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SINAMICS S120 - Parameterizing and Commissioning
Course DR-S12-PM

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SINAMICS S120 - Parameterizing and Commissioning

Course DR-S12-PM

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Course From: __________ To: __________

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2	STARTER project structure
3	Control Units and additional system components
4	STARTER connection to target device
5	Booksize power units
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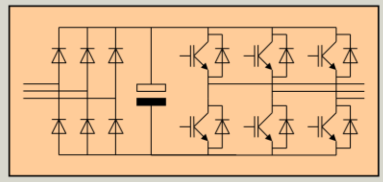

Chapter 1

Fundamentals and overview

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Learning Targets

- You will become familiar with the fundamental principle of a frequency converter
- You will become familiar with the concept of the modular SINAMICS S120 system
- You will be able to identify the most important components

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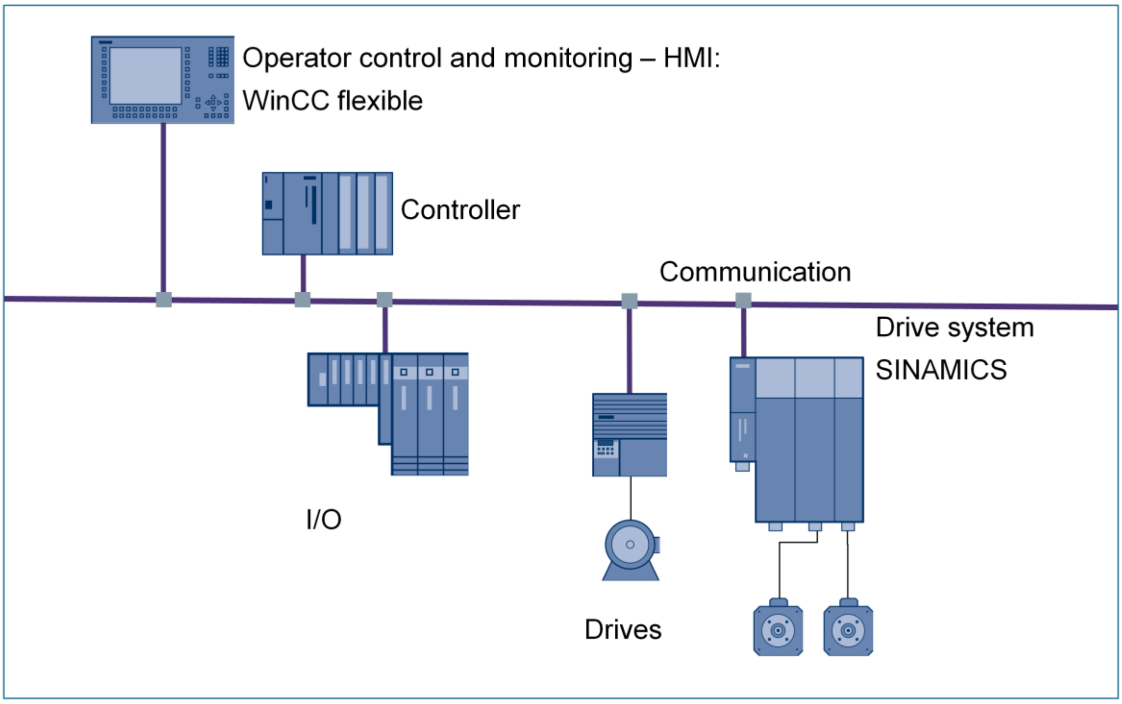
Fundamentals
Setup of the automation solution



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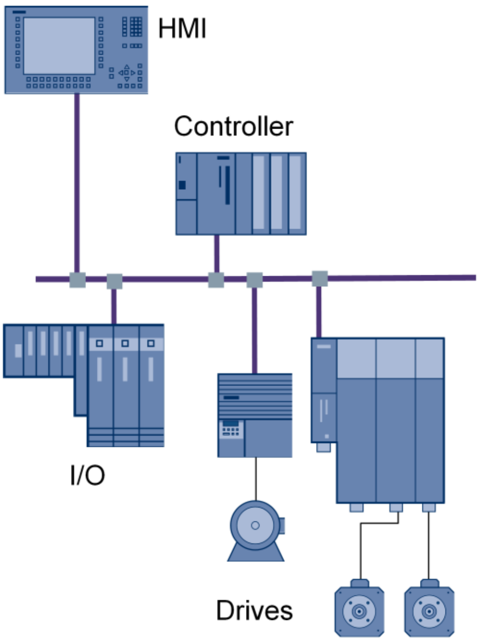
Automation	The automation systems require various hardware and software components for the machine control.
HMI	The Human Machine Interface is used for the operator control and monitoring of the machine. An HMI can consist of simple switches and lamps or a graphical panel, part of a PC controller.
Controller	The controller is the brain of the machine. Depending on the variant, it is designated as programmable logic controller (PLC), motion controller or industrial PC, and is responsible for open- and closed-loop control tasks in the machine.
I/O	Input and output signals (possibly distributed, this means physically separated and connected via the bus system) and valve islands for the pneumatics.
Drives	Drives are the mechanisms or processes with which an object is moved or its movement created. This includes all types of actuators, e.g. motors and their power units, pneumatic cylinders and their valve control, etc.

Fundamentals
Tasks of a controller



Tasks of a controller

- Logic control
  - Processing I/O signals
  - Closed-loop control tasks
  - Data processing
- Output of the speed setpoint or position setpoint via PROFIBUS, PROFINET

Tasks of a drive system

- Speed, torque or position control
  Consisting of:
  - Rectifier/inverter
  - Motor
  - Encoder system
  - Drive control
- Conversion of the specified speed to the actual speed

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Controller The tasks of a programmable logic controller are the processing of I/O signals, closed-loop control tasks and data processing.

Drive system The drive system should move a motor with a specified speed or to a defined position. Various modules are required to do this: infeed, power units, motors, encoders and a Control Unit.

The drive system can run independent of a higher-level controller. If a motion control controller is deployed as higher-level controller, speed setpoints are transferred to the various drives.

The Control Unit then uses an integrated speed and current controller to ensure that the actual speed of the motor follows the transferred speed setpoint.

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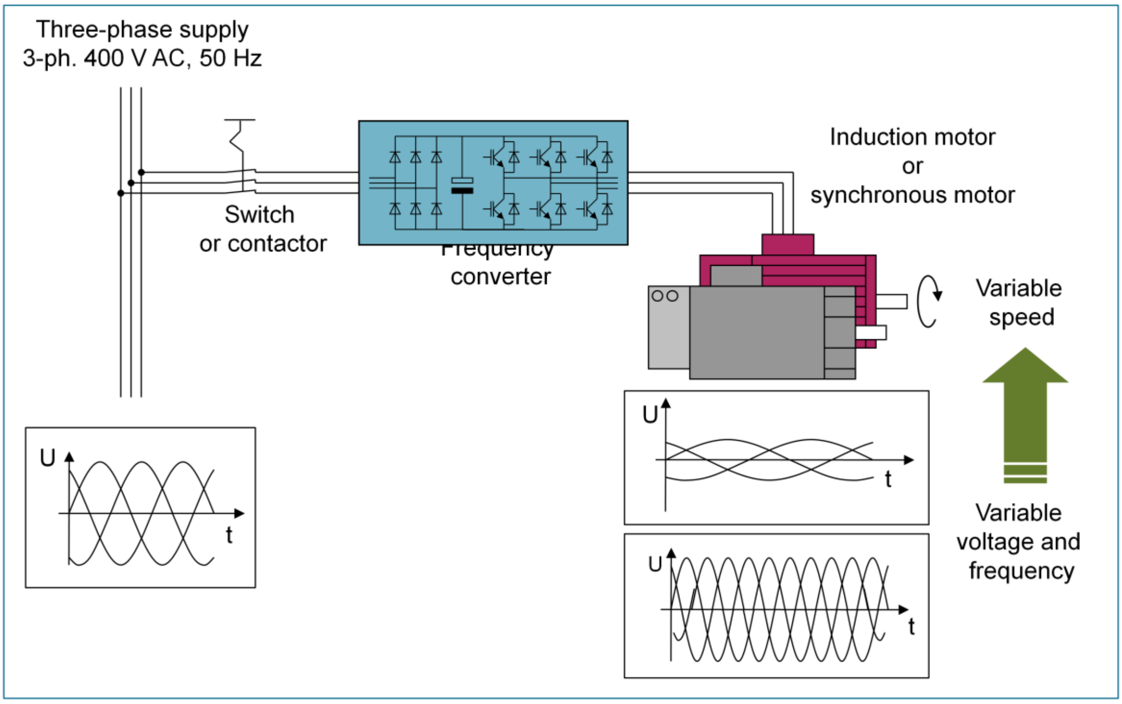
Fundamentals
Operation with frequency converter



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Converter

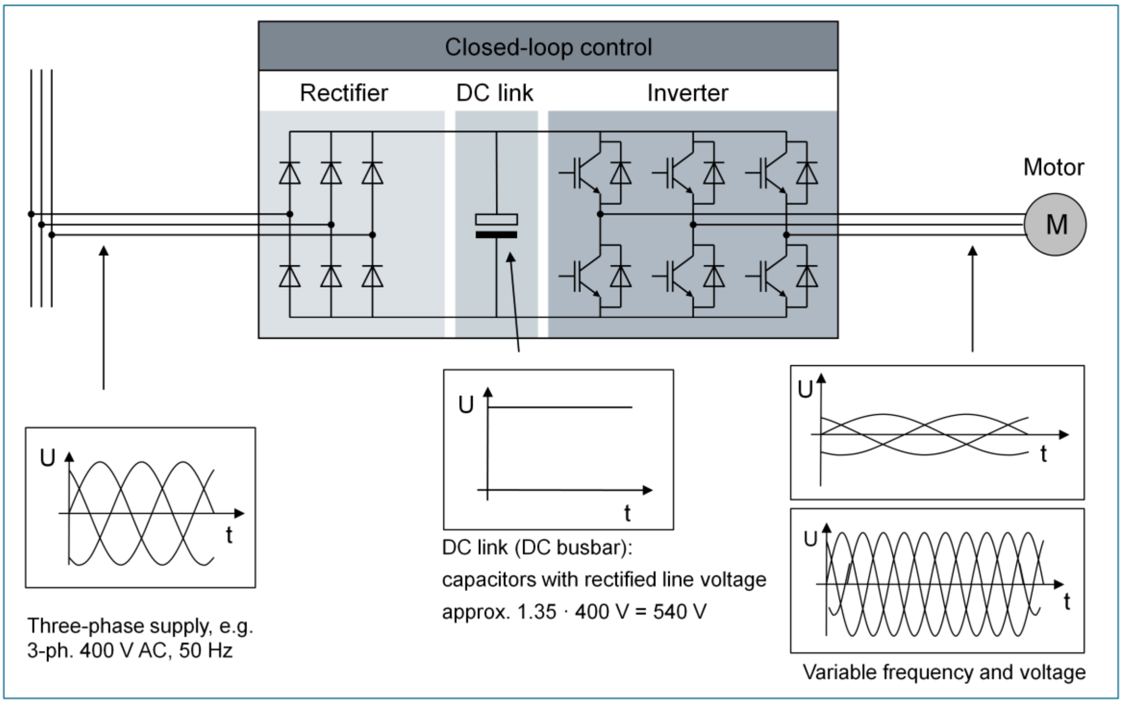
A converter supplies a three-phase motor with a variable three-phase current. For this purpose, the three-phase current from the supply system is rectified in the converter and a three-phase current with variable frequency is created.

Frequencies

Depending on the speed setpoint that is input, the converter outputs a frequency of 0 to 50 Hz. Higher frequencies are also possible, depending on the motor.

Speed

In some applications, a desired frequency is specified instead of the speed setpoint. Based on the motor data, such as rated current, rated power and rated speed, the converter knows which output frequency needs to be produced and output to the motor.



Rectifier

In a rectifier circuit, the three-phase current from the power supply is rectified.

The module for rectifying is also called the Infeed or Line Module.

Depending on the version, these modules can feed energy to the DC link or from the DC link to the line.

DC link

The DC voltage from the infeed is applied to the DC link, which is buffered using capacitors. These capacitors are used to store the energy and are integrated into the infeed and the inverter modules.

Inverter

A power unit with transistors takes this DC voltage and generates a three-phase current with a variable frequency and voltage from it.

The module is also referred to as a Motor Module.

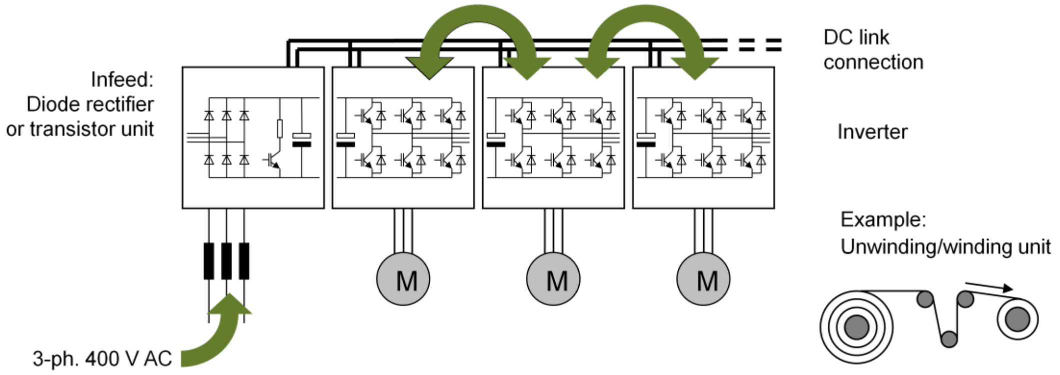
Closed-loop control

For open-loop and closed-loop control of these modules, a module is needed to handle the application requirements and control and regulate the modules accordingly.

Note

The diagram above shows the principle of how a converter works. Today, (almost) all converters for three-phase motors function according to this principle. Additional components such as reactors, fuses, braking resistors, etc., are not shown.

Fundamentals
Modular drive system



Advantages

1. Energy exchange between drives (braking/driving)
   Typical: Machine tools with multiple axes
   Typical: Unwinding unit (regenerative) and winding unit (motorized) combined
2. Joint use of DC link components (braking resistors, capacitor modules)
3. Only one connection to the line: lower costs for line-side components and their installation
4. Designs supported for controlled deceleration and retraction motions in the event of power failure

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Modular system

In a modular drive system, several modules of one type can be used in the drive system. For example, several inverters (Motor Modules) can be connected to a DC link.

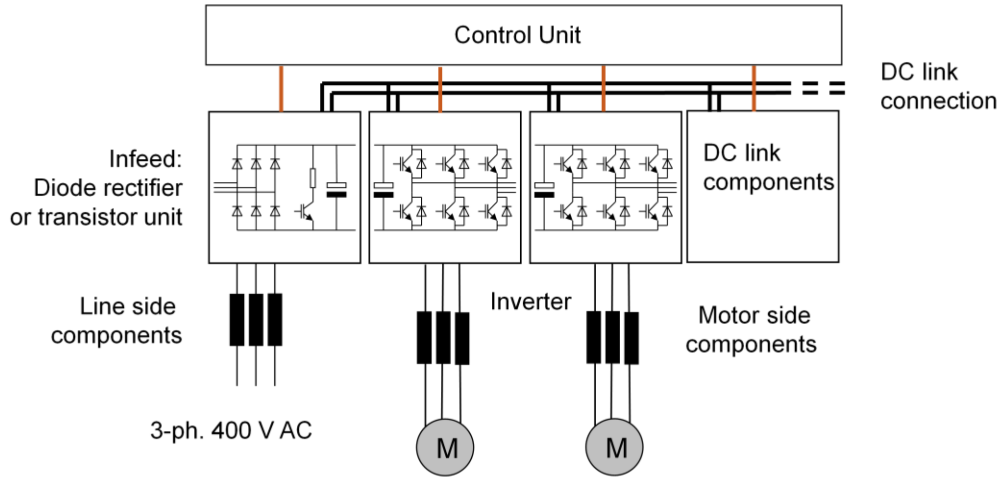
Energy exchange

Energy exchange can relieve the strain on the infeed/regenerative feedback unit; even then a diode rectifier may be sufficient.
Efficiency via the DC link connection is better than with energy exchange via the supply system. In the latter case, the power unit of an infeed/regenerative feedback unit would be involved in the process twice.

Retraction motion

With machine tools and production machines, individual axes may need to be retracted in order to protect tools or products in the event of a power failure.
Decelerating other drives (e.g. main spindle) means that energy is still available for active motions.
The following must be taken into account:

- What is the most inefficient operating instance with the lowest kinetic energy?
- The control electronics must still be supplied with power (differs according to the converter type)



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Control Unit The closed-loop and open-loop control unit is also referred to as the Control Unit. It controls and regulates the drive modules with which it exchanges data via a communication bus (DRIVE-CLiQ).

It is also the communication interface to the application. A speed setpoint, for example is connected here via an analog input or a PROFIBUS network.

Line-side components Line-side power components are fuses, contactors, reactors and filters, which are required for switching the energy supply and meeting EMC requirements.

DC link components DC link components are used optionally to stabilize the DC link voltage.

Motor-side components Motor side (output side) components are motor reactors or sine filters, for example.

SINAMICS overview
Various formats

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Flexible
built-in units for
high power ranges (Chassis)

Ready-to-use
cabinet units for
high power ranges
(Cabinet)

Modular
booksize units for
small and medium
power ranges

Compact
blocksize units for
small and medium
power ranges

Compact
booksize units for
small and medium
power ranges

Blocksize format Blocksize format units are optimized for single-axis applications and are supplied only as Power Modules. The CU310 Control Unit can be snapped onto them directly. The devices are cooled with an internal air cooling.

Booksize Compact format Derived from the Booksize format, we have developed the Booksize Compact format for machines that place particularly high requirements on the compactness of their drives. The Booksize Compact format is thus particularly suitable for integration into machines with high dynamic requirements and confined installation conditions.

Booksize format Booksize format units are optimized for multi-axis applications and are mounted adjacent to one another. The connection for the common DC link is an integral feature.

Chassis format Higher-output units (approximately 100 kW and above) are constructed in Chassis format. These are available as Line Modules, Power Modules and Motor Modules. Chassis format units are cooled by an internal air cooling circuit as standard. For special applications, e.g. for extrusion or marine applications, liquid-cooled devices can be ordered.

Cabinet format Ready-to-use cabinet units are available for largest power ranges.

Overview SINAMICS

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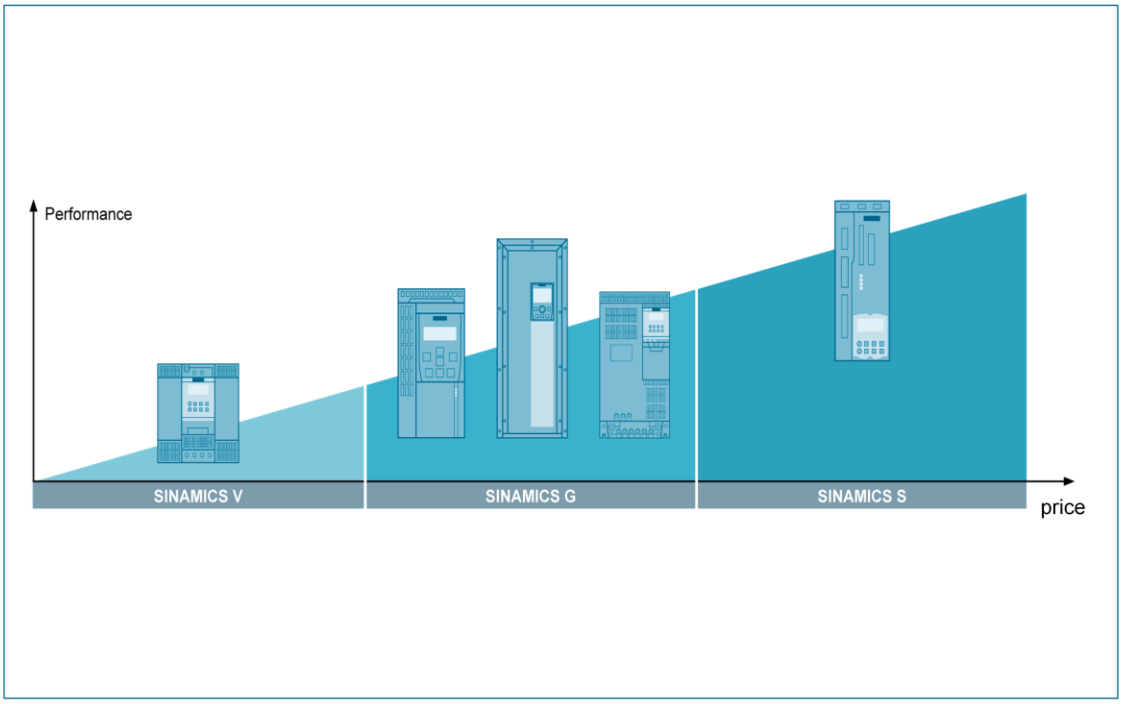

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SINAMICS V

These inverters focus on the essential issues, regarding both the hardware as well as the functionality. This results in a high degree of robustness – and at the same time low investment costs for the user.

Operation is directly at the inverter itself without having to use any additional engineering tools. SINAMICS V are especially suitable for applications that do not require any special drive know-how.

SINAMICS G

In operation, SINAMICS G inverters fully utilize their technological strengths. They are available from 0.37 kW up to 250 kW (0.5hp up to 400hp). Users benefit from their standard and straightforward operating concept. This minimizes training and service costs. And last but not least, SINAMICS G inverters are attractive as a result of optimum price-performance ratio.

SINAMICS S

SINAMICS S are predestined to address complex applications in plant and machinery construction – as well as for the widest range of motion control tasks. They set themselves apart as a result of an outstanding feature: the highest degree of standard and integrated engineering.

The drives family SINAMICS low voltage V and G

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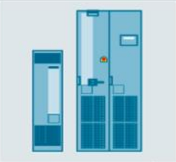
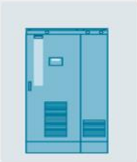
Low voltage				
Basic performance	General Performance			
				
V20	G120C/G120/G120P/ G120P Cabinet	G110D/G120D/ G110M	G130/G150	G180
012 .. 15 kW	0,37 … 400 kW	0,37 … 7,5 kW	75 … 2700 kW	2,2 … 6600 kW
Pumps, fans, conveyor belts, compressors, mixers, mills , Textile machines	Pumps, fans, compressors, conveyortechnology, mixers, mills and extruders G120:single axis positioining applications	G120D conveyor technology: single-axis positioning applications	Pumps, fans, conveyor belts, compressors, mixers, mills and extruders	Industry specific for pumps, fans, compressors, extruders, mixers, mills, kneaders, centrifuges, separators

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The drives family SINAMICS low voltage S, DCM and medium voltage

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Low voltage converters			Direct voltage	Medium voltage conv.
For Basic Servo applications	High Performance		DC applications	Applications with high outputs
				
S110	S120	S150	DCM	GH180/GM150/ SM150/GL150/ SL150
0,12 … 90 kW	0,12 … 5700 kW	75 … 1200 kW	6 kW… 3 MW	0,15 … 85 MW
Single-axis positioning applications for machine and plant engineering	Packaging and textile machines, printing presses, machine tools, plants, process lines, rolling mills	Test stands, cross cutters, centrifuges	Rolling mill drives, wiredrawing machines, extruders and kneaders, cableways and elevators, test stand drives	Rolling mill drives, wiredrawing machines, extruders and kneaders, cableways and elevators, test stand drives

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SINAMICS S120 overview
Optimized for single-axis and multi-axis applications

Modular drive system for single-axis and multi-axis applications					
AC/AC units for single-axis applications		DC/AC units for multi-motor drive applications			
Blocksize	Chassis	Booksize Compact	Booksize	Chassis	Cabinet Modules
0.12 – 90 kW	110 – 250 kW	0.9 – 9.7 kW	1.6 – 107 kW	110 – 1200 kW	1.6 – 4500 kW

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AC/AC devices

On AC/AC devices, the infeed and motor power supply functions are combined in one device, the Power Module – available in Blocksize and Chassis formats.

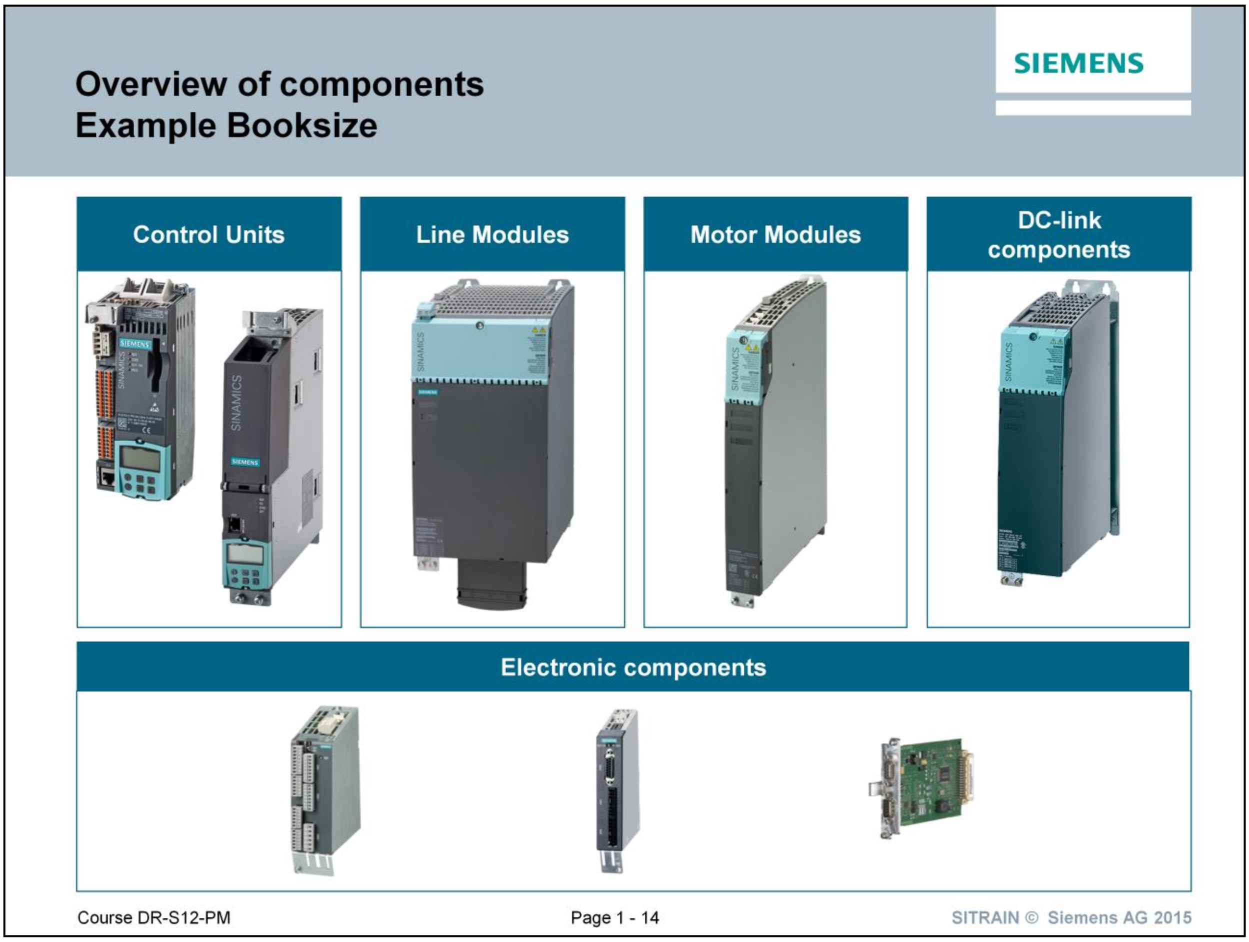
For single-axis applications, drive control functions are performed by a special Control Unit (CU310) mounted on the Power Module and for multi-axis applications, by a Control Unit (e.g. CU320) connected by a DRIVE-CLiQ link. In this case, a CU adapter is mounted on the Power Module in place of the Control Unit.

DC/AC devices

DC/AC devices (= Motor Modules) – available in Compact Booksize, Booksize and Chassis formats – are characterized by their modular design.

SINAMICS S120 Cabinet Modules are components forming part of a modular cabinet system for multi-motor drives with a central line infeed and a common DC busbar of the type typically used in, for example, paper-making machines, roller mills, test stands, or hoisting gear.

As standard, they are installed side by side in a row. Other installation types (e.g. back-to-back) are possible on request.



CU320-2 For open- and closed-loop control of the drive units. A Control Unit CU320-2 can be used to couple up to several drives via Single and Double Motor Modules. The number of drives is dependent on the mode.

CU310-2 CU310 Control Units are designed to control a single drive. They feature as standard a PROFIBUS interface (CU310-2 DP) or a PROFINET interface (CU310-2 PN) and a TTL/HTL or SSI encoder evaluation.

Line Module Line Modules generate a DC voltage from the line voltage and supply Motor Modules with energy via the DC link. A distinction is made between the Basic, Smart and Active Line Modules.

Motor Module Motor Modules are responsible for the power unit of the individual drives. A distinction is made between

- Single Motor Modules for one drive
- Double Motor Modules for two drives

In principle, all Single and Double Motor Modules can be operated on Basic Line Modules, Smart Line Modules or Active Line Modules for the appropriate voltage range.

A wide range of single-axis and two-axis Motor Modules with graded current/ power ratings can be supplied.

DC link components DC link components are available as Braking Modules, braking resistors, Capacitor Modules and Control Supply Modules. The DC link components also allow the implementation of multi-line constructions.

Electronic components Further digital and analog inputs/outputs can be connected to the system using the expansion components. Functions such as measuring probes or output cams can be implemented.

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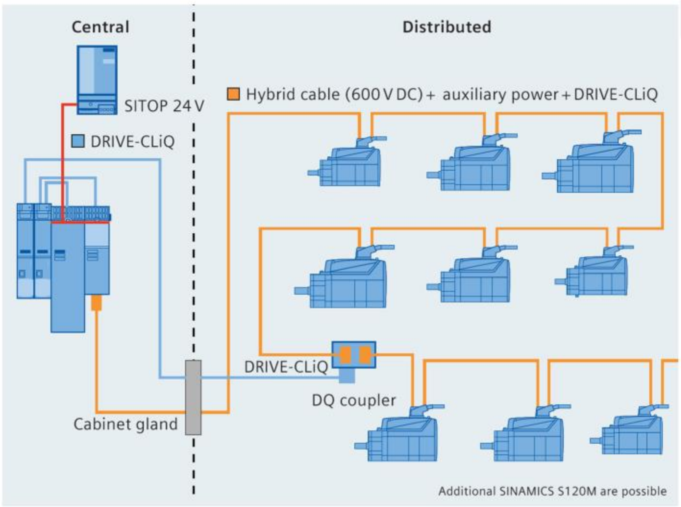
SINAMICS S120M

Components

AM600 S120M

Hybrid cable

Topology overview



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S120M The S120M is a servo motor in the IP65 degree of protection with integrated Power Module

- With/without holding brake

- Absolute encoder with 20-bit resolution per revolution or 12-bit multiturn

- The SINAMICS S120M is connected using a hybrid cable (power supply and bus line for closed-loop control) to the Adapter Module 600 of the SINAMICS S120 central drive system. The open- and closed-loop control of the S120M is also made from the central drive system.

AM600 The Adapter Module 600 (AM600) is the interface between the central SINAMICS (Booksize) components and the S120M integrated in the motor. The AM600 is implemented in the Booksize Compact format with 75 mm module width and opens a line of distributed S120M drives. Correspondingly, the DC-link connections, the 24 V electronic power supply, the status LEDs, the DQ sockets and the terminal strips are arranged and labeled similarly

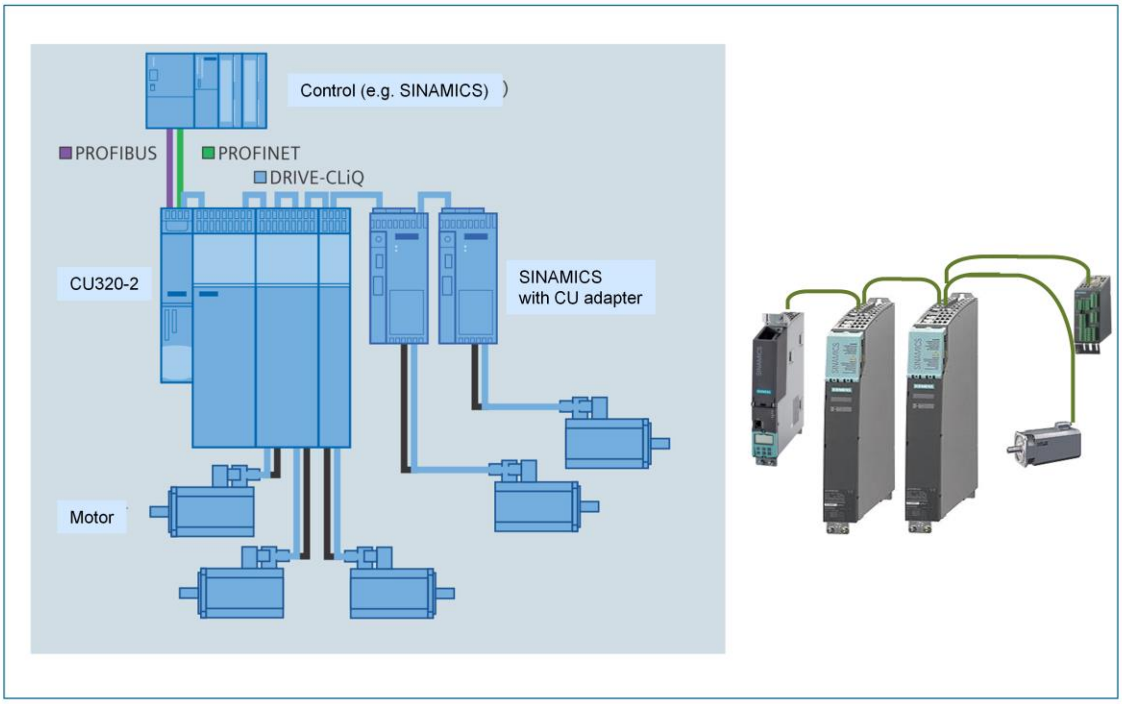
Hybrid cable The pre-assembled hybrid cable already contains the signal and power cable in a single cable. This reduces the time required for the wiring and for cutting cables to length.

- Maximum permissible line length per Adapter Module 600: 100 m
- Segment length between an AM600 and the first node: ≥ 3 m ... ≤ 75 m

Segment length between two S120M: maximum 75 m

The complete cable length of the motor + hybrid cable depends on the central power infeed (Line Modules)

Communication among components DRIVE-CLiQ



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Communication

The communication between the Control Unit and the individual components of the drive system is carried out via DRIVE-CLiQ, an Ethernet-based communication protocol.

DRIVE-CLiQ

The internal drive communication has the following properties and features:

- Connects all components including motors and encoders.
- Implements the connection of drive-related I/Os and encoder systems integrated in the motor.
- Encoders in DRIVE-CLIQ motors are powered via a 24 V supply integrated in the cable.
- Uniform design of cables and connectors reduces part diversity, storage costs and commissioning work.

Overview of motors
Spectrum of motors that can be used

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SIMOTICS S Servo motors	SIMOTICS M Main motors	SIMOTICS L Linear motors	SIMOTICS T Torque motors	Motor spindles
• SIMOTICS S-1FK7 • SIMOTICS S-1FT7	• SIMOTICS M-1PH8 • SIMOTICS M-1FE1	• SIMOTICS L-1FN3 • SIMOTICS L-1FN6	• SIMOTICS T-1FW3 • SIMOTICS T-1FW6	Motor spindles and spindle drives for machine tools

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Motor spectrum

Not only Siemens motors, but also third-party motors, can be connected to SINAMICS.

SINAMICS S120 is optimized for the operation with Siemens motors.

Preferred motors for production machines:

- 1F synchronous servo motors
- 1PH asynchronous servo motors

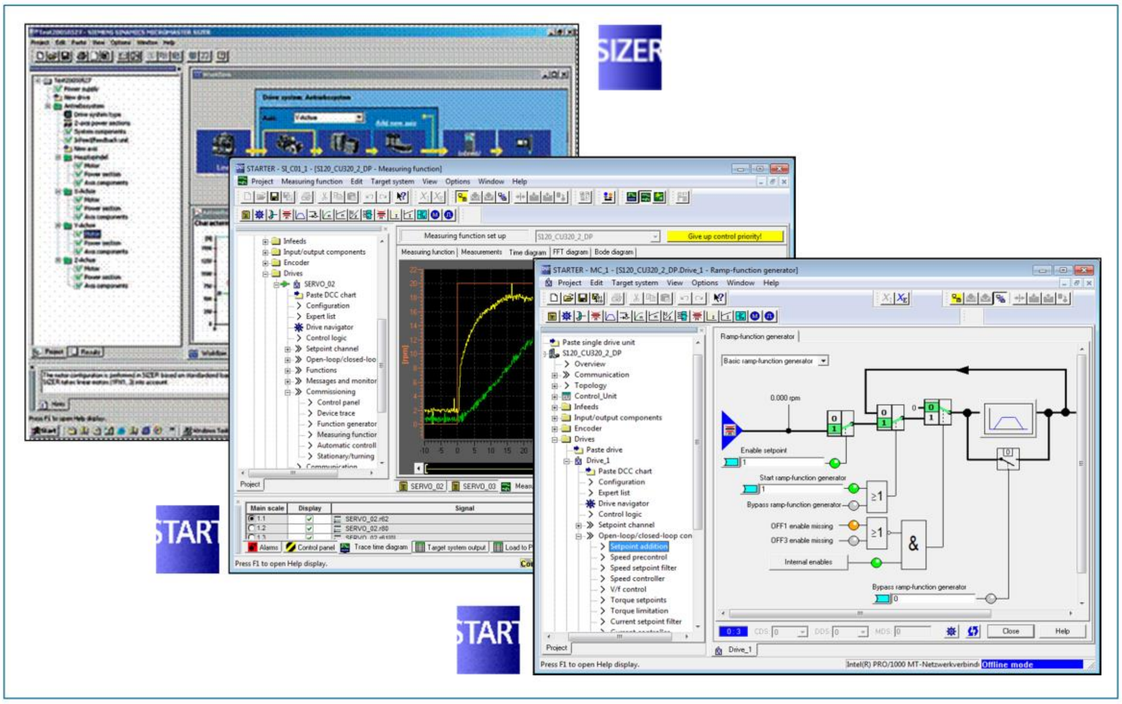
Innovative machine solutions with

- 1FN linear motors
- 1FW torque motors (e.g. for extruders, rotary tables or servo presses)

Rating plate data

With SINAMICS S120, it is also possible to use third-party motors. Only the rating plate data needs to be entered for induction motors. The system can determine the remaining data using stationary or rotating measurement.

STARTER engineering system



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SIZER This tool will support you during the technical configuration of the hardware and software components required for automation including calculation of the load machine.

The results can be exported in different formats for order processing or documentation.

In a future version, the data of the STARTER service tool will also be supplied with the information from the SIZER project.

For detailed specification of low-voltage standard motors, the SIZER can incorporate the DT configurator.
Furthermore, the MOTOX gear designer can be used for standard gear motors.

STARTER The STARTER standalone tool is provided for easy, guided, graphics-oriented start-up of the SINAMICS and MICROMASTER drive units; it is also integrated in the SIMATIC Manager as part of DriveES Basic.

The tool also allows high-level expert access with comprehensive diagnostics and trace functions.

Safety information for our course participants

General safety

- For safety reasons, course participants have access only to those areas, especially in the course room, for which an instruction has been given
- In the event of an emergency, they must follow the instructions issued by their trainer and the Training Center personnel
- If the building has to be evacuated, follow the emergency exit signs (emergency exit lights)
- In an emergency, please use the emergency number, which your teacher gave you or which can be found in the training room.
- Please familiarize yourself with the location of the fire extinguishers, wall hydrants and Emergency Off buttons.
- Please report any accidents that happen on the way to the Training Center or during course attendance to the Course Office or to your trainer.
- All equipment and tools used by the course participants must be in correct working order; please report any faulty equipment to the trainer.

Safety information for our course participants

Safety at the units

- Please exercise extreme caution when working on devices or parts that are under voltage (e.g. when checking/testing the 600 V DC link voltage)!
- It is only permissible to use insulated tools/equipment.
- DC link capacitors have discharge times of up to 4 minutes. You must not resume operation before this time has elapsed and you have carried out a test to ensure that they are discharged, as the discharge resistors might be faulty.
- The exercises must never be carried out alone. At least one other person must be present.
- When working on the training equipment, please exercise caution with rotating parts (motor shafts, etc.). It is only permissible to work without protective cover if the control is switched off (Emergency Off).

Caution !!
High voltages

Caution !!
Rotating parts

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Exercises

- Exercise 1: Become acquainted with the training equipment

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Safety information

Please note that:

- The course exercises have been produced for:
  - A course held by the course leader
  - Activities carried out on special training equipment
- The training equipment is operated under laboratory conditions.
  In case of doubt, always ask your course leader – particularly when handling components that carry electrical current or can move.
- When carrying out work on equipment, the safety information in the associated product documentation must always be observed!
  The Training Documents alone are not sufficient.

Exercise 1: Structure of the training equipment
Which components?

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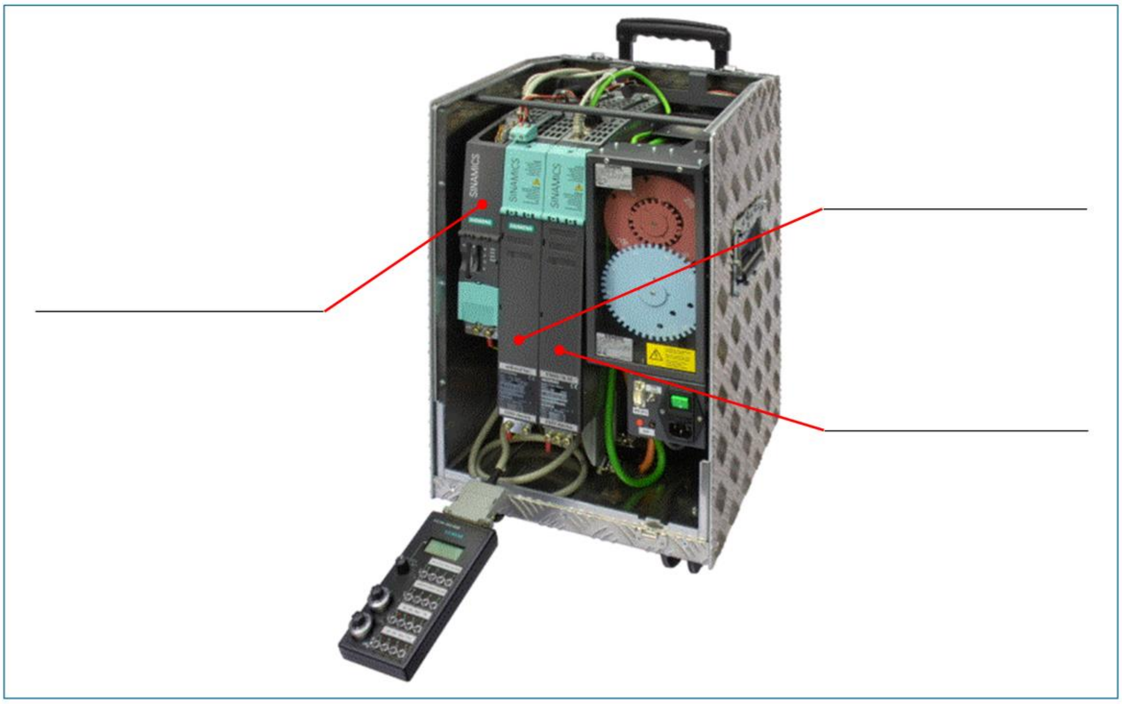

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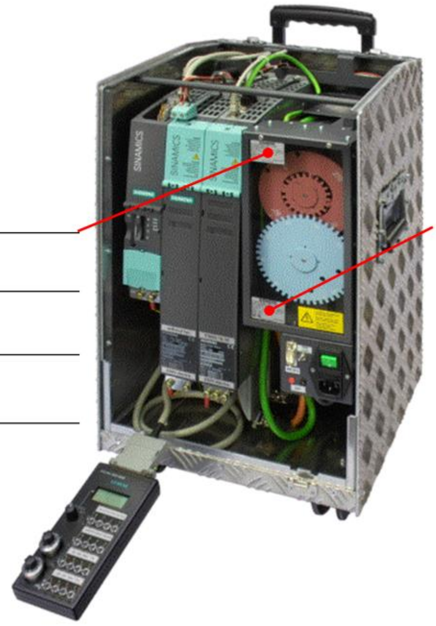
Task Familiarize yourself with your training equipment. Determine which components of the SINAMICS S120 system are installed.

1. Enter the components determined for the SINAMCIS S120 converter system above.
   Order numbers are not necessary.

Exercise 1: Structure of the training equipment
Which motors?



Type	Type
n_{Rated}	n_{Rated}
M_{Rated}	M_{Rated}
I_{Rated}	I_{Rated}

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Task Determine which motors are installed.

1. Enter the data for the motors installed above.
   Order numbers are not necessary.

2. Also clarify which encoder is installed.

Exercise 1: Structure of the training equipment
Which connections?

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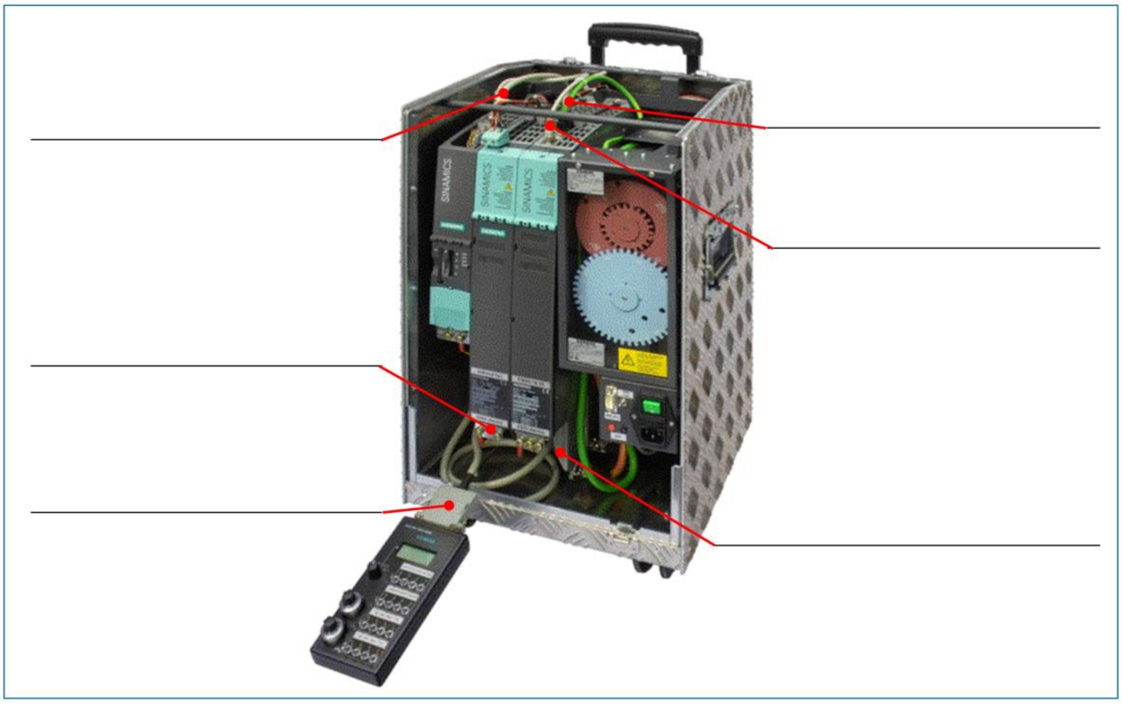

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Task Gain an overview of the electrical wiring.

1. Determine the most important connections:
   - Where is the line infeed connected?
   - Where are the motors connected?
   - Where are the encoders connected?
   - Where is the connection between CU 320-2 and Line Module?
   - Where is the connection between CU 320-2 and Motor Module?
   - Where is the switch box connected?

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Chapter 2

STARTER project structure

Course DR-S12-PM

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Learning Targets

- You will become familiar with the basic operating procedures of STARTER
- You will become familiar with the procedure for project creation
- You will become familiar with the project structure with objects and components
- You will be able to create an offline project using the wizard

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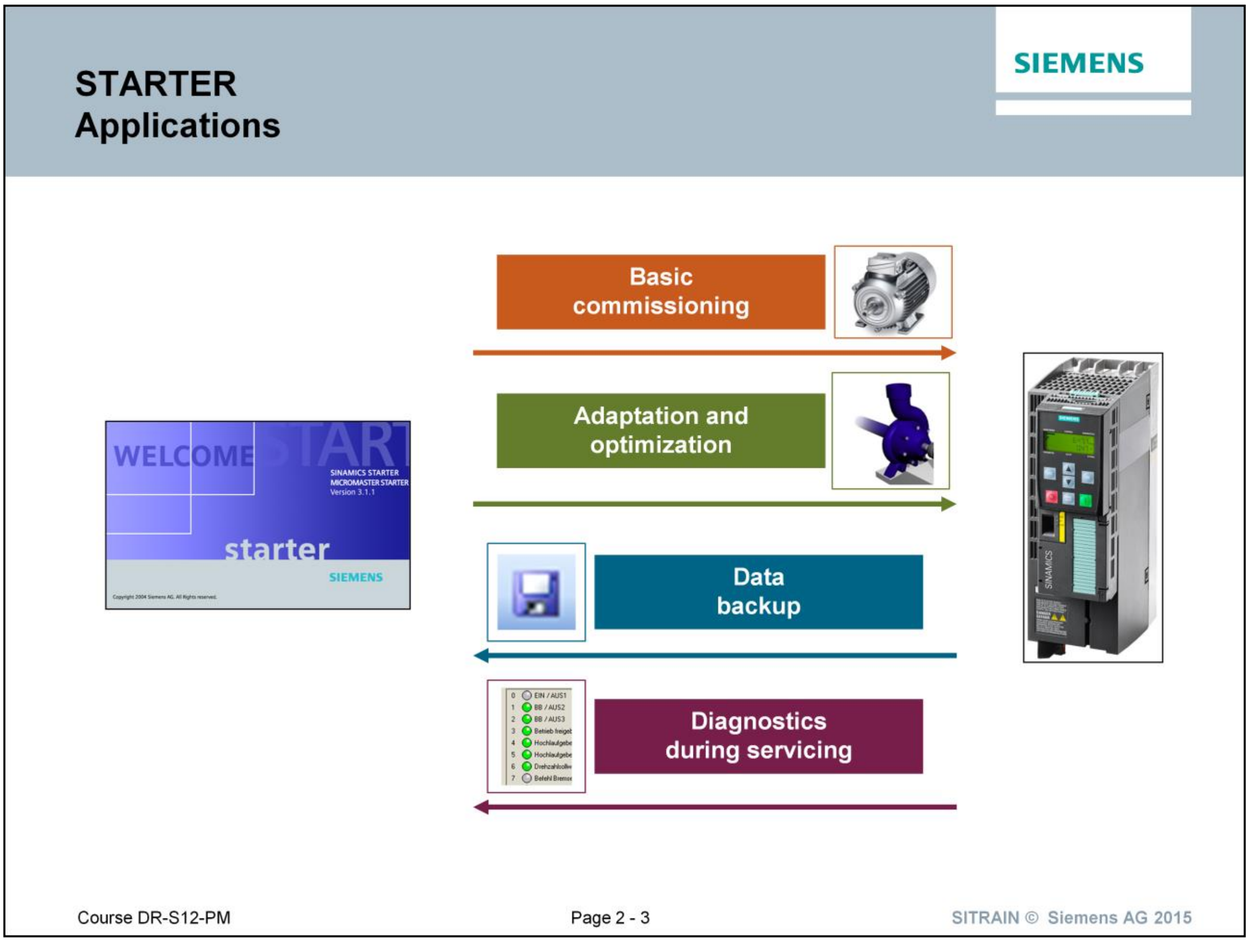
STARTER	A user-friendly and powerful PC program is available for commissioning. With STARTER, every inverter of the SINAMICS family can be parameterized largely in the same way.
Wizards	The drive is inserted in STARTER in the form of a project. Creation of the project and insertion of the correct drive type is simplified by a wizard.
Offline configuration	When going through the configuration, primarily the motor data, encoder data and the interface assignment are entered.
Online commissioning	Commissioning is carried out in online mode.
Control panel	Using the control panel, the drive can be switched on and off for test purposes directly from the PC. The speed setpoint is specified by the slider. Actual values are clearly displayed.



