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SINAMICS S120

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SINAMICS S120

Commissioning Manual

Manufacturer/service documentation

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Valid for

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SINAMICS S120

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2.3

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Information on SINAMICS S120 is available at:
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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. Suggestions for improvement are welcomed.

We reserve the right to make technical changes.

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 1-1 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 <ul style="list-style-type: none">• Control units and additional system components• Booksize power sections• Chassis power sections
Commissioning	<ul style="list-style-type: none">• STARTER parameterization and commissioning tool• Getting Started: SINAMICS S120• SINAMICS S120 Installation and Start-Up Manual• SINAMICS S120 Function Manual• SINAMICS S List Manual
Usage/operation	<ul style="list-style-type: none">• SINAMICS S120 Installation and Start-Up Manual• SINAMICS S120 Function Manual• SINAMICS S List Manual
Maintenance/servicing	<ul style="list-style-type: none">• SINAMICS S120 Installation and Start-Up Manual• SINAMICS S120 Function Manual• SINAMICS S List Manual• Booksize power sections• Chassis power sections

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	SINAMICS Safety Integrated
Chapter 6	Diagnostics
Chapter 7	Basic Information About the Drive System

Advice for beginners:

First read Chapters 1 and 7 and then read the relevant chapters.

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

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. 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:

- Trained or authorized to energize, de-energize, ground, and tag circuits and equipment in accordance with established safety procedures.
- 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
<http://www.siemens.com/automation/support-request>

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

Fax: +49 (0) 9131 98 – 2176
 Fax form: See the correction sheet at the end of the documentation
 E-mail: 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/motioncontrol>

Information about SINAMICS can be found on the Internet at the following address:

<http://www.siemens.com/sinamics>.

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
- p2098[1].3 Adjustable parameter 2098, index 1, bit 3
- 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):

- F12345 Fault 12345
- A67890 Alarm 67890

General notation:

- The sign “ \doteq ” means “is equal to”

ESD notices



Caution

An **electrostatic-sensitive device** (ESD) is an individual component, integrated circuit, or module that can be damaged by electrostatic fields or discharges.

Regulations for handling ESD components:

- 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.
 - The 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, otherwise they can be destroyed.
-

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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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.

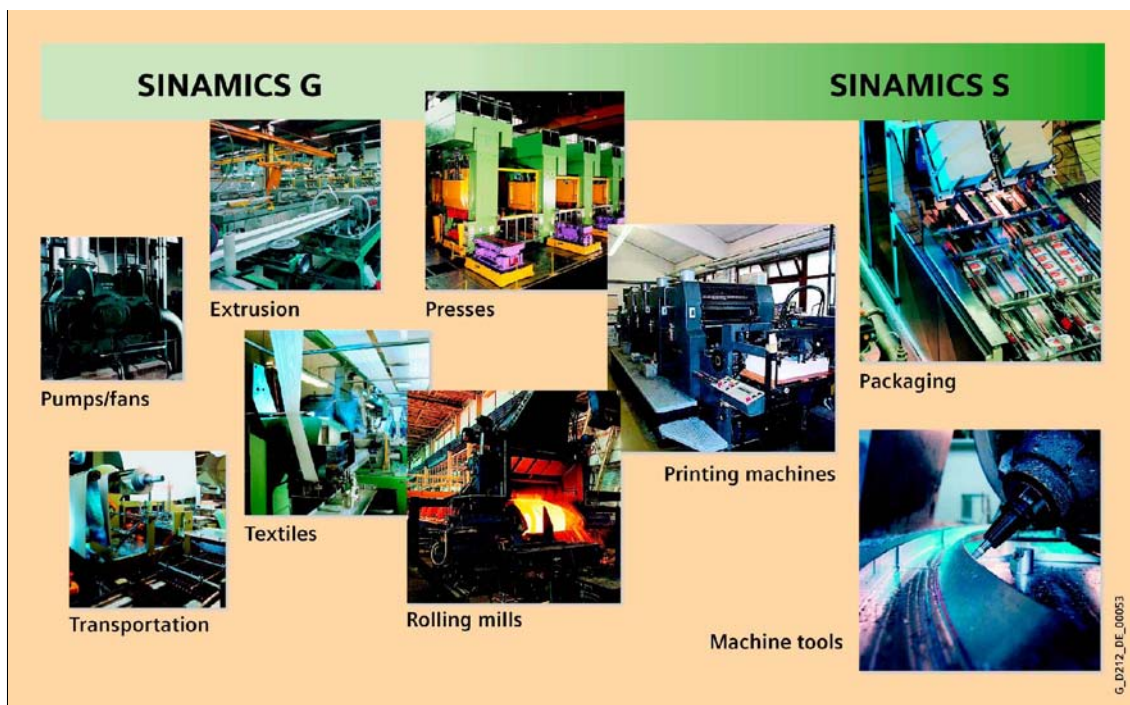


Fig. 1-1 SINAMICS applications

1.2 Versions

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

- 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.

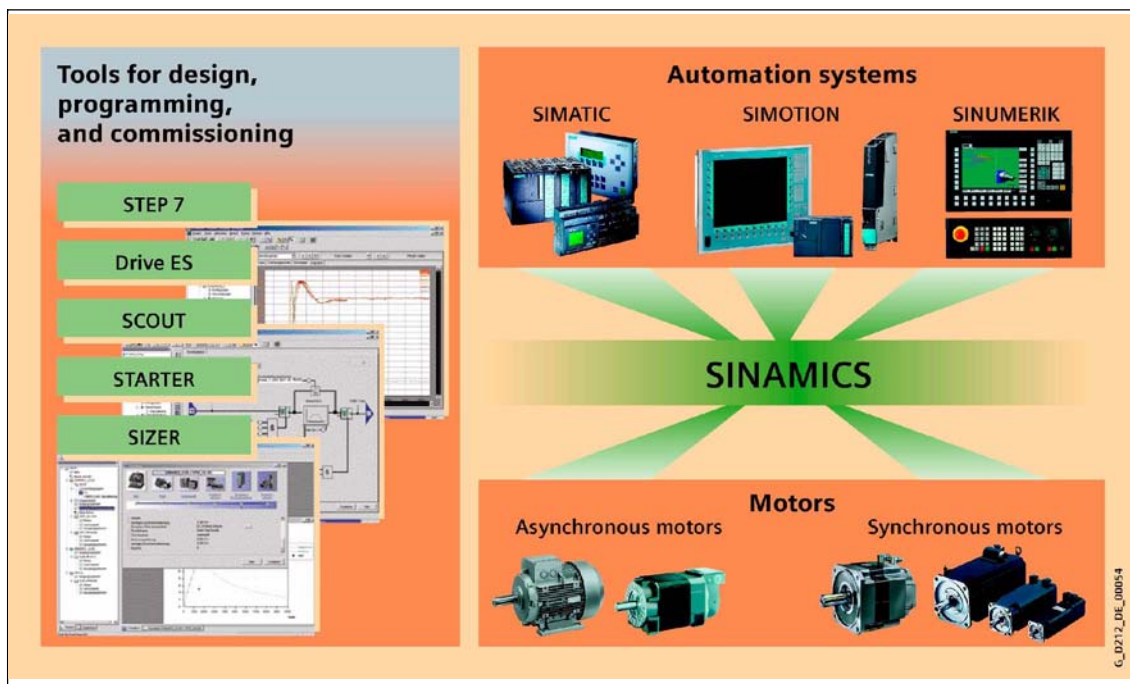


Fig. 1-2 SINAMICS as part of the Siemens modular automation concept

1.4 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.

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 drives and axes. Since all the required data is stored in the central Control Unit, it does not need to be transferred. Inter-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 technological tasks, the user-programmable modules in the SIMOTION D product spectrum are used instead.

DRIVE-CLiQ – a digital interface between all components

All SINAMICS S120 components, including the compact asynchronous 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 (sensor modules) for converting standard signals to DRIVE-CLiQ are available for motors without an integrated DRIVE-CLiQ interface.

Electronic type plates in all components

All SINAMICS S120 components have an electronic type plate that which contains all the relevant data about that particular component. In the compact asynchronous motors with a DRIVE-CLiQ interface, this data includes the parameters of the electric equivalent circuit diagram and 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.

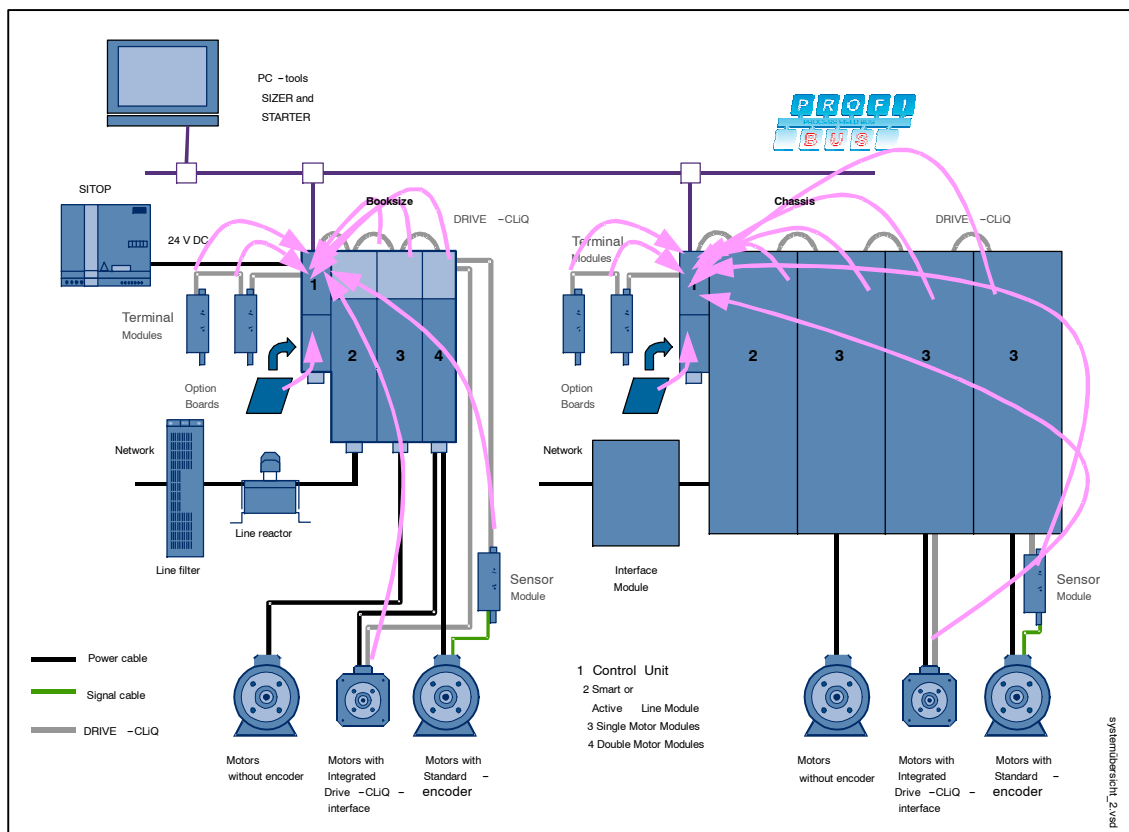


Fig. 1-4 Detection of the electronic rating plate via DRIVE-CLiQ on SINAMICS S120

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.

1.5 SINAMICS S120 components

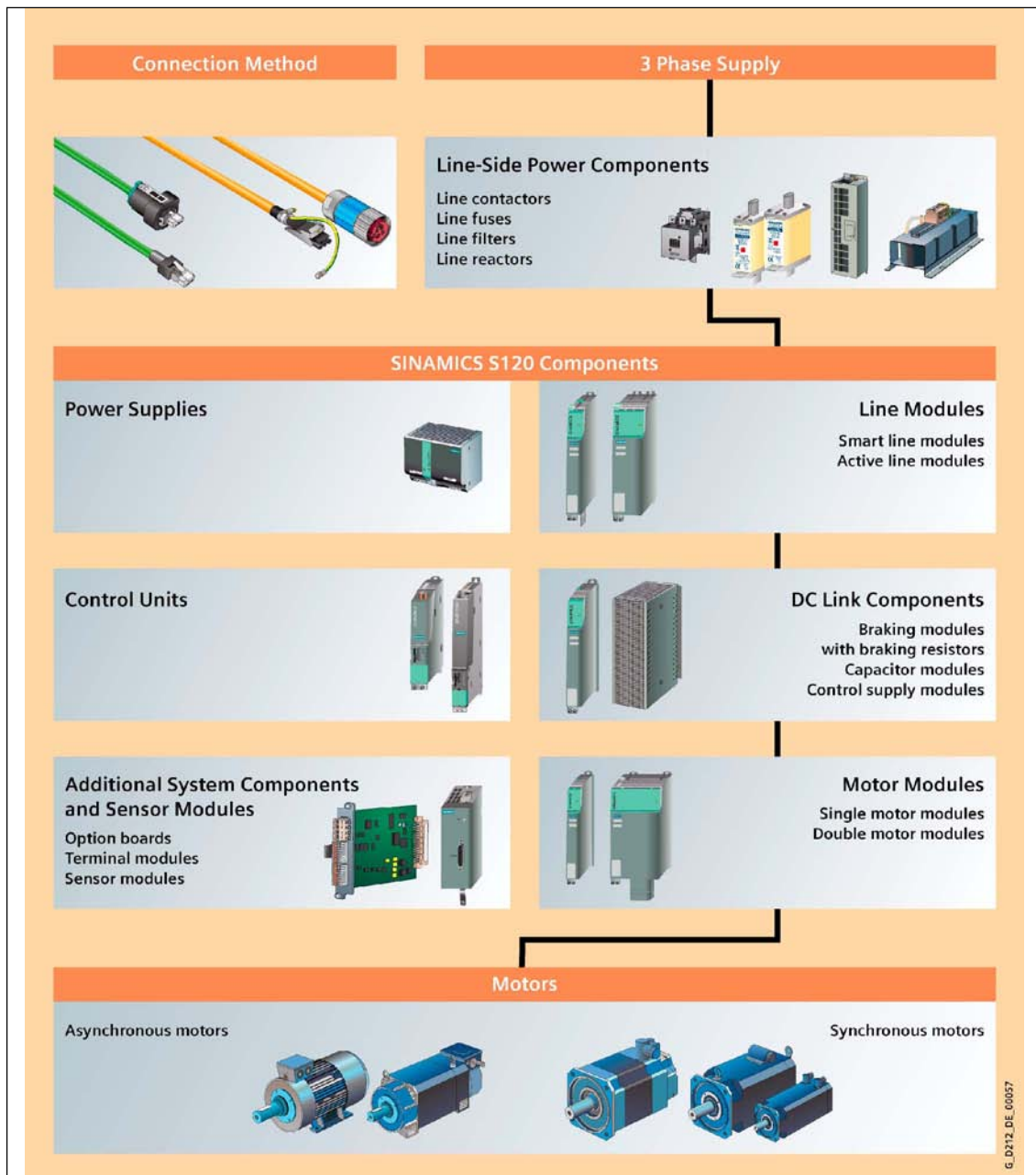


Fig. 1-5 SINAMICS S120 component overview

1.6 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 and torque controlled drives with high speed and torque accuracy particularly during operation without an encoder.
Maximum number of drives that can be controlled by one Control Unit.	1 Active Line Module + 6 Motor Modules (scanning frequency of current controller: 125 μ s / speed controller 125 μ s) 1 Active Line Module + 2 Motor Modules (scanning frequency of current controller: 62.5 μ s / speed controller 62.5 μ s)	1 Active Line Module + 2 Motor Modules (scanning frequency of current controller: 250 μ s / speed controller 1 ms) 1 Active Line Module + 4 Motor Modules (scanning frequency of current controller: 400 μ s / speed controller 1.6 ms) 1 Active Line Module + 10 Motor Modules (scanning frequency of current controller: 500 μ s / speed controller 2 ms)
Dynamic response	High	Medium
Scanning frequency of current controller/ speed controller/ pulse frequency	Booksize: 125 μ s / 125 μ s / \geq 4 kHz	Booksize: 250 μ s / 1000 μ s / \geq 2 kHz (factory setting 4 kHz) 400 μ s / 1600 μ s / \geq 1.25 kHz (factory setting 2.5 kHz) Chassis: \leq 250 kW: 250 μ s / 1000 μ s / \geq 2 kHz > 250 kW: 400 μ s / 1600 μ s / \geq 1.25 kHz 690 V: 400 μ s / 1600 μ s / \geq 1.25 kHz
Connectable motors	Synchronous servomotors Asynchronous motors	Reluctance motors Torque motors Asynchronous motors Note: No synchronous motors of types 1FT6, 1FK6, and 1FK7
Position interface via PROFIBUS for higher-level motion control	Yes	No
Sensorless speed control	Yes (as of 10% of rated motor speed)	Yes (as of standstill or 2% rated motor speed)

Table 1-1 Servo versus vector, continued

	Servo	Vector
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)
Field weakening range for induction motors	$\leq 16 * \text{field-weakening threshold speed (with encoder)}$ $\leq 5 * \text{field-weakening threshold speed (without encoder)}$	$\leq 5 * \text{rated motor speed}$
Maximum output frequency with closed-loop control	650 Hz with 125 μs / 4 kHz	300 Hz with 250 μs / 4 kHz or with 400 μs / 5 kHz
Note: Note the derating characteristics in the Equipment Manuals.		
Response during operation at thermal limit of motor	Reduction of current setpoint or shutdown	Reduction of pulse frequency and/or current setpoint or shutdown (not with parallel connection/sinusoidal filter)
Speed setpoint channel (ramp-function generator)	Optional (reduces the number of drives from 6 to 5 Motor Modules with a sampling time for current controller of 125 μs / speed controller 125 μs)	Standard
Parallel connection of Power Modules	No	Booksized: No Chassis: Yes



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
- PROFIBUS components
- Rules for wiring with DRIVE-CLiQ

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 (see Equipment Manual)

The following diagram shows a basic sample configuration with booksize and chassis components.

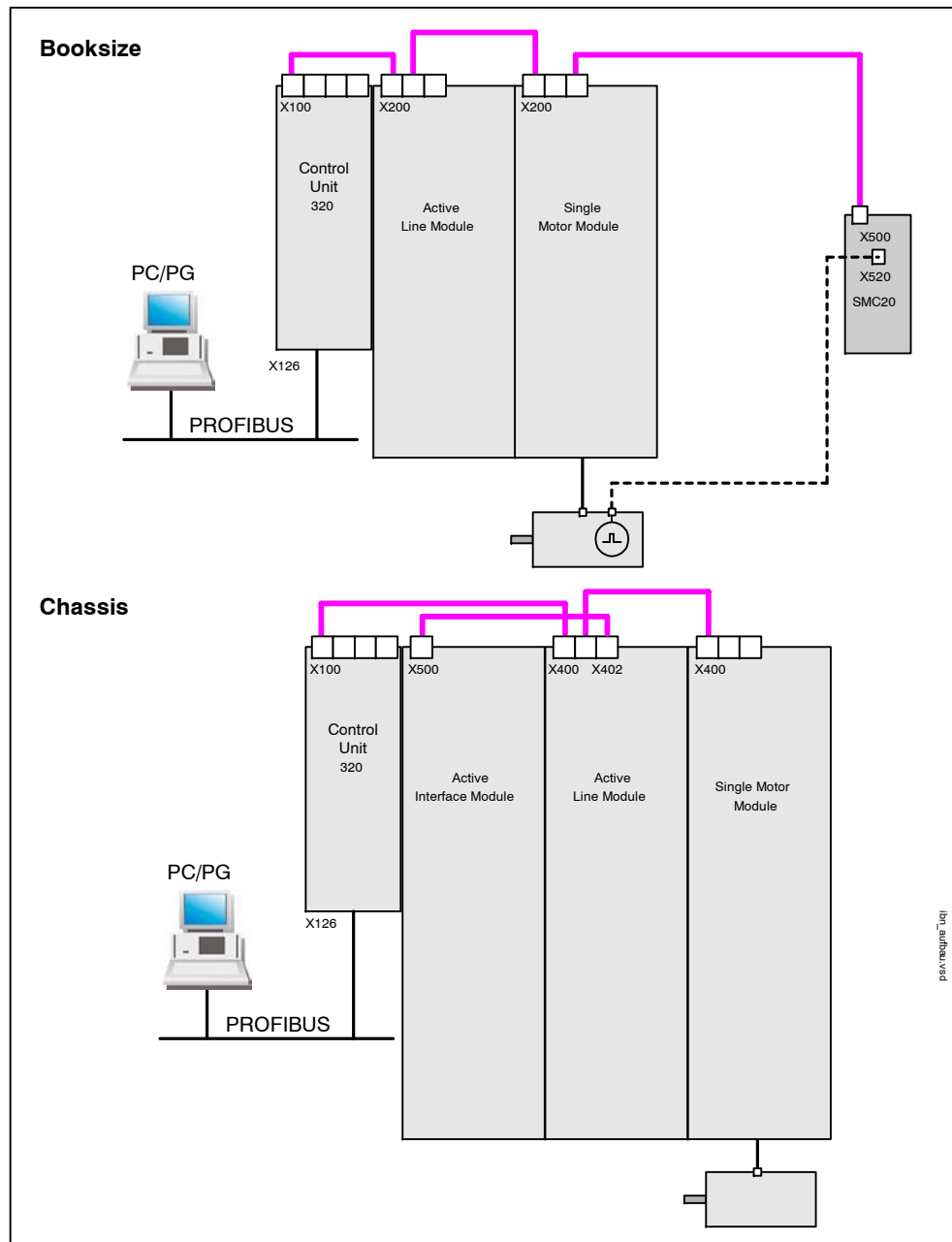


Fig. 2-1 Component configuration (example)

Checklist for commissioning booksize power sections

The following checklist must be carefully observed. Read the safety information in the Equipment Manuals before starting work.

Table 2-1 Checklist for commissioning (booksize)

Check	O. K. ✓
The ambient conditions must be permissible. See Equipment Manuals. The components must be firmly attached to the fixing points provided. The cooling air can flow unobstructed.	
The ventilation clearances for the components must be observed.	
The CompactFlash card must be inserted in the Control Unit.	
All necessary components of the configured drive line-up are installed and available.	
The DRIVE-CLiQ topology rules must be observed. For information about DRIVE-CLiQ wiring, see Section 2.3.	
The line-side and motor-side power cables must be dimensioned and routed in accordance with the ambient and routing conditions. The maximum permissible cable lengths between the converter and the motor must be observed depending on the type of cables used. The cables must be properly connected with the correct torque to the component terminals. The cables for the motor and low-voltage switchgear must also be connected with the required torques.	
Has all wiring work been successfully completed?	
Are all connectors correctly plugged in and screwed in place?	
Have all the screws been tightened to the specified torque?	
Have all the covers for the DC link been closed and latched into place?	
Are the shield connections installed correctly?	

Checklist for commissioning chassis power sections

The following checklist must be carefully observed. Read the safety information in the Equipment Manuals before starting work.

Table 2-2 Checklist for commissioning (chassis)

Activity	O. K. ✓
<p>The ambient conditions must be permissible. See Equipment Manuals.</p> <p>The components must be properly installed in the cabinet units.</p> <p>The air flow for the modules, which undergo forced cooling, must be ensured. The ventilation clearances must be ensured. The air flow specified in the technical specifications must be ensured. An air short-circuit must not be allowed to form between the chassis air inlet and outlet on account of the installation.</p>	
<p>The ventilation clearances for the components must be observed.</p>	
<p>The CompactFlash Card must be inserted in the Control Unit.</p>	
<p>All necessary components of the configured drive line-up are installed and available.</p>	
<p>The DRIVE-CLiQ topology rules must be observed.</p> <p>For information about DRIVE-CLiQ wiring, see Section 2.3.</p>	
<p>The line-side and motor-side power cables must be dimensioned and routed in accordance with the ambient and routing conditions. The maximum permissible cable lengths between the converter and the motor must be observed depending on the type of cables used.</p> <p>The ground for the motor should be directly connected to the ground for the Motor Module (short distance).</p> <p>The cables must be properly connected with the correct torque to the component terminals. The cables for the motor and low-voltage switchgear must also be connected with the required torques.</p>	
<p>The busbar/wiring for the DC connection between the infeed and the Motor Modules must be checked with regard to the load and installation conditions. When more than one motor is used, the total current of the DC connection must be observed.</p>	
<p>The cables between the low-voltage switchgear and the power section must be protected with line fuses for conductor protection (VDE 636, Part 10). Combined fuses are recommended for conductor and semi-conductor protection (VDE 636, Part 40 / EN 60269-4). For information about the relevant fuses, see the catalog.</p>	
<p>Ensure that measures are taken to relieve strain on the cables.</p>	

Table 2-2 Checklist for commissioning (chassis), continued

Activity	O. K. ✓
<p>When EMC-shielded cables are used, screwed glands that connect the shield to ground with the greatest possible surface area must be provided on the motor terminal box.</p> <p>The cable shields must be connected as close to the conductor terminal connections as possible to ensure a low-impedance connection with cabinet ground.</p>	
<p>The cable shields must be properly applied and the cabinet properly grounded at the appropriate points.</p>	
<p>The connection voltage for the fans in the chassis units must be adapted accordingly to the supply voltages by making the appropriate settings on the fan transformers.</p>	
<p>The connection bracket for the interference-suppression capacitor must be removed from the infeeds for operation with an ungrounded supply.</p>	
<p>The type plate can be used to ascertain the date of manufacture. If the period from the date of manufacture to initial commissioning or the downtime of the power components is less than two years, the DC link capacitors do not have to be reformed. If the downtime period is longer than two years, they must be reformed in accordance with the description in the "Maintenance and Servicing" chapter in the Equipment Manual.</p>	
<p>With an external auxiliary supply, the cables must be connected in accordance with the Equipment Manual.</p>	
<p>Drive operation by higher-level controller / control room. The control cables must be connected in accordance with the required interface configuration and the shield applied. Taking into account electrical interference and the distance from power cables, the digital and analog signals must be routed with separate cables.</p>	

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
- CP5512 (PROFIBUS connection via CARDBUS)
 Configuration: PCMCIA type 2 card + adapter with 9-pin SUB-D socket for connection to PROFIBUS.
 For MS Windows 2000/XP Professional and PCMCIA 32 only
 Order no.: 6GK1551-2AA00
- 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
- USB addapter (PROFIBUS connection via USB)
 Configuration: Adapter with USB connection to PC/PG and 9-pin SUB-D socket for connection to PROFIBUS
 For MS Windows 2000/XP Professional only and max. 1.5 Mbaud
 Order no.: 6ES7972-0CB20-0XA0

2. Connection cables

- Between: CP 5xxx <--> PROFIBUS
 Order no.: 6ES7901-4BD00-0XA0

Cable lengths

Table 2-3 Permissible PROFIBUS cable lengths

Baud rate [bit/s]	Max. cable length [m]
9.6 k to 187.5 k	1000
500 k	400
1.5 M	200
3 to 12 M	100

2.3 Rules for wiring with DRIVE-CLiQ

The following rules apply for wiring components with DRIVE-CLiQ. The rules are subdivided into **DRIVE-CLiQ rules**, which must be observed, and **recommended rules** which, when observed, do not require any subsequent changes to the topology created offline in STARTER.

If the actual topology does not match the topology created offline by STARTER, the offline topology must be changed before it is downloaded (see also Subsection 2.3.5).

2.3.1 General rules

DRIVE-CLiQ rules:

- A maximum of 16 nodes can be connected to a DRIVE-CLiQ line on the Control Unit.
- Up to 8 nodes can be connected in a row. A row is always seen from the perspective of the Control Unit.

Note

One Double Motor Module corresponds to two DRIVE-CLiQ nodes.

- Ring wiring is not permitted.
- Components must not be double-wired.
- All components on a DRIVE-CLiQ chain must have the same basic sampling time.

One exception here is the Line Module, see “Rules for FW2.2”.

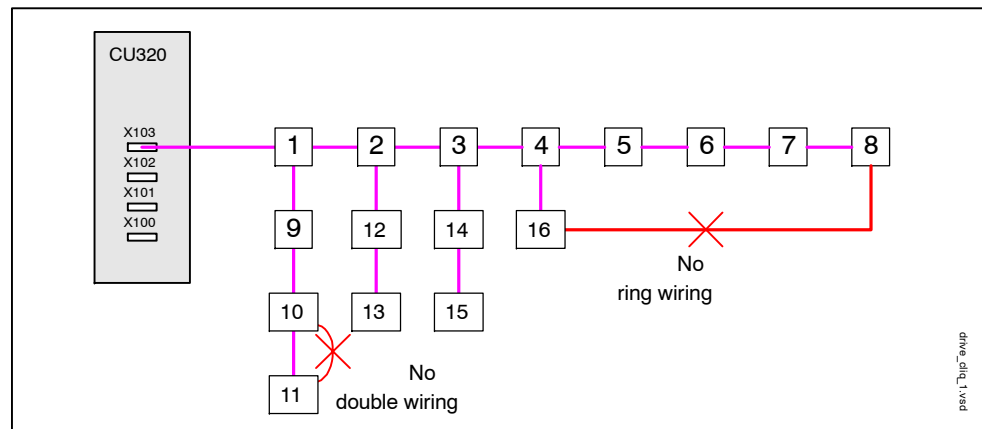


Fig. 2-2 Example: DRIVE-CLiQ line on a CU320 X103

Note

You can call up the “Topology” screen in STARTER to change and/or check the DRIVE-CLiQ topology for each drive unit.

Recommended rules:

- The DRIVE-CLiQ cable from the Control Unit must be connected to X200 on the first booksize power section or X400 on the first chassis power section.
- The DRIVE-CLiQ connections between the power sections must each be connected from interface X201 to X200 / from X401 to X400 on the follow-on component.

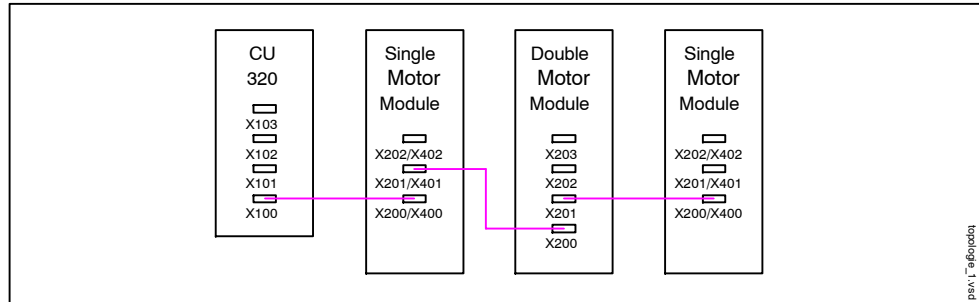


Fig. 2-3 Example: DRIVE-CLiQ line

- The motor encoder must be connected to the associated Motor Module.

Table 2-4 Motor encoder connection

Component	Motor encoder connection
Single Motor Module (booksize)	X202
Double Motor Module (booksize)	<ul style="list-style-type: none"> • Motor terminal X1: encoder to X202 • Motor terminal X2: encoder to X203
Single Motor Module (chassis)	X402

Note

If an additional encoder is connected to a Motor Module, it is automatically assigned to this drive as encoder 2.

- The Voltage Sensing Module must be connected to the associated Active Line Module. The Voltage Sensing Module is installed in the Active Interface Module (chassis).

Table 2-5 VSM connection

Component	VSM connection
Active Line Module (chassis)	X402

2.3.2 Rules for different firmware releases

Rules for FW2.1:

- Only one Active Line Module can be connected to a Control Unit.
- The default sampling times must not be changed.
- A Double Motor Module must not be operated as a single drive.
- Mixed operation (servo and vector) is not permitted.
- A maximum of nine Sensor Modules can be connected.
- The Active Line Module and the Motor Modules must be connected to separate DRIVE-CLiQ lines.

Table 2-6 Maximum number of drives that can be controlled by a Control Unit 320

	Servo	Vector
Number of components	1 Active Line Module + 6 Motor Modules	1 Active Line Module + 2 Motor Modules (scanning frequency of current controller: 250 µs / speed controller: 1000 µs)
Note: In addition, the "Safe standstill" function can be activated and a TM31 connected.		

Rules for FW2.2:

- Only one Active Line Module can be connected to a Control Unit.
- The default sampling times must not be changed.
- A Double Motor Module must not be operated as a single drive.
- Mixed operation (servo with vector V/f) is possible.
- A maximum of nine Sensor Modules can be connected.
- The Active Line Module (booksize) and Motor Modules (booksize)
 - can be connected to one DRIVE-CLiQ line in **servo** mode.
 - must be connected to separate DRIVE-CLiQ lines in **vector** mode.
- During mixed operation (servo and vector V/f), separate DRIVECLiQ lines must be used.
- The Active Line Module (chassis) and the Motor Modules (chassis) must be connected to separate DRIVE-CLiQ lines.
- Motor Modules (chassis) with different pulse frequencies must be connected to separate DRIVE-CLiQ lines.

Table 2-7 Maximum number of drives that can be controlled by a Control Unit 320

	Servo	Vector V/f (=vector without speed control function module)	Vector
Number of components	1 Active Line Module + 6 Motor Modules	1 Active Line Module + 4 Motor Modules (Sampling time of current controller 250 µs) 1 Active Line Module + 6 Motor Modules (Sampling time of current controller 400 µs)	1 Active Line Module + 2 Motor Modules (sampling time of current controller: 250 µs / speed controller: 1000 µs) 1 Active Line Module + 4 Motor Modules (sampling time of current controller: 400 µs / speed controller: 1600 µs)
	Servo and vector V/f: 1 Active Line Module + 5 Motor Modules (Servo: current controller 125 µs / speed controller 125 µs Vector V/f control Sampling time of current controller 250 µs for maximum of 2 V/f drives Sampling time of current controller 400 µs for more than 2 V/f drives)		
Notes on the maximum number of drives that can be controlled by a CU320:			
<ul style="list-style-type: none"> • In addition, the “Safe standstill” function can be activated and a TM31 connected. • No function modules must be activated. 			

Rules for FW2.3:

- Only one Active Line Module (or if connected in parallel, several) can be connected to a Control Unit.
- The default sampling times must not be changed.
- A Double Motor Module must not be operated as a single drive.
- Mixed operation (servo with vector V/f) is possible.
- A maximum of nine Sensor Modules can be connected.
- The Active Line Module (booksize) and Motor Modules (booksize)
 - can be connected to one DRIVE-CLiQ line in **servo** mode.
 - must be connected to separate DRIVE-CLiQ lines in **vector** mode.
- During mixed operation (servo and vector V/f), separate DRIVECLiQ lines must be used.
- The Active Line Module (chassis) and the Motor Modules (chassis) must be connected to separate DRIVE-CLiQ lines.
- Motor Modules (chassis) with different pulse frequencies must be connected to separate DRIVE-CLiQ lines.

Table 2-8 Maximum number of drives that can be controlled by a Control Unit 320

	Servo	Vector V/f (=vector without speed control function module)	Vector
Number of components	1 Active Line Module + 6 Motor Modules	1 Active Line Module + 4 Motor Modules (Sampling time of current controller 250 μs) 1 Active Line Module + 6 Motor Modules (Sampling time of current controller 400 μs) 1 Active Line Module + 10 Motor Modules (Sampling time of current controller 500 μs)	1 Active Line Module + 2 Motor Modules (sampling time of current controller: 250 μs / speed controller: 1000 μs) 1 Active Line Module + 4 Motor Modules (sampling time of current controller: 400 μs / speed controller: 1,600 μs)
	Servo and vector V/f: 1 Active Line Module + 5 Motor Modules (Servo: current controller 125 μs / speed controller 125 μs Vector V/f control Sampling time of current controller 250 μs with max. 2 V/f drives Sampling time of current controller 400 μs with more than 2 V/f drives)		
Notes on the maximum number of drives that can be controlled by a CU320: In addition, the "Safe standstill" function can be activated and a TM31 connected. No function modules must be activated.			

2.3.3 Sample wiring for vector drives

Drive line-up comprising three Motor Modules (chassis) with identical pulse frequencies or vector (booksize)

Motor Modules (chassis) with identical pulse frequencies or vector (booksize) can be connected to a DRIVE-CLiQ interface on the Control Unit.

In the following diagram, three Motor Modules are connected to interface X101.

Note

This topology does not match the topology created offline by STARTER and must be changed (see Subsection 2.3.5.)

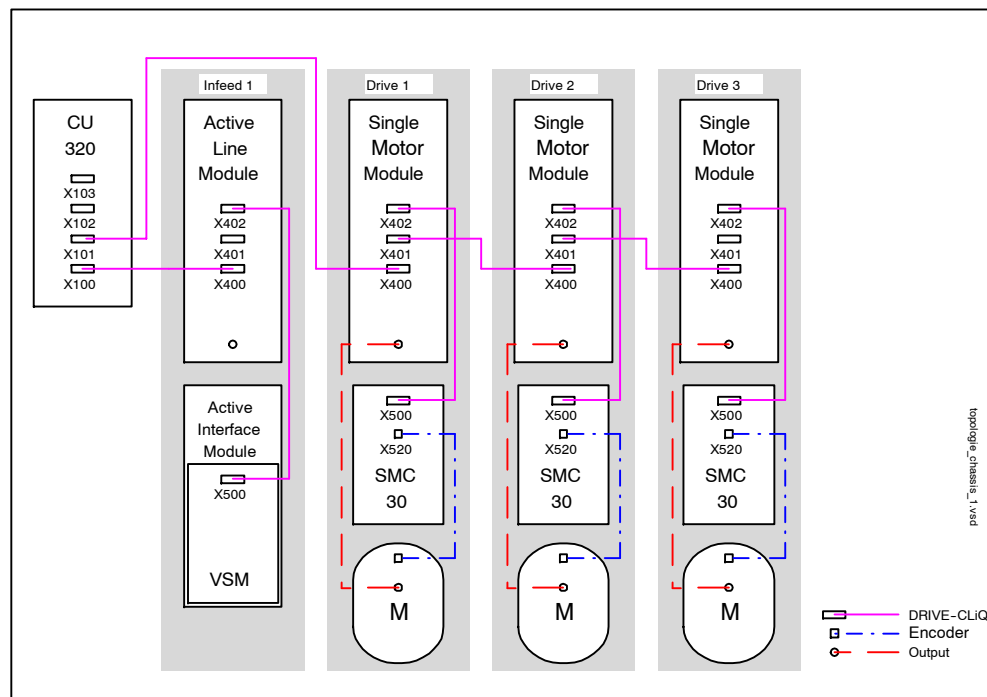


Fig. 2-4 Drive line-up (chassis) with identical pulse frequencies

Drive line-up comprising four Motor Modules (chassis) with different pulse frequencies

Motor Modules with different pulse frequencies must be connected to different DRIVE-CLiQ interfaces on the Control Unit.

In the following diagram, two Motor Modules (400 V; output \leq 250 kW; pulse frequency 2 kHz) are connected to interface X101 and two Motor Modules (400 V; output $>$ 250 kW; pulse frequency 1:25 kHz) are connected to X102.

Note

This topology does not match the topology created offline by STARTER and must be changed (see Subsection 2.3.5.)

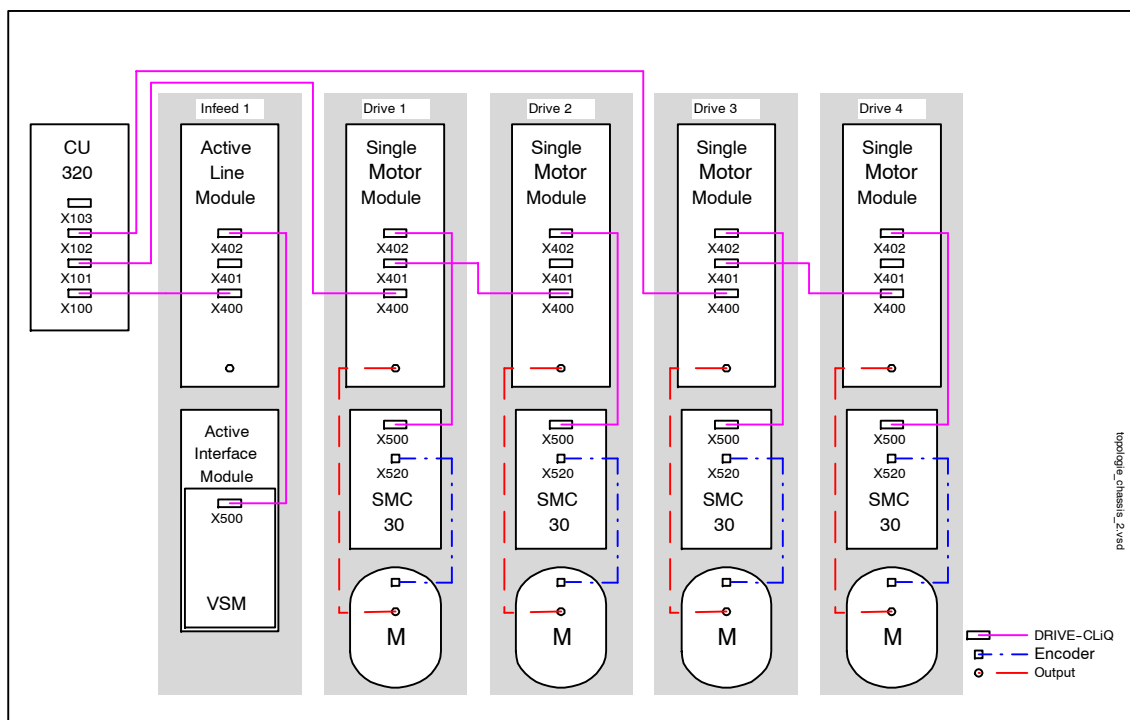


Fig. 2-5 Drive line-up (chassis) with different pulse frequencies

2.3.4 Sample wiring of Vector drives connected in parallel

Drive line-up with two parallel-connected Line Modules and Motor Modules (chassis) of the same type

Parallel-connected Line Modules (chassis) and Motor Modules (chassis) of the same type can be connected to a DRIVE-CLiQ interface of the Control Unit.

In the following diagram, two Active Line Modules and two Motor Modules are connected to the X100 and X101 interface.

For further information on parallel connection, refer to the Function Manual.

Note

This topology does not match the topology created offline by STARTER and must be changed (see Subsection 2.3.5.)

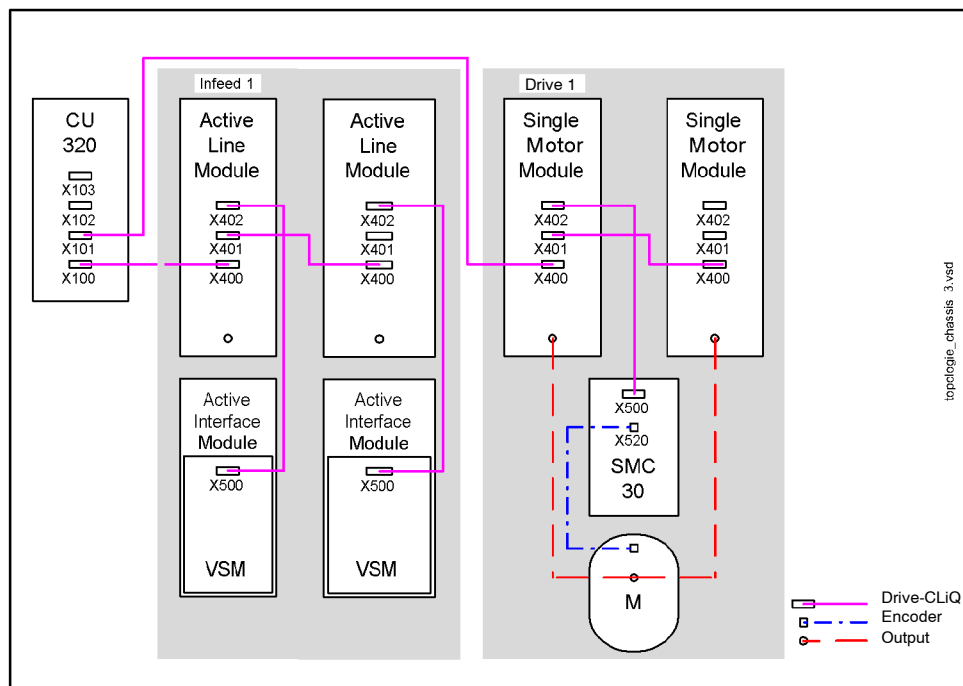


Fig. 2-6 Drive line-up with parallel-connected power units (chassis)

2.3.5 Changing the offline topology in STARTER

The device topology can be changed in STARTER by moving the components in the topology tree.

Table 2-9 Example: changing the DRIVE-CLiQ topology

	Topology tree view	Comments
		<p>Select the DRIVE-CLiQ component.</p>
		<p>Keeping the mouse button depressed, drag the component to the required DRIVE-CLiQ interface and release the mouse button.</p>
		<p>You have changed the topology in STARTER.</p>



Commissioning

3

This chapter describes the following:

- The sequence of operations during commissioning
- The STARTER commissioning tool
- Creating a project in STARTER
- Initial commissioning using servo (booksize) as an example
- Initial commissioning using vector (booksize) as an example
- Initial commissioning using vector (chassis) as an example
- Notes on commissioning linear motors (servo)

3.1 Sequence of operations during commissioning

Once the basic requirements have been met (see Chapter 2), you may proceed as follows to commission the drive:

Table 3-1 Commissioning sequence

Step	Procedure	Section
1	Create project with STARTER.	3.3
2	Configure the drive unit in STARTER.	3.4.4, 3.5.4, 3.6.4
3	Save the project in STARTER.	3.4.4, 3.5.4, 3.6.4
4	Go online with the target device in STARTER.	3.2.2
5	Load the project to the target system.	3.4.4, 3.5.4, 3.6.4
6	The motor starts rotating.	3.4.4, 3.5.4, 3.6.4

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.

Please follow the instructions on the component!



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.

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).

Residual risk

A risk assessment enables the machine manufacturer to determine the residual risk for his machine with respect to the drive units. The following residual risks are defined:

- Unexpected drive movement from standstill:
Caused, for example, by installation/operational errors or by a malfunction in the higher-level controller, drive controller, encoder evaluator, or the encoder.
This residual risk can be significantly reduced by means of the “Safe standstill” function (see Chapter 5, Safety Integrated).
- Unexpected change in speed/velocity during operation:
Caused, for example, by a malfunction in the higher-level controller, drive controller, or encoder.

3.2 STARTER commissioning tool

Brief description

STARTER is used for commissioning drive units in the MICROMASTER and SINAMICS product ranges.

STARTER can be used for the following:

- Commissioning
- Testing
- Diagnostics

System requirements

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

3.2.1 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
- Commissioning Wizard
- Displaying toolbars

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 data is loaded to the target system by choosing “Load project to target system”, the data is stored in 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
- Project 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.

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.

For more information about STARTER, see Getting Started.

Displaying toolbars

The toolbars can be activated by choosing View -> Toolbars (checkmark).

