used for compensating short–time power failures (up to approx. 1 s or as long as the drive is still rotating). Vdc_min control can normally only be used for predominantly motorized drives. A prerequisite here is that the working machine has a sufficiently large centrifugal mass (i.e. sufficient kinetic energy).

If there is a risk of the –> “DC link voltage” falling below the minimum value (Vdc_min) due to a voltage dip or power failure, the speed setpoint is reduced. As a result of the regenerative power supplied back to the DC link, the DC link voltage is maintained at the Vdc_min point and the drive can continue running without shutting down.

Once the power supply has been re–established, standard motoring operation is resumed.

When Vdc_min control is used, you must ensure that motor –> “Coast down” or braking during the power failure can be tolerated.

In certain applications with multi–motor drives, the speed ratios between the individual drives are also to be maintained during Vdc_min control so that the goods conveyor is not damaged. In cases such as this, Vdc_min control must only be activated for one of the drives (normally the main drive). The reduced speed setpoints must then be supplied back to the entire setpoint cascade.

See –> “Vdc_max control”

Vector control

Vector control (field–oriented control) is a high–performance control type for induction machines. It is based on an exact model calculation of the motor and two current components that simulate and accurately control the flux and torque by means of software algorithms, thereby enabling predefined speeds and torques to be observed and limited accurately and with a good dynamic response.

Two vector control types exist:

- Frequency control (–> “Sensorless vector control”)
- Speed–torque control with speed feedback (–> “Encoder”).

Vibration damping

Vibration damping absorbs and suppresses most mechanical resonance that occurs as a result of elasticities and backlashes in the drive train and in the working machine.

These unwanted vibrations are either determined by means of a software–based load model or measured by means of the load–side speed or acceleration encoder. By activating the appropriate torque setpoints, the vibrations are reduced (dampened) or eliminated.

Visualization parameter **r...**

These read–only parameters are used to display important internal software signals.

See –> “Adjustable parameter”

Voltage boost

The motor voltage is increased by a parameterizable value at low converter output frequencies. In this way, voltage drops that occur in the motor can be compensated and a high torque achieved when the motor is started.

Voltage class

Simplified term referring to the different voltage ranges for which the drive units are designed and manufactured.

The following voltage classes exist: “400 V”, “500 V”, “690 V”

- Voltage class “400 V”: Line voltages of between 380 V –10 % and 480 V +10 %
- Voltage class “500 V”: Line voltages of between 500 V –10 % and 600 V +10 %
- Voltage class “690 V”: Line voltages of between 660 V –10 % and 690 V +10 %

The voltage class specification only refers to the line or AC side. This means that an inverter, which is designed to be connected to a DC link voltage of between 890 V DC –10 % and 930 V DC +10 %, belongs to voltage class “690 V” because the DC link voltage is achieved by rectifying a line voltage of 690 V (and because an output voltage of max. 690 V AC is achieved).

Voltage sensing module **VSMxx**

Snap–on module that captures the current line voltage values. It is used in combination with the –> “Active line module” as a feedback sensor.

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To SIEMENS AG A&D MC BMS P.O. box 3180 D-91050 Erlangen Tel.: +49 (0) 180 / 5050 – 222 (hotline) Fax: +49 (0) 9131 / 98 – 2176 (documentation) email: motioncontrol.docu@erlf.siemens.de	**Suggestions** **Corrections** For publication/manual: SINAMICS S120 Manufacturer/service documentation
From Name Company/dept. Street Zip code: Location: Telephone: / Fax: /	Installation and Start-up Manual Order no.: 6SL3 097-2AF00-0BP0 Edition: 04.2004 Should you notice any printing errors when reading this publication, please notify us on this sheet. Suggestions for improvement are also welcome.

Suggestions and/or corrections

SINAMICS documentation overview (01/2004)

General documentation/catalogs

MICRO-MASTER
410/420/430/440
DA 51.2
Converter
0.12 to 250 kW

SINAMICS
G110/G130/G150
D11
Converter
0.12–3 kW blocksize devices
75–560 kW cabinet units

SINAMICS
S150
D 21.3
Vector control
Cabinet units

SINAMICS
S120
D 21.1
Vector control
Drive system

SINAMICS
S120
D 21.2
Servo control
Drive system
(incl. servo motors)

Manufacturer/service documentation

SINAMICS
S120
Equipment manual
Control unit,
Encoder

SINAMICS
S120
Equipment manual
Booksize power sections

SINAMICS
S120
Equipment manual
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