Application

The user-friendly STARTER drive/commissioning software can be used for:

- Commissioning
- Optimization
- Diagnostics

Integration

This software can either be operated as a stand-alone PC application or it can be integrated into the SCOUT engineering system (with SIMOTION) or STEP 7 (with Drive ES Basic). The basic functions and handling are the same in both cases.

STARTER
Sourcing options

All the information on the STARTER commissioning software

Download the current version:

- http://support.automation.siemens.com/WW/view/en/10804985/133100
- approximately 2 GB of data

Ordering the current version:

- Order No. (DVD): 6SL3072-0AA00-0AG0
- Online ordering in the Industry Mall: https://eb.automation.siemens.com/

Information on STARTER:

http://www.automation.siemens.com/mcms/mc/de/software/ibn-tool-starter/Seiten/ibn-tool-starter.aspx

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Download The current version can be downloaded directly from the Internet. Please note the capacity of your Internet connection. The data package is approximately 2 GB.

Purchase via DVD If an Internet download is not practicable, STARTER can also be ordered on DVD. A fee is charged for this.

STARTER
Work areas overview

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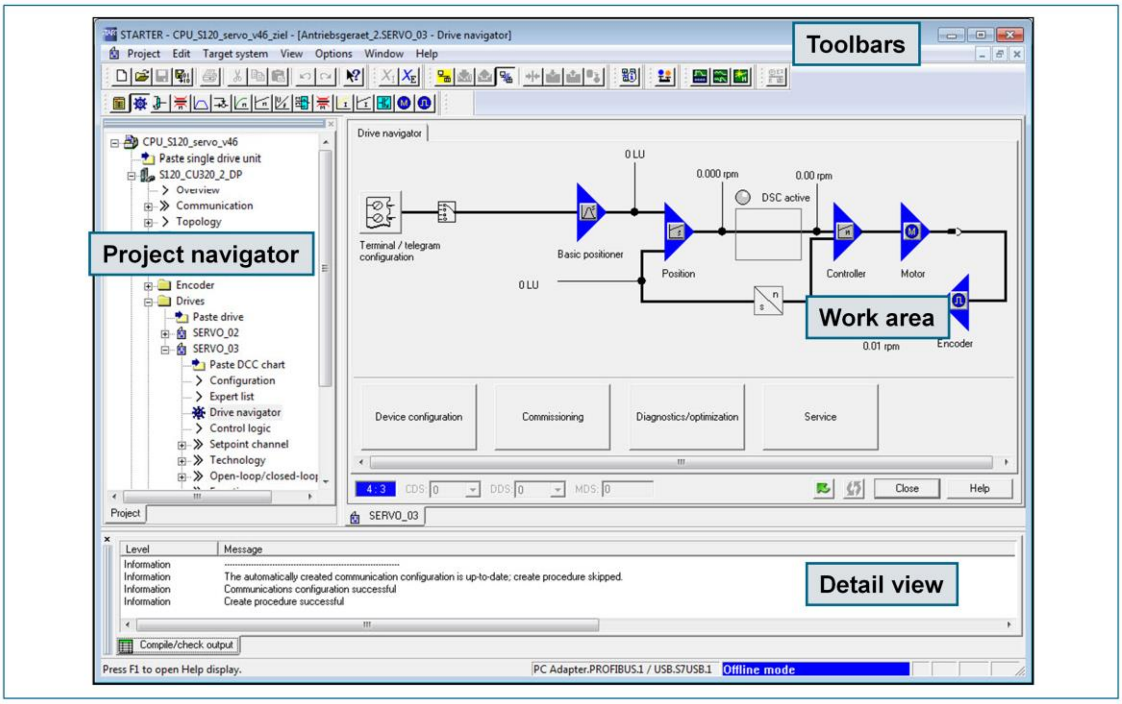

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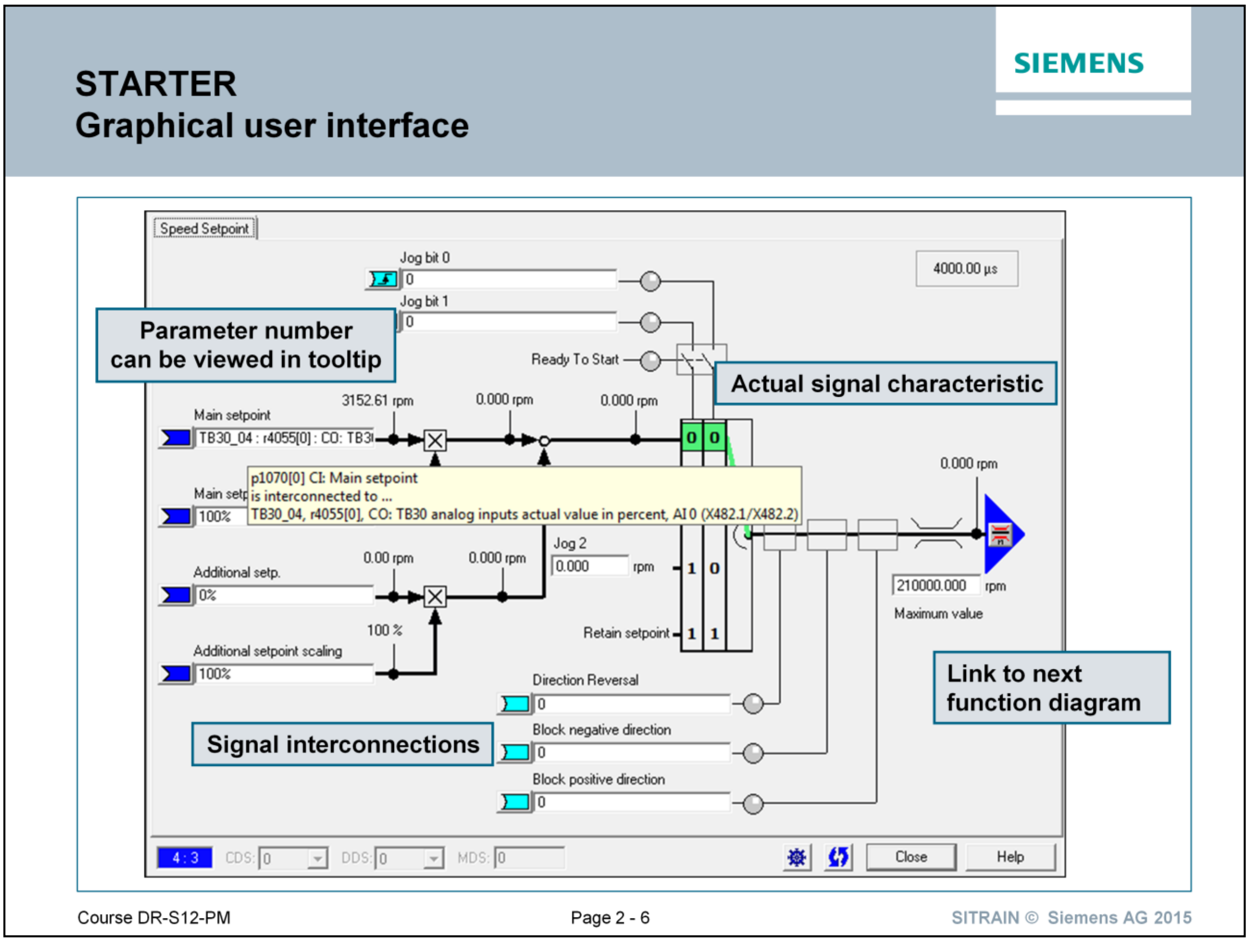
Project navigator The project navigator displays an overview of all other elements contained in the project. All defined elements are displayed in a tree structure.

After selection of an element, the detail view displays additional information about the selected element.

Toolbars Frequently used menu commands are available in selectable toolbars, thus allowing quick access to the associated functions. The toolbars can be dragged from the header and positioned anywhere on the screen.

Work area The task-specific windows are displayed here. The actual tasks, e.g. configuring and programming, are performed in these windows.

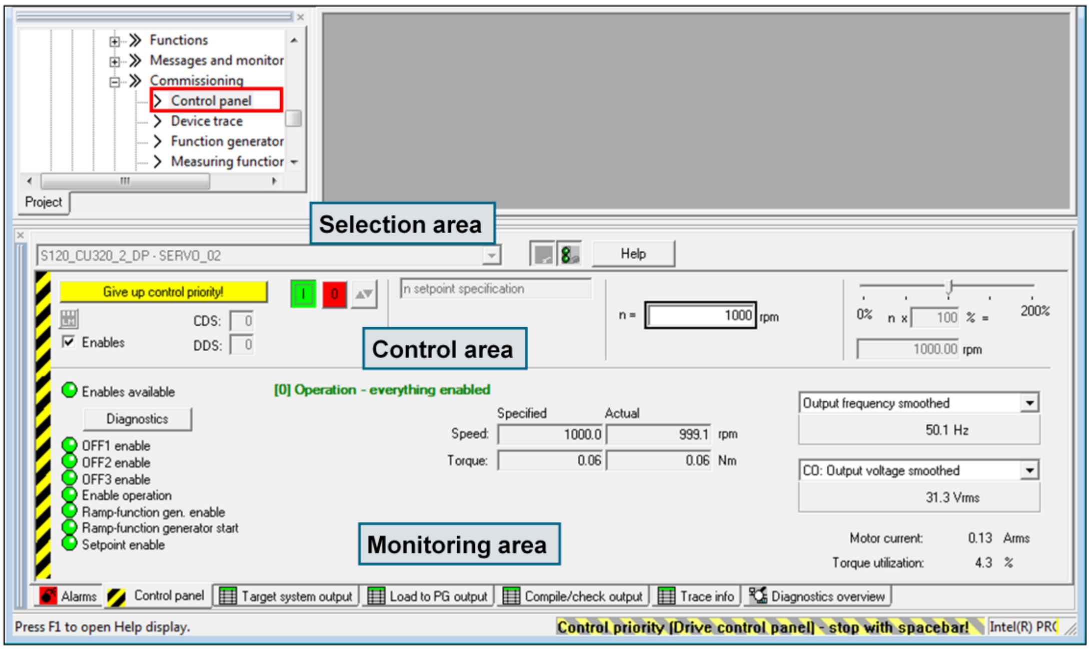
Detail view Further information for example about the the status of the connection to the target device and if online about the faults and alarms of the the target device are displayed in the detail view.



Graphical user interface

STARTER's graphical user interface represents signals and their characteristics and interconnections in a way that makes them easy to understand.
Functions and input values are specified in plain text. Parameter numbers play a subordinate role, but can be viewed if necessary using mouseover and tooltip.

STARTER control panel



Control panel

The control panel is used for the control and monitoring of individual drives. Drives can be operated with the control panel. This allows the commissioning engineer:

- To test each part of the plant individually before the drives are traversed in coordination by means of a program.
- To test, in a fault situation, whether the individual drives can be traversed by the control panel at all, or whether these are also affected by the fault.

Selection area

In the selection area of the control panel, you can select the drive you want to monitor from the selection list in monitoring mode.

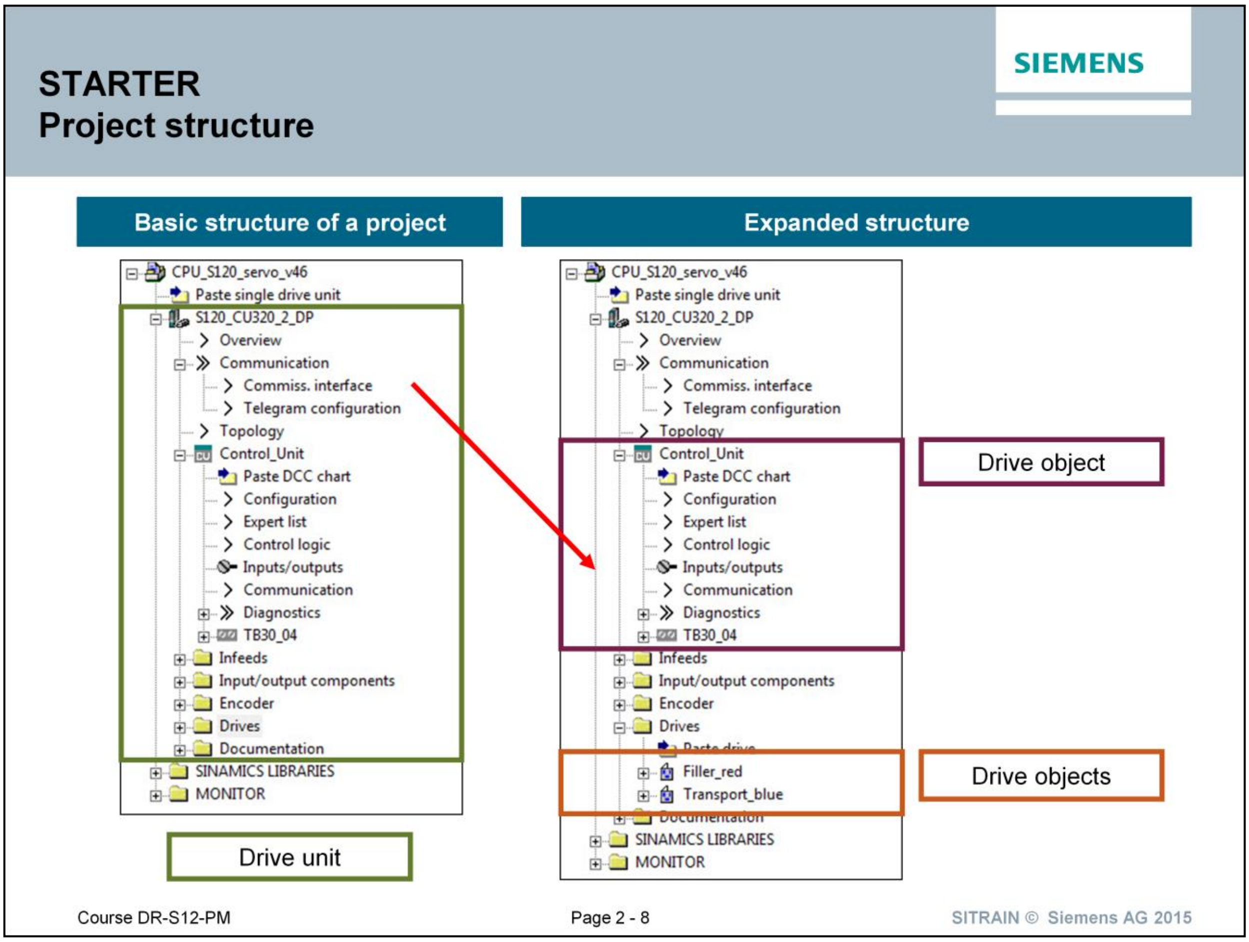
The selection list is not available in control mode.

Control area

You can assume control priority of the selected drive and send motion commands to the drive here.

Monitoring area

Displays the enables, setpoints and actual values of the drive selected in the selection area of the control panel.



Project structure

The project navigator has a tree structure and manages hierarchically the individual elements of a project.

The project is made up of drive units, a directory for the SINAMICS libraries and a "Monitoring" directory. The drive units are made up of drive objects, which in turn consist of individual components.

Drive unit

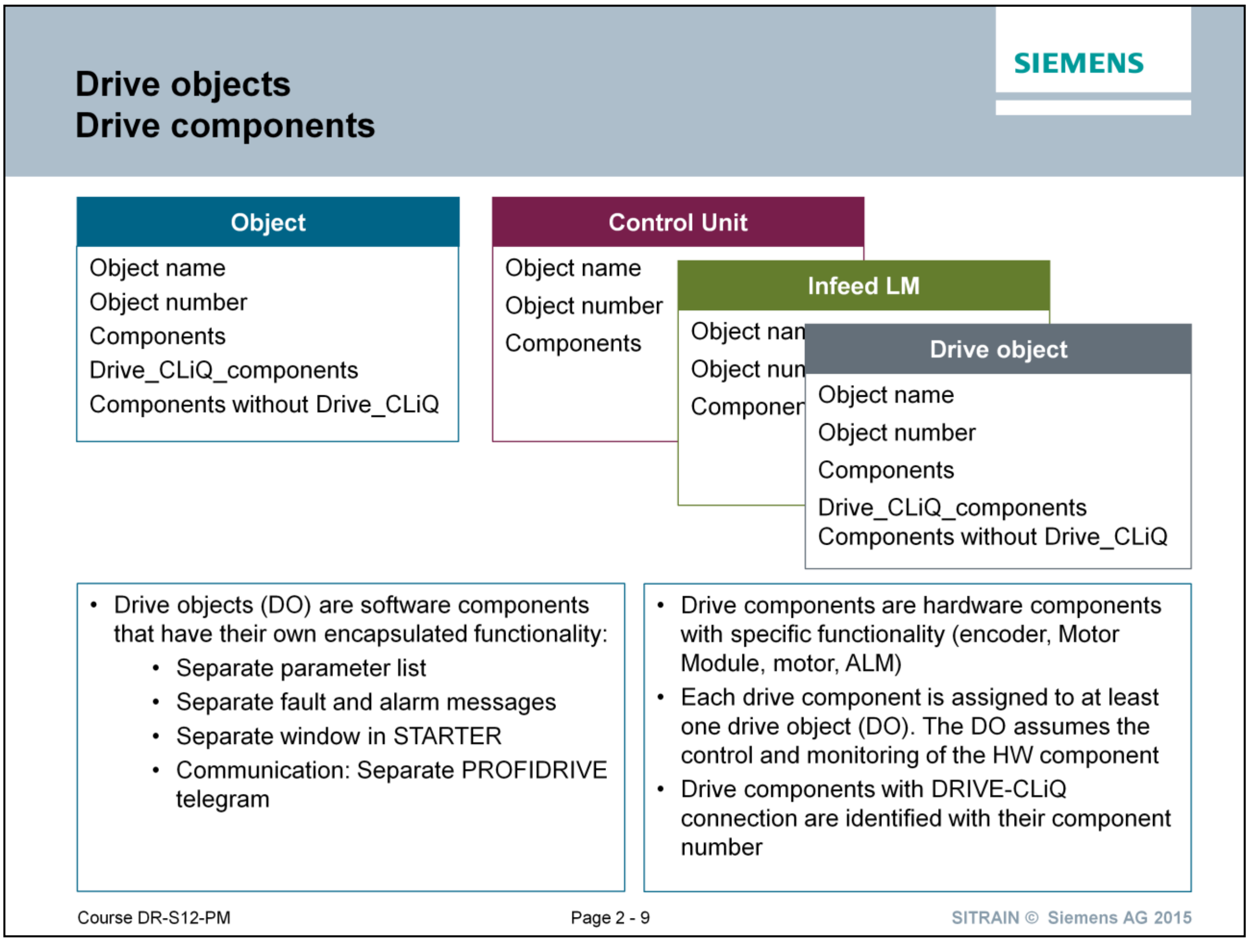
The drive unit consists of a Control Unit and further drive objects.

The project tree shows the drive units (e.g. SINAMICS_S120) and drive objects (e.g. CU_S_004, Filler_red, Transport_blue, etc.).

The drive components can be viewed under Configuration.

The project tree also shows the following in the drive units:

- Automatic configuration (only in online mode)
- Overview (of drive objects)
- Communication
- Topology
- Documentation



Drive unit

A drive unit consists of a Control Unit and several components that are combined to form drive objects in STARTER.

Drive object

A drive object (DO) is an independent, "self-contained" software function that has its own parameters and, in some cases, its own faults and alarms. Drive objects can be provided as standard (e.g. evaluation of inputs/outputs), or you can add single (e.g. Terminal Board) or multiple objects (e.g. drive control).

Overview of the drive objects:

- Drive control

  The drive control handles closed-loop control of the motor. At least 1 Motor Module and at least 1 motor and up to 3 encoders are assigned to the drive control.
- Control Unit with inputs/outputs
- Infeed: Line Module infeed control with DRIVE-CLiQ interface
- Option Board
- Terminal Module
- External encoder

Each installed drive object is allocated a number between 0 and 62 during first commissioning for unique identification.

Components

Components are hardware modules that are assigned to drive objects in the STARTER.

Drive objects
Names and numbers

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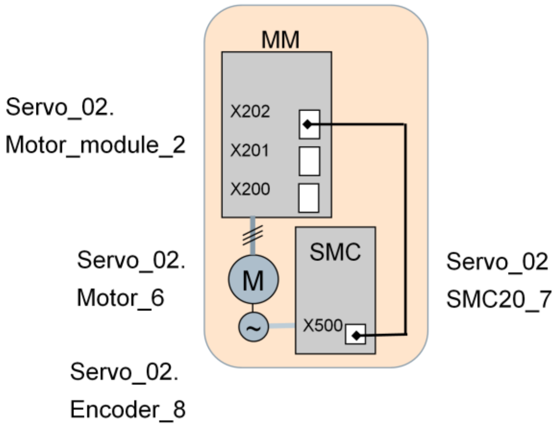
Drive object

- Object name: servo_02
- Object number: 02
- Components
- Drive_CLiQ_components
  - servo_02.motor_module_2
  - servo_02.SMC20_7
- Components without Drive_CLiQ
  - servo_02.motor_6
  - servo_02.encoder_8



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Drive object

The drive object receives a number and a name in the configuration. These names can be changed in the offline project.

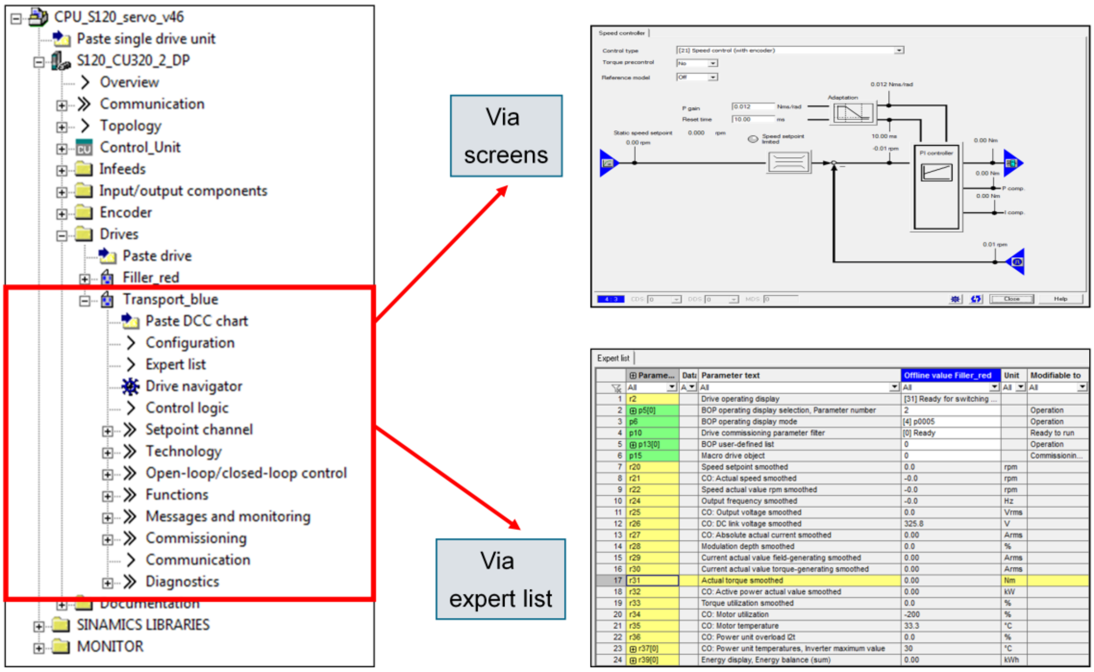
The components that are assigned to the particular drive object are also designated by a name and a number.

A drive object (drive control) includes:

- a power unit (Motor Module)
- a motor
- an encoder
- an encoder connection to DRIVE-CLIiQ.

The components are designated by pre-assigned names, e.g. servo_02.motor_6.

Drive objects
Parameter assignment via screens, expert list



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DO configuration

You must perform several steps before you can use the DO. In the first step, the configuration creates an instance of the DO. A DO is configured with the STARTER engineering system. You are supported by the corresponding Wizards (parameterizing screens) to create an object and configure it.

A double-click on "Paste drive" adds a DO to the Drives directory in the project navigator. The drive wizard then automatically starts and helps the user create the base configuration of a drive.

Certain object-specific properties are determined in the first configuration (e.g. Servo, Vector, Motor Module, motor, encoder).

Parameterization screens

Further settings, such as the gain factors for the speed or current control loop, can be made from the appropriate parameterization screens. Below each DO there is a project tree with setting screens that support configuring engineers and commissioning engineers with their work. Each input in a parameter screen results in the input or change of a parameter in the expert list.

Expert list

In addition to access to the parameters via the wizards and parameter screens, you can also access the data directly via an expert list.

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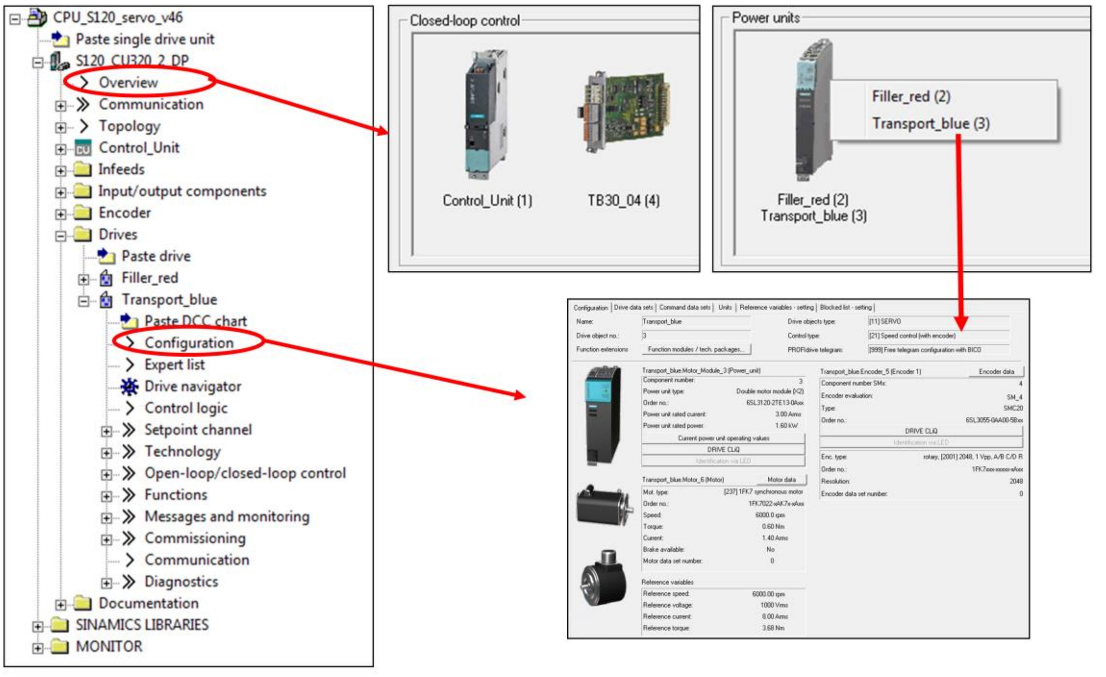
Drive objects
Overview and navigation to drive objects



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Overview Double-click "Overview" to open the Overview window of the drive system. The following drive objects are displayed in this window:

Closed-loop control This window displays the "Control_Unit" object and the configured option module of the drive system.

Power units Shows the configured infeeds and drives of the drive system. For infeeds connected in parallel, only one button is displayed.

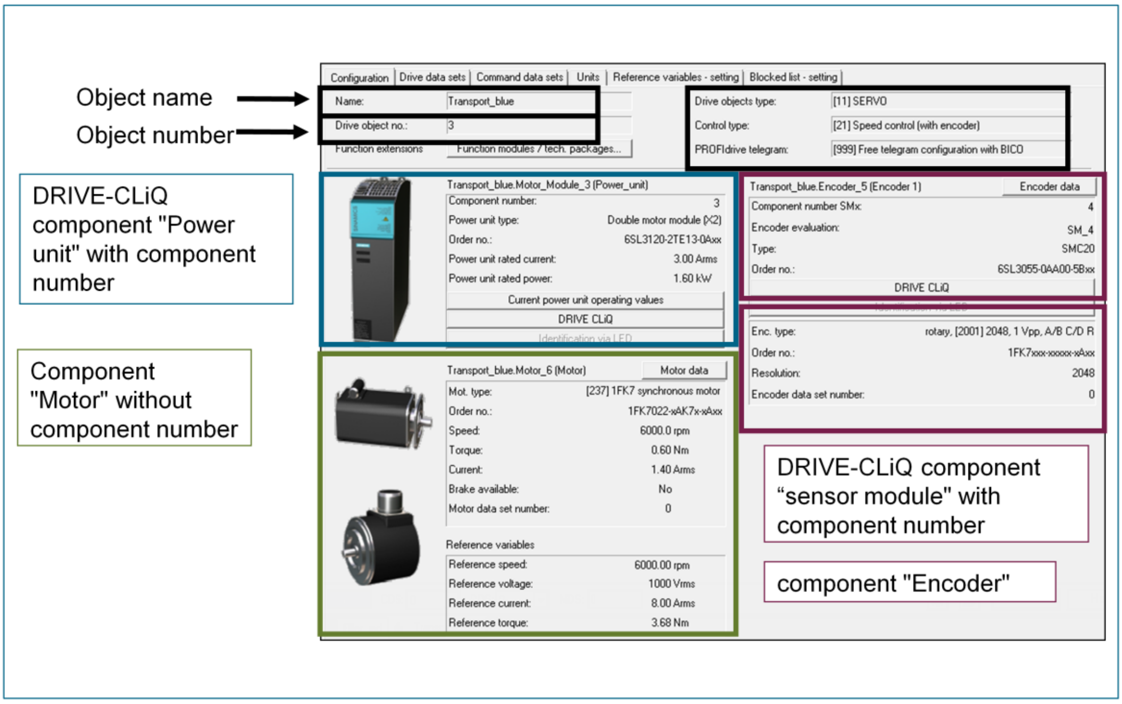
Input/output Displays the configured input/output modules of the drive system.

Options Displays additional optional modules.

Navigation Click the corresponding module icon to open the configuration window of the desired drive object.

The name of the drive object and the object number are displayed in this window as well as all assigned drive components complete with the associated component numbers.

Drive objects
STARTER information about objects, components



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Drive object

Information about the drive object and assigned drive components is displayed in the configuration window associated with a drive object.

The object name (e.g. "Drive_1") and the associated object number (e.g. "2") are displayed for the drive object. The most important information about this object is also displayed:

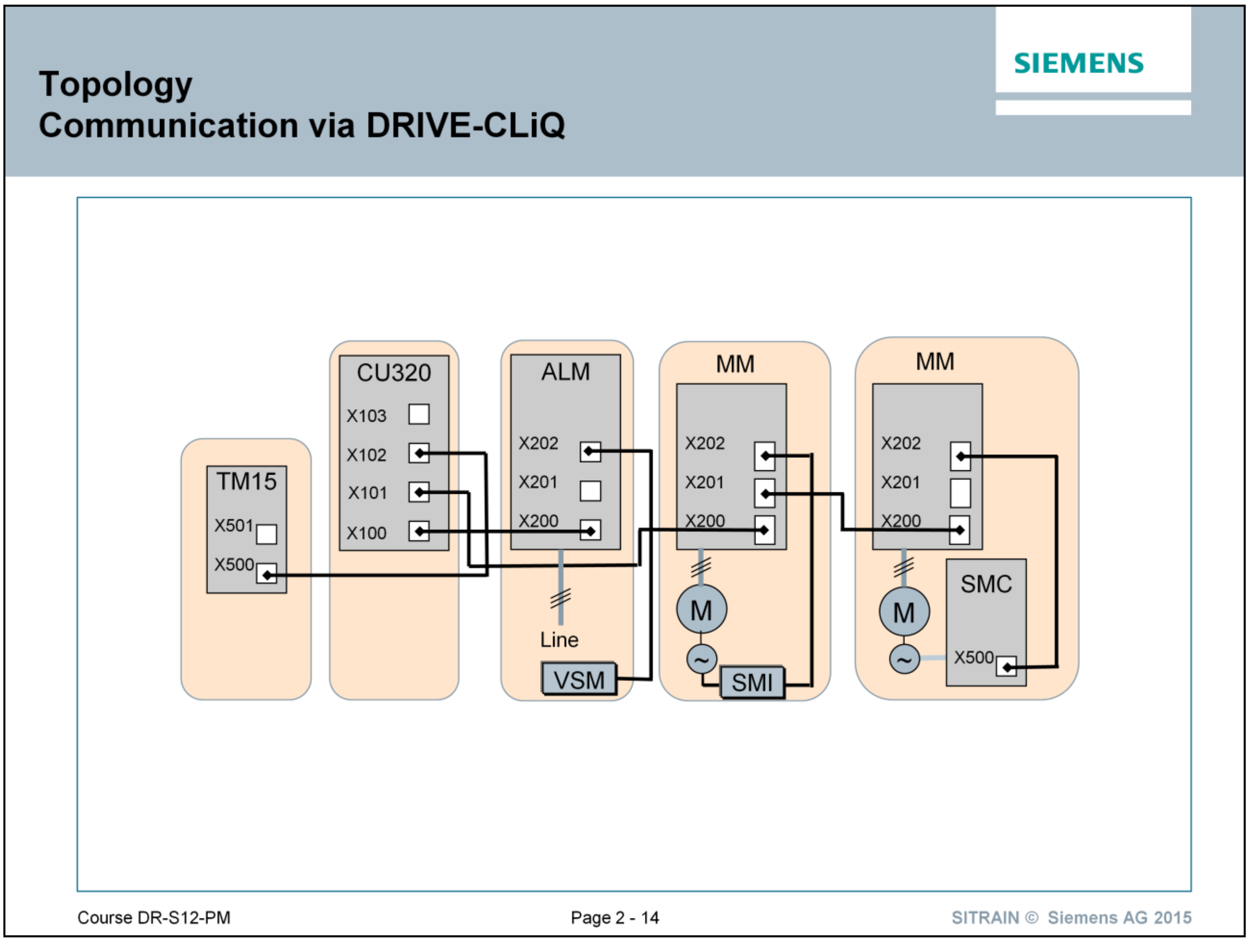
- Drive type (e.g. SERVO)
- Control type (e.g. speed control with encoder)
- Communication with technology via SIEMENS telegram 105

Drive components

Properties of drive components

- All drive components, such as power units, motors, encoder systems and SMI, SMC, are identified with their associated component numbers.
- For drive components with DRIVE-CLiQ connection, the component number is displayed in this overview. Drive components without DRIVE-CLiQ connection are displayed without component numbers in this overview. The numbers of these components are, however, displayed in the "Configuration -> Version overview" window.
- For components with DRIVE-CLiQ connection, a detection for active online connection can be performed via a flashing LED.

The most important characteristic quantities are displayed for all components.



Communication Communication between the drive units and/or components and the Control Unit takes place via the DRIVE-CLiQ connection.

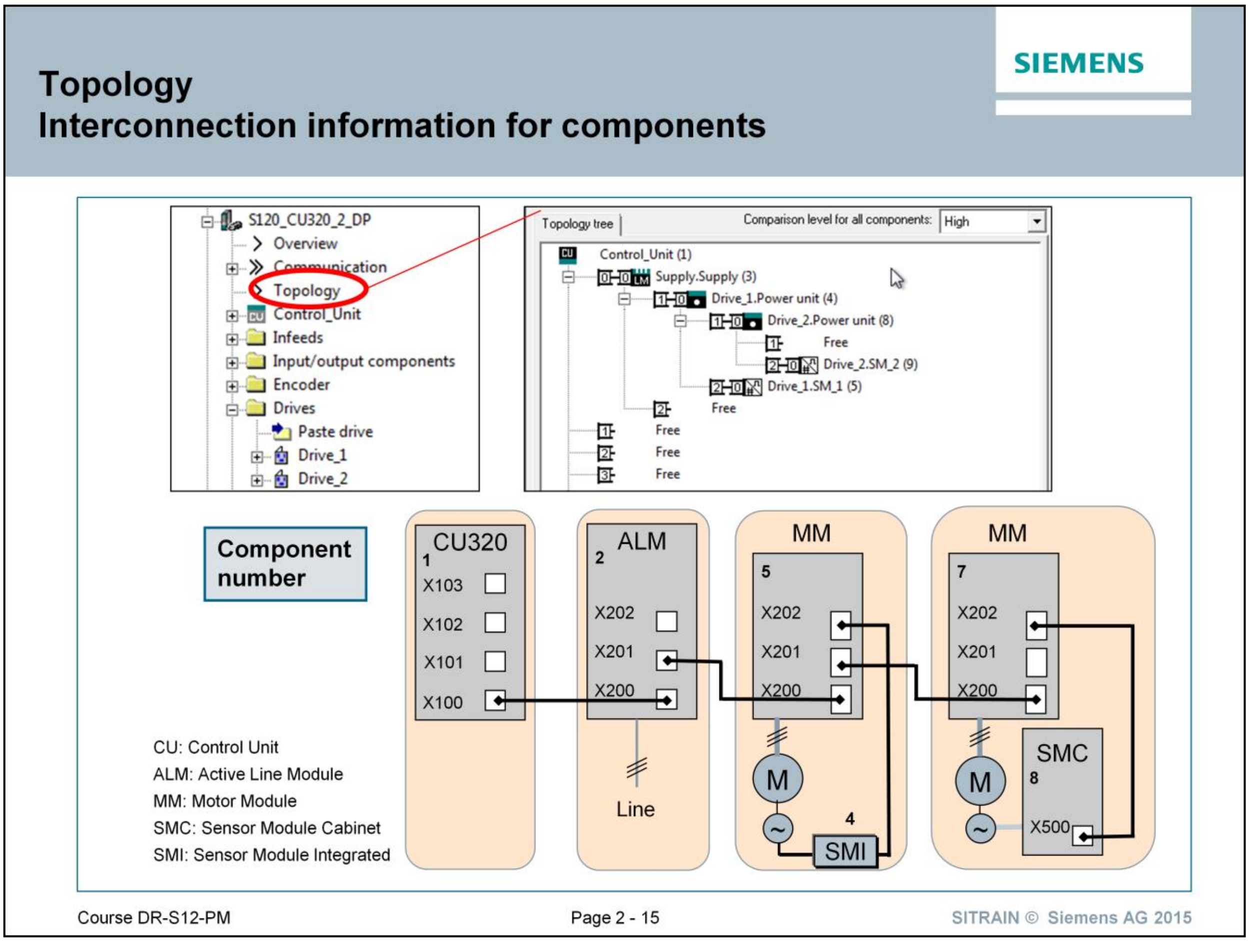
Number of ports Each component capable of communication has one or more ports for connection of the DRIVE-CLiQ connector.

In this way, all components can be connected with the Control Unit via different communication paths.

For example, the number of ports for

- Control Unit: 4 ports
- Active Line Module: 3 ports
- Motor Module: 3 ports
- Double Motor Module: 4 ports
- SMC: 1 port
- Terminal Module: 2 ports

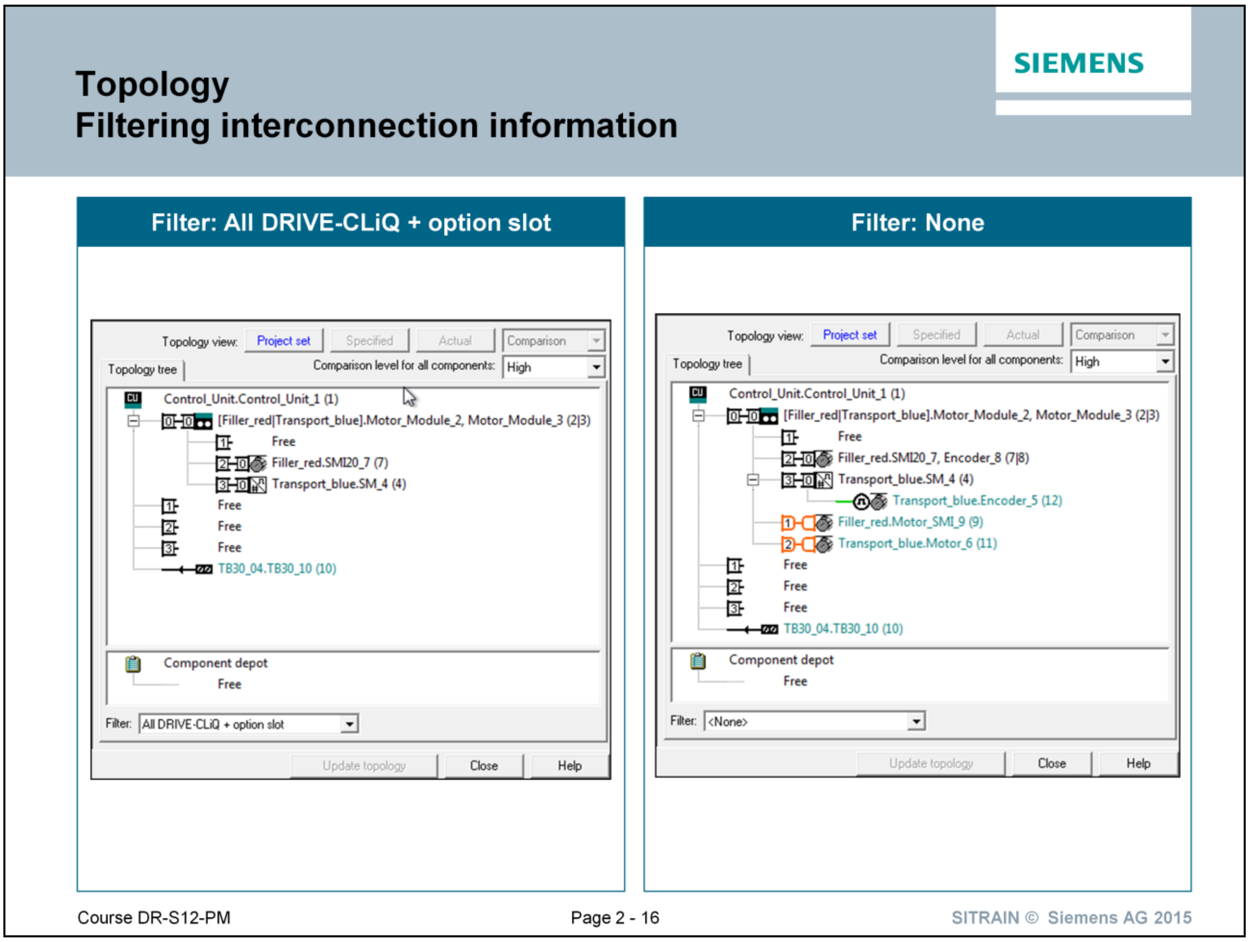
Topology The component wiring is shown graphically in the topology.



Structure of topology The topology is shown as a wiring tree. The Control Unit is the first element of the tree. All components are attached to the CU. The terminal designations correspond to the last digit of the port designation. For example, [0] stands for port X100. The port designations can be picked off via the tooltip.

Component number The name of the component (object name.component_name) is also indicated in addition to the port number.

The component number is indicated in brackets.



Filter

Two filters are available in the topology:

All DRIVE-CLiQ + option slot

- Display of all components with DRIVE-CLiQ connections and wiring with DRIVE-CLiQ (status specification Activate, Deactivate and Deactivate not present)
- Assignment of the option slot in the Control Unit (e.g. CU320)
- Display of the interface designations on the components with tooltip

<None>

- Display of the components with DRIVE-CLiQ connections and wiring with DRIVE-CLiQ
- Assignment of the option slot in the control unit (e.g. CU320)
- Display of the encoders, motors and wiring with the drive components
- Display of all interface designations (DRIVE-CLiQ, signal cables, power cables) using tooltip

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Exercises

- Exercise 1: Creating a new project in STARTER
- Exercise 2: Topology and DRIVE-CLiQ connection
- Exercise 3: Project topology
- Exercise 4: Modifying the STARTER project: Pasting a new drive
- Exercise 5: Expanding the STARTER project: Copying the drive unit

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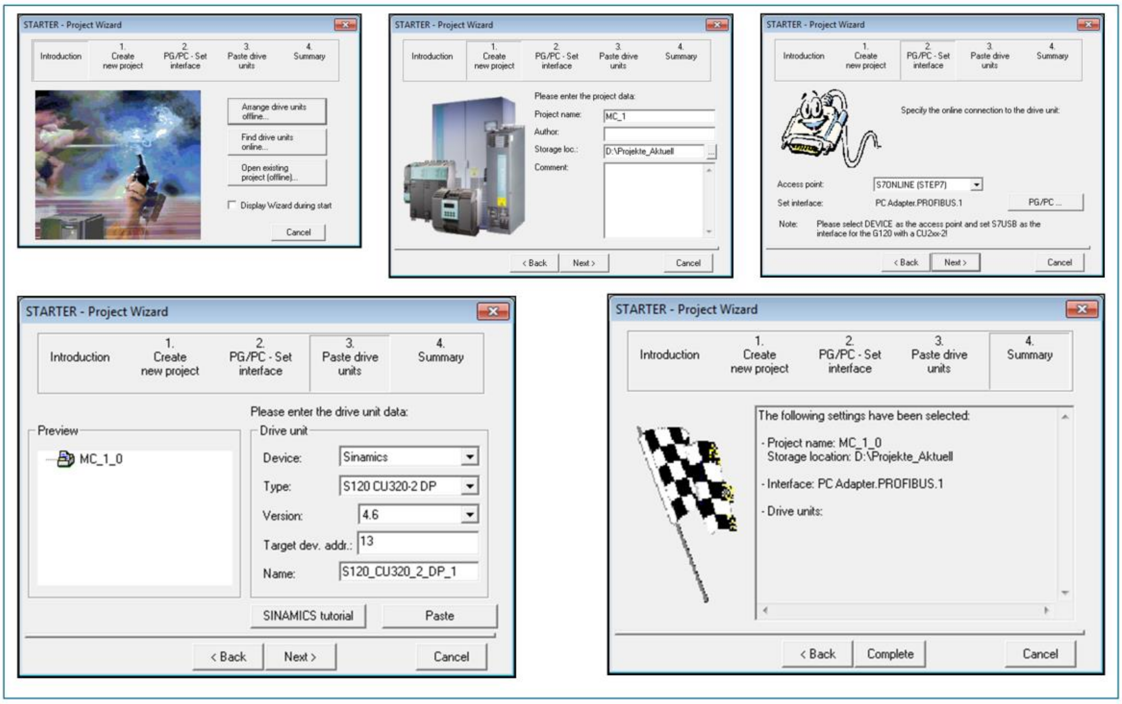
Safety information

Please note that:

- The course instructions have been produced for:
  - A course held by a course leader
  - Activities carried out on special training equipment
- The training equipment is operated under laboratory conditions.
  In case of doubt, always ask your course leader – particularly when handling components that carry electrical current or which can move.
- When carrying out work on equipment, the safety information in the associated product documentation must always be observed!
  The Training Documents alone are not sufficient.

Exercise 1: New STARTER project
Project wizard



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Task Using the project wizard, create a new STARTER project with a SINAMICS S120 drive unit

Start the project wizard
>> *Project* > *New with Wizard* > *Arrange drive units offline*
Project name: Porj_train_1

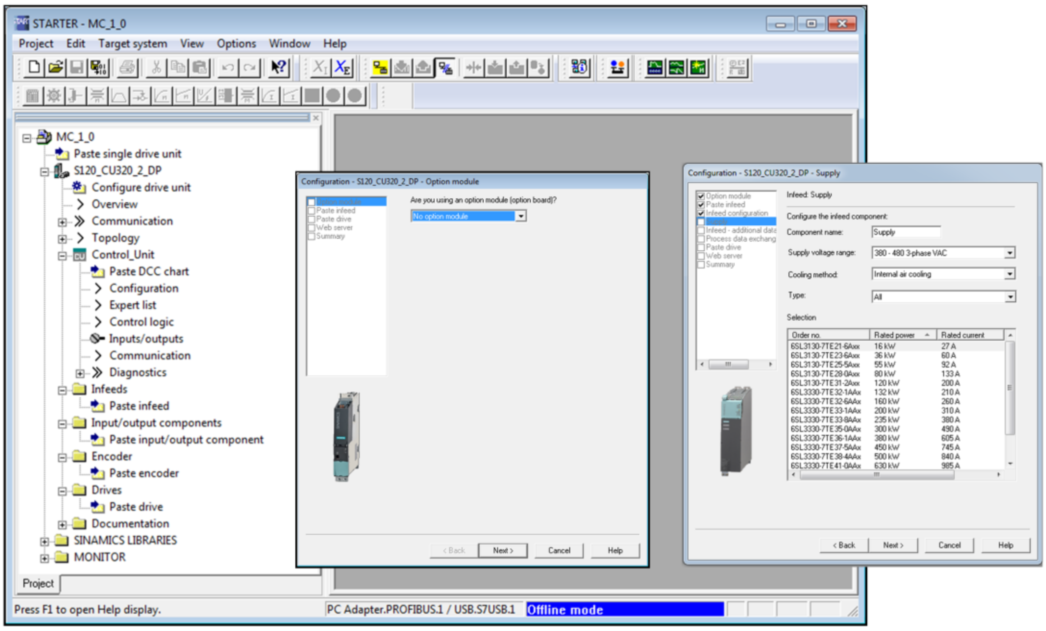
1. Storage location:

2. Skip the interface settings

3. As drive unit, select:
   - Device: SINAMICS
   - Type: S120 CU320-2 DP
   - Version: 4.7
   - Target device address: 1
   - Name: S120_CU320_2_DP_1

4. Continue to follow the wizard
   >> *Paste* > *Next* > *Complete*

Exercise 1: New STARTER project
Configure drive unit



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Task

Configure the drive unit

- The following specifications do not correspond to your training equipment.
- For data that is not specified, select as required.