3.2.2 Activating online operation: STARTER via PROFIBUS

Description

The following options are available for online operation via PROFIBUS:

- Online operation via PROFIBUS

STARTER via PROFIBUS (example with 3 Control Units)

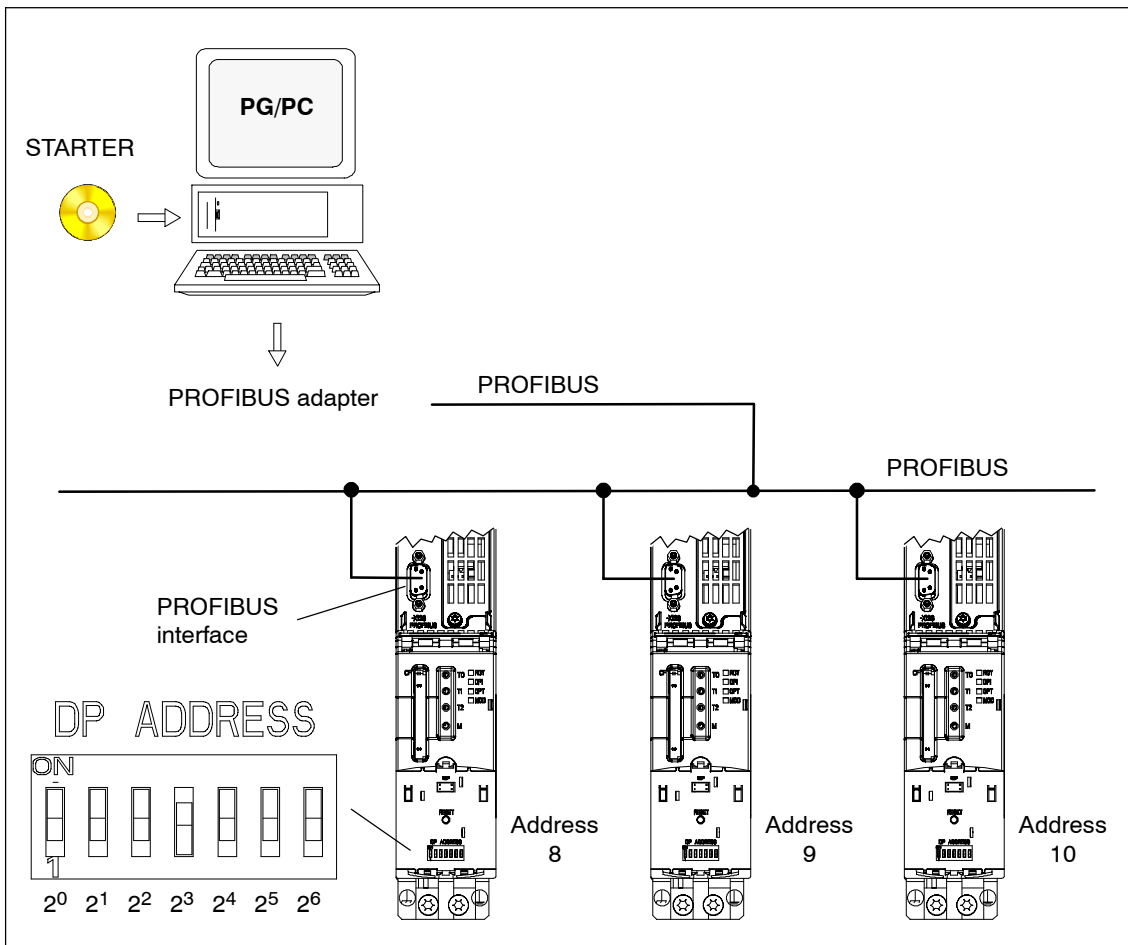


Fig. 3-1 STARTER via PROFIBUS (example with 3 Control Units)

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...
Add/remove interfaces
- Set Extras - PG/PC interface... - Properties
Activate/deactivate "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.
-

3.3 Creating a project in STARTER

3.3.1 Creating a project offline

To create a project offline, you need the PROFIBUS address, the device type (e.g. SINAMICS S120), and the device version (e.g. FW 2.2).

Table 3-2 Sequence for creating a project in STARTER (example)

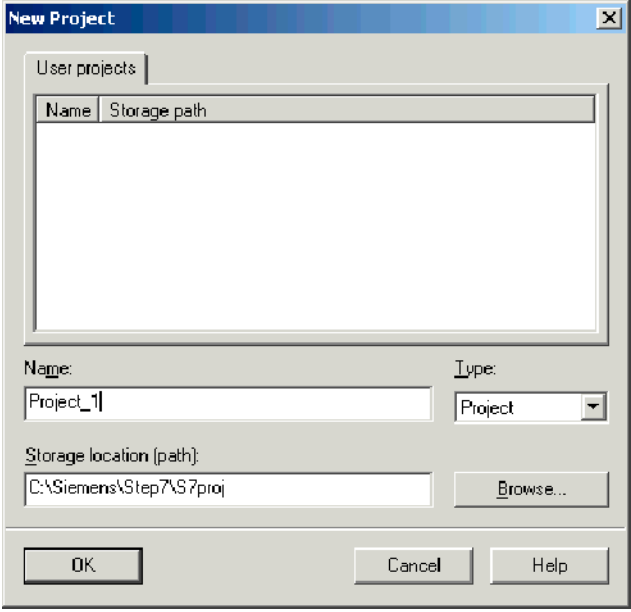
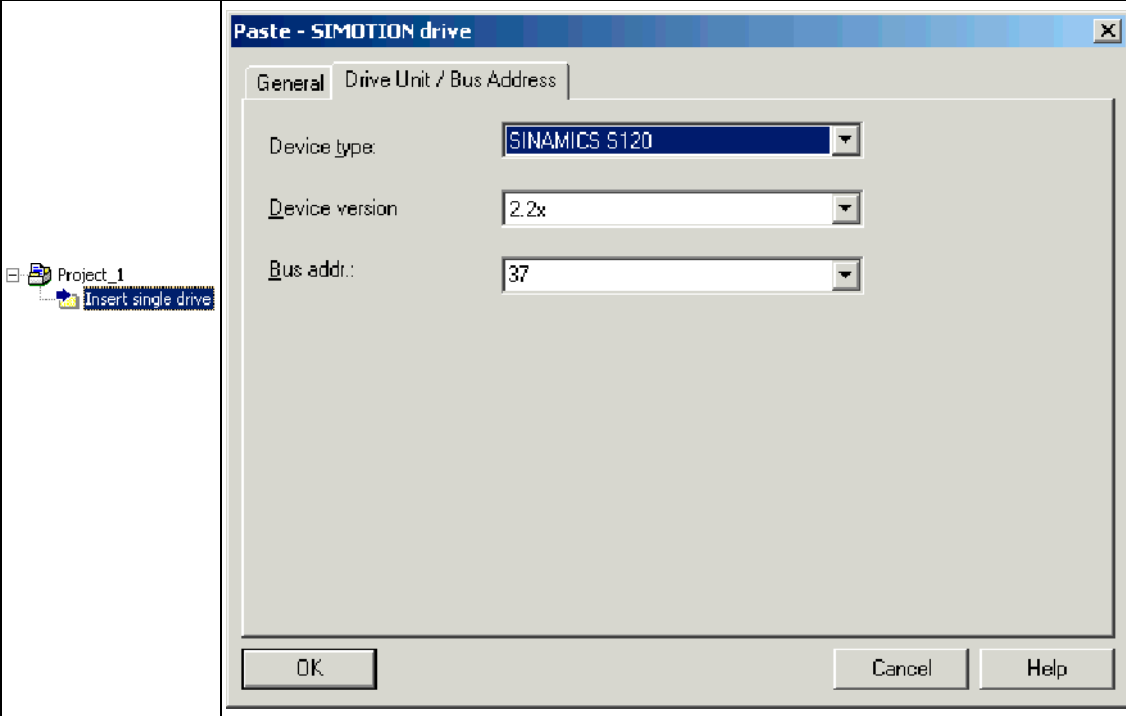
What to do	How to do it	Note
<p>1. Create a new project</p>	<p>Operator action: Menu: "Project"--> New ...</p> <p>User projects: Projects already available in the target directory</p> <p>Name: Project_01 (choose any name)</p> <p>Type: Project</p> <p>Storage location (path): Default (can be set as req.)</p>	<p>The project is created offline and loaded to the target system when configuration is complete.</p>
		

Table 3-2 Sequence for creating a project in STARTER (example), continued

What to do	How to do it	Note
<p>2. Add individual drive</p>	<p>Operator action: --> Double-click "Add individual drive". Device type: SINAMICS S120 (choose one) Device version: 2.2x (choose one) Bus address: 37 (choose one)</p>	<p>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)).</p>
		
<p>3. Configure the drive unit</p>	<p>Once you have created the project, you have to configure the drive unit. The following sections provide some examples.</p>	

3.3.2 Searching for a drive unit online

To search for a drive unit online, the drive unit and the PG/PC must be connected via PROFIBUS.

Table 3-3 Search sequence in STARTER (example)

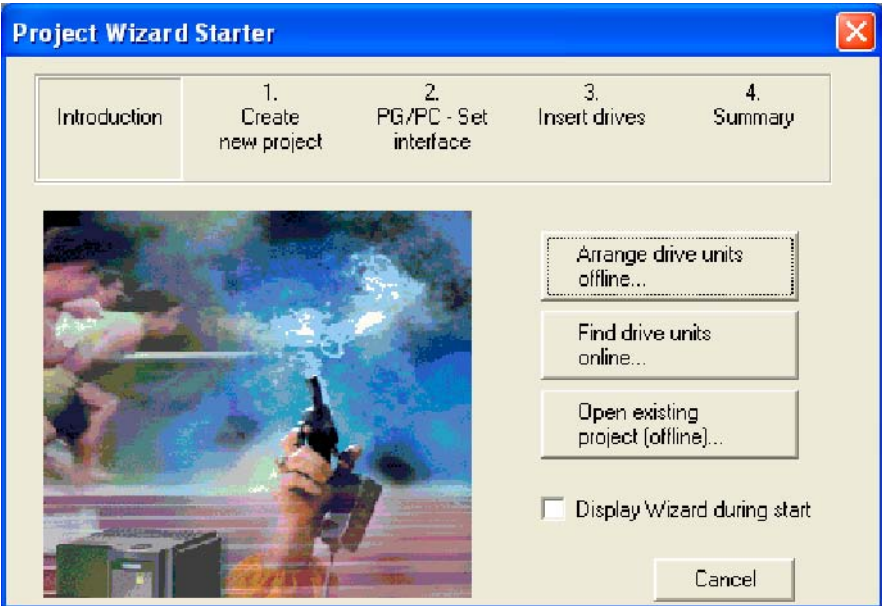
What to do	How to do it	Note
<p>1. Create a new project</p>	<p>Operator action: Menu: "Project"--> New with Wizard</p> <p>Click "Find drive unit online".</p>	
		

Table 3-3 Search sequence in STARTER (example), continued

What to do	How to do it	Note
<p>1.1. Enter the project data</p>	<p>Project name: Project_01 (choose any name) Author: Choose any name Comment: Enter any</p>	
<p>2. Set up the PG/PC interface</p>	<p>Here, you can set up the PG/PC interface by clicking "Change and test".</p>	

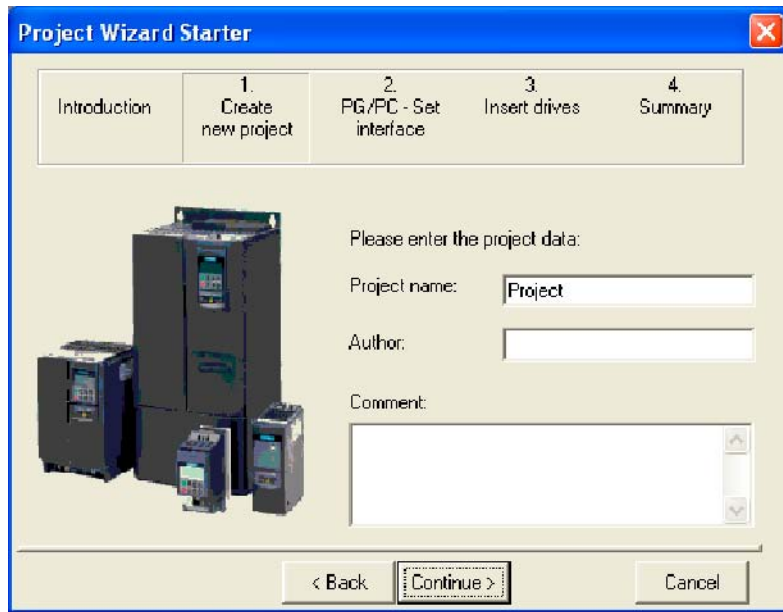
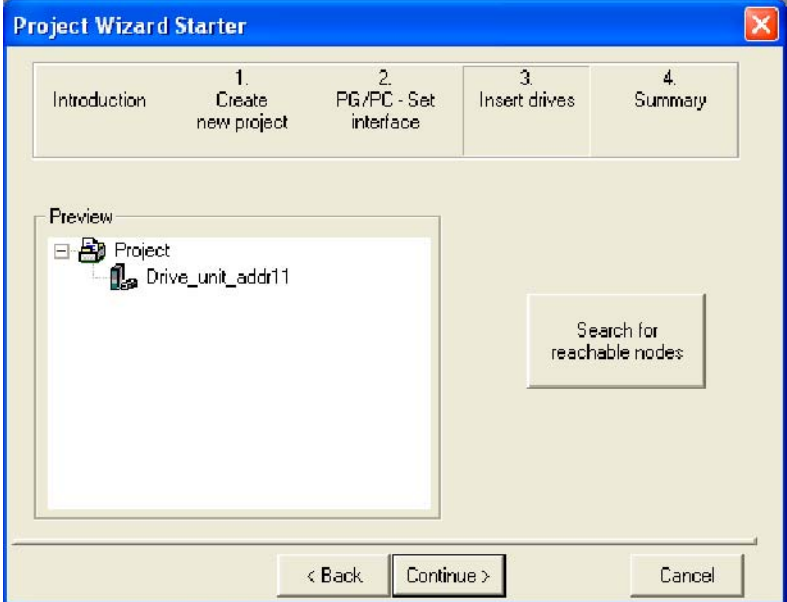



Table 3-3 Search sequence in STARTER (example), continued

What to do	How to do it	Note
<p>3. Insert the drive units</p>	<p>Here, you can search for nodes that can be accessed.</p> 	
<p>4. Summary</p>	<p>You have now created the project. --> Click "Complete".</p> 	
<p>5. Configure the drive unit</p>	<p>Once you have created the project, you have to configure the drive unit. The following sections provide some examples.</p>	

3.4 Initial commissioning using servo (booksize) as an example

The commissioning example described in this section shows all the necessary configuration and parameter settings and testing routines. Commissioning is carried out with the STARTER commissioning tool.

Requirements for commissioning

1. The commissioning requirements have been met.
--> see Chapter 2
2. The checklist for commissioning has been completed and all items are O.K.
--> see Chapter 2
3. STARTER is installed and ready to run.
--> see the "read me" file on the STARTER installation CD.
4. The electronics power supply (24 V DC) is switched on.

3.4.1 Task

1. Commission a drive system with the following components:

Table 3-4 Component overview

Designation	Component	Order No.
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 18 A	6SL3120-1TE21-8AAx
Motor 2	Induction motor	1PH7103-xNGxx-xLxx
Sensor Module 2	SMC20	6SL3055-0AA00-5BAx
Motor encoder 2	Incremental sin/cos 1Vpp 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
Telegram 370 infeed, 1 word
 - Telegram for drive 1
Standard telegram 4: speed control, 2 position encoder
 - Enable signals for drive 2
Standard telegram 3: speed control, 1 position encoder

Note

For more information on the telegram types, see "Communication via PROFIBUS" or refer to the SINAMICS S120 List Manual.

3.4.2 Component wiring (example)

The following diagram shows a possible component configuration and wiring option. The DRIVE-CLIQ wiring is highlighted in **bold**.

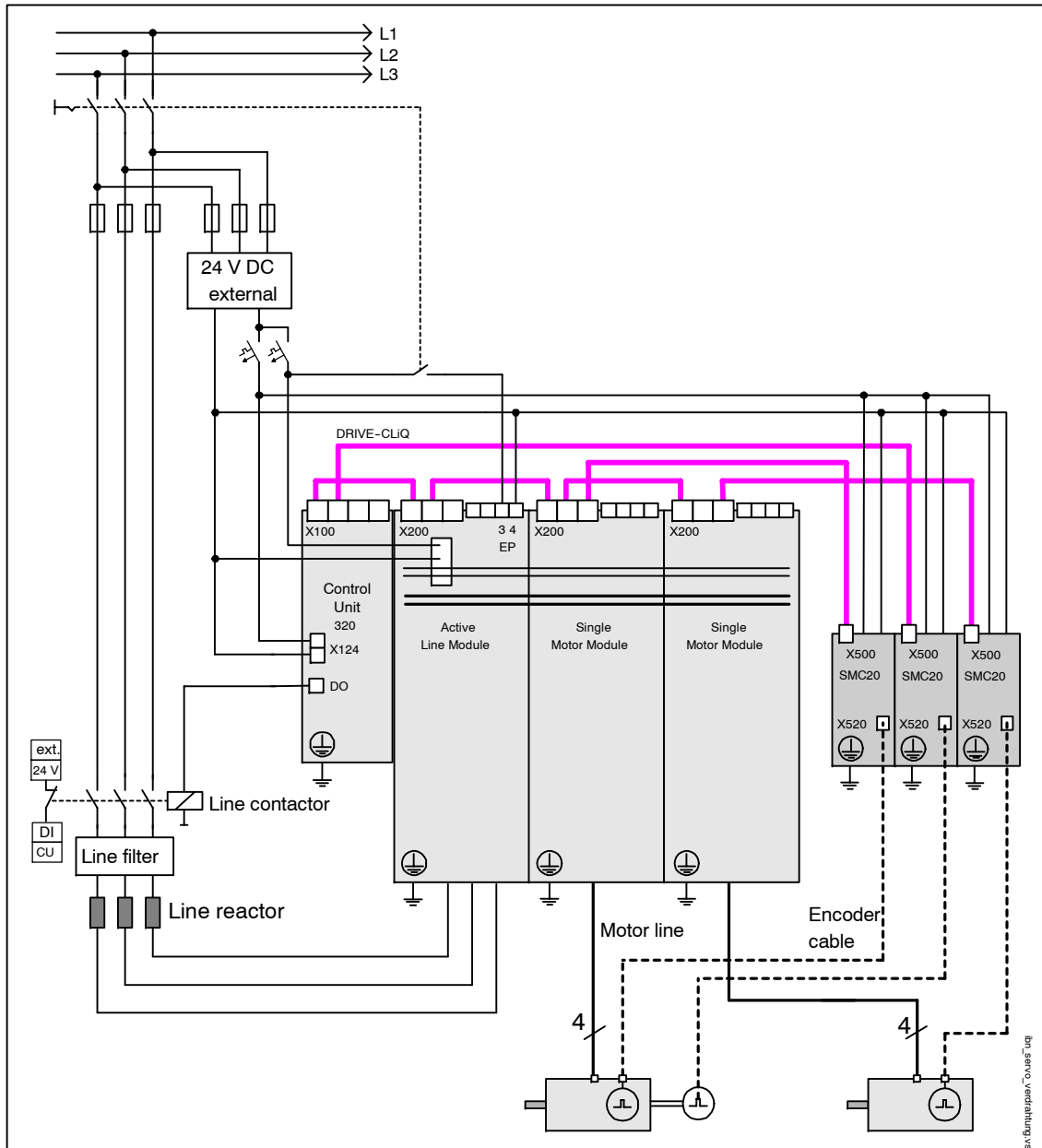


Fig. 3-2 Component wiring (example)

For more information on wiring, see the Equipment Manual.

3.4.3 Signal flow for commissioning example

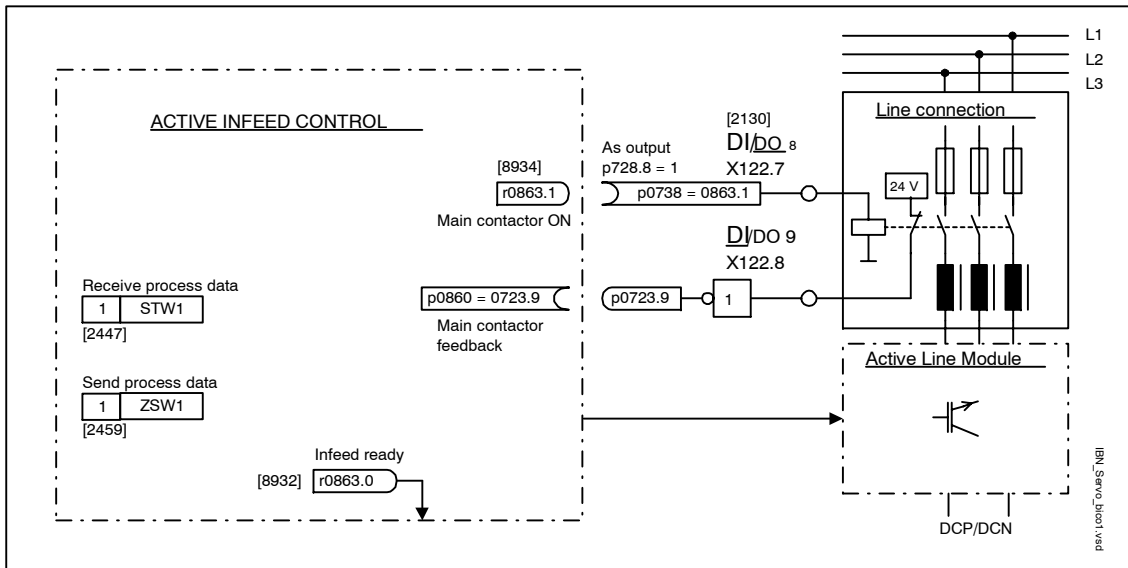


Fig. 3-3 Signal flow for initial commissioning example (servo; part 1)

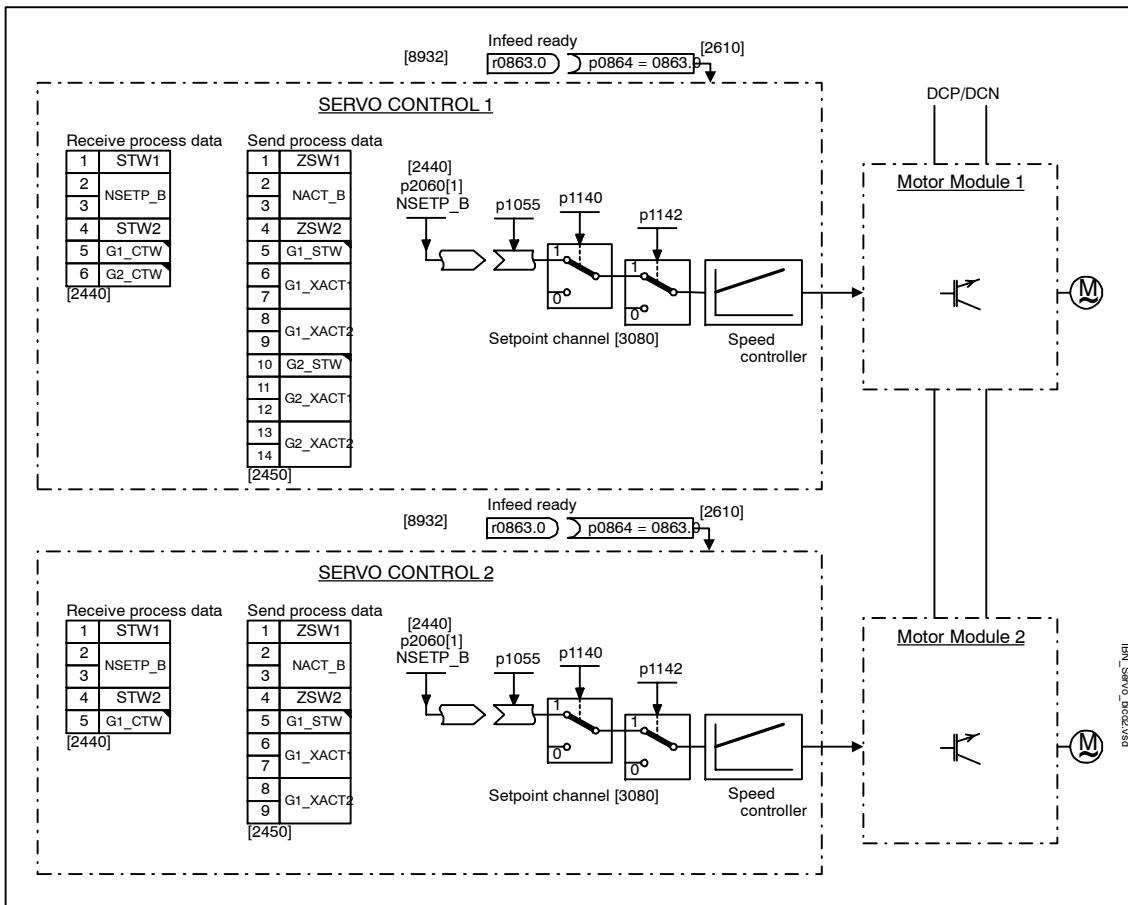


Fig. 3-4 Signal flow for initial commissioning example (servo; part 2)

3.4.4 Commissioning with STARTER (example)

The table 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	Note
1. Automatic configuration	Operator action: --> "Project" --> "Connect to target system" --> Double-click "Automatic configuration". --> Follow the instructions provided in the Wizard.	
2. Configure the supply	The supply must be configured. Name of supply --> Double-click "Configuration" --> Click "Configure DDS"	
2.1. Supply Wizard	The Wizard displays the data determined automatically from the electronic type plate. You can now set the line/DC link identification. You have to enter the device connection voltage and rated line frequency. "Line filter available" must be active. PROFIBUS telegram type 370 must be installed. This completes the configuration for the supply.	If the line environment or DC link components are changed, line/DC link identification should be repeated.
3. Configure drives	The drives must be configured individually. --> "Drives" --> Drive name --> Double-click "Configuration" --> Click "Configure DDS"	
3.1. Control structure	You can activate the function modules. You can select the control type.	
3.2. Power unit	The Wizard displays the data determined automatically from the electronic type plate.	
3.3. Motor	You can enter the name of the motor (e.g. equipment ID). Select standard motor from list: Yes Select the motor type (see type plate).	You can select a standard motor from the list of motors or you can enter the motor data yourself. You can then select the motor type.
3.4. Motor brake	You can activate and configure the motor brake.	
3.5. Process data exchange	PROFIBUS telegram type 4 (drive 1) and 3 (drive 2) must be selected.	

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

What to do	How to do it	Note
3.6. Motor data	You can enter the motor data on the type plate here. Induction motors (rotary): If known, mechanical data for the motor and drive line can be entered. Synchronous motors (rotary, permanent-magnet) If known, the data for a PE spindle can be entered.	If you do not enter any mechanical data, it is estimated on the basis of the data on the type plate. The equivalent circuit diagram data is also estimated on the basis of the data on the type plate or determined by means of automatic motor data identification.
3.7. Motor brakes	Here, you can configure the brake and activate the "Extended brake control" function module.	For more information, see the Function Manual.
3.8. Encoder	Motor encoder (encoder 1): Choose standard encoder from list: Yes Choose "2048, 1Vpp, A/B C/D R". External encoder (encoder 2): Rotary: Yes Measuring system: "incremental sinusoidal/cosinusoidal" Resolution: "4096" Zero marker: "No zero marker"	If you are using an encoder that is not in the list, you can also enter the data.
3.9. Drive functions	You can choose the application here.	Your choice of application influences the calculation for the open-loop/closed-loop control parameters.
3.10. Summary	The drive data can be copied to the clipboard for plant documentation purposes and then added to a text program, for example.	
4. 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] In the Function --> Line contactor control screen, you can check that the interconnection is correct.

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

What to do	How to do it	Note
5. Save the parameters on the device	<ul style="list-style-type: none"> • 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.
6. The motor starts rotating.	<p>The drives can be started via the control panel in STARTER.</p> <ul style="list-style-type: none"> • This can be done once the pulses have been enabled for the infeed and line/DC link identification has been activated. The infeed then switches to operational mode. 	<p>For more information about the control panel, see Getting Started.</p> <p>For more information about line/DC link identification, see the Function Manual.</p>

STARTER diagnosis options

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

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

3.5 Initial commissioning using vector (booksize) as an example

The commissioning example described in this section shows all the necessary configuration and parameter settings and testing routines. Commissioning is carried out with the STARTER commissioning tool.

Requirements for commissioning

1. The commissioning requirements have been met.
--> see Chapter 2
2. The checklist for commissioning has been completed and all items are O.K.
--> see Chapter 2
3. STARTER is installed and ready to run.
--> see the "read me" file on the STARTER installation CD.
4. The electronics power supply (24 V DC) is switched on.

3.5.1 Task

1. Commission a drive system with the following components:

Table 3-6 Component overview

Designation	Component	Order No.
Closed-loop control and infeed		
Control unit	Control Unit 320	6SL3040-0MA00-0AAx
Smart Line Module	Smart Line Module 10 kW	6SL3130-6AE21-0AAx
Line filter package 10 kW	Line filter and line reactor	6SL3130-0GE21-0AAx
Drive 1		
Motor Module	Single Motor Module 5 A	6SL3120-1TE15-0AAx
Motor	Induction motor	1LA
Drive 2		
Motor Module	Single Motor Module 5 A	6SL3120-1TE15-0AAx
Motor	Induction motor	1LA

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

3.5.2 Component wiring (example)

The following diagram shows a possible component configuration and wiring option. The DRIVE-CLIQ wiring is highlighted in **bold**.

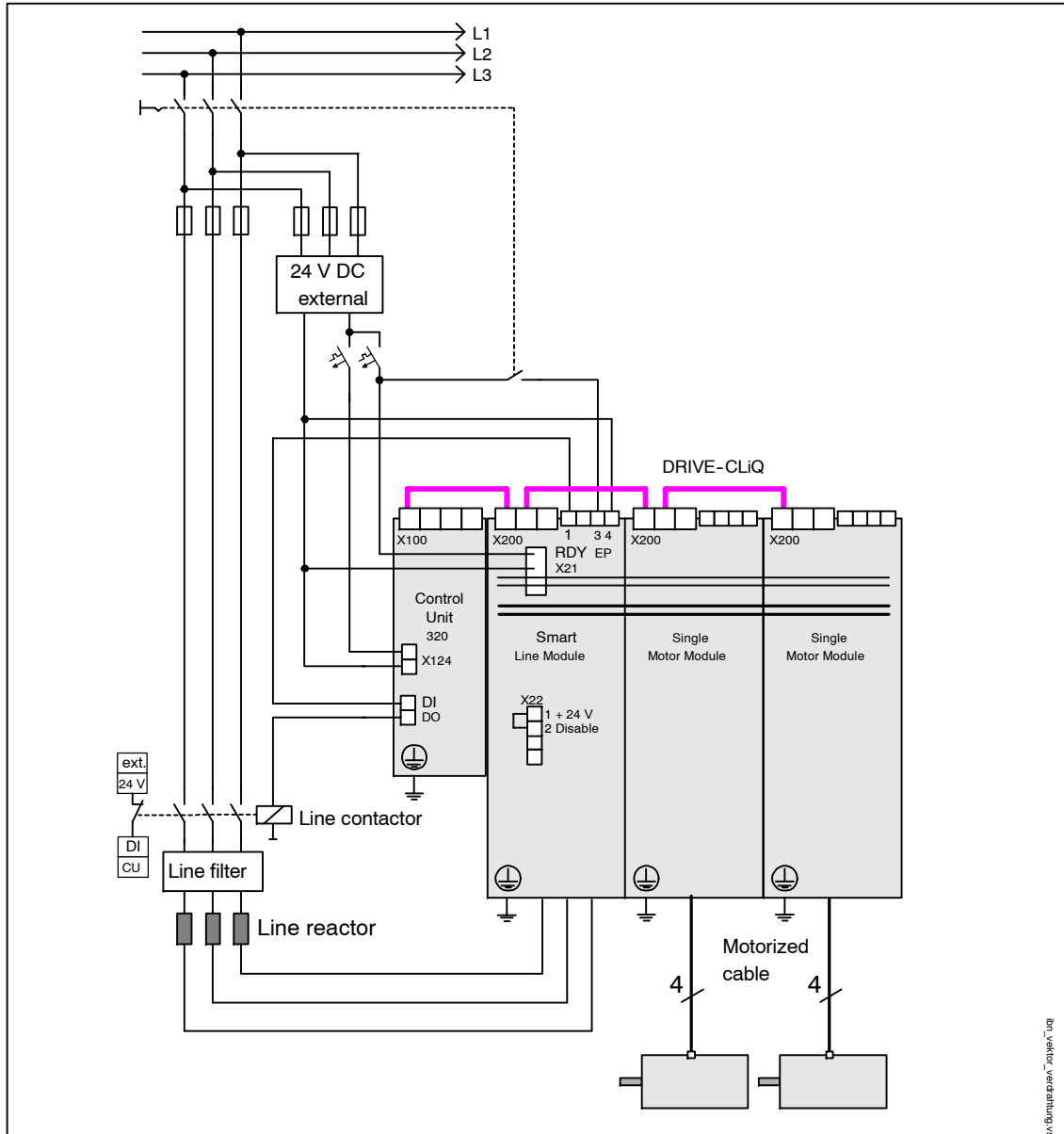


Fig. 3-5 Component wiring (example)

For more information on wiring, see the Equipment Manual.

3.5.3 Signal flow for commissioning example

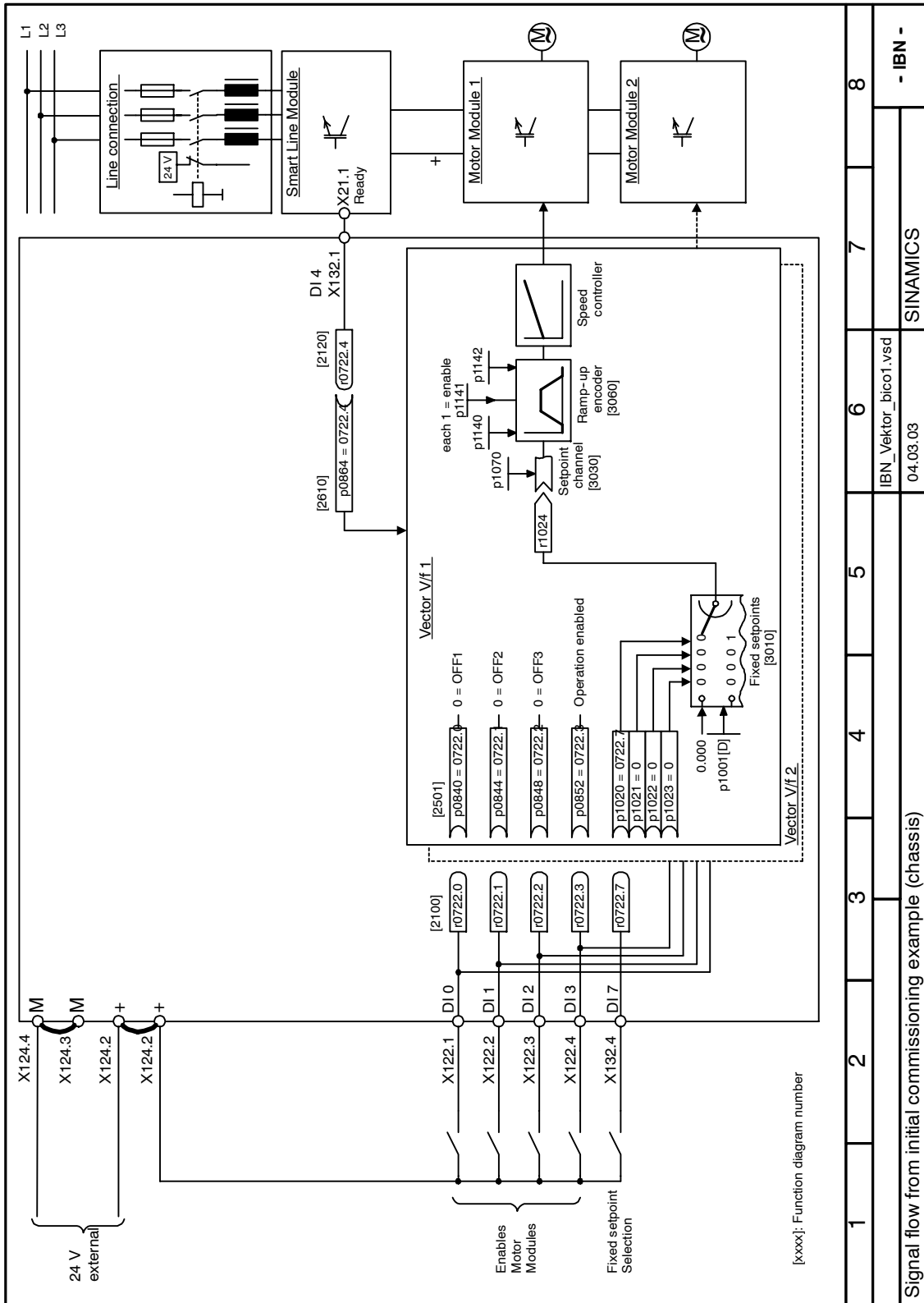


Fig. 3-6 Signal flow for initial commissioning example (booksize; vector)

3.5.4 Commissioning with STARTER (example)

The table below describes the steps for commissioning the example with STARTER.

Table 3-7 Commissioning sequence with STARTER (example)

What to do	How to do it	Note
1. Automatic configuration	Operator action: --> "Project" --> "Connect to target system" --> Double-click "Automatic configuration". --> Follow the instructions provided in the Wizard.	
2. Configure drives	The drives must be configured individually. --> "Drives" --> Drive name --> Double-click "Configuration" --> Click "Configure DDS"	
2.1. Control structure	You can activate the function modules. You can select the control type.	
2.2. Power unit	The Wizard displays the data determined automatically from the electronic type plate.	Caution If a sinusoidal filter is connected, it must be activated here to prevent it from being destroyed.
2.3. BiCo power section	Supply in operation Control Unit: r0722.4 (digital input 4)	
2.4. Drive setting	You can select the motor standard (IEC / NEMA) and power unit application (duty cycles).	
2.5. Motor	You can enter the name of the motor (e.g. equipment ID). Enter motor data: Yes Select motor type "1Lax".	You can select a standard motor from the list of motors or you can enter the motor data yourself. You can then select the motor type.
2.6. Motor data	You can enter the motor data on the type plate here. If known, mechanical data for the motor and drive line can be entered. Equivalent circuit diagram data: No	If you do not enter any mechanical data, it is estimated on the basis of the data on the type plate. The equivalent circuit diagram data is also estimated on the basis of the data on the type plate or determined by means of automatic motor data identification.
2.7. Motor brake	Here, you can configure the brake and activate the "Extended brake control" function module.	For more information, see the Function Manual.

Table 3-7 Commissioning sequence with STARTER (example), continued

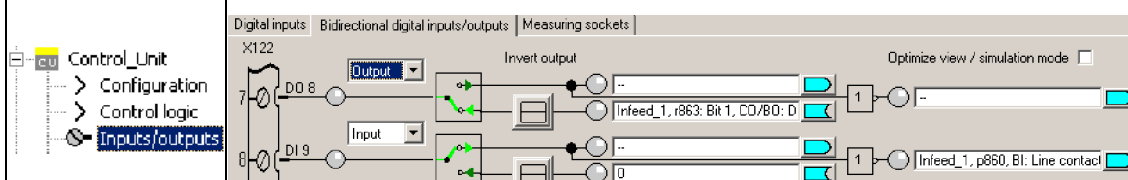
What to do	How to do it	Note
2.8. Encoder	The encoder must be deselected in this example.	If you are using an encoder that is not in the list, you can also enter the data.
2.9. Drive functions	You can choose the application and motor identification here. Motor identification: "1"	Your choice of application influences the calculation for the open-loop/closed-loop control parameters. When the pulses are enabled, a one-off identification run is carried out. Current flows through the motor which means that it can align itself by up to a quarter of a revolution. Once the measurement is complete, optimization with rotating motor is carried out the next time the pulses are enabled.
2.10. Key parameters	You must enter key parameters in accordance with the relevant application. Note, for example, the general mechanical conditions for the drive line.	
2.11. Summary	The drive data can be copied to the clipboard for plant documentation purposes and then added to a text program, for example.	
3. Enable signals and BICO interconnections	The enable signals for the infeed and the two drives must be transmitted via the digital input on Control Unit 320.	
3.1. Line contactor	<ul style="list-style-type: none"> Line contactor <p>p0728.8 = 1 Set DI/DO as output p0738 = 863.1 Activate line contactor p0860 = 723.9 Line contactor feedback</p>	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]
		

Table 3-7 Commissioning sequence with STARTER (example), continued

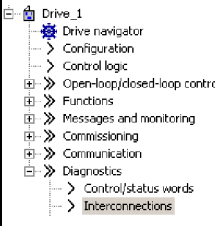
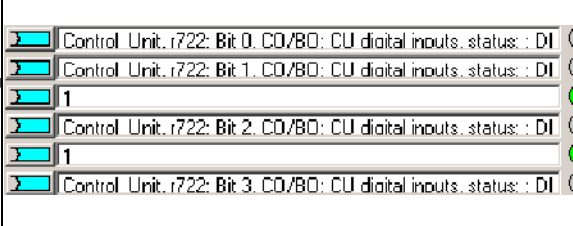
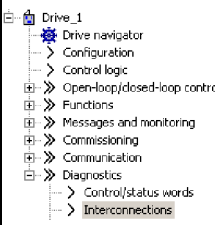

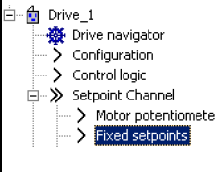
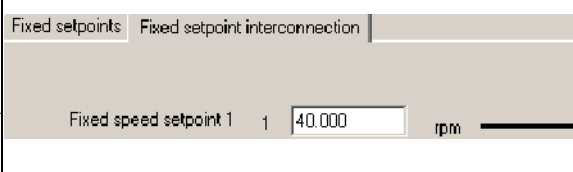
What to do	How to do it	Note												
<p>3.2. Enable Motor Module</p>	<ul style="list-style-type: none"> Enable signals for the Motor Module (drive_1) <ul style="list-style-type: none"> p0840 = 722.0 ON/OFF1 p0844 = 722.1 1st OFF2 p0845 = 1 2nd OFF2 p0848 = 722.2 1st OFF3 p0849 = 1 2nd OFF3 p0852 = 722.3 Enable operation 	<p>See function diagram [2501]</p>												
		<table border="0"> <tr> <td><input type="radio"/></td> <td>p840[0], BI: ON/OFF1</td> </tr> <tr> <td><input type="radio"/></td> <td>p844[0], BI: 1. OFF2</td> </tr> <tr> <td><input checked="" type="radio"/></td> <td>p845[0], BI: 2. OFF2</td> </tr> <tr> <td><input type="radio"/></td> <td>p848[0], BI: 1. OFF3</td> </tr> <tr> <td><input checked="" type="radio"/></td> <td>p849[0], BI: 2. OFF3</td> </tr> <tr> <td><input type="radio"/></td> <td>p852[0], BI: Enable operation</td> </tr> </table>	<input type="radio"/>	p840[0], BI: ON/OFF1	<input type="radio"/>	p844[0], BI: 1. OFF2	<input checked="" type="radio"/>	p845[0], BI: 2. OFF2	<input type="radio"/>	p848[0], BI: 1. OFF3	<input checked="" type="radio"/>	p849[0], BI: 2. OFF3	<input type="radio"/>	p852[0], BI: Enable operation
<input type="radio"/>	p840[0], BI: ON/OFF1													
<input type="radio"/>	p844[0], BI: 1. OFF2													
<input checked="" type="radio"/>	p845[0], BI: 2. OFF2													
<input type="radio"/>	p848[0], BI: 1. OFF3													
<input checked="" type="radio"/>	p849[0], BI: 2. OFF3													
<input type="radio"/>	p852[0], BI: Enable operation													
<p>3.3. Ramp-function generator</p>	<p>Ramp-function generator</p> <ul style="list-style-type: none"> p1140 = 1 Enable ramp-function generator p1141 = 1 Start ramp-function generator p1142 = 1 Enable speed setpoint 	<p>See function diagram [3060]</p>												
		<table border="0"> <tr> <td><input checked="" type="radio"/></td> <td>p1140[0], BI: Enables the ramp-function generator</td> </tr> <tr> <td><input checked="" type="radio"/></td> <td>p1141[0], BI: Start ramp-function generator</td> </tr> <tr> <td><input checked="" type="radio"/></td> <td>p1142[0], BI: Enable speed setpoint</td> </tr> </table>	<input checked="" type="radio"/>	p1140[0], BI: Enables the ramp-function generator	<input checked="" type="radio"/>	p1141[0], BI: Start ramp-function generator	<input checked="" type="radio"/>	p1142[0], BI: Enable speed setpoint						
<input checked="" type="radio"/>	p1140[0], BI: Enables the ramp-function generator													
<input checked="" type="radio"/>	p1141[0], BI: Start ramp-function generator													
<input checked="" type="radio"/>	p1142[0], BI: Enable speed setpoint													
<p>3.4. Setpoint</p>	<p>Specify setpoint</p> <p>p1001 = 40 Fixed speed setpoint 1</p>	<p>See function diagram [3010]</p>												
														

Table 3-7 Commissioning sequence with STARTER (example), continued

What to do	How to do it	Note
4. Save the parameters on the device	<ul style="list-style-type: none"> • 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.
5. The motor starts rotating.	<p>The drives can be started via the control panel in STARTER.</p> <ul style="list-style-type: none"> • This can be done once the pulses have been enabled for the infeed and line/DC link identification has been activated. The infeed then switches to operational mode. • Once the pulses are enabled, a one-off motor data identification run (if activated) is carried out. • When the pulses are enabled again, optimization with a rotating motor (if activated) is carried out. 	<p>For more information about the control panel, see Getting Started.</p> <p>During motor identification, a current flows through the motor, which means that it can align itself by up to a quarter of a revolution.</p> <p>For more information about line/DC link identification and motor identification, see the Function Manual.</p>

STARTER diagnosis options

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

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

3.6 Initial commissioning using vector (chassis) as an example

The commissioning example described in this section shows all the necessary configuration and parameter settings and testing routines. Commissioning is carried out with 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 2.2
3. STARTER is installed and ready to run.
--> see the "read me" file on the STARTER installation CD.
4. The electronics power supply (24 V DC) is switched on.

3.6.1 Task

1. Commission a drive system with the following components:

Table 3-8 Component overview

Designation	Component	Order No.
Closed-loop control and infeed		
Control unit	Control Unit 320	6SL3040-0MA00-0AAx
Active Line Module	Active Line Module 380 kW / 400 V	6SL3330-7TE36-1AAx
Active Interface Module	Active Interface Module	6SL3300-7TE38-4AAx
Drive 1		
Motor Module	Motor Module 380 A	6SL3320-1TE33-8AAx
Motor	Induction motor - without brake - with encoder	Type: 1LA8 Rated voltage = 400 V Rated current = 345 A Rated power = 200 kW Rate power factor = 0.86 Rated frequency = 50.00 Hz Rated speed = 989 rpm Cooling method = Self cooling HTL encoder, 1024 p/r, A/B, R
Drive 2		
Motor Module	Motor Module 380 A	6SL3320-1TE33-8AAx
Motor	Induction motor - without brake - with encoder	Type: 1LA8 Rated voltage = 400 V Rated current = 345 A Rated power = 200 kW Rate power factor = 0.86 Rated frequency = 50.00 Hz Rated speed = 989 rpm Cooling method = Self cooling HTL encoder, 1024 p/r, A/B, R

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

3.6.2 Component wiring (example)

The following diagram shows a possible component configuration and wiring option. The DRIVE-CLiQ wiring is highlighted in **bold**.

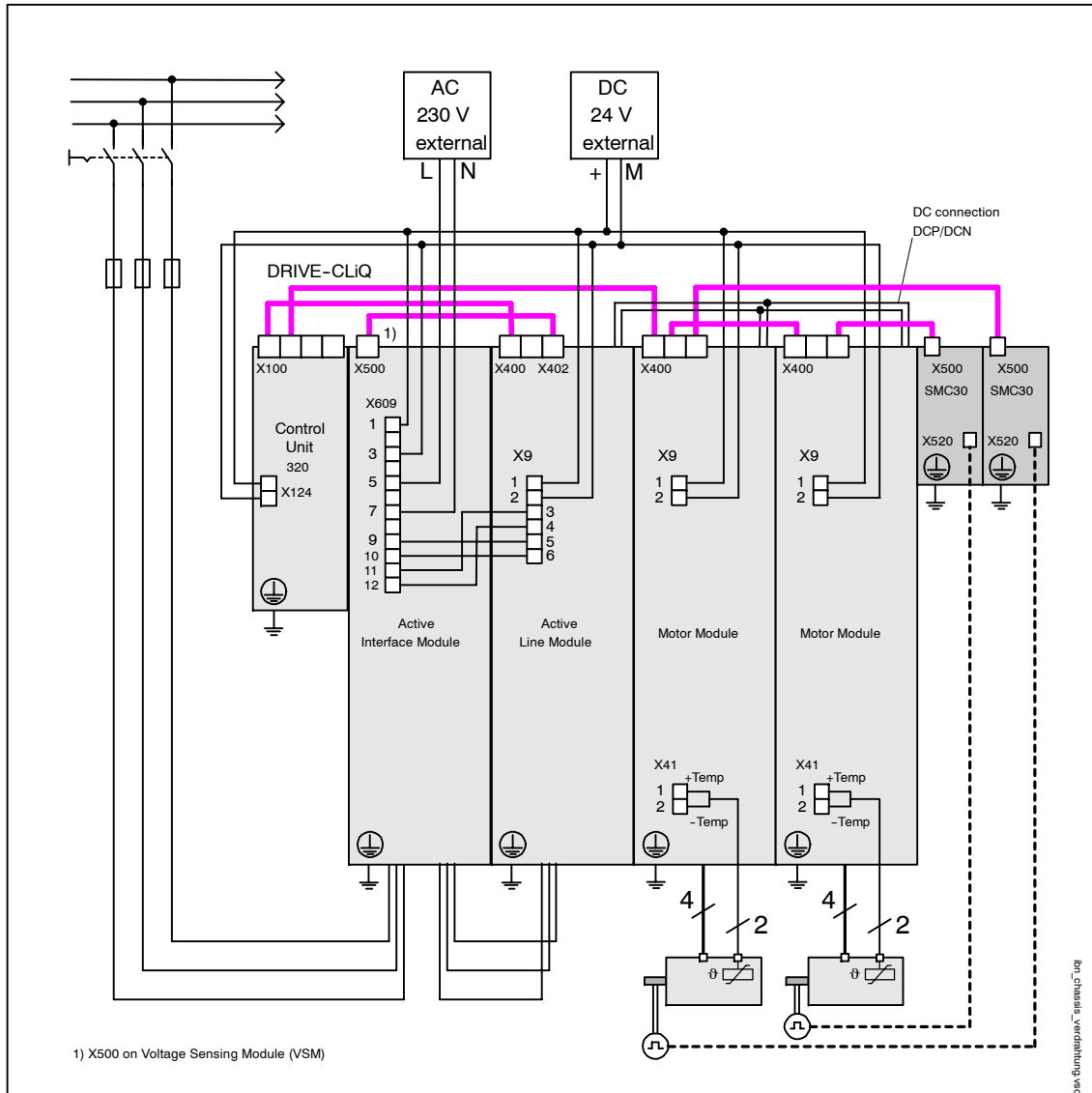


Fig. 3-7 Component wiring (example)

For more information on wiring, see the Equipment Manual.

3.6.3 Signal flow for commissioning example

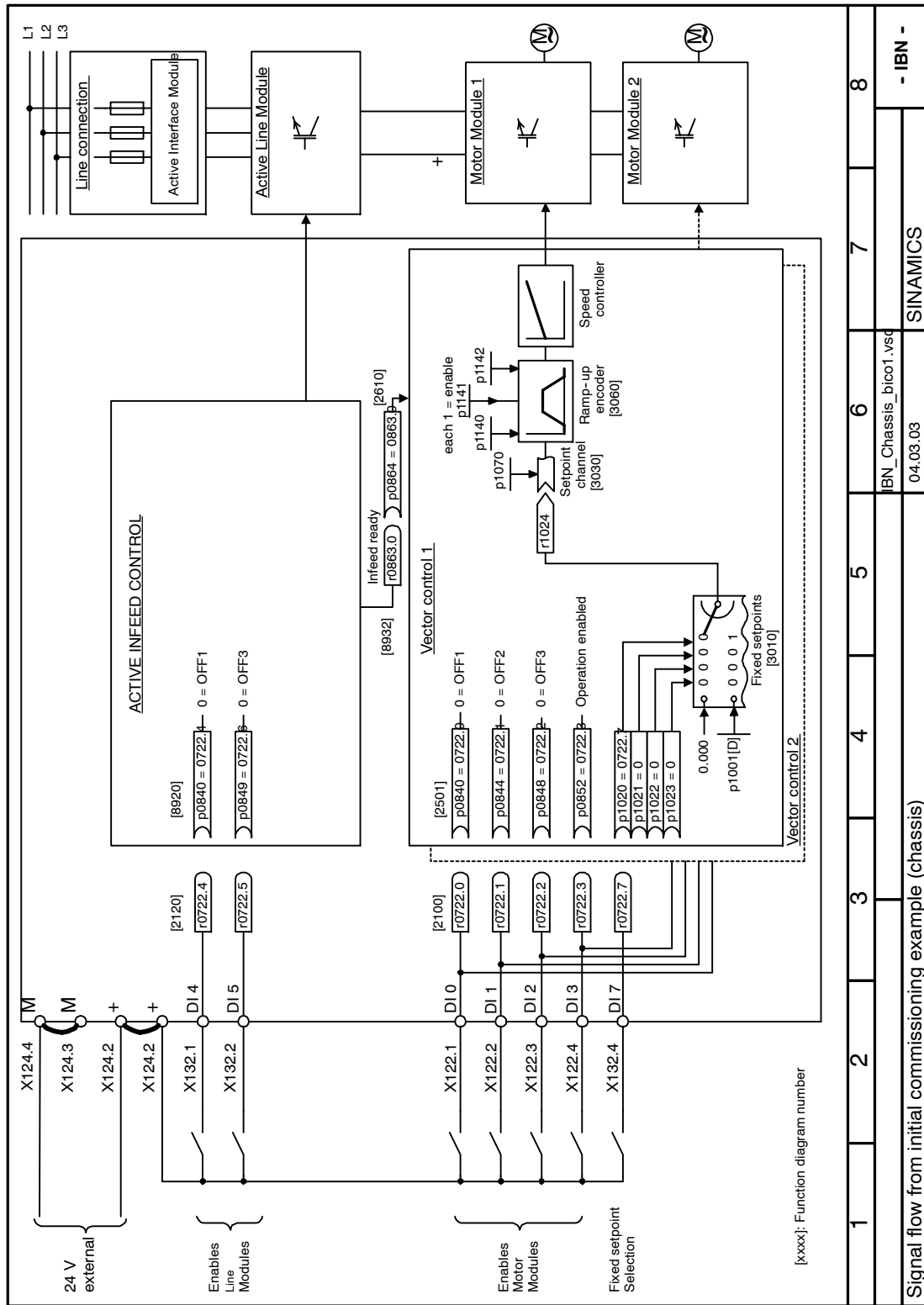


Fig. 3-8 Signal flow from initial commissioning example (chassis)

3.6.4 Commissioning with STARTER (example)

The table below describes the steps for commissioning the example with STARTER.

Table 3-9 Commissioning sequence with STARTER (example)

What to do	How to do it	Note
1. Automatic configuration	Operator action: --> "Project" --> "Connect to target system" --> Double-click "Automatic configuration". --> Follow the instructions provided in the Wizard. STARTER then automatically switches to offline mode.	The DRIVE-CLiQ topology is determined and the electronic type plates are read. The data is then transferred to STARTER. The next steps are carried out offline.
2. Configure the supply	The supply must be configured. Name of supply --> Double-click "Configuration" --> Click "Configure DDS"	
2.1. Supply Wizard	The Wizard displays the data determined automatically from the electronic type plate. You can now set the line/DC link identification. You have to enter the device connection voltage and rated line frequency. This completes the configuration for the supply.	If the line environment or DC link components are changed, line/DC link identification should be repeated.
3. Configure drives	The drives must be configured individually. --> "Drives" --> Drive name --> Double-click "Configuration" --> Click "Configure DDS"	
3.1. Control structure	You can activate the function modules. You can select the control type.	
3.2. Power unit	The Wizard displays the data determined automatically from the electronic type plate.	Caution If a sinusoidal filter is connected, it must be activated here to prevent it from being destroyed.
3.3. Drive setting	You can select the motor standard (IEC / NEMA) and power unit application (duty cycles).	
3.4. Motor	You can enter the name of the motor (e.g. equipment ID). Enter motor data: Yes Select motor type "1LA8".	You can select a standard motor from the list of motors or you can enter the motor data yourself. You can then select the motor type.

Table 3-9 Commissioning sequence with STARTER (example), continued

What to do	How to do it	Note
3.5. Motor data	You can enter the motor data on the type plate here. If known, mechanical data for the motor and drive line can be entered. Equivalent circuit diagram data: No	If you do not enter any mechanical data, it is estimated on the basis of the data on the type plate. The equivalent circuit diagram data is also estimated on the basis of the data on the type plate or determined by means of automatic motor data identification.
3.6. Motor brake	Here, you can configure the brake and activate the "Extended brake control" function module.	For more information, see the Function Manual.
3.7. Encoder	Choose standard encoder from list: Yes Choose "1024 HTL A/B R to X521/X531".	If you are using an encoder that is not in the list, you can also enter the data.
3.8. Drive functions	You can choose the application and motor identification here. Motor identification: "1"	Your choice of application influences the calculation for the open-loop/closed-loop control parameters. When the pulses are enabled, a one-off identification run is carried out. Current flows through the motor which means that it can align itself by up to a quarter of a revolution. Once the measurement is complete, optimization with rotating motor is carried out the next time the pulses are enabled.
3.9. Key parameters	You must enter key parameters in accordance with the relevant application. Note, for example, the general mechanical conditions for the drive line.	
3.10. Summary	The drive data can be copied to the clipboard for plant documentation purposes and then added to a text program, for example.	
4. Enable signals and BICO interconnections	The enable signals for the infeed and the two drives must be transmitted via the digital input on Control Unit 320.	Note: If an Active Line Module is installed, the same signal source must not be used to enable both the infeed and the drive. See also: Fig. 3-8

Table 3-9 Commissioning sequence with STARTER (example), continued

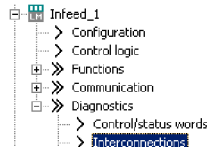
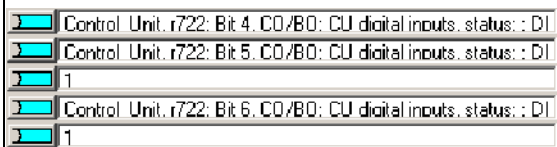
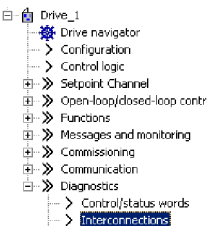
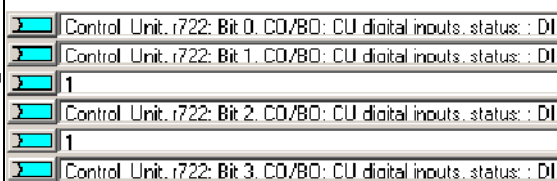
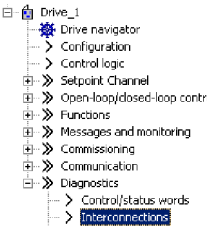

What to do	How to do it	Note
<p>4.1. Active Line Module</p> 	<ul style="list-style-type: none"> Enable signals for the Active Line Module p0840 = 722.4 ON/OFF1 p0844 = 722.5 OFF2 p0852 = 722.6 Enable operation 	See function diagram [8920]
		<p>p840[0], BI: ON/OFF1</p> <p>p844[0], BI: 1. OFF2</p> <p>p845[0], BI: 2. OFF2</p> <p>p852[0], BI: Enable operation</p> <p>p854[0], BI: Master ctrl by PLC</p>
<p>4.2. Enable Motor Module</p> 	<ul style="list-style-type: none"> Enable signals for the Motor Module (drive_1) p0840 = 722.0 ON/OFF1 p0844 = 722.1 1st OFF2 p0845 = 1 2nd OFF2 p0848 = 722.2 1st OFF3 p0849 = 1 2nd OFF3 p0852 = 722.3 Enable operation p0864 = 863.0 Infeed operation 	See function diagram [2501]
		<p>p840[0], BI: ON/OFF1</p> <p>p844[0], BI: 1. OFF2</p> <p>p845[0], BI: 2. OFF2</p> <p>p848[0], BI: 1. OFF3</p> <p>p849[0], BI: 2. OFF3</p> <p>p852[0], BI: Enable operation</p>
<p>4.3. Ramp-function generator</p> 	<p>Ramp-function generator</p> <ul style="list-style-type: none"> p1140 = 1 Enable ramp-function generator p1141 = 1 Start ramp-function generator p1142 = 1 Enable speed setpoint 	See function diagram [3060]
		<p>p1140[0], BI: Enables the ramp-function generator</p> <p>p1141[0], BI: Start ramp-function generator</p> <p>p1142[0], BI: Enable speed setpoint</p>
<p>4.4. Setpoint</p>	<p>Specify setpoint</p> <ul style="list-style-type: none"> p1001 = 40 Fixed speed setpoint 1 p1020 = r0722 Fixed speed setpoint selection r1024 = p1070 Fixed setpoint effective 	<p>A setpoint of 0 or 40 is defaulted via digital input 7. This setpoint is then applied to the main setpoint p1070. See function diagram [3010]</p>

Table 3-9 Commissioning sequence with STARTER (example), continued

What to do	How to do it	Note																																																								
	<p>Fixed setpoints</p> <p>Fixed setpoint interconnection</p> <p>Bit 0: Control_Unit, r722: Bit 7, CO/B0: Cl</p> <p>Bit 1: 0</p> <p>Bit 2: 0</p> <p>Bit 3: 0</p> <p>Fixed speed setpoint</p> <table border="1"> <tr><td>1</td><td>40.000</td><td>rpm</td><td>0</td><td>0</td><td>0</td><td>1</td></tr> <tr><td>2</td><td>0.000</td><td>rpm</td><td>0</td><td>0</td><td>1</td><td>0</td></tr> <tr><td>3</td><td>0.000</td><td>rpm</td><td>0</td><td>0</td><td>1</td><td>1</td></tr> <tr><td>4</td><td>0.000</td><td>rpm</td><td>0</td><td>1</td><td>0</td><td>0</td></tr> <tr><td>5</td><td>0.000</td><td>rpm</td><td>0</td><td>1</td><td>0</td><td>1</td></tr> <tr><td>6</td><td>0.000</td><td>rpm</td><td>0</td><td>1</td><td>1</td><td>0</td></tr> <tr><td>7</td><td>0.000</td><td>rpm</td><td>0</td><td>1</td><td>1</td><td>1</td></tr> <tr><td>8</td><td>0.000</td><td>rpm</td><td>1</td><td>0</td><td>0</td><td>0</td></tr> </table> <p>0.000 rpm</p> <p>Fixed speed setpoint effective</p> <p>p1070[0], Cl: Main setpoint</p>	1	40.000	rpm	0	0	0	1	2	0.000	rpm	0	0	1	0	3	0.000	rpm	0	0	1	1	4	0.000	rpm	0	1	0	0	5	0.000	rpm	0	1	0	1	6	0.000	rpm	0	1	1	0	7	0.000	rpm	0	1	1	1	8	0.000	rpm	1	0	0	0	
1	40.000	rpm	0	0	0	1																																																				
2	0.000	rpm	0	0	1	0																																																				
3	0.000	rpm	0	0	1	1																																																				
4	0.000	rpm	0	1	0	0																																																				
5	0.000	rpm	0	1	0	1																																																				
6	0.000	rpm	0	1	1	0																																																				
7	0.000	rpm	0	1	1	1																																																				
8	0.000	rpm	1	0	0	0																																																				
<p>4.5. Motor temperature</p>	<p>Thermistor selection: via Motor Module (11)</p> <p>Temperature sensor type: KTY84 (2)</p> <p>Response to overtemperature: Alarm and fault (no reduction of I_{max})</p> <p>Fault message for thermistor failure: ON</p> <p>Delay time: 0.100 s</p> <p>Alarm threshold: 120,0 °C</p> <p>Fault threshold: 155,0 °C</p>																																																									

Table 3-9 Commissioning sequence with STARTER (example), continued

What to do	How to do it	Note
5. Save the parameters on the device	<ul style="list-style-type: none"> • 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.
6. The motor starts rotating.	<p>The drives can be started via the control panel in STARTER.</p> <ul style="list-style-type: none"> • This can be done once the pulses have been enabled for the infeed and line/DC link identification has been activated. The infeed then switches to operational mode. • When the pulses are enabled, a one-off motor data identification run (if activated) is carried out. • When the pulses are enabled again, optimization with a rotating motor (if activated) is carried out. 	<p>For more information about the control panel, see Getting Started.</p> <p>During motor identification, a current flows through the motor, which means that it can align itself by up to a quarter of a revolution.</p> <p>For more information about line/DC link identification and motor identification, see the Function Manual.</p>

Parameter overview for diagnosis (see List Manual)

r0002	Infeed/drive operating display
r0046	Missing enable signals (see Diagnostics chapter for further information)

3.7 Notes on commissioning linear motors (servo)

3.7.1 General information on commissioning linear motors

Before commissioning motors, the following questions must be answered:

- Are all of the prerequisites for commissioning checked and were the points in the checklist for commissioning checked (refer to Chapter 2)?

Detailed information on linear motors, encoders and power connection, configuring and mounting are provided in:

/PJLM/ Configuration Manual for Linear Motors 1FN1, 1FN3

Terminology for rotary and linear drives

Table 3-10 Comparison

Terminology for rotary drives	Terminology for linear drives
Speed	Velocity
Torque	Force
Stator	Primary section
Rotor	Secondary section
Rotor	Secondary section
Direction of rotation	Direction
Pulse number	Grid spacing
rotate	run

Checks in the no-current state

The following checks can be made:

1. linear motors

- Which linear motor is being used?
1FN _____ - _____ - _____
- Is the motor already mounted and ready to be powered up?
- If a cooling circuit is being used, is it functional?

2. Mechanical system

- Is the axis easy to move over the complete traversing range?
- Does the air gap between the primary and secondary section and the mounting dimensions correspond to the motor manufacturer's data?

- Vertical axis:
Is weight equalizing is used for the axis, is this functioning?
- Brake:
If a brake is being used, is it correctly controlled (see Function Manual)?
- Traversing range limit:
Are mechanical end stops available and tightly bolted to both ends of the traversing path?
- Are the moving feeder cables correctly routed in a cable drag assembly?

3. Measuring system

- Which measuring system is being used?

Absolute or incremental abs incr

Grid spacing _____ μm

Zero marks (number and position) _____

- Which is the positive drive direction?
Where is the positive counting direction of the measuring system?
Invert (p0410)? yes no

4. Wiring

- Power Module (connect UVW, phase sequence, clockwise rotating field)
- Protective conductor connected?
- Screen connected?
- Temperature monitoring circuits:
Are the cables connected to the terminal block of the screen connecting plate?
 - > Temperature sensor (Temp-F):
The temperature sensor (Temp-F) can be used to carry out an absolute measurement of the mean winding temperature.
 - > Overtemperature switch (Temp-S)
The overtemperature trip circuit (Temp-S) enables each individual motor phase winding to be digitally monitored for an overtemperature condition.



Danger

The circuits of Temp-F and Temp-S neither have “protective separation” between each other nor to the power circuits in accordance with VDE 0160/EN 50178.

Thus, they may not be used as SELV/PELV circuits, or connected with these.

See also the /PJLM/ Configuration Manual for Linear Motors 1FN1, 1FN3

- Temperature sensor evaluation
-

5. Encoder system connection

Is the encoder system connected properly to SINAMICS?

3.7.2 Commissioning: Linear motor with one primary section

Commissioning with STARTER



Danger

Linear drives can achieve significantly higher rates of acceleration and velocities than conventional drives.

The traversing range must always be kept clear in order to avoid any potential danger for man or machine.

Commissioning the motor with STARTER

1. Selecting the motor type

You can select a standard motor from the list of motors or you can enter the motor data yourself if third-party motors are used.

The number of parallel primary sections (p0306) must be entered.

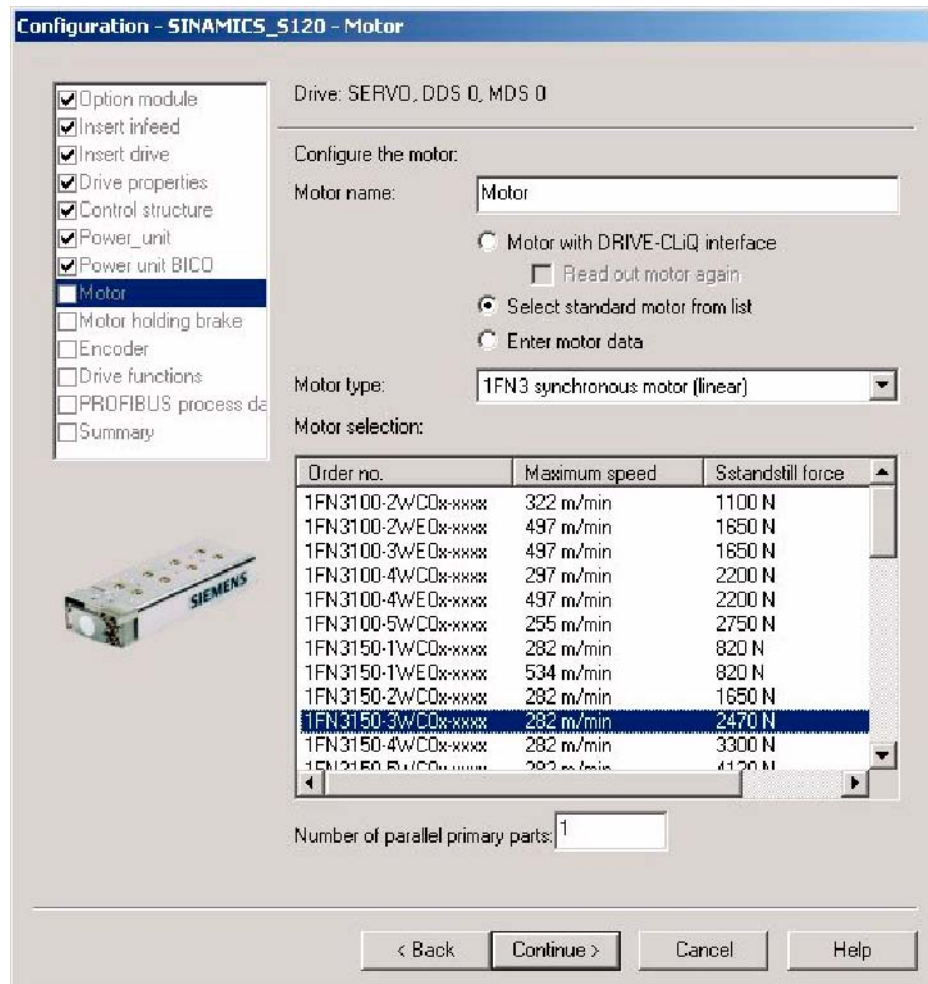


Fig. 3-9 Motor screen in STARTER

2. Enter motor data

The following motor data can be entered for third-party motors.

Table 3-11 Motor data

Parameters	Description	Note
p0305	Rated motor current	-
p0311	Motor rated velocity	-
p0315	Motor pole pair width	
p0316	Motor force constant	-
p0322	Motor velocity, maximum	-
p0323	Maximum motor current	-
p0338	Motor limit current	-
p0341	Motor weight	-
p0350	Motor stator resistance, cold	-
p0356	Motor stator leakage inductance	-

Table 3-12 Optional motor data, synchronous motor (linear)

Parameters	Description	Note
p0312	Rated motor force	-
p0317	Motor voltage constant	-
p0318	Motor stall current	-
p0319	Motor stall force	-
p0320	Rated motor magnetization current	-
p0326	Stall torque correction factor	-
p0329	Pole position identification current	-
p0348	Speed at start of field weakening	-
p0353	Motor series inductance	-
p0391	Current controller adaptation, lower starting point	-
p0392	Current controller adaptation, upper starting point	-
p0393	Current controller adaptation, P gain, scaling upper	-

3. User-defined encoder data

With linear motors, the encoder is configured in the “User-defined encoder data” screen.

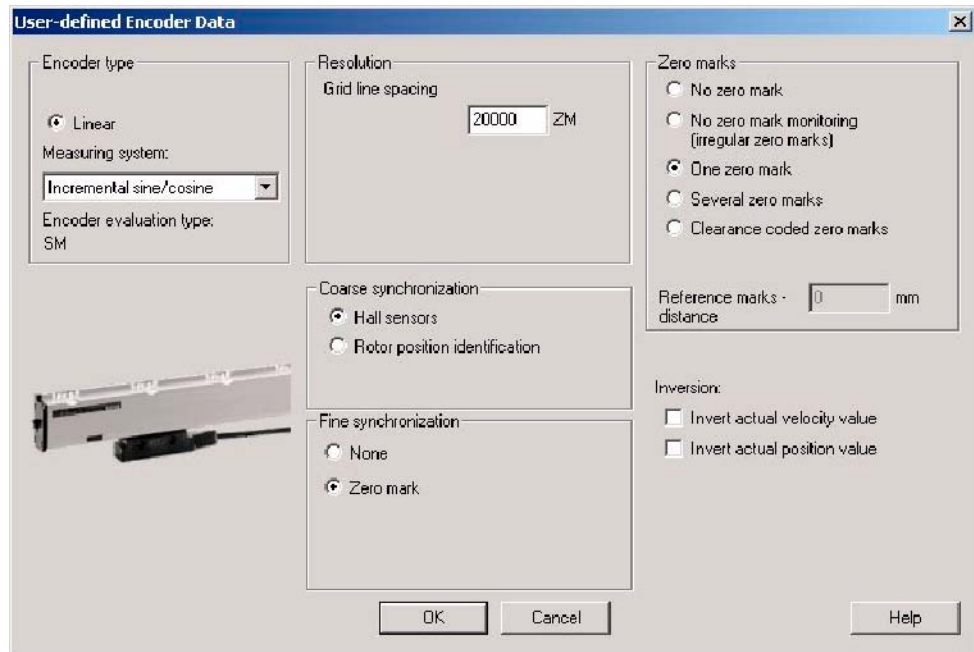


Fig. 3-10 Encoder data screen in STARTER



Warning

When linear motors are configured for the first time, the commutation angle offset (p0431) must be adjusted. Refer to the functional description for further information on the commutation angle offset and pole position identification (servo).

3.7.3 Commissioning: Linear motor with several identical primary sections

General

If it is certain that the EMF of more than one motor has the same relative phase position to one another, the connecting cables can be connected in parallel and operated from one drive.

Linear motors, which are connected in parallel, are commissioned, based on the commissioning of a single linear motor. The number of parallel-connected primary sections is entered in the "Motor" screen (p0306) when the drive is configured in STARTER.

First, only one linear motor (motor 1) is connected to the drive, and is commissioned as individual motor (1FNx ...). The angular commutation offset is automatically determined and noted.

Instead of motor 1, the other motors are connected and commissioned as individual motors. Also here, the angular commutation offset is automatically determined and noted.

If the difference between the commutation angle offset of motor 1 and the other motors is less than 10 degrees (electrical), all the motors can be connected to the drive in parallel and commissioned as a parallel configuration of n linear motors (e.g. 2 • 1FN1xxx).

Note

Only identical linear motors (the same forces, winding types, secondary section types and air gap) may be connected in parallel. (Order number of the primary sections to be connected in parallel must be identical up to the winding sense and/or primary section length.)

If linear motors in an axis are connected in parallel, the position of the primary sections with respect to one another and to the secondary sections must exhibit a specific grid, in order to achieve a matching electrical phase position.

For more information see: /PJLM/ Planning Guide 1FN1, 1FN3 Linear Motors

Temperature sensor and electrical wiring

The temperature sensors can be evaluated, for example, as follows:

- Temperature sensor
 - Motor 1: Evaluated via the drive
 - Motor n: Not connected (short-circuited and connected to the PE)
- Temperature switch
 - Motor 1 to n: Evaluation via a PLC

see also: /PJLM/ Configuration Manual for Linear Motors 1FN1, 1FN3



Warning

When connecting-up the temperature monitoring circuits, carefully observe the specifications relating to protective separation. DIN EN 50178.

see also: /PJLM/ Configuration Manual for Linear Motors 1FN1, 1FN3

3.7.4 Thermal motor protection

Description

Two independent monitoring circuits are available for the 1FN1, 1FN3 primary sections for thermal motor protection.

The absolute, average winding temperature can be measured using the temperature sensor (Temp-F) comprising a temperature sensor (KTY 84).

The overtemperature shutdown circuit (Temp-S) allows each individual motor phase winding to be digitally monitored for an overtemperature condition.

The two independent temperature circuits Temp-F and Temp-S can be used for motor protection, either individually or together. At least one Temp_S must be used for the motor overtemperature protection.

The circuit and connection system for Temp-F and Temp-S are described in detail in: /PJLM/ Configuration Manual for Linear Motors 1FN1, 1FN3



Danger

The circuits of Temp-F and Temp-S neither have “protective separation” between each other nor to the power circuits in accordance with VDE 0160/EN 50178.



Danger

Temp-S must be connected for thermal motor protection; it is not permissible not to connect Temp-S!

Temp-F can be optionally connected to a measuring device for commissioning and testing.

For regular operation, the Temp-F connections should be short-circuited and connected to PE.

Note

The temperature sensor (Temp-F) only evaluates the winding temperature of one phase in the primary section. The phases in the synchronous motor are, however, loaded to different degrees with the result that, in the worst case, the phases that are not measured have higher temperatures.

Note

If protection by electrical separation is provided, it is not permissible to connect Temp-F to a Sensor Module in the SINAMICS drive system without using a suitable protection module.

When handling and connecting Temp-F, it must be assumed that when the drive is powered up, there are hazardous voltages at the terminals on the motor side and at the Temp-F connecting cable. This means that the drive must always be disconnected so that it is ensured that it really is in a no-voltage condition.

Note

With protective separation, you must not connect Temp-S to the PLC or to the Sensor Module of the SINAMICS drive system without using a 3RN1013-1BW10 thermistor motor protective device.

When handling and connecting Temp-F, it must be assumed, that when the drive is powered up, there are hazardous voltages at the terminals on the motor side and at the Temp-F connecting cable – this means that the drive must always be disconnected so that it is ensured that it really is in a no-voltage condition.

Evaluating the temperature sensors

See also: /PJLM/ Configuration Manual for Linear Motors 1FN1, 1FN3

3.7.5 Measuring system

Determining the control sense

The control sense of an axis is correct if the positive direction of the drive (= clockwise rotating field U, V, W) coincides with the positive counting direction of the measuring system.

Note

The data to determine the drive direction is only valid for Siemens motors (1FNx motors).

If the positive direction of the drive and positive counting direction of the measuring system **do not match**, the actual speed value (P0410.0) must be inverted when the drive is commissioned.

The control sense can also be checked by first parameterizing the drive, and then manually moving it, with the enable signals inhibited (switched out).

If the axis is pushed in the positive direction, the actual speed value must also count in the positive direction.

Determining the drive direction

The direction of the drive is positive if the primary section moves relative to the secondary section in the opposite direction to the cable outlet direction.

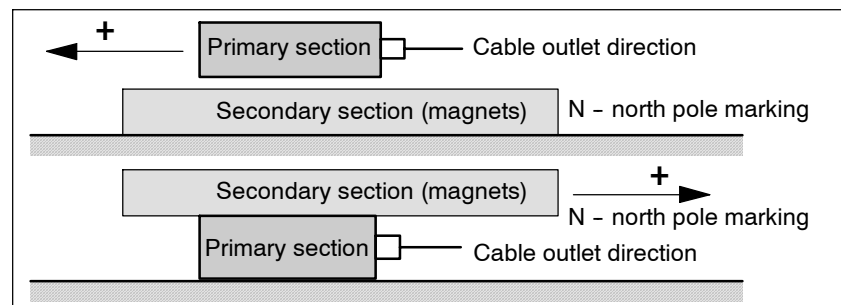


Fig. 3-11 Determining the positive direction of the drive

Determining the counting direction of the measuring system

The counting direction is determined depending on the measuring system.

- Measuring systems from Heidenhain

Note

The counting direction of the measuring system is positive, if the distance between the sensor head and rating plate increases.

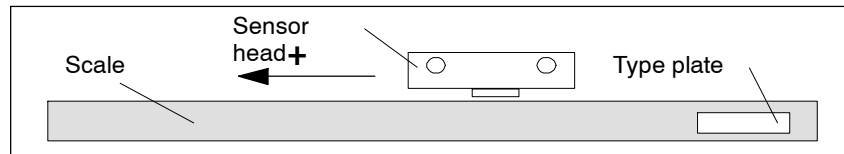


Fig. 3-12 Determining the counting direction for measuring systems from the Heidenhain Company

- Measuring systems from Renishaw (e.g. RGH22B)

As the reference mark for the Renishaw RGH22B has a direction-dependent position, with control cables BID and DIR, the encoder must be parameterized, so that the reference mark is only output in one direction.

The direction (positive/negative) depends on the geometrical arrangement at the machine and the reference point approach direction.

Table 3-13

Signal	Cable color	12-pin circular connector	connected to	
			+5 V	0 V
BID	black	Pin 9	Reference marks in both directions	Reference marks in one direction
DIR	Orange	Pin 7	Positive directions	Negative direction
+5 V	Brown	Pin 12		
0 V	White	Pin 10		

The counting direction of the measuring system is positive if the sensor head moves relative to the gold band in the cable outlet direction.

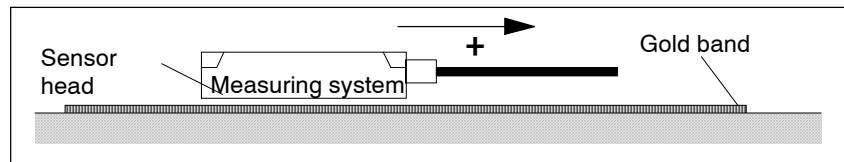


Fig. 3-13 Determining the counting direction for measuring systems from Renishaw

Note

If the sensor head is mechanically connected to the primary section, the cable outlet direction must be different. Otherwise, invert the actual value.

3.7.6 Checking the linear motor by making measurements**Why make measurements?**

If the linear motor was commissioned according to the relevant instructions, and unexplained fault/error messages still occur, then all of the signals must be checked using an oscilloscope.

Checking the phase sequence U-V-W

For primary sections connected in parallel, the EMF_U from motor 1 must be in phase with the EMF_U from motor 2. The same applies to EMF_U and EMF_W. This must be measured.

Making the necessary measurements:

- Disconnect the drive line-up from the power supply.
- Caution: Wait until the DC link has been discharged!
- Disconnect the power cables from the drive.
Disconnect any primary components connected in parallel.
- Form an artificial neutral point using 1 kOhm resistors.

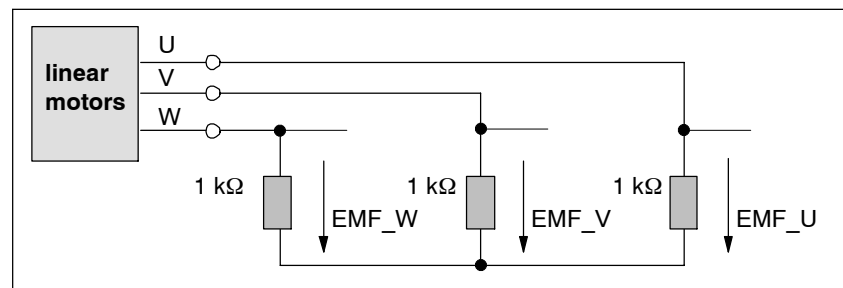


Fig. 3-14 Configuration for making the measurements

For a positive traversing direction, the phase sequence must be U-V-W. The direction of the drive is then positive if the primary section moves relative to the secondary section in the opposite direction to the cable outlet direction.

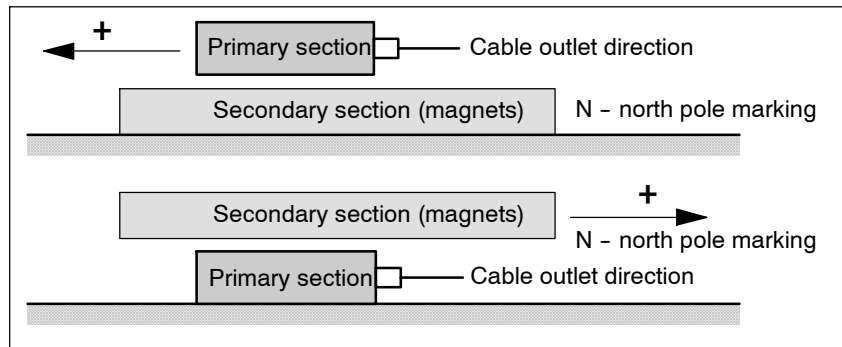


Fig. 3-15 The positive direction of the drive (clockwise rotating field)

Determining the commutation angle using an oscilloscope

Once the oscilloscope has been connected, the drive must first pass the zero mark so that fine synchronization can be carried out.

The commutation angle offset can be determined by measuring the EMF and normalized electrical rotor angular displacement via an analog output.

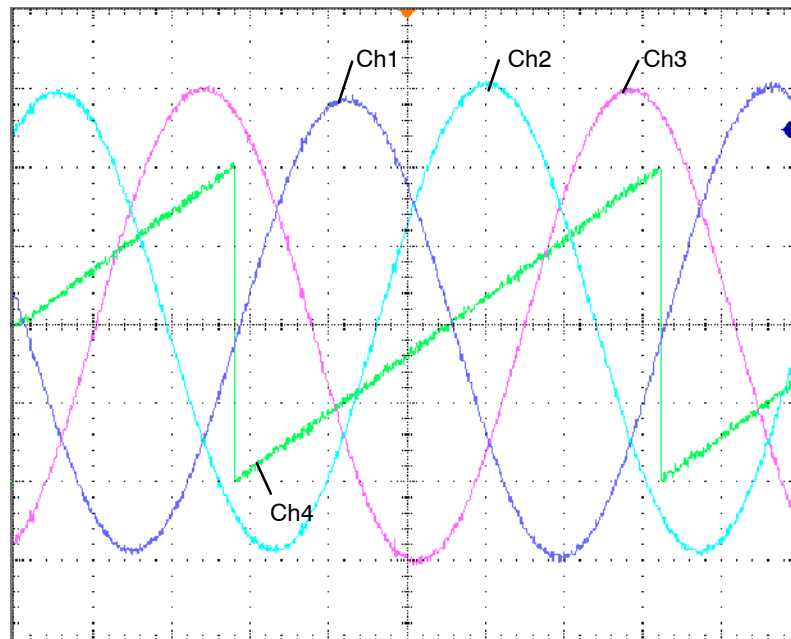


Fig. 3-16 Oscillogram

Definition of channels (Ch1 ... Ch4):

- Ch1 EMF phase U to neutral point
- Ch2: EMF phase V to neutral point
- Ch3: EMF phase W to neutral point
- Ch4: Normalized electrical rotor angular displacement via analog output

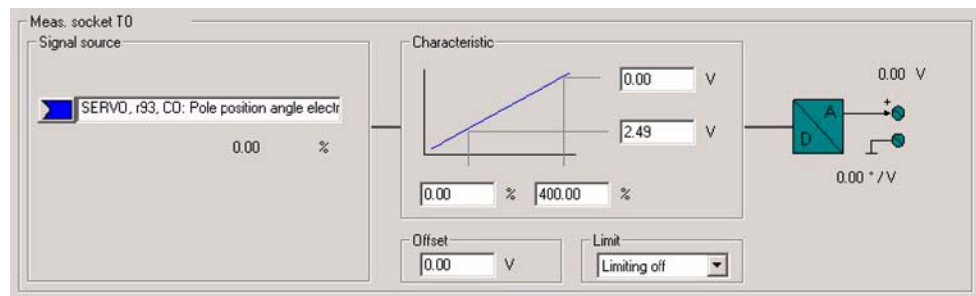


Fig. 3-17 Example of setting for measuring socket T0 on the CU320

When the drive is synchronized, the difference between the EMF/phase U and the electrical rotor position is a maximum of 10° .

If the difference is greater, the commutation angle offset must be adjusted.



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:

References: /P5/ PROFIdrive Profile Drive Technology

Caution

When synchronization is carried out for the first time, the infeed and all the drives in the drive unit switch to pulse inhibit during synchronization on the clock-synchronous PROFIBUS (approx. 1s). This is followed by a sudden return of the pulses. This applies to clock-synchronous and non-clock-synchronous drives within the drive unit. With non-clock-synchronous drives, no alarm or fault is currently output. If the PROFIBUS cycle is lost after synchronization has been carried out, all the drives in the unit are stopped via F01911. The infeed remains in operation, provided that it does not receive its process data via PROFIBUS.

This can have the following effects:

- Overcurrent when the pulses return
 - Drives that must run (e.g. spinning pumps) may stop.
-



Caution

If the CAN connector is mistakenly plugged into the PROFIBUS connector, this can destroy the CAN master.

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

With respect to PROFIBUS, the SINAMICS drive unit is a slave.

Bus access method

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

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

PROFIBUS telegram for cyclic data transmission and acyclic services

Each drive unit that supports cyclic process data exchange uses a telegram to send and receive all the process data. A separate telegram is sent in order to perform all the acyclic services (read/write parameters) under a single Profibus address. The acyclic data is transmitted with a lower priority after cyclic data transmission.

The overall length of the telegram increases with the number of drive objects that are involved in exchanging process data.

Sequence of drive objects in the telegram

On the drive side, the sequence of drive objects in the telegram is displayed via a list in p0978[0...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.

The following drive objects can exchange process data:

Drive object

- Active Infeed (A_INF)
- Basic Infeed (B_INF)
- Smart Infeed (S_INF)
- SERVO
- VECTOR
- Terminal Module 15 (TM15DI/DO)
- Terminal Module 31 (TM31)
- Terminal Board 30 (TB30)
- Control Unit (CU)

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 Subsection 4.1.2.

The following configurations, for example, are possible:

--> Configuration with SERVO, SERVO, SERVO

--> Configuration with A_INF, SERVO, SERVO, SERVO, TB30

--> and others

4.1.2 Example: telegram structure for cyclic data transmission

Task

The drive system comprises the following drive objects:

- Control Unit (CU_S)
- Active Infeed (A_INF)
- SERVO 1 (comprises a Single Motor Module and other components)
- SERVO 2 (comprises a Double Motor Module terminal X1 and other components)
- SERVO 3 (comprises a Double Motor Module terminal X2 and other components)
- Terminal Board 30 (TB30)

The process data is to be exchanged between the drive objects and the higher-level automation system.