1. Under "S120_CU320_2_DP", select
   >> *Configure drive unit*

2. No option module: > *Next*

3. Infeed with DRIVE CLiQ connection: > *Yes* > *Next*
   - Active Infeed, 380-480V, internal air cooling, 16 kW
   - Line/DC link identification at first switch on
   - Device supply voltage: 400 V
   - Line filter available AIM 400 V 16 kW
   - Free telegram configuration with BICO

4. Do you want to configure a drive? Yes

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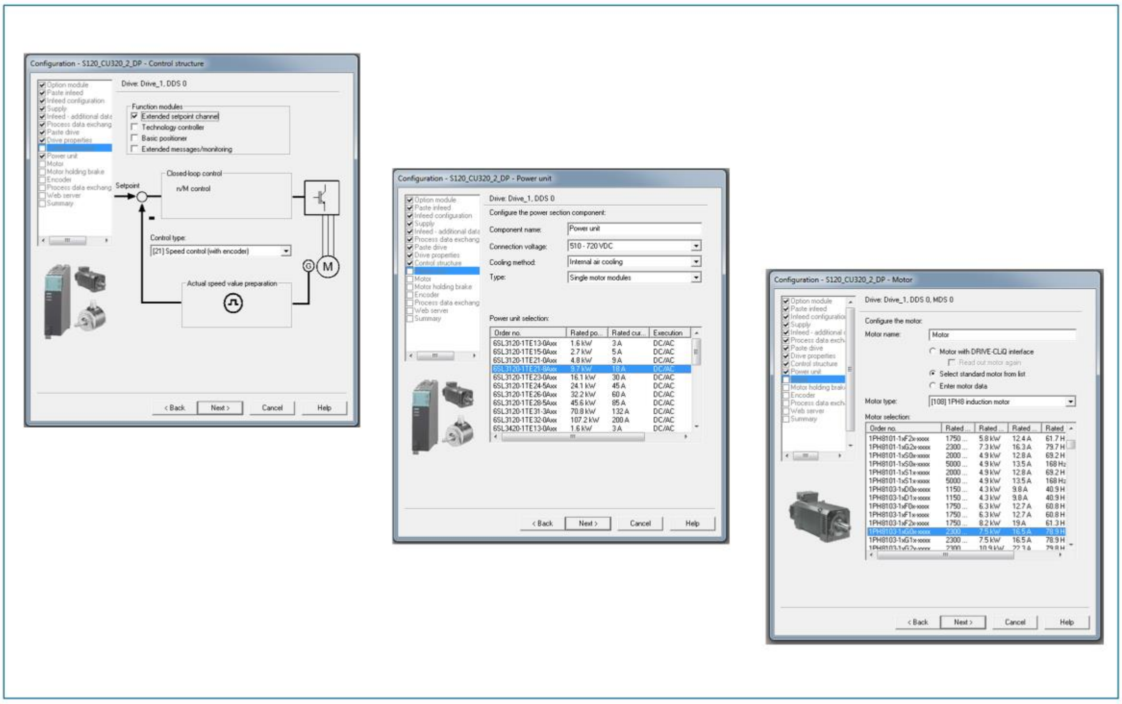
Exercise 1: New STARTER project
Checking the configuration



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5. Drive1:
   - Drive pbject type:"Servo"
   - Function modules: Extended setpoint channel
   - Control type: Speed control (with encoder)
   - Power unit: DC 510-720V, internal cooling, Single Motor Module,18A: 6SL3120-...

6. Select standard motor from list: 1PH8 induction motor
   - 1PH 8103-1MG00-0BAE (2300 rpm, 7.5kW)
   - Bearing version: Standard; no motor holding brake;
   - Encoder 1 = Motor encoder: sine/cosine encoder incremental:; 2048 S/R; Order number: xMxxx Code number 2001

7. Free telegram configuration with BICO

8. Configure the web server: Activate the web server

9. > *Next* > *finish*

10. Open the overview in the work area

11. Check the new tree in the project navigator. Have the 3 drive objects been inserted: Control Unit, infeed and Drive_1?

Exercise 1: New STARTER project
Expanding the configuration

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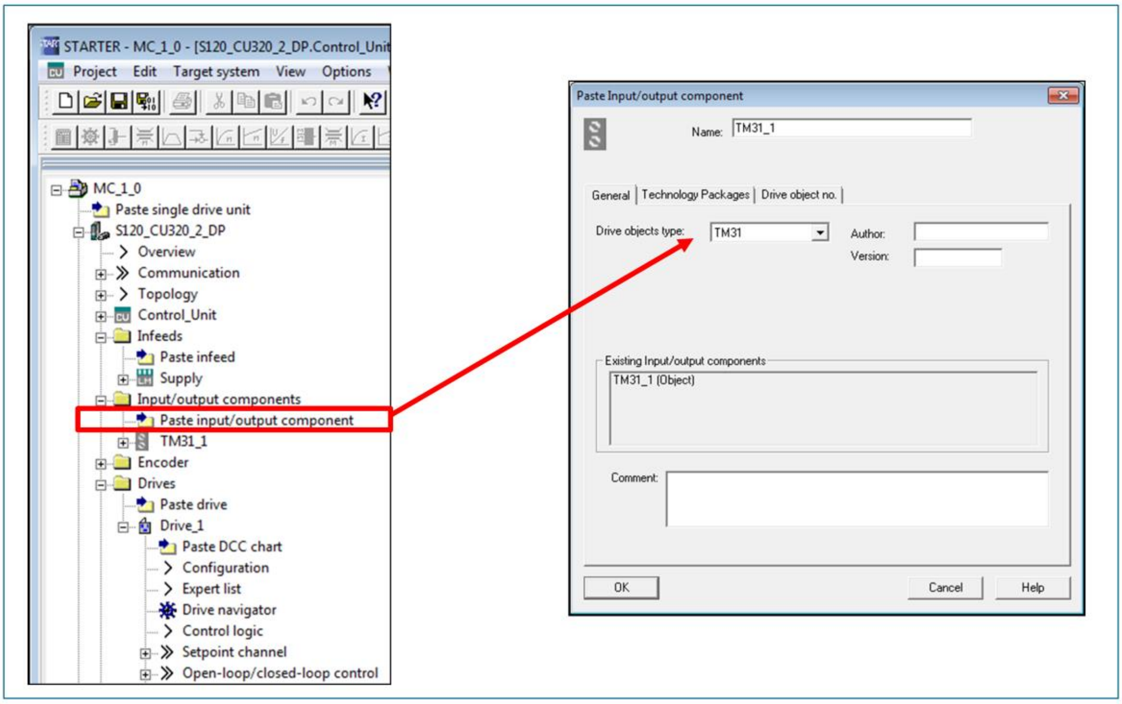

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Task

In an existing project, you can check, change and expand the configuration.

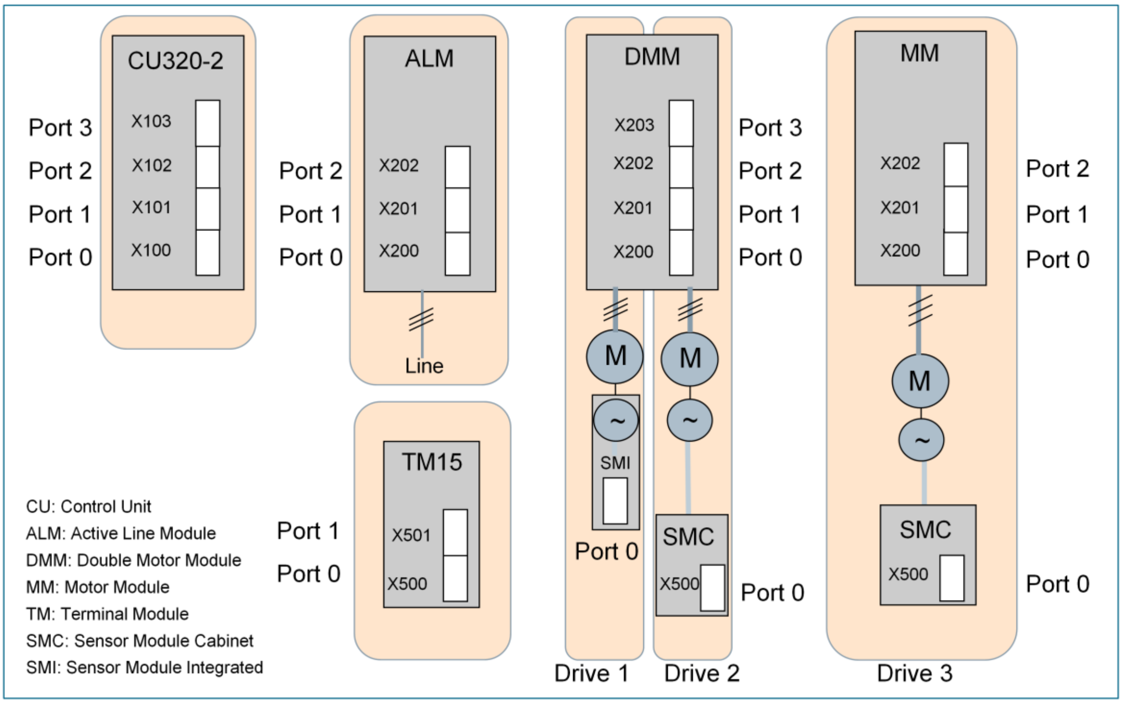
Look at the configuration, and expand this by including Terminal Module TM31!

1. Check your configuration
   >> S120_CU320_2_DP > Infeeds > Infeed > Configuration
   >> S120_CU320_2_DP > Drives > Drive_1 > Configuration

2. In the area **Input/output components** insert a Terminal ModuleTM31 with the name TM31_1:
   >> Paste input/output component >name: TM31> drive object type: TM31 > OK

3. Save your project:
   >> Project > Save

Exercise 2: Topology and DRIVE-CLiQ connection
Drawing the connections



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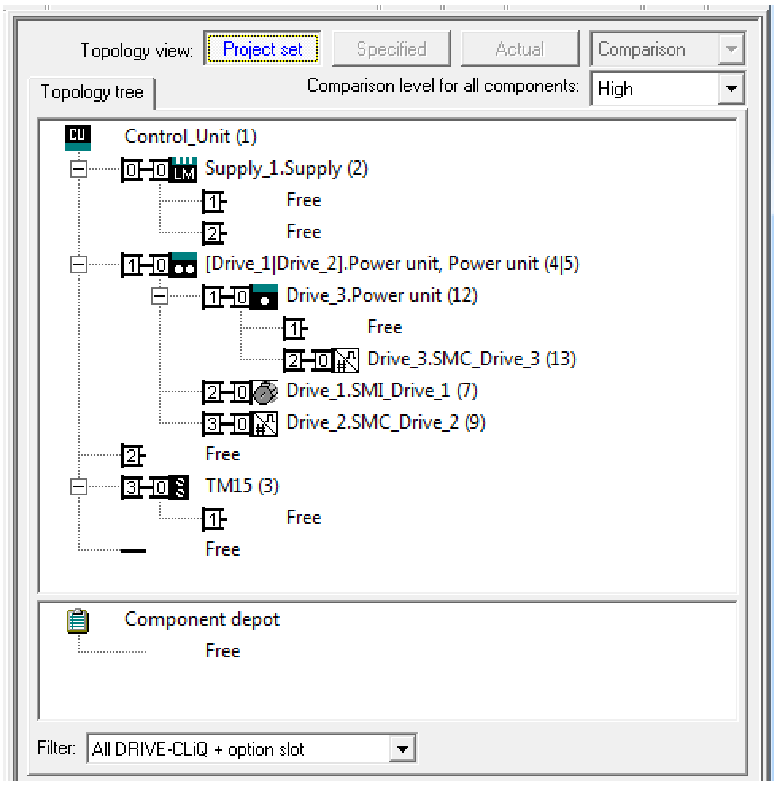
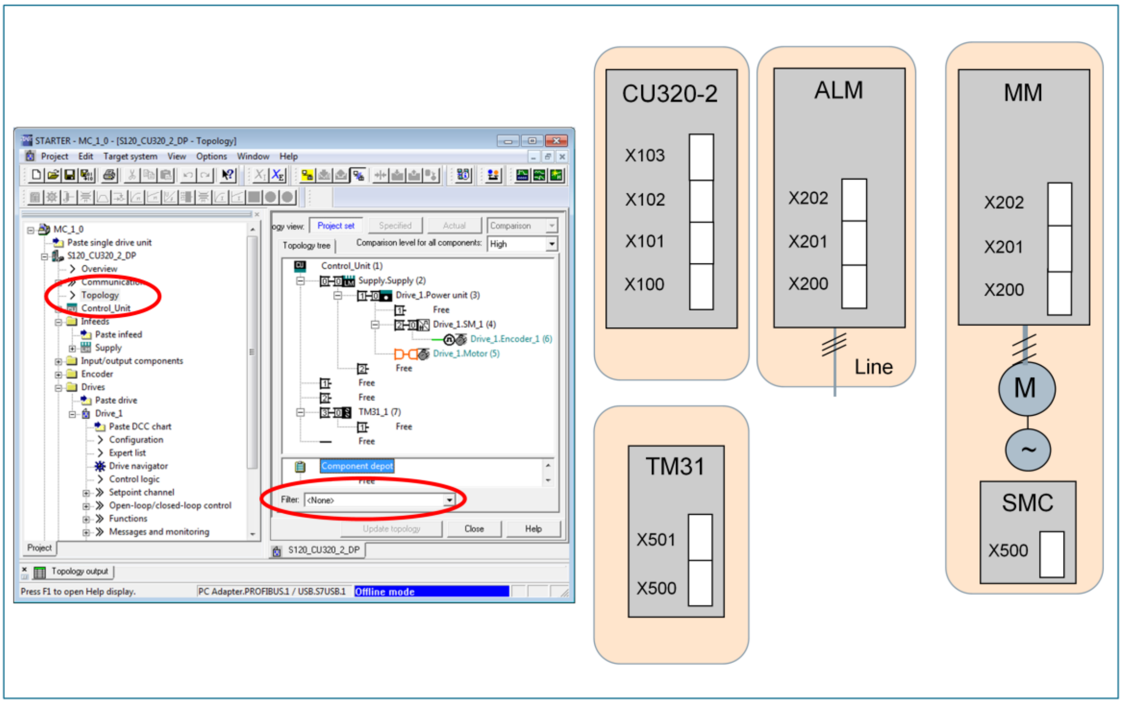
Aim of the exercise The information from the topology is to be used to create the wiring of the individual components using DRIVE-CLiQ.

Task Draw the following DRIVE-CLiQ wiring in the upper figure.



Exercise 3: Project topology
Drawing the topology



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Task Analyze the topology of your project Pro_train_1

1. Open the topology:
   >> S120_CU320_2_DP > Topology

2. Select the view with filter. If the filter is set to “all DRIVE-CLiQ-Objects and option slot” you see only the components with a DRIVE-CLiQ-Interface and the module which is inserted in the option slot e.g. TB30.

3. Select the view without filter. If the filter is set to none you see all the components.

4. Complete the drawing above according to the DRIVE-CLiQ interconnection shown in the topology.

Exercise 4: Changing the STARTER project
Adding an additional drive

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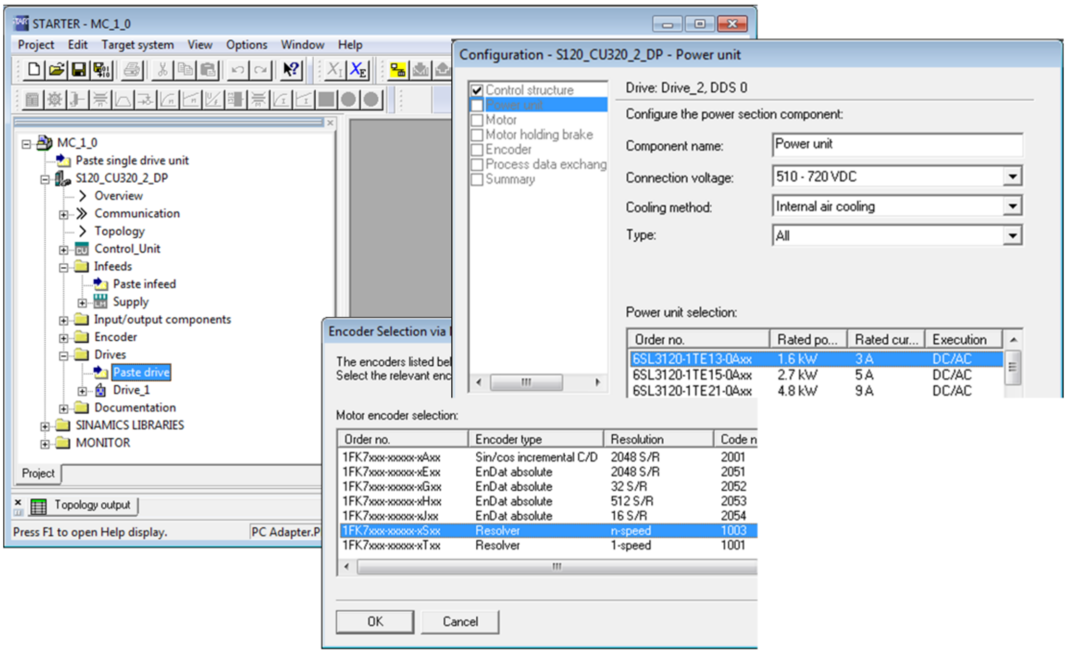

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Task Expand the drive unit to include an additional drive!

1. Insert a second drive:
   >> *Drives* > *Paste drive*
2. Name: Drive_2, drive objects type: Servo
3. No function modules
4. Control type: Speed control (with encoder)
5. Power unit:
   - 510-720 V DC
   - Internal air cooling
   - Type: Single Motor Modules, 6SL31.. 1.6 kW, 3A, DC/AC
   - Select a standard motor from the list, motor type: 1FK7 synchronous motor
   - 1FK7022-5AK71-1SA3: 6000 rpm = 0.6 Nm, 1.4 A
   - Do not use a motor holding brake
6. Encoder 1:
   - Resolver, n-speed (code number: 1003)
   - Details: Fine resolution G1_XIST1: Bit 11: 2^{11} = 2048;
7. Encoder 2:
   - 4096, HTL, A/B, SSI, single turn (code number: 3090)
8. Free telegram configuration with BICO > next > complete.
9. Now analyze the valid project reference topology in the views, with and without filter:
   >> *S120_CU320_2_DP* > *Topology*

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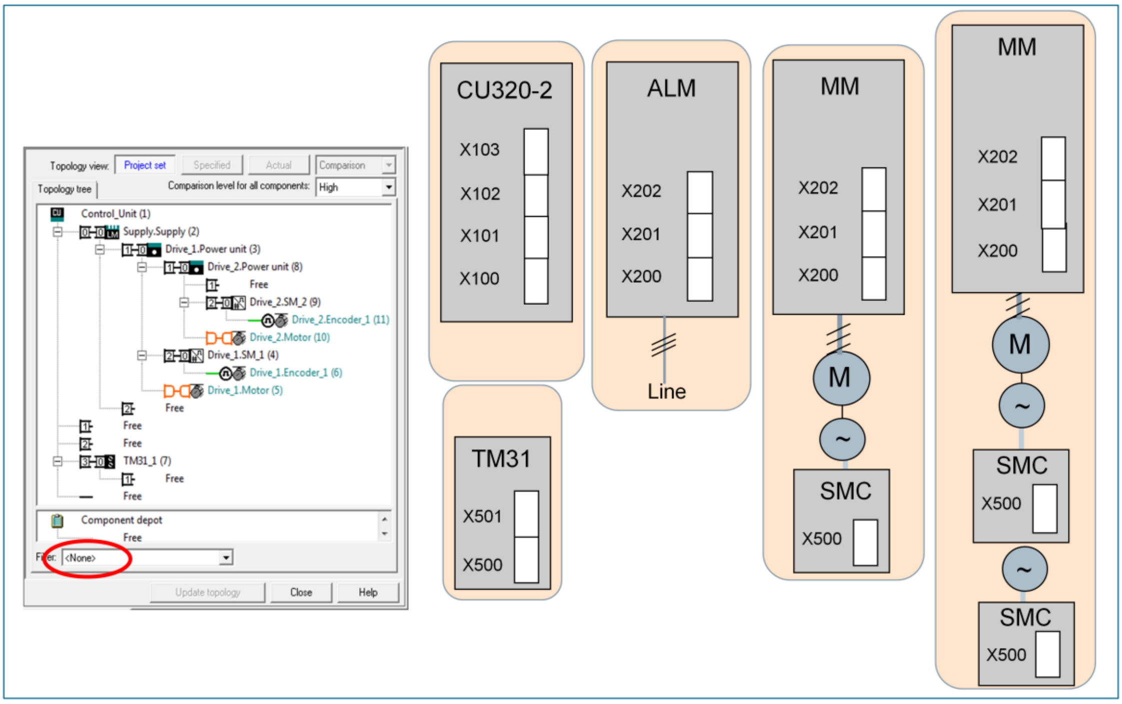
Exercise 4: Changing the STARTER project
Changing the DRIVE-CLiQ port



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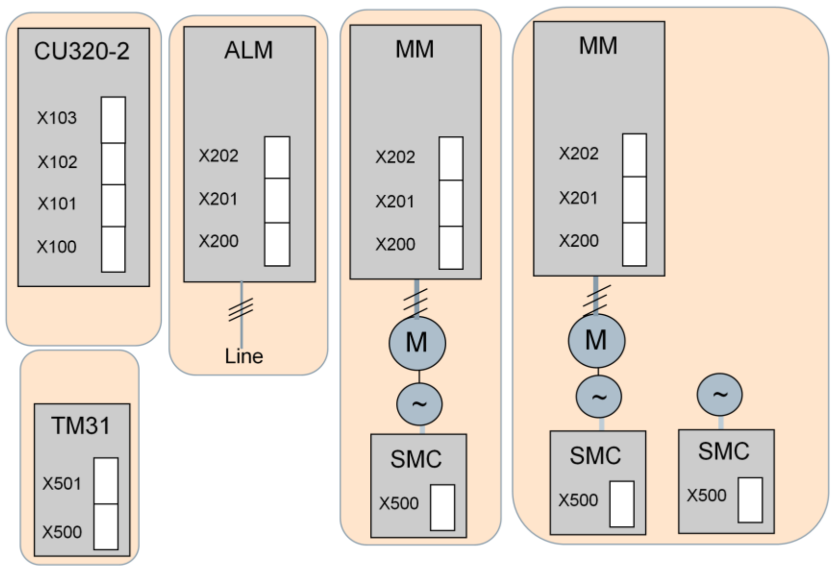
Task For the purposes of the exercise, change the position of the TM31 Terminal Module from port X103 to port X101 on the Control Unit!

1. Select the TM31, and with the left mouse key pressed, drag it to the target (port X101 of the CU320-2DP).

2. Complete the prepared drawing for the DRIVE-CLiQ wiring.

Exercise 4: Changing the STARTER project
Object and component number



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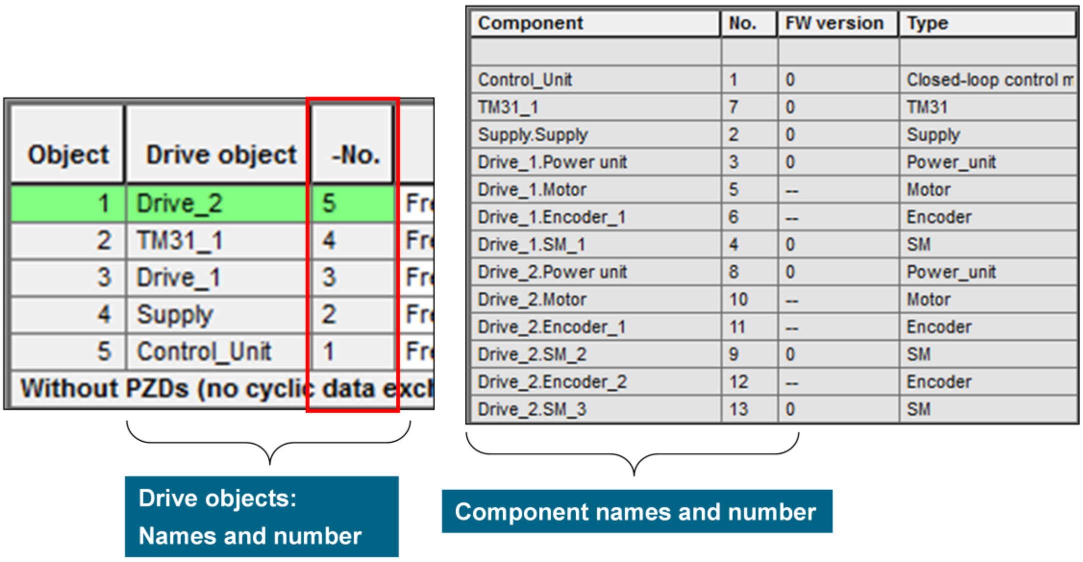
Task In the prepared overview, list the numbers and names of the drive components and drive objects allocated by the system.

Use the information provided by the STARTER given on the next page to do this.

Object name	Object nummer	Component name	Component number	Type

Exercise 4: Changing the STARTER project
Drive object and component number



Object	Drive object	-No.	
1	Drive_2	5	Fr
2	TM31_1	4	Fr
3	Drive_1	3	Fr
4	Supply	2	Fr
5	Control_Unit	1	Fr
Without PZDs (no cyclic data excl			

Component	No.	FW version	Type
Control_Unit	1	0	Closed-loop control m
TM31_1	7	0	TM31
Supply.Supply	2	0	Supply
Drive_1.Power unit	3	0	Power_unit
Drive_1.Motor	5	--	Motor
Drive_1.Encoder_1	6	--	Encoder
Drive_1.SM_1	4	0	SM
Drive_2.Power unit	8	0	Power_unit
Drive_2.Motor	10	--	Motor
Drive_2.Encoder_1	11	--	Encoder
Drive_2.SM_2	9	0	SM
Drive_2.Encoder_2	12	--	Encoder
Drive_2.SM_3	13	0	SM

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Objects You can find the object numbers clearly arranged under the telegram configuration:

>> S120_CU320_2_DP > Communication > Telegram configuration

Components You can find the component numbers, clearly arranged in the version overview:

>> S120_CU320_2_DP > Overview > Version overview

Note Each drive object (software unit) was also assigned a number and a name while configuring.

You require this information for:

- configuration, communication and SW functionality

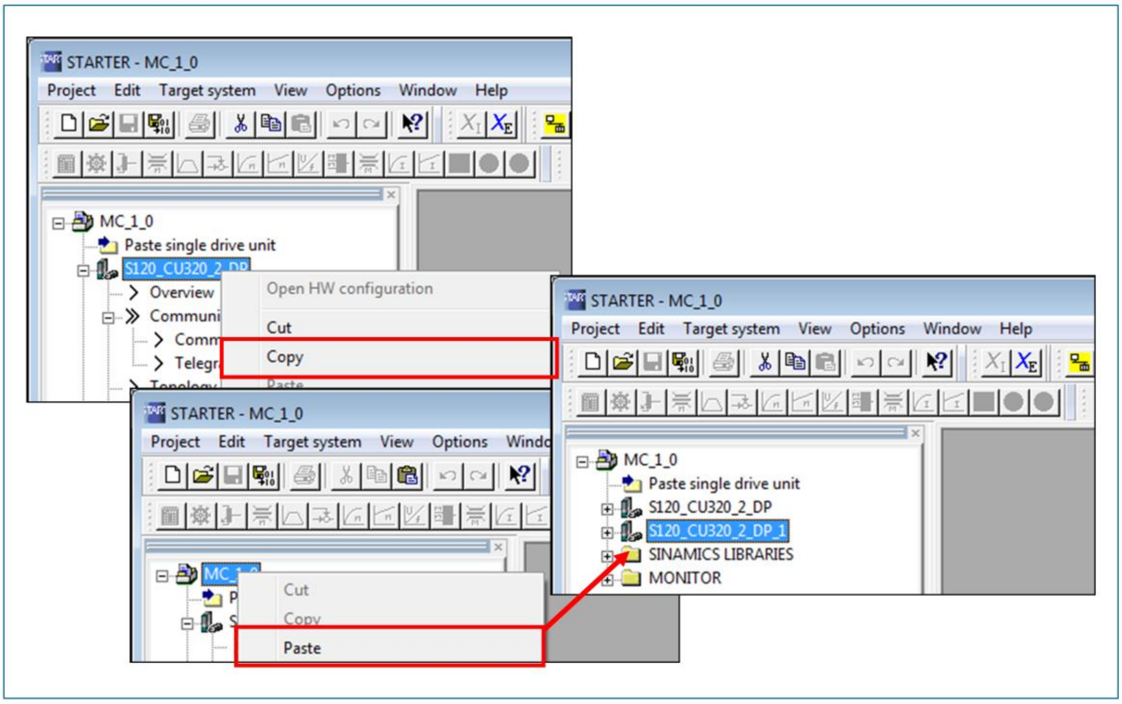
Each drive component (hardware) was assigned a number and a name while configuring.

You require this information for:

- the topology of the DRIVE-CLiQ connections
- the assignment of the faults displayed
- a possibly necessary update of the firmware for individual components

The object and component numbers are also accessible in the configuration screen form or via the expert list of the respective drive object.

Exercise 5: Expanding the STARTER project
Copying a drive unit



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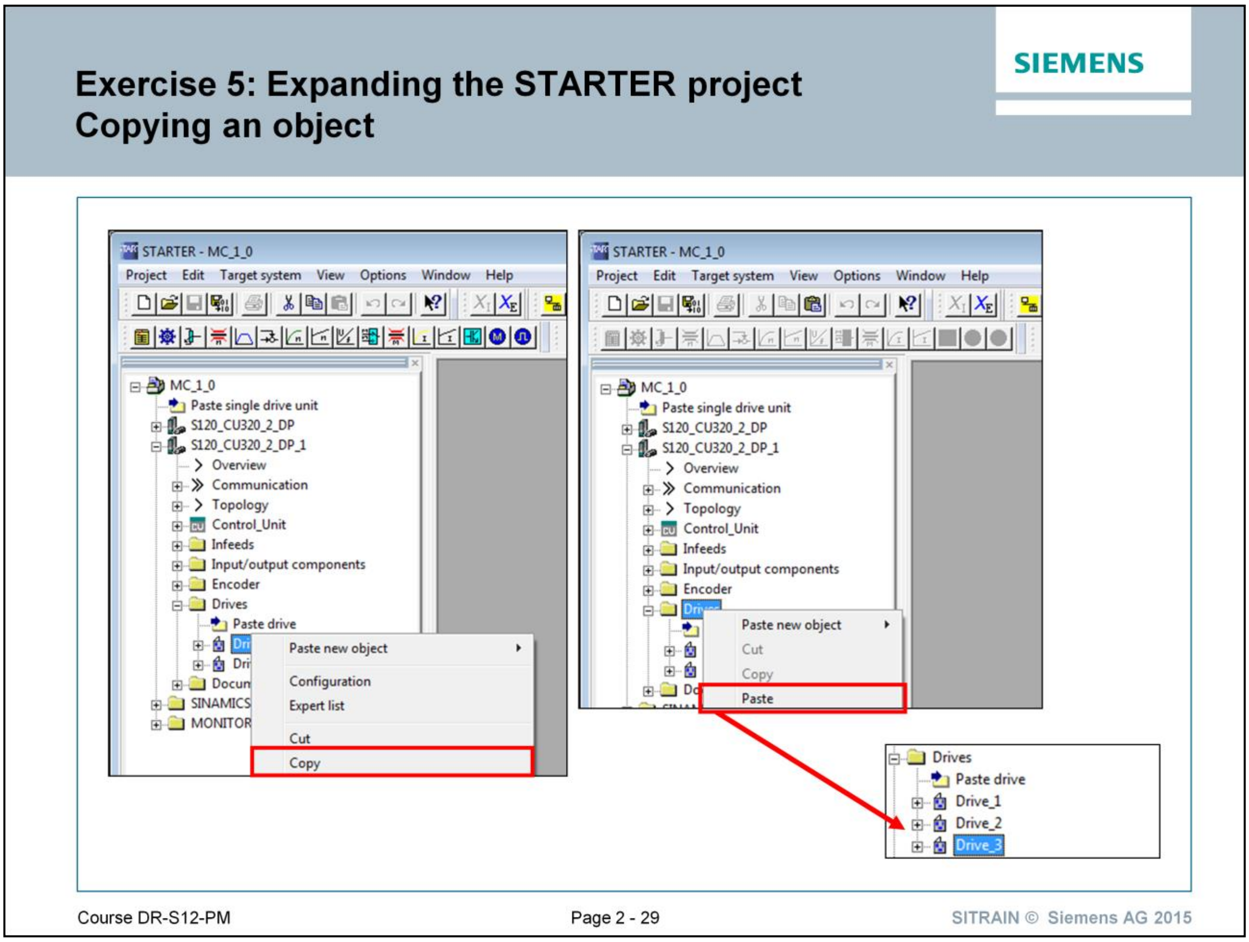
Drive units and objects of a project can be copied with their properties and inserted in the same project, another project or drive unit.

Task Insert a second, identical drive unit into your project!

1. Using the right mouse key, select the S120_CU320_2_DP drive unit > *Copy*
2. Using the right mouse key, select your project > *Paste*
3. Result*:* a second drive unit with the name "S120_CU320_2_DP_1" is created.
4. Select your drive unit "S120_CU320_2_DP_1", and change the name to suit your requirements:
   >> *Rename*

Note You can also copy individual drive objects in the same way, and re-insert them in the appropriate subdirectory.



Task Insert an identical Drive_2 into your drive unit 1.

1. Using the right mouse key, in the project S120_CU320_2_DP_1, select *>> Drive_2 > Copy*

2. Using the right mouse key, select the "Drives" directory *>> Paste*

3. Result: a third drive is inserted.

4. Select your drive "Drive_3", and rename it corresponding to your requirements:
   >> Rename

5. Save your project.

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Chapter 3

Control Units and additional sytem components

Course DR-S12-PM

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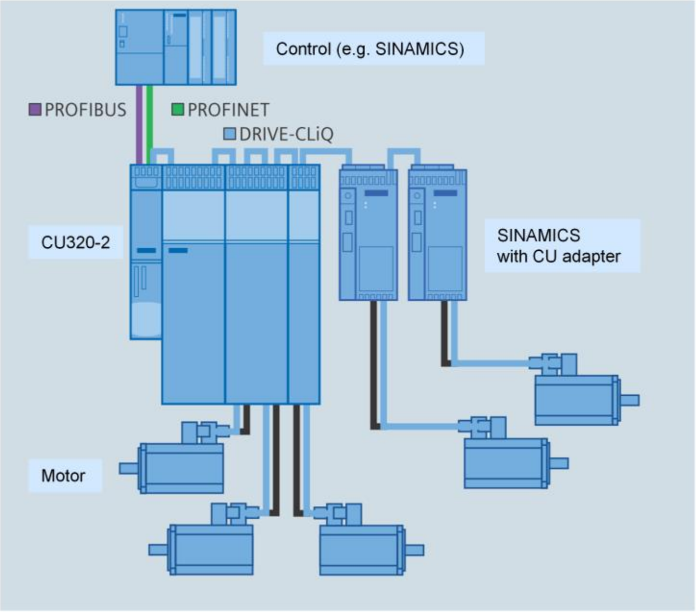
Learning Targets

- You will become familiar with the other components of the SINAMICS S120 drive system such as single-axis devices, chassis units, cabinet modules, sensors and Terminal Modules

Overview



Automated system A typical automation solution often comprises a control system, drive systems and an operator control and monitoring system. These systems communicate via bus systems such as PROFIBUS DP or PROFINET.

Control system The control system, e.g. SIMATIC S7, handles central monitoring and coordination of the entire automation task.

Drive system The drive system, e.g. SINAMICS, is the actuator that performs the movements of the individual drive axes.

Operator control and monitoring system The operator control and monitoring system, e.g. Operator Panel or Touch Panel, represents the manufacturing process graphically depending on the design and allows manufacturing parameters to be entered.

Control Unit CU320-2
Connection overview CU320-2 DP and CU320-2 PN

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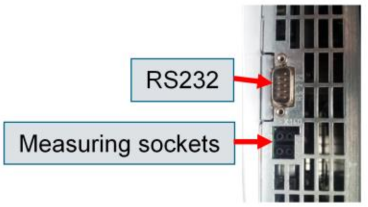
CU320-2 DP

CU320-2 PN

Lower side (bottom)



Nr.	Description	
1	4 DRIVE-CLiQ ports	
2	Inputs/outputs	
3	24 V supply	
4	PROFIBUS-DP	PROFINET
5	Status LEDs	
6	LAN	
7	Connection for BOP20	
8	CF card	
9	DP address	

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Connections

The Control Unit CU320-2 DP / PN features the following connections and interfaces:

- 4 x DRIVE-CLiQ sockets for communication with other DRIVE-CLiQ devices, e.g. Motor Modules, Active Line Modules, Sensor Modules, Terminal Modules
- 1 PROFIBUS interface with PROFIdrive V4 profile
- 2 rotary coding switches for manually setting the PROFIBUS address

or:

- 1 PROFINET interface with 2 ports (RJ45) with PROFIdrive V4 profile
- 12 parameterizable digital inputs (floating)
- 8 parameterizable bidirectional digital inputs/digital outputs (non-floating)
- 1 serial RS232 interface
- 1 interface for the BOP20 Basic Operator Panel
- 1 slot for the CompactFlash card on which firmware and parameters are stored
- 1 slot for mounting an option module (e.g. TB30, CBE20)
- 1 Ethernet interface for commissioning and diagnostics
- 3 test sockets and one reference ground for commissioning support
- 1 connection for the electronics power supply via the 24V DC supply connector
- 1 PE (protective earth) connection

A shield connection for the signal cable shield on the option module is located on the CU320-2 Control Unit.

The available option slot is used to expand the connections and interfaces, for example, to include additional terminals or for communication purposes.

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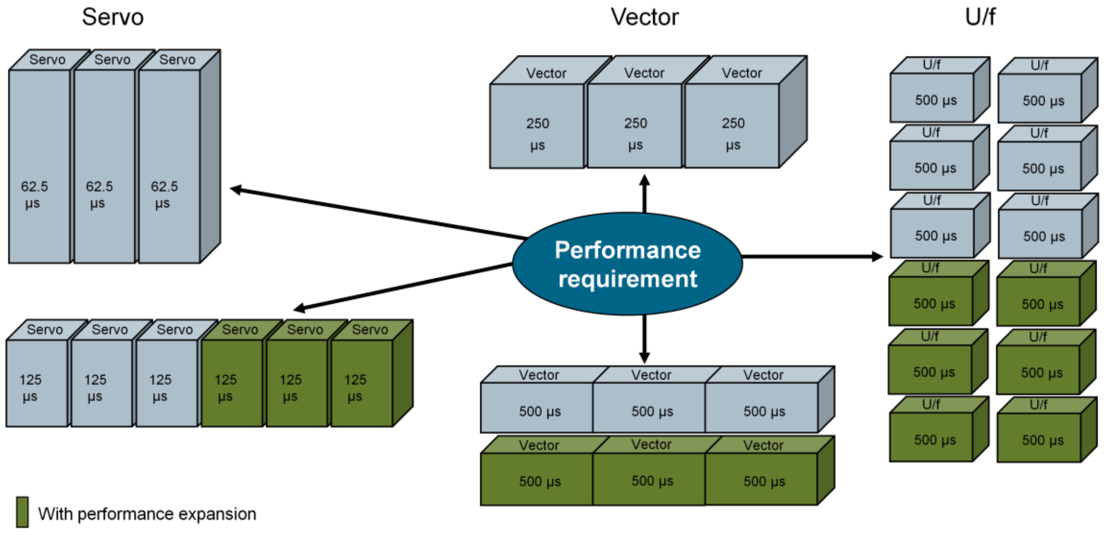
CU320-2 Control Unit
Quantity structure



A performance expansion is required from the 4th drive
Red flashing RDY-LED
Alarm A13000: License not adequate

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CU320-2 The CU320-2 Control Units of the SINAMICS S system are designed for use with several drives.

Number of drives The number of variable-speed drives depends on:

- the required performance
- the required special functions
- the required operating mode (servo, vector, or U/f).

The software and the parameters are stored on an insertable CompactFlash card.

Performance license The license concept of the performance license has changed compared to Version V4.3 of the CU320-2. Here, a performance license is required regardless of the performance utilization beginning with the 4th axis in the servo/vector operating mode and beginning with the 7th axis in U/f mode.

Missing license If no license is available, an alarm (A13000) is issued and the red LED SF flashes at the CU320-2. In this case, a license must be obtained and the license number transferred to the CompactFlash card.

Projects created for a CU320 (6SL3040-0MA00-0AAx) can be converted with the STARTER.

Alarm A13000 The drive unit uses licensed options but the license is not sufficient. Additional licenses are required and must be activated (p9920, p9921).

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Control Unit CU320-2 generate license key

Licences:

performance per CU

Extended Safety-functions per axis

Runtime-License „Sinamics DCB Extension“ per CU

„OALINK“ License per CU (open application link)

Example CF-Karte: 040846E8

"WEB License Manager"
http://www.siemens.com/automation/license

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The following information is required:

Memory card serial number (printed on the memory 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 memory card serial number.’
5. Select a product e.g. "SINAMICS S CU320-2 DP". --> Click "Next".
6. Choose "Available license numbers".--> Click "Next".
7. Check the assignment.--> Click "Assign".
8. When you are sure that the license has been correctly assigned, click "OK".
9. The license key is displayed and can be entered. Enter license key in STARTER

Control Unit CU310-2
Connection overview CU310-2 DP and CU310-2 PN

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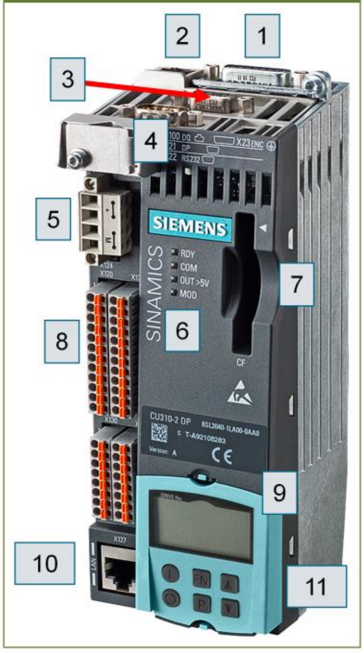
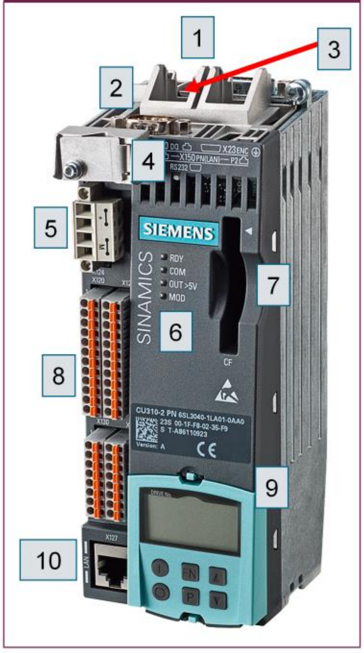
CU320-2 DP



CU320-2 PN



Nr.	Description	
1	Encoder interface	
2	DRIVE-CLiQ port	
3	PROFIBUS-DP	PROFINET
4	RS232	
5	24 V supply	
6	Status LEDs	
7	CF card	
8	Inputs/outputs	
9	BOP20	
10	LAN	
11	DP address	

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Connections

The CU310 DP/PN Control Unit features the following connections and interfaces:

- 1 DRIVE-CLiQ socket for communication with other DRIVE-CLiQ devices, e.g. Sensor Modules or Terminal Modules
- 1 PM-IF interface for communication with Power Modules in blocksize format
- 1 interface to the BOP20 Basic Operator Panel
- 1 PROFIBUS interface with PROFIdrive V4 profile

or

- 1 PROFINET interface with 2 ports (RJ45 sockets) with PROFIdrive V4 profile
- 1 encoder evaluation for the following encoder signals:
  - TTL/HTL incremental encoder
  - SSI encoder without incremental signals
- 4 parameterizable digital inputs (floating)
- 4 parameterizable bidirectional digital inputs/outputs (non-floating)
- 1 serial RS232 interface
- 1 slot for the CompactFlash card
- 3 test sockets and one reference ground
- 1 connection for the electronics power supply via the 24 V DC power supply connector
- 1 PE (protective earth) connection
- 1 safe standstill input (enable pulses) for controlling the connected PM340 Power Module
- 1 temperature sensor input (KTY84-130 or PTC)

CU310-2 Control Unit Installation

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Installation of CU310-2 in chassis-format Power Module	Snapping the CU310-2 onto PM340 Power Module
	

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Design

The CU310-2 Control Unit uses the PM-IF interface to control the Power Modules in blocksize format. In this case, other DRIVE-CLiQ components such as Sensor Modules or Terminal Modules can be connected to the DRIVE-CLiQ socket on the CU310-2 Control Unit.

Power Modules in chassis format are controlled from the CU310-2 Control Unit via the DRIVE-CLiQ interface. Here, the Sensor Modules and Terminal Modules must be connected to the free DRIVE-CLiQ sockets on the Power Module.

Parameter settings can be changed with the BOP20 Basic Operator Panel. The BOP20 Basic Operator Panel can also be snapped onto the CU310-2 Control Unit during operation to perform troubleshooting procedures.

Control Unit Adapters CUA31 and CUA32 Interfaces

CUA31

CUA32

Nr.	Bezeichnung
1	DRIVE-CLiQ
2	Status LEDs
3	EP terminal, temperature sensor
4	24 V supply
5	Encoder interface

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CUA31 / CUA32 The CUA 31 / CUA32 Control Unit Adapter converts the Power Module interface to the DRIVE-CLiQ interface.

CUA32 The CUA32 Control Unit Adapter is also equipped with an integral encoder evaluation device which can be configured for an HTL/TTL or SSI encoder.

The CUA31 / CUA32 Control Unit Adapter allows Power Modules in blocksize format to operate on a CU320-2 or SIMOTION D Control Unit, e.g. as a single axis in addition to a multi-axis drive.

Interfaces The CUA31 Control Unit Adapter features the following connections and interfaces:

- 1 temperature sensor input (KTY84-130 or PTC)
- 3 DRIVE-CLiQ sockets
- 1 connection for the electronics power supply via the 24 V DC power supply connector
- 1 safe standstill input (enable pulses)

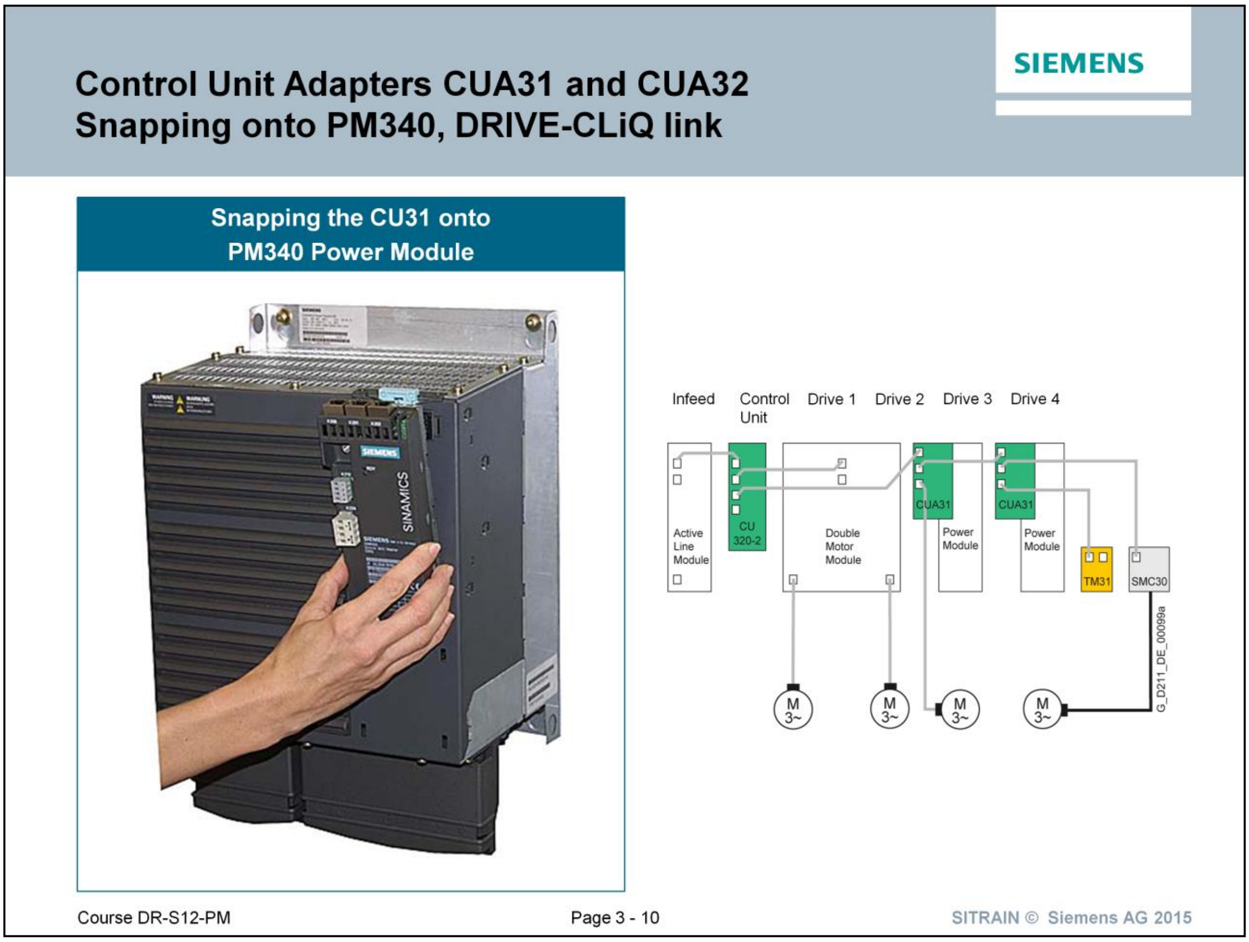
The status of the CUA31 Control Unit Adapter is indicated via a multi-color LED.

The CUA32 Control Unit Adapter also features the following connection:

- 1 encoder evaluation

The following encoder signals can be evaluated:

- TTL/HTL incremental encoder
- SSI encoder without incremental signals



Layout with PM340

The CUA31 / CUA32 Control Unit Adapter is snapped onto the Power Module in blocksize format and communicates with a CU320-2 or a SIMOTION D Control Unit by means of a DRIVE-CLiQ link.

The CUA31 / CUA32 Control Unit Adapter's power is supplied by the Power Module via the Power Module interface. If the CUA31 / CUA32 Control Unit Adapter needs to communicate when the Power Module is switched off, it must be supplied with 24 V DC from an external source.

Other DRIVE-CLiQ devices such as Sensor Modules or Terminal Modules can be connected to the CUA31/CUA32 Control Unit Adapter.

Option boards
Overview

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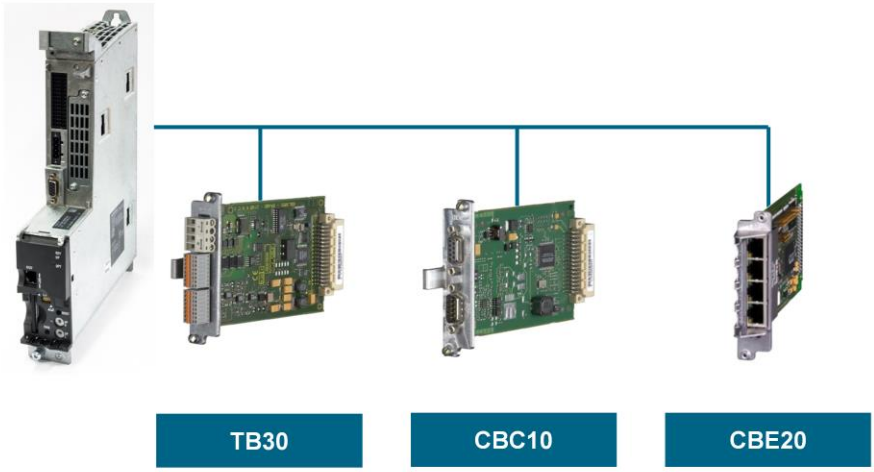

Terminal Board TB30

- Digital inputs/outputs: 4 DI, 4 DO
- Analog inputs/outputs: 2 AI, 2 AO, e.g. for analog setpoint interface

Communication Boards

- CBC10: CAN Bus interface with CAN protocol according to CANopen drive profile
- CBE20: PROFINET (as Device, TCP, RT, IR

TB30

The following are located on the TB30:

- Power supply for digital inputs/outputs
- 4 digital inputs / 4 digital outputs
- 2 analog inputs / 2 analog outputs

CBC10

The CBC10 is used to interface to the CAN (Controller Area Network) protocol. The associated driver software fulfills the standards of the following CANopen specifications of the CiA organization (CAN in Automation):

- Communication profiles in accordance with DS 301
- Drive profile in accordance with DSP 402 (in this case Profile Velocity Mode)
- EDS (Electronic Data Sheet) in accordance with DSP 306
- Operational status signaling in accordance with DSP 305

CBE20

The CBE20 connects to a PROFINET IO network. This makes the SINAMICS S120 a PROFINET IO-Device as defined by PROFINET and provides the following functions:

- PROFINET IO-Device
- 100 Mbit/s full duplex
- Supports real-time classes of PROFINET IO:
- RT (Real-Time)
- IRT (Isochronous Real-Time), minimum send cycle 500 µs
- Connection to controllers as PROFINET IO-Devices using PROFIdrive compliant with Specification V4
- Standard TCP/IP communication to STARTER
- Integrated 4-port switch based on the PROFINET ASIC ERTEC400.
- Supports the media redundancy procedure and shared device functions.

Terminal Modules
Overview

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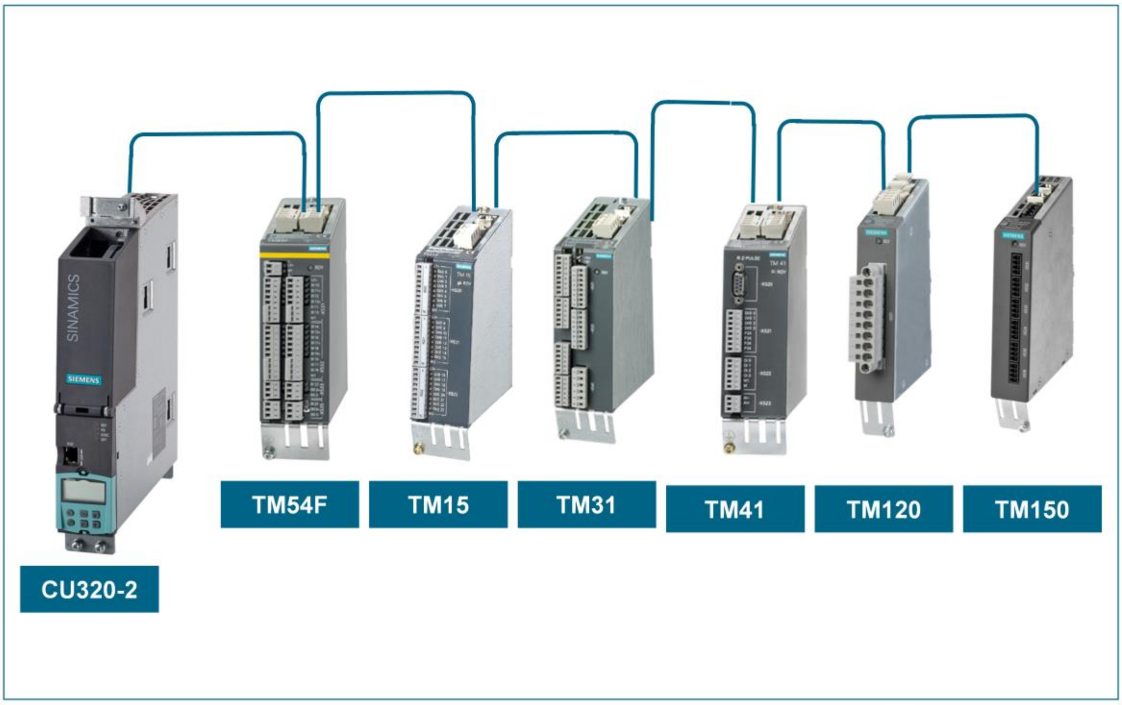

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TM15 The TM15 expands the CU320-2 to include additional DI/DO.

TM31 The TM31 provides a large number of additional I/Os and a PTC/KTY interface. It constitutes the central customer interface for digital and analog inputs and outputs in the SINAMICS cabinet units.

TM41 The TM41 supplies TTL signals which emulate an incremental encoder, e.g. to a higher-level controller. The encoder interface (incremental encoder emulation) can be linked to an encoder signal from the Control Unit, e.g. incremental encoder sin/cos, by parameter assignment.

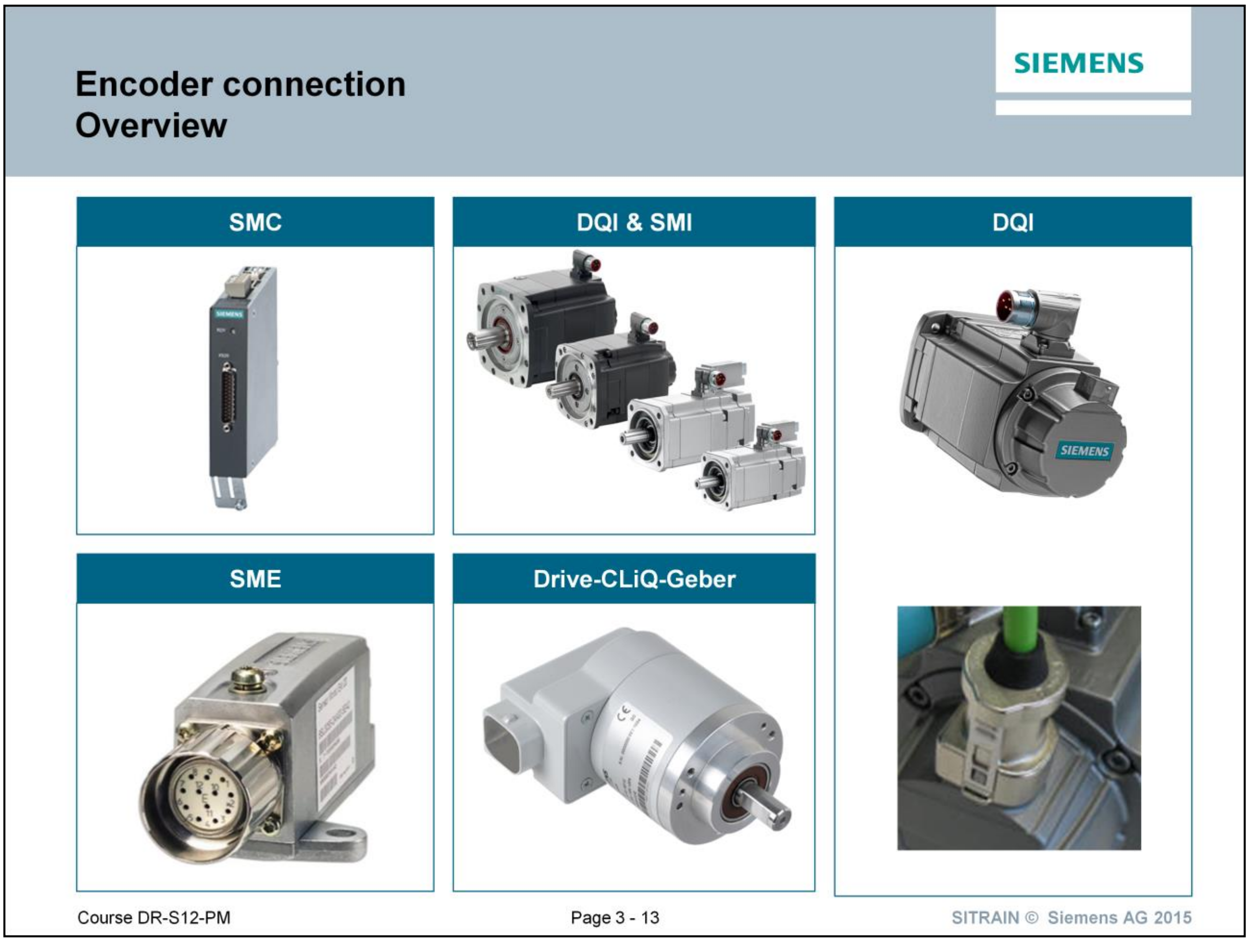
TM54F The TM54F is a dual-processor I/O interface with 4 fail-safe digital outputs and 10 fail-safe digital inputs for utilization of the Safety Integrated functions of the SINAMICS S120 drive system over external actuators and sensors. (Safety topic)

TM120 The TM120 is capable of evaluating up to 4 temperature sensors (KTY84-130 or PTC). The temperature sensor inputs are safely electrically isolated from the evaluation electronics in the TM120 Terminal Module and are suitable for evaluating the temperature of special motors, e.g. 1FN linear motors and 1FW6 built-in torque motors.

TM150 The TM150 is a DRIVE-CLiQ component for temperature evaluation. The temperature is measured in a temperature range from -99 °C to +250 °C for the following temperature sensors:

- Pt100 (with monitoring for open-circuit and short-circuit)
- Pt1000 (with monitoring for open-circuit and short-circuit)
- KTY84 (with monitoring for open-circuit and short-circuit)
- PTC (with monitoring for short-circuit)

- Bimetallic NC contact (without monitoring)



With DRIVE-CLiQ

The encoder system should be connected to SINAMICS S120 preferably via DRIVE-CLiQ.

Motors with DRIVE-CLiQ interfaces (e.g. synchronous motors 1FK7 and 1FT6, and induction motors 1PH7) are designed for this purpose.

These motors simplify commissioning and diagnostics because the motor and encoder type are identified automatically.

Without DRIVE-CLiQ

Motors without DRIVE-CLiQ interfaces, as well as external encoders, must be connected via Sensor Modules to enable the encoder and temperature signals to be evaluated.

Sensor Modules Cabinet-Mounted (SMC) are available for installation in control cabinets and Sensor Modules External (SME) for installation outside control cabinets.

With DRIVE-CLiQ

Motors with DRIVE-CLiQ interfaces can be connected to the associated Motor Module directly via the MOTION-CONNECT DRIVE-CLiQ cables available.

The connection of the MOTION-CONNECT DRIVE-CLiQ cable at the motor has degree of protection IP67.

The DRIVE-CLiQ interface supplies the motor encoder via the integrated 24 V DC supply and transfers the motor encoder and temperature signals and the electronic rating plate data, e.g. a unique identification number, rated data (voltage, current, torque, etc.) directly to the Control Unit.

Different encoder cables are therefore no longer required for the various encoder types, e.g. resolvers or absolute encoders. Wiring can be effected throughout with a MOTION-CONNECT DRIVE-CLiQ cable.

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Encoder connection
Sensor Module: SMC – Cabinet, SME – External

Gebersysteme	SMC				SME			
	SMC10	SMC20	SMC30	SMC40	SME20	SME25	SME120	SME125
Resolver	ja	-	-	-	-	-	-	-
Inkrementalgeber sin/cos (1 Vpp) mit/ohne Referenzsignal	-	ja	-	-	ja	-	ja	-
Inkrementalgeber TTL/HTL	-	-	ja	-	-	-	-	-
Absolutwertgeber EnDat 2.1	-	ja	-	-	-	ja	-	ja
Absolutwertgeber EnDat 2.2	-	-	-	ja	-	-	-	-
Absolutwertgeber SSI	-	ja 1)	ja 2)	-	-	ja 1)	-	ja 1)
Temperaturauswertung	ja	ja	ja	-	ja 3)	-	ja (sicher elektr. getrennt)	ja (sicher elektr. getrennt)

1) nur SSI-Geber mit 5-V-Versorgung möglich
2) SSI-Geber mit 5-V- oder 24-V-Versorgung möglich
3) mit vorgeschriebener Adapterleitung 6FX8002-2CA88

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SME20/25

SME20/SME25 Sensor Modules External are encoder evaluation units for machine encoders (direct measuring systems). The housings are designed with IP67 degree of protection.

The following encoder signals can be evaluated:

- Incremental encoder sin/cos 1 Vpp without rotor position track (C/D track)
- Absolute encoder EnDat
- SSI absolute encoder with incremental signals sin/cos 1 Vpp
- Neither motor nor encoder data are saved in the SME20/SME25.

SMC40

The Sensor Module Cabinet-Mounted SMC40 is used to convert encoder signals from absolute encoders with EnDat 2.2 to DRIVE-CLiQ and send these to the Control Unit. Two encoder systems with EnDat 2.2 can be connected to the SMC40. Their signals are converted independent of each other to two DRIVE-CLiQ encoder signals.

SME120/125

The SME120/SME125 Sensor Modules External are encoder evaluation units with degree of protection IP67, especially suitable for use in linear and torque motor applications.

- The motor temperature signals are safely electrically isolated. A Hall-effect sensor box can be connected for the SME120 to determine the commutation position of a linear motor.
- Neither motor nor encoder data are saved in the SME120/SME125.

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Chapter 4

STARTER
Connection to target device

Course DR-S12-PM

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Learning Targets

- You will be familiar with the options for connecting the Control Unit to the PC
- You will be able to establish an online connection
- You will be able to configure the drive online
- You will be able to operate the drive with the control panel

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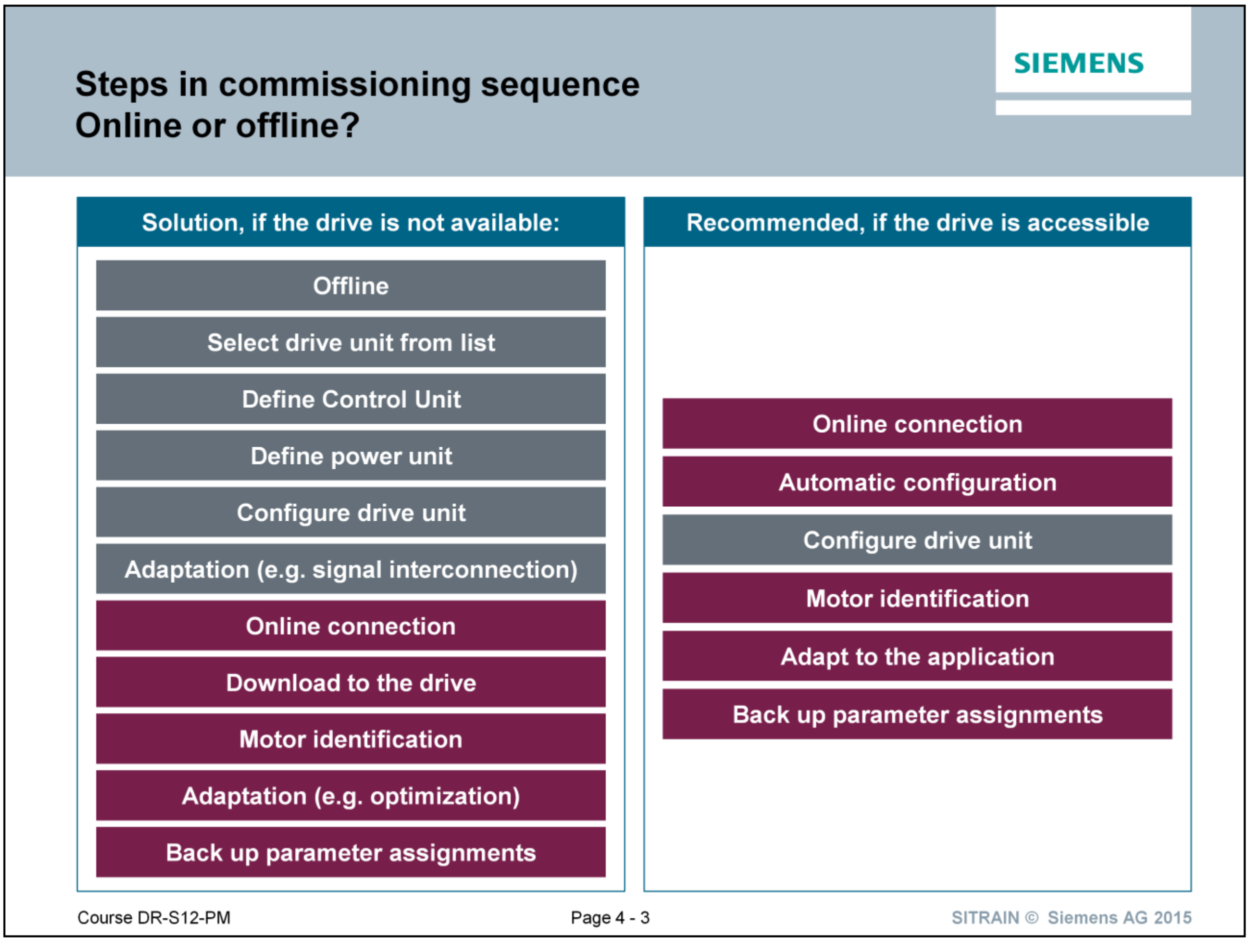
STARTER A user-friendly and powerful PC program is available for commissioning. With STARTER, every converter of the SINAMICS family can be parameterized largely in the same way.

Wizards The drive is inserted in STARTER in the form of a project. Creation of the project and insertion of the correct drive type is simplified by a wizard.

Offline configuration When going through the configuration, primarily the motor data, the encoder data and the interface assignment are entered.

Online commissioning Commissioning is carried out in online mode.

Control panel Using the control panel, the drive can be switched on and off for test purposes directly from the PC. The speed setpoint is specified by the slider. Actual values are clearly displayed.



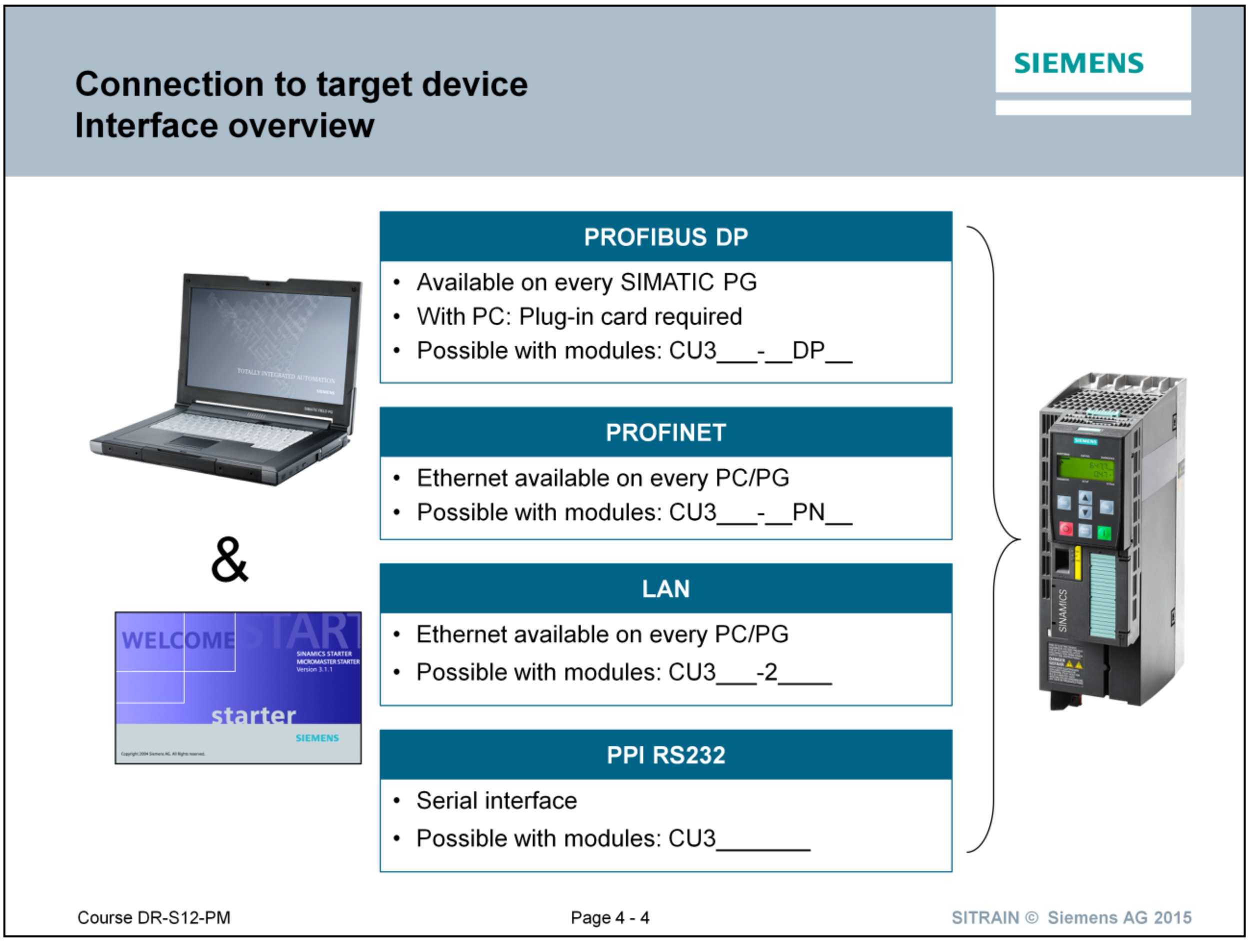
Online / Offline

There are two options for pasting a new drive unit:

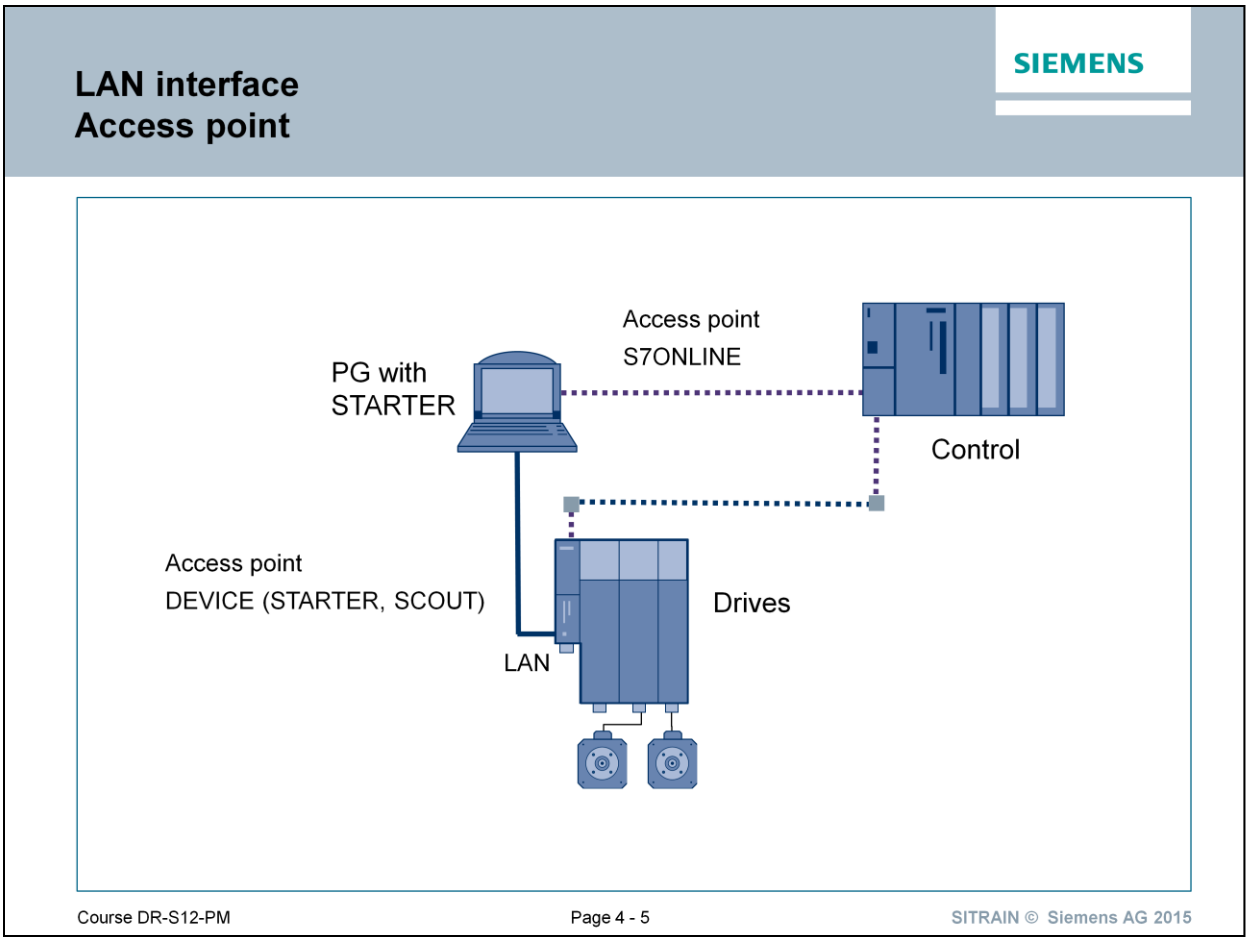
- If you can establish an online link to the drive, then this is generally the easier option since the device variant and firmware versions are identified automatically.
- If you cannot access the drive, then carefully input the planned devices. The firmware versions are identified when you connect online for the first time.

Remaining steps

You will be guided step by step by the prompts. You cannot terminate the process prematurely. If you work consistently with the <Next> key, any data already stored or determined beforehand will be displayed as default and, at the end of the process, you will find that you have not overwritten any values by mistake



PROFIBUS DP	The PROFIBUS DP fieldbus is widely used in the automation world. As well as controllers, input/output modules, operator panels and drives, commissioning PCs can also communicate via this bus. A point-to-point connection between a PC and a drive is also possible. The PC must be equipped with a PROFIBUS DP interface.
PROFINET	This fieldbus represents the further development of PROFIBUS based on Ethernet.
LAN	Ethernet interface that enables a further online access in addition to the network interfaces.
RS232	Connection for AOP 30 (Advanced Operator Panel).



LAN interface

The LAN interface (X127) of the CU320-2 enables a direct connection to be set up between the Control Unit and the PG/PC. The LAN interface is an Ethernet interface for communication via TCP/IP.

Network communication

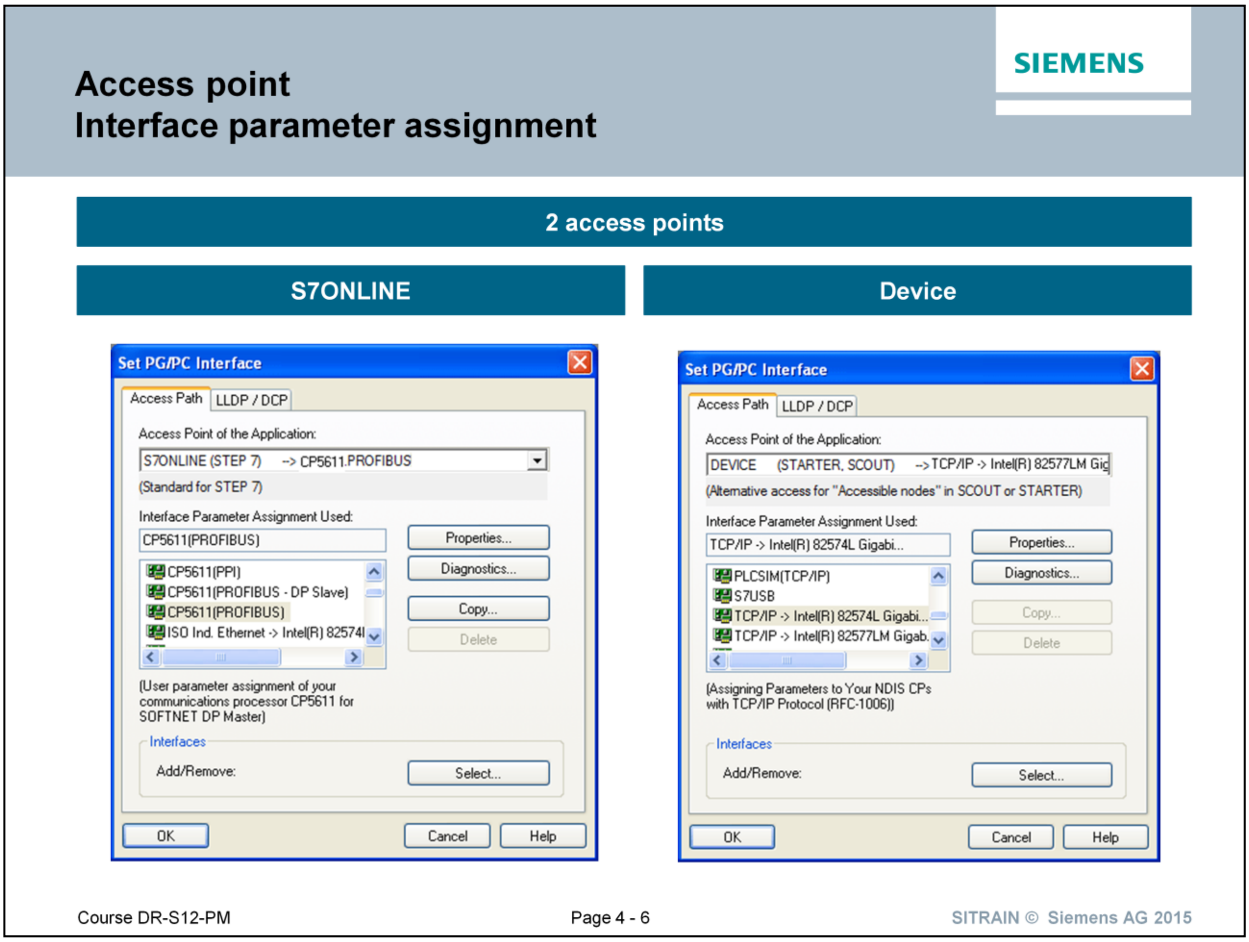
The network connection (PROFIBUS-DP or PROFINET) can be used to integrate the Control Unit in a communication network where one CPU provides the master and/or the controller. A PG may also be integrated into this network which can communicate with all network stations via the network.

Access point

STARTER offers two access points for these two options for communication to a Control Unit:

- DEVICE (STARTER, SCOUT)
- S7ONLINE (STEP7)

The "DEVICE“ access point is preferred for direct communication, while the access point "S7ONLINE“ is used for communication within a network.



Access point STARTER offers the user two methods of setting up a communication connection:

- DEVICE (STARTER, SCOUT)
- S7ONLINE (STEP7)

Parameter assignment The interface to be used for communication must be defined for both access points.

The following sequence can be used to assign parameters:

>> Tools > Set PG/PC interface

A pulldown menu is used to select the access point to be configured.

The "Interface Parameter Assignment Used" table is used to select which interface this access point utilizes for communication.

Example Communication between the PG and the Control Unit is carried out via the LAN interface.

The PG has 2 LAN interfaces with names:

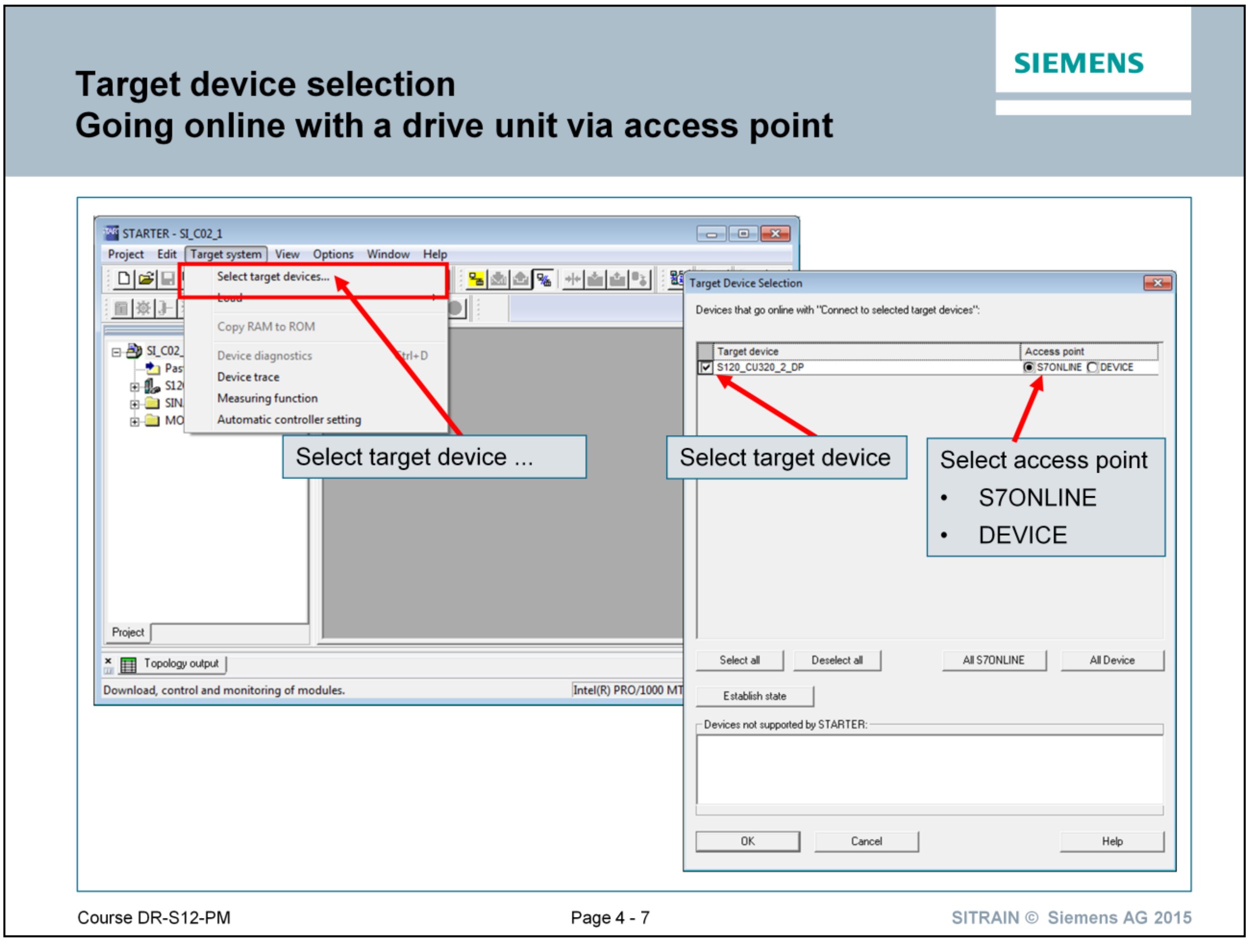
- LAN connection: Intel 82574L Gigabit network …. (left interface)
- LAN connection 2: Intel 82574LM Gigabit network …. (right interface)

Communication to the CU should take place via the left interface.

To do this, use an Ethernet cable to connect the LAN interface on the PG to the LAN interface on the CU. Select the "DEVICE" access point for this direct connection.

The "DEVICE" access point is assigned the following interface parameters:

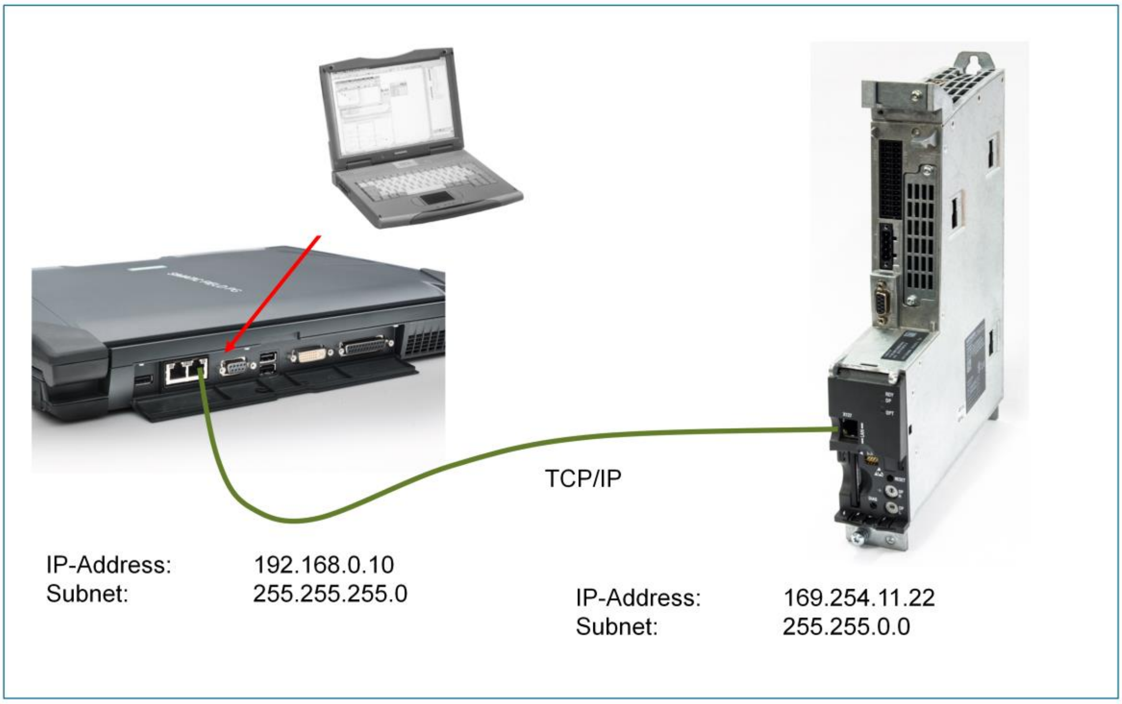
TCP/IP- Intel 82574L Gigabit network ….



Select target devices If a project contains several drive units, you can select the devices to which a connection is to be set up when the "Online connection" button is pressed. In this way, it is possible to connect selectively to specific target devices.

Connect online If a drive unit is to be connected to a target device (go online), it is possible to specify the access point (and thereby the interface) to be used to set up the connection.

Access point DEVICE interace TCP/IP



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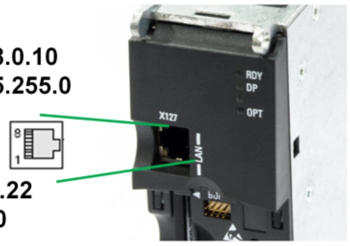
IP addresses
Default PG and Control Unit

IP address: 192.168.0.10
Subnet: 255.255.255.0



IP address: 169.254.11.22
Subnet: 255.255.0.0

Class	Address structure			Valid range	#Networks	#Host
Class A:	0	7 bits network	24 bits host	1 to 126	126	16777214
Subnet mask: 255.0.0.0						
Class B:	10	14 bits network	16 bits host	128 to 191	16384	65534
Subnet mask: 255.255.0.0						
Class C:	110	21 bits network	8 bits host	192 to 223	2097152	254
Subnet mask: 255.255.255.0						

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IP addresses

Each access point for a device on a network is identified by its address. The IP address is used in TCP/IP networks. It comprises 4 bytes and is structured according to rules, e.g.:
192.168.0.1 (dot notation)

With the dot notation, each IP address is expressed by four decimal numbers between 0 and 255, separated by dots.

IP addresses have two parts: the network ID and the host ID. The network ID specifies the subnet to which the host is connected. The host ID specifies the address of the access point for the host.

IP Classes

The subdivision of an IP address into a subnet and host breaks the IP network down into a large collection of interconnected subnets with the different sizes. 5 classes were originally defined, however only the classes A, B and C are used.

Subnet mask

A subnet mask is a filter used to identify all systems connected to the same physical network section.
The rules for the subnet mask are very simple:

- Ones in the subnet mask identify the number part of the subnet.
- Zeros identify the part of the address that is available for the host ID.

Even if the subnet masks are not used, the hardware automatically defines the default subnet mask for class A, B or C.

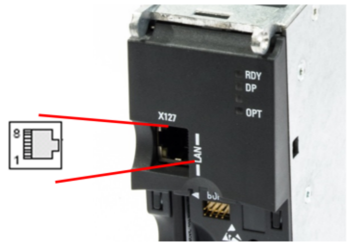
Note

If send and receive stations are connected to the same network, or connected directly by a crossed Ethernet cable, the network ID of both IP addresses must match.

IP addresses
Adapting the IP addresses

IP-Adresse: 192.168.0.10
Subnet: 255.255.255.0

No communi-cation



IP-Adresse: 169.254.11.22
Subnet: 255.255.0.0

Adapting the IP addresses

1. Changing IP addresses
   1. Of the PG: via the network configuration
   2. Of the CU: via "Edit Ethernet node"
2. Adding an additional IP address to the PG

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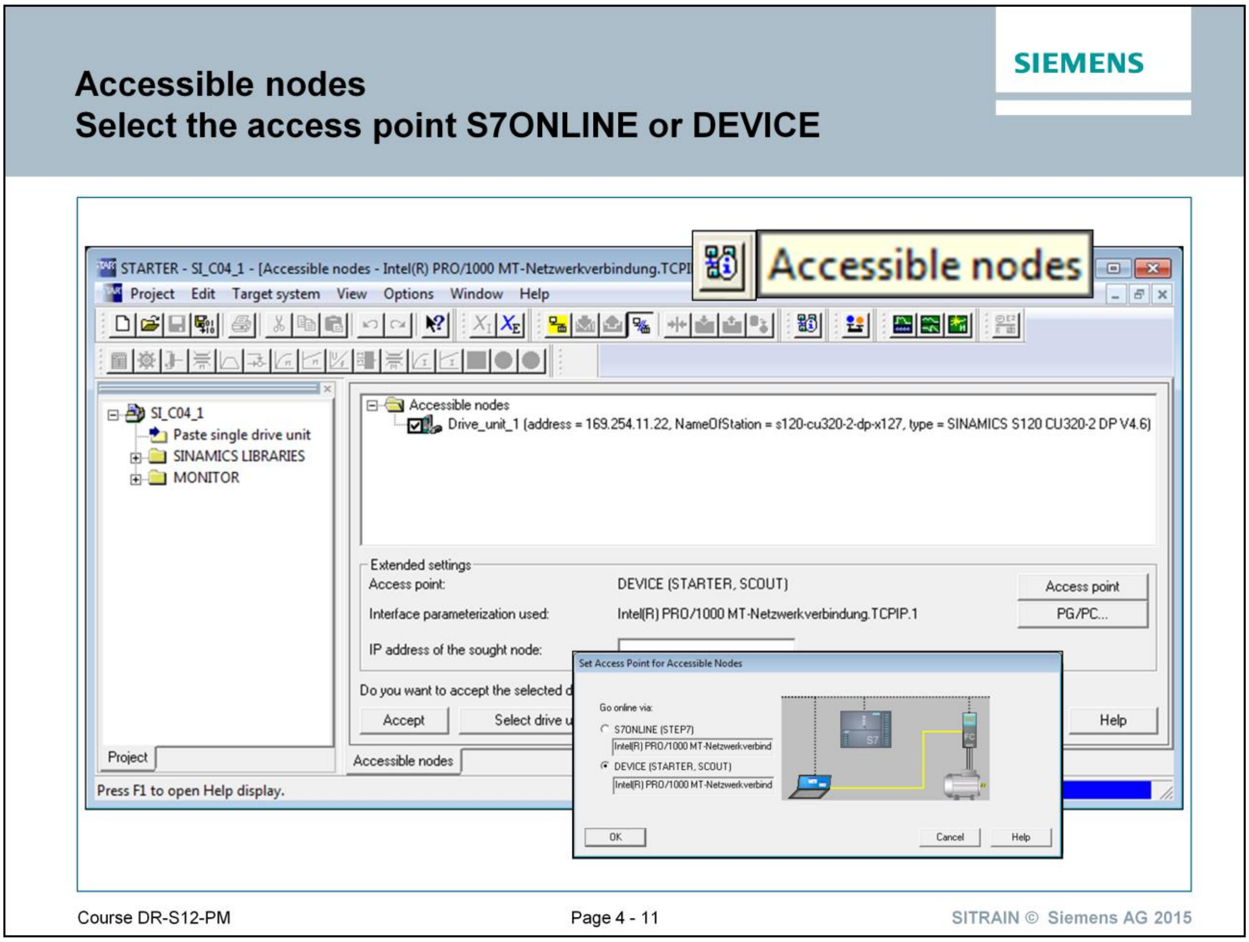
Changing IP address For communication between the PG and the Control Unit via the LAN interface, the network ID of both IP addresses must match and the host addresses must be different.

Control Unit The LAN address can be edited using the "Edit Ethernet node" tool.

PG The IP addresses of the PG are set via the network configuration. This network configuration can also be used to assign a further IP address to the LAN interface of the PG.

In addition, STARTER can also set up a temporary IP address. This address remains active until STARTER is terminated.

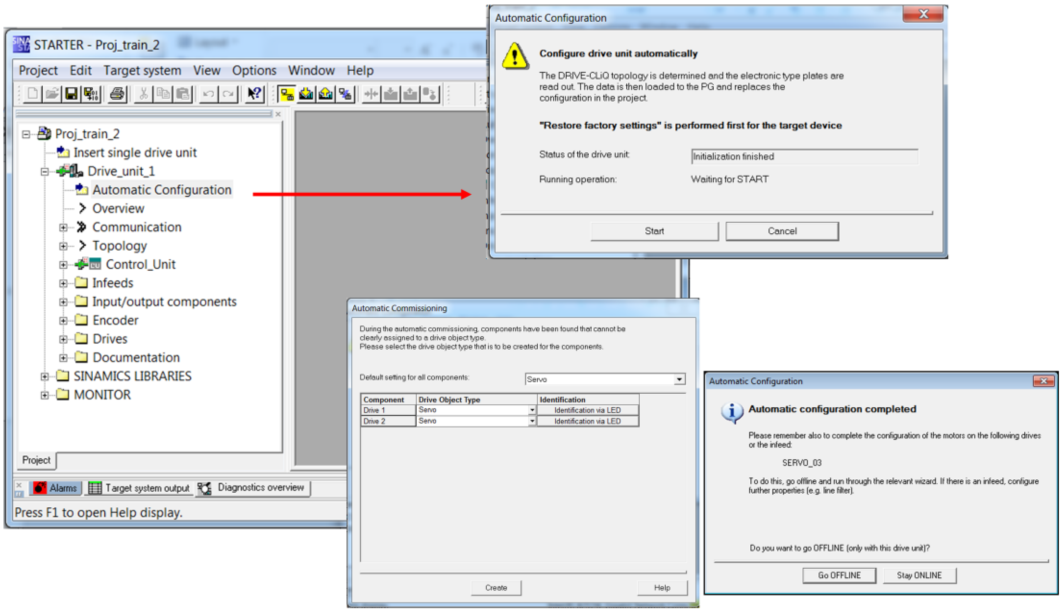


A drive can be inserted extremely conveniently into a project using this function. This is especially useful on a network with a large number of drives, but it can also be used for a simple point-to-point connection.

Access point

The selected access point S7ONLINE or DEVICE is used to search for accessible nodes. The access point can be selected using the "Access point" button. The "PG/PC…" button can be used to change the interface configuration for the access point.

Automatic configuration
Determining the DRIVE-CLiQ topology



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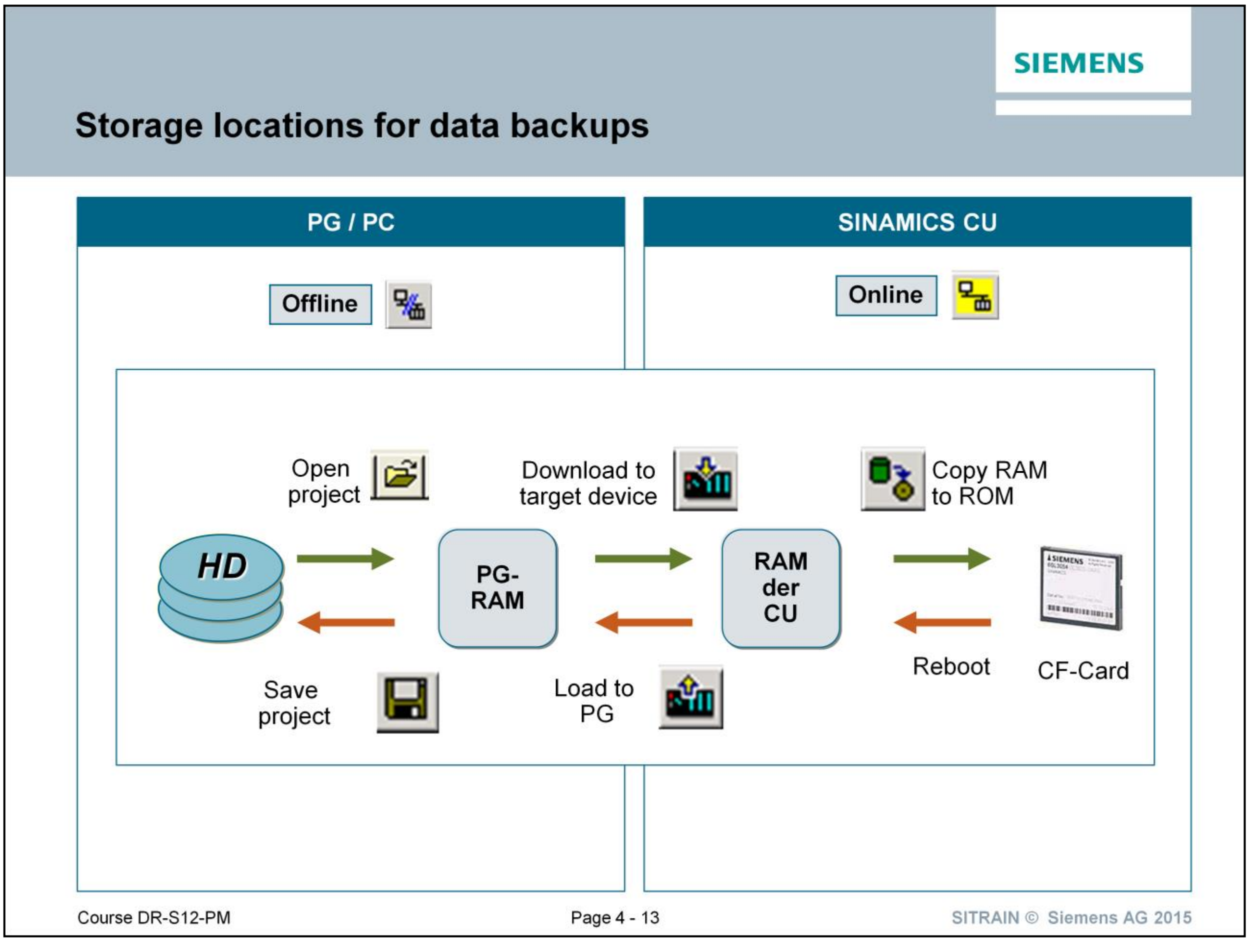
The topology is determined and transferred automatically to the PG using "Automatic Configuration" (quick commissioning).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Storage locations for data backups
PG / PC
SINAMICS CU
Offline
Online
Open
project
Download to
target device
Copy RAM
to ROM
HD
PG-
RAM
RAM
der
CU
Save
project
Load to
PG
Reboot
CF-Card
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Project or drive unit
Download and save parameters

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Download/upload complete project to/from target device
All project data from all target devices
→ Drive unit 1 (e.g. address 4)
→ Drive unit 2 (e.g. address 5)
→ SIMOTION …

Saving the data of a drive unit
Only the selected drive unit of the project
(e.g. drive unit 2)

Download project to target system

Download project to PG

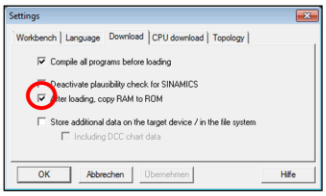
Restore factory settings

Copy RAM to ROM

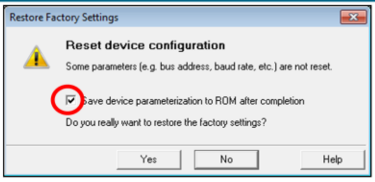
Download to target system

Load to PG

Download with/without copy RAM to ROM:



Factory settings with/without copy RAM to ROM



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Exercises

- Exercise 1: Setting up the training case
- Exercise 2: Online access via LAN interface
- Exercise 3: Configuring the drives
- Exercise 4: Testing with control panel
- Exercise 5: Data backup
- Exercise 6: Changing the IP addresses

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Safety information

Please note that:

- The course instructions have been produced for:
  - A course held by a course leader
  - Activities carried out on special training equipment
- The training equipment is operated under laboratory conditions.
  In case of doubt, always ask your course leader – particularly when handling components that carry electrical current or which can move.
- When carrying out work on equipment, the safety information in the associated product documentation must always be observed!
  The Training Documents alone are not sufficient.