- Telegrams to be used:
 - Telegram 370 for Active Infeed
 - Standard telegram 6 for servo
 - User defined for Terminal Board 30

Component and telegram structure

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

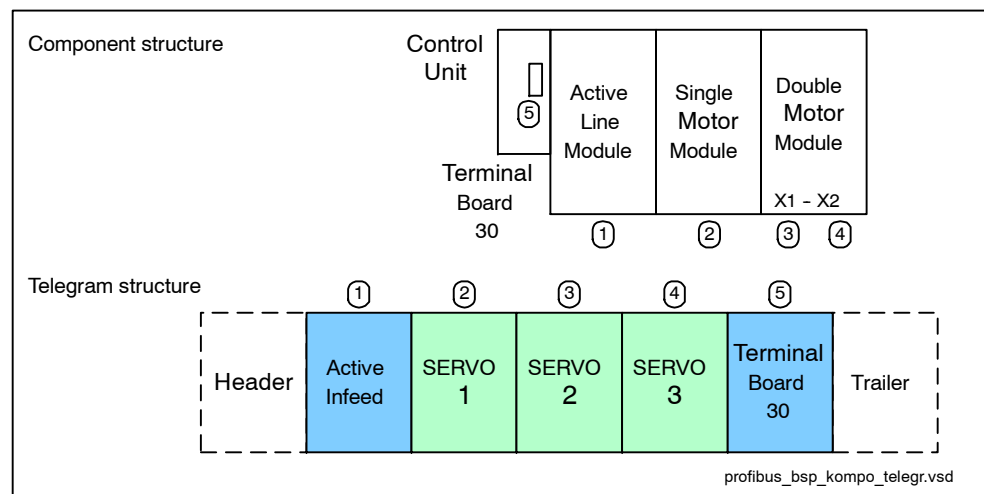


Fig. 4-1 Component and telegram structure

You can check and change the sequence of the telegrams via 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. 4-1, the objects in the “DP slave properties” overview must be configured as follows:

- Active Infeed (A_INF): Telegram 370
- SERVO 1: Standard telegram 6
- SERVO 2: Standard telegram 6
- SERVO 3: Standard telegram 6
- Terminal Board 30 (TB30): User defined

DP slave properties: overview

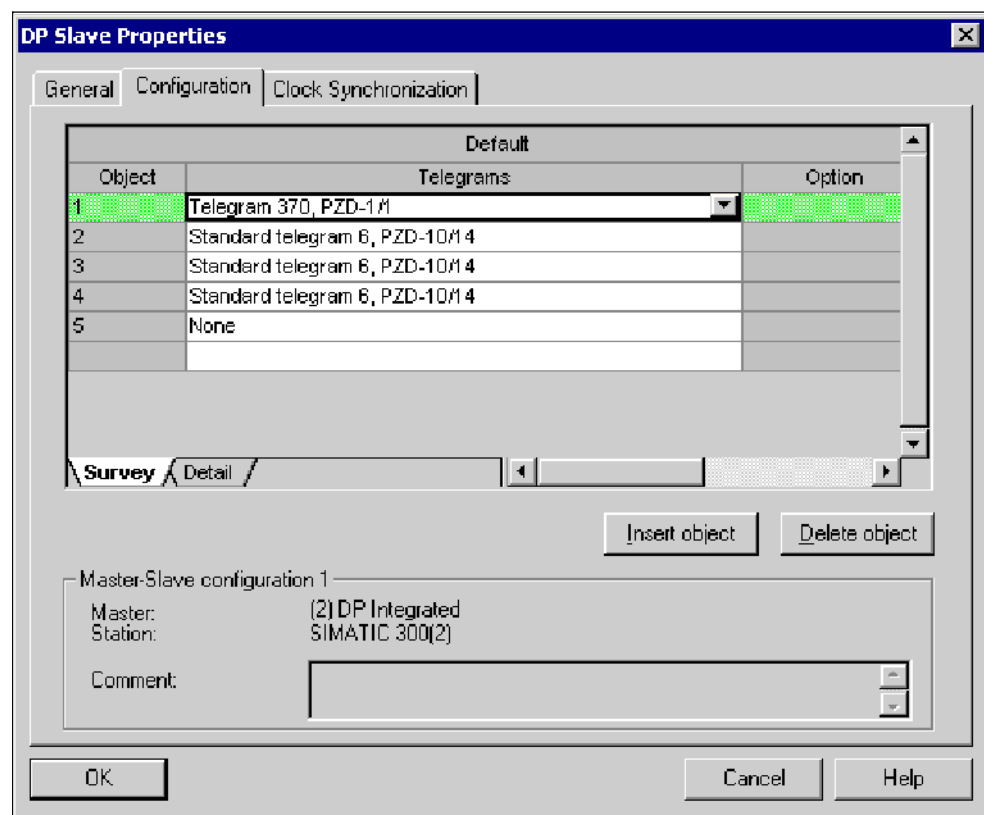


Fig. 4-2 Slave properties: overview

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

DP slave properties: details

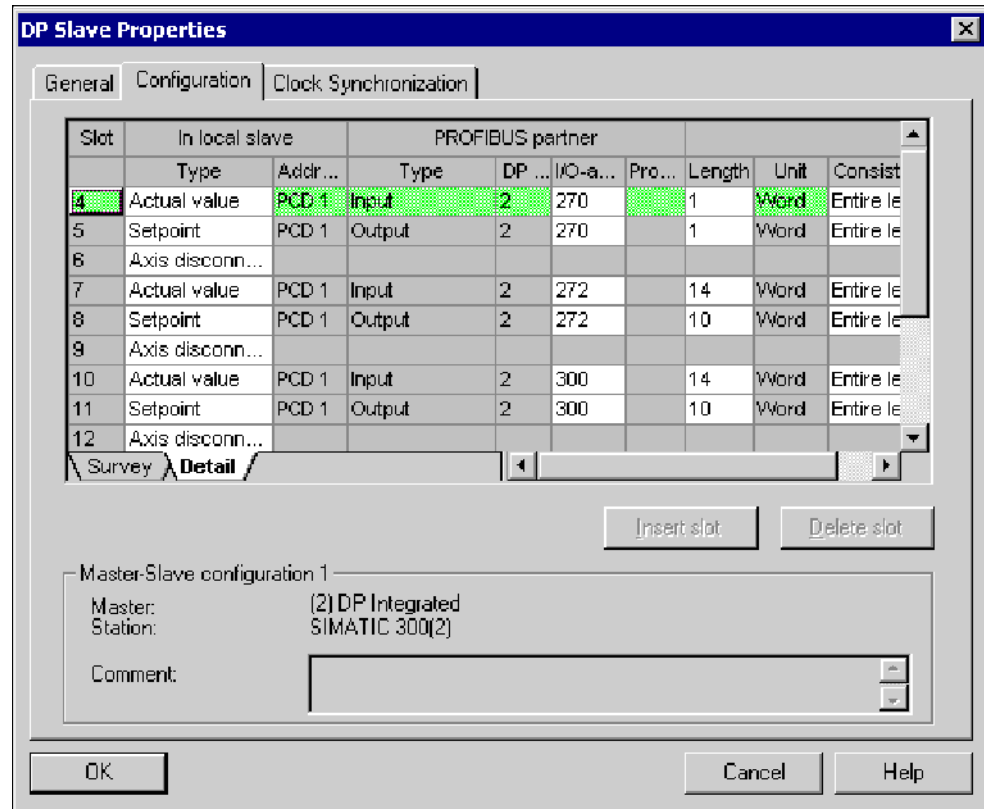


Fig. 4-3 Slave properties: details

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

- Slot 4 and 5: Object 1 --> Active Infeed (A_INF)
 - Slot 7 and 8: Object 2 --> SERVO 1
 - Slot 10 and 11: Object 3 --> SERVO 2
- etc.

4.2 Commissioning PROFIBUS

4.2.1 General information about commissioning

Interfaces and diagnostic LED

A PROFIBUS interface with LEDs and address switches is available as standard on the Control Unit.

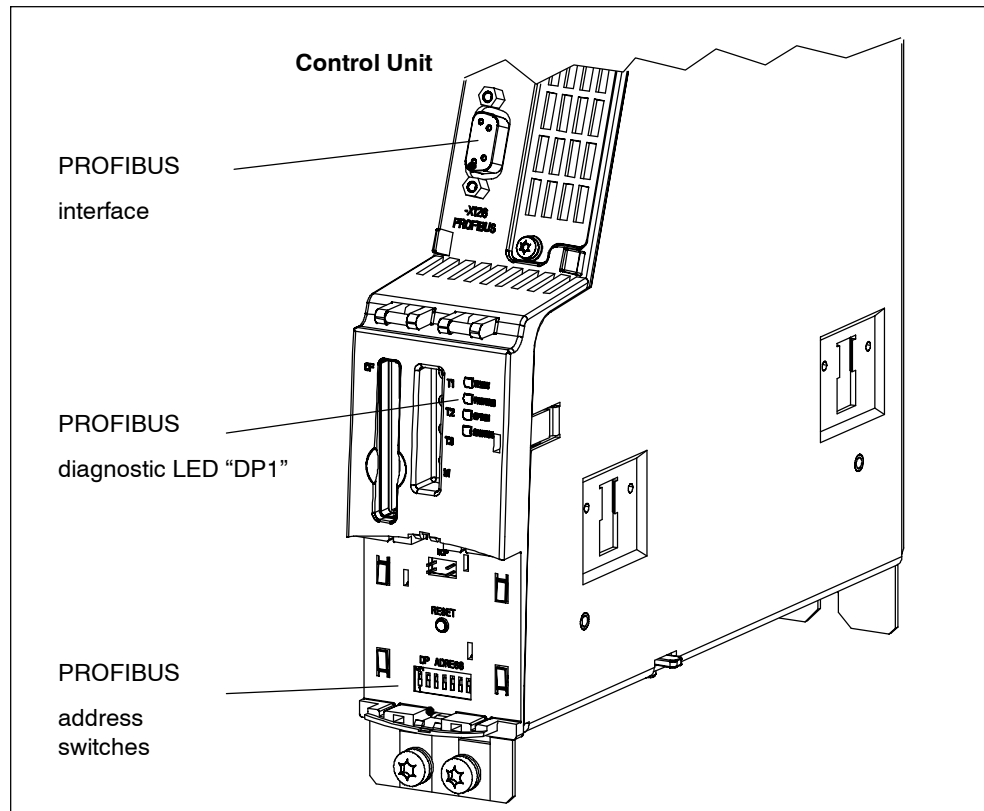


Fig. 4-4 Interfaces and diagnostic LED

- PROFIBUS interface

The PROFIBUS interface is described in the following documentation:

References: /GH1/ SINAMICS S120 Equipment Manual
Control Units and additional system components

- PROFIBUS diagnostic LED

For a description of the diagnostics LED --> see Subsection 6.1.1.

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.
 - Address changes made via parameters must be saved in a non-volatile memory using the "Copy from RAM to ROM" function.
 - A change is not effective until POWER ON.

Example:

Setting the PROFIBUS address using the PROFIBUS address switches on the Control Unit

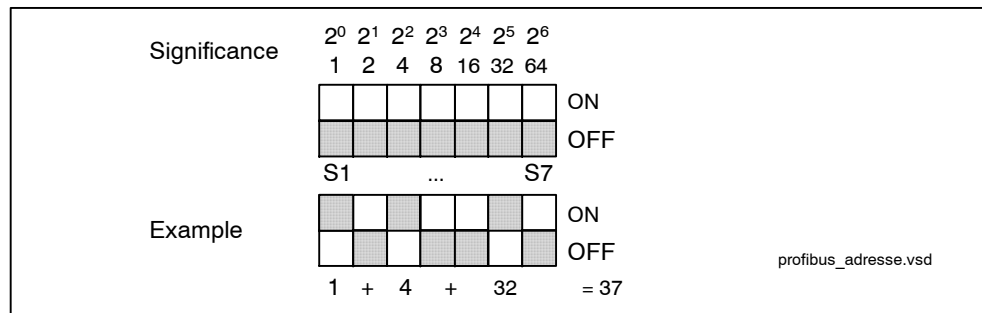


Fig. 4-5 Example: setting the PROFIBUS address using the PROFIBUS address switch on the Control Unit

Note

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

Parameter p0918 is unique to the Control Unit (see Control Unit). The factory setting is 126.

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

If several CUs are connected to one Profibus line, the address settings must differ from the factory settings. Note that each address can only be assigned once on a PROFIBUS line. This can be achieved using the address switch or by setting parameter p0918 accordingly. The setting can be made by connecting the 24 V supply step by step and resetting p0918, for example.

The address setting on the switch is displayed in r2057.

Each change made to the bus address is not effective until POWER ON.

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.gse English
- si0280e5.gsf French
- si0280e5.gsg German
- si0280e5.gsi Italian
- si0280e5.gss Spanish

The DMF files are in accordance with the DMF guidelines (revision 4) and allow you to configure clock-synchronous operation via a DMF. STEP7 as of V5.1 SP3 is required for use in the SIMATIC environment.

The DMFs can be found at the following locations:

- On the Internet: <http://www4.ad.siemens.de/WW/view/de/113204>
- On the CD for the STARTER commissioning tool
Order No. 6SL3072-0AA00-0AGx
- On the CompactFlash card in directory
\\SIEMENS\SINAMICS\DATA\CFG\

Commissioning for VIK-NAMUR

To be able to operate a SINAMICS drive as a VIK-NAMUR drive, standard telegram 20 must be set and the VIK-NAMUR identification number activated via p2042 =1. In this case, only the NAMUR DMF can be used.

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 CU-specific parameter:

r0964[0...6] Device identification

Bus terminating resistor and shielding

Reliable data transmission via PROFIBUS depends, amongst other things, on the setting 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 on 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.

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

4.2.2 Commissioning procedure

Preconditions and assumptions for commissioning

PROFIBUS slave

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

PROFIBUS master

- The communication properties of the SINAMICS 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 Subsection 4.2.1

2. Set the telegram type on the slave.

See Subsection 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 controlled via terminals).

4. The I/O addresses must be assigned in accordance with the user program.

4.2.3 Diagnosis options

Diagnosis via parameters (see List Manual)

- r2050 CO: PROFIBUS PZD receive word
- r2053 PROFIBUS diagnostics send PZD word
- r2054 PROFIBUS status (CU_S)
- r2055 PROFIBUS diagnostics standard (CU_S)
- r2060 CO: PROFIBUS PZD receive double word
- r2063 PROFIBUS diagnostics send PZD double word
- r2064 PROFIBUS diagnostics isochronous mode (CU_S)
- r2065 PROFIBUS diagnostics master sign-of-life
- r2075 PROFIBUS diagnostics telegram offset PZD receive
- r2076 PROFIBUS diagnostics telegram offset send PZD
- r2090 BO: PROFIBUS PZD1 receive bit-serial

Diagnosis via LED DP1 (see Section 6.1)

4.2.4 SIMATIC HMI addressing

You can use a SIMATIC HMI as a PROFIBUS master (master class 2) to access SINAMICS directly. With respect to SIMATIC HMI, SINAMICS behaves like a SIMATIC S7. For accessing drive parameters, the following simple rule applies:

- Parameter number = data block number
- Parameter sub-index = bit 0 - 9 of data block offset
- Drive object number = bit 10 - 15 of data block offset

Pro Tool and WinCC flexible

The SIMATIC HMI can be configured flexibly with "Pro Tool" or "WinCC flexible".

The following specific settings for drives must be observed when configuring drives with Pro Tool or WinCC flexible.

Controllers: Protocol always "SIMATIC S7 - 300/400"

Table 4-2 Further parameters

Field	Value
Network parameter profile	DP
Network parameter baud rate	Any
Communication partner address	PROFIBUS address of the drive unit
Communications partner Slot/subrack	don't care, 0

Table 4-3 Tags: "General" tab

Field	Value
Name	Any
Controller	Any
Type	Depending on the addressed parameter value, e.g.: INT: for integer 16 DINT: for integer 32 WORD: for unsigned 16 REAL: for float
Area	DB
DB (data block number)	Parameter number 1 ... 65535
DBB, DBW, DBD (data block offset)	Drive object no. and sub-index Bit 15 - 10: Drive object no. 0 ... 63 Bit 9 - 0: Sub-index 0 ... 1023 In other words, $DBW = 1024 * \text{drive object no.} + \text{sub-index}$
Length	Not activated
Acquisition cycle	Any
No. of elements	1
Decimal places	Any

Note

- You can operate a SIMATIC HMI in conjunction with a drive unit independently of a controller.
A simple "point-to-point" connection with just two nodes is possible.
- The "variable" HMI functions can be used for drive units. Other functions cannot be used (e.g. "messages" or "recipes").
- Individual parameter values can be accessed. Entire arrays, descriptions, or texts cannot be accessed.

4.3 Cyclic communication

Cyclic communication is used to exchange time-critical process data.

4.3.1 Telegrams and process data

General information

The selection of a telegram via p0922 determines on the drive unit side 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. 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 encoders
- 4 Speed control, 2 position encoders
- 5 DSC, 1 position encoders
- 6 DSC, 2 position encoders
- 20 Speed control, VIK-NAMUR

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 encoders
- 103 Speed control with torque reduction, 2 position encoders
- 105 DSC with torque reduction, 1 position encoders
- 106 DSC with torque reduction, 2 position encoders
- 116 DSC with torque reduction, 2 position encoders
- 352 Speed control, PCS7
- 370 Telegram for the infeed
- 390 Telegram for Control Unit (drive object 1, DO1), Digital inputs/outputs
- 391 Telegram for Control Unit (drive object 1, DO1), Digital inputs/outputs and probe

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 process data.

Table 4-4 Receive and send process data

	SERVO, VECTOR	CU_S	A_INF, B_INF, S_INF, CU_S, TB30, TM31, TM15DI/DO
Receive process data			
DWORD connector output	r2060[0 ... 14]	-	
WORD connector output	r2050[0 ... 15]	r2050[0 ... 4]	
Binector output	r2090.0 ... 15 r2091.0 ... 15 r2092.0 ... 15 r2093.0 ... 15	r2090.0 ... 15 r2091.0 ... 15	
Free binector-connector converter	p2080[0 ... 15], p2081[0 ... 15], p2082[0 ... 15], p2083[0 ... 15] / r2089[0 ... 3]		
Send process data			
DWORD connector input	p2061[0 ... 14]	-	
WORD connector input	p2051[0 ... 18]	p2051[0 ... 6]	p2051[0 ... 4]
Free connector-binector converter	p2099[0 ... 1] / r2094.0 ... 15, r2095.0 ... 15		

Telegram interconnections

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

Note

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

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

When you reset $p0922 = 999$ and $p2079 \neq 999$, the telegrams are interconnected automatically (as parameterized via $p2079$) and blocked. The telegram can, however, be extended in the direction of transmission.

These are both easy methods of interconnecting free telegrams as required on the basis of existing telegrams.

The telegram structure

$p0978$ can be re-sorted and a zero inserted in order to identify those drive objects that participate in the PZD exchange and to define their sequence in the PZD exchange. Drive objects that are listed after the first zero, are excluded from the process data exchange.

With $p0978$, the value 255 can also be inserted more than once. $P0978[n] = 255$ emulates a visible, empty drive object for the PROFIBUS master without process data actually being exchanged. This enables cyclic communication of a PROFIBUS master with the same configuration with drive units with a different number of drive objects.

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.
 - One PZD = one 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	Appl. class	Function in drive	PZD 01	PZD 02	PZD 03	PZD 04	PZD 05	PZD 06	PZD 07	PZD 08	PZD 09	PZD 10	PZD 11	PZD 12	PZD 13	PZD 14	PZD 15	PZD 16	PZD 17	PZD 18	PZD 19
1	1	Speed control, 2 words	STW1 ZSW1	NSET_A NACT_A	Receive telegram from PROFIBUS Send telegram to PROFIBUS																
2	1	Speed control, 4 words	STW1 ZSW1	NSETP_B NACT_B	STW2 ZSW2																
3	1, 4	speed control, 1 position encoder	STW1 ZSW1	NSETP_B NACT_B	STW2 ZSW2	G1_CTW G1_STW															
4	1, 4	speed control, 2 position encoder	STW1 ZSW1	NSETP_B NACT_B	STW2 ZSW2	G1_CTW G1_STW															
5	4	DSC, 1 position encoder	STW1 ZSW1	NSETP_B NACT_B	STW2 ZSW2	G1_CTW G1_STW															
6	4	DSC, 2 position encoders	STW1 ZSW1	NSETP_B NACT_B	STW2 ZSW2	G1_CTW G1_STW															
20	1	Speed control, VIK-NAMUR	STW1 ZSW1	NSET_A NACT_A	TH TH	SMOOTH SMOOTH															
102	1, 4	Speed control with torque reduction, 1 position encoder	STW1 ZSW1	NSETP_B NACT_B	STW2 ZSW2	TRQDER MSGW															
103	1, 4	Speed control with torque reduction, 2 position encoders	STW1 ZSW1	NSETP_B NACT_B	STW2 ZSW2	TRQDER MSGW															
105	4	DSC with torque reduction, 1 position encoder	STW1 ZSW1	NSETP_B NACT_B	STW2 ZSW2	TRQDER MSGW															
106	4	DSC with torque reduction, 2 position encoder	STW1 ZSW1	NSETP_B NACT_B	STW2 ZSW2	TRQDER MSGW															
116	4	DSC with torque reduction, 2 position encoder	STW1 ZSW1	NSETP_B NACT_B	STW2 ZSW2	TRQDER MSGW															
352	1	Speed control, PCS7	STW1 ZSW1	NSET_A NACT_A	TH TH	SMOOTH SMOOTH															
370	-	infeed, 1 word	E_CTW1 E_ZSW1																		
380	-	CU (DO1), digital IOs	CU_STW CU_ZSW	A_DIGITAL L_DIGITAL																	
381	-	CU (DO1), digital IOs and probes	CU_STW CU_ZSW	A_DIGITAL L_DIGITAL	MT_STW MT_ZSW	MT1_ZS_F MT2_ZS_F															
999	-	Free interconnection via BICO	STW1 ZSW1																		

Fig. 4-6 Structure of the telegrams

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

Drive object	Telegrams
• A_INF	p0922 = 370, 999
• B_INF	p0922 = 370, 999
• S_INF	P0922 = 370, 999
• SERVO	p0922 = 2, 3, 4, 5, 6, 102, 103, 105, 106, 116, 999
• VECTOR	p0922 = 1, 20, 352, 999
• TM15DI/DO	No predefined telegram
• TM31	No predefined telegram
• TB30	No predefined telegram
• CU	p0922 = 390, 391

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

Drive object	Max. number of PZD for sending / receiving
• A_INF	5
• A_INF	5
• S_INF	5
• SERVO	Send 19, receive 16
• VECTOR	Send 19, receive 16
• TM15DI/DO	5
• TM31	5
• TB30	5
• CU	Send 7, receive 5

Interface mode

Interface mode is used for adjusting the assignment of the control and status words in line with other drive systems and standardized interfaces.

The mode can be set as follows:

Value	Interface mode
• p2038 = 0	SINAMICS (factory setting)
• p2038 = 1	SIMODRIVE 611 universal
• p2038 = 2	VIK-NAMUR

Procedure:

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

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

Interface mode defines the setting of the standard telegram 20 (p2038 = 2). The assignment cannot be modified.

When a telegram defined by the interface mode (e.g. p0922 = 102) is changed to a different telegram (e.g. p0922 = 3), the setting in p2038 is retained.

Function diagram overview (see List Manual)

- 2410 PROFIBUS address, diagnostics
- ...
- 2483 Send telegram, free interconnection via BICO (p0922 = 999)

4.3.2 Monitoring: telegram failure

Description

After a telegram failure and a monitoring time has elapsed (t_{An}), bit r2043.0 is set to "1" and alarm A01920 is output. Binector output r2043.0 can be used for an emergency stop, for example.

After a delay time has elapsed (p2044), fault F01910 is output. Fault F01910 triggers fault response OFF2 (pulse inhibit) for the supply and fault response OFF3 (emergency stop) for SERVO/VECTOR. If no OFF response is to be triggered, the fault response can be reparameterized accordingly.

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

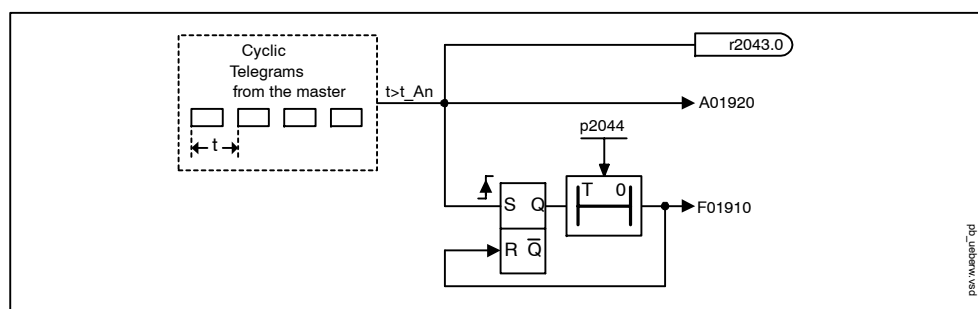


Fig. 4-7 Monitoring: telegram failure

Example: emergency stop with telegram failure

Assumption:

A drive unit with an Active Line Module and a Single Motor Module.

VECTOR mode is activated.

After the ramp-down time has elapsed (p1135), the drive is at a standstill.

Settings:

- A_INF p2044 = 2
- VECTOR p2044 = 0

Sequence:

After a telegram failure ($t > t_{An}$), binector output r2043.0 of drive object CU switches to "1". At the same time, alarm A01920 is output for the A_INF drive objects and alarm A01920 and fault F01910 are output for VECTOR. When F01910 is output, an OFF3 is triggered for the drive. After a delay time (p2044) of two seconds has elapsed, fault F01910 is output on the infeed and triggers OFF2.

4.3.3 Description of control words and setpoints

Note

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

The reference parameter is also specified for the relevant process data. The process data is generally normalized in accordance with parameters p2000 to r2004.

The following scalings apply:

a temperature of 100 °C = 100%; a temperature of 0 °C = 0%

an electrical angle of 90° = 100% too; an electrical angle of 0° = 0%.

For more information, see Section 7.4.

Overview of control words and setpoints

Table 4-5 Overview of control words and setpoints

Abbreviation	Name	Signal number	Data type 1)	Interconnection parameter
CTW1	Control word 1	1	U16	(bit serial) ²⁾
CTW2	Control word 2	3	U16	(bit serial) ²⁾
NSETP_A	Speed setpoint A (16-bit)	5	I16	p1070
NSETP_B	Speed setpoint B (32-bit)	7	I32	p1155 p1430(DSC)
G1_CTW	Encoder 1 control word	9	U16	p0480[0]
G2_CTW	Encoder 2 control word	13	U16	p0480[1]
G3_CTW	Encoder 3 control word	17	U16	p0480[2]
A_DIGITAL	digital outputs	22	U16	(bit serial)
XERR	Position deviation	25	I32	p1190
KPC	Position controller gain factor	26	I32	p1191
TRQRED	Torque reduction	101	I16	p1542
MT_STW	Control word for probe	130	U16	p0682
E_CTW1	Control word for INFEED	320	U16	(bit serial) ²⁾
CU_STW	Control word for Control Unit (CU)	500	U16	(bit serial)

1) Data type to PROFIdrive Profile V3.1:

I16 = Integer16, I32 = Integer32, U16 = Unsigned16, U32 = Unsigned32

2) Bit-serial interconnection: see the following pages

CTW1 (control word 1)

See function diagram [2442]

Table 4-6 Description of CTW1 (control word 1)

Bit	Meaning	Remarks		BICO
0	ON/OFF1	0/1	ON Pulse enable possible	Bl: p0840
		0	OFF1 Braking with the ramp-function generator, then pulse cancellation and power-on inhibit.	
1	OFF2	1	No OFF2 Enable possible	Bl: p0844
		0	OFF2 Immediate pulse cancellation and power-on inhibit	
Note: Control signal OFF2 is generated by ANDing Bl: p0844 and Bl: p0845.				
2	OFF3	1	No OFF3 Enable possible	Bl: p0848
		0	Fast stop (OFF3) Braking along the OFF3 ramp (p1135), then pulse cancelation and power-on inhibit.	
Note: Control signal OFF3 is generated by ANDing Bl: p0848 and Bl: p0849.				
3	Enable operation	1	Enable operation Pulse enable possible	Bl: p0852
		0	Inhibit operation Cancel the pulses	
4	Enables the ramp-function generator	1	Operating condition Ramp-function generator enable possible	Bl: p1140
		0	Inhibit ramp-function generator Set ramp-function generator output to zero	
5	Start ramp-function generator	1	Start ramp-function generator	Bl: p1141
		0	Freeze ramp-function generator	
Note: The ramp-function generator cannot be frozen via p1141 in jog mode (r0046.31 = 1).				
6	Enable speed setpoint	1	Enables the setpoint	Bl: p1142
		0	Inhibit setpoint Set ramp-function generator input to zero	
7	Acknowledge fault	0/1	Acknowledge fault	Bl: p2103
		0	No effect	
Note: The error is acknowledged at a 0/1 edge via Bl: p2103, Bl: p2104, or Bl: p2105.				

Table 4-6 Description of CTW1 (control word 1), continued

Bit	Meaning	Remarks		BICO
8	Reserved	-	-	-
9	Reserved	-	-	-
10	Master ctrl by PLC	1	Master ctrl 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: p0854
		0	PLC has no master control 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 of rotation reversal	1	Direction reversal	BI: p1113
		0	No direction reversal	
12	Reserved			
13	Motorized potentiometer, setpoint, raise	1	Motorized potentiometer, setpoint, raise	BI: p1035
		0	Motorized potentiometer setpoint raise not selected	
14	Motorized potentiometer, lower setpoint	1	Motorized potentiometer, lower setpoint	BI: p1036
		0	Motorized potentiometer setpoint lower not selected	
Note: If motorized potentiometer setpoint raise and lower are 0 or 1 simultaneously, the current setpoint is frozen.				
15	Reserved	-	-	-

CTW2 (control word 2)

See function diagram [2444]

Table 4-7 Description of CTW2 (control word 2)

Bit	Meaning	Remarks		BICO
0	Drive data set selection DDS bit 0	-	Drive data set selection (5-bit counter) For more information about data sets, see Section 7.2.	BI: p0820[0]
1	Drive data set selection DDS bit 1	-		BI: p0821[0]
2	Drive data set selection DDS bit 2	-		BI: p0822[0]
3	Drive data set selection DDS bit 3	-		BI: p0823[0]
4	Drive data set selection DDS bit 4	-		BI: p0824[0]
5...6	Reserved			
7	Parking axis	1	Request parking axis (handshake with ZSW2 bit 7)	BI: p0897
		0	No request	
8	Travel to fixed endstop	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	Reserved	-	-	-
10		-	-	-
11		-	-	-
11	Motor changeover/selection	0/1	Motor switchover complete	BI: p0820[0]
		0	No effect	
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	-		

E_CTW1 (control word for INFEED)

See function diagram [8920]

Table 4-8 Description E_CW1 (control word for INFEED)

Bit	Meaning	Remarks		BICO
0	ON/OFF1	0/1	ON Pulse enable possible	BI: p0840
		0	OFF1 Reduce DC link voltage via ramp (p3566), then pulse inhibit/line contactor open	
1	OFF2	1	No OFF2 Enable possible	BI: p0844
		0	OFF2 Immediate pulse cancellation and power-on inhibit	
Note: Control signal OFF2 is generated by ANDing BI: p0844 and BI: p0845.				
2	Reserved	-	-	-
3	Enable operation	1	Enable operation Pulse enable is present	BI: p0852
		0	Inhibit operation Pulse inhibit is present	
4	Reserved	-	-	-
5	Inhibit motor operation	1	Inhibit motor 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 regenerating	1	Inhibit regenerating 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 error	0/1	Acknowledge error	BI: p2103
	Note: The error is acknowledged at a 0/1 edge via BI: p2103, BI: p2104, or BI: p2105.			

Table 4-8 Description E_CW1 (control word for INFEED), continued

Bit	Meaning	Remarks		BICO
8 9	Reserved	-	-	-
10	Master ctrl by PLC	1	Master ctrl 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: p0854
		0	PLC has no master control 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 12 13 14 15	Reserved	-	-	-

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.

$$\text{NSETP_A} = 4000 \text{ hex or } 16384 \text{ dec} \hat{=} \text{ speed in p2000}$$

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.

$$\text{NSETP_B} = 4000\ 0000\ \text{hex or } 1\ 073\ 741\ 824\ \text{dec} \hat{=} \text{speed in p2000}$$

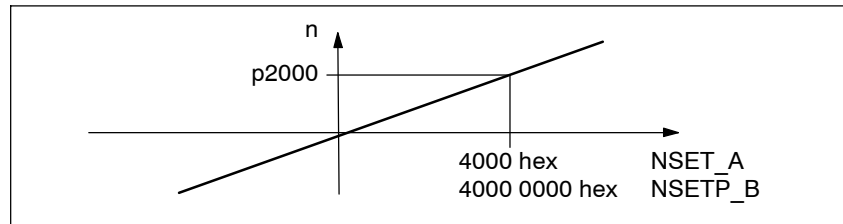


Fig. 4-8 Normalization of speed

Gn_CTW (encoder n control word)

This process data belongs to the encoder interface and is described in Subsection 4.3.5.

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 Subsection 4.3.5).

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:

$$\text{A2C2A hex} \hat{=} 666666\ \text{dec} \hat{=} \text{KPC} = 666.666\ 1/\text{s} \hat{=} \text{KPC} = 40\ 1000/\text{min}$$

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.

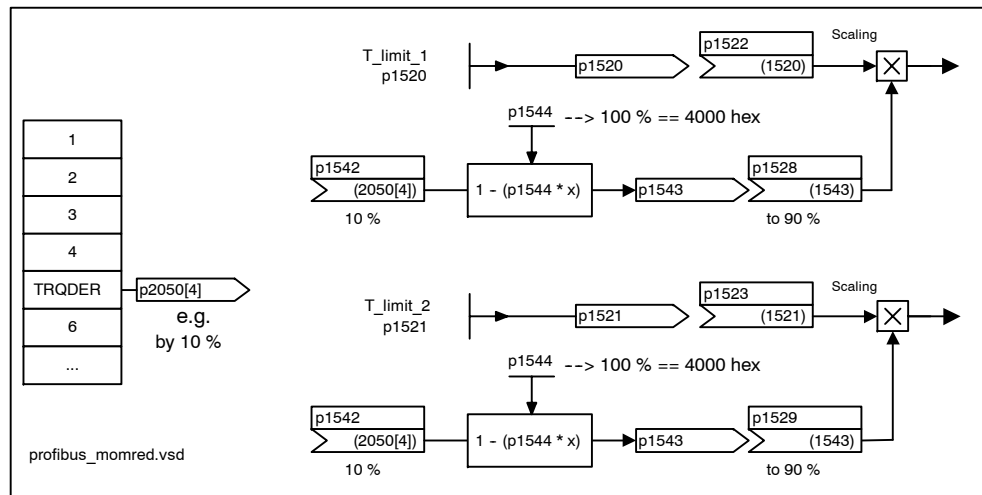


Fig. 4-9 TRQRED setpoint

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.

MT_STW
CU_STW
A_DIGITAL

This process data is part of the central process data and is described in Subsection 4.3.6.

4.3.4 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).

The reference parameter is also specified for the relevant process data. The process data is generally normalized in accordance with parameters p2000 to r2004.

The following scalings apply:

a temperature of 100 °C = 100%

an electrical angle of 90° also = 100%.

For more information, see Section 7.4.

Overview of status words and actual values

Table 4-9 Overview of status words and actual values

Abbreviation	Name	Signal number	Data type 1)	Note
STW1	Status word 1	2	U16	r2089[0] (bit serial) ²⁾
STW2	Status word 2	4	U16	r2089[1] (bit serial) ²⁾
NACT_A	Speed setpoint A (16 bit)	6	I16	r0063 (servo) r0063[0] (vector)
NACT_B	Speed setpoint B (32 bit)	8	I32	r0063 (servo) r0063[0] (vector)
G1_STW	Encoder 1 status word	10	U16	r0481[0]
G1_XACT1	Encoder 1 actual position 1	11	U32	r0482[0]
G1_XACT2	Encoder 1 actual position 2	12	U32	r0483[0]
G2_STW	Encoder 2 status word	14	U16	r0481[1]
G2_XACT1	Encoder 2 actual position 1	15	U32	r0482[1]
G2_XACT2	Encoder 2 actual position 2	16	U32	r0483[1]
G3_STW	Encoder 3 status word	18	U16	r0481[2]
G3_XACT1	Encoder 3 actual position 1	19	U32	r0482[2]
G3_XACT2	Encoder 3 actual position 2	20	U32	r0483[2]
I_DIGITAL	Digital inputs	21	U16	r2089[2]
ITACT_SMOOTH	Current actual value, torque-generating	52	I16	r0078[1]
MSGW	Message word	102	U16	r2089[2] (bit serial) ²⁾
MSET_SMOOTH	Total speed setpoint	120	I16	r00079[1]
AACT_SMOOTH	Torque utilization	121	I16	r0081
MT_ZSW	Status word for probe	131	U16	r0688

Table 4-9 Overview of status words and actual values, continued

Abbreviation	Name	Signal number	Data type 1)	Note
MT1_ZS_F	Probe 1 measuring time, falling edge	132	U16	r0687[0]
MT1_ZS_S	Probe 1 measuring time, rising edge	133	U16	r0686[0]
MT2_ZS_F	Probe 1 measuring time, falling edge	134	U16	r0687[1]
MT2_ZS_S	Probe 2 measuring time, rising edge	135	U16	r0686[1]
NACT_A_SMOOTH	Actual speed smoothed	*	U16	r0063[1]
IAACT_SMOOTH	Absolute actual current smoothed	*	I16	r0068[1]
MACT_SMOOTH	Actual torque smoothed	*	I16	r0080[1]
PACT_SMOOTH	Power factor, smoothed	*	I16	r0082[1]
MELD_NAMUR	VIK-NAMUR message bit bar	*	U16	r3113
FAULT_CODE	Fault code	301	U16	r2131
WARN_CODE	Alarm code	303	U16	r2132
E_ZSW1	Status word for INFEED	321	U16	r899, r2139 (bit serial) ²⁾
CU_ZSW	Control word for Control Unit (CU)	501	U16	r2089[1]

1) Data type to PROFIdrive Profile V3.1:

I16 = Integer16, I32 = Integer32, U16 = Unsigned16, U32 = Unsigned32

2) Bit-serial interconnection: see the following pages, r2089 via binector-connector converters

STW1 (status word 1)

See function diagram [2452]

Table 4-10 Description of STW1 (status word 1)

Bit	Meaning	Remarks		BICO
0	Ready to start	1	Ready to start Power supply on, electronics initialized, line contactor released if necessary, pulses inhibited.	BO: r0899.0
		0	Not ready to start	
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.	

Table 4-10 Description of STW1 (status word 1), continued

Bit	Meaning	Remarks		BICO
2	Operation enabled	1	Operation enabled Enable electronics and pulses, then ramp up to active setpoint.	BO: r0899.2
		0	Operation inhibited	
3	Fault active	1	Fault active 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	Coasting active (OFF2)	1	No OFF2 active	BO: r0899.4
		0	Coasting active (OFF2) An OFF2 command is present.	
5	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 A restart is only possible through OFF1 followed by ON.	BO: r0899.6
		0	No power-up inhibit Power up is possible.	
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	SpeedSpeed setpoint-actual value deviation within the tolerance bandwidth	1	Setpoint/actual value monitoring within tolerance bandwidth Actual value within tolerance band; dynamic overshoot or shortfall permitted for $t < t_{\max}$, e.g. $n = n_{\text{setp}\pm}$ $f = f_{\text{setp}\pm}$, etc., t_{\max} is parameterizable	BO: r2197.7
		0	Setpoint/actual value monitoring not within tolerance band	

Table 4-10 Description of STW1 (status word 1), continued

Bit	Meaning	Remarks		BICO
9	Control requested	1	Control from the PLC 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 reached or exceeded	1	I, M or P limit not reached	BO: r1407.7
		0	I, M or P limit reached or exceeded	
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	n_act >= 0	1	Actual speed value > = 0	BO: r2197.3
		0	Actual speed value < 0	
15	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 4-11 Description of STW2 (status word 2)

Bit	Meaning	Remarks		BICO
0	DDS eff., bit 0	-	Drive data set effective (5-bit counter) For more information about data sets, see Section 7.2.	BO: r0051.0
1	DDS eff., bit 1	-		BO: r0051.1
2	DDS eff., bit 2	-		BO: r0051.2
3	DDS eff., bit 3	-		BO: r0051.3
4	DDS eff., bit 4	-		BO: r0051.4
5...7	Reserved	-	-	-
7	Parking axis	1	Axis parking active	BO: r0896.0
		0	Axis parking not active	
8	Travel to fixed endstop	1	Travel to fixed endstop	BO: r1406.8
		0	No travel to fixed stop	
9 10	Reserved	-	-	-
11	Data set changeover	1	Data record changeover active	BO: r0835.0
		0	No data set changeover active	
12	Slave sign-of-life bit 0	-	User data integrity (4-bit counter)	Implicitly inter- connected
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 NSET_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 Subsection 4.3.5.

ITACT_SMOOTH

The actual current value smoothed with p0045 is displayed.

MSGW (message word)

See function diagram [2456]

Table 4-12 Description of MSGW (message word)

Bit	Meaning	Remarks		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: <ul style="list-style-type: none"> • 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: <ul style="list-style-type: none"> • 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 4-12 Description of MSGW (message word), continued

Bit	Meaning	Remarks		BICO
1	Torque utilization < p2194	1	Torque utilization < p2194 The current torque utilization is less than the set torque utilization threshold (p2194). or Ramp-up is not yet complete.	BO: r2199.11
		0	Torque utilization > p2194 The current torque utilization is greater than the set torque utilization threshold (p2194).	
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).				
2	n_act < p2161	1	n_act < p2161 The actual speed value is less than the set threshold value (p2161).	BO: r2199.0
		0	n_act ≥ p2161 The actual speed value is greater than or the same as the set threshold value (p2161).	
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.				
3	n_act ≤ p2155	1	n_act ≤ p2155 The actual speed value is less than or the same as the set threshold value (p2155).	BO: r2197.1
		0	n_act > p2155 The actual speed value is greater than the set threshold value (p2155).	
Note: The message is parameterized as follows: p2155 Threshold value p2140 Hysteresis Application: Speed monitoring				
4	Reserved	1	-	-
		0	-	

Table 4-12 Description of MSGW (message word), continued

Bit	Meaning	Remarks		BICO
5	Reserved	1	-	-
		0	-	
6	No motor overtemperature alarm	1	No motor overtemperature alarm The temperature of the motor is within the permissible range.	BO: r2135.14
		0	Alarm, motor overtemperature The temperature of the motor is greater than the set motor temperature threshold (p0604).	
<p>Note:</p> <ul style="list-style-type: none"> 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. <p>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.</p>				
7	No thermal overload in power section alarm	1	No thermal overload in power section alarm The temperature of the heat sink in the power section is within the permissible range.	BO: r2135.15
		0	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.	
8	Speed setp - act val deviation in tolerance t_on	1	The speed setpoint/actual value deviation is within the tolerance range p2163: The signal is switched off after the delay specified in p2167 has elapsed.	BO: r2199.4
		0	The speed setpoint/actual value deviation is outside the tolerance range p2163:	
9 ... 12	Reserved	1	-	-
		0	-	
13	Pulses enabled	1	Pulses enabled The pulses for activating the motor are enabled.	BO: r0899.11
		0	Pulses inhibited	
<p>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.</p>				

Table 4-12 Description of MSGW (message word), continued

Bit	Meaning	Remarks		BICO
14	Reserved	1	-	-
15		0	-	

MSET_SMOOTH

The torque setpoint smoothed with p0045 is displayed.

AACT_SMOOTH

The torque utilization smoothed with p0045 is displayed.

I_DIGITAL**MT_STW****MT_n_ZS_F/MT_n_ZS_S****CU_ZSW**

This process data is part of the central process data and is described in Subsection 4.3.6.

IAACT_SMOOTH

The actual current value smoothed with p0045 is displayed.

MACT_SMOOTH

The actual torque value smoothed with p0045 is displayed.

PACT_SMOOTH

The power factor smoothed with p0045 is displayed.

MELD_NAMUR

Display of the NAMUR message bit bar

WARN_CODE

Display of the alarm code (see function diagram 8066)

FAULT_CODE

Display of the alarm code (see function diagram 8060)

E_ZSW1 (status word for INFEED)

See function diagram [8926]

Table 4-13 Description of E_ZSW1 (status word for E_INF)

Bit	Meaning	Remarks		BICO
0	Ready to start	1	Ready to start	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 active	1	Fault active	BO: r2139.3
		0	No fault	
4	No OFF2 active	1	No OFF2 active	BO: r0899.4
		0	OFF2 active	
5	Reserved	-	-	-
6	Power-up inhibit	1	Power-up inhibit Fault active	BO: r0899.6
		0	No power-up inhibit	
7	Alarm present	1	Alarm present	BO: r2139.7
		0	No alarm	
8	Reserved	-	-	-
9	Control requested	1	Control from the PLC 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	-	-	-
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 activated	1	Line contactor activated	BO: r0899.12
		0	Line contactor not energized	

Table 4-13 Description of E_ZSW1 (status word for E_INF), continued

Bit	Meaning	Remarks		BICO
13	Reserved			
14		-	-	-
15				

4.3.5 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

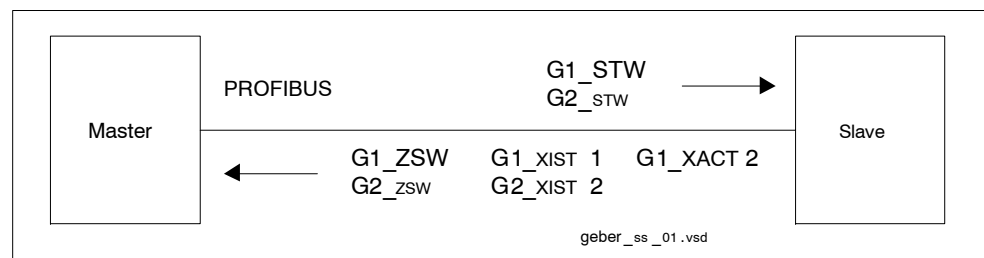


Fig. 4-10 Example for encoder interface (encoder -1: two actual values, encoder -2: one actual value)

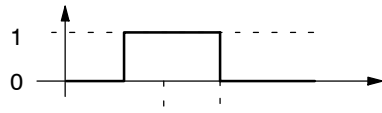

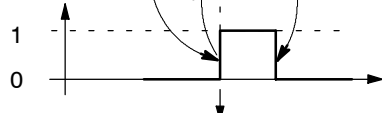
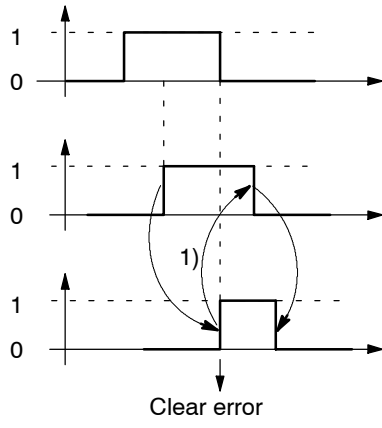
Encoder n control word (Gn_STW, n = 1, 2, 3)

The encoder control word controls the encoder functions.