Exercise 1: Structure of the training case Components

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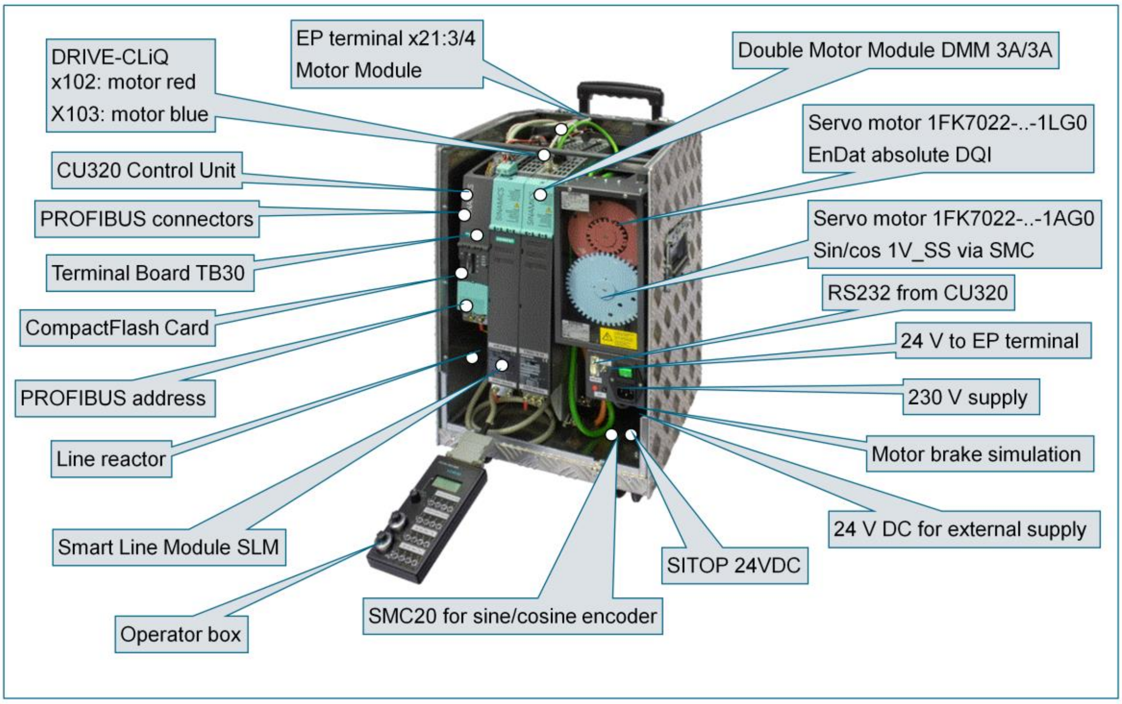

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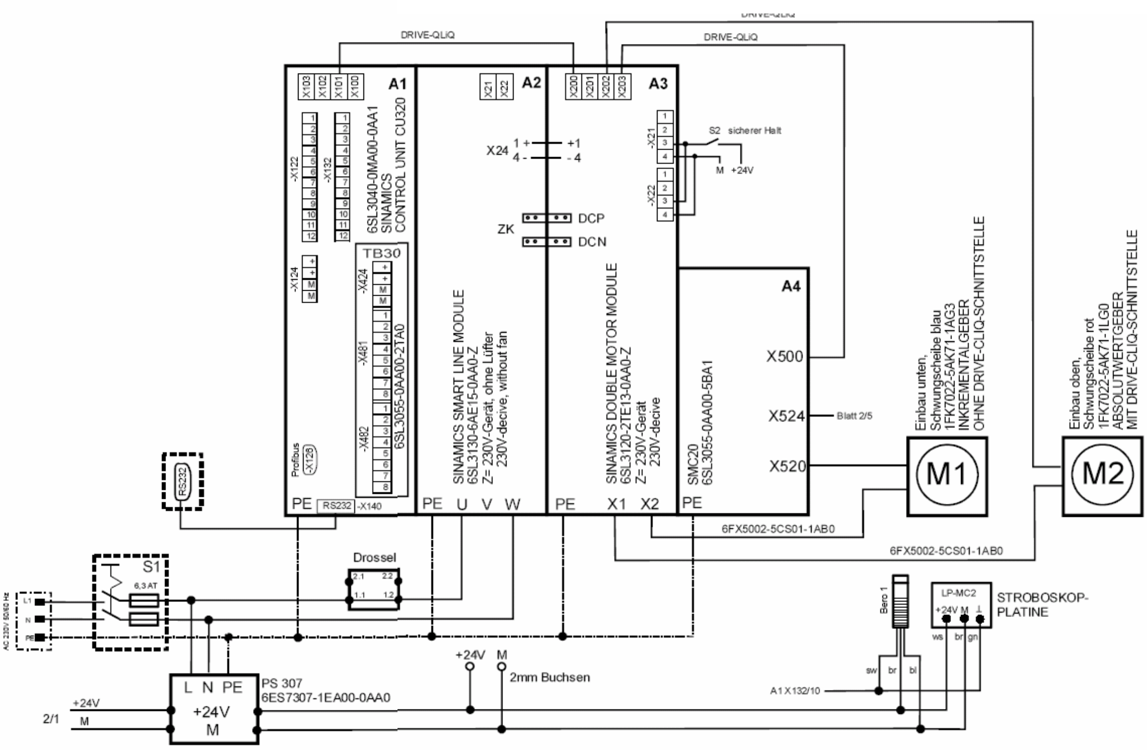
Task Compare your training equipment with this diagram and become familiar with the installed components.



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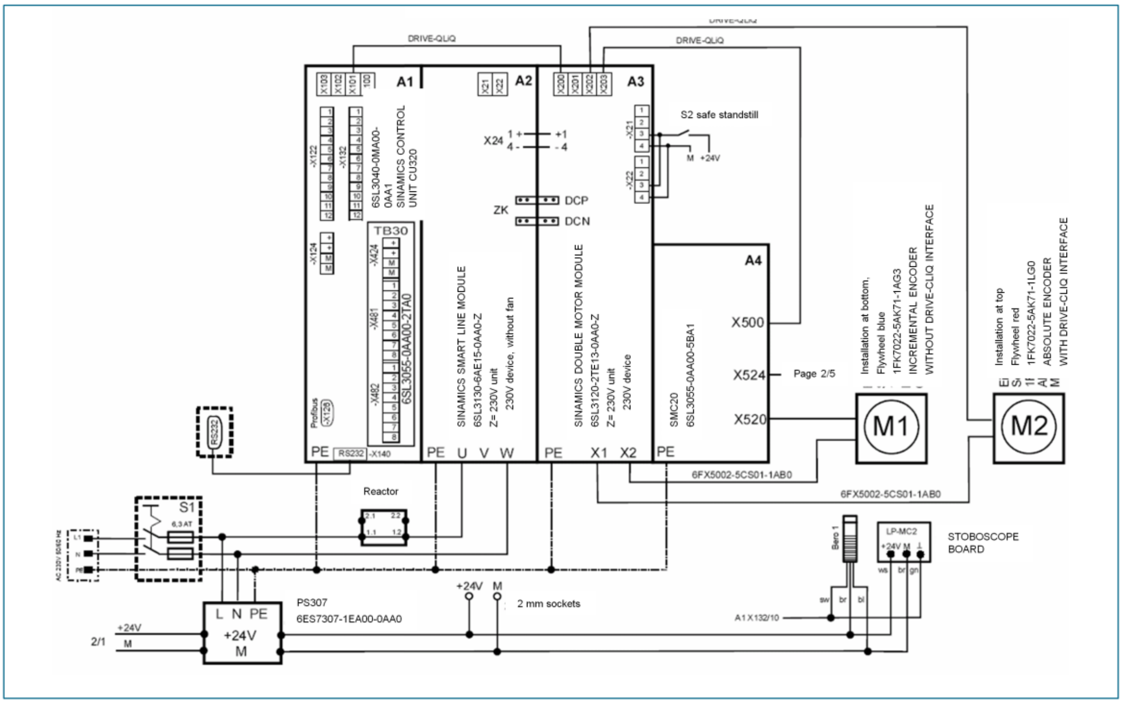
Exercise 1: Structure of the training case
Wiring



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Task Compare your training equipment with this diagram and become familiar with the installed components.

Exercise 1: Structure of the training case
Operator box

Nr.	Bezeichnung
1	Display of analog I/O
2	Changeover switch indicator
3	TB30 analog input 0
4	TB30 analog input 1
5	CU320-2: DI 0 to 3
6	CU320-2: DI 4 to 7
7	CU320-2: DI/O 8 to 11
8	CU320-2: DI/O 12 + 13
9	CU320-2: DI/O 20 + 21

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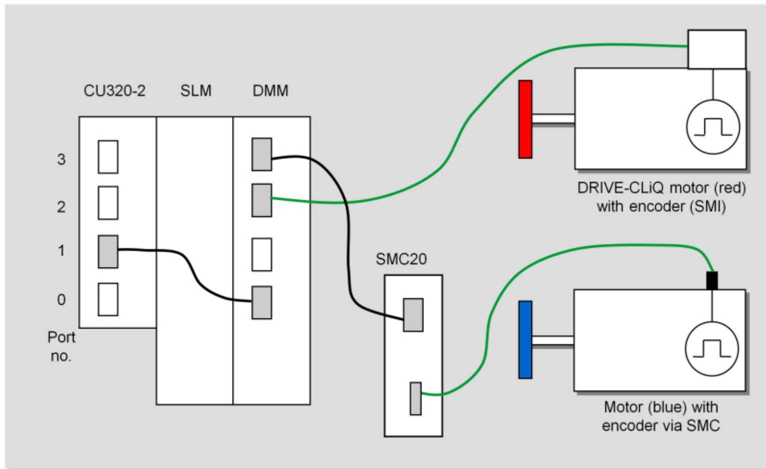
Task

Understand the function of the switches (= inputs for the drive) and the LEDs (= outputs for the drive).

Abbreviations:

- CU = Control Unit
- TB = Terminal Board
- DI = Digital Input
- DO = Digital Output
- AI = Analog Input
- AO = Analog Output

Exercise 1: Structure of the training case
Checking the hardware



Abbreviations:

CU320-2:	Control Unit
SLM:	Smart Line Module
DMM:	Double Motor Module
SMC20:	Sensor Module Cabinet
SMI:	Sensor Module Integrated

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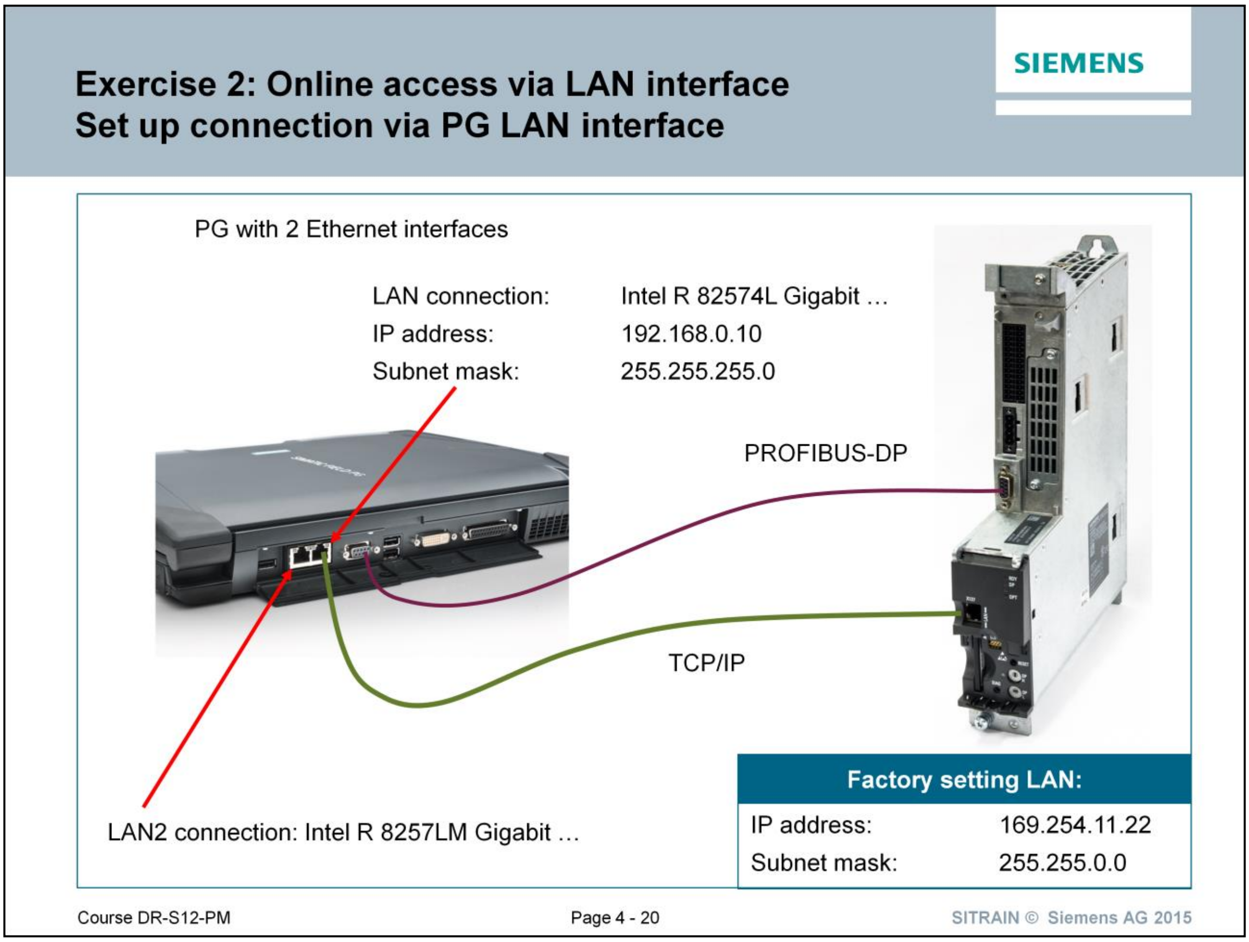
Task Check whether your training equipment corresponds to the standard structure.

1. Are all of the modules available and connected?
   - In the CU320-2 module, check whether a CompactFlash card has been inserted with a "structure" that matches the SINAMICS S120 device currently being used.
   - Check that the modules are reliably supplied with 24V DC.
   - Check whether the drive components are wired according to the DRIVE-CLiQ topology above.

2. Establish the DRIVE-CLiQ topology shown above at the training case (if this is required).



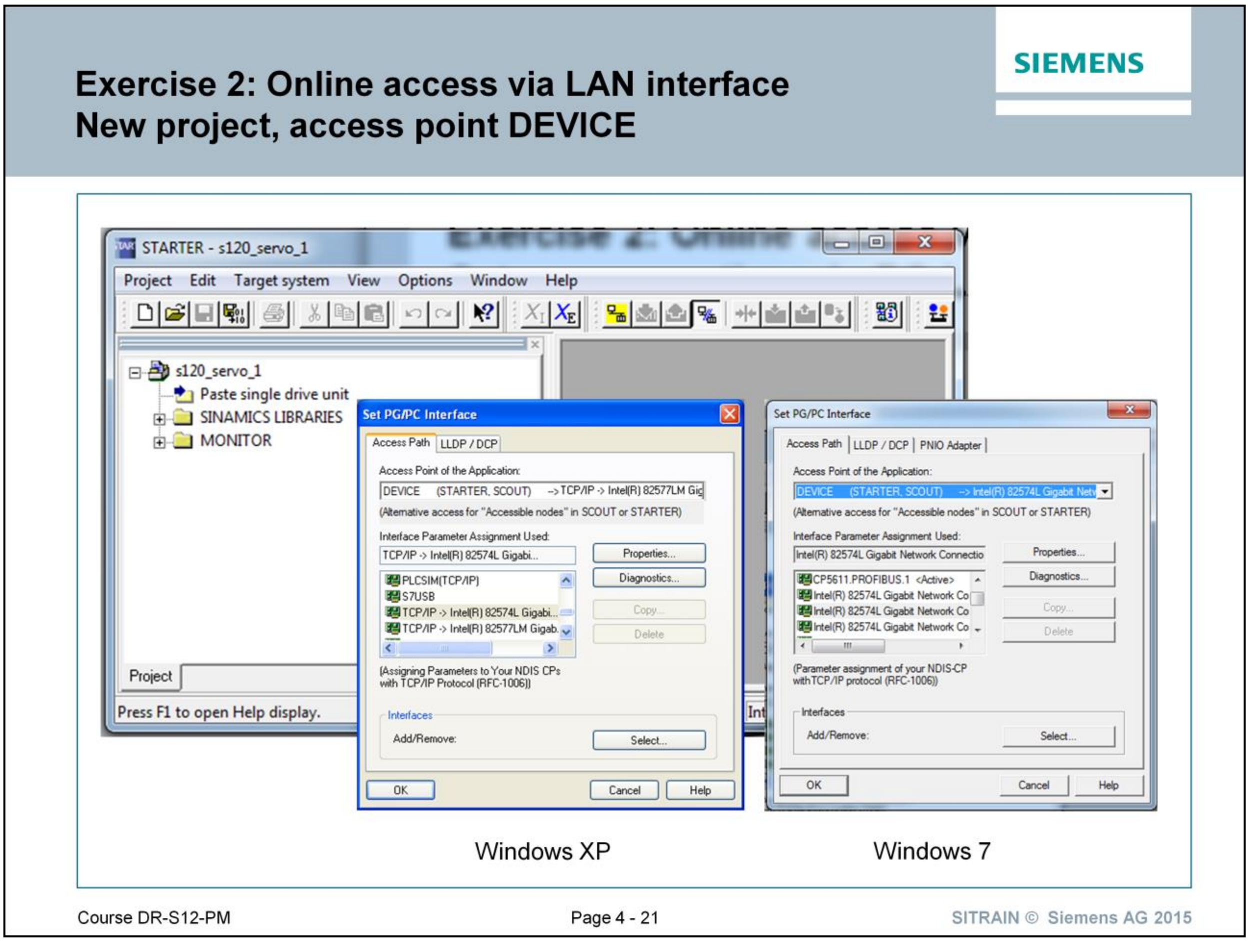
Task

An online connection is to be set up between the PG and the CU320-2 to initiate automatic configuration of the training equipment and commission the drives.

Then, the parameters should be saved in ROM and in the PG.

Procedure

Connect the LAN interface (left Ethernet interface viewed from the front) to the LAN interface of the CU320-2 using an Ethernet cable.



1. Create a new project with the name "S120_Servo_1“ using:
   >> *Project > New*

2. To set up a connection to the CU320-2, the access point and the interface configuration must be defined.
   Then open the parameter screen via:
   >> *Tools > Set PG/PC interface…*

3. At access point, select: DEVICE (STARTER, SCOUT), and for the interface parameter assignment used:
   - Windows XP: TCP/IP -> Intel® 82574L Gigabit…
   - Windows 7: Intel ® 82574L Gigabit Network Connection TCPIP.1

4. Accept the parameterization with "OK".

Exercise 2: Online access via LAN interface
Accessible nodes, access point via DEVICE

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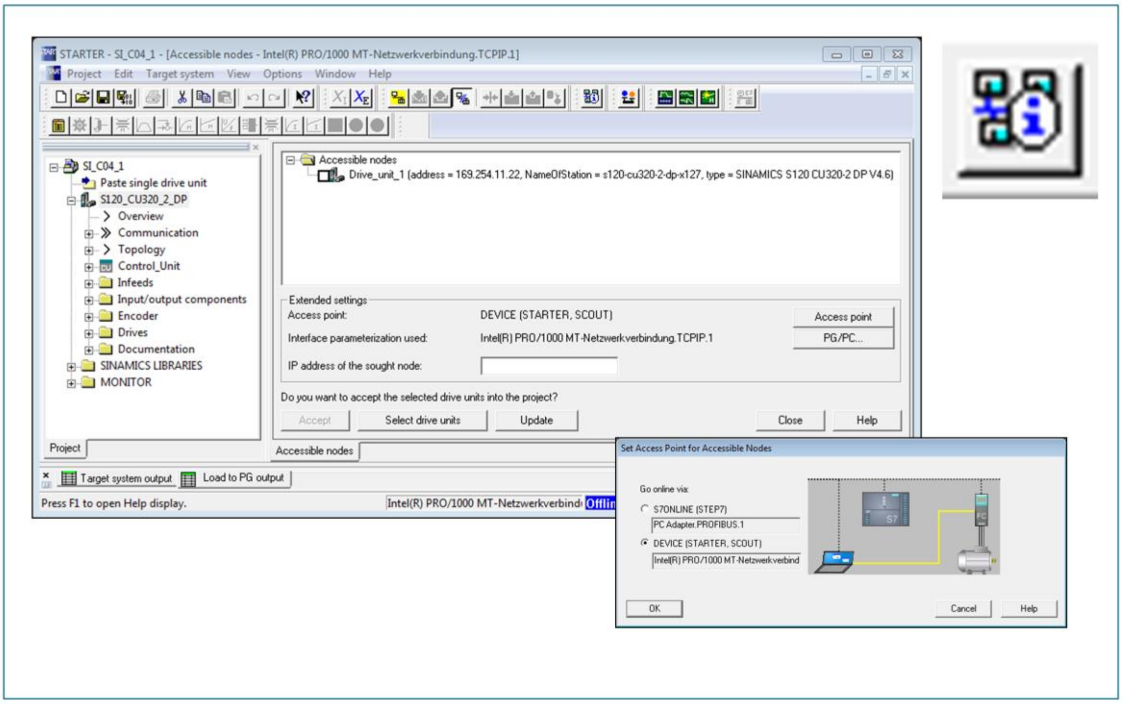

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Procedure

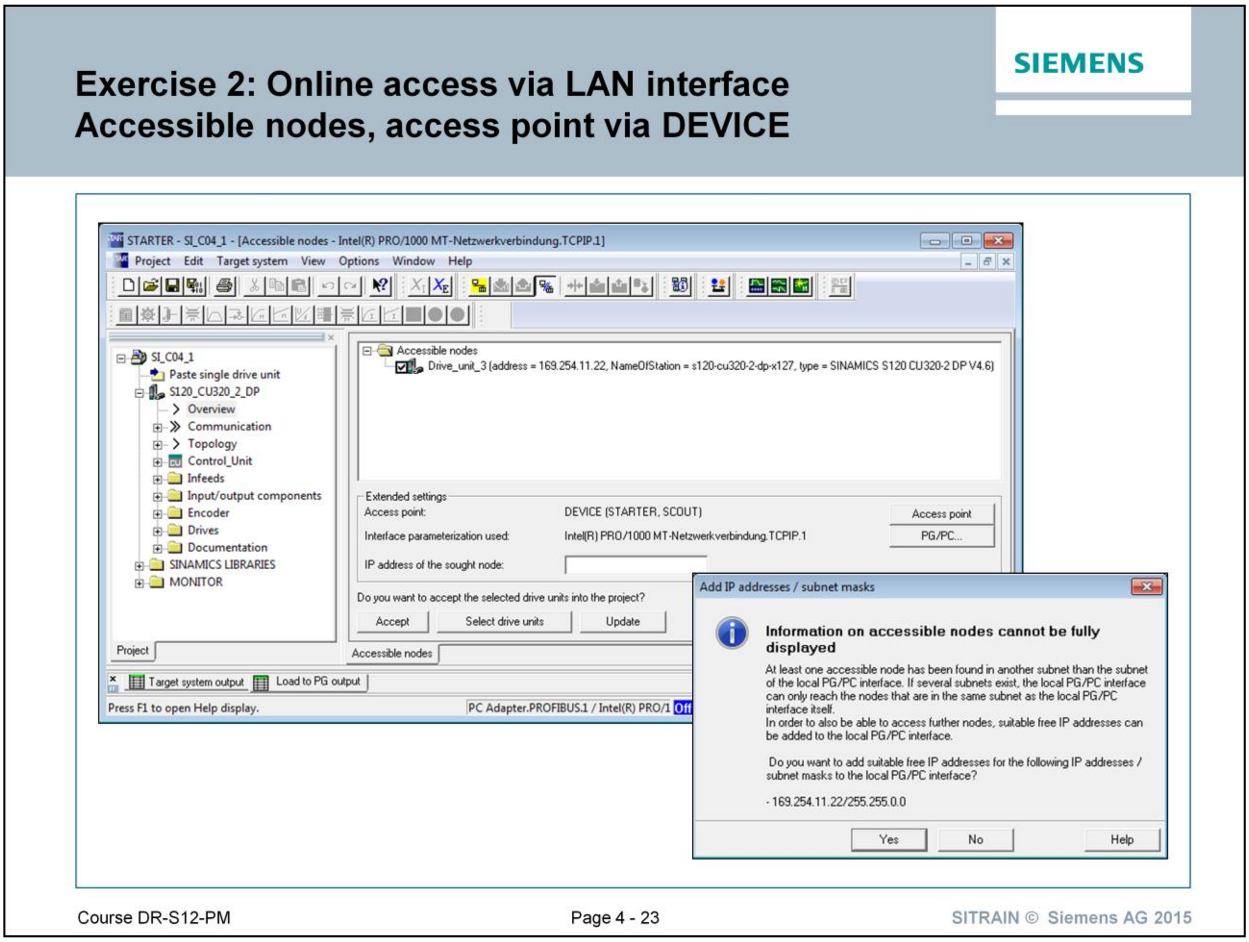
The "accessible nodes" function should be used to search for nodes in the network.

1. Click on the
   >> *Accessible nodes*
   button to start the function.
   Depending on configuration of the PG interface and settings, either the message:
   - No further node found

   or
   - Information on accessible nodes cannot be fully displayed“ appears.

2. Acknowledge the first message with "OK" and the second message with "No". Then, the "Accessible nodes" screen is visible.

3. Select the "Access point" button.
   In this screen, you can now choose the access point (S7ONLINE or DEVICE) to which a connection is to be established.
   Click on the "DEVICE" access point.
   The "Update" button initiates a search for accessible nodes via the DEVICE access point again.



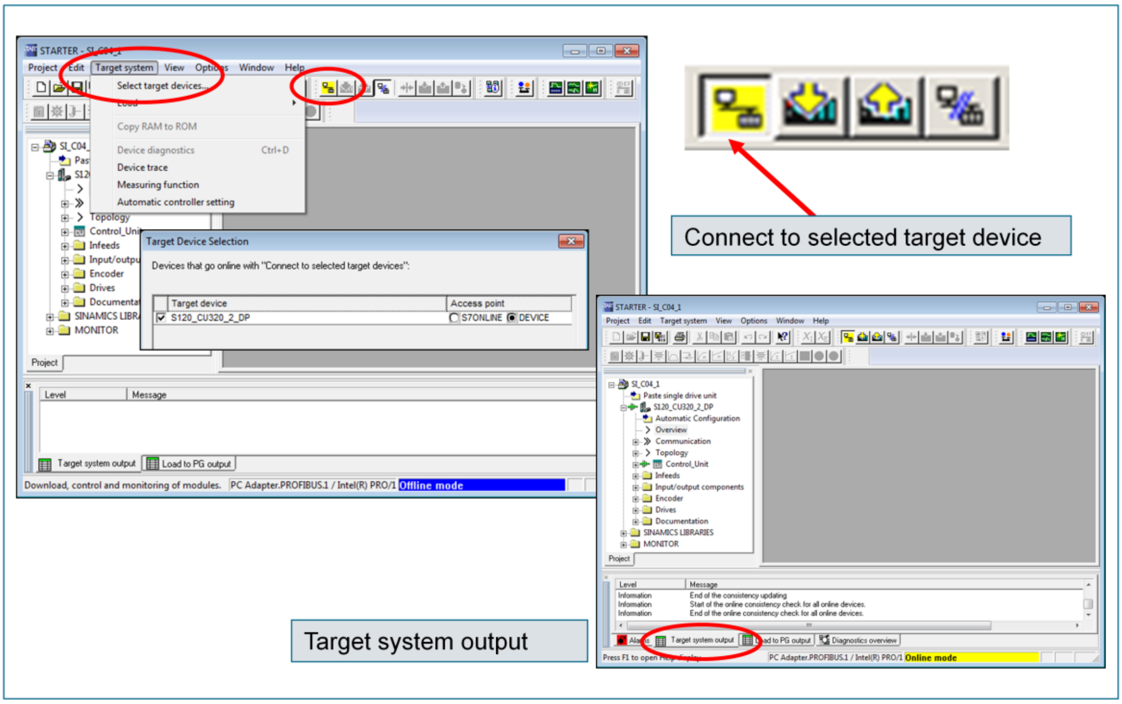
4. The message "Information on accessible nodes cannot be fully displayed“ appears.

5. Since the CU320-2 CU has the IP address 169.254.11.22 and the PG has the IP address 192.168.0.10, it is suggested that you set up a temporary IP address to communicate with the CU.
   Acknowledge this message with "Yes".

6. The node with the IP address 169.254.11.22 appears in the screen of accessible nodes. The node is detected as a CU320-2 with firmware version 4.6.

7. Select the drive unit and with the button “accept” you can incorporate it into the still empty project.
   This creates a project tree.

Exercise 2: Online access via LAN interface
Connect to target device, go online



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Task

The next step is to go online (connect to tarrget system) with the project

The drive unit in the project is to be connected to CU via the "DEVICE" access point:

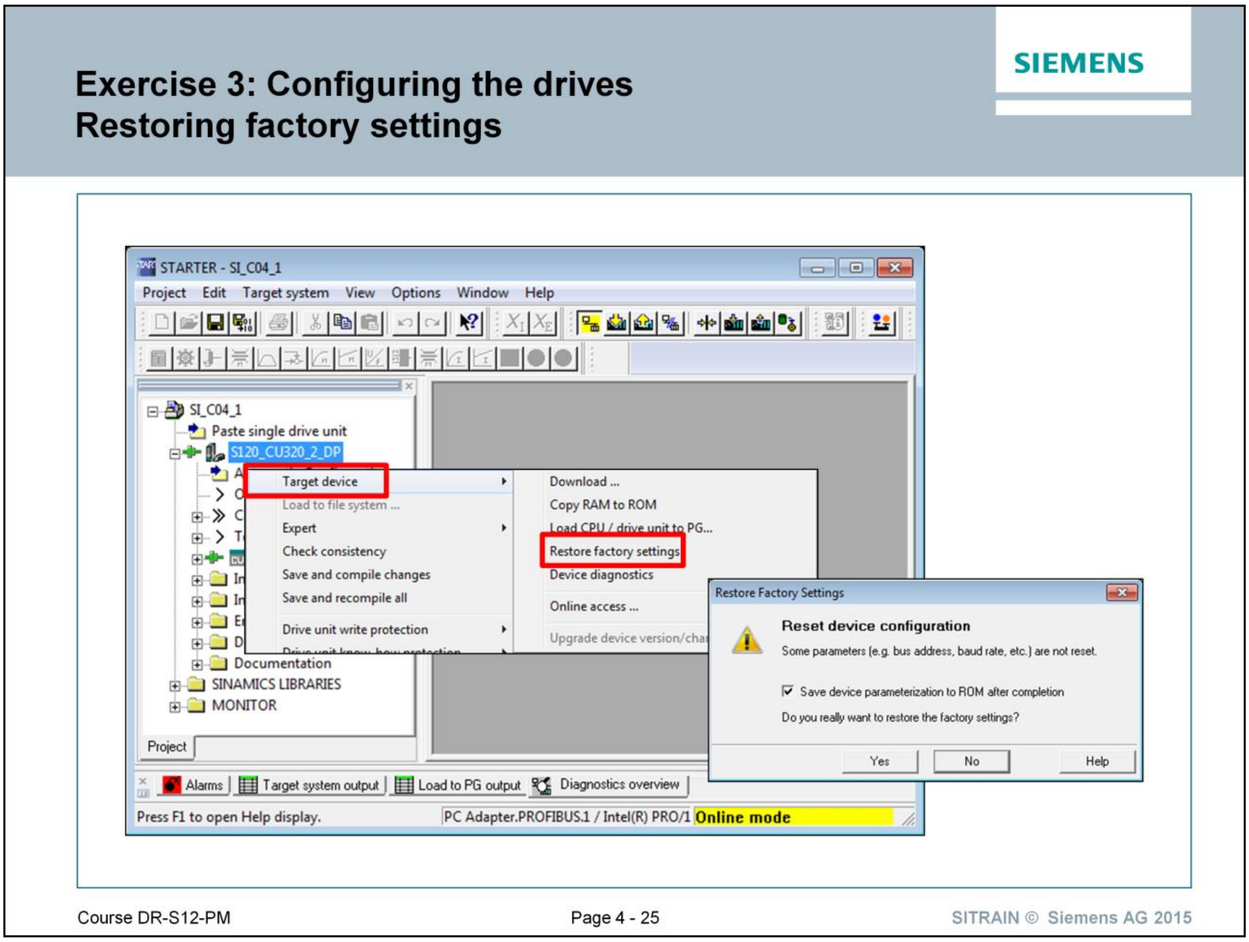
1. Open the "Target Device Selection" screen via:
   >> Target system -> Select target devices.

2. In this screen, you can select which drive units are to establish a connection and define which access point is to be used to connect each drive unit in the project to the target device.

3. Select the drive unit and the "DEVICE" access point.

4. The "Connect to selected target devices" button establishes the connection to the CU320-2 via TCP/IP.

5. The "Target system output" diagnostics information provides information about the access point and the IP address of the target system.



Task

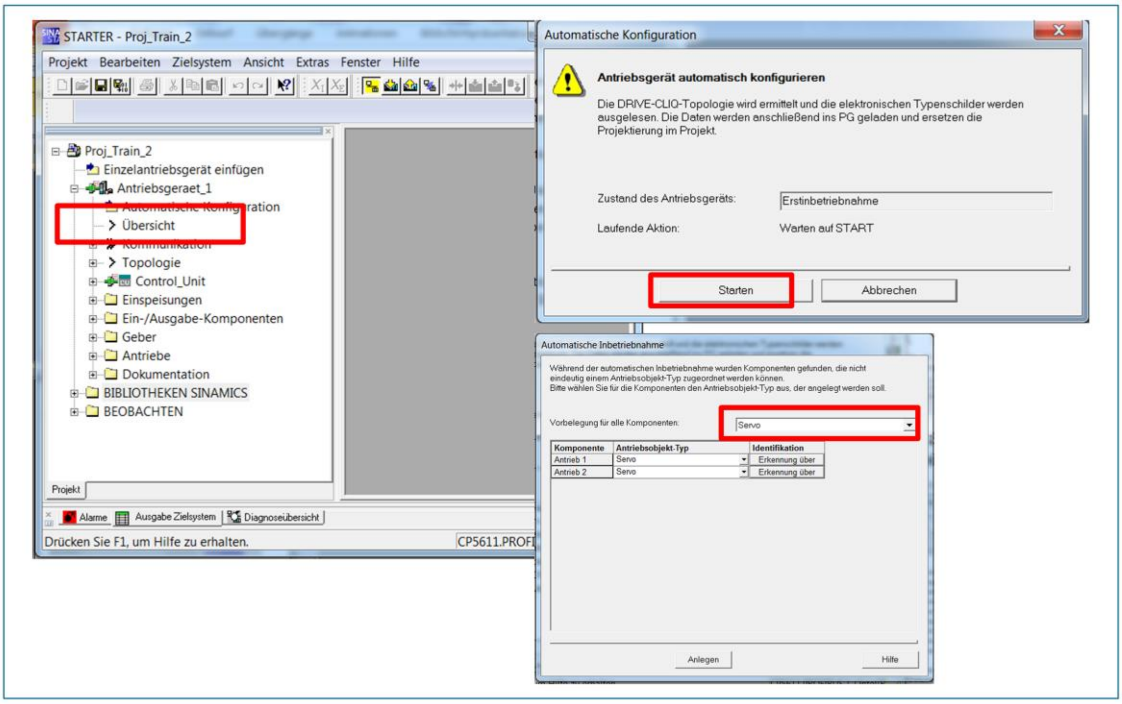
By restoring the factory settings, establish a neutral starting state, and then start with the automatic configuration:

Procedure

1. Restore the factory settings for the drive:
   Select the drive unit using the right mouse key:
   >> Target device > Restore factory settings

2. Set the check mark at the "Save device parameterization to ROM after completion" checkbox

Exercise 3: Configuring the drives automatic configuration



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1. Carry out an "Automatic configuration":
   >> *Automatic configuration*
   [Message "Status of the drive unit: First commissioning“]

2. Start the automatic configuration:
   >> *Configure*

3. Pre-assignment for all components:
   >> *SERVO > Create*

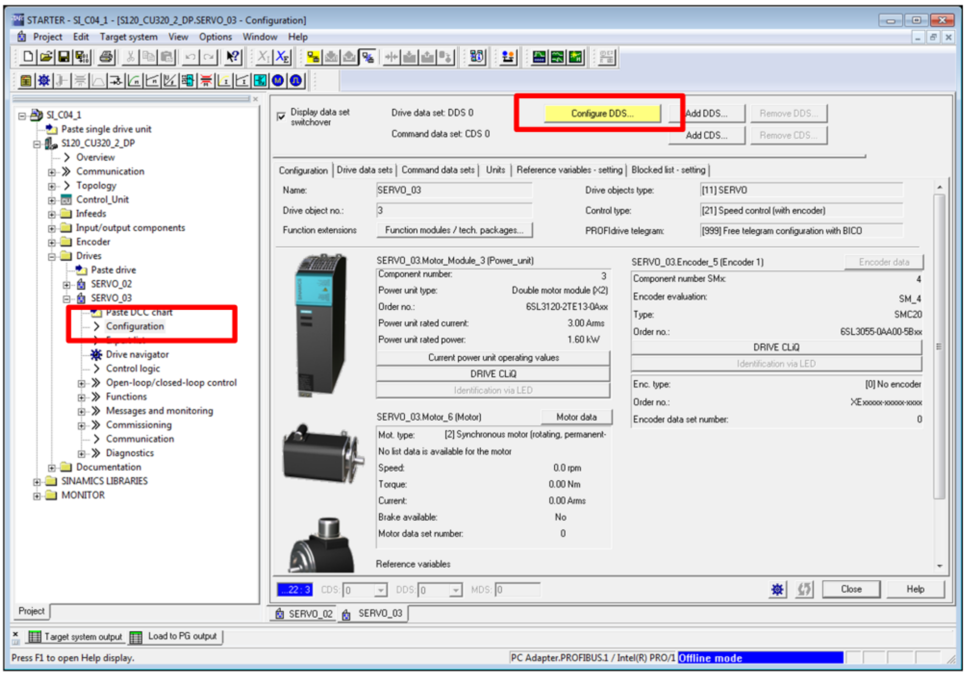
4. Exit the automatic configuration using the following function:
   >> *Go OFFLINE*

5. Select "Drive_unit_1" using the right mouse key:
   >> *Rename > SINAMICS_S120*
   → the name has been changed to "SINAMICS_S120".

Note

If the CU 320-2 detects a DRIVE-CLiQ component with a different firmware release (possibly also with hotfix), a FW upgrade/downgrade is started automatically as of FW version 2.5.1. The message "Update in progress" is displayed. A POWER ON must then be executed to activate the new FW version.

Exercise 3: Configuring the drives
Configuration "Drive_03"



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Task In the project navigator, compare the results of the automatic configuration for your training equipment with the above diagram:

1. *SINAMICS_S120 > Communication > Telegram configuration > IF1*
   Drive object no. 1 = CU_S_004

   Drive object no. 2 = ……………………………………..

   Drive object no. 3 = ……………………………………..

   Drive object no. 4 = ……………………………………..

2. *Drives > Drive_02 > Configuration*

   Power unit order no.: ……………………………………..

   Motor order no.: ……………………………………..

   Encoder type: ……………………………………..

3. *Drives > Drive_03 > Configuration*

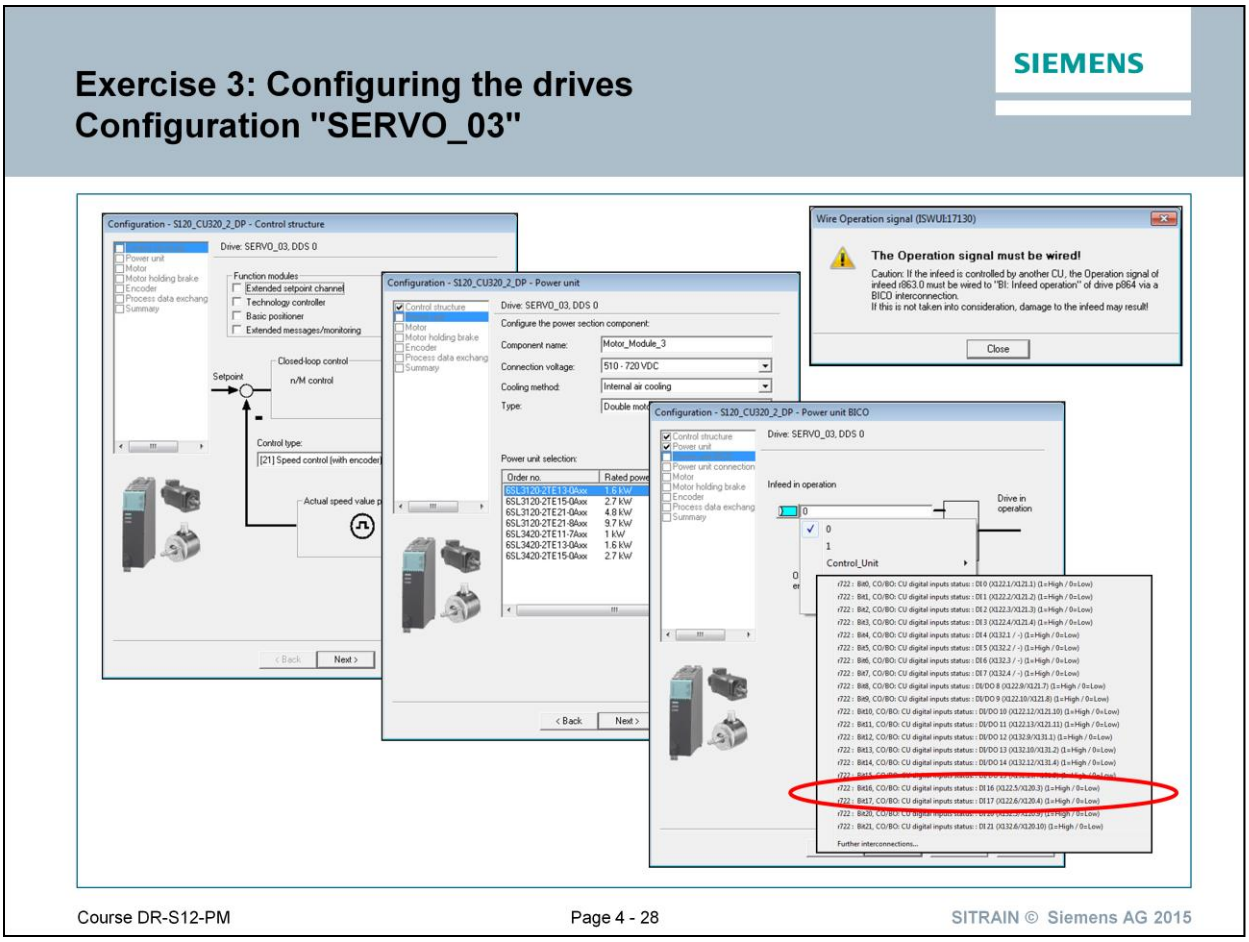
   Power unit order no.: ……………………………………..

   Motor order no.: ……………………………………..

   Encoder type: ……………………………………..

4. Conclusion:

   ………………………………………………………………………………



Task

As only the power unit (Motor Module) and the encoder interface (SMC20) have been identified for drive object "Servo_03", the motor and encoder data must now be configured:

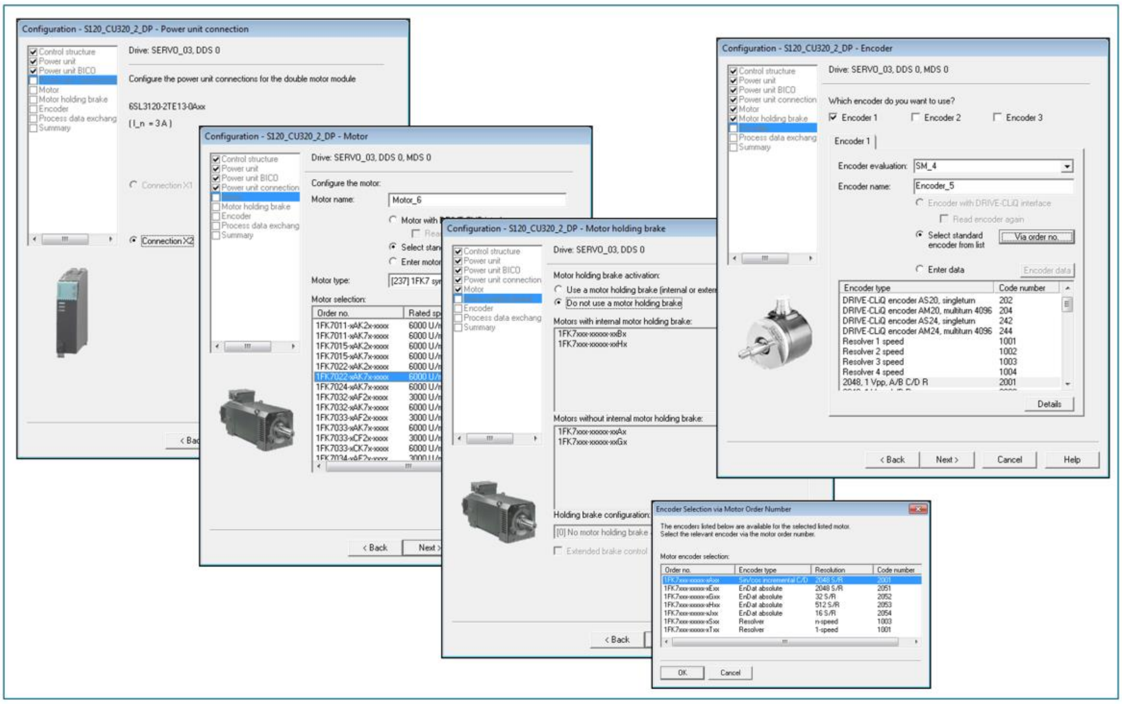
1. Configure the drive object "Servo_03":
   >> Drives > Servo_03 > Configuration > Configure DDS…

2. Run through the configuration routine with the following settings for the control structure:
   - NO function modules
   - Control type: Speed control (with encoder)

3. Power unit: keep the preassigned settings!

4. Power unit BICO: Here, to evaluate the feedback signal from the infeed unit, select the following BICO interconnection:
   Infeed in operation (p864): *>> CU_S_004, r722: Bit 16*

Exercise 3: Configuring the drives
Configuration "SERVO_03"



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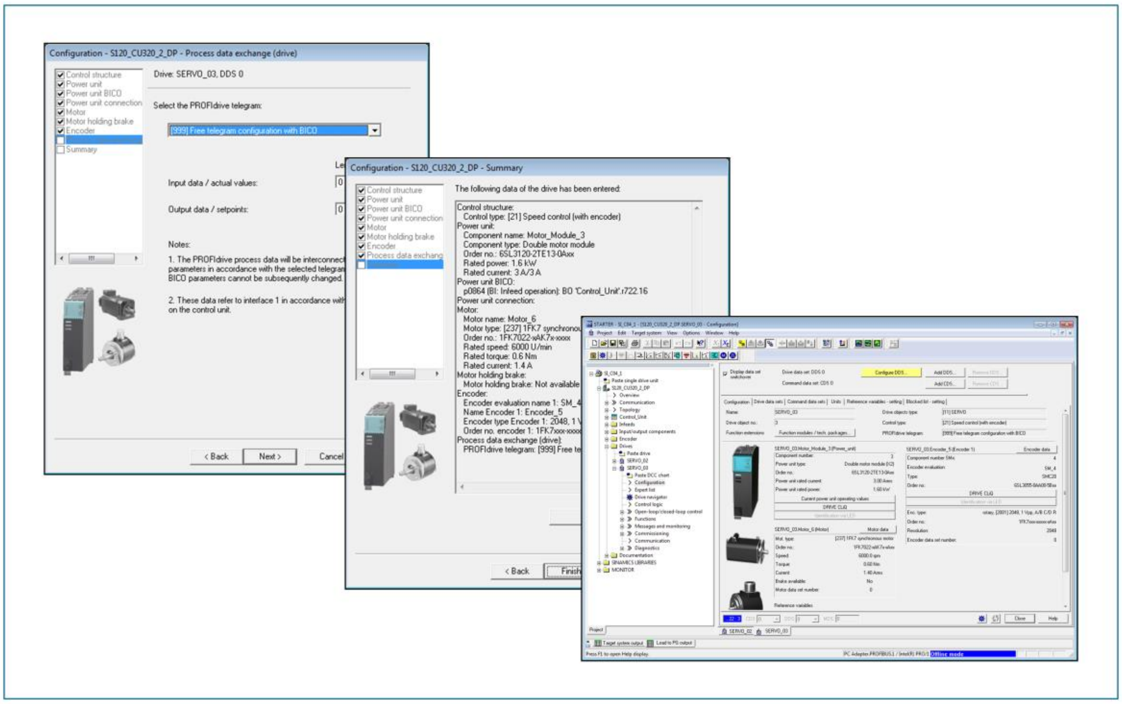
5. Motor: Enter the motor data based on the motor order number:
   >> Select a standard motor from the list
   >> Motor type: 1FK7 synchronous motor …

6. Motor holding brake: >> *Do not use a motor holding brake.*

7. Encoder: >> *Sin/cos incremental C/D (Code number: 2001) > OK*

Exercise 3: Configuring the drives
Configuration "SERVO_03"



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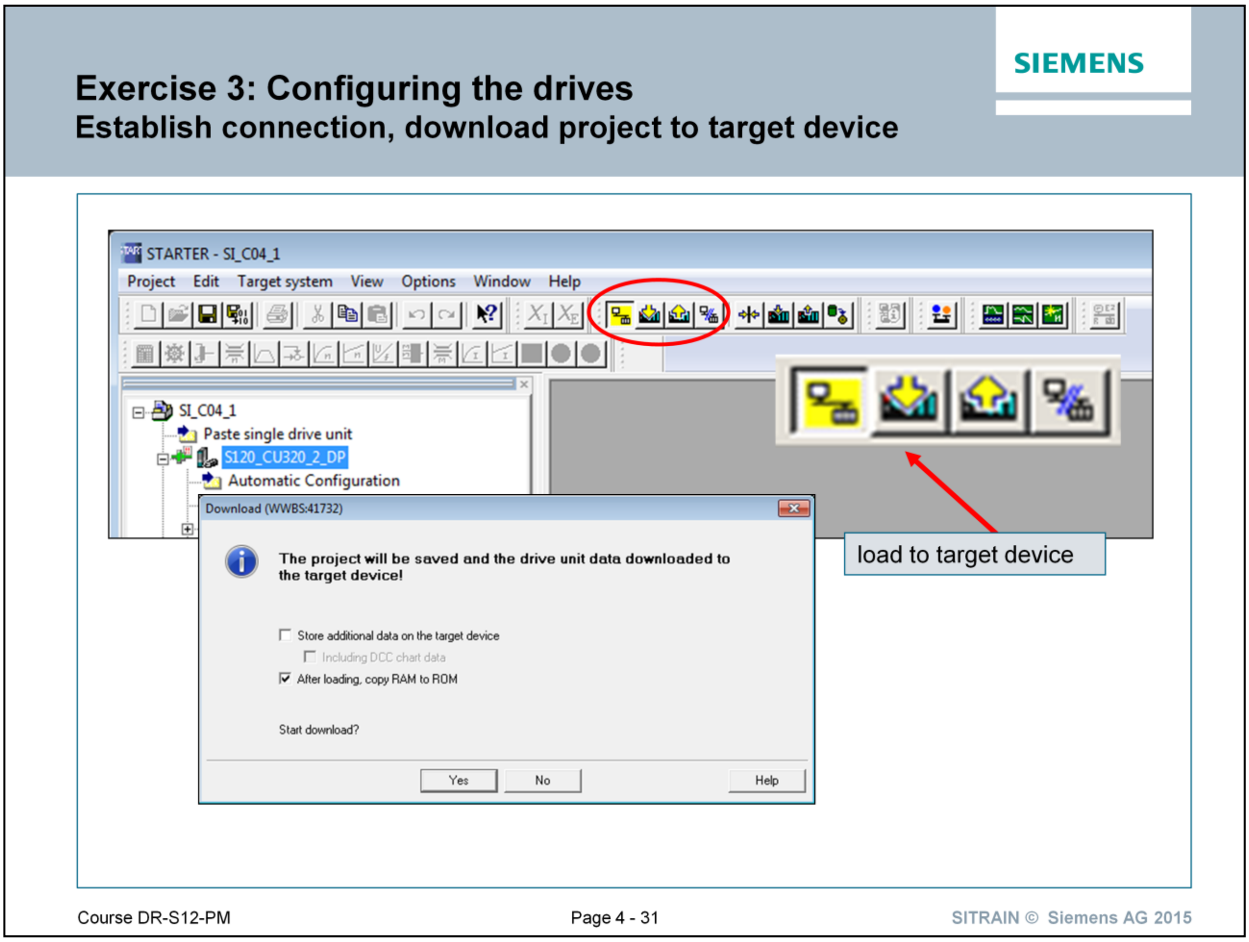
8. Process data exchange (drive): Keep the default "Free telegram configuration with BICO" and exit the drive configuration for "SERVO_03".

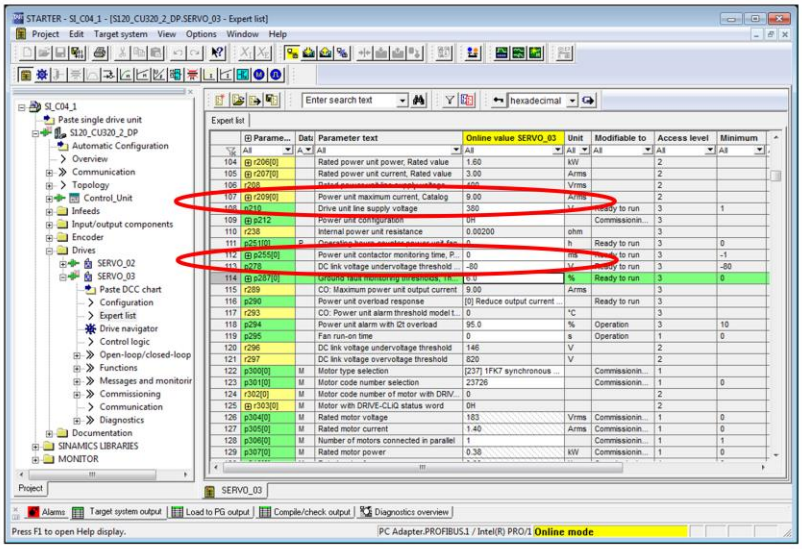
9. Save the data.



Task The data saved in the project should now be transferred to the CU320-2.

1. Go online using the yellow button.
2. Download the data to the target device.
3. The data should then also be saved in the ROM of the target device.

Exercise 3: Configuring the drives
Adapting the training equipment



P210: Drive unit line supply voltage: 380 V

P278: DC-link voltage undervoltage threshold reduction: -80 V

P340: Complete calculation: 1

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Task

As the training cases are operated with a 1-phase 230 V AC supply voltage instead of 3-phase supply voltage, and have therefore also been adapted from the hardware perspective, the voltage of the DC link monitoring must now also be appropriately adapted:

The drive unit line supply voltage for the Motor Module (drive: p210) is obtained from the line voltage and the infeed type:

U_line: 400V, controlled ➔ U_DC_link = U_line * 1.5
(e.g.: 400V AC * 1.5 = 600V DC)

U_line: 230V, unregulated ➔ U_DC_link = U_line * 1.43
(e.g.: 230V AC * 1.43 = 329 V DC)

Procedure

On the 230 V training case, p210 must be set to 329.

In order to ensure a higher margin to the internal fault threshold "U_DC_link_max“ in generator mode, the following setting is recommended:

>> **SERVO_03, p210 = 380**

To ensure that the fault threshold "U_DC_link_min" is not undershot in motor mode:

>> **SERVO_03, p278 = - 80**

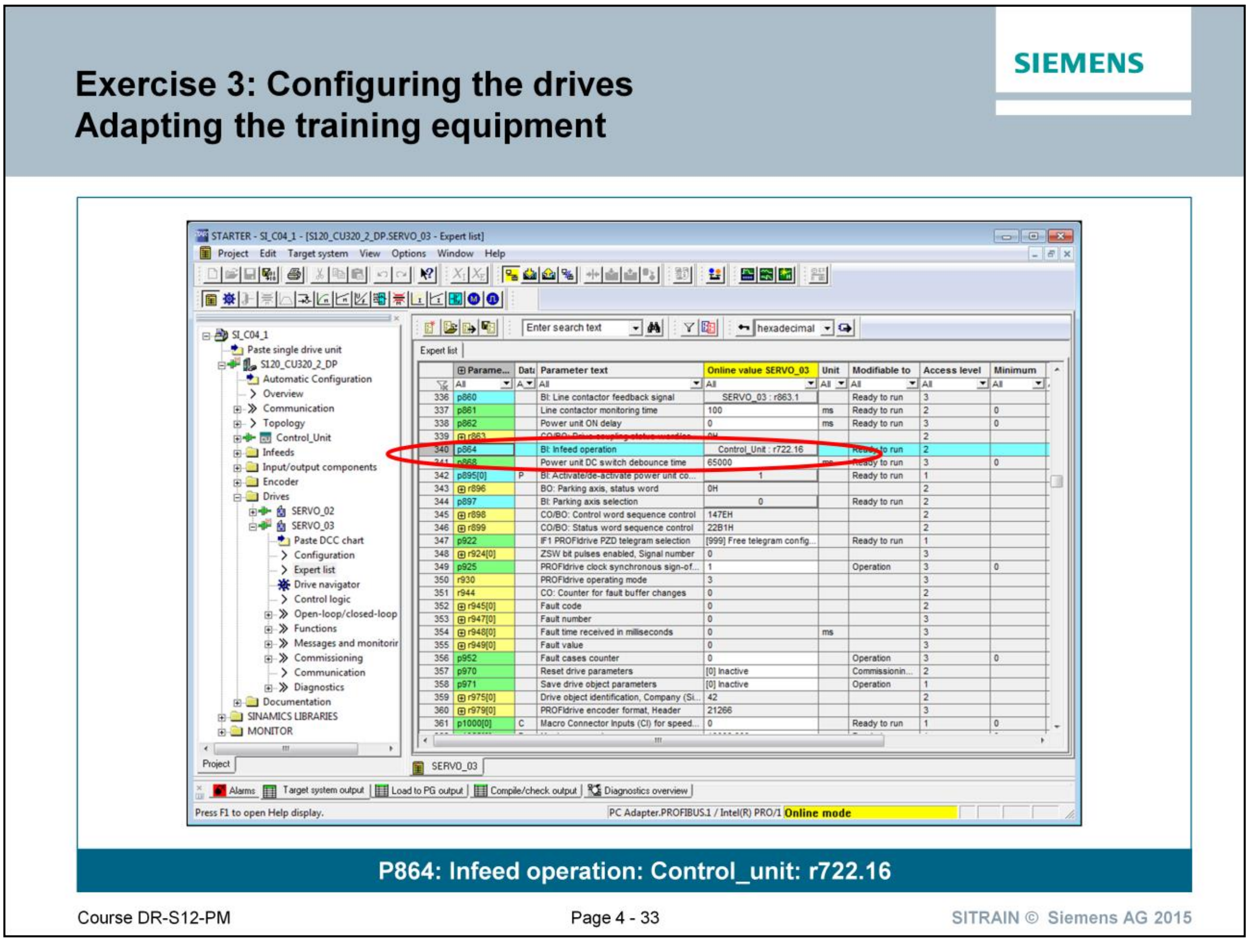
The upper and lower limits for DC link monitoring (p1244 = 710, p1248 = 205) are recalculated using:

>> **SERVO_03, p340 = 1**

Also use these settings for SERVO_02.

Note for SINUMERIK

At the 400V rack with SINUMERIK 840D solution line, the setting remains: p210 = 600.



Task

The training case has an infeed (Smart Line Module) without DRIVE-CLiQ connection to the CU320. The infeed provides a ready signal via terminal X21. On the training equipment, this signal is routed to the digital input DI16 of the CU.

In addition to the control signals, each drive also requires the signal "Infeed ready" for the enable.

This signal must be applied to parameter p864.

1. Open the expert list of the drive.

2. At parameter "p864: Infeed operation", the digital input of the CU to which the infeed signal is connected must be specified.

3. Go to the line of p864. Click on the value of the parameter to open the value screen.

4. Select "CU_S_004" as signal source and the parameter value p722: bit16. The result is then:
   p864: CU_S_004: r722.16

5. Check this parameter assignment also for the "SERVO_02" drive.

Exercise 3: Configuring the drives maximum speed

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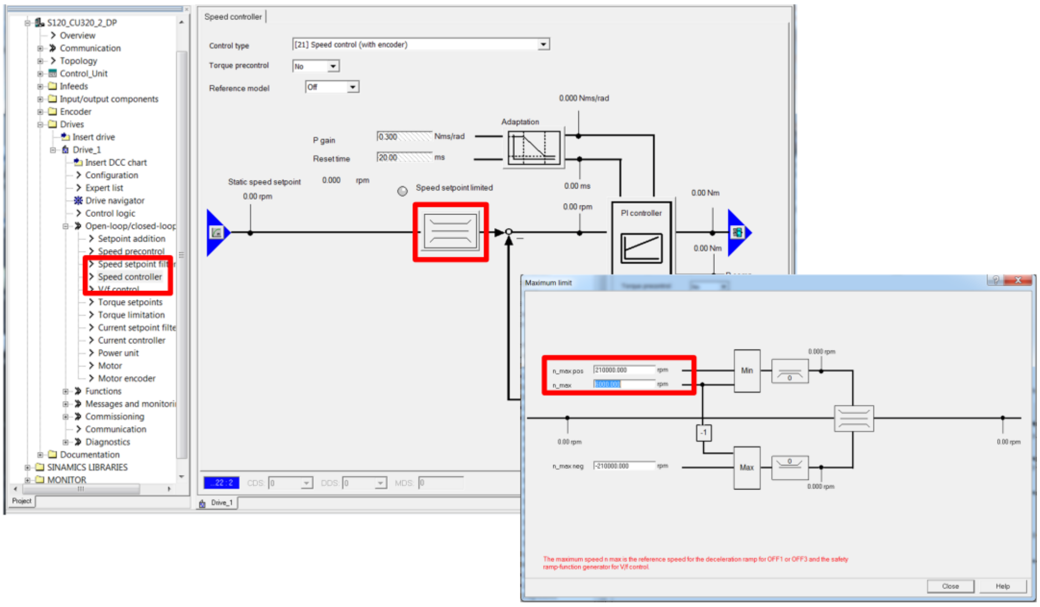

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8. The drives in the trainingsrack may turn only with a maximum speed of 6000 rpm. Using the automatic setting the rated motor speed is set to 6000 rpm and the maximum speed is set to 10000 rpm. Change the maximum speed to 6000 rpm in the menue: drive >> open loop/closed loop control >> speed controller >> speed setpoint limit: n_max: 6000 rpm.

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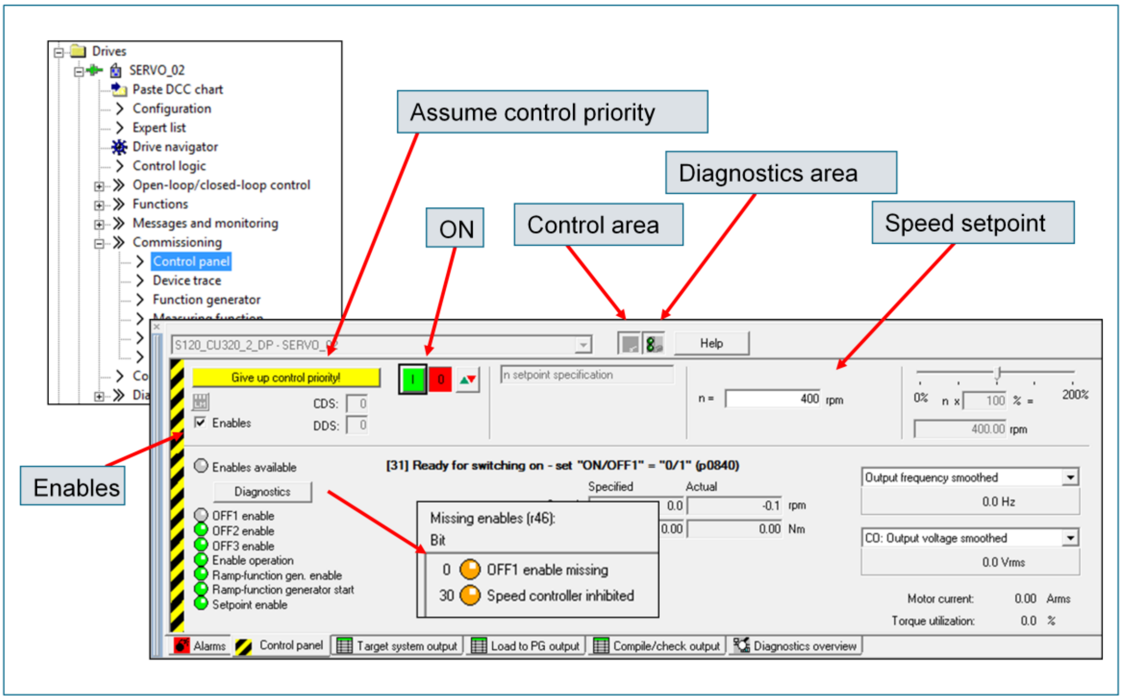
Exercise 4: Testing with control panel



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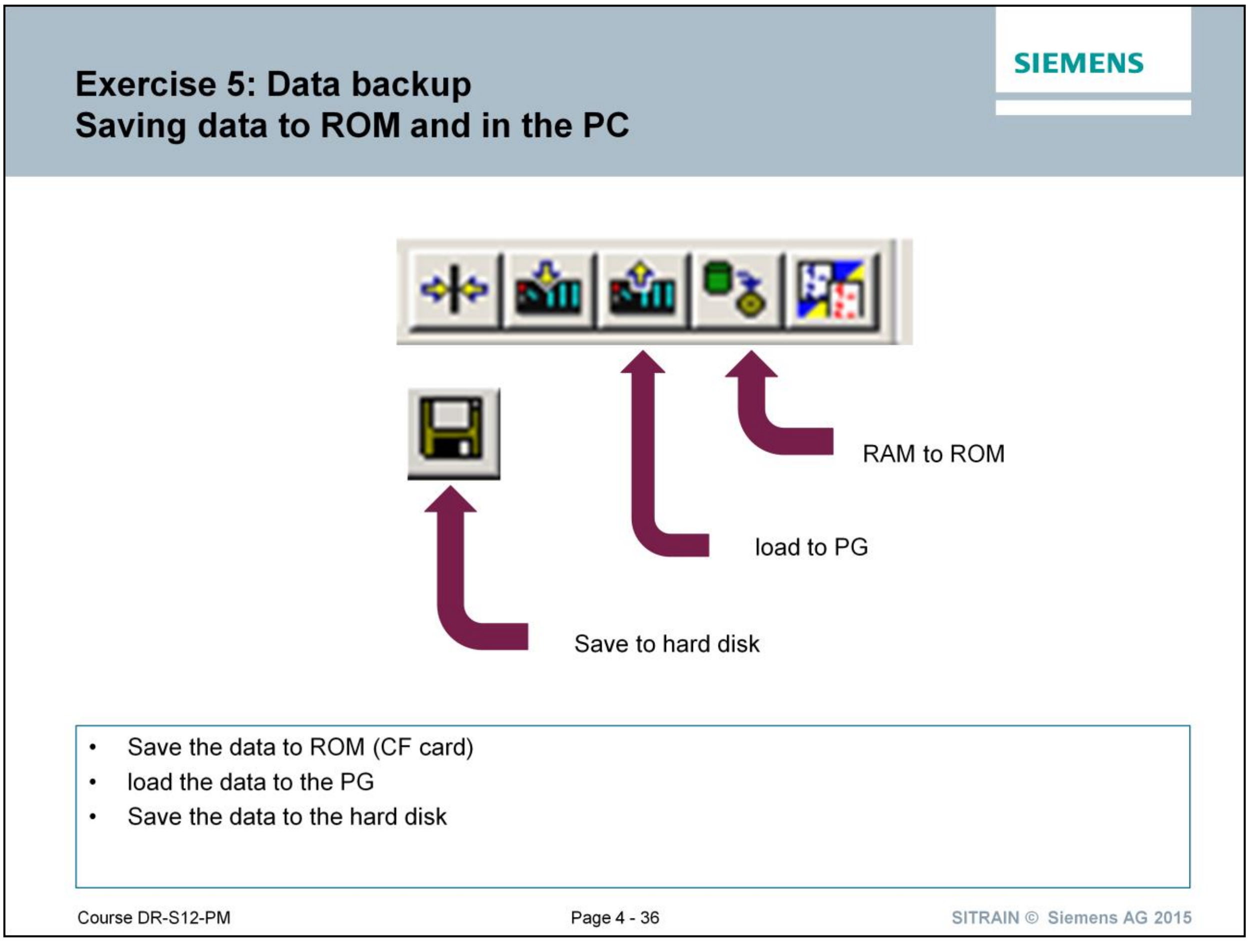
Task Test the drive function using the control panel:

1. Activate the control panel for SERVO_02:
   >> Drives > SERVO_02 > Commissioning > Control panel
2. If required, shift the screen split somewhat towards the top
3. Using the appropriate button, select:
   • "Show control area"
   • "Show diagnostics area"
4. Assume control priority – and observe the safety notes under all circumstances
5. Press the "Diagnostics" button and select the "Missing enables" tab: Observe the missing enables!
6. Set the required enables
7. Now observe the feedback messages:
   • OFF1 enable missing
   • Speed controller inhibited
8. Set the scaling slider to 0%
8. For the 100% setpoint, for example, specify 1000 rpm
9. Now issue the ON command using the green button and monitor the drive.
10. Change the scaling:
    The drive can be operated between 0 and 2000 rpm.
    Monitor the setpoint and actual value display
11. After the test has been successfully completed, give up the control priority.
12. Test SERVO_03 in the same way.



Task

After the drives have been tested using the control panel, the data can be saved. The data should be saved both to ROM (and therefore on the CF card) and to the hard disk of the PG:

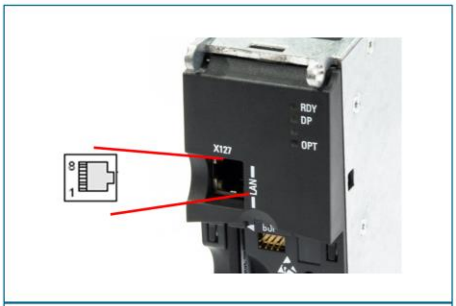
1. To save the data to ROM, press the "Copy RAM to ROM" icon.

2. To save the data in the PG, press the "Load drive unit to PG" icon and then save the data to the hard disk using the "Save project" icon.

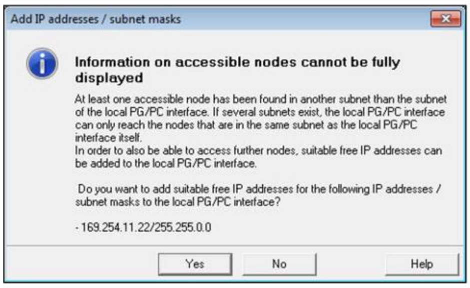
This ensures that the same parameter values are present both in the PG and in the control after restart.

Exercise 6: Changing the IP addresses
Changing the IP address for the PG

IP-Adresse: 192.168.0.10
Subnetz: 255.255.255.0



IP-Adresse: 169.254.11.22
Subnetz: 255.255.0.0



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Task

The "Accessible nodes" function has added a further temporary IP address in the PG, which can set up communication to the CU320-2.

This IP address is deleted again when STARTER is exited.

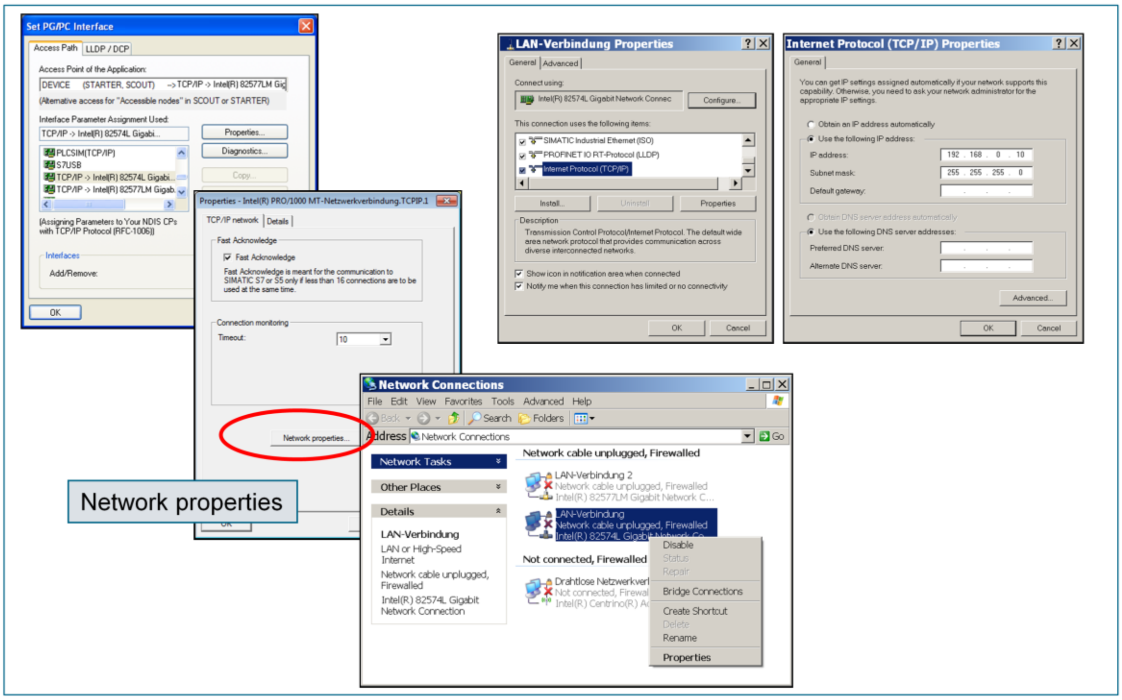
If STARTER is restarted, no online connection would be set up, since the temporary IP address is no longer available.

In this case, it is necessary either to assign a non-temporary IP address to the PG or to change the IP address of the CU 320-2.

In this exercise, a further non-temporary IP address is assigned to the PG initially.

The last step shows how to change the IP address of the CU320-2 if it is not possible to adapt the IP address of the PG.

Exercise 6: Changing the IP addresses
Changing the IP address for the PG



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Task

The IP addresses of both Ethernet interfaces of the PGs are configured via the network connections. In this task, a further IP address is to be added to an existing one.

Procedure

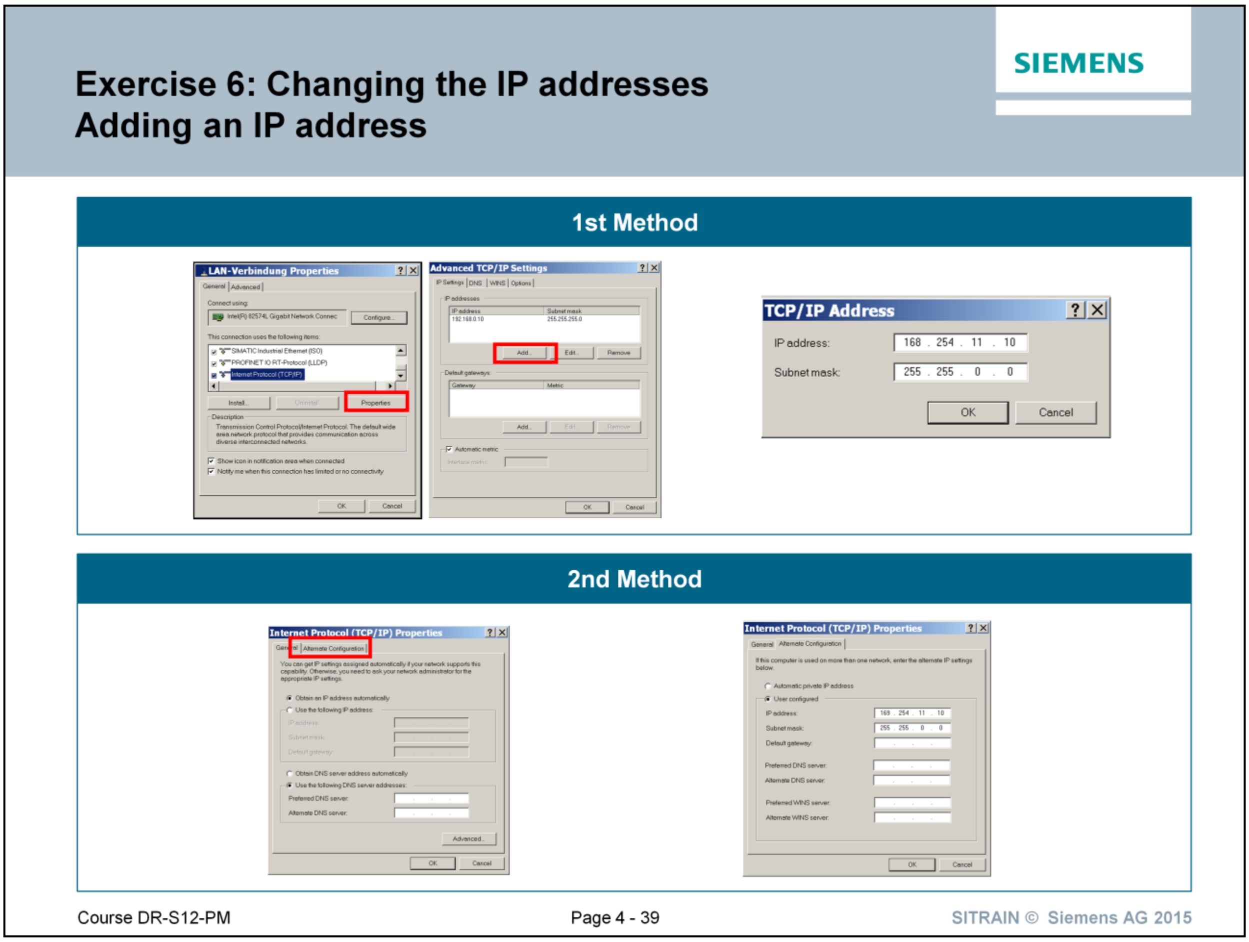
The IP addresses of the LAN interfaces of the PG can be read and changed via the network connections.

Another method is via the PG/PC interface:

1. Open the "Set PG/PC Interface" screen. If "DEVICE" is selected as the access point, TCP/IP… is shown as interface configuration.'

2. "Properties" and "Network properties" enable you to access the network connections.

If you select the LAN interface, you can use the context menu to read out and modify the properties.



Procedure If a fixed IP address is assigned to the PG, the "Add" button can be used to add new IP address:

Procedure Add the new IP address 169.254.11.10 with subnet mask 255.255.0.0. If "Obtain an IP address automatically" is set in the properties, the "Alternate configuration" tab can be used to enter a further IP address. This is not the case for our training PG but could be for PCs that are integrated into the network.

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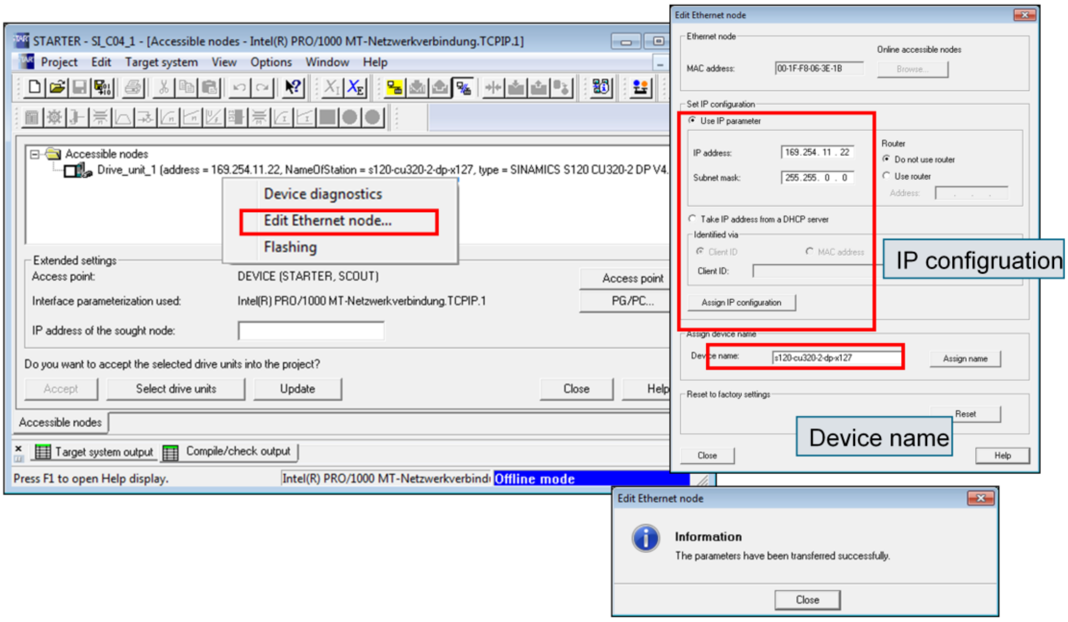
Exercise 6: Changing the IP addresses

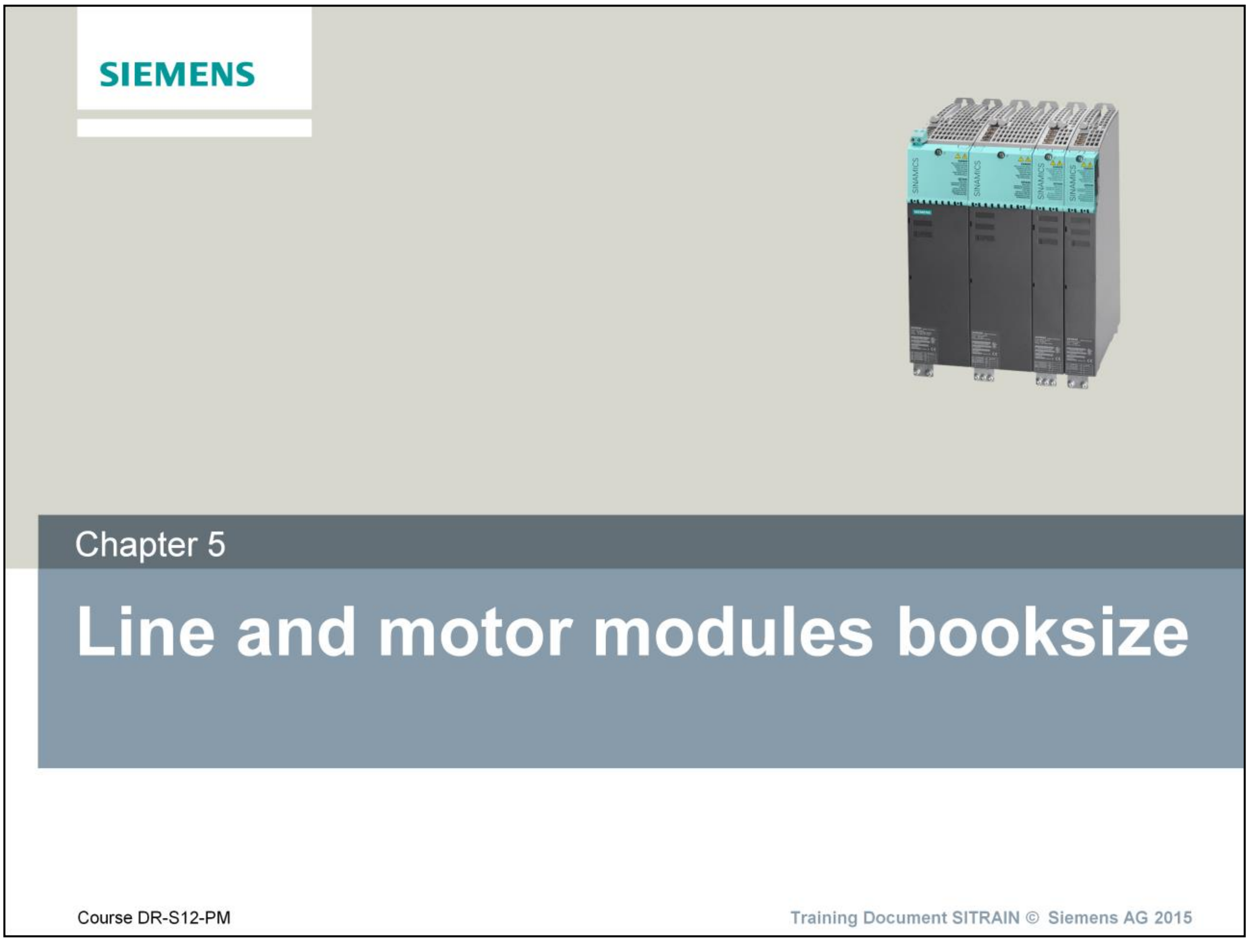
Changing the IP address of the LAN interface of the CU320-2



Procedure

The IP address of the LAN interface of the CU320 can also be changed and thereby matched to the IP addresses of the communications partners:

1. The "Accessible nodes" button shows the nodes in the network and is used to create a temporary IP address in the PG, if this is required.
2. The context menu of the mode enables you to access the "Edit Ethernet node …“ function.
3. The screen that follows can be used to output the IP and MAC addresses of the nodes.
4. The IP address of an individually selected node can also be changed in this screen.
5. Nodes that are integrated in a PROFINET network can also be assigned a device name.



Component overview 3
Line-side Power Modules 4
Line-side Power Modules 5
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Drive unit line supply voltage 11
DC link components 13
Motor-side Power Modules 19

Learning Targets

- You will be familiar with the principle of line infeed operation:
  Basic Line Module, Smart Line Module, Active Line Module
- You will be familiar with the operating principle of the Motor Module
- You will be familiar with the task of a braking resistor
- You will be familiar with the DC link and the electrical hazards

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Component overview
Component designations

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Line Modules — For supplying the motor power. A distinction is made between the Basic Line Module, Smart Line Module and Active Line Module.

Motor Modules — The Motor Module is responsible for the power unit of a drive. A differentiation is made between Single Motor Modules for one drive and Double Motor Modules for two drives.

DC-link components — Braking Modules, braking resistors, Capacitor Modules and Control Supply Modules are available as DC link components.
DC link components allow the modules to be implemented in multi-tier arrangements.

Line-side components — Line-side power components are fuses, contactors, reactors and filters, which are required for switching the energy supply and meeting EMC requirements.

Motor-side / load-side components — Motor side components are motor reactors or sine filters, for example.

Additional system components — Further digital and analog inputs/outputs can be connected to the system using the expansion components. Functions such as measuring probes or output cams can be implemented.

Line-side Power Modules
Overview of infeeds

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Characteristics	Basic Infeed	Smart Infeed	Active Infeed
	Line-commutated B6 rectifier	Line-commutated IGBT rectifier	Actively controlled IGBT rectifier
Modules	Basic Line Module	Smart Line Module	Active Line Module Active Interface Module
Operating mode	Infeed / unregulated	Infeed and regenerative feedback/unregulated	Infeed and regenerative feedback/regulated
Power electronics	Thyristors	IGBTs	IGBTs
Grid fluctuation	Influence the DC link voltage	Influence the DC link voltage	Are smoothed out
Harmonics	To be taken into account	To be taken into account	Can be neglected
Reactive power compensation	No	No	Yes
Availability	G130, G150, S120	S120	S120, S150

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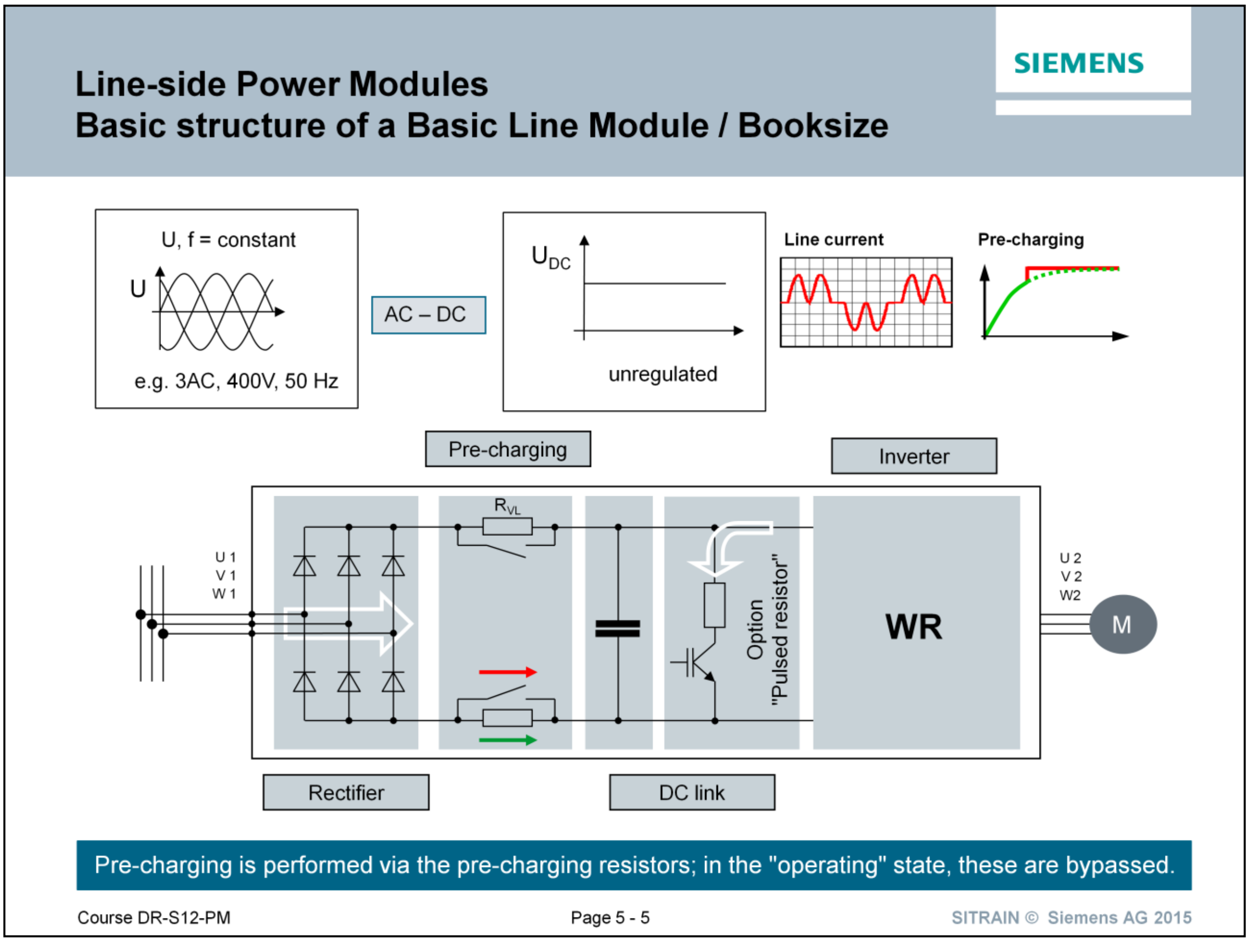
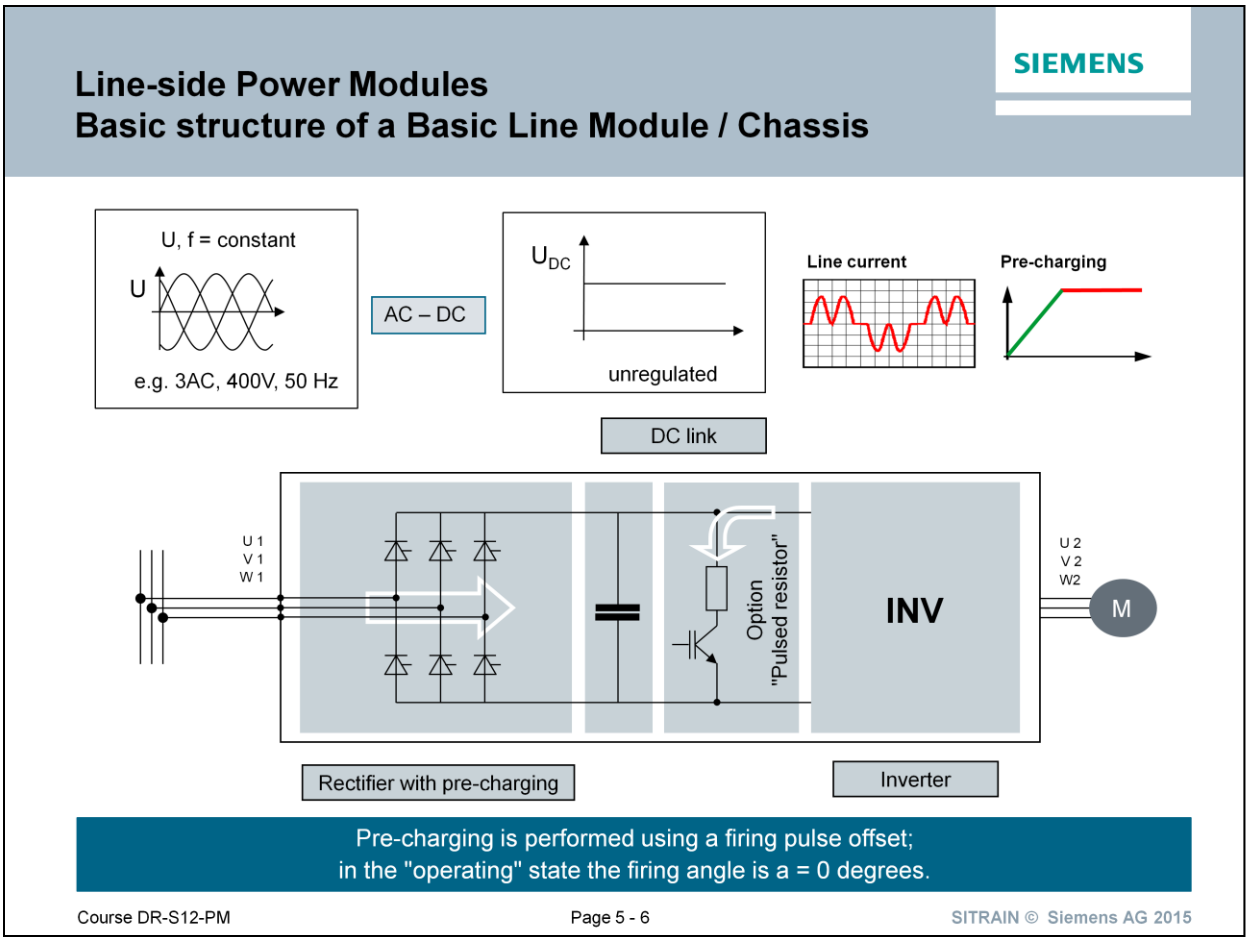


Properties

Properties of the Basic Line Module "**booksize**" format:

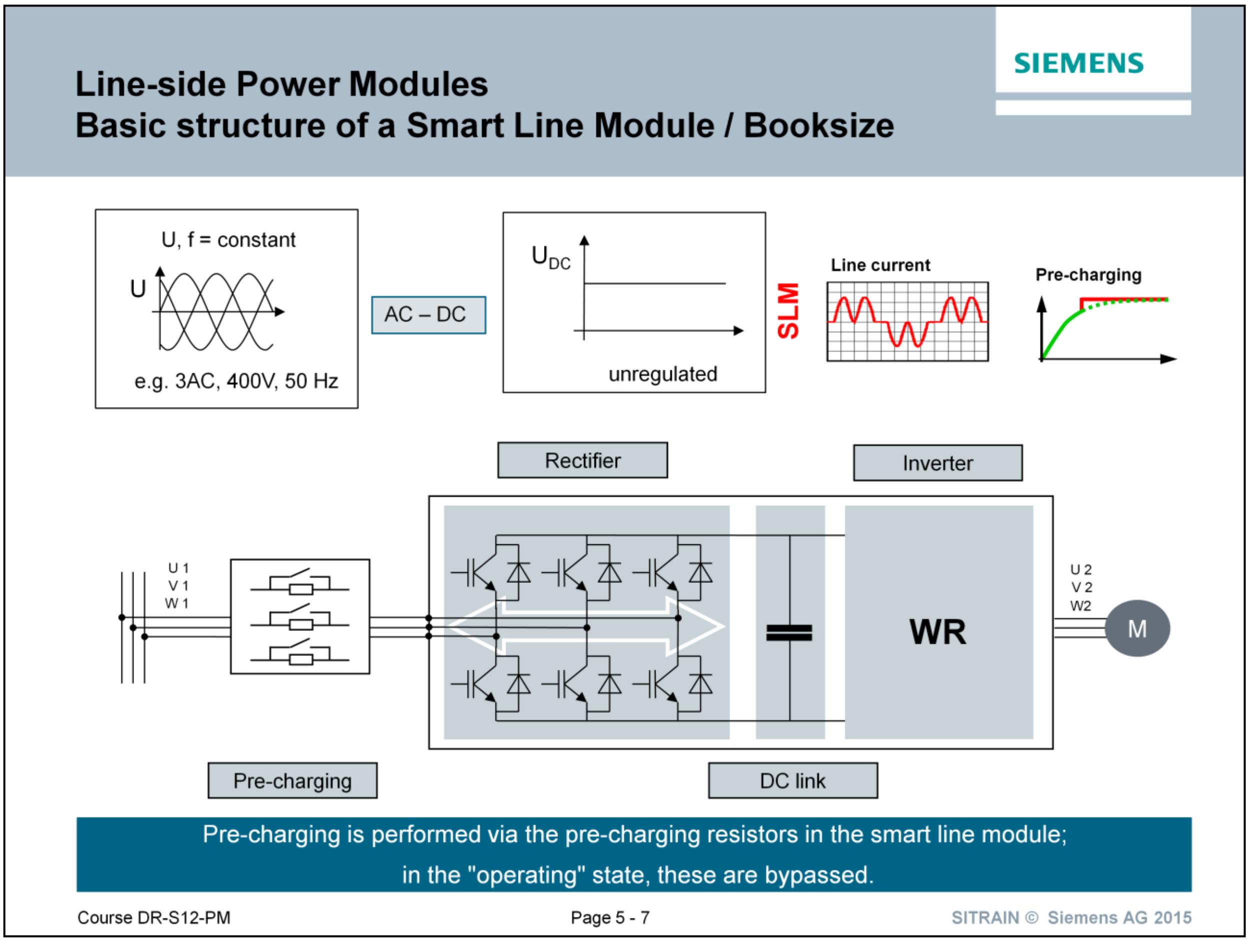
- Unregulated infeed unit with diode bridge (B6 circuit)
- Pre-charging via the pre-charging resistors with time monitoring
- Not capable of energy recovery
- Integrated protective functions (overtemperature, DC link undervoltage/ overvoltage, phase failure)
- Dimensioned for continuous rated current (power overload possible at reduced rated current)



Properties

Properties of the Basic Line Module in "**chassis**" format:

- Unregulated infeed unit with thyristor technology (B6 circuit)
- Integrated time-controlled pre-charging via firing angle (no pre-charging resistors)
- Not capable of energy recovery
- Integrated protective functions (overtemperature, DC link undervoltage/ overvoltage, phase failure)
- Dimensioned for continuous rated current (power overload possible at reduced rated current)
- Line-side reactor with 2% uk normally required
- Infeed of an external 24 V supply necessary

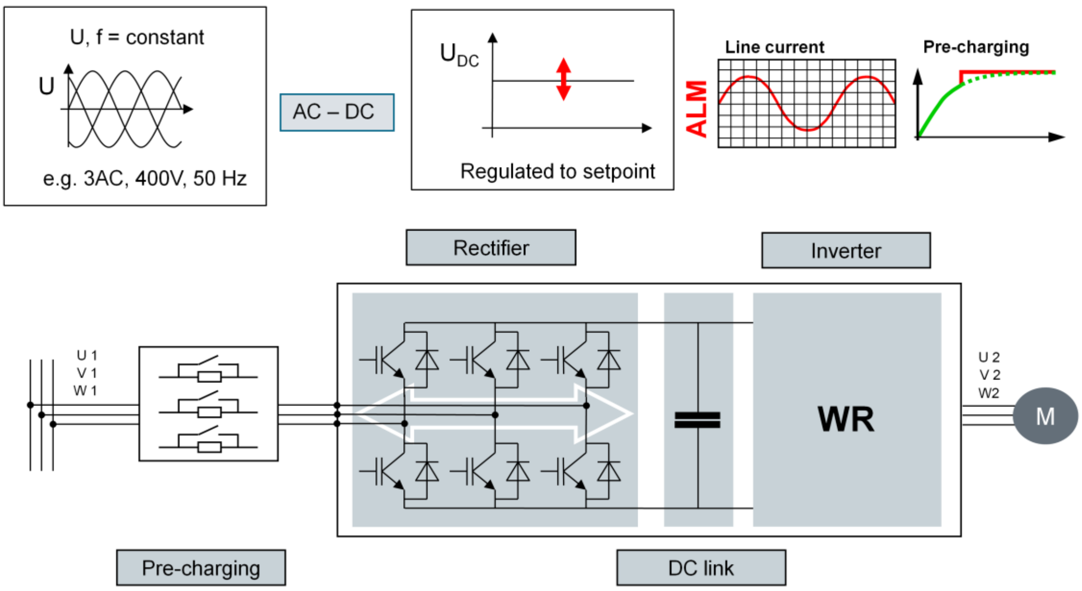


Properties

Properties of the Smart Line Module:

- Unregulated infeed/regenerative feedback unit in IGBT technology
- External pre-charging through line-side contactors and resistors
- Stable regenerative feedback by using IGBT modules. Prevention of switching losses results in better utilization of the IGBT modules
- Integrated protective functions (overtemperature, DC link undervoltage/ overvoltage, phase failure)
- Dimensioned for continuous rated current (power overload possible at reduced rated current)
- Line-side reactor with 4% uk normally required

Line-side Power Modules
Basic structure of an Active Line Module / Booksize



Pre-charging is performed via the pre-charging resistors (Booksize: in the ALM, Chassis in the AIM); in the "operating" state, these are bypassed.