Table 4-14 Description of the individual signals in Gn_STW

Bit	Name	Signal state/description	
0	Func-tions Find refer-ence mark or On-the-fly measure-ment	If bit 7 = 0, then find reference marker request applies: Bit Meaning 0 Function 1 Reference marker 1 1 Function 2 Reference mark 2 2 Function 3 Reference mark 3 3 Function 4 Reference mark 4	
1		If bit 7 = 1, then measurement on-the-fly request applies: Bit Meaning 0 Function 1 Measuring input 1 rising edge 1 Function 2 Measuring input 1 falling edge 2 Function 3 Measuring input 2 rising edge 3 Function 4 Measuring input 2 falling edge	
2		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 mark It is possible to search for a reference marker. • Equivalent zero mark • On-the-fly measurement The positive and negative edge can be activated simultaneously.	
3			
4		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)
5			
6			
7	Mode	1 Measurement on-the-fly (fine resolution via p0418)	
		0 Find reference marker (fine resolution via p0418)	
8 ... 12	Reserved	-	

Table 4-14 Description of the individual signals in Gn_STW, continued

Bit	Name	Signal state/description	
13	Request cyclic absolute value	1	Request cyclic transmission of the absolute actual position value in Gn_XACT2. Used for (e.g.): <ul style="list-style-type: none"> • Additional measuring system monitoring • Synchronization during ramp-up
		0	No request
14	Parking encoder	1	Request parking encoder (handshake with Gn_ZSW bit 14)
		0	No request
15	Acknowledge encoder error	0/1	Request to reset encoder errors <div style="display: flex; align-items: flex-start;"> <div style="margin-right: 20px;"> <p>Gn_ZSW.15 Encoder error</p>  </div> <div style="margin-right: 20px;"> <p>Gn_STW.15 Acknowledge encoder error</p>  </div> <div style="margin-right: 20px;"> <p>Gn_ZSW.11 Encoder fault acknowledge active</p>  </div> <div style="margin-left: 20px;">  </div> </div> <p>1) Signal must be reset by user</p>
		0	No request

Example 1: Find reference mark

Assumptions for the example:

- Distance-coded reference mark
- Two reference markers (function 1 / function 2)
- Position control with encoder 1

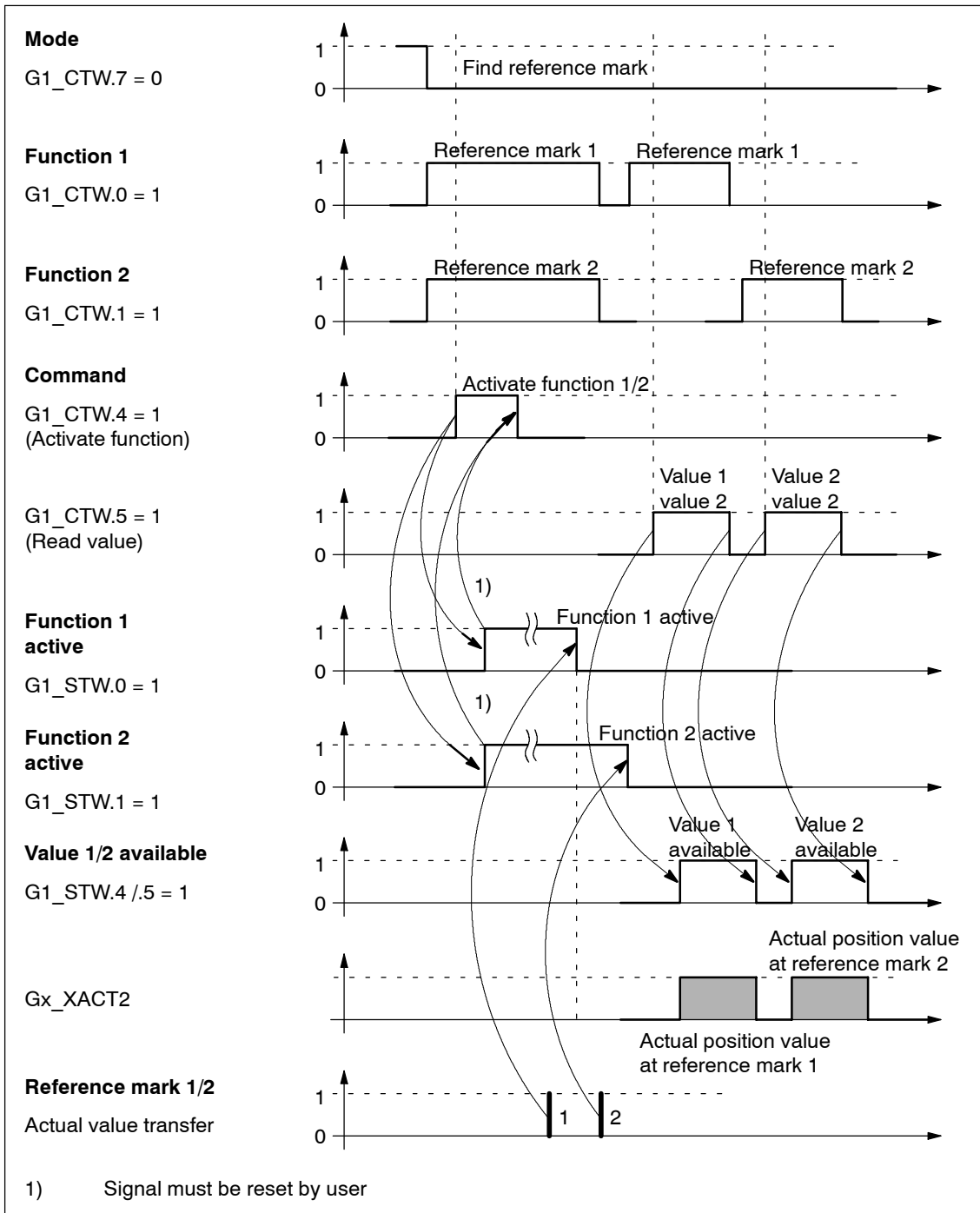


Fig. 4-11 Flowchart for "find reference mark"

Example 2: Flying measurement

Assumptions for the example:

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

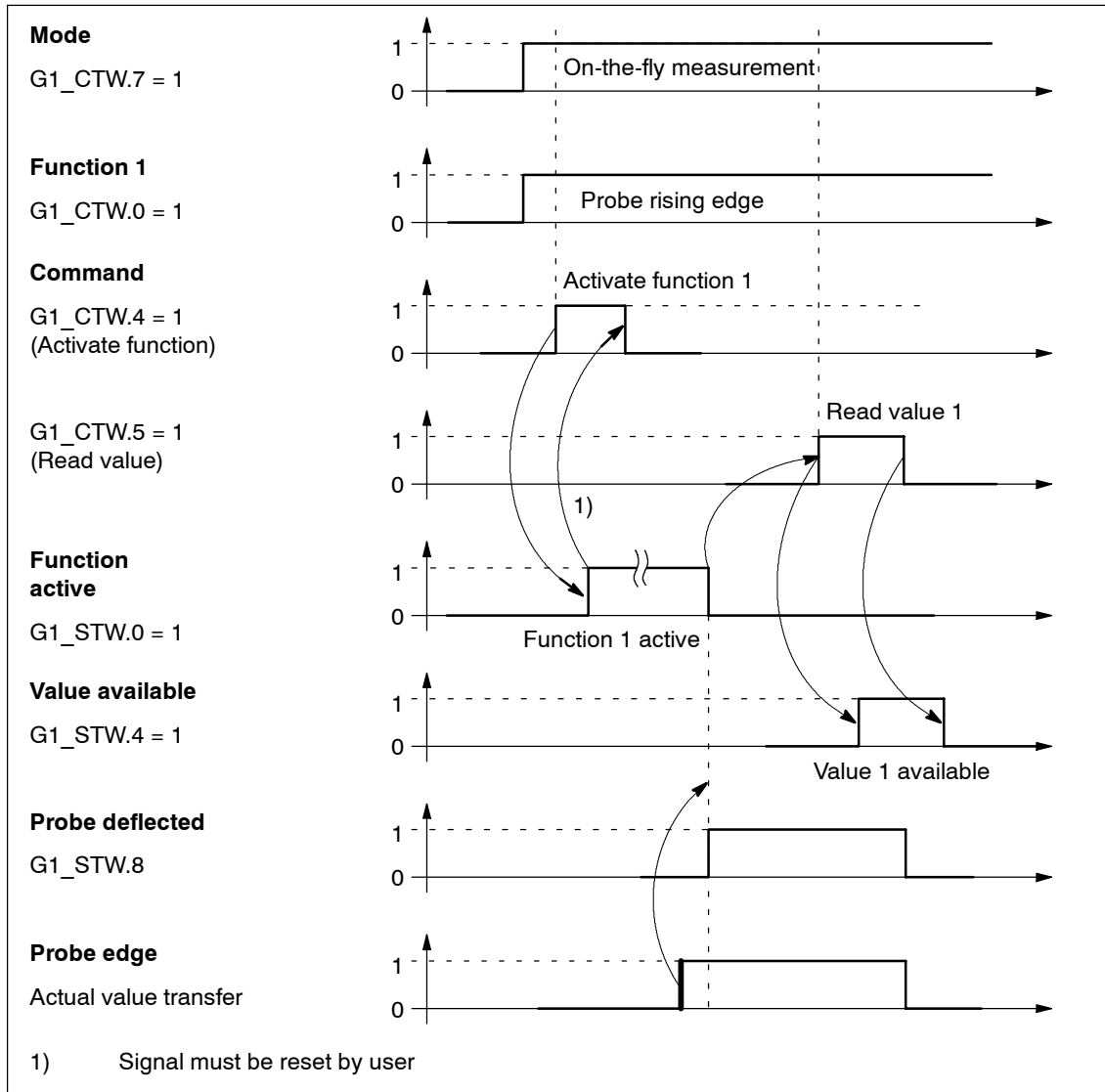


Fig. 4-12 Function chart for "measurement on-the-fly"

Encoder 2 control word (G2_CTW)

- see G1_CTW (Table 4-14)

Encoder 3 control word (G3_CTW)

- see G1_CTW (Table 4-14)

Encoder n status word (Gn_STW, n = 1, 2, 3)

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

Table 4-15 Description of the individual signals in Gn_ZSW

Bit	Name	Signal state/description
0	Status: Function 1 - 4 active	Valid for find reference marker and measurement on-the-fly
1		Bit Meaning 0 Function 1 Reference marker 1 Probe 1 rising edge
2		1 Function 2 Reference mark 2 Probe 1 falling edge
3		2 Function 3 Reference mark 3 Probe 2 rising edge 3 Function 4 Reference mark 4 Probe 2 falling edge
3		Note: • Bit x = 1 Function active Bit x = 0 Function inactive
4	Find refer- ence mark or On-the-fly measure- ment	Valid for find reference marker and measurement on-the-fly
5		Bit Meaning 4 Value 1 Reference marker 1 Probe 1 rising edge
6		5 Value 2 Probe 1 falling edge 6 Value 3 Probe 2 rising edge
7		7 Value 4 Probe 2 falling edge
6	Status: Value 1 - 4 available	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 Gn_XACT2 is available for reading the values.
7		• The probe must be configured to a "high-speed input" DI/DO on the Control Unit.
8	Probe 1 deflected	1 Probe deflected (high signal)
		0 Probe not deflected (low signal)

Table 4-15 Description of the individual signals in Gn_ZSW, continued

Bit	Name	Signal state/description	
9	Probe 2 deflected	1	Probe deflected (high signal)
		0	Probe not deflected (low signal)
10	Reserved		-
11	Encoder fault acknowledge active	1	Encoder fault acknowledge active Note: see CTW.15 (acknowledge encoder error)
		0	No acknowledgement active
12	Reserved		-
13	Transmit cyclic absolute value	1	Acknowledgement for Gn_STW.13 (request cyclic absolute value) Note: Cyclic transmission of the absolute value can be interrupted by a function with higher priority. --> see Fig. 4-14 --> See Gn_XACT2
		0	No acknowledgement
14	Parking encoder	1	Parking encoder active (i.e. parking encoder switched off)
		0	No active parking encoder
15	Encoder error	1	Error from encoder or actual-value sensing is active. Note: The error code is stored in Gn_XACT2
		0	No error is active.

Encoder 1 actual position value 1 (G1_XACT1)

- Resolution: encoder lines $\cdot 2^n$
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.

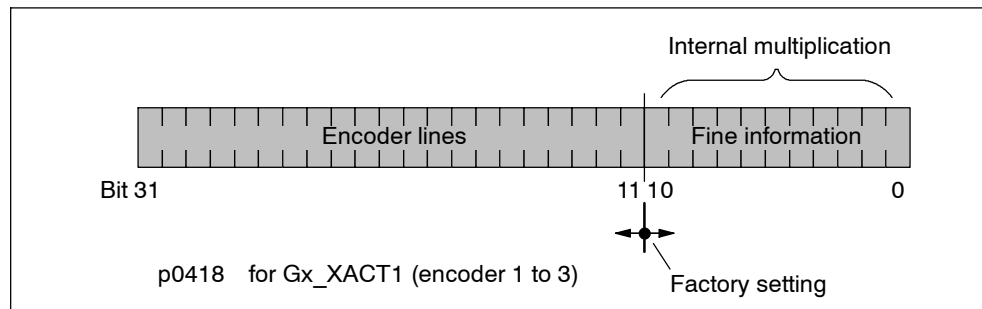


Fig. 4-13 Partitioning and settings for Gx_XACT1

- 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. 4-14).

- Priorities for Gx_XACT2

The following priorities should be considered for values in Gx_XACT2:

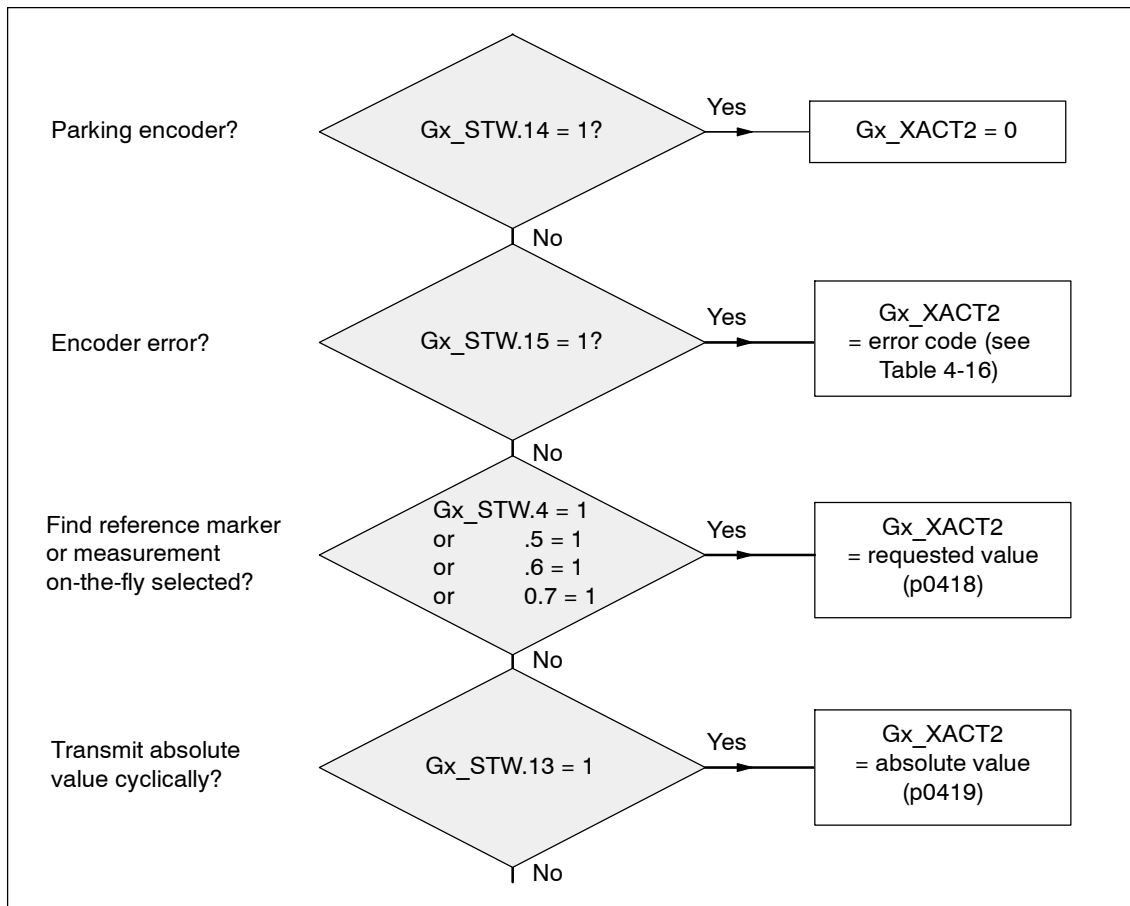


Fig. 4-14 Priorities for functions and Gx_XACT2

- Resolution: encoder lines $\cdot 2^n$
n: fine resolution, no. of bits for internal multiplication

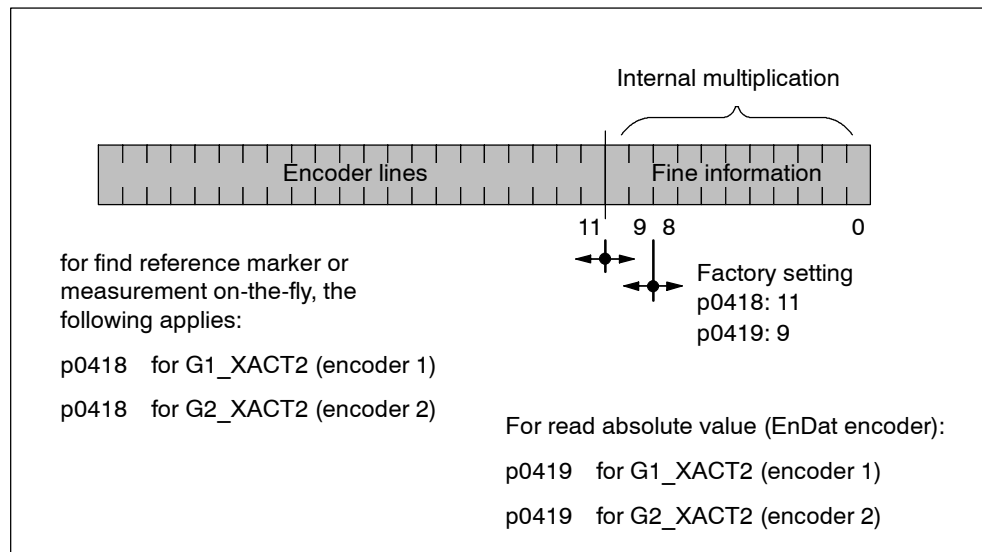


Fig. 4-15 Partitioning and settings for Gx_XACT2

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

Error code in Gn_XACT2

Table 4-16 Error code in Gn_XACT2

n_XACT2	Meaning	Possible causes/description
1	Encoder error	One or more encoder errors, detailed information in drive messages
2	Zero marker monitoring	-
3	Abort parking sensor	<ul style="list-style-type: none"> • Parking drive object already selected
4	Abort find reference marker	<ul style="list-style-type: none"> • A fault exists (Gn_ZSW.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. • Inconsistent position measured value with distance-coded reference markers
5	Abort get reference value	<ul style="list-style-type: none"> • More than four values requested • No value requested • Requested value not available

Table 4-16 Error code in Gn_XACT2, continued

n_XACT2	Meaning	Possible causes/description
6	Abort, flying measurement	<ul style="list-style-type: none"> • 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.
7	Abort get measured value	<ul style="list-style-type: none"> • More than one value requested • No value requested • Requested value not available • Parking encoder active • Parking drive object active
8	Abort absolute value transmission on	<ul style="list-style-type: none"> • Absolute encoder not available • Alarm bit absolute value protocol set
3841	Function not supported	-

Encoder 2 status word (G2_STW)

- See G1_STW (Table 4-15)

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 4-15)

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
- 4735 Find reference marker with equivalent zero mark, encoders n
- 4740 Measuring probe evaluation, measured value memory, encoders n

Parameter overview (see List Manual)

Adjustable parameter drive, CU_S parameter is marked

- p0418[0...15] Fine resolution Gx_XACT1
- p0419[0...15] Fine resolution Gx_XACT2
- 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 (CU_S)

Visualization parameters drive

- 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

4.3.6 Central control and status words**Description**

The central process data exists for different telegrams. For example, telegram 391 is used for transferring measuring times and digital inputs/outputs.

The following central process data is available:

Receive signals:

- CU_STW Control Unit control word
- A_DIGITAL Digital outputs
- MT_STW Probe control word

Transmit signals:

- CU_ZSW Control Unit status word
- E_DIGITAL Digital inputs
- MT_ZSW Probe status word
- MTn_ZS_F Probe n measuring time, falling edge (n = 1, 2)
- MTn_ZS_S Probe n measuring time, rising edge (n = 1, 2)

CU_STW (control word for Control Unit, CU)

See function diagram [2448]

Table 4-17 Description CU_STW (control word for Control Unit)

Bit	Meaning	Remarks		BICO
0	Synchronizations flag	-	This signal is used to synchronize the joint system time between the master and slave.	Bl: p0681
1...6	Reserved	-	-	-
7	Acknowledging faults	0/1	Acknowledging faults	Bl: p2103
8...11	Reserved	-	-	-
12	Master sign-of-life bit 0	-	Master sign of life	Cl: p2045
13	Master sign-of-life bit 1	-		
14	Master sign-of-life bit 2	-		
15	Master sign-of-life bit 3	-		

A_DIGITAL (digital outputs)

This process data can be used to control the Control Unit outputs. See function diagram [2449]

Table 4-18 Description A_DIGITAL (digital outputs)

Bit	Meaning	Remarks		BICO
0	Digital input/output 8 (DI/ <u>DO</u> 8)	-	DI/DO 8 on the Control Unit must be parameterized as an output (p0728.8 = 1).	Bl: p0738
1	Digital input/output 9 (DI/ <u>DO</u> 9)	-	DI/DO 9 on the Control Unit must be parameterized as an output (p0728.9 = 1).	Bl: p0739
2	Digital input/output 10 (DI/ <u>DO</u> 10)	-	DI/DO 10 on the Control Unit must be parameterized as an output (p0728.10 = 1).	Bl: p0740
3	Digital input/output 11 (DI/ <u>DO</u> 11)	-	DI/DO 11 on the Control Unit must be parameterized as an output (p0728.11 = 1).	Bl: p0741
4	Digital input/output 12 (DI/ <u>DO</u> 12)	-	DI/DO 12 on the Control Unit must be parameterized as an output (p0728.12 = 1).	Bl: p0742
5	Digital input/output 13 (DI/ <u>DO</u> 13)	-	DI/DO 13 on the Control Unit must be parameterized as an output (p0728.13 = 1).	Bl: p0743
6	Digital input/output 14 (DI/ <u>DO</u> 14)	-	DI/DO 14 on the Control Unit must be parameterized as an output (p0728.14 = 1).	Bl: p0744
7	Digital input/output 15 (DI/ <u>DO</u> 15)	-	DI/DO 15 on the Control Unit must be parameterized as an output (p0728.15 = 1).	Bl: p0745
8...15	Reserved	-	-	-
Note: The bidirectional digital inputs/outputs (DI/DO) can be connected as either an input or an output (see also transmit signal E_DIGITAL).				

MT_STW

Control word for the “central probe” function. Display via r0685.

Table 4-19 Description MT_STW (control word for Control Unit)

Bit	Meaning	Remarks		BICO
0	Falling edge probe 1	-	Activation of measuring time determination with the next falling edge	Cl: p0682
1	Falling edge probe 2	-		
2...7	Reserved	-	-	
8	Rising edge probe 1	-	Activation of measuring time determination with the next rising edge	
9	Rising edge probe 2	-		
10...15	Reserved	-	-	

CU_ZSW (status word for Control Unit, CU)

See function diagram [2458]

Table 4-20 Description CU_ZSW (status word for Control Unit)

Bit	Meaning	Remarks		BICO
0...2	Reserved	-	-	-
3	Fault active	1	Fault active	BO: r2139.3
		0	No fault present	
4...6	Reserved	-	-	-
7	Alarm present	1	Alarm present	BO: 2139.7
		0	No alarm present	
8	SYNC	-	-	BO: r0899.8
12	Slave sign-of-life bit 0	-	Slave sign of life	Implicitly interconnected
13	Slave sign-of-life bit 1	-		
14	Slave sign-of-life bit 2	-		
15	Slave sign-of-life bit 3	-		

E_DIGITAL (digital inputs)

See function diagram [2459]

Table 4-21 Description E_DIGITAL (digital inputs)

Bit	Meaning		Remarks	BICO
0	Digital input/output 8 (DI/DO = 8)	-	DI/DO 8 on the Control Unit must be parameterized as an input (p0728.8 = 0).	BO: p0722.8
1	Digital input/output 9 (DI/DO = 9)	-	DI/DO 9 on the Control Unit must be parameterized as an input (p0728.9 = 0).	BO: p0722.9
2	Digital input/output 10 (DI/DO = 10)	-	DI/DO 10 on the Control Unit must be parameterized as an input (p0728.10 = 0).	BO: p0722.10
3	Digital input/output 11 (DI/DO = 11)	-	DI/DO 11 on the Control Unit must be parameterized as an input (p0728.11 = 0).	BO: p0722.11
4	Digital input/output 12 (DI/DO = 12)	-	DI/DO 12 on the Control Unit must be parameterized as an input (p0728.12 = 0).	BO: p0722.12
5	Digital input/output 13 (DI/DO = 13)	-	DI/DO 13 on the Control Unit must be parameterized as an input (p0728.13 = 0).	BO: p0722.13
6	Digital input/output 14 (DI/DO = 14)	-	DI/DO 14 on the Control Unit must be parameterized as an input (p0728.14 = 0).	BO: p0722.14
7	Digital input/output 15 (DI/DO = 15)	-	DI/DO 15 on the Control Unit must be parameterized as an input (p0728.15 = 0).	BO: p0722.15
8	Digital input 0 (DI 0)	-	Digital input DI 0 on the Control Unit	BO: r0722.0
9	Digital input 1 (DI 1)	-	Digital input DI 1 on the Control Unit	BO: r0722.1
10	Digital input 2 (DI 2)	-	Digital input DI 2 on the Control Unit	BO: r0722.2
11	Digital input 3 (DI 3)	-	Digital input DI 3 on the Control Unit	BO: r0722.3
12	Digital input 4 (DI 4)	-	Digital input DI 4 on the Control Unit	BO: r0722.4
13	Digital input 5 (DI 5)	-	Digital input DI 5 on the Control Unit	BO: r0722.5
14	Digital input 6 (DI 6)	-	Digital input DI 6 on the Control Unit	BO: r0722.6
15	Digital input 7 (DI 7)	-	Digital input DI 7 on the Control Unit	BO: r0722.7
Note: The bidirectional digital inputs/outputs (DI/DO) can be connected as either an input or an output (see also receive signal A_DIGITAL).				

MT_ZSW

Status word for the “central probe” function.

Table 4-22 Description MT_ZSW (status word for the central probe function)

Bit	Meaning	Remarks		BICO
0	Digital input probe 1	-	Display of the digital inputs	CO: r0688
1	Digital input probe 2	-		
2...7	Reserved	-	-	
8	Sub-sampling probe 1	-	Not yet carried out.	
9	Sub-sampling probe 2	-		
10...15	Reserved	-	-	

MTn_ZS_F and MTn_ZS_S

Display of the measuring time determined

The measuring time is specified as a 16-bit value with a resolution of 0.25 μ s.

Features of the central probe

- The time stamps from probes in more than one drive can be transferred simultaneously in a single telegram.
- The time in the controller and drive unit is synchronized via the CU_STW and the CU_ZSW.
Note: The controller must support time synchronization!
- A higher-level controller can then use the time stamp to determine the actual position value of more than one drive.
- The system outputs a message if the measuring time determination function in the probe is already in use (see also p0488, p0489, and p0580).

Example: central probe

Assumptions for the example:

- Determination of the time stamp MT1_ZS_S by evaluating the rising edge of probe 1
- Determination of the time stamp MT2_ZS_S and MT2_ZS_F by evaluating the rising and falling edge of probe 2
- Probe 1 on DI/DO9 of the Control Unit (p0680[0] = 1)
- Probe 2 on DI/DO10 of the Control Unit (p0680[1] = 2)
- Manufacturer-specific telegram p0922 = 391 is set

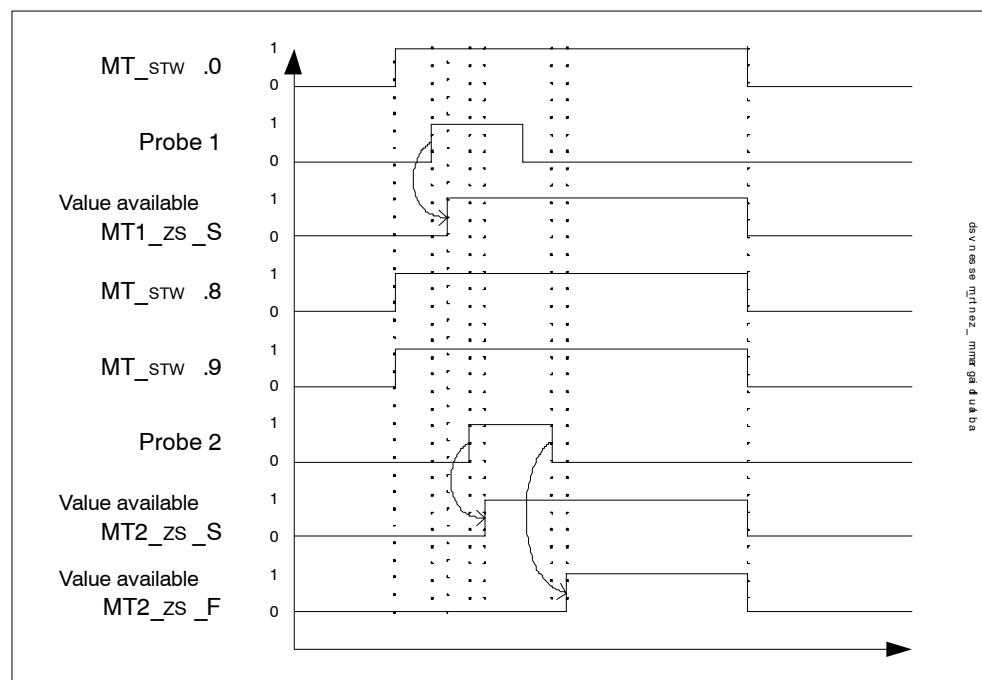


Fig. 4-16 Function chart for central probe example

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:

References: /P5/ 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.
- 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).
- The task or response header are user data.

4.4.2 Requests and responses according to DPV1

Structure of parameter request and parameter response

Parameter request			Offset
Request header	Request reference	Task identification	0
	axis	No. of parameters	2
1. parameter address	Attribute	No. of elements	4
	Parameter number		6
	Subindex		8
...			
Parameter address n	Attribute	No. of elements	
	Parameter number		
	Subindex		
1. 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
1. 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 4-23 Description of fields

Field	Data type	Values	Note
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.
Task identification	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.
Drive object number	Unsigned8	0x00 ... 0xFF	Number Setting for the drive object number with a drive unit with more than one drive object. Different drive objects with separate parameter number ranges can be accessed over the same DPV1 connection.
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 Text (not implemented) Type of parameter element 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	No. 1 ... 65535 Addresses the parameter to be accessed.

Table 4-23 Description of fields, continued

Field	Data type	Values	Note
Subindex	Unsigned16	0x0000 ... 0xFFFF	No. 0 ... 65535 Addresses the first array element of the parameter to be accessed.
Format	Unsigned8	0x02 0x03 0x04 0x05 0x06 0x07 0x08 Other values 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 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.
error values	Unsigned16	0x0000 ... 0x00FF	Meaning of the error values --> see table 4-24 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.
Values	Unsigned16	0x0000 ... 0x00FF	The values of the parameter for read or write access. If the values make up an odd number of bytes, a zero byte is appended. This ensures the integrity of the word structure of the telegram.

Error values in DPV1 parameter responses

Table 4-24 Error values in DPV1 parameter responses

Error value	Meaning	Note	Extra info
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 4-24 Error values in DPV1 parameter responses, continued

Error value	Meaning	Note	Extra info
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).	-
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.	-	-
0x78	Parameter %s [%s]: write access only in the commissioning state, drive configuration (device: p0009 = 3).	-	-

Table 4-24 Error values in DPV1 parameter responses, continued

Error value	Meaning	Note	Extra info
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]: Parameter change blocked (see p0300, p0400, p0922)	-	-
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.	-
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).	-

Table 4-24 Error values in DPV1 parameter responses, continued

Error value	Meaning	Note	Extra info
0xCC	Write access not permitted.	Write access is not permitted because an access key is not available.	-

4.4.3 Determining the drive object numbers

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

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

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

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

Example:

If the number of drive objects is "5", the values for indices 0 to 4 for parameter p0101 are read. Of course, the relevant indexes can also be read at once.

Note

The first two points provide you with the following information:

- The number of drive objects 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 in parameter r0107/p0107 indicates the drive object type. The coding for the drive object type is specified in the parameter list.

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

4.4.4 Example 1: read parameters

Requirements

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 (also drive object number 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
	1. value = 1355 dec	6
	2. value = 0 dec	8

	8. value = 0 dec	20

Information about the parameter response:

- Request reference mirrored:
This response belongs to the request with request reference 25.
- Response 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.
- 1. 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)

Requirements

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.

Special requirements for this example:

4. Control type: VECTOR

Task description

Jog 1 and 2 are to be set up for drive 2 (also drive object number 2) via the input terminals of the Control Unit. A parameter request is to be used to write the corresponding parameters as follows:

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

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

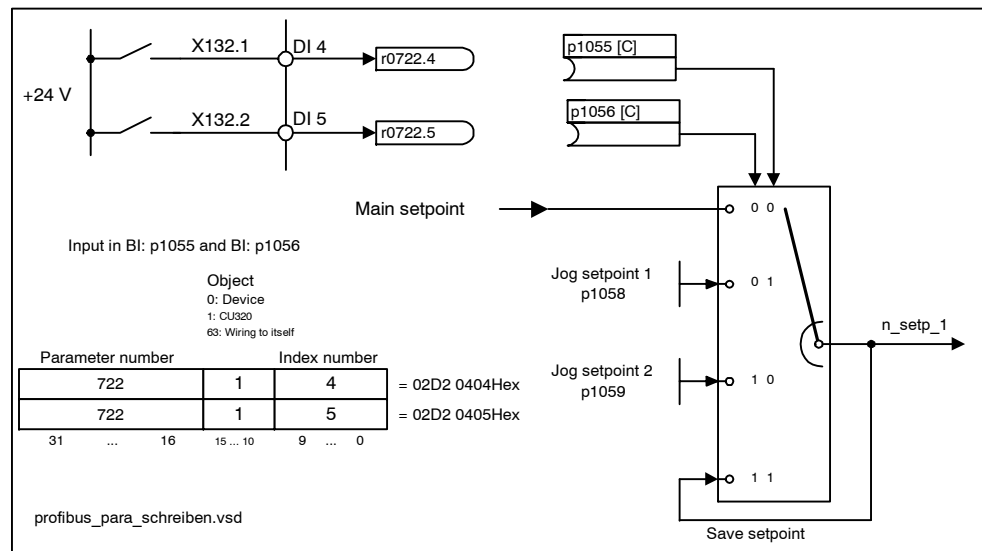


Fig. 4-17 Task description for multi-parameter request (example)

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
1. parameter address	Attribute = 10 hex	No. of elements = 01 hex	4 + 5
	Parameter no. = 1055 dec		6
	Subindex = 0 dec		8
2. parameter address	Attribute = 10 hex	No. of elements = 01 hex	10 + 11
	Parameter no. = 1056 dec		12
	Subindex = 0 dec		14
3. parameter address	Attribute = 10 hex	No. of elements = 01 hex	16 + 17
	Parameter no. = 1058 dec		18
	Subindex = 0 dec		20
4. parameter address	Attribute = 10 hex	No. of elements = 01 hex	22 + 23
	Parameter no. = 1059 dec		24
	Subindex = 0 dec		26
1. parameter value(s)	Format = 07 hex	No. of values = 01 hex	28 + 29
	Value = 02D2 hex		30
	Value = 0204 hex		32
2. parameter value(s)	Format = 07 hex	No. of values = 01 hex	34 + 35
	Value = 02D2 hex		36
	Value = 0205 hex		38
3. parameter value(s)	Format = 08 hex	No. of values = 01 hex	40 + 41
	Value = 4396 hex		42
	Value = 0000 hex		44
4. 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.
1. 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.
1. 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. 4-17)
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:

References: /P5/ 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.
- The master-side default setting is made via the hardware configuration (e.g. HWConfig with SIMATIC S7). The slave-side default setting is made via the parameterization telegram when the bus is ramping up.
- 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 bus configuration: When the clock cycle is selected, the bus configuration tool (e.g. HWConfig) supports:
 - Large number of drives per slave/drive unit -> long cycle
 - Large number of slaves/drive units -> 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.

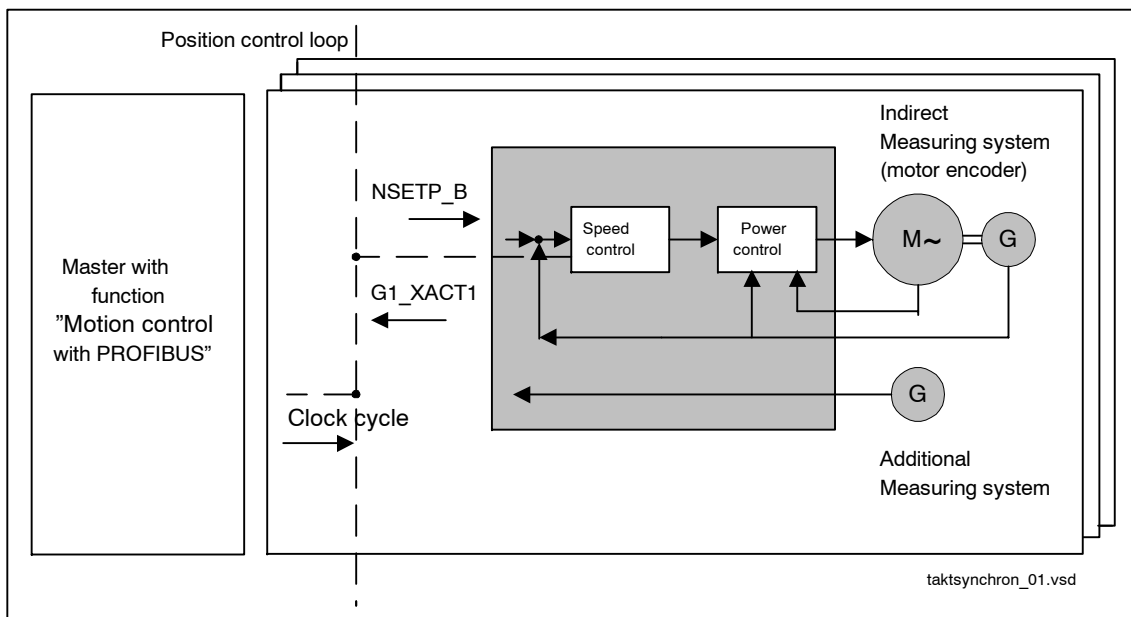


Fig. 4-18 Overview of "Motion control with PROFIBUS" (example: master and 3 slaves)

Structure of the data cycle

The data cycle comprises the following elements:

1. Global control message frame
2. Cyclic part
 - Setpoints and actual values
3. Acyclic part
 - Parameters and diagnostic data
4. Reserved part
 - Transmission of token (T_{TH}).
 - For searching for a new node in the drive line-up (GAP)
 - Waiting time until next cycle

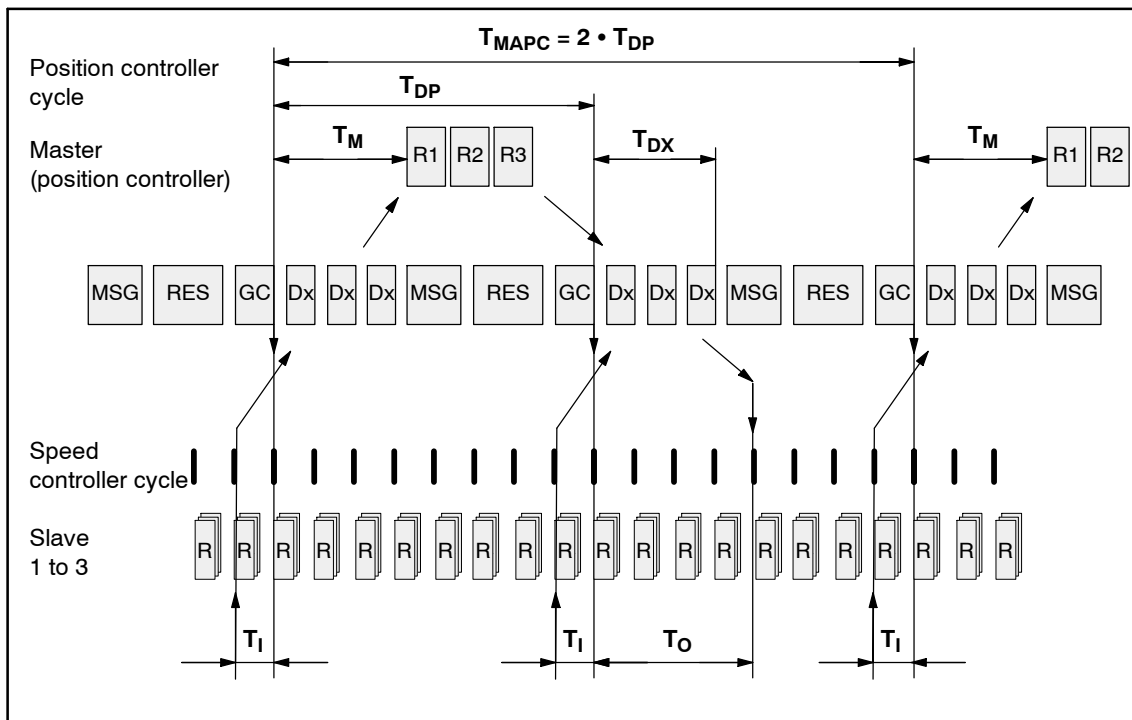


Fig. 4-19 Example: Optimized cycle with $T_{MAPC} = 2 \cdot T_{DP}$

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_B 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 4-25 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	$T_{DP} \geq T_{DP_MIN}$ $T_{DP_MIN} = 8$	Cycle time $T_{DP} = \text{integer multiple} \cdot T_{BASE_DP}$ Calculation: $T_{DP} = 8 \cdot T_{BASE_DP} = 1 \text{ ms}$ Minimum DP cycle time Calculation: $T_{DP_MIN} = 8 \cdot T_{BASE_DP} = 1 \text{ ms}$
T_{MAPC}	1	$n \cdot T_{DP}$ $n = 1 - 14$	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: $T_{MAPC} = 1 \cdot T_{DP} = 1 \text{ ms}$
T_{SAPC}			Slave application cycle time
T_{BASE_IO}	5DC hex ≐ 1500 dec	-	Time base for T_I , T_O Calculation: $T_{BASE_IO} = 1500 \cdot T_{Bit} = 125 \mu s$ $T_{Bit} = 1/12 \mu s$ 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. $T_I = \text{integer multiple of } T_{BASE_IO}$ Calculation: $T_I = 2 \cdot 125 \mu s = 250 \mu s$ For $T_I = 0$: $T_I = T_{DP}$ Minimum T_I Calculation: $T_{I_MIN} = 1 \cdot T_{BASE_IO} = 125 \mu s$

Table 4-25 Time settings and meanings, continued

Name	Value ¹⁾	Limit value	Description
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 • 125 μs = 500 μs For T _O = 0: T _O = T _{DP} Minimum time interval between T _O and T _{DX} T _{O_MIN} = 1 • T _{BASE_IO} = 125 μs
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 μs at 12 Mbaud Calculation: T _{DX} = 3600 • T _{BIT} = 300 μs
T _{PLL_W}	0	-	PLL window (half the width of the GC synchronization window) The following applies to the setting: <ul style="list-style-type: none"> • 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 • T _{BIT} = 0.833 μs T _{Bit} = 1/12 μs 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 • T _{BIT} = 0 μs T _{Bit} = 1/12 μs 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.

Table 4-25 Time settings and meanings, continued

Name	Value ¹⁾	Limit value	Description
RES			Reserve: "Active pause" until the isochronous cycle has expired
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.gs_

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} ≥ 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 (e.g. HWConfig in SIMATIC S7). Note the following:
 - Configuring reserves allows the following:
 - Class 2 masters can be connected.
 - Non-cyclic communication

Minimum times for reserves

Table 4-26 Minimum time for reserve

Data	Time required [μ s]
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}).



SINAMICS Safety Integrated (Booksize)

5

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
- Application Examples
- Acceptance test and certificate

5.1 General information about SINAMICS Safety Integrated

5.1.1 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 innovative 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

In conjunction with certified components, the safety functions of the SINAMICS S120 drive system fulfill the following requirements:

- Category 3 to EN 954-1.
- Safety integrity level 2 (SIL 2) to IEC 61508.

A list of certified components is available on request from your local Siemens office.

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. 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)

5.1.2 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 different 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).

All the factory settings can be restored (p0976 = 1 and p0009 = 1 on the Control Unit) even when the safety functions are enabled (p9601 = p9801 = 1).

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.

- Change password
 - p0010 = 95 commissioning mode (see Section 5.4)
 - 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 (Control Unit with all connected drives/components) to the factory setting (see Subsection 3.2.1).
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

5.2 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.
- Enable of the function using parameters required
- 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).



Caution

If two power transistors in the Motor Module (one in the upper and one in the lower bridge) fail at the same time, this can cause a momentary movement.

The maximum movement can be:

Synchronous rotary motors: Max. movement = $180^\circ / \text{number of pole pairs}$

Synchronous linear motors: max. movement = pole width

- The status of the “Safe standstill” function is displayed via the appropriate parameters.

Note

The grouping must be identical in both monitoring channels.

If a fault in a drive results in a “Safe standstill (SH)”, this does not automatically mean that the other drives in the same group also switch to “Safe standstill (SH)”.

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.

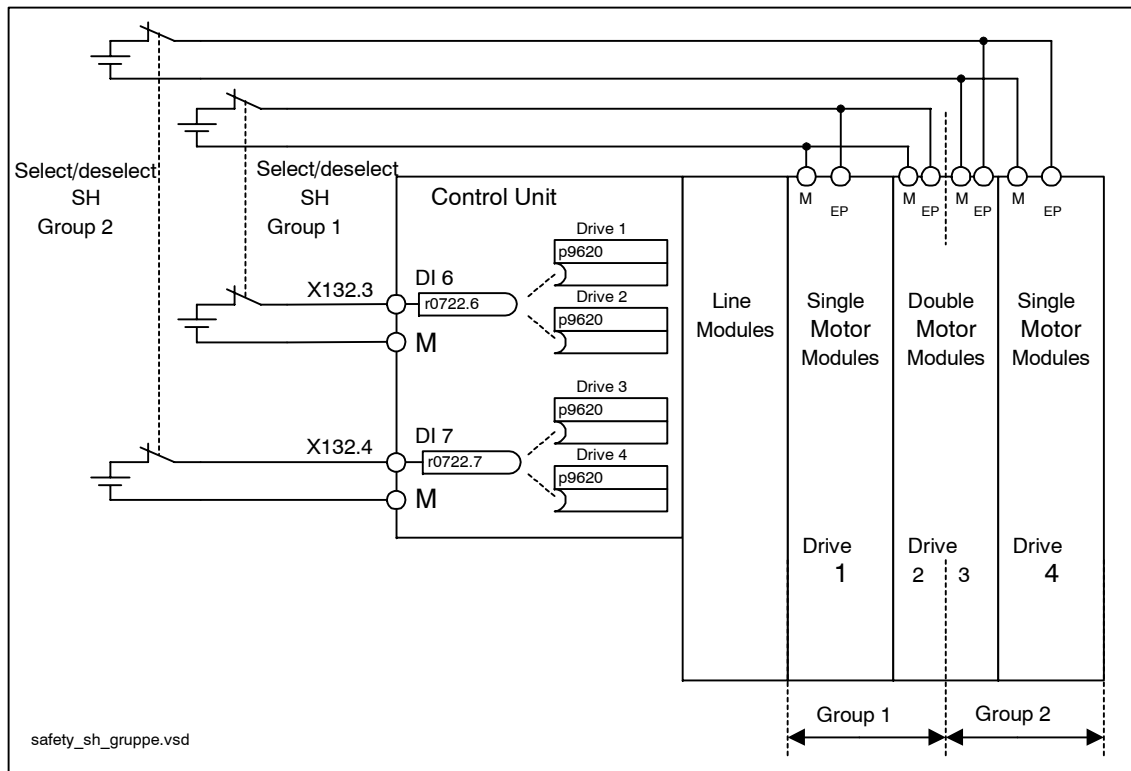


Fig. 5-2 Example: terminal grouping for “Safe standstill (SH)”

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 using the input terminals and act only on the associated drive.

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. In this case, the pulses have already been canceled as a result of the selection of “safe standstill” on one channel.

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.
- Any STOP F or STOP A commands are canceled (see r9772 / r9872).

Note

If the two input signals for selecting/deselecting “Safe standstill” differ momentarily (i.e. within the tolerance time in p9650/p9850), the drive pulses are canceled although no message is output.

If you want a message to be displayed in this case, however, you have to reconfigure N01620/N30620 via p2118 and p2119 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 following values can be specified for the response times when the function is selected/deselected via input terminals:

- Typical response time
 $2 \times \text{Safety monitoring cycle CU (r9780)} + \text{input/output time sampling time (p0799)}$
- Max. response time when error is present
 $4 \times \text{Safety monitoring cycle CU (r9780)} + \text{input/output time sampling time (p0799)}$

Examples:

Assumption:

Safety monitoring cycle time CU (r9780) = 4 ms and

Inputs/outputs sampling time (r0799) = 4 ms

$$t_{R_typ} = 2 \times r9780 (4 \text{ ms}) + r0799 (4 \text{ ms}) = 12 \text{ ms}$$

$$t_{R_max} = 4 \times r9780 (4 \text{ ms}) + r0799 (4 \text{ ms}) = 20 \text{ ms}$$

Parameter overview (see List Manual)

- p0799 CU inputs/outputs sampling times
- r9780 Safety Integrated monitoring clock cycle (Control Unit)
- r9880 Safety Integrated monitoring clock cycle (Motor Module)

5.3 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).