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Properties

Properties of the Active Line Module:

- Regulated infeed/regenerative feedback unit in IGBT technology
- Pre-charging in the Active Interface Module through contactors and resistors
- Unrestricted line feedback
- Step-up converter (boost) operation enables regulated DC link voltage and sinusoidal line currents
- Innovative Clean Power Filter for minimum line harmonic distortion
- Reactive power compensation possible
- Integrated protective functions (overtemperature, DC link undervoltage/ overvoltage, phase failure)
- Dimensioned for continuous rated current (power overload possible at reduced rated current)
- Line-side reactor required for step-up converter operation

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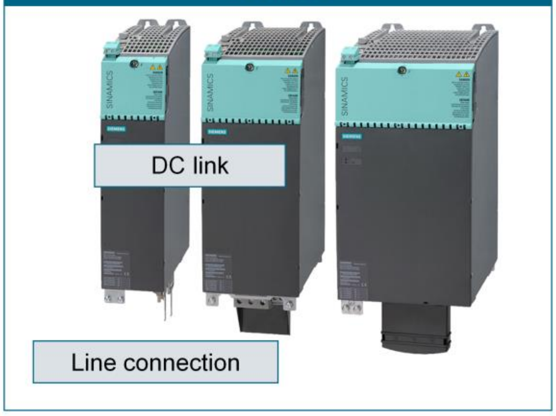
Line-side Power Modules
Product overview Booksize and Booksize Compact

Basic Line Module	Smart Line Module	Active Line Module
Booksize compact 400 V 20/40/100 kW Booksize 400 V 20/40/100 kW	Booksize compact 400 V 20/40/100 kW Booksize 400 V 5/10/16/36 kW	Booksize compact 400 V 20/40/100 kW Booksize 400 V 16/36/55/80/120 kW

Booksize compact

Booksize



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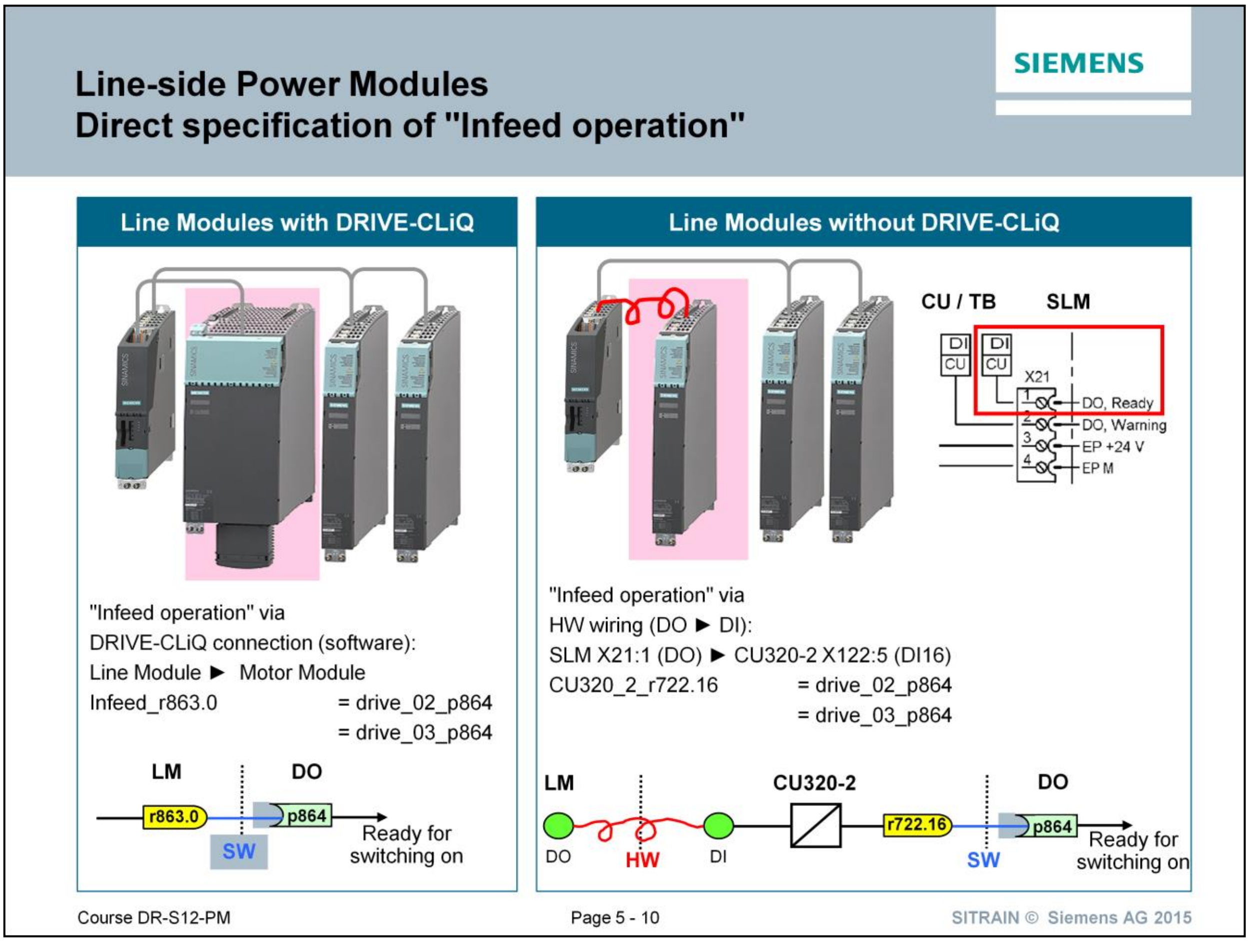


Infeed operation

With a Basic Line Module or Smart Line Module that does not have a DRIVE-CLiQ connection, the "Infeed Ready" signal is sent to the outside via connector X21.1 (DO: Ready).

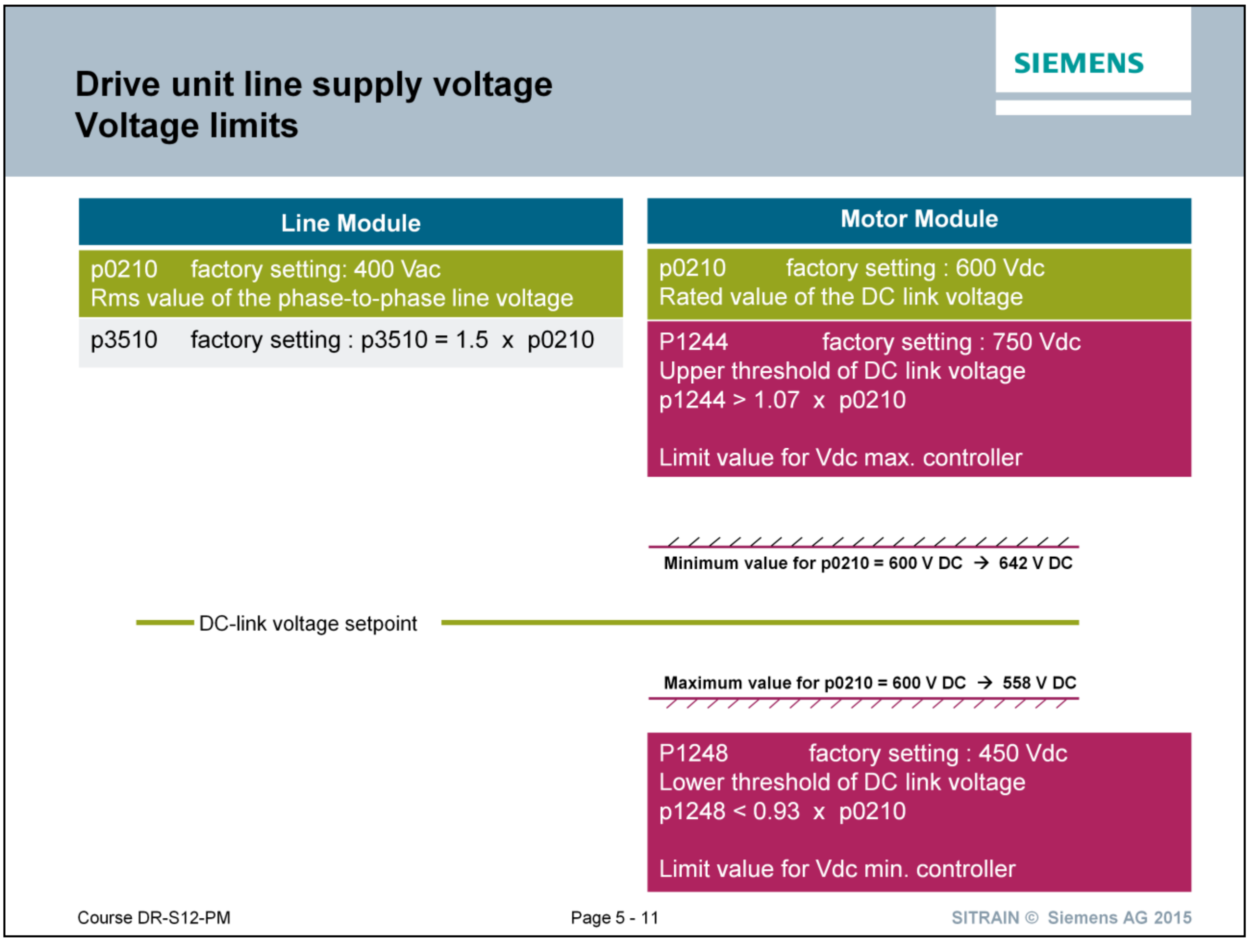
The signal is set by the module to "1" ("High level") if the following conditions are fulfilled:

- Electronic power supply (X24) is "OK"
- DC link is precharged
- Pulse enable (X21.3/.4) in effect
- No overtemperature
- No overcurrent tripping

For correct operation, this signal must be "interconnected" to the parameter p864 ("Infeed operation") of every drive object.

Because the DRIVE-CLiQ connection is missing, this signal cannot be interconnected directly to parameter p864; it first has to be wired to a digital input of the CU or the TB30 (if available). This signal state is then available in the parameter r722 (CU) or r4022 (TB30).

From there, the signal can be interconnected to parameter p864. The interconnection is made via the expert list of the relevant drive object.



Supply voltage

The drive unit supply voltage of the relevant Line Module or Motor Module is entered at parameter p210.

Line Module

For the infeed:

p210: Rms value of the phase-to-phase line voltage

p3510: DC-link voltage setpoint

Default: p3510 = p210 * 1.5

Motor Module

For the Motor Module:

p210: Rated value of the DC link voltage

This is used to calculate the monitors and limit values for the Vdc controller:

p1244: Upper DC link voltage threshold (Vdc_max)

p1248: Lower DC link voltage threshold (Vdc_min)

Drive unit line supply voltage
Training case

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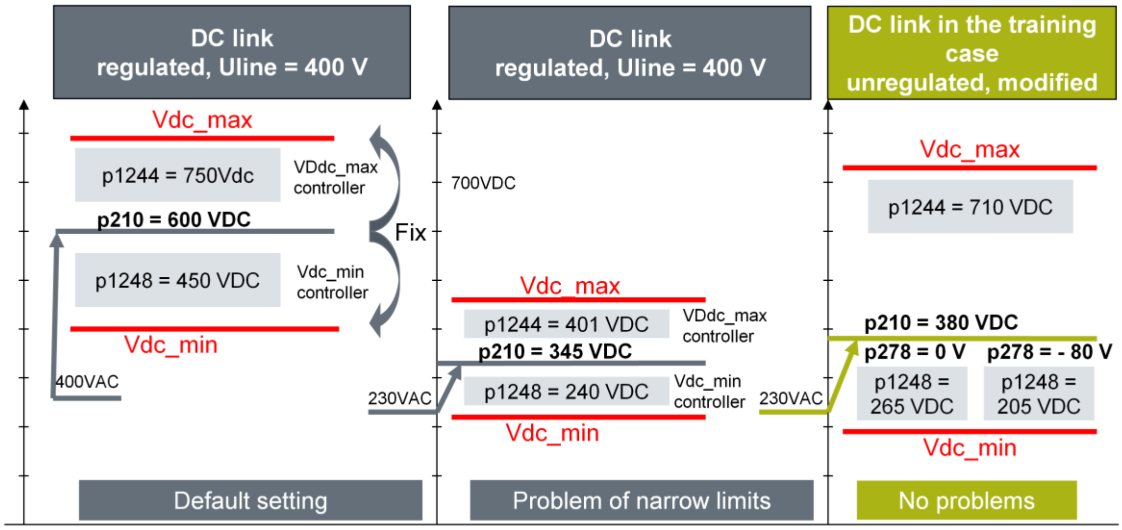

SERVO_02: After automatic configuration, the drive unit supply voltage in SERVO_02 is set to p210 = 600 V.
The following parameter assignment is recommended for the training case: p210 = 380 V, p278 = - 80 V.
When automatic calculation of the controller parameters is activated p340 = 1 all limits are set correctly ONLINE.
For SERVO_03 the drive data must be configured offline first. p210, p278 are then modified online and the limits are calculated with p340 = 1.

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Training case

The Smart Line Module is adapted to the voltage in the office in the training case:

- Instead of the usual 380 ... 480 V 3 AC the supply voltage is 230 V 1 AC, N
- Voltage monitoring has been changed
- Regenerative feedback is blocked

The limits must be moved further apart to allow the servo motors to be accelerated or delayed with short ramps.

Important are:

- The limits of the Vdc controller: p1244, p1248,
- The rigid internal limits in relation to parameter p210

Limit Vdc_max

Even though the unregulated DC link voltage on the training case assumes a value around 320 V at Uline = 230 V, p210=380 V is parameterized.

This means that following recalculation, the internal upper limit will be raised to 710 V.

Limit Vdc_min

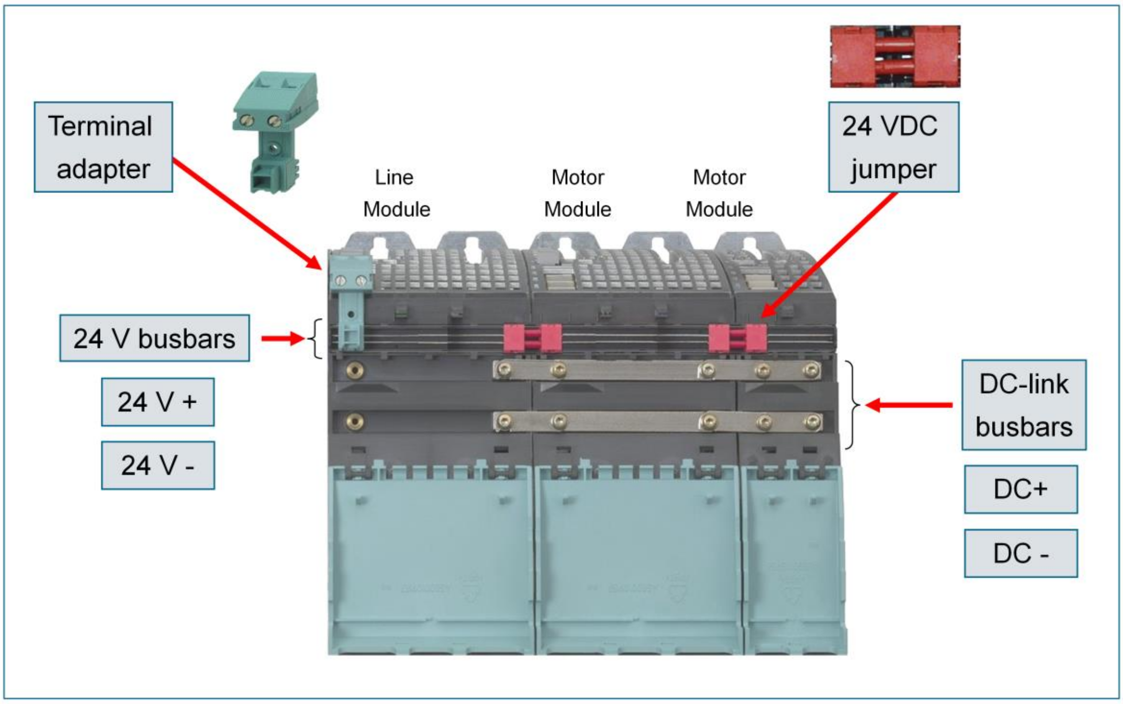
To achieve a low Vdc_min limit with this setting, the limit is reduced by 80 V via parameter p278.

Rectification

Despite this, with dynamic controller adjustment of the servo drives and maximum acceleration from 0 to 6000 rpm, undervoltage can still occur for the DC link and as a result of the only partially utilized diode rectifier also inadmissible voltage dips.

The best remedy is usually to limit I max to 3 A.

DC link components
Busbars



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DC link components
Busbars – Hazard warnings

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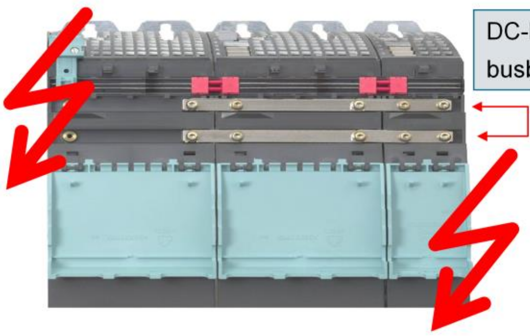
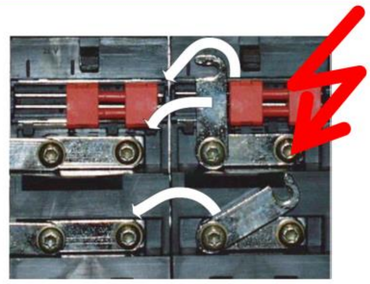
Danger when working with the DC link

- There is a risk of electric shock. Hazardous voltage is still present for up to 5 minutes after the power supply has been switched off.
- The protective cover for the DC link must not be opened until this time has elapsed.
- When opening the cover, ensure that there are no live parts. Use an insulated tool if needed.
- The protective cover for the DC link must be closed for all components before the voltage supply is switched on.



DC-link busbars



DC-link connecting bridge

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Danger This means that there is a risk of an electric shock. Hazardous voltage is still present for up to 5 minutes after the power supply has been switched off.

The protective cover must not be opened until this time has elapsed.

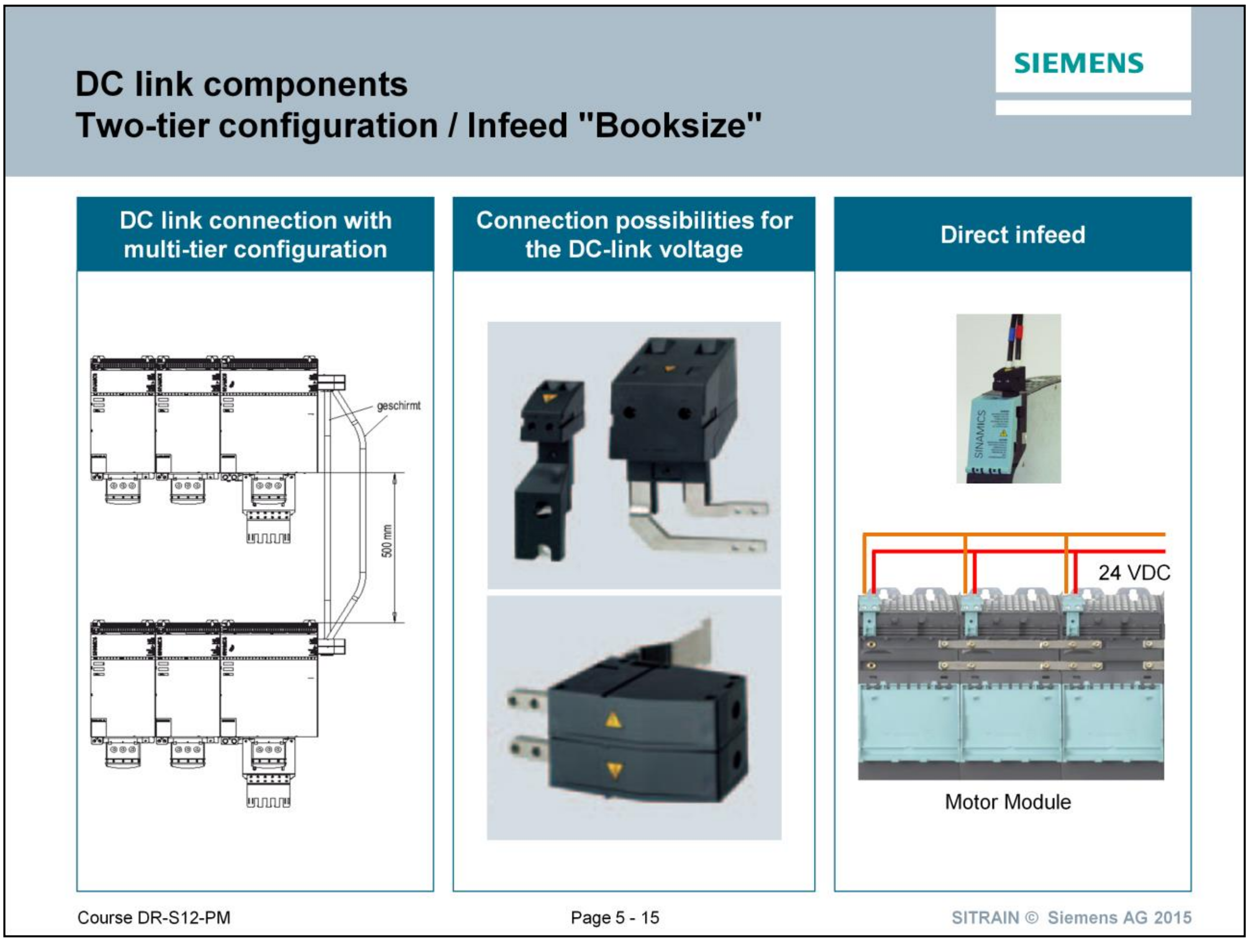
When opening the protective cover for the DC link, you must press the release catch. Use a suitable tool (e.g. a screwdriver) for this.

Operation The components must only be operated when the protective cover of the DC link is closed. Damaged components must not be operated further, otherwise this could result in secondary damage or accidents.

Hazard warning The DC link discharge time hazard warning in the local language must be attached to all of the components. A set of labels in 16 languages is provided with the component.

If a 50 mm wide Motor Module or a DC link component of corresponding width (e.g. Braking Module, Control Supply Module, Voltage Clamping Module) is located at the left-hand end of the drive line-up, the DC link bridge (together with the screws) must be removed.

Installation It is not permissible to insert the screws without a DC link bridge. For all other power units and DC link components (e.g. Capacitor Module) that are wider than 50 mm, the DC link bridge must be swiveled completely to the right and tightened. It must not be moved to the left or removed.



Multi-tier configuration Continuation of the DC link with the DC link adapter (installation above) external to the components is achieved using single-core, finely-stranded and shielded cables that are laid so as to ensure they are short-circuit and ground-fault proof.

The distance between the two module rows depends on the wiring and cable cross-section:

- For modules with a width of between 50 and 100 mm, the distance between the upper and lower module row must be at least 300 mm.
- For modules with a width of between 150 and 300 mm, the distance between the upper and lower module row must be at least 500 mm.

DC link components
Capacitor Module and Voltage Clamping Module

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Capacitor Module

- Used to increase the DC-link capacity to bridge short power failures and to absorb regenerative peaks
- No LEDs

Voltage Clamping Module

- Ensures that the motor voltage remains within the permissible values even when there is resonance.
- No LEDs

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Capacitor Module The Capacitor Module is precharged by the Line Module. The applicable maximum permissible DC link capacitances of the Line Modules must be taken into account.

Voltage Clamping Module

Under certain unfavorable conditions, voltage rises can occur in extended drive line-ups due to the stimulation of the system resonance frequency. This can be particularly damaging for the insulation systems of the connected motors since partial discharges can occur.

The Voltage Clamping Module ensures that the motor voltages are limited to permissible values even when resonance occurs. In conjunction with an Active Line Module with an HF line reactor the Voltage Clamping Module must always be used if the total lengths of all the motor and DC link cables exceed the following value:

- 350 m for shielded cables / 560 m for unshielded cables.

In conjunction with the Voltage Clamping Module, the following total cable lengths are permitted:

- 630 m shielded cables / 850 m unshielded cables

Marginal conditions The following details also apply:

- Power derating for Line Modules to 80% for cable lengths > 350 m.
- Maximum step-up factor 1.4 to 1.6 (rectification factor Vdc link/Uline)
- No built-in motors can be connected (torque motors, linear motors)
- Can only be connected to TN line supply systems with grounded neutral point.
- The EMC limit values (radio interference voltage) are no longer observed, which means that special measures have to be taken to ensure CE conformity (on-site measurement (subject to charge) and adjusted filter).

U_{DC}:
DC 26V, 20A

Ready
DC Link

Control Supply Module

- Provides the 24 V DC power supply via the line or DC link

U_{Zk}:
DC 430..882V (300V<1min)

U_{Netz}:
3AC 380..480V (+-15%)

- Several Control Supply Modules possible at various (!) output lines with 20 A fuse.
- Internal fan

Description

The Control Supply Module (CSM) in booksize format provides a 24 V DC power supply.

In normal operation the component obtains its supply from the line voltage.

In the event of a power failure, the component automatically changes over to supply from the DC link.

This makes it possible, for example, to execute retraction movements in the event of a failure of the line supply.

The Control Supply Module has safe electrical separation between the line and the DC link potential. This means that there is no danger that the DC link will be charged unintentionally. The Control Supply Module can therefore remain connected to the supply if the Line Module is metallically separated from the supply, for example via a line contactor.

The 24 V ground of the Control Supply Module is internally grounded.

The CSM has an internal line filter (Class A for TN systems) and the pre-charging circuit for the DC link inside the unit, from which the isolated 24 V supply is generated.

The CSM also features a current limitation function. When conductors of 2.5 mm^2 in cross-section are used at operating temperatures up to 40 °C, no additional protection or short-circuit-proof assignment of the cables is necessary on the 24 V side.

If several branches are planned, it is recommended that a SITOP select diagnostics module is used as overcurrent protection.

DC link components
Braking Module

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Braking Module (braking unit and braking resistor)

- Module operates autonomously
- When triggered, the DC-link energy is converted into heat loss via an external braking resistor
- Two braking resistors are available:

  Booksize:

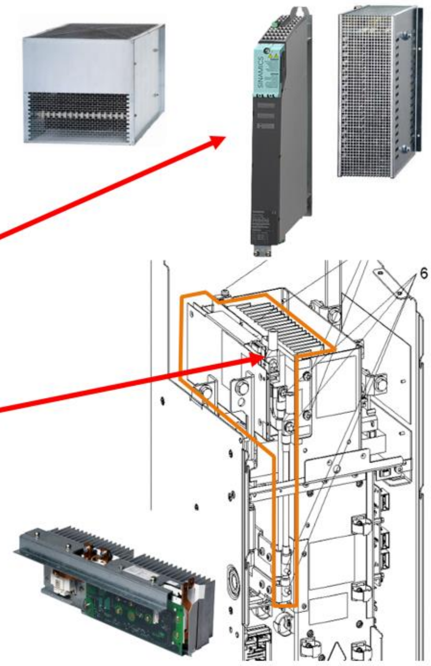
  0.3 kW continuous braking power (25 kW peak power)

  1.5 kW continuous braking power (100 kW peak power)

  Chassis:

  25 kW continuous braking power (125 kW peak power)

  50 kW continuous braking power (250 kW peak power)



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Description

Properties of Braking Modules and braking resistors:

- Conversion of DC link energy to heat loss in the external braking resistor
- As the Smart and Active Line Modules are feedback-capable, Braking Modules and braking resistors are not required for normal operation.
- These components must only be provided if a machine has to be stopped specifically in the event of a power failure (regenerative feedback mode no longer possible).
- The Chassis Braking Module is built directly in to a Motor Module or Line Module and does not require additional space in the control cabinet.

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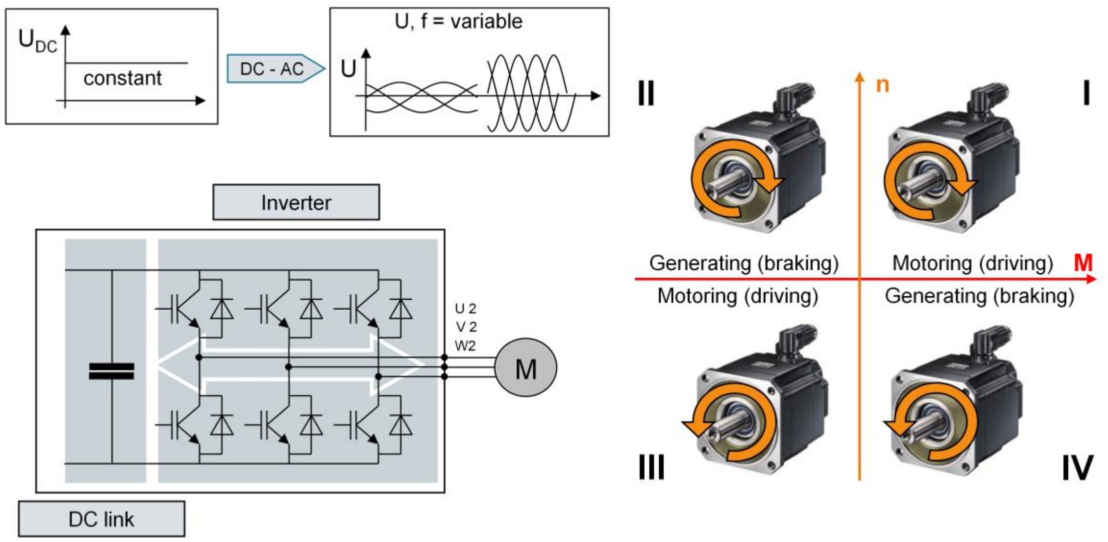
Motor-side Power Modules
Electrical structure of a frequency converter



The rms value of the inverter output voltage is formed by means of pulse width modulation of the DC link voltage (space-vector modulation, edge modulation).

Motor Modules are generally 4Q-capable: Clockwise and counterclockwise rotation, driving and braking.

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Motor-side Power Modules
Booksize format

Characteristics

- Compact design due to high power density
- Integrated DC link and 24 V DC busbars
- Diagnostic LEDs
- Short-circuit and ground-fault proof
- Integrated safety functions "Safe Torque Off", "Safe Stop1"
  and "Safe Brake Control"
- Integrated motor brake control (up to 132 A)
- Direct connection for temperature sensor KTY 84 or PTC

Single Motor Module

Power: At 400 V and 3 / 5 / 9 / 18 / 30 / 45 / 60 / 85 / 132 / 200 A

Double Motor Module

Power: At 400 V and 2x1.7 / 2x3 / 2x5 / 2x9 / 2x18 A

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Motor Module

A Motor Module is a power unit (inverter) that provides the power supply for the connected motor(s). The power is supplied by the Infeed Module via the DC link. A Motor Module must be connected to a Control Unit via DRIVE-CLiQ. The open-loop and closed-loop control functions for the Motor Module are stored in the Control Unit. One motor can be connected to the Single Motor Module and two motors can be connected to the Double Motor Module.

Depending on the type (Single or Double), each Motor Module has one or two DRIVE-CLiQ interfaces for connecting the motor encoder evaluation unit (Sensor Modules). A Double Motor Module saves up to 50% space compared to the Single Motor Modules.

The specified depth of 270 mm only applies to devices with air cooling. The models with push-through cooling and cold plate cooling have a reduced mounting depth.

All components in the SINAMICS S system are cULus approved. The cULus mark is a test mark of Underwriters Laboratories (UL), an independent, non-profit product safety certification organization in the USA and indicates compliance with UL and CSA (Canadian Standard Association) standards.

Characteristics

- Compact design with high power density, particularly in the case of Double Motor Modules
- Integrated DC link and 24 V DC busbar
- Short-circuit and ground-fault proof
- Integrated safety function, such as "Safe Torque Off" (STO), "Safe Stop1" (SS1) and "Safe Brake Control" (SBC)
- Integrated motor brake connection and armature short-circuit brake
- Motor connection via connectors (up to 30 A) or bolts

Motor-side Power Modules
Booksize format

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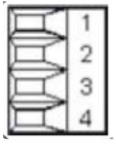
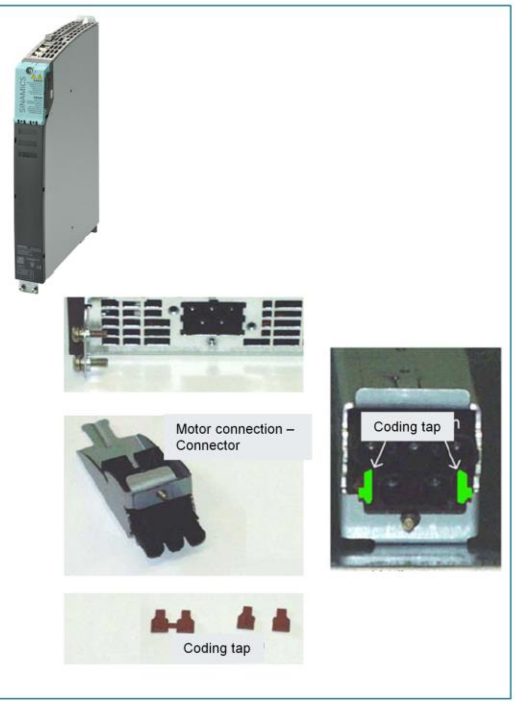
Features

- Shield connection directly on the module
- Encoded motor connection plug
- Temperature sensor connection on terminal or via DRIVE-CliQ
- Brake connection on motor connection plug

X21/X22 (EP terminal)

1. +Temp
2. -Temp
3. +24V Enable pulses (EP)
4. M Enable pulses (EP)





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Note

Cable shields and unused power cable conductors (e.g. brake conductors) must be connected to PE potential to prevent capacitive cross-talk charges.

It is essential to apply the shield for the motor holding brake. Furthermore, only Motion-Connect cables must be used for integrated motor holding brakes, as otherwise insulation of the cores is not guaranteed. Risk of electric shock.

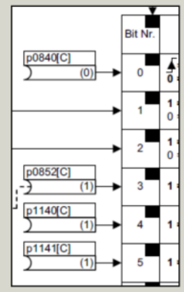
The temperature sensor connection is required for motors where the temperature value is not transmitted via DRIVE-CLiQ. Cables to connect temperature sensors must always be installed with shielding. The cable shield must be connected to the ground potential at both ends over a large surface area. Temperature sensor cables that are routed together with the motor cable must be twisted in pairs and shielded separately.

A regulated DC power supply is required to operate motors with a built-in holding brake. The power supply is realized via the internal 24 V busbars. The voltage tolerances of the motor holding brakes and the voltage losses of the cables must be taken into account.

If the "Safe Torque Off“, "Safe Stop1“ or "Safe Brake Control“ safety integrated function is selected, the -X21:3 24 V DC and -X21:4 terminals must be grounded for operation. Upon removal, pulse suppression is activated.

Chapter 6

Control word, setpoint and device trace



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Diagnostics using parameters 16
Trace function 18
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Exercise 2: Control via terminal signals 26
Exercise 3: Tracing the signals 31

Learning Targets

- You will know the signals required for switching on
- You will become familiar with the function of control word and status word
- You will be able to connect signals to input and output terminals
- You will be able to interconnect signals using the BICO technology
- You will be able to trace status values and bit signals using the trace tool

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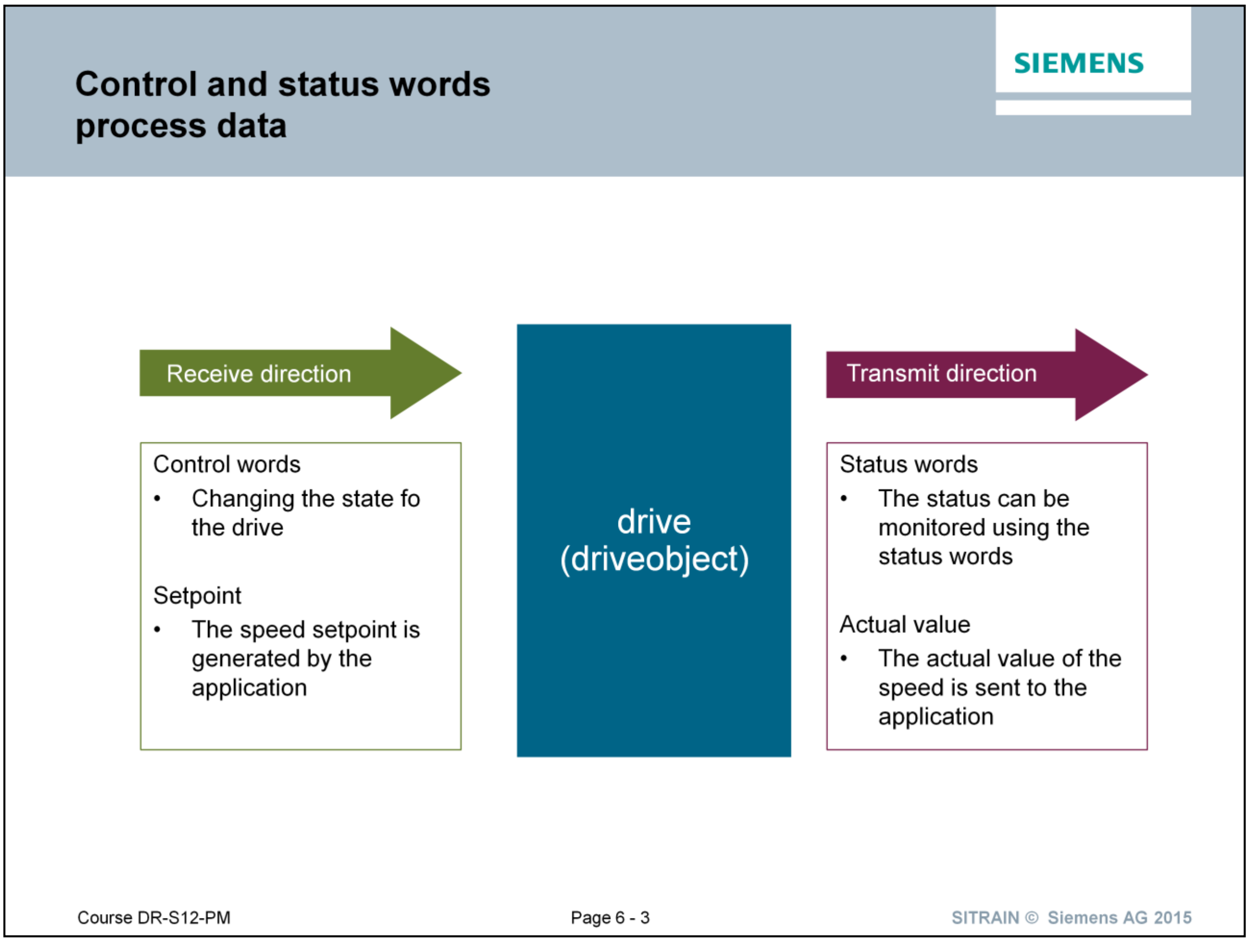


Communication

To execute functions, the drive object requires enable signals and a speed setpoint. The enable signals are connected via the control word. Feedback signals from the drive object are output via the status word.

In this way, the control word (STW1) and the status word (ZW 1) form the command interface between the controller and the drive.

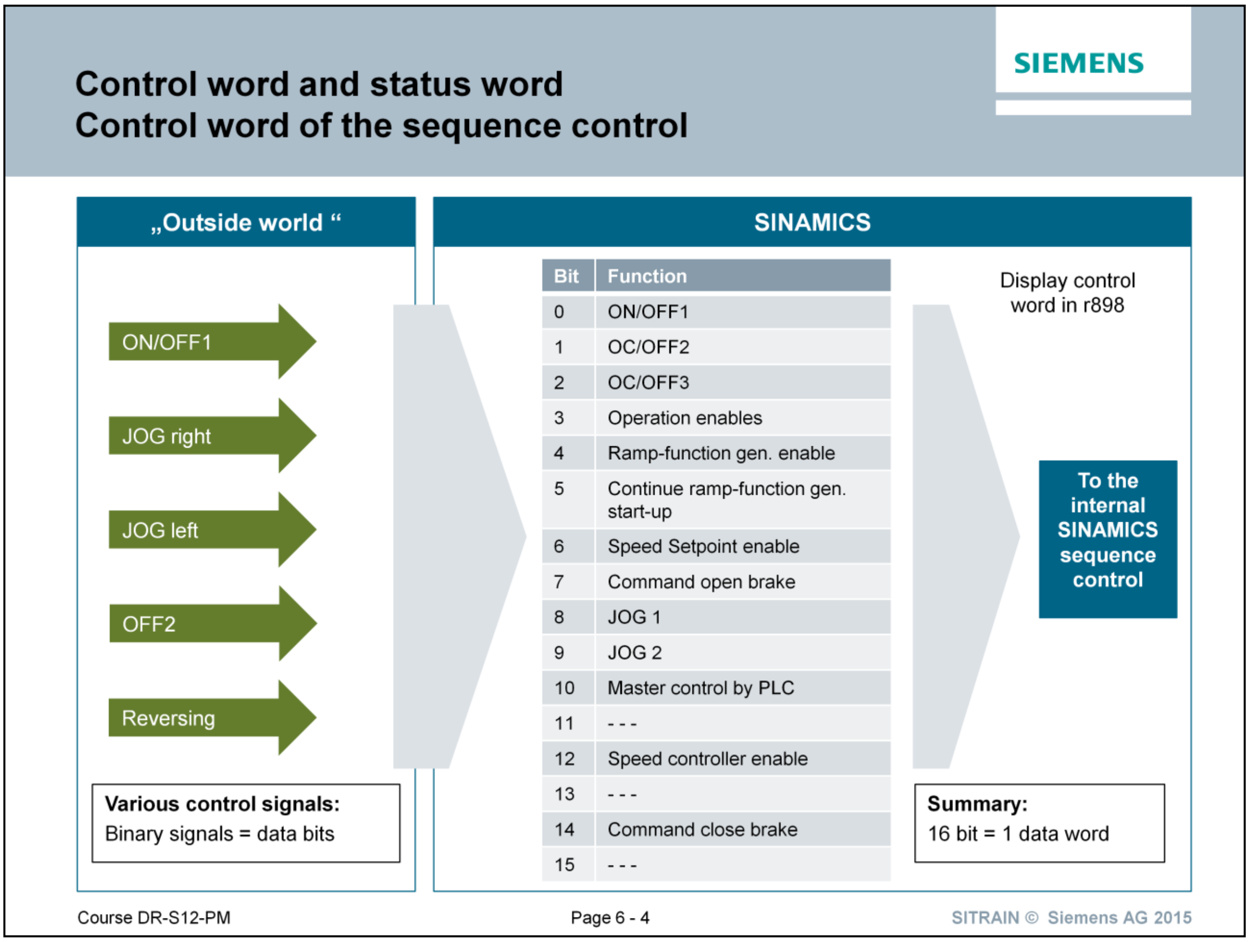
Control word

The control word is a group of 16 internal binary signals that must be provided for controlling the internal sequence control/inverter. In order to move the drive, the control word must be connected via the sequence control.

The control word corresponds to the PROFIdrive profile standard.

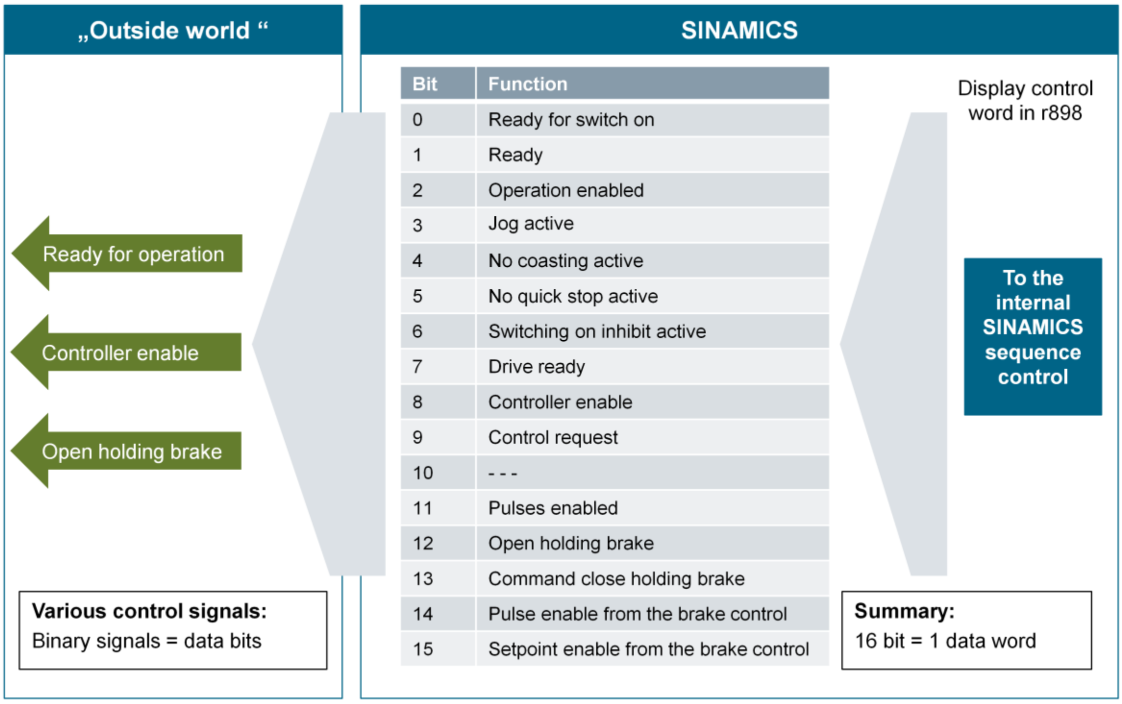
Status word

The status word is a group of 16 internal binary signals that must be provided for controlling the internal sequence control / inverter. The control word (Bit 0-10) corresponds to the PROFIdrive standard profile.



Control word	The control word is a group of 16 binary signals that must be provided to the internal sequence control / closed-loop control of the converter. If the converter and SIMATIC S7 are connected to each other via PROFIBUS or PROFINET, the control word can be provided by a higher-level output word.
ON/OFF1	An edge change is required to switch on and OFF2 and OFF3 must not be active. When switching off the motor brakes on the down ramp of the ramp-function generator and the converter then switches off.
OFF2	The motor coasts to a standstill without braking and the converter shuts down immediately.
OFF3	The motor brakes with the return edge of the OFF3 signal. The converter remains switched on.

Control word and status word
Status word of the sequence control



Bit	Function
0	Ready for switch on
1	Ready
2	Operation enabled
3	Jog active
4	No coasting active
5	No quick stop active
6	Switching on inhibit active
7	Drive ready
8	Controller enable
9	Control request
10	- - -
11	Pulses enabled
12	Open holding brake
13	Command close holding brake
14	Pulse enable from the brake control
15	Setpoint enable from the brake control

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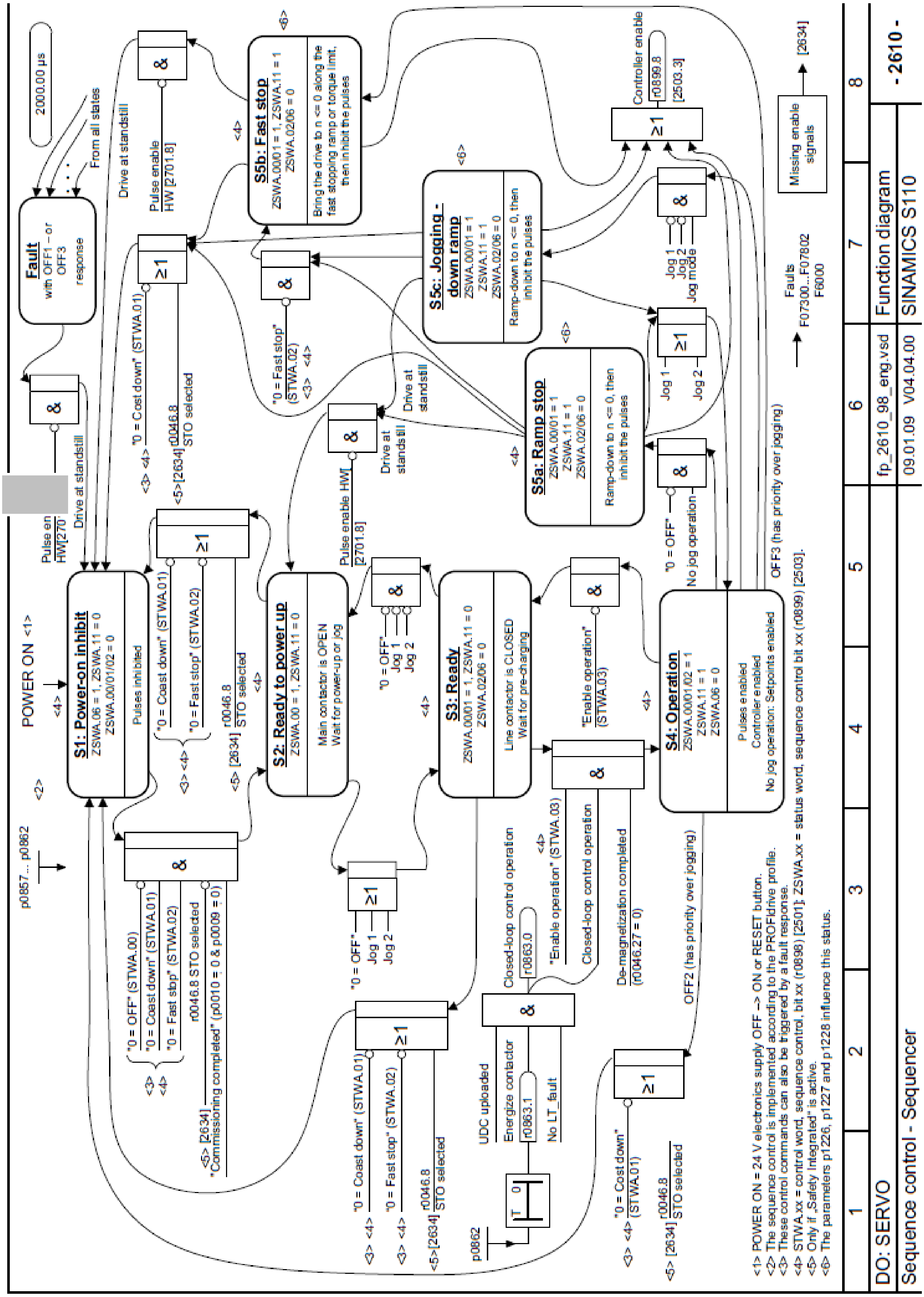
Status word — The status word is a group of 16 binary signals that are provided from the internal sequence control / closed-loop control of the converter.

If the converter and SIMATIC S7 are connected to each other via PROFIBUS, the status word can be monitored and analyzed by a higher-level input word.

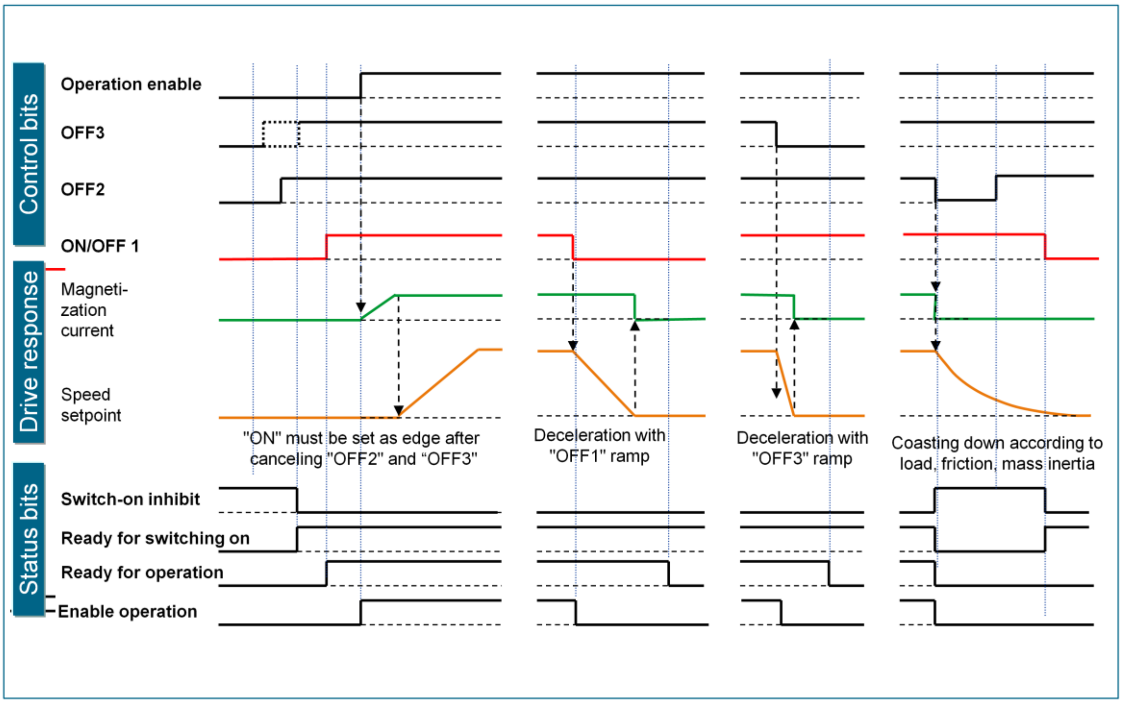
Switch-on inhibit — This status is reached when the error is remedied and a drive fault is acknowledged. A subsequent restart is only possible through OFF1 followed by ON.