If a cable breaks, this is only recognized by the “safe brake control” function when the status changes (e.g. when the brake is applied/released).

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. “SBC” is not recommended, however, when 1215 = 0 or 3.
- Enable of the function using parameters required
- 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.

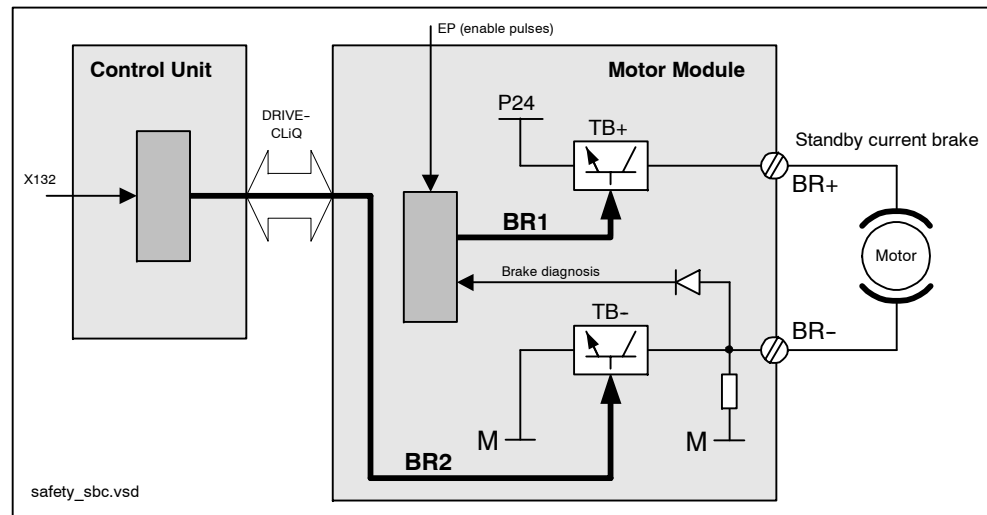


Fig. 5-3 Two-channel brake control

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.

Response time for “Safe brake control” function

The following values can be specified for the response times when the function is selected/deselected via input terminals:

- Typical response time
4 x Safety monitoring cycle CU (r9780) + input/output time sampling time (p0799)
- Max. response time when error is present
8 x Safety monitoring cycle CU (r9780) + input/output time sampling time (p0799)

Examples:

Assumption:

Safety monitoring cycle time CU (r9780) = 4 ms and

Inputs/outputs sampling time (r0799) = 4 ms

$$t_{R_typ} = 4 \times r9780 (4 \text{ ms}) + r0799 (4 \text{ ms}) = 20 \text{ ms}$$

$$t_{R_max} = 8 \times r9780 (4 \text{ ms}) + r0799 (4 \text{ ms}) = 36 \text{ ms}$$

Parameter overview (see List Manual)

- p0799 CU inputs/outputs sampling times
- r9780 Safety Integrated monitoring clock cycle (Control Unit)
- r9880 Safety Integrated monitoring clock cycle (Motor Module)

5.4 Commissioning the "SH" and "SBC" functions

5.4.1 General information about commissioning safety functions

Commissioning notes

Notice

For safety reasons, safety functions cannot be commissioned offline with the STARTER commissioning tool (or SCOUT).

Note

- 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: comparison of the monitoring functions) is output. The fault triggers the stop response OFF2.
The fault cannot be acknowledged until safety commissioning mode (p0010 0 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"
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.

Standard commissioning of the safety functions

1. A project that has been commissioned and uploaded to STARTER can be transferred to another drive unit without losing the safety parameterization.
2. If the source and target devices have different software versions, it may be necessary to adjust the setpoint checksums (p9799, p9899). This is indicated by faults F01650 (fault value: 1000) and F30650 (fault value: 1000).
3. Once the project has been downloaded to the target device, a short acceptance must be carried out (see table 5-8). This is indicated by fault F01650 (fault value: 2004).

Notice

Once a project has been downloaded, it must be stored on the non-volatile CompactFlash card (copy from RAM to ROM).

5.4.2 Procedure for commissioning "SH" and "SBC"

To commission the "SH" and "SBC" functions, carry out the following steps:

Table 5-1 Commissioning the "SH" and "SBC" functions

No.	Parameters	Description / comments
1	p0010 = 95	<p>Safety Integrated: set commissioning mode.</p> <ul style="list-style-type: none"> • The following alarms and faults are output: <ul style="list-style-type: none"> - A01698 (Safety Integrated Control Unit: commissioning mode active) <p>During initial commissioning only:</p> <ul style="list-style-type: none"> - 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). <p>For information on the acceptance test and certificate, see Step 13.</p> <ul style="list-style-type: none"> • 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. <p>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.</p>
2	p9761 = "Value"	<p>Set the safety password.</p> <p>When Safety Integrated is commissioned for the first time, the following applies:</p> <ul style="list-style-type: none"> • Safety password = 0 • Default setting for p9761 = 0 <p>This means that the safety password does not need to be set during initial commissioning.</p>
3	p9601.0 p9801.0	<p>Enable the "Safe standstill" function</p> <p>SH via Control Unit terminals SH via Motor Module terminals</p> <ul style="list-style-type: none"> • 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 5-1 Commissioning the “SH” and “SBC” functions, continued

No.	Parameters	Description / comments
4	p9602 = 1 p9802 = 1	<p>Enable the “Safe brake control” function</p> <p>Enable “SBC” on the Control Unit Enable “SBC” on the Motor Module</p> <ul style="list-style-type: none"> • 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 activated until at least one safety monitoring function is enabled (i.e. p9601 = p9801 ≠ 0).
5	p9620 = “Value” Terminal “EP”	<p>Set terminals for “Safe standstill”</p> <p>Set the signal source for “Safe standstill” on the Control Unit. Wire terminal “EP” (enable pulses) on the Motor Module.</p> <ul style="list-style-type: none"> • Control Unit monitoring channel: When BI: p9620 is interconnected appropriately on the individual drives, the following is possible: <ul style="list-style-type: none"> - 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: <ul style="list-style-type: none"> - Select/deselect “Safe standstill” - Group the terminals for “Safe standstill” <p>Note: The “Safe standstill” terminals must be grouped identically in both monitoring channels.</p>
6	p9650 = “Value” p9850 = “Value”	<p>Set the tolerance time for the SGE changeover</p> <p>Tolerance time for the SGE changeover on the Control Unit Tolerance time for the SGE changeover on the Motor Module</p> <ul style="list-style-type: none"> • 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 switchover, dynamic data is not subject to a crosswise data comparison 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 5-1 Commissioning the "SH" and "SBC" functions, continued

No.	Parameters	Description / comments
7	<p>p9658 = "Value"</p> <p>p9858 = "Value"</p>	<p>Set transition period from STOP F to STOP A</p> <p>Transition period from STOP F to STOP A on the Control Unit</p> <p>Transition period from STOP F to STOP A on the Motor Module</p> <ul style="list-style-type: none"> • The parameters are not changed until safety commissioning mode has been exited (i.e. when p0010 ≠ 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) is initiated. <p>The default setting for p9658 and p9858 is 0 (i.e. STOP F immediately results in STOP A).</p> <ul style="list-style-type: none"> • 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	<p>p9659 = "Value"</p>	<p>Time for carrying out forced checking procedure and testing the Safety switch-off signal paths</p> <ul style="list-style-type: none"> • Once this time has elapsed, alarm A01699 (Safety Integrated Control Unit: switch-off signal paths must be tested) prompts the user to test the switch-off signal paths (i.e. 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	<p>p9799 = "r9798"</p> <p>p9899 = "r9898"</p>	<p>Adjust specified checksums.</p> <p>Specified checksum on the Control Unit</p> <p>Specified checksum on the Motor Module</p> <p>The current checksums for the Safety parameters that have undergone a checksum check are displayed as follows:</p> <ul style="list-style-type: none"> • Actual checksum on the Control Unit: r9798 • Actual checksum on the Motor Module: r9898 <p>By setting the actual checksum in the parameter for the specified checksum, the commissioning engineer confirms the Safety parameters in each monitoring channel.</p> <p>This procedure is performed automatically when STARTER and the commissioning Wizard for SINAMICS Safety Integrated are used.</p>
10	<p>p9762 = "Value"</p> <p>p9763 = "Value"</p>	<p>Set the new Safety password</p> <p>Enter a new password</p> <p>Confirm the new password</p> <ul style="list-style-type: none"> • 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.

Table 5-1 Commissioning the "SH" and "SBC" functions, continued

No.	Parameters	Description / comments
11	p0010 = Value not equal to 95	<p>Safety Integrated: exit commissioning mode</p> <ul style="list-style-type: none"> • If at least one Safety monitoring function is enabled (p9601 = p9801 ≠ 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. <p>When Safety commissioning mode is exited, the following is carried out:</p> <ul style="list-style-type: none"> • All the drive parameters are stored on the non-volatile CompactFlash card. • The Safety parameters on the motor module are loaded by the control unit and stored on the non-volatile CompactFlash card. • The new Safety parameters are active on the Control Unit and Motor Module.
12	POWER ON	<p>Carry-out a power on</p> <p>After commissioning, a POWER ON reset must be carried out.</p>
13	-	<p>Carry out acceptance test and create test certificate.</p> <p>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 5.7).</p>

5.4.3 Safety faults

Stop reaction

When Safety Integrated faults occur, the following stop reactions can be triggered:

Table 5-2 Safety Integrated stop reactions

Stop response	Action	Effect	Triggered when...
STOP A Cannot be acknowledged	Trigger safe pulse disable via the switch-off signal path for the relevant monitoring channel.	The motor coasts to a standstill or is braked by the holding brake.	For all non-acknowledgeable Safety faults with pulse disable.
STOP A	During operation with SBC: apply motor holding brake.		For all acknowledgeable Safety faults with pulse disable. As a follow-up reaction of STOP F.
	<p>STOP A is identical to stop category 0 to EN 60204-1.</p> <p>With STOP A, the motor is switched directly to zero torque via the "Safe standstill (SH)" function.</p> <p>A motor at standstill cannot be started again accidentally.</p> <p>A moving motor coasts to standstill. This can be prevented by using external braking mechanisms (e.g. armature short-circuiting, holding or operational brake).</p> <p>When STOP A is present, "Safe standstill (SH)" is effective.</p>		
STOP F	Transition to STOP A	None ¹⁾	If an error occurs in the crosswise data comparison.
	<p>STOP F is permanently assigned to the crosswise data comparison (CDC). In this way, errors are detected in the monitoring channels.</p> <p>After STOP F, STOP A is triggered.</p> <p>When STOP A is present, "Safe standstill (SH)" is effective.</p>		

- 1) If STOP F is output by the crosswise data comparison of the two input signals when the "Safe standstill" function is selected, this means that the pulses have already been canceled when "Safe standstill" was selected on one channel.



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.

Notice

The Safety faults can also be acknowledged (as with all other faults) by switching the drive unit off and then on again (Power On).

If this action has not eliminated the fault cause, the fault is displayed again immediately after power up.

Description of faults and alarms

Note

The faults and alarms for SINAMICS Safety Integrated are described in the following documentation:

References: /LH1/ SINAMICS S List Manual – Section 3.2

5.5 Overview of parameters and function diagrams

Parameter overview (see List Manual)

Table 5-3 Safety Integrated parameters

No. Control Unit (CU)	No. Motor Module (MM)	Name	Can be changed in
p9601	p9801	Enable safety functions	Safety Integrated commissioning (p0010 = 95)
p9602	p9802	Enable safe brake control	
p9620	-	Signal source for safe standstill	
p9650	p9850	Tolerance time SGE changeover	
p9658	p9858	Transition period STOP F to STOP A	
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]	r9870[0...2]	Version	-
r9771	r9871	Shared functions	-
r9772	r9872	Status	-
r9773	-	Status (Control Unit + Motor Module)	-
r9774	-	Status (group safe standstill)	-
r9780	r9880	Monitoring clock cycle	-
r9794	r9894	Cross monitoring list	-
r9795	r9895	Diagnostics for STOP F	-
r9798	r9898	Actual checksum SI parameters	-
p9799	p9899	Specified checksum SI parameters	Safety Integrated commissioning (p0010 = 95)

Description of the parameters

Note

The SINAMICS Safety Integrated parameters are described in the following documentation:

References: /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)

5.6 Application Examples

5.6.1 Safe standstill with locked protective door (emergency stop shutdown)

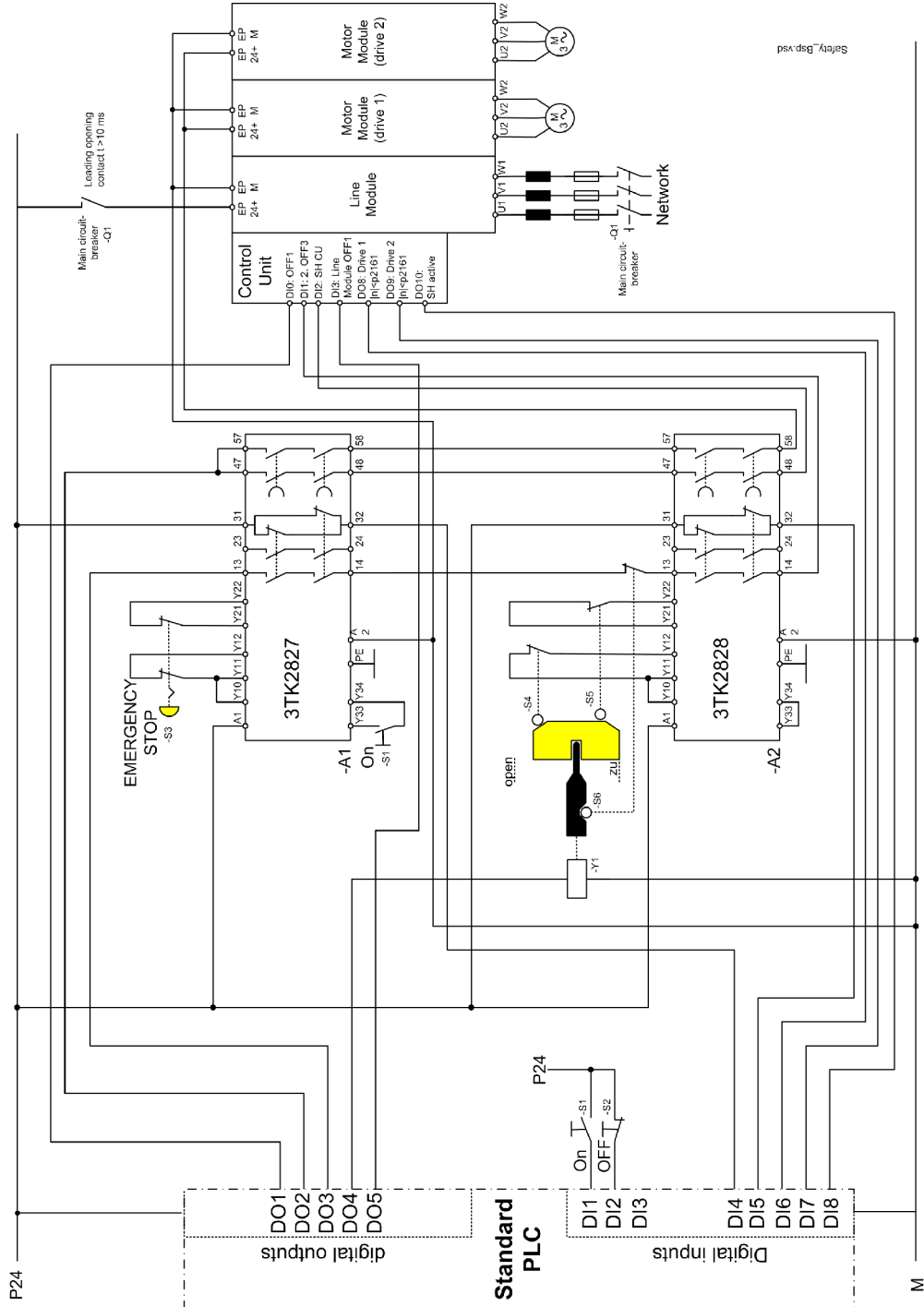


Fig. 5-4 Application example

Notice

This example illustrates implementation options. The solution required for the machine must be suitable for the machine function, which means that parameters and control commands are defined individually.

Notice

The fault responses and output functions (e.g. inversion or simulation) must not be changed or activated with respect to the factory setting.

Function description

With two SIGUARD safety combinations for emergency stop and the protective door as well as a standard PLC, the system can be set up in accordance with EN 954-1 category 3 and EN1037 .

The drives are brought to a standstill in accordance with stop category 1 to EN 60204-1.

- The “Safe standstill” safety function, which is integrated in the drive, complies with category 3 to EN 954-1 and SIL 2 to IEC 61508. The non-safe message “Safe standstill active” is sufficient.
- Safety combinations for emergency stop and protective door monitoring comply with category 4 (instantaneous enable circuits) or category 3 (delayed enable circuits).
- The electric circuits for emergency stop and protective door monitoring are monitored for cross-circuits on two channels.
- Switches S4, S5, and S6 are positively-opening position switches corresponding to EN 1088.
- Being a higher-level circuit with contacts, the “Safe standstill” function also works if the PLC malfunctions or fails.
- I/O communication via the digital interface between the drive and PLC can also be replaced by non-safe standard communication (e.g. PROFIBUS).
- Electrical isolation is not essential for the emergency stop function. A higher-level line contactor is not required. When work is carried out on the motor or converter, the voltage is disconnected via a main circuit-breaker (that can be terminated).

Response to EMERGENCY STOP

An emergency stop is triggered by the S3 button ("Emergency stop"). The drive is brought to a standstill in accordance with stop category 1 of EN 60204-1.

- Signal 0 is specified at terminal X122.2 (DI 1: 2nd OFF3) of the drive by means of the instantaneous enable contacts for safety combination A1. The drives are immediately braked via the speed ramp (p1135) and the pulses canceled.
- The safe delayed enable contacts for safety combination A1 open once the set delay time has elapsed. This activates the "Safe standstill" function of the drives via two channels via terminal X122.3 (DI 2) on the Control Unit and terminals X21.3 (EP +24 V) and X21.4 (EP M) on the Motor Module. When all the grouped drives have activated "Safe standstill", this is confirmed via terminal X122.10 (DO 10: SH group active).
- The confirmation from the safety combination and the drive is monitored in the PLC to ensure that it is plausible.

Behavior when the protective door is opened

To issue a request to open the protective door, press the S2 button ("OFF"). The drive is brought to a standstill in accordance with stop category 1 of EN 60204-1.

- Signal 0 is specified at terminal X122.2 (DI 1: 2nd OFF3) of the drives when PLC output DO3 is reset. The drives are immediately braked via the speed ramp (p1135) and the pulses canceled.
- When the drives have reached a standstill (DO 8 and DO 9: |n|<p2161), the "Safe standstill" function for the drive is activated via two channels when the PLC output DO 2 is reset. The status is returned to the PLC (DI 8) via terminal X122.10 (DO 10: SH active).
- When the PLC detects that the "Safe standstill" function has been selected (PLC DI 8 "SH active"), the interlock for the protective door is released when coil Y1 is energized (PLC output DO 4). When the protective door is released, this interrupts the safety circuit for the door. Safety combination A2 opens its safety circuits.

Note

The position of the protective door interlock is monitored by S6! If the PLC malfunctions and causes the interlock for the protective door to open before the drives reach speed = 0, signal 0 is specified by means of S6 at terminal X122.2 (DI 1: 2nd OFF3) of the Control Unit via the BICO interconnection with the drives. The drives are immediately braked via the speed ramp (p1135) and the pulses canceled. When the protective door is opened, the "Safe standstill" function is selected. It must be ensured that movements that will result in danger are brought to a halt beforehand.

Switching on the drives

The drives can be started when the protective door is shut and emergency off button S3 is released. The Line Module must be switched on via PLC output DO5 by means of an edge from "0" to "1".

- Once you have pressed button S1 ("ON"), safety combination A1 switches to "ready for operation". When PLC output DO 4 is reset, the coil of tumbler Y1 is no longer energized and the protective door is locked. Safety combination A2 is also ready for operation.
- When PLC outputs DO 2 and DO 3 are set simultaneously, the "Safe standstill" safety function is deselected via two channels via terminal X122.3 on the Control Unit and terminals X21.3 (EP +24 V) and X21.4 (EP M) on the Motor Modules. The fast stop function is also deselected at terminal X122.2 (DI 1: 2. OFF3).
- Due to a rising edge at PLC output DO1, the drives can be switched back to operation mode via terminal X122.1 (DI 0: OFF1).

5.7 Acceptance test and certificate

5.7.1 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.

Notice

The acceptance test must only be carried out after the safety functions have been commissioned and POWER ON reset.

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 5.1 to 5.5 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 Subsection 5.7.2)

Machine documentation (including the SI functions)

1. Machine description and overview diagram (see Tables 5-4 and 5-5)
2. SI functions for each drive (see Table 5-6)
3. Description of safety equipment (see Table 5-7)

Functional test (see Subsection 5.7.3)

Check the individual SI functions used

4. "Safe standstill" function, part 1 (see Table 5-8)
5. "Safe standstill" function, part 2 (see Table 5-9)
6. "Safe brake control" function (see Table 5-10)

Completion of certificate (see Subsection 5.7.4)

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

5.7.2 Documentation

Table 5-4 Machine description and overview diagram

Designation	
Type	
Serial number	
Manufacturer	
End customer	
Electrical axes	
Other axes	
Spindles	
Overview diagram of machine	

Table 5-5 Values from relevant machine data

Parameters Control Unit		FW version	-
		r0018 =	-
Parameters Motor Modules	Drive number	FW version	SI version
		r0018 =	r9770 =
		r0128 =	r9870 =
		r0128 =	r9870 =
		r0128 =	r9870 =
		r0128 =	r9870 =
		r0128 =	r9870 =
		r0128 =	r9870 =
	Drive number	SI monitoring clock cycle Control Unit	SI monitoring clock cycle Motor Module
Parameters Motor Modules		r9780 =	r9880 =
		r9780 =	r9880 =
		r9780 =	r9880 =
		r9780 =	r9880 =
		r9780 =	r9880 =
		r9780 =	r9880 =

Table 5-6 SI functions for each drive

Drive number	SI function

5.7.3 Functional test

The functional test must be carried out individually for each drive (as far as the machine allows).

Carrying out the test

Initial commissioning	
Standard commissioning	
	Please tick

“Safe standstill” (SH) function, part 1

This test comprises the following steps:

Table 5-8 “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, r2132)	
	• 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, r2132)	
	• 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 5-8 "Safe standstill" (SH) function, part 1, continued

No.	Description	Status
7.	Check the following:	
	• No Safety faults or alarms (r0945, r2122, r2132)	
	• 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: <ul style="list-style-type: none"> • 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 5-9 "Safe standstill" (SH) function, part 2

No.	Description	Status
1.	Initial state	
	• A channel for selecting SH is permanently connected to HIGH level. (Example here: SH wiring Motor Module)	
	• Drive in "Ready" status (p0010 = 0)	
	• Enable SH function (p9601.0 = 1, p9801.0 = 1)	
	• No Safety faults or alarms (r0945, r2122, r2132)	
	• 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 5-9 "Safe standstill" (SH) function, part 2, continued

No.	Description	Status
4.	Select SH when you issue the run command.	
5.	Check the following:	
	<ul style="list-style-type: none"> • The drive coasts to a standstill or is braked and stopped by the mechanical brake (if available and configured (p1215, p9602, p9802)). 	
	<ul style="list-style-type: none"> • The following Safety faults are output (r0945, r0949, r2122, r2132): <ul style="list-style-type: none"> - F01611, fault value = 2000 - F01600, fault value = 9999 - F30611, fault value = 2000 - F30600, fault value = 9999 	
	<ul style="list-style-type: none"> • r9772.0 = r9772.1 = 1 (SH selected and active – CU) 	
	<ul style="list-style-type: none"> • r9872.0 = 0, r9872.1 = 1 (SH deselected but active – MM) 	
	<ul style="list-style-type: none"> • r9773.0 = 0, r9773.1 = 1 (SH deselected but active – drive) 	
	<p>The following is tested:</p> <ul style="list-style-type: none"> • 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 5-10 “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 5-10 "Safe brake control" (SBC) function, continued

No.	Description	Status
7.	Check the following: <ul style="list-style-type: none"> <li>• Vertical axis: Mechanical brake remains applied <li>• No vertical axis: Mechanical brake is released <li>• No Safety faults or alarms (r0945, r2122) <li>• r9772.0 = r9772.1 = 0 (SH deselected and inactive – CU) <li>• r9872.0 = r9872.1 = 0 (SH deselected and inactive – MM) <li>• r9773.0 = r9773.1 = 0 (SH deselected and inactive – drive) <li>• r9772.4 = r9872.4 = 0 (SBC not requested – CU and MM) <li>• 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: <ul style="list-style-type: none"> <li>• The brake is connected properly. <li>• The hardware is functioning properly. <li>• The SBC is parameterized correctly. <li>• Routine for forced dormant error detection of brake control 	

5.7.4 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	Designation	Date	
Parameters				
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



Diagnositics

6

This chapter describes the following diagnostic features of the SINAMICS S120 drive system:

- Diagnostics using LEDs
- Diagnostics using STARTER
- Fault and alarm messages

6.1 Diagnostics using LEDs

Overview of the module LEDs

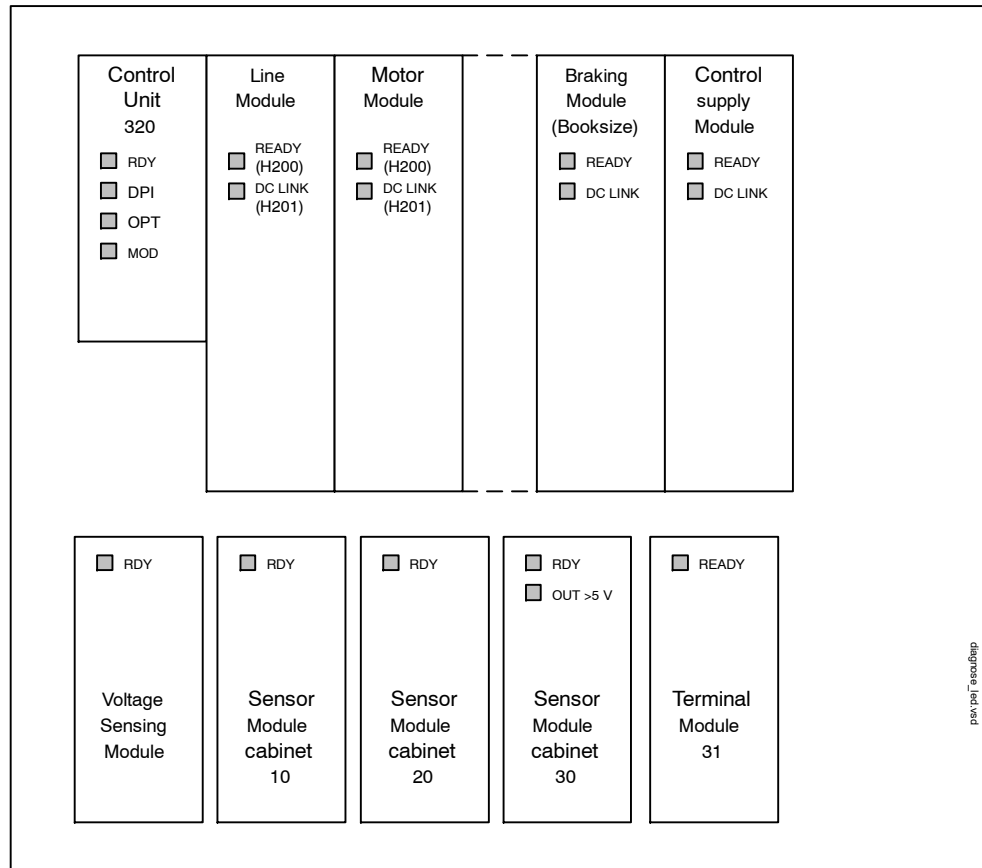


Fig. 6-1 Overview of the module LEDs

6.1.1 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 indicated 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 6-2).

Table 6-1 Control Unit 320 – description of the LEDs during booting

LED	Load software 1		Load software 2				Firmware		
	Reset	Error	Loaded	Running	Error file	Error crc	FW Loaded	initializing	Running
RDY	Red	Red 2 Hz	OFF	OFF	OFF	OFF	OFF	OFF	See table 6-2
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	
		<p>Possible causes:</p> <ul style="list-style-type: none"> • 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. <p>Remedy: Plug the appropriate CompactFlash card with the correct software and parameters into the unit.</p>							

LEDs after the Control Unit has booted

Table 6-2 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	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 6-2 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: <ul style="list-style-type: none"> The master is not transmitting setpoints. During isochronous operation, no global control (GC) or a faulty global control (GC) is transferred by the master. 	-
	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	-

6.1.2 Active Line Module

Table 6-3 Active Line Module – description of LEDs

Status		Description, cause	Remedy
Ready (H200)	DC link (H201)		
OFF	OFF	Electronics power supply is missing or outside permissible tolerance range.	-
Green	OFF	The component is ready for operation and cyclic DRIVE-CLiQ communication is taking place.	-
	Orange	The component is ready for operation and cyclic DRIVE-CLiQ communication is taking place. The DC link voltage is present.	-
	Red	The component is ready for operation and cyclic DRIVE-CLiQ communication is taking place. The DC link voltage is too high.	Check supply voltage
Orange	Orange	DRIVE-CLiQ communication is being established.	-
Red	-	At least one fault is present in this component. Note: LED is driven irrespective of the corresponding messages being reconfigured.	Remedy and acknowledge fault
Green/ Red	-	Firmware is being downloaded.	-
Green/ Orange or Red/ Orange	-	Component recognition via LED is activated (p0124). Note: Both options depend on the LED status when component recognition is activated via p0124 = 1.	-



Caution

Hazard DC link voltages may be present at any time regardless of the status of the “DC link” LED.

Note the warnings on the component!

6.1.3 Basic Line Module

Table 6-4 Basic Line Module - description of the LEDs

Status		Description, cause	Remedy
Ready (H200)	DC link (H201)		
OFF	OFF	Electronics power supply is missing or outside permissible tolerance range.	-
Green	OFF	The component is ready for operation and cyclic DRIVE-CLiQ communication is taking place.	-
	Orange	The component is ready for operation and cyclic DRIVE-CLiQ communication is taking place. The DC link voltage is present.	-
	Red	The component is ready for operation and cyclic DRIVE-CLiQ communication is taking place. The DC link voltage is too high.	Check supply voltage
Orange	Orange	DRIVE-CLiQ communication is being established.	-
Red	-	At least one fault is present in this component. Note: LED is driven irrespective of the corresponding messages being reconfigured.	Remedy and acknowledge fault
Green/ Red	-	Firmware is being downloaded.	-
Green/ Orange or Red/ Orange	-	Component recognition via LED is activated (p0124). Note: Both options depend on the LED status when component recognition is activated via p0124 = 1.	-



Caution

Hazard DC link voltages may be present at any time regardless of the status of the "DC link" LED.

Note the warnings on the component!

6.1.4 Smart Line Module 5 kW and 10 kW

Table 6-5 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	Steady light	Component is ready to operate.	-
	Red	Steady light	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	Steady light	DC link voltage within permissible tolerance range.	-
	Red	Steady light	DC link voltage outside permissible tolerance range. Supply failure.	Check supply voltage

6.1.5 Smart Line Module 16 kW and 36 kW

Table 6-6 Smart Line Module 16 kW and 36 kW – description of LEDs

Status		Description, cause	Remedy
Ready (H200)	DC link (H201)		
OFF	OFF	Electronics power supply is missing or outside permissible tolerance range.	-
Green	OFF	The component is ready for operation and cyclic DRIVE-CLiQ communication is taking place.	-
	Orange	The component is ready for operation and cyclic DRIVE-CLiQ communication is taking place. The DC link voltage is present.	-
	Red	The component is ready for operation and cyclic DRIVE-CLiQ communication is taking place. The DC link voltage is too high.	Check supply voltage
Orange	Orange	DRIVE-CLiQ communication is being established.	-
Red	-	At least one fault is present in this component. Note: LED is driven irrespective of the corresponding messages being reconfigured.	Remedy and acknowledge fault
Green/ Red	-	Firmware is being downloaded.	-
Green/ Orange or Red/ Orange	-	Component recognition via LED is activated (p0124). Note: Both options depend on the LED status when component recognition is activated via p0124 = 1.	-



Caution

Hazard DC link voltages may be present at any time regardless of the status of the “DC link” LED.

Note the warnings on the component!

6.1.6 Single motor module / double motor module

Table 6-7 Motor Module - description of LEDs

Status		Description, cause	Remedy
Ready (H200)	DC link (H201)		
OFF	OFF	Electronics power supply is missing or outside permissible tolerance range.	-
Green	OFF	The component is ready for operation and cyclic DRIVE-CLiQ communication is taking place.	-
	Orange	The component is ready for operation and cyclic DRIVE-CLiQ communication is taking place. The DC link voltage is present.	-
	Red	The component is ready for operation and cyclic DRIVE-CLiQ communication is taking place. The DC link voltage is too high.	Check supply voltage
Orange	Orange	DRIVE-CLiQ communication is being established.	-
Red	-	At least one fault is present in this component. Note: LED is driven irrespective of the corresponding messages being reconfigured.	Remedy and acknowledge fault
Green/ Red	-	Firmware is being downloaded.	-
Green/ Orange or Red/ Orange	-	Component recognition via LED is activated (p0124). Note: Both options depend on the LED status when component recognition is activated via p0124 = 1.	-



Caution

Hazard DC link voltages may be present at any time regardless of the status of the "DC link" LED.

Note the warnings on the component!

6.1.7 Braking Module booksize

Table 6-8 Braking Module Booksize - description of the LEDs

LED	Color	Status	Description, cause	Remedy
READY	-	OFF	Electronics power supply is missing or outside permissible tolerance range. Component deactivated via terminal.	-
	Green	Steady light	Component is ready to operate.	-
	Red	Steady light	Overtemperature. Overcurrent switch off. I ² t 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. Component not active.	-
	Green	Flashing	Component active (DC link discharge via braking resistor in progress).	-

6.1.8 Control supply module

Table 6-9 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	Steady light	Component is ready to operate.	-
DC LINK	-	OFF	Electronics power supply is missing or outside permissible tolerance range.	-
	Orange	Steady light	DC link voltage within permissible tolerance range.	-
	Red	Steady light	DC link voltage outside permissible tolerance range.	-

6.1.9 Sensor module cabinet 10 / 20 (SMC10 / SMC20)

Table 6-10 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	Steady light	The component is ready for operation and cyclic DRIVE-CLiQ communication is taking place.	-
	Orange	Steady light	DRIVE-CLiQ communication is being established.	-
	Red	Steady light	At least one fault is present in this component. Note: LED is driven irrespective of the corresponding messages being reconfigured.	Remedy and acknowledge fault
	Green/ Red	Flashing	Firmware is being downloaded.	-
	Green/ Orange or Red/ Orange	Flashing	Component recognition via LED is activated (p0144) Note: Both options depend on the LED status when component recognition is activated via p0144 = 1.	-

6.1.10 Sensor module cabinet 30 (SMC30)

Table 6-11 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	Steady light	The component is ready for operation and cyclic DRIVE-CLiQ communication is taking place.	-
	Orange	Steady light	DRIVE-CLiQ communication is being established.	-
	Red	Steady light	At least one fault is present in this component. Note: LED is driven irrespective of the corresponding messages being reconfigured.	Remedy and acknowledge fault
	Green/ Red	Flashing	Firmware is being downloaded.	-
	Green/ Orange or Red/ Orange	Flashing	Component recognition via LED is activated (p0144) Note: Both options depend on the LED status when component recognition is activated via p0144 = 1.	-
OUT >5 V	-	OFF	Electronics power supply is missing or outside permissible tolerance range. Power supply ≤ 5 V.	-
	Orange	Steady light	Electronics power supply for measuring system available. Power supply >5 V. Notice You must ensure that the connected encoder can be operated with a 24 V supply. If an encoder that is designed for a 5 V supply is operated with a 24 V supply, this can destroy the encoder electronics.	-

6.1.11 Terminal module 31 (TM31)

Table 6-12 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	Steady light	The component is ready for operation and cyclic DRIVE-CLiQ communication is taking place.	-
	Orange	Steady light	DRIVE-CLiQ communication is being established.	-
	Red	Steady light	At least one fault is present in this component. Note: LED is driven irrespective of the corresponding messages being reconfigured.	Remedy and acknowledge fault
	Green/ Red	Flashing	Firmware is being downloaded.	-
	Green/ Orange or Red/ Orange	Flashing	Component recognition via LED is activated (p0154). Note: Both options depend on the LED status when module recognition is activated via p0154 = 1.	-

6.2 Diagnostics using STARTER

Description

The diagnostic functions support commissioning and service personnel during commissioning, troubleshooting, diagnostics and service activities.

General information

Prerequisite: STARTER is online.

The following diagnostic functions are available in STARTER:

- Specifying signals with the ramp-function generator
See Subsection 6.2.1
- Signal recording with the trace function
See Subsection 6.2.2
- Analyzing the control response with the measuring function
See Subsection 6.2.3
- Outputting voltage signals for external measuring devices via measuring sockets
See Subsection 6.2.4

6.2.1 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.

In the connector output operating mode, the output signal can be injected into the control loop via the BICO interconnection.

In servo operation and depending on the mode set, this setpoint can also be injected into the control structure as a current setpoint, disturbing torque, or speed setpoint, for example. 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.

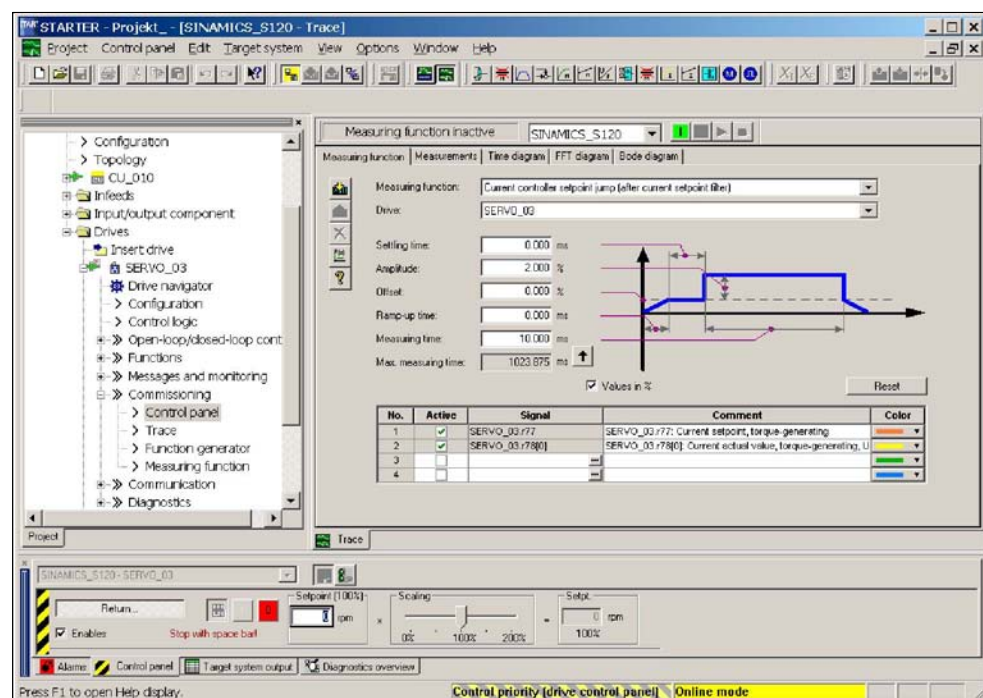


Fig. 6-2 “Ramp-function generator” initial screen

Note

Please refer to the online help for more information about parameterizing and using the measuring sockets.

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 for servo and vector
 - Connector output
- Operating modes of the ramp-function generator (servo only)
 - 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)

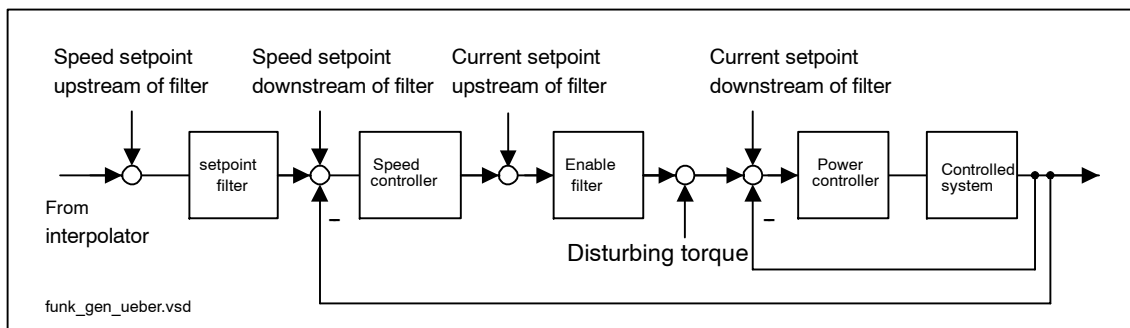
Injection points of the ramp-function generator

Fig. 6-3 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.

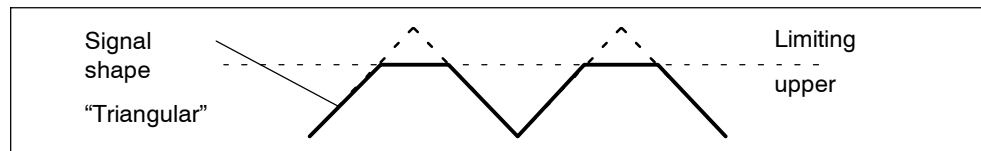


Fig. 6-4 “Triangular” signal without peak

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 measuring function:

“Stop FctGen” pushbutton

Parameterization

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



Fig. 6-5 STARTER icon for “trace function/ramp-function generator”

6.2.2 Trace function

Description

The trace function can be used to record measured values over a defined period depending on trigger conditions.

Parameterizing and using the trace function

The trace function is parameterized and operated via the parameterization and commissioning tool STARTER.

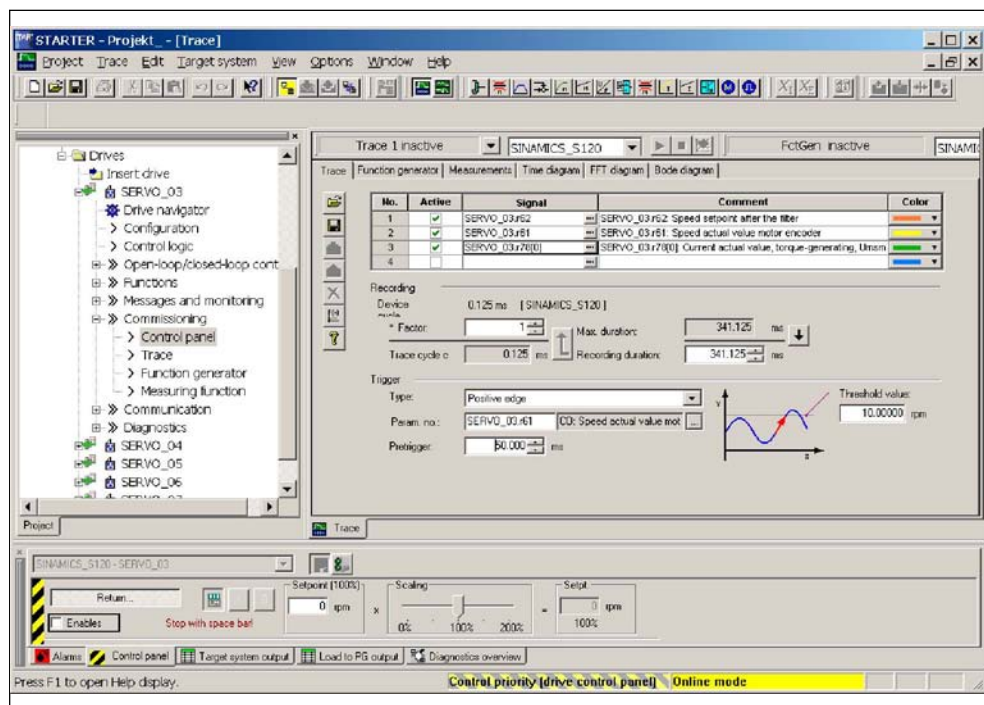


Fig. 6-6 "Trace function" initial screen

Note

Please refer to the online help for more information about parameterizing and using the measuring sockets.

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 base sample time
(See also: Section 7.7).

Parameterization

The “trace function” parameter screen is selected via the following icon in the toolbar of the STARTER commissioning tool.



Fig. 6-7 STARTER icon for “trace function/ramp-function generator”

6.2.3 Measuring function (Servo)

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 operated via the parameterization and commissioning tool STARTER.

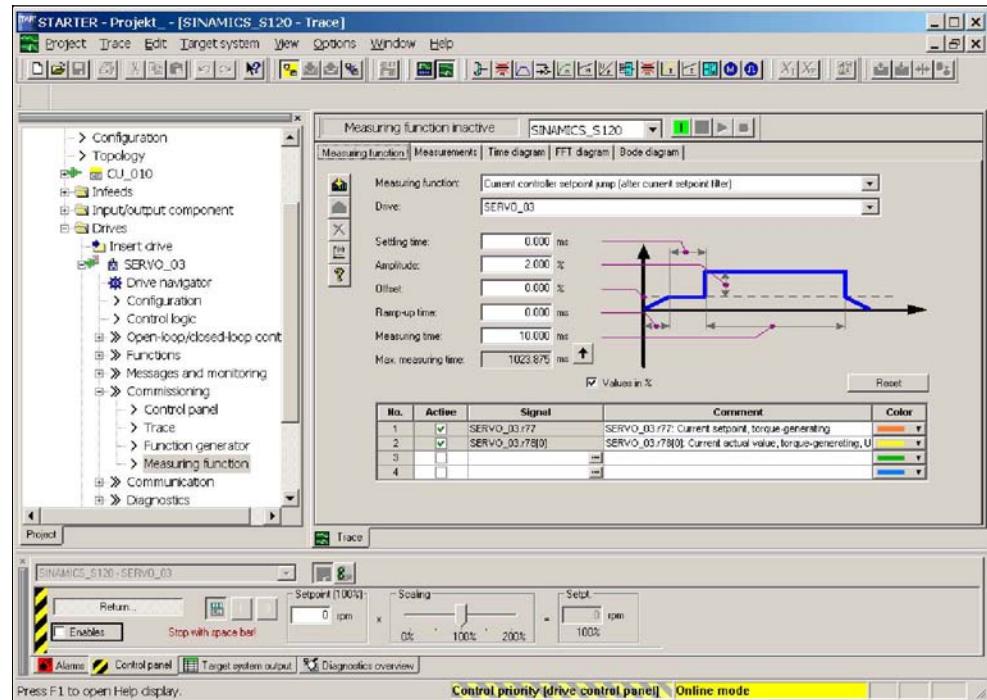


Fig. 6-8 “Measuring function” initial screen

Note

Please refer to the online help for more information about parameterizing and using the measuring sockets.

Properties

- 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 controller path (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 measuring function:

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 drive (as control board)
3. Set the measuring function
e.g. current controller setpoint change
4. Load the settings to the target system (“Download parameters” pushbutton)
5. 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. 6-9 STARTER icon for “measuring function”

6.2.4 Test 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.

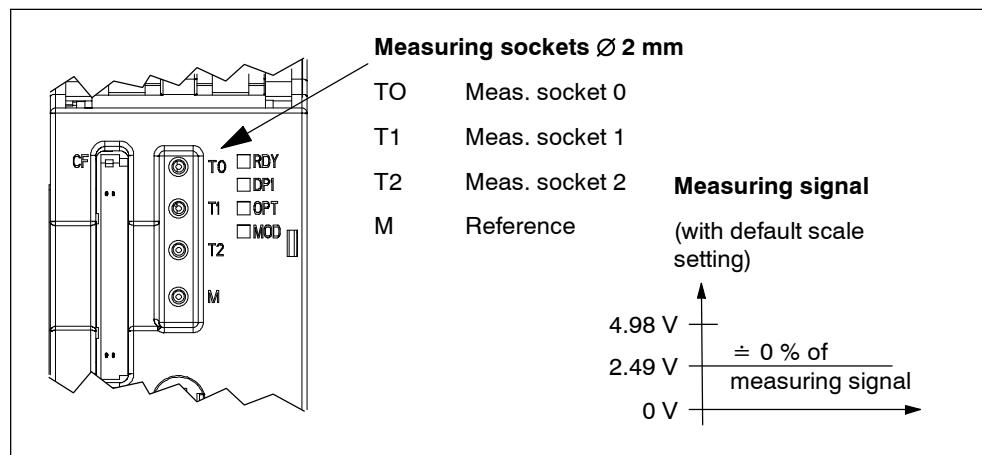


Fig. 6-10 Arrangement of the measuring sockets on the Control Unit 320

Parameterizing and using the measuring sockets

The parameterization and commissioning tool STARTER (see Section 3.2) will help you parameterize and use the trace function properly.

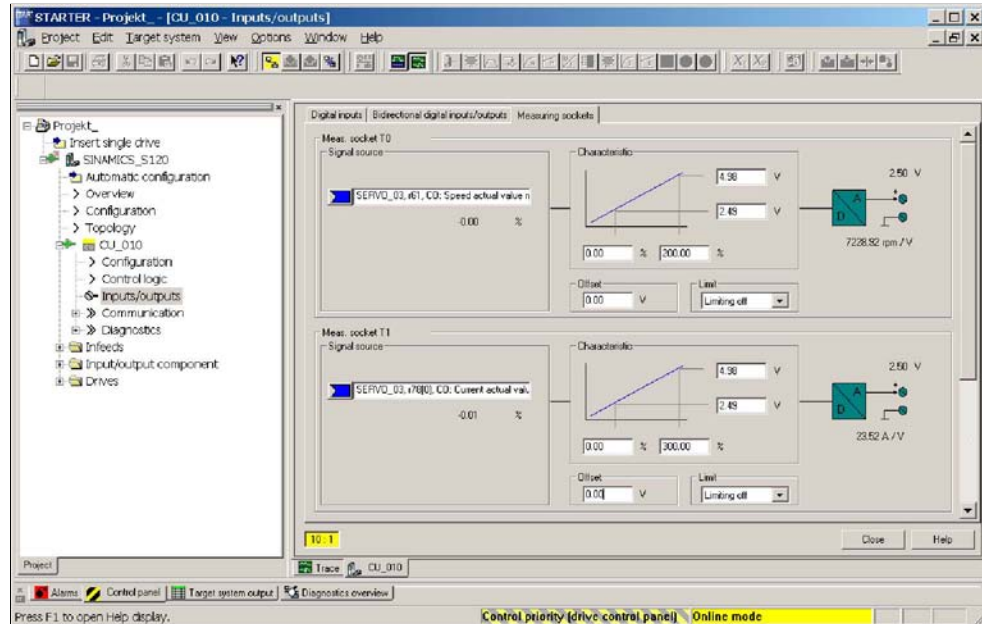


Fig. 6-11 “Measuring sockets” initial screen

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 Dependent on measuring signal
(e.g. actual speed value in speed controller cycle, 125 μ s)
- Short-circuit-proof
- Parameterizable scaling
- Adjustable offset
- Adjustable limitation

Signal chart for measuring sockets

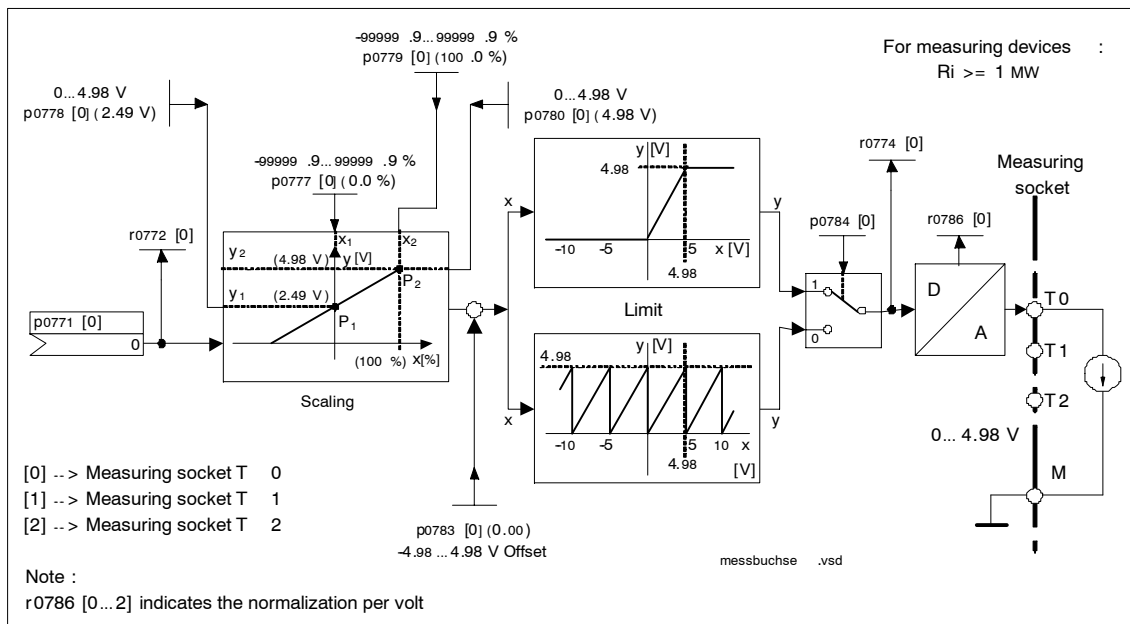


Fig. 6-12 Signal chart for measuring sockets

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 value
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:

$$x1 / y1 = 0.0 \% / 2.49 \text{ V} \quad x2 / y2 = 100.0 \% / 4.98 \text{ V (default setting)}$$

--> 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

If signals are output outside the permissible measuring range, the signal is limited to 4.98 V or to 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 (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 units are determined by the interconnected test signal.

Example:

r0786 = 1500.0 and the measuring signal is r0063 (CO: Speed actual value

A change of 1 volt at the output of the measuring socket corresponds to 1500.0 rpm.

Parameter overview (see List Manual)

Variable 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

6.3 Fault and alarm messages

6.3.1 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 Fxxxxx.
 - Can lead to a fault reaction.
 - Must be acknowledged once the cause has been remedied.
 - Status via Control Unit and LED RDY.
 - Status via PROFIBUS status signal STW1.3 (fault active).
 - Entry in the fault buffer (see Subsection 6.3.2).
- Alarms (identification A56789)
 - Are identified by Axxxxx.
 - Have no further effect on the drive.
 - The alarms are automatically reset once the cause has been remedied. No acknowledgement is required.
 - Status via PROFIBUS status signal STW1.7 (alarm active).
 - Entry in the alarm buffer (see Subsection 6.3.2).
- 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.

Acknowledgement of 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.

6.3.2 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.

The contents of the fault buffer are saved to non-volatile storage when the Control Unit 320 (CU320) is powered down, i.e. the fault buffer history is still available when the unit is powered up again.

Notice

The entry in the fault/alm buffer is made after a delay. For this reason, the fault/alarm buffer should not be read until a change in the buffer is also recognized (r0944, r2121) after "Fault active"/"Alarm active" is output.

Fault buffer

Faults which occur are entered in the fault buffer as follows:

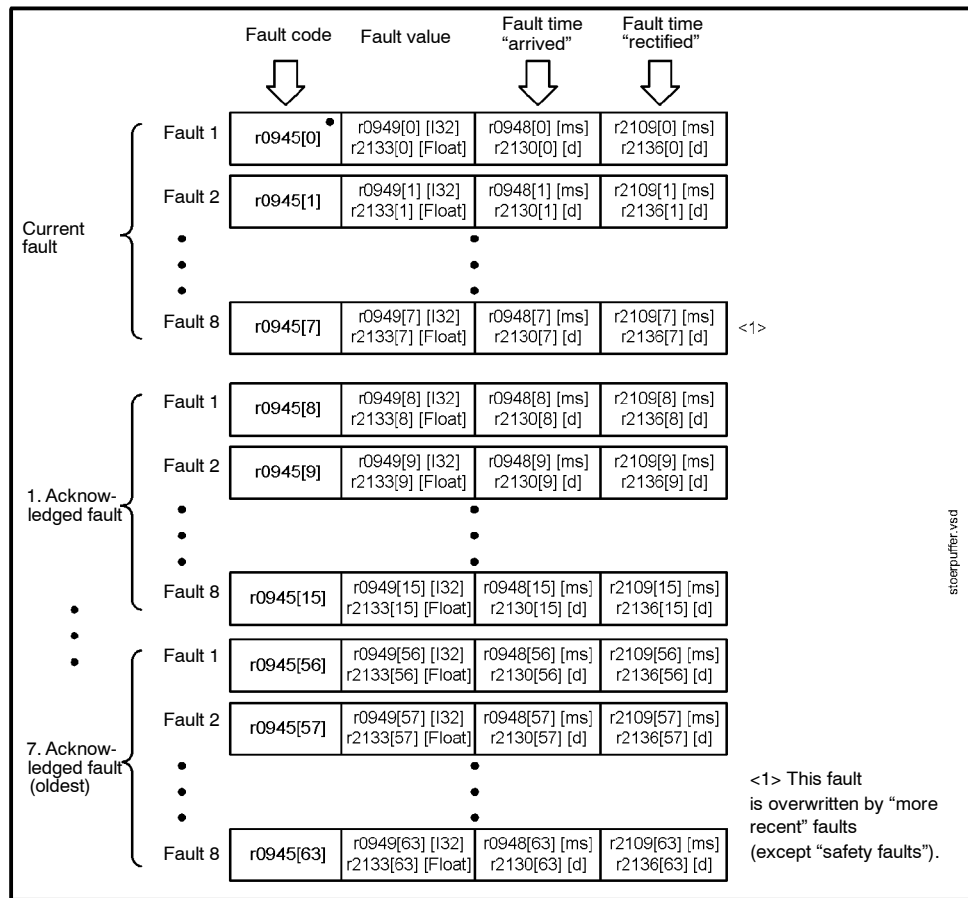


Fig. 6-13 Structure of fault buffer

Properties of the fault buffer:

- A new fault incident encompasses one or more faults and is entered in "Current fault incident".
- The entries are arranged in the buffer according to the time at which they occurred.
- If a new fault incident occurs, the fault buffer is reorganized. The history is recorded in "Acknowledged fault incident" 1 to 7.
- If the cause of at least one fault in "Current fault incident" is remedied and acknowledged, the fault buffer is reorganized. The faults that have not been remedied remain in "Current fault incident".
- If "Current fault incident" contains eight faults and a new fault occurs, the fault in the parameters in index 7 is overwritten by the new fault.
- r0944 is incremented each time the fault buffer changes.

- A fault value (r0949) can be output for a fault. The fault value is used to diagnose the fault more accurately; please refer to the fault description for details of the meaning.

Clearing the fault buffer:

- The fault buffer is reset as follows: p0952 = 0

Alarm buffer

Alarms that occur are entered in the alarm buffer as follows:

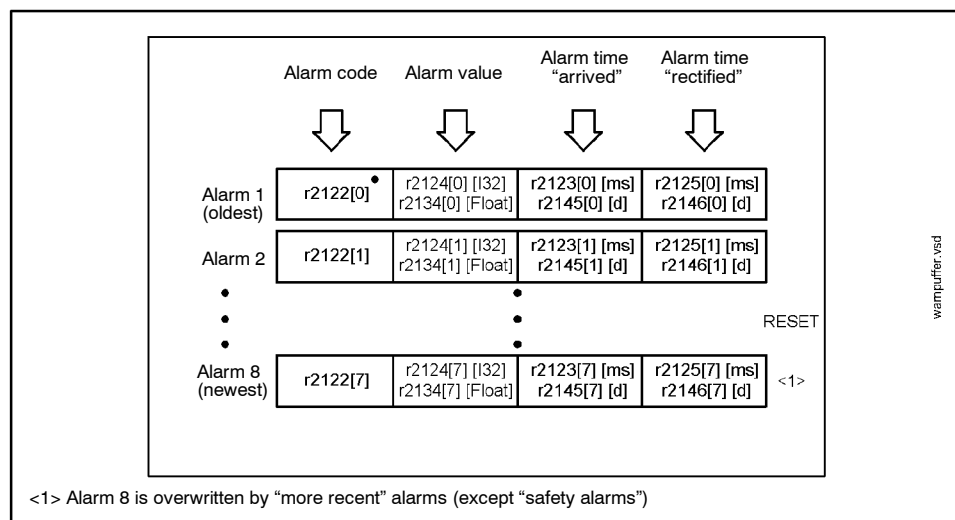


Fig. 6-14 Structure of alarm buffer

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 the time at which they occurred.
- 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:

- The alarm buffer is reset as follows: p2111 = 0

6.3.3 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] = 1001	p2119[5] = 1: Fault (F)
	= 2: alarm (A, alarm)
	= 3: no message (N, no report)

- Change fault reaction (example)

Select message	Set fault reaction
p2100[3] = 1002	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] = 1003	p2127[4] = 1: POWER ON
	= 2: IMMEDIATELY

Note

- 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]. The factory settings are to be reinstated.
--> p2100[n] = 0
-

Triggering on messages (example)

Select message	Trigger signal
p2128[0] = 1001	BO: r2129.0
or	
p2128[1] = 1002	BO: r2129.1

Note

The value of CO: r2129 can be used as a group trigger.

CO: r2129 = 0 None of the selected message occurred.

CO: r2129 > 0 Group trigger.

At least 1 selected message 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.

Once an external fault (1 to 3) has been triggered on the Control Unit drive object, this fault is also present on all associated drive objects. If one of these external faults is triggered on a different drive object, it is only present on that particular drive object.

Bl: p2106	--> External fault 1	--> F07860(A)
Bl: p2107	--> External fault 2	--> F07861(A)
Bl: p2108	--> External fault 3	--> F07862(A)
Bl: p2112	--> External fault 1	--> A07850(F)
Bl: p2116	--> External fault 2	--> A07851(F)
Bl: 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.

6.3.4 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
- ...
- r2139 Status word faults/alarms

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

7

Contents of “Basic information about the drive system”

- 7.1 Parameters
- 7.2 Data sets
- 7.3 Drive objects
- 7.4 BICO technology: interconnection of signals
- 7.5 Function Modules
- 7.6 DRIVE-CLiQ topology
 - 7.6.1 Permissible combinations of Line Modules and Motor Modules
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 - 7.9.5 Thermal motor protection
- 7.10 Updating the firmware
- 7.11 Licensing

7.1 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

- Display Parameter (read only)

These parameters are used to display internal variables.

Example: Current motor current

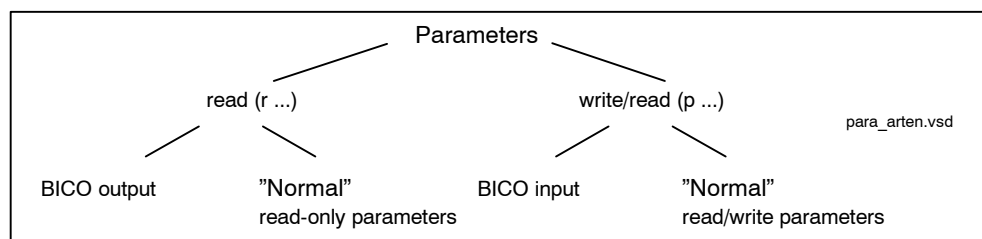


Fig. 7-1 Parameter types

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

Parameter categories

The parameters for the individual drive objects (see Section 7.2) are categorized according to data sets as follows (see Section 7.2):

- 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 7.2)

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

- DDS: Drive Data Set

The drive data set contains the parameters for switching between different drive control configurations.

The CDS and DDS can be switched over during normal operation. Further types of data set also exist, however these can only be activated indirectly by means of a DDS switchover.

- EDS (Encoder Data Set)
- MDS (Motor Data Set)

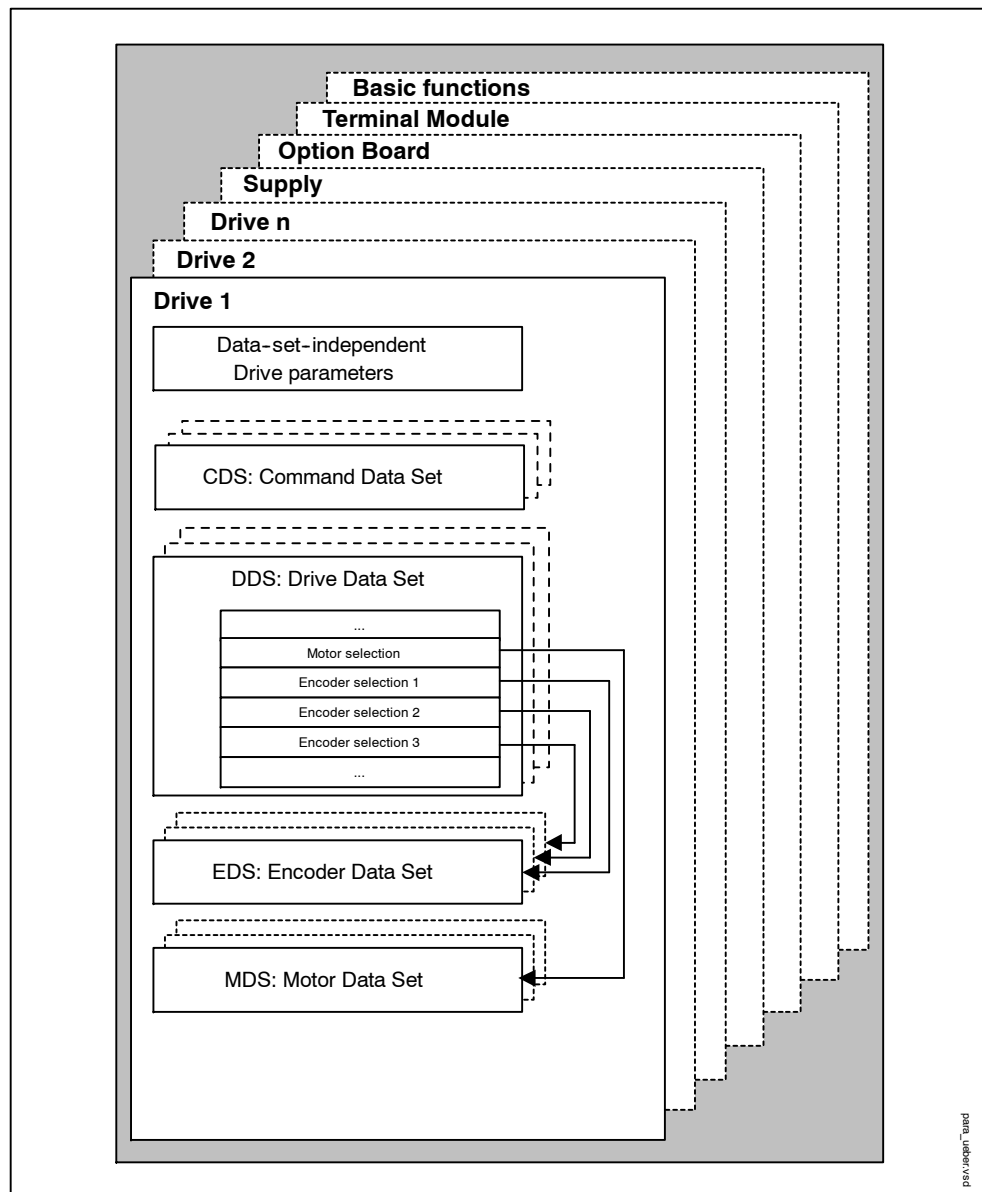


Fig. 7-2 Parameter categories

Saving parameters in a non-volatile memory

The modified parameter values are stored in the volatile RAM. When the drive system is switched off, this data is lost.

The data 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 all drives
p0977 = 1 Is automatically reset to 0
- Saving parameters with STARTER
See the “Copy from RAM to ROM” function.

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 of drive object “Control Unit”
p0009 = 30 Parameter reset
p0976 = 1 Is automatically reset to 0

7.2 Data sets

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 7.4).

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)

One command data set is available for servo mode and two for vector mode.

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

Table 7-1 Command data set: selection and display

CDS	Selection	Display	
	Bit 0 p0810	Selected r0836	Active r0050
0	0	0	0
1	1	1	1

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

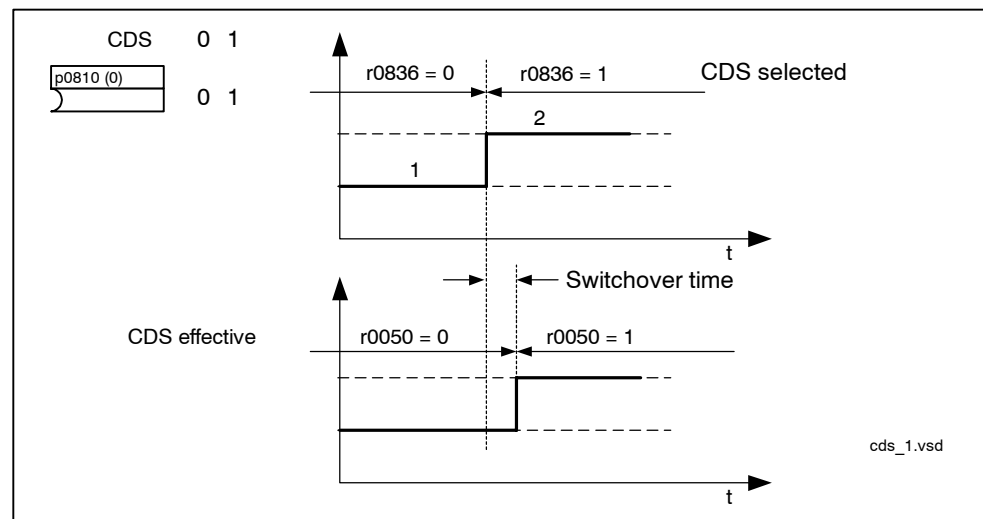


Fig. 7-3 Switching the command data set (example)

DDS: Drive Data Set

A drive data set contains various adjustable parameters that are relevant with respect to open and closed-loop drive control:

- Numbers of the assigned motor and encoder data sets:
 - p0186: assigned motor data set (MDS)
 - p0187 to p0189: up to 3 assigned encoder data sets (EDS)
- Various control parameters, e.g.:
 - Fixed speed setpoints (p1001 to p1015)
 - Speed limits min./max. (p1080, p1082)
 - Characteristic data of ramp-function generator (p1120 ff)
 - Characteristic data of controller (p1240 ff)
 - ...

The parameters that are grouped together in the drive data set are identified in the SINAMICS parameter list by "Data Set DDS" and are assigned an index [0..n].

It is possible to parameterize several drive data sets. You can switch easily between different drive configurations (control type, motor, encoder) by selecting the corresponding drive data set.

One drive object can manage up to 32 drive data sets. The number of drive data sets is configured with p0180.

Binector inputs p0820 to p0824 are used to select a drive data set. They represent the number of the drive data set (0 to 31) in binary format (where p0824 is the most significant bit).

- p0820 BI: Drive data set selection DDS bit 0
- p0821 BI: Drive data set selection DDS bit 1
- p0822 BI: Drive data set selection DDS bit 2
- p0823 BI: Drive data set selection DDS bit 3
- p0824 BI: Drive data set selection DDS bit 4

Supplementary conditions and recommendations

- Recommendation for the number of 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:
 $p0180 \text{ (DDS)} \geq \max(p0120 \text{ (PDS)}, p0130 \text{ (MDS)})$
- Max. number of DDS for one drive object = 32 DDS

EDS: Encoder Data Set

An encoder data set contains various adjustable parameters describing the connected encoder for the purpose of configuring the drive.

- Adjustable parameters, e.g.:
 - Encoder interface component number (p0141)
 - Encoder component number (p0142)
 - Encoder type selection (p0400)

The parameters that are grouped together in the encoder data set are identified in the SINAMICS parameter list by "Data Set EDS" and are assigned an index [0..n].

A separate encoder data set is required for each encoder controlled by the Control Unit. Up to 3 encoder data sets are assigned to a drive data set via parameters p0187, p0188, and p0189.

One drive object can manage up to 3 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.

Note

Only the same encoder data sets can be assigned to all the drive data sets for one drive object. You cannot switch between different encoder data sets.

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 p0186.

A motor data set can only be changed using a DDS changeover.

The motor data set changeover is, for example, used for:

- Changing over between different motors
- Changing-over between different windings in a motor (e.g. star-delta changeover)
- Motor data adaptation

If several motors are operated alternately on a Motor Module, a matching number of drive data sets must be created. For further information about motor changeover, see the “Motor switchover” section in the Function Manual.

Notice

Only a motor connected to a Motor Module can have an encoder – all additional motors must be operated without encoder (sensorless operation).

One drive object can manage up to 16 motor data sets. The number of motor data sets in p0130 may not exceed the number of drive data sets in p0180.

For the 611U interface mode (p2038 = 1), the drive data sets are divided into groups of eight (1-8; 8-16;...). Within a group, the assignment to the motor data set must be identical:

p0186[0] = p0186[1] = ... = p0186[7]

p0186[8] = p0186[9] = ... = p0186[15]

p0186[16] = p0186[17] = ... = p0186[23]

p0186[24] = p0186[25] = ... = p0186[31]

If this rule is not observed, alarm A07514 is output.

If you need a precise representation of the data set structure of the 611U, 32 drive data sets and 4 motor data sets must be configured.

Copying the command data set (vector only)

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.

Note

In STARTER, you can copy the command data sets (Drive -> Configuration -> "Command data sets" tab page).

You can select the displayed command data set in the relevant STARTER screens.

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 p0819[2] = 0.

Note

The drive data sets can be set via the drive configuration in STARTER.

Copying the motor data set

Set parameter p0139 as follows:

1. p0139[0] = Number of the drive data set that is to be copied (source)
2. p0139[1] = Number of the drive data set which should be copied into (target)
3. p0139[2] = 1

Start copying.

Copying has been completed, if p0139[2] = 0.

Note

The drive data sets can be set via the drive configuration in STARTER.

Function diagram overview (see List Manual)

- 8560 Command data sets (CDS)
- 8565 Drive data set (DDS)
- 8570 Encoder data set (EDS)
- 8575 Motor data sets (MDS)

Parameter overview (see List Manual)

Adjustable parameters

- p0120 Power Module data set (PDS) number
- p0130 Motor data set (MDS) number
- p0139 Copy motor data set (MDS)
- 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
- p0819[0...2] Copy drive data set DDS
- p0820 BI: Drive data set selection DDS bit 0
- p0821 BI: Drive data set selection DDS bit 1
- p0822 BI: Drive data set selection DDS bit 2
- p0823 BI: Drive data set selection DDS bit 3
- p0824 BI: Drive data set selection DDS bit 4

7.3 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. terminal board) or multiple objects (e.g. drive control).

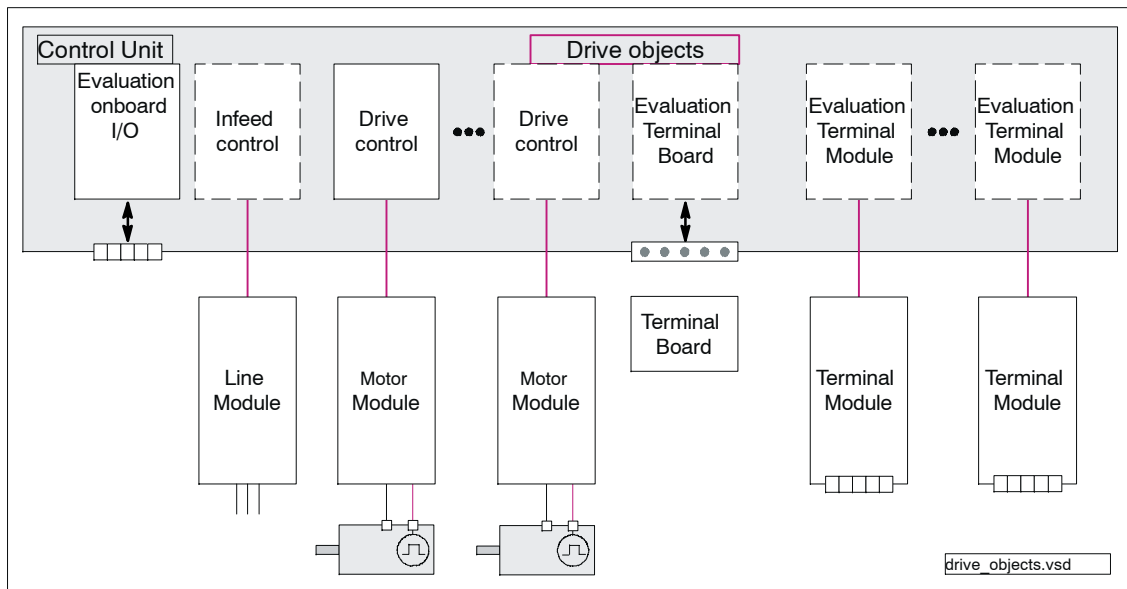


Fig. 7-4 Drive objects

Overview of drive objects

- Drive control

Drive control handles closed-loop control of the motor. At least 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, INFEED)
 - Separate PROFIBUS telegram for process data (for VECTOR, SERVO, A_INFEED)
- Infeed: Line Module infeed control with DRIVE-CLiQ interface

If an Active Line Module with a DRIVE-CLiQ interface is used for the infeed in a drive system, open-loop/closed-loop control is implemented on the Control Unit within a corresponding drive object.
- Infeed: Line Module infeed control with DRIVE-CLiQ interface

If a Line Module without a DRIVE-CLiQ interface 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 unique number during initial commissioning for internal identification in the range from 0 to 63.

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

7.4 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.

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 7-2 Binectors



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

Connectors, CI: connector input, CO: connector output

A connector is 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 7-3 Connectors

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

Interconnecting signals using BICO technology

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

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

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

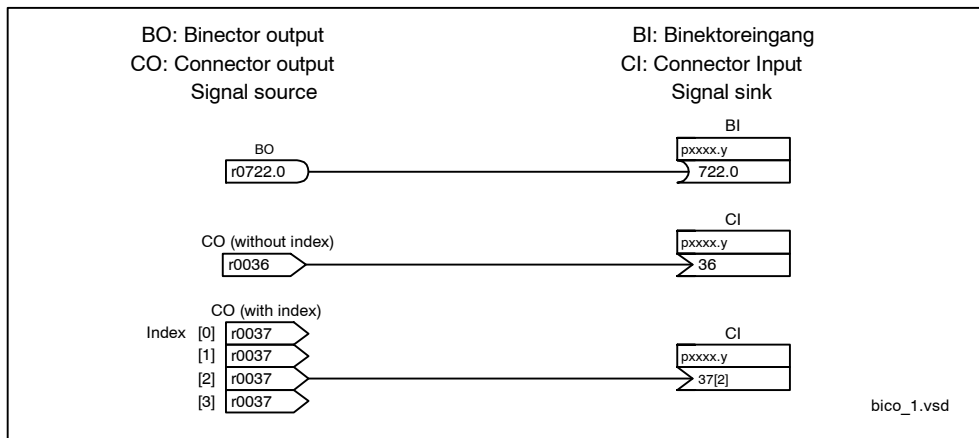


Fig. 7-5 Interconnecting signals using BICO technology

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.

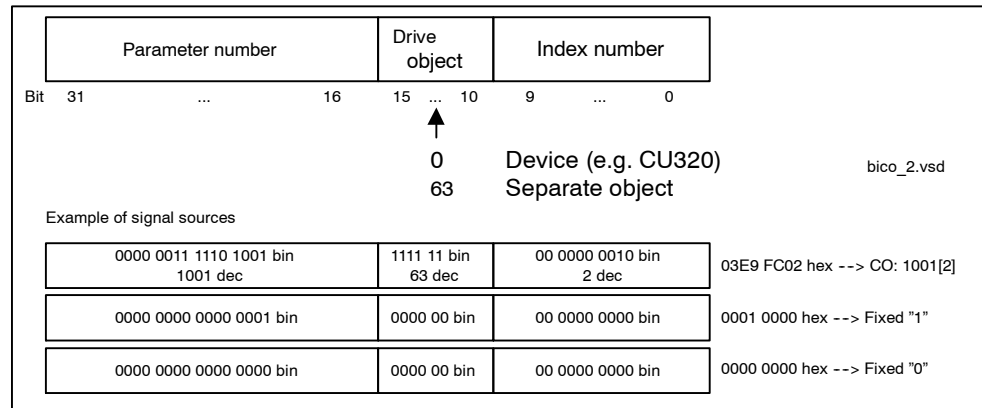


Fig. 7-6 Internal encoding of the binector/connector output parameters

Example 1: interconnecting digital signals

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

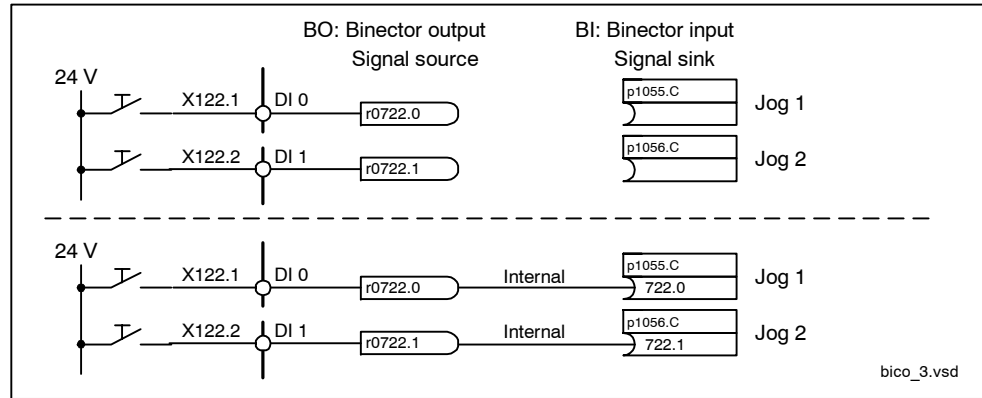


Fig. 7-7 Interconnection of digital signals (example)

Example 2: connection of OC/OFF3 to several drives

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

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

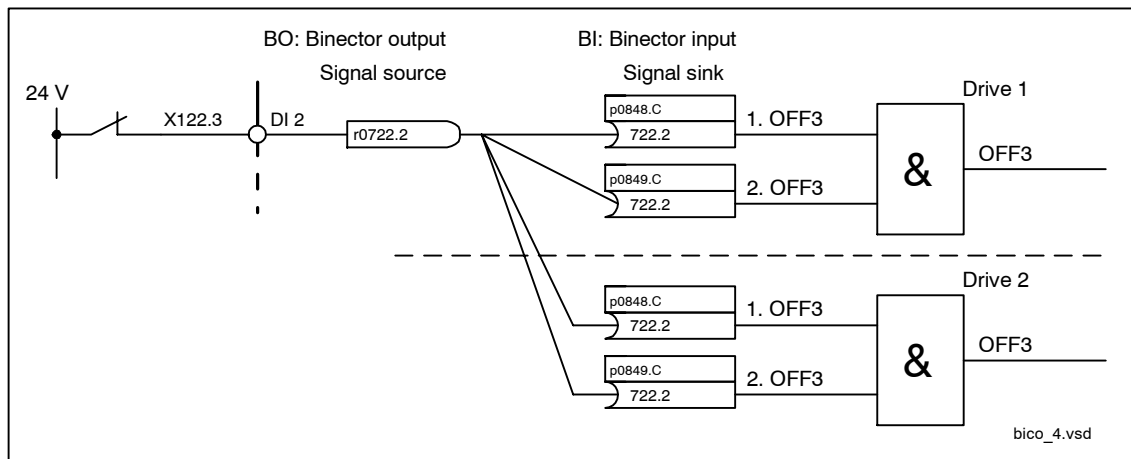


Fig. 7-8 Connection of OFF3 to several drives (example)

BICO interconnections to other drives

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

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

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 selection receive bit-serial

Fixed values for interconnection using BICO technology

The following connector outputs are available for interconnecting any fixed value settings:

- p2900[0...n] CO: Fixed value_%_1
- p2901[0...n] CO: Fixed value_%_2
- p2930[0...n] CO: Fixed Value_M_1

Example:

These parameters can be used to interconnect the scaling factor for the main set-point or to interconnect an additional torque.

Signals for the analog outputs

Table 7-4 List of signals for analog outputs

Signal	Parameters	Unit	Scaling (100% = ...)
Speed setpoint before the setpoint filter	r0060	1/min	p2000
Speed actual value motor encoder	r0061	1/min	p2000
Actual speed value	r0063	1/min	p2000
Drive output frequency	r0066	Hz	Reference frequency
Absolute current actual value	r0068	A _{eff}	p2002
Actual DC link voltage value	r0070	V	p2001
Total torque setpoint	r0079	Nm	p2003
Actual active power	r0082	kW	r2004
Control deviation	r0064	1/min	p2000
Control factor	r0074	%	Reference control factor
Current setpoint, torque-generating	r0077	A	p2002
Current actual value, torque-generating	r0078	A	p2002
Flux setpoint	r0083	%	Reference flux
Actual flux	r0084	%	Reference flux
Speed controller PI torque output	r1480	Nm	p2003
Speed controller I torque output	r1482	Nm	p2003

Scaling for vector object

Table 7-5 Scaling for vector object

Size	Scaling parameter	Default at initial commissioning
Reference speed	100 % = p2000	p2000 = Maximum speed (p1082)
Reference voltage	100 % = p2001	p2001 = 1000 V
Reference current	100 % = p2002	p2002 = Current limit (p0640)
Reference torque	100 % = p2003	p2003 = 2 * rated motor torque (p0333)
Reference power	100 % = r2004	r2004 = p2003 * p2000 * $2\pi / 60$
Reference frequency	100 % = p2000/60	-
Reference control factor	100 % = Maximum output voltage without overload	-
Reference flux	100 % = Rated motor flux	-
Reference temperature	100 % = 100°C	-
Reference electrical angle	100 % = 90°	-

Scaling for servo object

Table 7-6 Scaling for servo object

Size	Scaling parameter	Default at initial commissioning
Reference speed	100 % = p2000	Induction motor p2000 = Maximum motor speed (p0322) Synchronous motor p2000 = Rated motor speed (p0311)
Reference voltage	100 % = p2001	p2001 = 1000 V
Reference current	100 % = p2002	p2002 = Motor limit current (p0338); when p0338 = "0", then 2 * rated motor current (p0305)
Reference torque	100 % = p2003	p2003 = p0338 * p0334; when "0", 2 * rated motor torque (p0333)
Reference power	100 % = r2004	r2004 = p2003 * p2000 * $\pi / 30$
Reference frequency	100 % = p2000/60	-
Reference control factor	100 % = Maximum output voltage without overload	-
Reference flux	100 % = Rated motor flux	-
Reference temperature	100 % = 100°C	-
Reference electrical angle	100 % = 90°	-

Scaling for object A_Inf

Table 7-7 Scaling for object A_Inf

Size	Scaling parameter	Default at initial commissioning
Reference frequency	100 % = p2000	p2000 = p0211
Reference voltage	100 % = p2001	p2001 = r0206/r0207
Reference current	100 % = p2002	p2002 = p0207
Reference power	100 % = r2004	r2004 = p0206
Reference control factor	100 % = Maximum output voltage without overload	-
Reference temperature	100 % = 100°C	-
Reference electrical angle	100 % = 90°	-

Scaling for object B_Inf

Table 7-8 Scaling for object B_Inf

Size	Scaling parameter	Default at initial commissioning
Reference frequency	100 % = p2000	p2000 = 50
Reference voltage	100 % = p2001	p2001 = r0206/r0207
Reference current	100 % = p2002	p2002 = p0207
Reference power	100 % = r2004	r2004 = p0206
Reference temperature	100 % = 100°C	-
Reference electrical angle	100 % = 90°	-

7.5 Function Modules

A function module is a functional expansion of a drive object that can be activated during commissioning.

Examples of Function Modules:

- Technology controller
- Setpoint channel for SERVO drive object
- Parallel connection of Motor Modules or Line Modules
- Extended brake control
- Linear motors

A function module generally has separate parameters and, in some cases, separate faults and warnings too. These parameters and messages are only displayed when the function module is active. An active function module also generally requires additional processing time, which must be taken into account during configuration.

7.6 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, motors, 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)
- Technical specifications (e.g. rated current)

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:

- Using STARTER
by creating the configuration and loading it onto the drive
- Via quick commissioning (automatic configuration)

Reading the actual topology and writing the target topology 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)

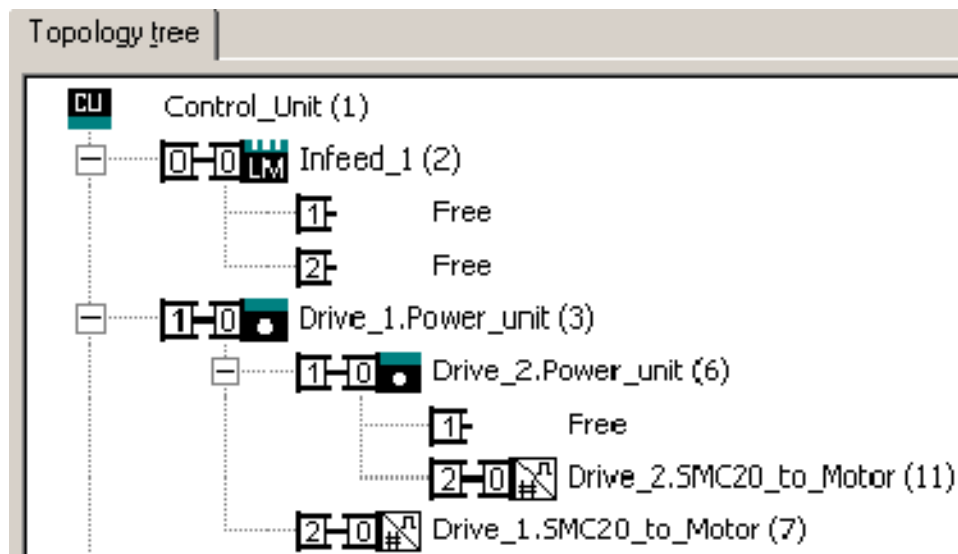


Fig. 7-9 Topology view in the STARTER tool

Notice

The Control Unit and the Option Board are not monitored. The system automatically accepts new components and does not output a message.

7.6.1 Permissible combinations of Line Modules and Motor Modules

With the exception of the Line Module, all components on a DRIVE-CLiQ line must have the same sampling time.

The following table shows the permissible sampling times of other nodes on a DRIVE-CLiQ line for a Line Module.

Table 7-9 Permissible sampling times on a DRIVE-CLiQ line

Line Module	Motor Module
250 μ s	125 μ s (booksize servo only) and 250 μ s
400 μ s	400 μ s

The sampling times are set automatically as follows:

- Active Line Module (booksize): 250 μ s
- Active Line Module (chassis)
 - 400 V ; \leq 300 kW / 490 A: 250 μ s
 - 400 V ; > 300 kW / 490 A: 400 μ s
 - 690 V ; \leq 330 kW / 310 A: 250 μ s
 - 690 V ; > 330 kW / 310 A: 400 μ s
- Basic Line Module (chassis)
 - 2 ms
- Smart Line Module (booksize): 250 μ s
- Motor Module (booksize)
 - Servo: 125 μ s
 - Vector; \leq 2 x vector control; \leq 4 x vector V/f only: 250 μ s
 - Vector; > 2 x vector (min. one vector control); > 4 x vector V/f: 400 μ s
 - Vector; > 6 vector V/f: 500 μ s
- Motor Module (chassis)
 - 400 V; \leq 250 kW; \leq 2 x vector control; \leq 4 x vector V/f: 250 μ s
 - 400 V; \leq 250 kW; > 2 x vector control; > 4 x vector V/f: 400 μ s
 - 400 V; > 250 kW: 400 μ s
 - 690 V: 400 μ s
 - Servo control: 250 μ s
- Mixed operation
 - Servo control with vector V/f; \leq 2 x vector V/f: 250 μ s
 - Servo control with vector V/f; > 2 x vector V/f: 400 μ s

7.6.2 Examples of replacing components

Note

To ensure that the entire functionality of a firmware version can be used, it is recommended that all the components in a drive line-up have the same firmware version.

Description

If the type of comparison is set to the highest setting, the following examples apply.

A distinction is made between the following scenarios:

- Components with identical order number
 - Topology comparison component replacement active (p9909 = 1)
 - Topology comparison component replacement inactive (p9909 = 0)
- Component with a different order number

Example: topology comparison component replacement active (p9909 = 1)

Prerequisite:

- The replaced component has an identical order number
- The target topology of the Control Unit must not contain the serial number of the replaced component.
- Topology comparison component replacement active (p9909 = 1)

Components that are not contained in the target topology of the Control Unit and have identical order numbers are automatically transferred to the target topology and saved in a non-volatile memory.

Note

Components must be replaced before POWER ON in order that the changes in the target topology are automatically saved in a non-volatile fashion.

Example of replacing a defective component with an identical order number (p9909 = 0)

Prerequisite:

- The replaced component has an identical order number
- Topology comparison component replacement inactive (p9909 = 0)

Table 7-10 Example: Replacing a Motor Module

Action	Response	Note
<ul style="list-style-type: none"> • Switch off the power supply • Replace the defective component and connect the new one • Switch on the power supply 	Alarm F1425	
<ul style="list-style-type: none"> • Set p9905 to "1" 	<ul style="list-style-type: none"> • 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 7-11 Example of replacing a component with a different order number

Action	Response	Note
<ul style="list-style-type: none"> • Switch off the power supply • Replace the defective component and connect the new one • Switch on the power supply 	Alarm F1420	
<ul style="list-style-type: none"> • 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) 	<ul style="list-style-type: none"> • 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		

7.7 System sampling times

7.7.1 Features

The software functions installed in the system are executed cyclically at different sampling times (p0115).

The sampling times (p0115) of the drives are always integer multiples of the basic sampling time (p0110) of the Control Unit.

The basic sampling time and the sampling times for the functions are set automatically when the drive unit is configured.

The settings are based on the selected mode (vector/servo), the number of connected components, and the functions activated.

With the exception of the Active Line Module, all components connected via a DRIVE-CLiQ socket on the Control Unit (DRIVE-CLiQ line) must be set to the same basic sampling time (see p0111). The sampling times of other components on the same DRIVE-CLiQ line must be integer multiples of the sampling time of the Active Line Module (minimum: half the sampling time of the Active Line Module).

7.7.2 Description

If the system sampling times are to be changed (e.g. to adjust the dynamic response), the basic sampling time and the current controller sampling time (fastest current controller sampling time) must always be the same.

The pulse frequency is entered in p1800 and must be an integer multiple of the current controller sampling frequency. The minimum pulse frequency that can be entered corresponds to half the current controller sampling frequency.

The basic sampling rate of a TMxx (p0111) is automatically set to the basic sampling time of the DRIVE-CLiQ line used. The sampling times of the inputs/outputs are entered in p4099 and must be a multiple of the basic sampling time (p0111).

Note

With a clock-synchronous PROFIBUS, the PROFIBUS DP clock cycle must be an integer multiple of all three basic sampling times (p0110[0..2]).

7.7.3 Commissioning sequence

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 sampling times 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.

Presetting the basic sampling times

Once they have been downloaded to the Control Unit, the basic sampling times (p0110[0..2]) are defaulted as follows:

- When the current controller sampling times (p0115[0]) of the drives are identical, the basic sampling times (p0110[0..2]) are set to these.
- When the current controller sampling times are different:
 - p0110[0] is set to the shortest current controller sampling time (in vector mode: to the longest current controller sampling time).
 - p0110[1] is set to 250 μ s when p0110[2] \geq 250 μ s (otherwise it is set to p0110[2]).
 - p0110[2] is set to the longest current controller sampling time

Notice

One exception here is presetting the basic sampling time (p0110[2]) in vector mode. When the number of drives is more than two (vector control) or four to six (vector V/f), p110[2] is set to 400 μ s. When the number of drives is more than six (vector V/f), p110[2] is set to 500 μ s.

7.7.4 Integration

The system sampling times are integrated in the system as follows.

Parameter overview (see List Manual)

Adjustable parameters

- p0110 [0..2] DRIVE-CLiQ basic clock cycle times
- p0111 DRIVE-CLiQ basic sampling time selection
- p0112 Sampling times pre-setting p0115
- p0115[0..6] Sampling times for internal control loops
- p0118 Current controller computation deadtime
- p1800 Pulse frequency
- p0799 CU inputs/outputs sampling time
- p4099 inputs/outputs sampling time
- r9780 Safety Integrated monitoring clock cycle (Control Unit)

7.8 Inputs/Outputs

7.8.1 Overview of inputs/outputs

The following digital/analog inputs/outputs are available:

Table 7-12 Overview of inputs/outputs

Component	Inputs	Digital		Analog	
		Inputs/ outputs bidirectional	Outputs	Inputs	Outputs
CU320	8 ¹⁾	8 ²⁾	-	-	-
TB30	4	-	4	2	2
TM15	-	24	-	-	-
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: /GH1/ SINAMICS S120 Equipment Manual: Control Units

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: /LH1/ SINAMICS S List Manual

Function diagram overview for digital inputs/outputs (see List Manual)

- 2100 Digital inputs, electrically isolated (DI 0 ... DI 3)
- 2120 Digital inputs, electrically isolated (DI 4 ... DI 7)
- 9100 Digital inputs, electrically isolated (DI 0 ... DI 3)
- 9550 Digital inputs, electrically isolated (DI 0 ... DI 3)
- 9552 Digital inputs, electrically isolated (DI 4 ... DI 7)

Digital outputs

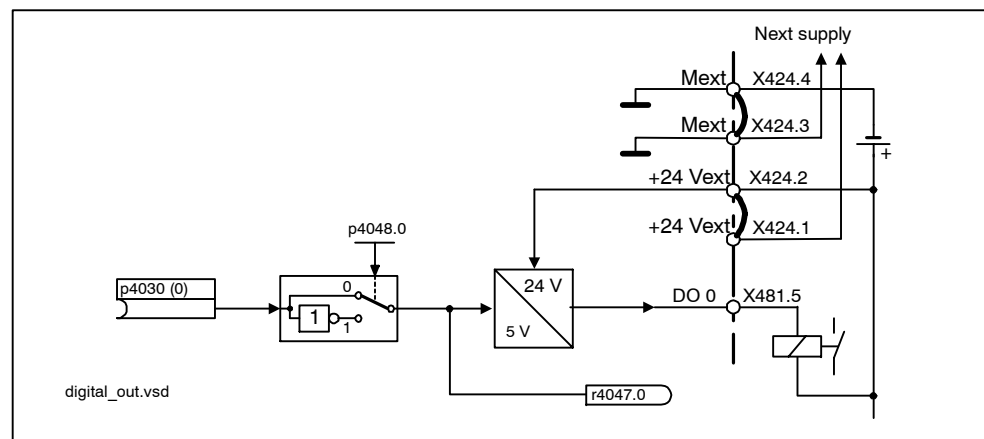


Fig. 7-11 Digital outputs: signal processing using DO 0 of TB30 as an example

Properties

- Separate power supply for the 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

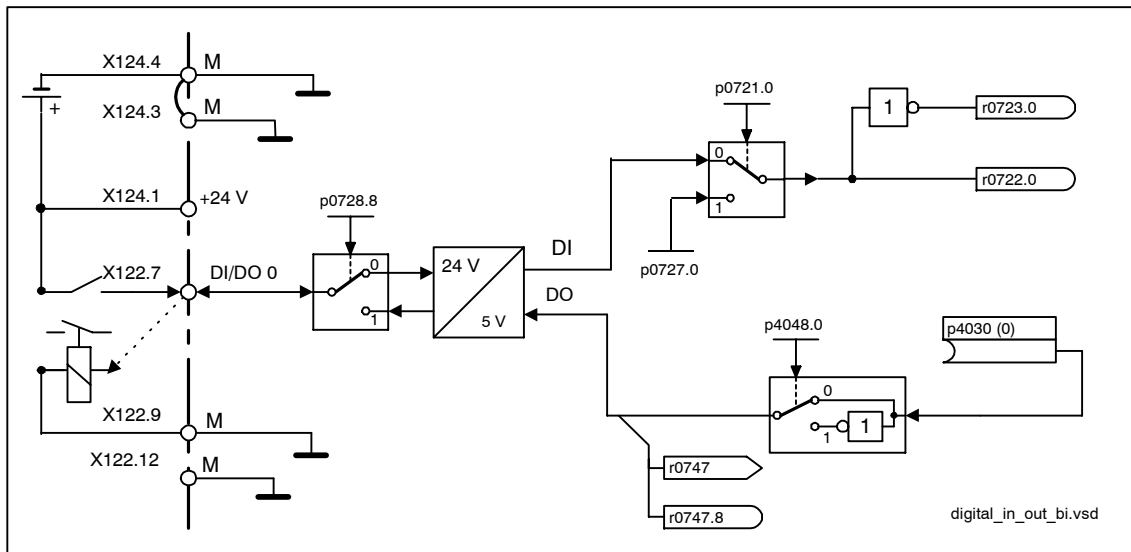


Fig. 7-12 Bidirectional inputs/outputs signal: processing using DI/DO 0 of CU320 as an example

Properties

- Can be parameterized as digital input or output.
- When 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 outputs apply.
- When set as digital output:
 - The properties of the “pure” digital outputs apply.

Function diagram overview (see List Manual)

- 2130 Bidirectional digital inputs/outputs (DI/DO 8 and DI/DO 9)
- 2131 Bidirectional digital inputs/outputs (DI/DO 10 and DI/DO 11)
- 2132 Bidirectional digital inputs/outputs (DI/DO 12 and DI/DO 13)
- 2133 Bidirectional digital inputs/outputs (DI/DO 14 and DI/DO 15)
- 9560 Bidirectional digital inputs/outputs (DI/DO 8 and DI/DO 9)
- 9562 Bidirectional digital inputs/outputs (DI/DO 10 and DI/DO 11)

7.8.3 Analog inputs

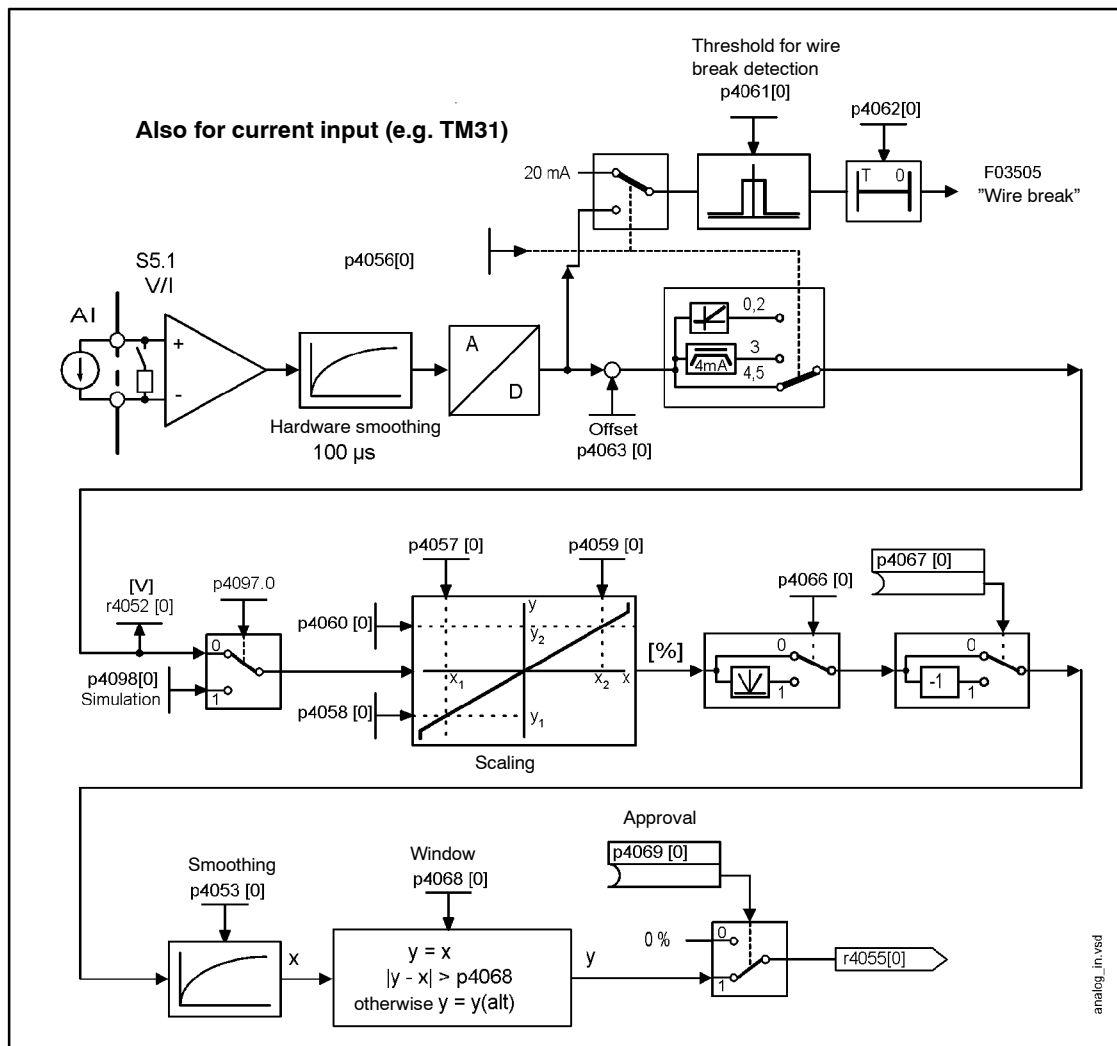


Fig. 7-13 Analog inputs: Signal processing using TB30/TM31 as an example

Properties

- Hardware input filter set permanently
- Simulation mode parameterizable
- Adjustable offset
- 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
- Smoothing

Notice

Scaling parameters p4057 to p4060 do not limit the voltage values.

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)

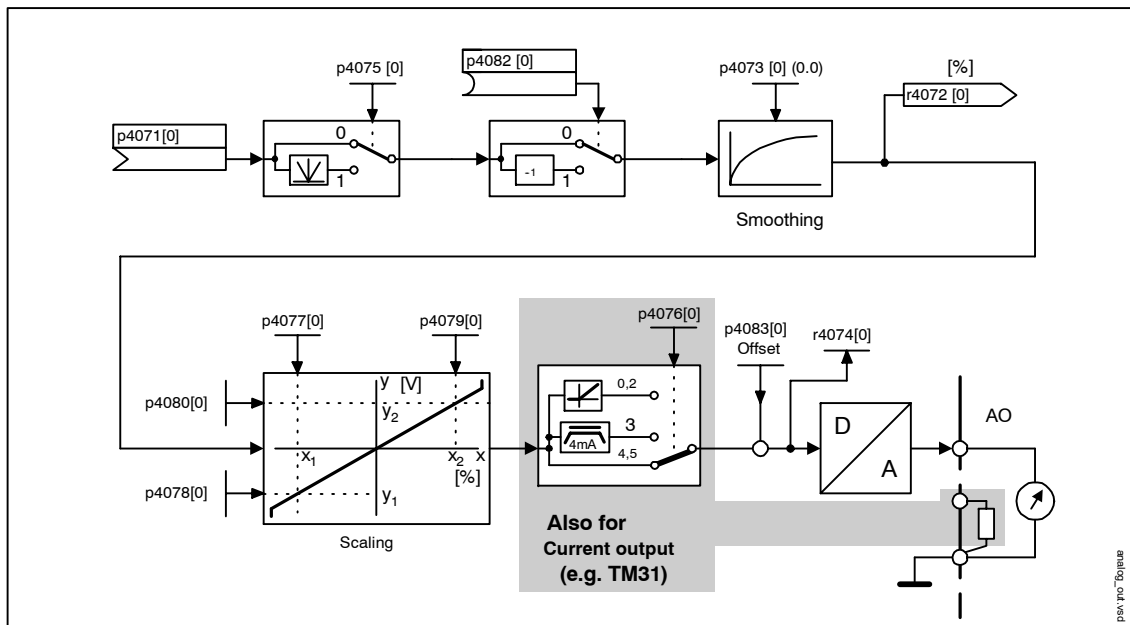
7.8.4 Analog outputs

Fig. 7-14 Analog outputs: Signal processing using AO 0 of TB30/TM31 as an example

Properties

- Adjustable absolute-value generation
- Inversion via binector input
- Adjustable smoothing
- Adjustable transfer characteristic
- Output signal can be displayed via visualization parameter

Notice

Scaling parameters p4077 to p4080 do not limit the voltage values.

Function diagram overview (see List Manual)

- 9106 Analog outputs (AO 0 and AO 1)
- 9572 Analog outputs (AO 0 and AO 1)

7.9 Monitoring and protective functions

7.9.1 Protecting power components

Description

SINAMICS power sections offer comprehensive functions for protecting power components.

Table 7-13 General protection for power sections

Protection against:	Protective measures	Responses
Overcurrent ¹⁾	Monitoring with two thresholds: <ul style="list-style-type: none"> • First threshold exceeded • Second threshold exceeded 	A30031, A30032, A30033 Current limitation of phase activated. Pulsing in the phase in question is inhibited for one pulse period. F30017 -> OFF2 is triggered if the threshold is exceeded too often. F30001 "Overcurrent" -> OFF2
Overvoltage ¹⁾	Comparison of the DC link voltage with the hardware shutdown threshold	F30002 "Overvoltage" -> OFF2
Undervoltage ¹⁾	Comparison of the DC link voltage with the hardware shutdown threshold	F30003 "Undervoltage" -> OFF2
Short-circuit ¹⁾	<ul style="list-style-type: none"> • Second monitoring threshold checked for overcurrent • Uce monitoring of IGBT modules (chassis only) 	F30001 "Overcurrent" -> OFF2 F30022 "Uce monitoring" -> OFF2 (chassis only)
Ground fault	Monitoring the sum of all phase currents	After threshold in p0287 is exceeded: F30021 "Power section: ground fault" --> OFF2 Note: The sum of all phase currents is displayed in r0069[6]. For operation, the value in p0287[1] must be greater than the sum of the phase currents when the insulation is intact.
Mains phase failure detection ¹⁾		F30011 "Line phase-failure in main circuit" -> OFF2

¹⁾The monitoring thresholds are permanently defined in the converter and cannot be changed.

7.9.2 Thermal monitoring and overload responses

Description

The priority of thermal monitoring for power components is to identify critical situations. If alarm thresholds are exceeded, the user can set parameterizable response options that enable continued operation (e.g. with reduced power) and prevent immediate shutdown.

The parameterization options, however, only enable intervention below the shutdown thresholds, which cannot be changed by the user.

The following thermal monitoring options are available:

- I^2t monitoring – A07805 – F30005
 I^2t monitoring is used to protect components that have a high thermal time constant compared with semi-conductors. Overload with regard to I^2t is present when the converter load (r0036) is greater than 100% (load in % in relation to rated operation).
- Heat-sink temperature – A05000 – F30004
Monitoring of the heat-sink temperature (r0037) of the power semi-conductor (IGBT).
- Chip temperature – A05001 – F30025
Significant temperature differences can occur between the IGBT barrier junction and the heat sink. These differences are taken into account and monitored by the chip temperature (r0037).

If an overload occurs with respect to any of these three monitoring functions, an alarm is first output. The alarm thresholds p0294 (I^2t monitoring) or p0292 (heat-sink or chip temperature monitoring) can be parameterized relatively to the shutdown values.

Example

The factory setting for the alarm threshold for chip temperature monitoring is 15 °C. Temperature monitoring for the heat sink and inlet air is 5 °C, that is, the “Overtemperature, overload” alarm is triggered at 15 °C or 5 °C below the shutdown threshold.

The parameterized responses are induced via p0290 simultaneously when the alarm is output. Possible responses include:

- Reduction in pulse frequency (p0290 = 2, 3) This is a highly effective method of reducing losses in the power section, since switching losses account for a high proportion of overall losses. In many applications, a temporary reduction in pulse frequency is tolerable in order to maintain the process.

Disadvantage:

Reducing the pulse frequency increases the current ripple which, in turn, can increase the torque ripple on the motor shaft (with low inertia load), thereby increasing the noise level. Reducing the pulse frequency does not affect the dynamic response of the current control circuit, since the sampling time for the current control circuit remains constant.

- Reducing the output frequency (p0290 = 0, 2)
This variant is recommended when you do not need to reduce the pulse frequency or the pulse frequency has already been set to the lowest level. The load should also have a characteristic similar to the fan, that is, a quadratic torque characteristic with falling speed. Reducing the output frequency has the effect of significantly reducing the converter output current which, in turn, reduces losses in the power section.
- No reduction (p0290 = 1)
You should choose this option when a reduction in neither pulse frequency nor output current need to be reduced. The converter does not change its operating point once an alarm threshold has been overshoot, which means that the drive can be operated until it reaches its shutdown values. Once it reaches its shutdown threshold, the converter switches itself off and the “Overtemperature, overload” fault is output. The time until shutdown, however, is not defined and depends on the degree of overload. To ensure that an alarm can be output earlier or that the user can intervene, if necessary, in the drive process (e.g. reduce load/ambient temperature), only the alarm threshold can be changed.

Function diagram for thermal monitoring and overload responses

- 8014 Thermal monitor power section

Overview of key parameters

- r0036 Power Module overload
- r0037 Power Module temperatures
- p0290 Power Module overload response
- p0294 Power Module alarm I^2t overload

7.9.3 Block protection

Description

The error message “Motor blocked” is only triggered if the speed of the drive is below the variable speed threshold set in p2175. With vector control, it must also be ensured that the speed controller is at the limit. With V/f control, the current limit must already have been reached.

Once the ON delay (p2177) has elapsed, the message “Motor blocked” and fault F7900 are generated.

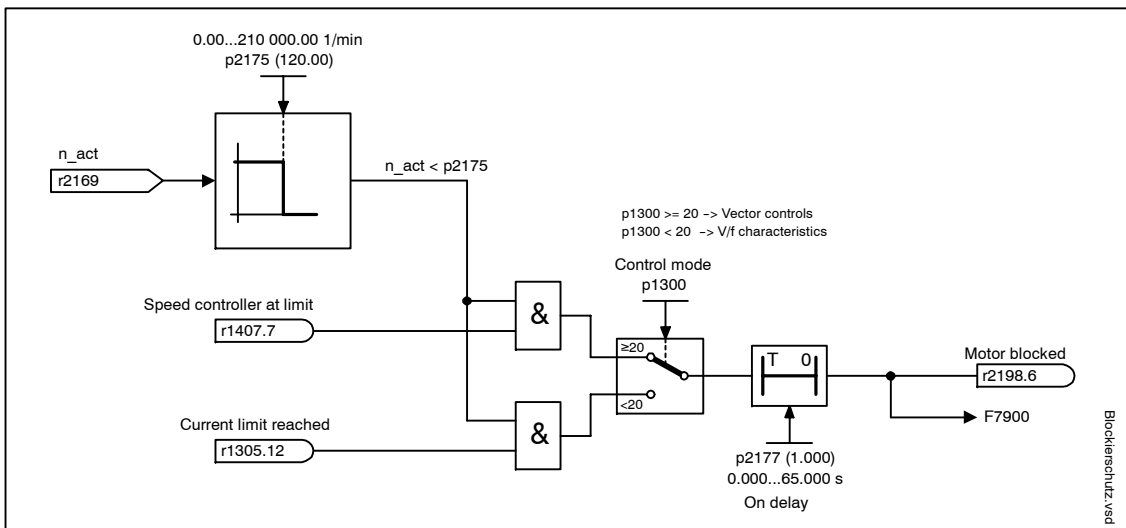


Fig. 7-15 Block protection

Function diagram for block protection

- 8012 Torque messages, motor blocked/stalled

Parameters for block protection

- p2175 Motor blocked speed threshold
- p2177 Motor blocked delay time

7.9.4 Stall protection

Description

If a stalled drive is detected (p1408.12 set), fault 7902 is output after the delay time set in P2178.

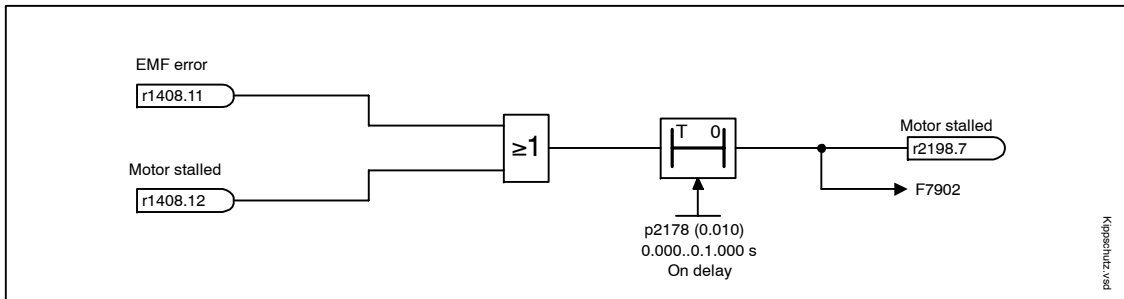


Fig. 7-16 Stall protection

Function diagram for stall protection

- 8012 Torque messages, motor blocked/stalled

Parameters for stall protection

- p2178 Motor stalled delay time

7.9.5 Thermal motor protection

Description

The priority of thermal motor protection is to identify critical situations. If alarm thresholds are exceeded, the user can set parameterizable response options that enable continued operation (e.g. with reduced power) and prevent immediate shut-down.

- Effective protection is also possible without a temperature sensor (p4100 = 0). The temperatures of different motor components (stators, core, rotors) can be determined indirectly using a temperature model.
- Connecting temperature sensors allows the motor temperature to be determined directly. In this way, accurate start temperatures are available immediately when the motor is switched on again or after a power failure.

Temperature measurement via KTY

The device is connected to terminals X522:7 (anode) and X522:8 (cathode) on the customer terminal block in the forward direction of the diode. The measured temperature value is limited to a range of -48 °C ... $+248\text{ °C}$ and made available for further evaluation.

- Set the KTY temperature sensor type: p0601 = 2
- Activate motor temperature measurement via the external sensor: p0600 = 10
- When the alarm threshold is reached (set via p0604; factory setting: 120 °C), alarm A7910 is triggered.

Parameter p0610 can be used to set how the drive responds to the alarm triggered:

- 0: No response, only alarm, no reduction of I_{max}
- 1: Alarm with reduction of I_{max} and fault (F7011)
- 2: Alarm and fault (F7011), no reduction of I_{max}
- When the fault threshold is reached (set via p0605), fault F7011 is triggered in conjunction with the setting in p0610.

Temperature measurement via PTC

The device is connected, for example, to terminal X522:7/8 on the terminal block (TM31). The threshold for switching to an alarm or fault is $1650\ \Omega$. If the threshold is exceeded, the system switches internally from an artificially-generated temperature value of -50 °C to $+250\text{ °C}$ and makes it available for further evaluation.

- Set the KTY temperature sensor type: p0601 = 1
- Activate motor temperature measurement via the external sensor: p0600 = 10
- Alarm A7910 is triggered once the PTC responds.
- Fault F7011 is triggered once the waiting time defined in p0606 has elapsed.

Sensor monitoring for cable breakage / short-circuit

If the temperature of the motor temperature monitor is outside the range -50 °C to $+250\text{ °C}$, the sensor cable is broken or has short-circuited. Alarm A07915 "Alarm temperature sensor fault" is triggered. Fault F07016 "Fault: temperature sensor fault" is triggered once the waiting time defined in p0607 has elapsed.

Fault F07016 can be suppressed by p0607 = 0. If an induction motor is connected, the drive continues operating with the data calculated in the thermal motor model.

If the system detects that the motor temperature sensor set in p0600 is not connected, alarm A07820 "Temperature sensor not connected" is triggered.

Function diagrams for thermal motor protection

- 8016 Thermal monitor motor
- 9576 Temperature evaluation KTY/PTC
- 9577 Sensor monitoring KTY/PTC

Parameters for thermal motor protection

- p0600 Motor temperature sensor for monitoring
- p0601 Motor temperature sensor type
- p0604 Motor overtemperature alarm threshold
- p0605 Motor overtemperature fault threshold
- p0606 Motor over temperature timer
- p0607 Temperature sensor fault timer
- p0610 Response to motor overtemperature condition

7.10 Updating the firmware

The firmware must be updated if extended functions are made available in a more recent firmware version and these functions are to be used.

The firmware versions for all DRIVE-CLiQ components are on the CompactFlash card. The Control Unit loads the firmware from the CompactFlash card while the system is booting up. You have to update the connected DRIVE-CLiQ components.

7.10.1 Upgrading firmware and the project in STARTER

To ensure that the project functions, you need a CompactFlash card containing the new firmware and a current version of STARTER.

Upgrade the project

1. Is the project in STARTER? Yes: continue with 3..
2. Upload project with STARTER.
Connect to target system -> Target system -> Load -> Project to PG
3. Install the latest firmware version for the project.
Right-click the drive unit -> Target device -> Device version -> e.g. select version "SINAMICS S120 V2.3x" -> Change version

Update the firmware and load the new project to the target device.

1. Insert CompactFlash Card with the new firmware version
Disconnect the Control Unit from the power supply ->
Insert the CF card with the new firmware version ->
Switch on the Control Unit again.
2. Go online and load the project to the target device -> Copy from RAM to ROM
3. Upgrading the firmware for the DRIVE-CLiQ components
Under Drive unit -> Configuration -> Version overview ->
Select all -> Start firmware update -> Copy from RAM to ROM

Notice

The firmware versions on the DRIVE-CLiQ components may be different.

4. Carry out POWER ON **for all** DRIVE-CLiQ components

7.11 Licensing

Description

To use the SINAMICS S120 drive system and the activated options, you need to assign the corresponding licenses to the hardware. When doing so, you receive a license key, which electronically links the relevant option with the hardware.

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.

Option performance 1

Option performance 1 (order no.: 6SL3074-0AA01-0AA0) is required for a CPU runtime utilization greater than 50%. The remaining computation time is displayed in parameter r9976[2]. As of a CPU runtime utilization greater than 50%, alarm A13000 is output and the READY LED on the Control Unit flashes green/red at 0.5 Hz.

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 “WEB License Manager” from a license database.

Generating a license key via the “WEB License Manager”

The following information is required:

- Serial number of the CompactFlash card (on CF card)
- License number, delivery note number, and the license (on the Certificate of License)

1. Call up the “WEB License Manager”.
<http://www.siemens.com/automation/license>
2. Choose “Direct access”.
3. Enter the license number and delivery note number of the license.
--> Click “Next”.
4. Enter the serial number of the CompactFlash card.
5. Select the product (“SINAMICS S CU320”).
--> Click “Next”.
6. Choose “Available license numbers”.
--> Click “Next”.
7. Check the assignment.
--> Click “Assignment”.
8. When you are sure that the license has been correctly assigned, click “OK”.
9. The license key is displayed and can be entered.

Entering the license key

Example of a license key:

E1MQ-4BEA = 69 49 77 81 45 52 66 69 65 dec (ASCII characters)

Procedure for entering a license key (see example):

1. p9920[0] = 69 1st character
...
2. p9920[8] = 65 9th character
3. p9920[9] = 0 No character
...
4. p9920[19] = 0 No character

Note

When changing p9920[x] to the value 0, all of the following indices are also set to 0.

After the license key has been entered, it has to be activated as follows:

5. p9921 = 1 Licensing, activate license key

The parameter is automatically reset to 0

In the table below, you can enter the characters in the license key and the associated decimal numbers.

Table 7-14 Licence key table

Letter / number												
decimal												

ASCII codes

Table 7-15 Excerpt of ASCII code

Letter / number	decimal	Letter / number	decimal
-	45	I	73
0	48	J	74
1	49	K	75
2	50	L	76
3	51	M	77
4	52	N	78
5	53	O	79
6	54	P	80
7	55	Q	81
8	56	R	82
9	57	S	83
A	65	T	84
B	66	U	85
C	67	V	86
D	68	W	87
I	69	X	88
F	70	Y	89
G	71	Z	90
H	72		

Parameter overview (see List Manual)

- p9920 Licensing, enter license key
- p9921 Licensing, activate license key
- p9950
- p9976[0...2] Remaining computation time



List of abbreviations

Abbreviation	German	English
A		
A ...	Warning	Alarm
AC	Wechselstrom	Alternating Current
ADC	Analog-Digital-Konverter	Analog Digital Converter
AI	Analog input	Analog Input
ALM	Active Line Module	Active Line Module
AO	Analog output	Analog Output
AOP	Advanced Operator Panel	Advanced Operator Panel
ASC	Ankerkurzschluss	Armature Short-Circuit
ASCII	American Standard Code for Information Interchange	American Standard Code for Information Interchange
B		
OC	Operating condition	Operating Condition
BERO	Tradename for a type of proximity switch	Tradename for a type of proximity switch
BI	Binektoreingang	Binector Input
BIA	Berufsgenossenschaftliches Institut für Arbeitssicherheit (German Institute for Occupational Safety)	Berufsgenossenschaftliches Institut für Arbeitssicherheit (German Institute for Occupational Safety)
BICO	Binector Connector Technology	Binector Connector Technology
BLM	Basic Line Module	Basic Line Module
BOP	Basic Operator Panel	Basic Operator Panel
C		
C	Capacitance	Capacitance
C...	Safety-Meldung	Safety message
CAN	Serielles Bussystem	Controller Area Network
CBC	Communication Board CAN	Communication board CAN
CD	Compact Disc	Compact Disc
CDS	Befehlsdatensatz	Command Data Set
CI	Konnektoreingang	Connector Input
CNC	Computer Numerical Control	Computer Numerical Control
CO	Konnektorausgang	Connector Output

Abbreviation	German	English
CO/BO	Connector Output/Binector Output	Connector Output/Binector Output
COB-ID	CAN object identification	CAN object identification
COM	Mid-position contact of a changeover contact	Mid-position contact of a changeover contact
CP	Communications Processor	Communications Processor
CPU	Central Processing Unit	Central Processing Unit
CRC	Cyclic Redundancy Check	Cyclic Redundancy Check
CT	Constant Torque	Constant Torque
CU	Control unit	Control unit
D		
DAC	Digital Analog Converter	Digital Analog Converter
DC	Direct Current	Direct Current
DCN	Direct current negative	Direct Current Negative
DCP	Direct current positive	Direct Current Positive
DDS	Antriebsdatensatz	Drive Data Set
DI	Digitaleingang	Digital Input
DI/DO	Bidirectional Digital Input/Output	Bidirectional Digital Input/Output
DMC	DRIVE-CLiQ Module Cabinet (Hub)	DRIVE-CLiQ Module Cabinet (Hub)
DO	Digitalausgang	Digital Output
DO	Drive object	Drive Object
DPRAM	Dual Ported Random Access Memory	Dual-Port Random Access Memory
DRAM	Dynamic Random Access Memory	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	Electrostatic Sensitive Devices (ESD)	Electrostatic Sensitive Devices
EMF	Electromagnetic force	Electromagnetic Force (EMF)
EMC	Electromagnetic Compatibility	Electromagnetic Compatibility
EN	European Standard	European Standard
EnDat	Encoder-Data-Interface	Encoder-Data-Interface
EP	Pulse enable	Enable Pulses
ES	Engineering System	Engineering System
ESB	Ersatzschaltbild	Equivalent circuit diagram
ESR	Erweitertes Stillsetzen und Rückziehen	Extended Stop and Retract
F		
F ...	Fault	Fault
FAQ	Frequently Asked Questions	Frequently Asked Questions

Abbreviation	German	English
FCC	Function Control Chart	Function Control Chart
FCC	Flux Current Control	Flux Current Control
FEPROM	Schreib- und Lesespeicher nichtflüchtig	Flash-EPROM
FG	Function generator	Function Generator
FI	Fehlerstrom-Schutzschalter	Residual-Current Circuit-Breaker (RCCB)
FP	Funktionsplan	Function diagram
FW	Firmware	Firmware
G		
GC	Global Control Telegram (broadcast telegram)	Global control telegram (broadcast telegram)
GSD	Device master file: describes the features of a PROFIBUS slave	Device master file: describes the features of a PROFIBUS slave
GSDML	GSDML ist die Beschreibungssprache zur Erstellung einer GSD-Datei. Diese ist XML-basiert.	Generic Station Description Markup Language
GPS	Gate Supply Voltage	Gate Supply Voltage
H		
HF	High frequency	High Frequency
HFD	High frequency reactor	High frequency reactor
RFG	Ramp-Function Generator	Ramp-Function Generator
HMI	Human Machine Interface	Human Machine Interface
HTL	High threshold logic	High-Threshold Logic
HW	Hardware	Hardware
I		
In preparation:	In Vorbereitung: this feature is currently not available	In preparation: this feature is currently not available
IBN	Commissioning	Commissioning
I/O	Input/Output	Input/Output
ID	Identification	Identifier
IEC	International Electrotechnical Commission	International Electrotechnical Commission
IGBT	Insulated Gate Bipolar Transistor	Insulated Gate Bipolar Transistor
IL	Pulse cancellation	Pulse suppression
IT	Insulated three-phase supply network	Three-phase supply network ungrounded
J		
JOG	Jog	Jogging
K		
KDV	Crosswise data comparison	Data cross-checking
KIP	Kinetic buffering	Kinetic buffering

Abbreviation	German	English
Kp	Proportionalverstärkung	Proportional gain
KTY	Positive temperature coefficient temperature sensor	Special temperature sensor
L		
L	Inductance	Inductance
LED	Light Emitting Diode	Light Emitting Diode
LSB	Least Significant Bit	Least Significant Bit
LSS	Line breaker	Line Side Switch
M		
M	Masse	Reference potential, zero potential
MB	Megabyte	Megabyte
MCC	Motion Control Chart	Motion Control Chart
MDS	Motordatensatz	Motor Data Set
Order No.	Machine-readable product designation	Machine-readable product designation
MMC	Man-Machine Communication	Man Machine Communication
MSB	Most Significant Bit	Most Significant Bit
MSCY_C1	Master Slave Cycle Class 1	Master Slave Cycle Class 1
MT	Measuring input	Measuring probe
N		
N. C.	Nicht angeschlossen	Not Connected
N...	No report or internal report	No Report
NAMUR	Normenarbeitsgemeinschaft für Mess- und Regeltechnik in der chemischen Industrie	Standardization association for measurement and control in chemical industries
NC	Öffner	Normally Closed contact
NC	Numerical Control	Numerical Control
NEMA	National Electrical Manufacturers Association	National Electrical Manufacturers Association
NM	Nullmarke	Zero mark
NO	Schließer	Normally Open contact
O		
OEM	Original Equipment Manufacturer	Original Equipment Manufacturer
OLP	Optical Link Plug	Optical Link Plug
OMI	Option Module Interface	Option Module Interface
P		
p ...	Einstellparameter	Adjustable parameter
PcCtrl	Master control	Master Control
PDS	Leistungsteildatensatz	Power Module Data Set
PE	Protective Earth	Protective Earth

Abbreviation	German	English
PELV	Protective Extra Low Voltage	Protective Extra Low Voltage
PG	Programming terminal	Programming device
PI	Proportional Integral	Proportional Integral
PID	Proportional Integral Differential	Proportional Integral Differential
PLC	Programmable Logical Controller	Programmable Logic Controller
PLL	Phase locked Loop	Phase Locked Loop
PNO	PROFIBUS user organisation	PROFIBUS user organisation
PRBS	Pseudo Random Binary Signal	Pseudo Random Binary Signal
PROFIBUS	Process Field Bus	Process Field Bus
PS	Power supply	Power Supply
PSA	Power Stack Adapter	Power Stack Adapter
PTC	Positive Temperature Coefficient	Positive Temperature Coefficient
PTP	Point to Point	Point To Point
PWM	Pulse Width Modulation	Pulse Width Modulation
PZD	PROFIBUS Process data	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	Standard. Describes an 8-pole plug connector with twisted pair Ethernet.	Standard Describes an 8-pole plug connector with twisted pair Ethernet.
RKA	Cooling system	Recooling system
RO	Read Only	Read Only
RPDO	Receive Process Data Object	Receive Process Data Object
RS232	Serial interface	Serial interface
RS485	Standard. Describes the physical characteristics of a digital serial interface.	Standard Describes the physical characteristics of a digital serial interface.
S		
S1	Continuous operation	Continuous operation
S3	Periodic Duty	Periodic duty
SBC	Safe Brake Control	Safe Brake Control
SBH	Sicherer Betriebshalt	Safe operating stop
SBR	Sichere Bremsrampe	Safe braking ramp
SGE	Safe input signal	Safe input signal
SH	Safe standstill	Safe standstill

Abbreviation	German	English
SI	Safety Integrated	Safety Integrated
SIL	Safety Integrity Level	Safety Integrity Level
SLM	Smart Line Module	Smart Line Module
SLVC	Sensorless vector control	Sensorless Vector Control
SM	Sensor Module	Sensor Module
SMC	Sensor Module Cabinet	Sensor Module Cabinet
SME	Sensor Module External	Sensor Module External
SPC	Setpoint channel	Setpoint Channel
SPS	Programmable Logic Controller (PLC)	Programmable Logic Controller (PLC)
STW	PROFIBUS Control Word	PROFIBUS control word
T		
TB	Terminal Board	Terminal Board
TIA	Totally Integrated Automation	Totally Integrated Automation
TM	Terminal Module	Terminal Module
TN	Drehstromversorgungsnetz geerdet	Grounded three-phase supply network
Tn	Nachstellzeit	Integral time
TPDO	Transmit Process Data Object	Transmit Process Data Object
TT	Drehstromversorgungsnetz geerdet	Grounded three-phase supply network
TTL	Transistor Transistor Logic	Transistor-Transistor-Logic
U		
UL	Underwriters Laboratories Inc.	Underwriters Laboratories Inc.
UPS	Unterbrechungsfreie Stromversorgung	Uninterruptible power supply
V		
VC	Vector control	Vector control
Vdc	Zwischenkreisspannung	DC link voltage
VDE	Association of German Electrical Engineers	Association of German Electrical Engineers
VDI	Association of German Engineers	Association of German Electrical Engineers
Vpp	Volt peak to peak	Volt peak to peak
VSM	Voltage Sensing Module	Voltage Sensing Module
VT	Variables Drehmoment	Variable Torque
W		
WZM	Machine tool	Machine tool
X		
XML	Extensible Markup Language	Extensible Markup Language

Abbreviation	German	English
Y		
Z		
ZK	DC Link	DC Link
ZSW	PROFIBUS Zustandswort	PROFIBUS status word



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/D11/	SINAMICS G130 Converter Chassis Units SINAMICS G150 Converter Cabinet Units Order number: E86060-K5511-A101-A2	Edition: 07.2004
/D21.1/	SINAMICS S120 Vector Control Drive System Order number: E86060-K5521-A111-A1	Edition: 04.2005
/D21.2/	SINAMICS S120 Servo Control Drive System Order number: E86060-K5521-A121-A1	Edition: 04.2004
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/ST70/	SIMATIC Products for Totally Integrated Automation, Catalog ST70 Ordering information Order number: E86060-K4670-A111-A9	Edition: 10.2004
/PM10/	SIMOTION Motion Control System, Catalog PM10 Ordering information Order no.: E86060-K4910-A101-A5	Edition: 07.2005

Interactive catalogs

- /CA01/ Automation and Drives' Offline Mall**
CD-ROM
Order number: E86060-D4001-A100-C3 Edition: 10.2004
- /Mall/ A&D Mall, Catalog and Online Ordering System**
<http://www.siemens.com/automation/mall>

Electronic documentation

- /CD2/ SINAMICS**
The SINAMICS System
Order no.: 6SL3097-2CA00-0YG2 Edition: 07.2005

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- /BA1/ SINAMICS G150**
Operating Instructions
Order number: On request Edition: 06.2005
- /BA2/ SINAMICS G130**
Operating Instructions
Order number: On request Edition: 06.2005
- /BA3/ SINAMICS S150**
Operating Instructions
Order number: On request Edition: 06.2005
- /GH1/ SINAMICS S120**
Equipment Manual for Control Units and Additional System Components
Order no.: 6SL3097-2AH00-0AP2 Edition: 06.2005
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Order no.: 6SL3097-2AC00-0AP2 Edition: 06.2005

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/LH1/	SINAMICS S List Manual Order no.: 6SL3097-2AP00-0AP3	Edition: 06.2005

Further supplementary documentation

1	Drive ES Basic V5.1 Function description Engineering system for drives from the SIEMENS A&D product range Order no.: 6SW1700-0JA00-0AA0	Edition: 08.2001
2	SIMOTION Engineering System Usage Order number: 6AU1900-1AB32-0AA0	Edition: 12.2004

- /PJAL/ SIMODRIVE, SIMOVERT MASTERDRIVES, SINAMICS
General Section for Synchronous Motors
Configuration Manual**
Order number: 6SN1197-0AD07-0BP2 Edition: 12.2004
- /PFK7S/ SIMODRIVE Synchronous Motors 1FK7
Configuration Manual**
Order number: 6SN1197-0AD16-0BP0 Edition: 12.2004
- /PFT6S/ SIMODRIVE Synchronous Motors 1FT6
Configuration Manual**
Order number: 6SN1197-0AD12-0BP0 Edition: 12.2004
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Basics, Tips, and Tricks for Users
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ISBN 3-7785-2781-9
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PROFIBUS Nutzerorganisation e.V.; Manfred Popp
Order no.: 4.071
- /P3/ Distributed Layouts using PROFIBUS-DP**
Architecture and Fundamentals, configuration and Use of PROFIBUS-DP with
SIMATIC S7
SIEMENS; Publics MCD Verlag; Josef Weigmann, Gerhard Kilian
Order number: A19100-L531-B714
ISBN 3-89578-074-X
- /P4/ Manual for PROFIBUS Networks, SIEMENS**
Order number: 6GK1970-5CA20-0AA0

/P5/ PROFIBUS Profile PROFIdrive Profile Drive Technology
PROFIBUS User Organization e.V.
Haid-und-Neu-Straße 7, 76131 Karlsruhe
Order number: 3.172 Version 3.1, November 2002

/IKPI/ SIMATIC NET, Industrial Communication and Field Devices
Catalog
Order number: E86060-K6710-A101-B4 Edition: 2005

/PDP/ PROFIBUS Installation Guidelines
Installation Guideline for PROFIBUS-FMS/DP
Installation and wiring recommendation for RS 485 transmission
Order number: 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.com/safety>

The following list contains some of the safety-related documentation available.

/LVP/	Low-Voltage Switchgear Catalog Order number: E86060-K1002-P101-A5	Edition: 2005
/LV10/	Controlgear for Industry Catalog Order number: E86060-K1002-A101-A4	Edition: 2004
/LV20/	BERO - Sensors for Automation Applications Catalog Order number: E86060-K1803-A101-A3	Edition: 2004
/LV30/	Products and Systems for Energy Distribution Catalog Order number: E86060-K1801-A101-A4	Edition: 2004
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/SIAH/	Safety Integrated Application manual Order no.: 6ZB5000-0AA01-0BA1	5th edition
/SICD/	Safety Integrated CD-ROM Order number: E20001-D10-M103-X-7400	Edition: 09.2004



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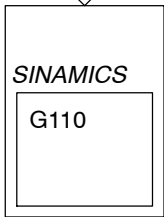
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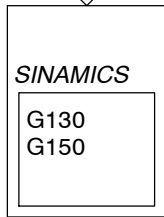
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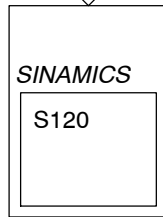
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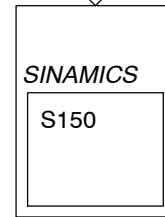
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0.12 kW to 3 kW



D11
Converter Chassis Units
Converter Cabinet Units

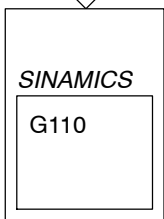


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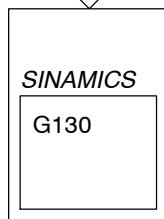


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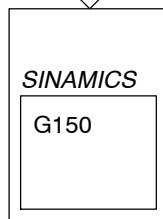
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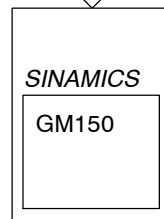
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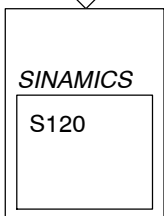


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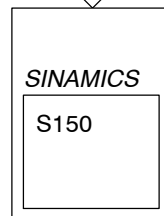


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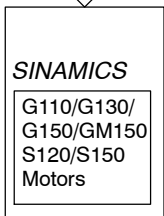


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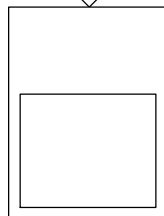


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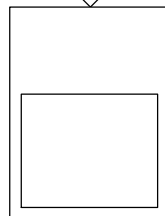
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