Alarm, fault — General fault (bit 3)

General alarm (bit 7)


S1: Power-on inhibit
ZSWA.06 = 1, ZSWA.11 = 0
ZSWA.00/01/02 = 0
Pulses inhibited
S2: Ready to power up
ZSWA.00 = 1, ZSWA.11 = 0
Main contactor is OPEN
Wait for power-up or jog
S3: Ready
ZSWA.00/01 = 1, ZSWA.11 = 0
ZSWA.02/06 = 0
Line contactor is CLOSED
Wait for pre-charging
S4: Operation
ZSWA.00/01/02 = 1
ZSWA.11 = 1
ZSWA.06 = 0
Pulses enabled
Controller enabled
No jog operation: Setpoints enabled
S5a: Ramp stop
ZSWA.00/01 = 1
ZSWA.11 = 1
ZSWA.02/06 = 0
Ramp-down to n <= 0, then inhibit the pulses
S5b: Fast stop
ZSWA.00/01 = 1, ZSWA.11 = 1
ZSWA.02/06 = 0
Bring the drive to n <= 0 along the fast stopping ramp or torque limit, then inhibit the pulses
S5c: Jogging - down ramp
ZSWA.00/01 = 1
ZSWA.11 = 1
ZSWA.02/06 = 0
Ramp-down to n <= 0, then inhibit the pulses
Fault
with OFF1 – or OFF3 response
2000.00 µs
From all states
POWER ON <1>
p0857 ... p0862
"0 = OFF" (STWA.00)
"0 = Coast down" (STWA.01)
"0 = Fast stop" (STWA.02)
r0046.8 STO selected
"Commissioning completed" (p0010 = 0 & p0009 = 0)
Pulse enable HW [2701.8]
Drive at standstill
"Enable operation" (STWA.03)
Closed-loop control operation
De-magnetization completed (r0046.27 = 0)
OFF2 (has priority over jogging)
OFF3 (has priority over jogging)
UDC uploaded
Energize contactor
r0863.1
r0863.0
No LT_fault
p0862
Jog 1
Jog 2
Jog mode
No jog operation
Controller enable
r0899.8
[2503.3]
Faults F07300...F07802 F6000
Missing enable signals
[2634]
<1> POWER ON = 24 V electronics supply OFF --> ON or RESET button.
<2> The sequence control is implemented according to the PROFIdrive profile.
<3> These control commands can also be triggered by a fault response.
<4> STWA.xx = control word, sequence control, bit xx (r0898) [2501]; ZSWA.xx = status word, sequence control bit xx (r0899) [2503].
<5> Only if „Safety Integrated" is active.
<6> The parameters p1226, p1227 and p1228 influence this status.
1 2 3 4 5 6 7 8
DO: SERVO
Sequence control - Sequencer
fp_2610_98_eng.vsd
09.01.09 V04.04.00
Function diagram
SINAMICS S110
- 2610 -

Control word and status word
Reactions to control bits ON, OFF2, OFF3



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The reactions to the signals are as follows:

OFF1

The drive is braked by immediately entering n_set = 0 along the ramp-function generator down ramp (p1121).
Once standstill is detected, any configured motor holding brake is closed (p1215). The pulses are suppressed when the brake application time (p1217) expires. Zero speed is detected when the actual speed value is less than the speed threshold (p1226) or when the monitoring time (p1227) that started when speed setpoint ≤ speed threshold (p1226) has expired.

OFF2

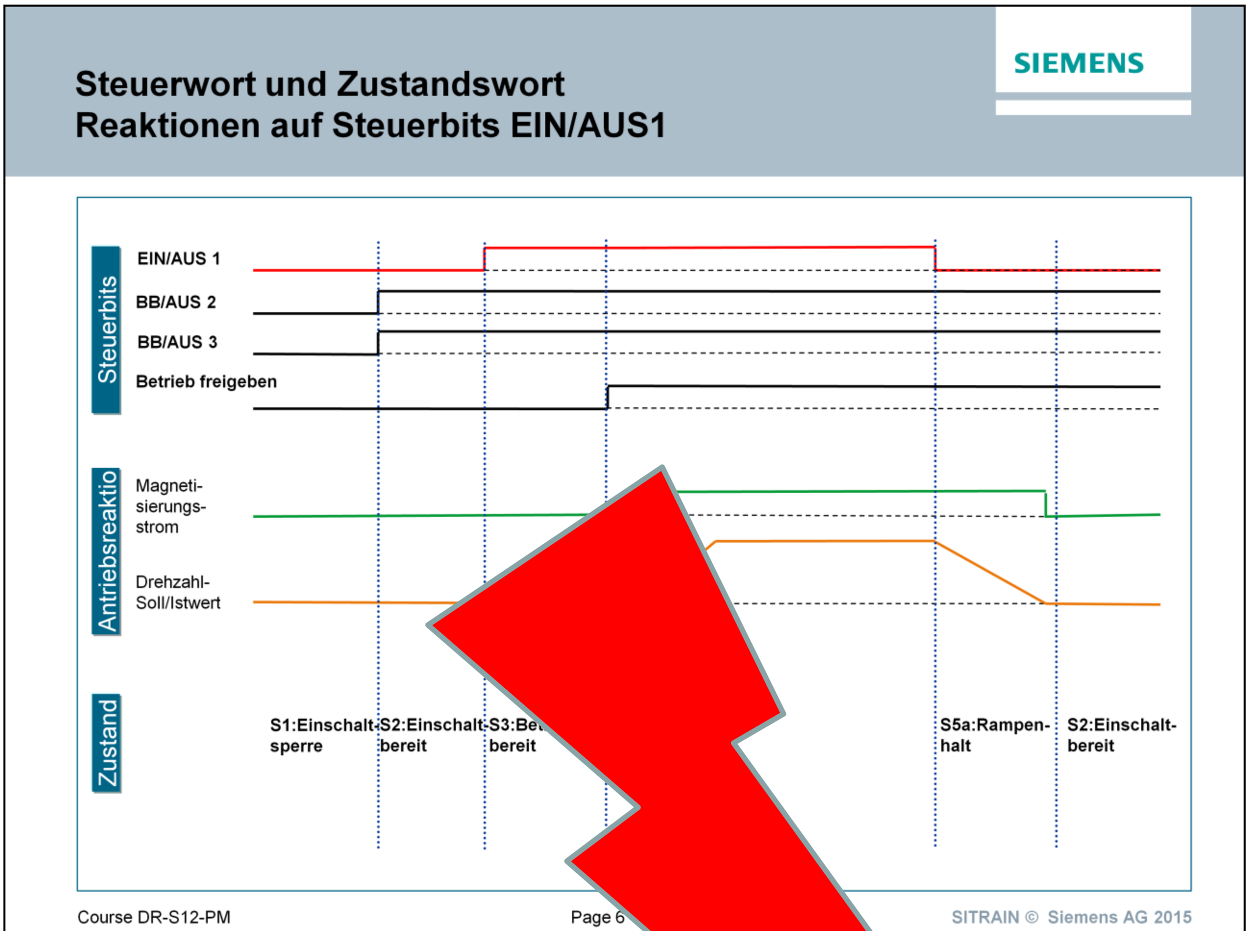
Immediate pulse suppression, the drive coasts to standstill.

- Any parameterized motor holding brake is closed immediately.
- The switch-on inhibit is activated.

OFF3

The drive is braked immediately by entering n_set = 0 along the OFF3 down ramp (p1135).

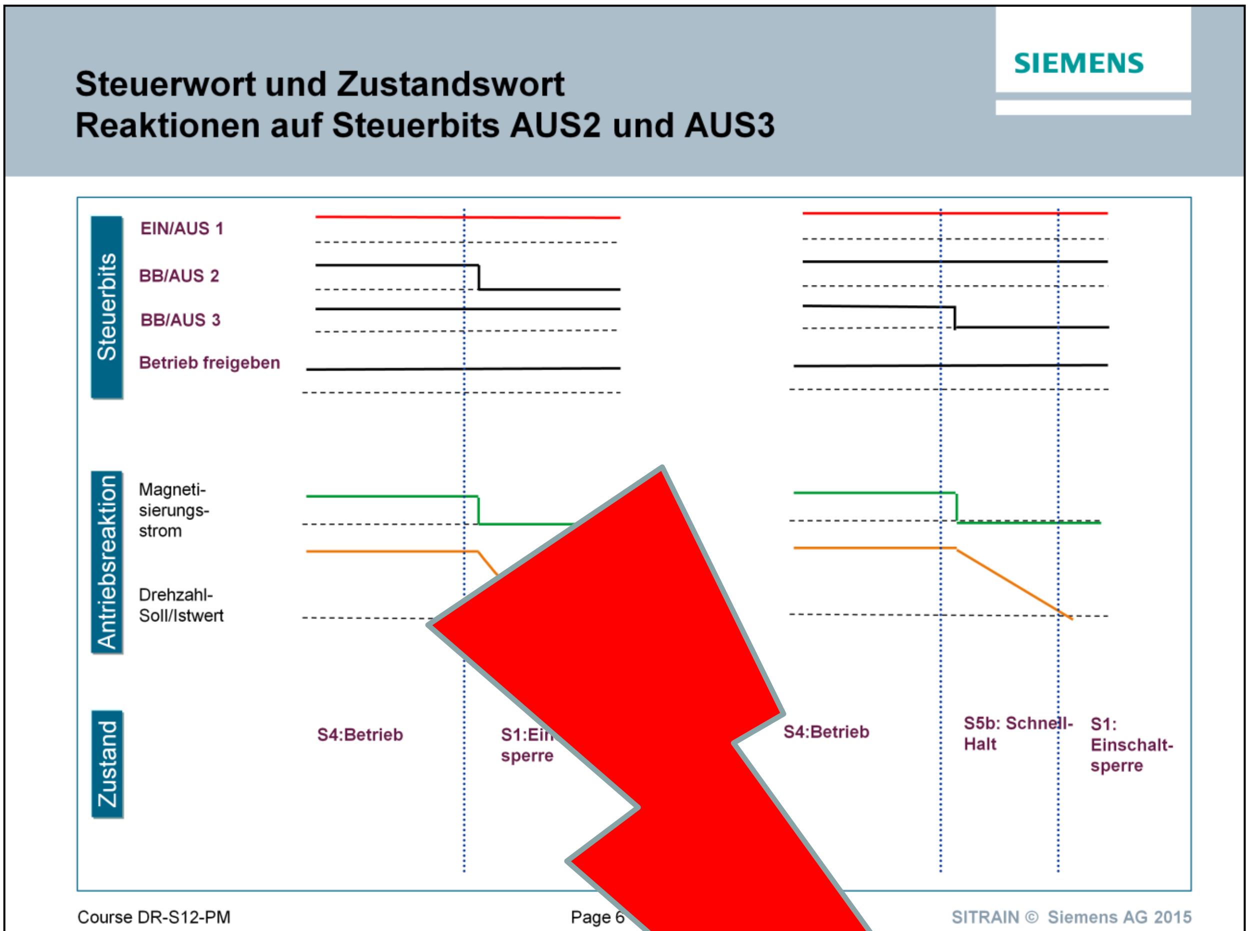
- When zero speed is detected, the motor holding brake (if parameterized) is closed. The pulses are suppressed when the closing time of the holding brake (p1217) expires. Zero speed is detected when the actual speed value is less than the speed threshold (p1226) or when the monitoring time (p1227) that started when speed setpoint ≤ speed threshold (p1226) has expired.
- The switch-on inhibit is activated.



Auf die Signale erfolgen diese Rea[illegible]

AUS1

Der Antrieb wird durch sofortige Vor[illegible]soll = 0 an der Hochlaufgeber-Rücklauframpe (p1121) abgebrems[illegible]
Nach Erkennen des Stillstands wird ei[illegible]parametrierte Motorhaltebremse geschlossen (p1215). N[illegible]f der Schließzeit (p1217) werden die Impulse gelöscht. Stillstand wird e[illegible]wenn der Drehzahlistwert die Drehzahlschwelle (p1226) unterschreitet ode[illegible] die bei Drehzahlsollwert ≤ Drehzahlschwelle (p1226) gestartete Überwachun[illegible]it (p1227) abgelaufen ist.



Auf die Signale erfolgen diese Rea[illegible]

AUS2

Sofortige Impulslöschung, der Antrie[illegible].

- Eine eventuell parametrierte Mot[illegible] wird sofort geschlossen.
- Die Einschaltsperre wird aktiviert.

AUS3

Der Antrieb wird durch sofortige Vorgabe von n_[illegible] an der AUS3-Rücklauframpe (p1135) abgebremst.

- Nach Erkennen des Stillstandes wird eine eventuell p[illegible]ametrierte Motorhaltebremse geschlossen. Am Ende der Schließze[illegible] der Haltebremse (p1217) werden die Impulse gelöscht. Stillstand wird erkannt, wenn der Drehzahlistwert die Drehzahlschwelle (p1226) unterschreitet oder wenn die bei Drehzahlsollwert ≤ Drehzahlschwelle (p1226) gestartete Überwachungszeit (p1227) abgelaufen ist.
- Die Einschaltsperre wird aktiviert.

Control logic
Control word for sequence control

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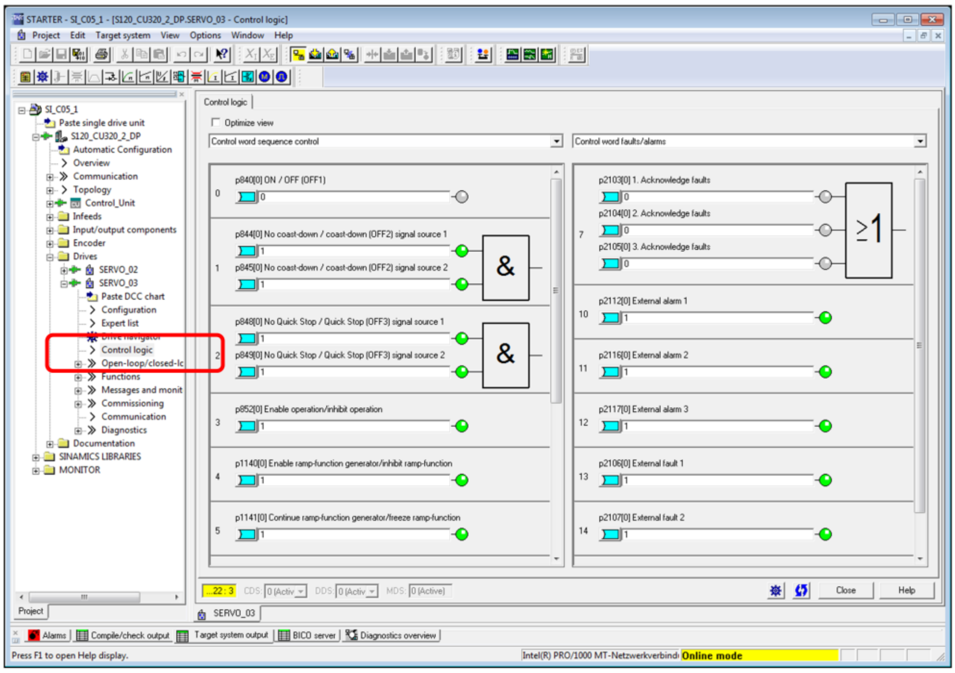
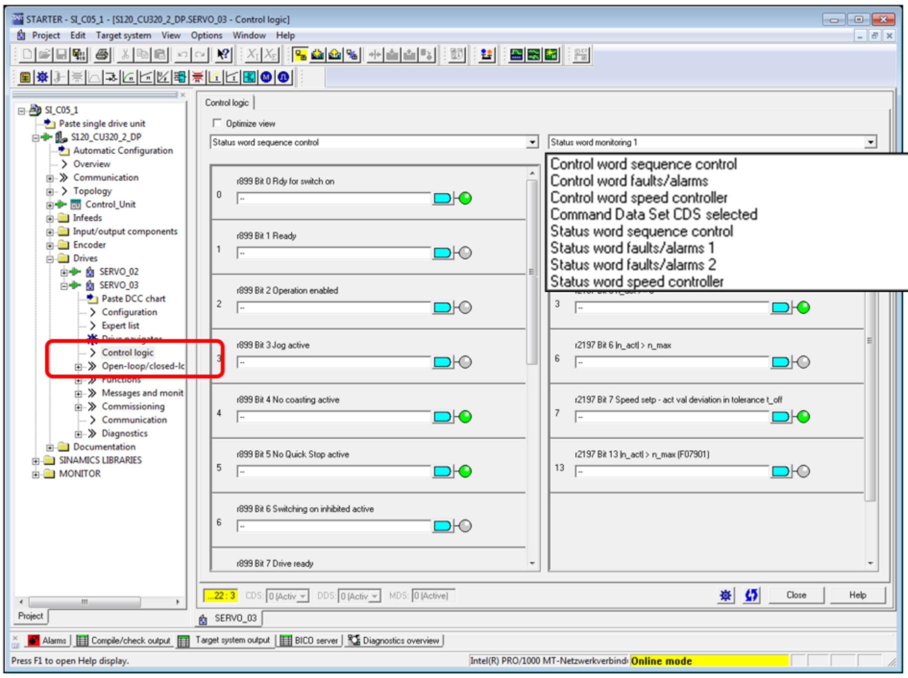


In addition to the control word and status word for sequence control, the drive objects have numerous other control words and status words, such as:

- Control word fault/alarm
- Control word, speed controller
- Control word, setpoint channel
- Control word encoder 1, 2, 3
- Control word command data set CDS selection
- Status word faults/alarms 1
- Status word faults/alarms 2
- Status word, speed controller
- Status word monitoring 1, 2, 3
- Status word encoder 1, 2, 3
- Status word closed-loop control
- Missing enables
- Status word ramp-function generator
- Status word Safety Integrated Control Unit
- Status word Safety Integrated Motor Module
- Status word Safety Integrated Control Unit and Motor Module

Control logic
Status words for sequence control



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Status words

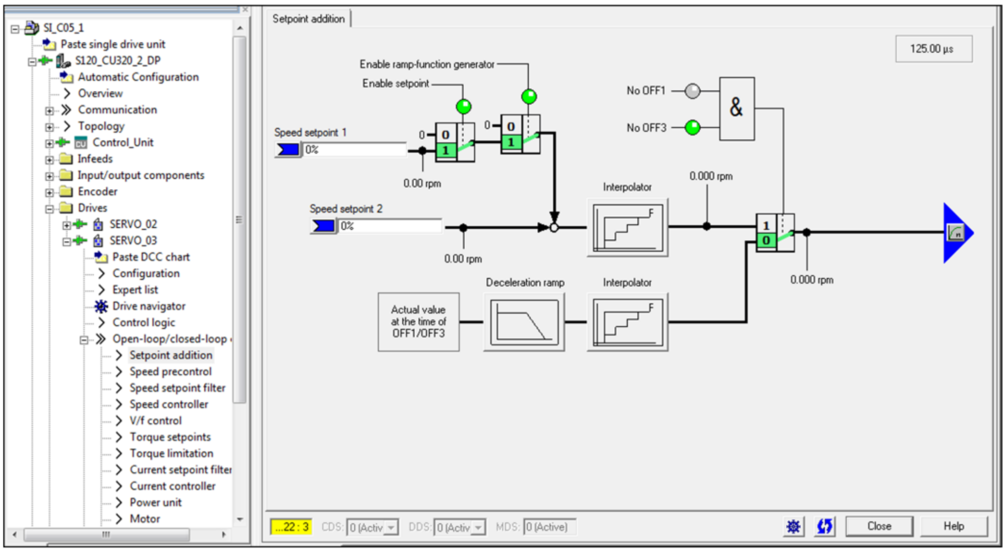
Via

>> Drive -> Control logic

It’s possible to display the states of the individual signals of the status word.

The selection menu allows you to display various status words.

Speed setpoint



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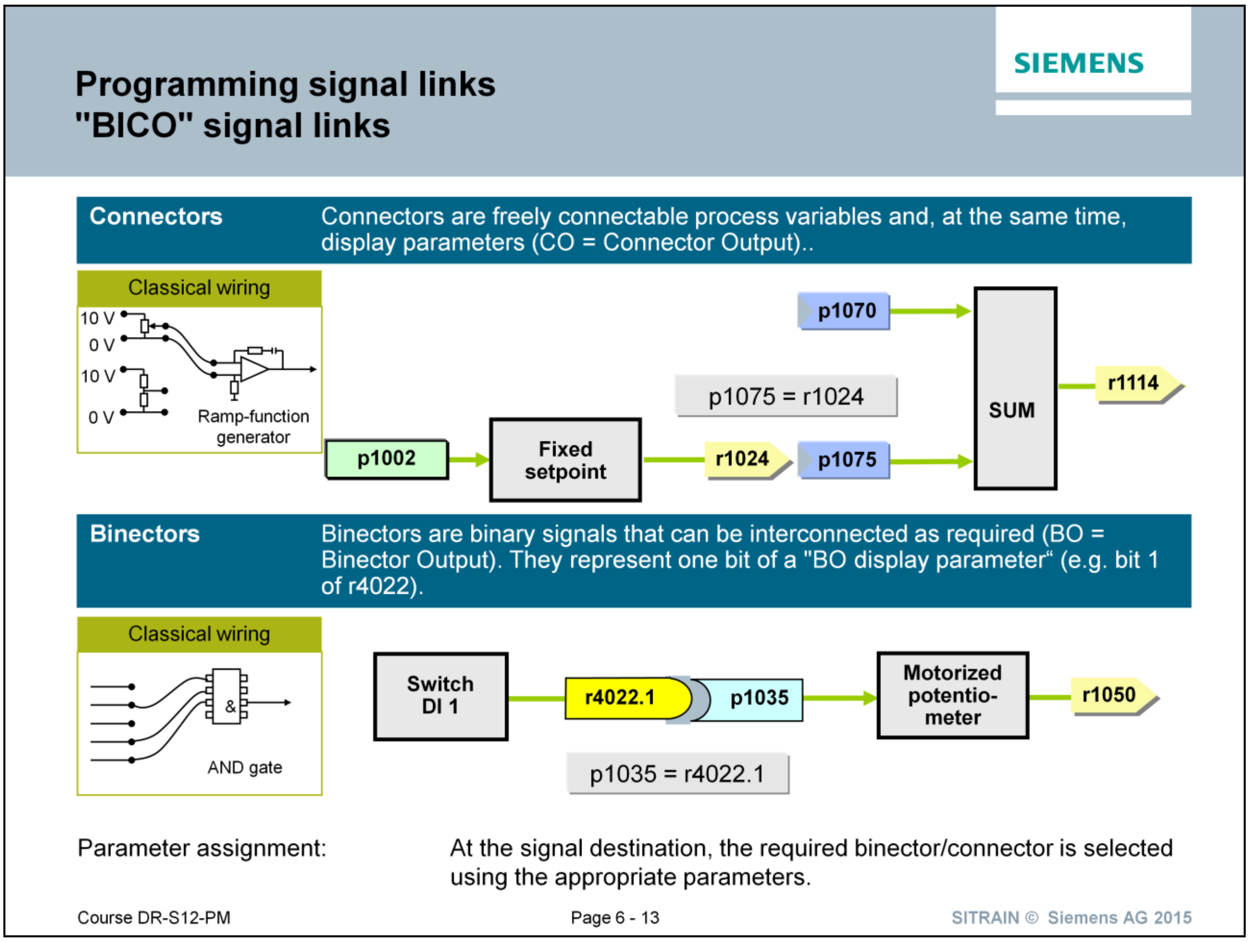
Speed setpoint

Besides specifying the control signals, a specified speed is also required for the drive by the application. The speed is specified in STARTER via the"Setpoint addition" screen which can be selected via the "Open-loop/closed-loop control“ directory in the drive.

Two speed setpoints can be specified in this screen. These speeds are processed further in the controller and converted to a pulse pattern to control the motor.



BICO technology

Each drive unit contains a large number of interconnectable input and output variables as well as internal control variables. Using BICO (BInector COnnector) technology allows the drive to be adapted to a wide variety of conditions.

Binary 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.

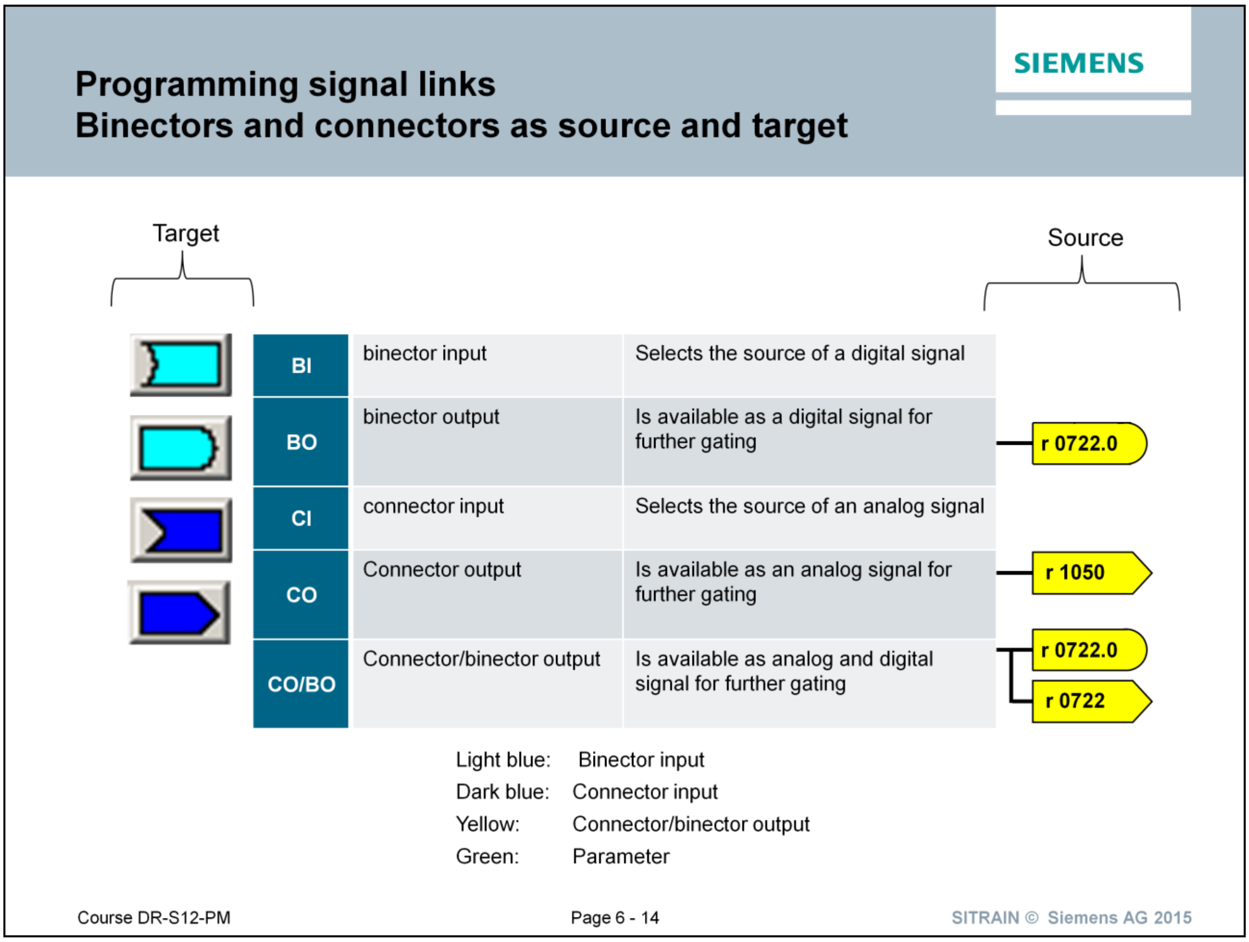
Binectors

Binectors are binary signals that can be interconnected as required (BO = Binector Output). They represent one bit of a "BO display parameter" (e.g. bit 15 of r0723).

Connectors

Connectors are "analog signals" that can be interconnected as required (e.g. percentages, speeds). Connectors are also display parameters (CO = Connector Output).

A CO (Connector Output) can also serve as a write parameter, e.g. p2900 fixed value 1 [%]. In this way, for example, parameters from an external device can be provided with values, and then used as a data source in a BICO interconnection.



BICO colors Different colors are assigned to the parameters, connectors and binectors in the STARTER expert list:

BI (Binector Input): light blue

BO (Binector Output): yellow

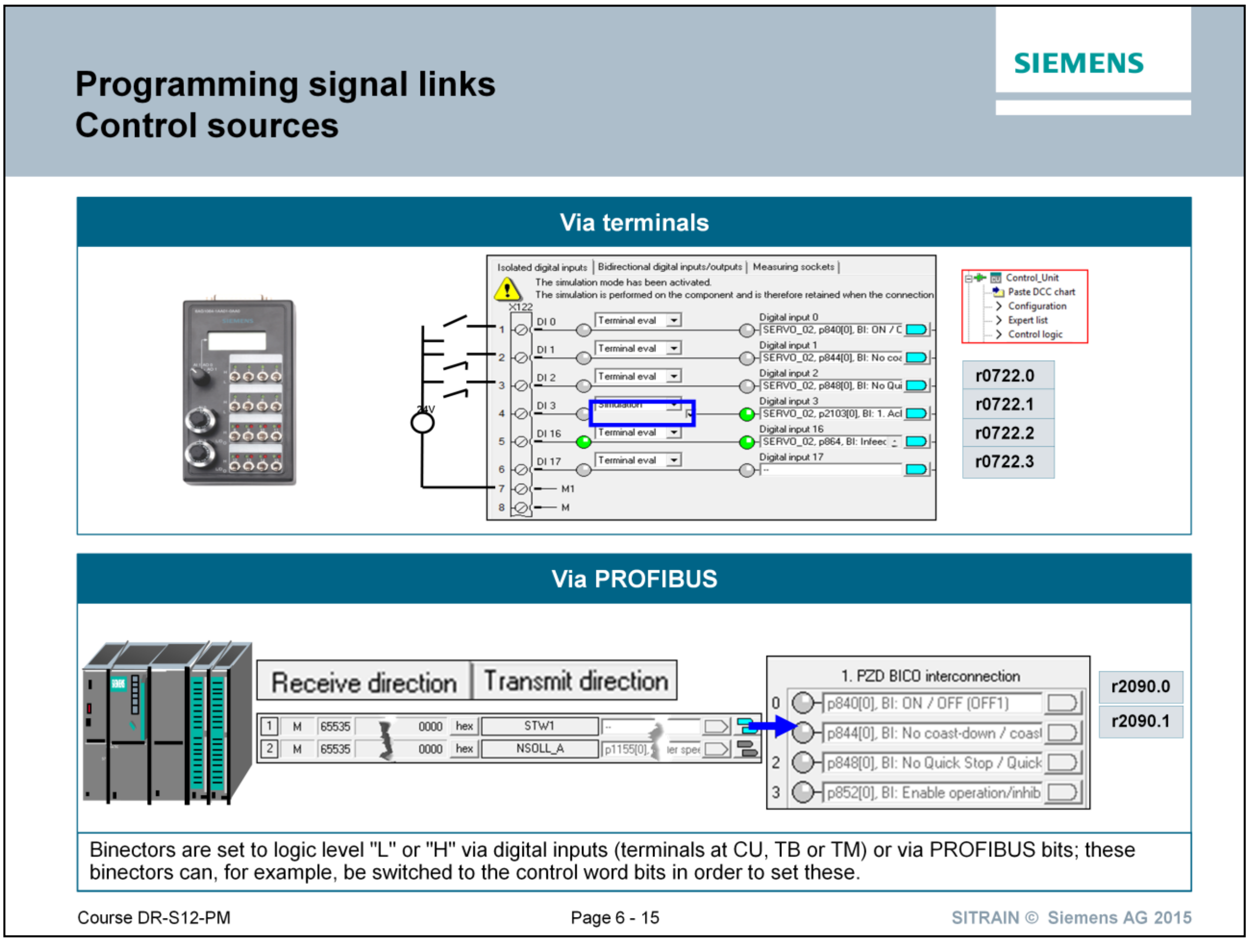
CI (Connector Input): dark blue

CO (Connector Output): yellow, if read-only parameters

CO (Connector Output): green, if fixed-value parameter

BICO symbols Different BICO symbols are used in the function diagrams

- Round symbols for binectors
- Square symbols for binectors



Terminal evaluation

This selection evaluates a level at the corresponding digital input. This means:

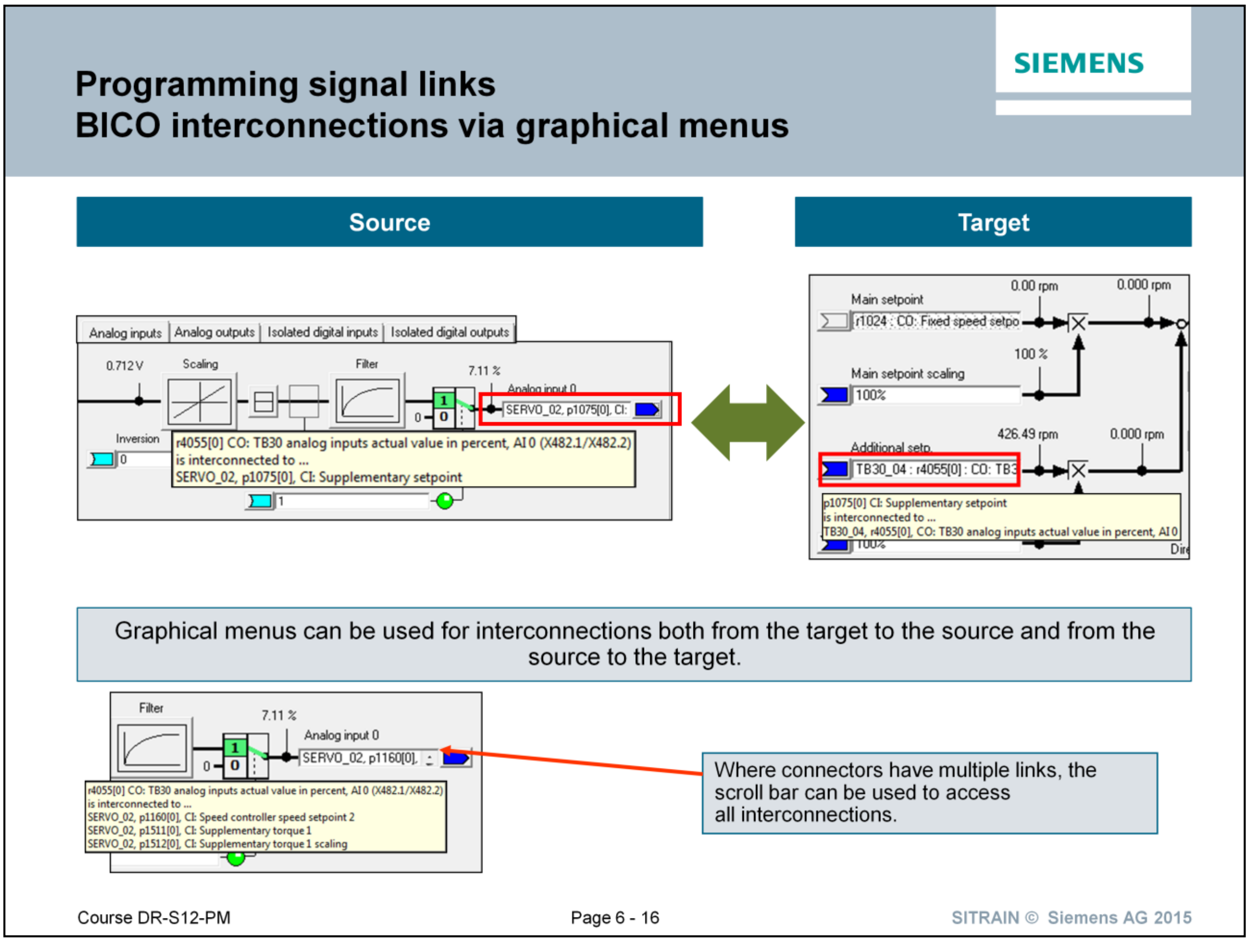
- 24 V corresponds to logical "1"
- 0 V corresponds to logical "0"

Simulation mode

Digital inputs can be operated in simulation mode. This allows the logical relationship between these signals and their further connections to be tested.

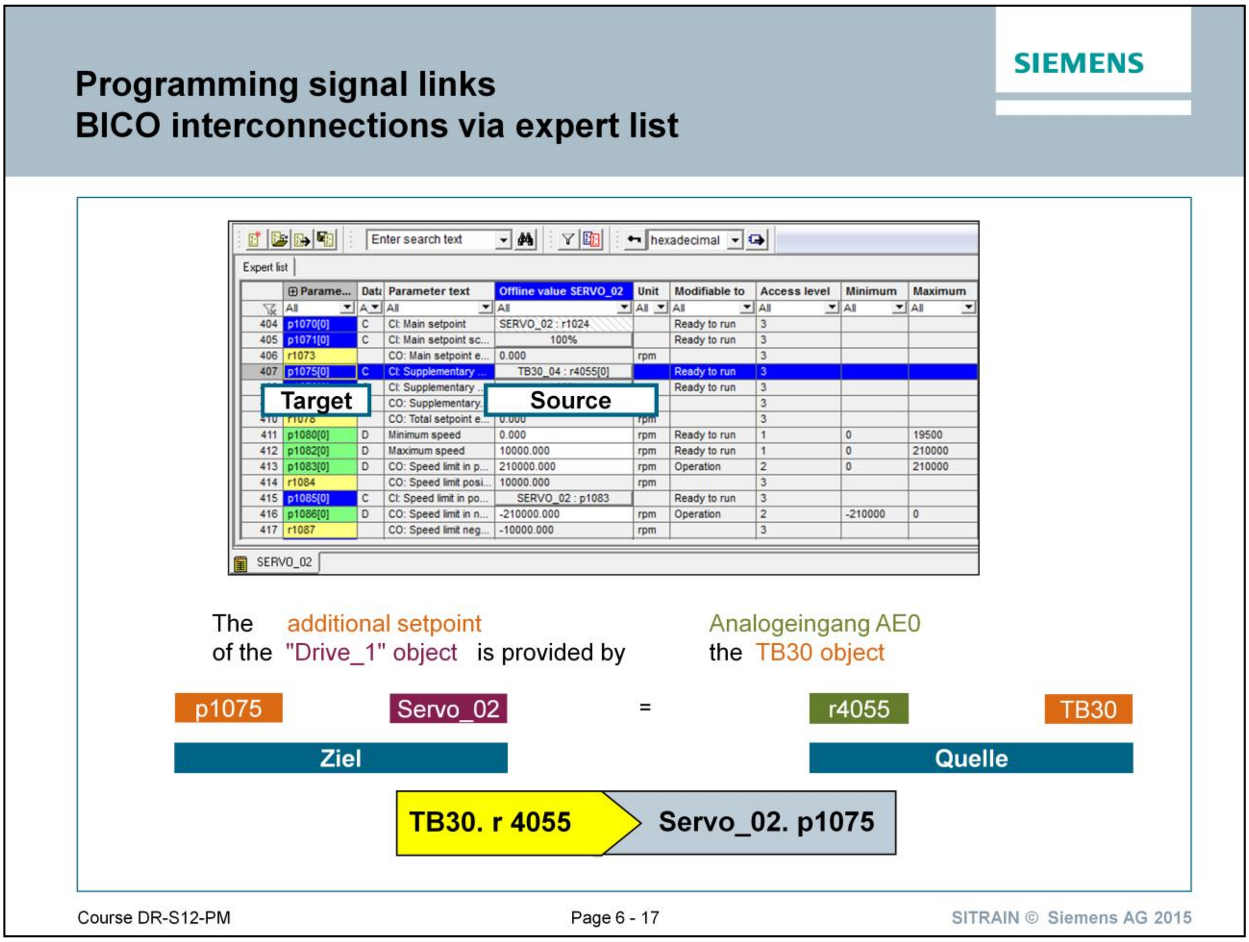
Note

Inputs can be switched to simulation mode only when they are in online mode Switching to offline does not exit simulation mode!



Using the graphical menus, BICO interconnections can be implemented from the source to the target, as well as from the target to the source. The same source parameter (here: TB30: r4055.0) can be connected to several target parameters.

If a source parameter is connected to a previously connected target parameter, Starter will detect this and output the following message:
"Remove existing connection?"



BICO interconnections can also be implemented within the expert list. Since a BICO interconnection is possible there from the target to the source, the following procedure must be considered:

1. Search for the target parameter in the object-specific expert list (here: p1075)

2. Select the drive object here with the required source parameter (here: TB30: r4055.0)

Diagnostics using parameters
Control/status words, missing enables

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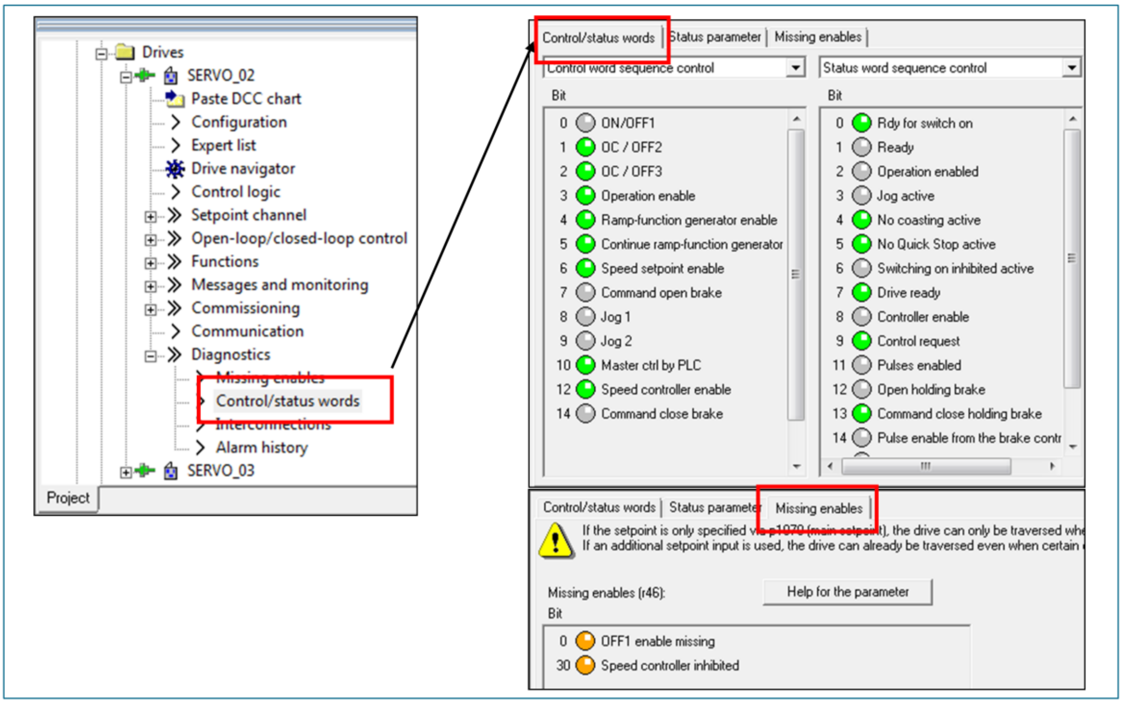

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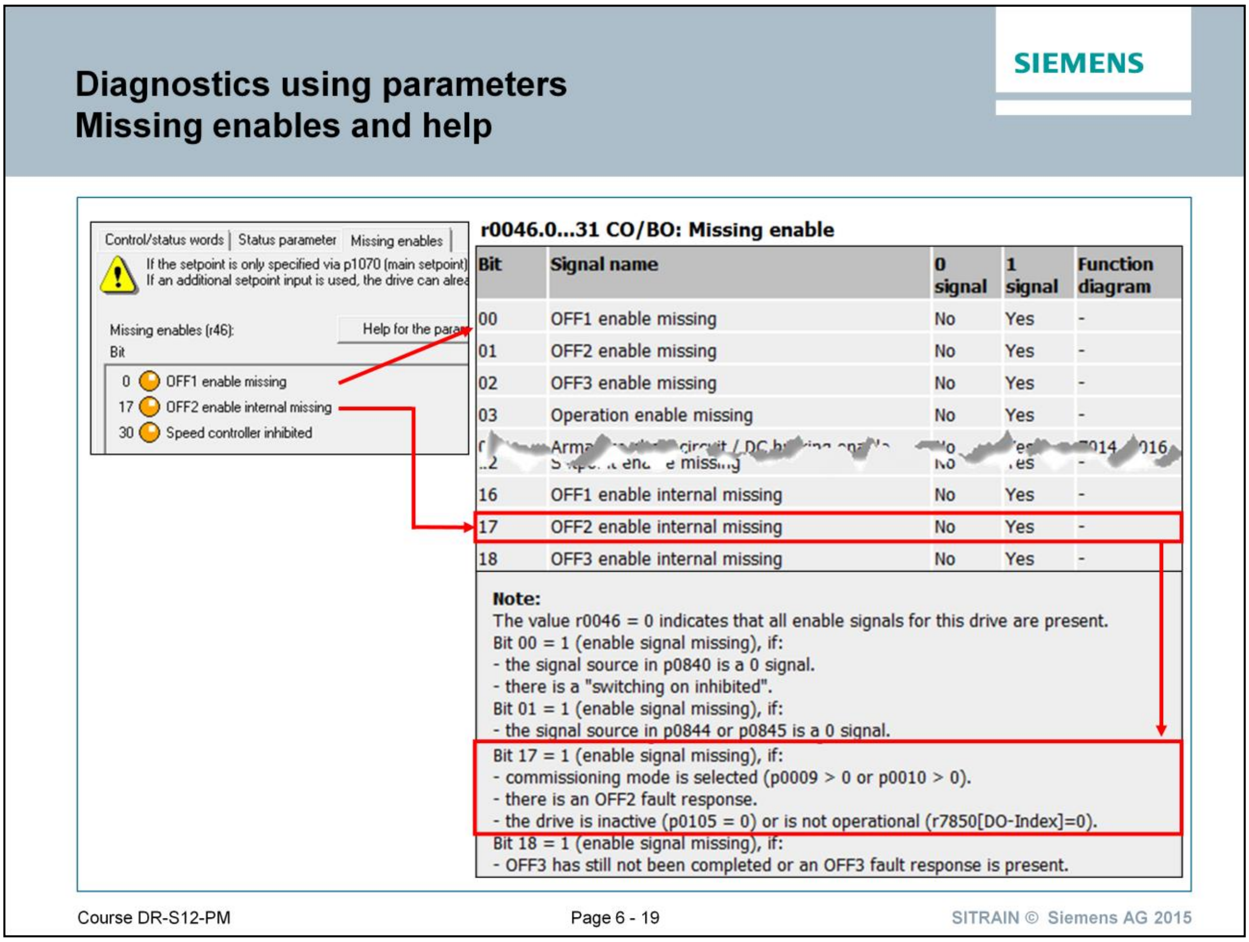
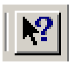
In online mode, the "Control word sequence control" and "Status word sequence control" are displayed here. A green LED represents a "1" signal and a gray LED represents a "0" signal.
Apart from these two words, depending on the enabled functionality, status and control words for faults and alarms, speed controller, encoder, basic positioner, etc. will be available.

Missing enables The missing enables of the respective drive object are displayed here. An orange LED means that the associated enable bit has not yet been set.



Missing enables The missing enables of the respective drive object are displayed here.
An orange LED means that the associated enable bit has not yet been set.
Comprehensive help with information about the reason for the missing enable can be accessed in Starter via the button



Trace function
Tool for tracing signals over time

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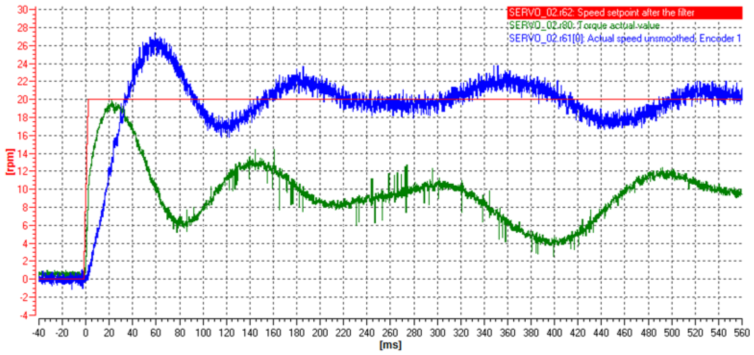

The trace tool allows

- Tracing of signals over time
- Definition of trigger conditions (start conditions)
- Tracing of bit signals
- Saving of measured characteristics
- Post-processing of measured characteristics

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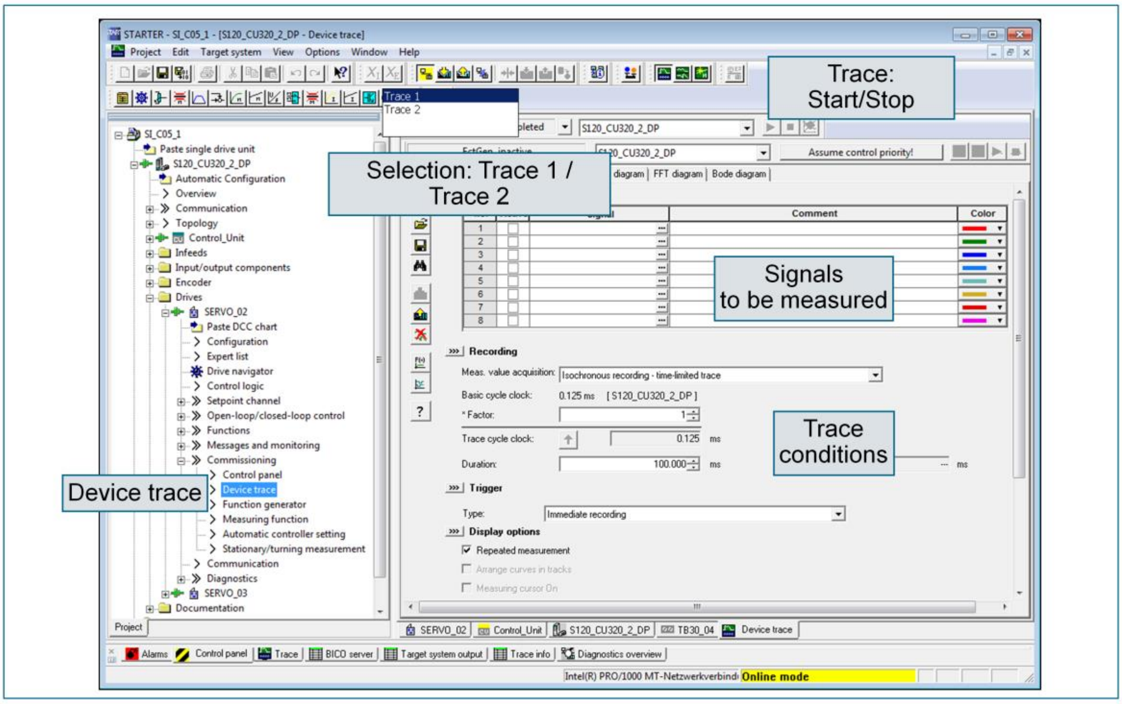
Trace function A trace is used to record signals over a period of time. STARTER allows eight signals each to be traced using two device traces. A trigger signal can be used to start tracing. The traced characteristic curves can be saved as a graphic or as a value file.

Trace function
Basic settings



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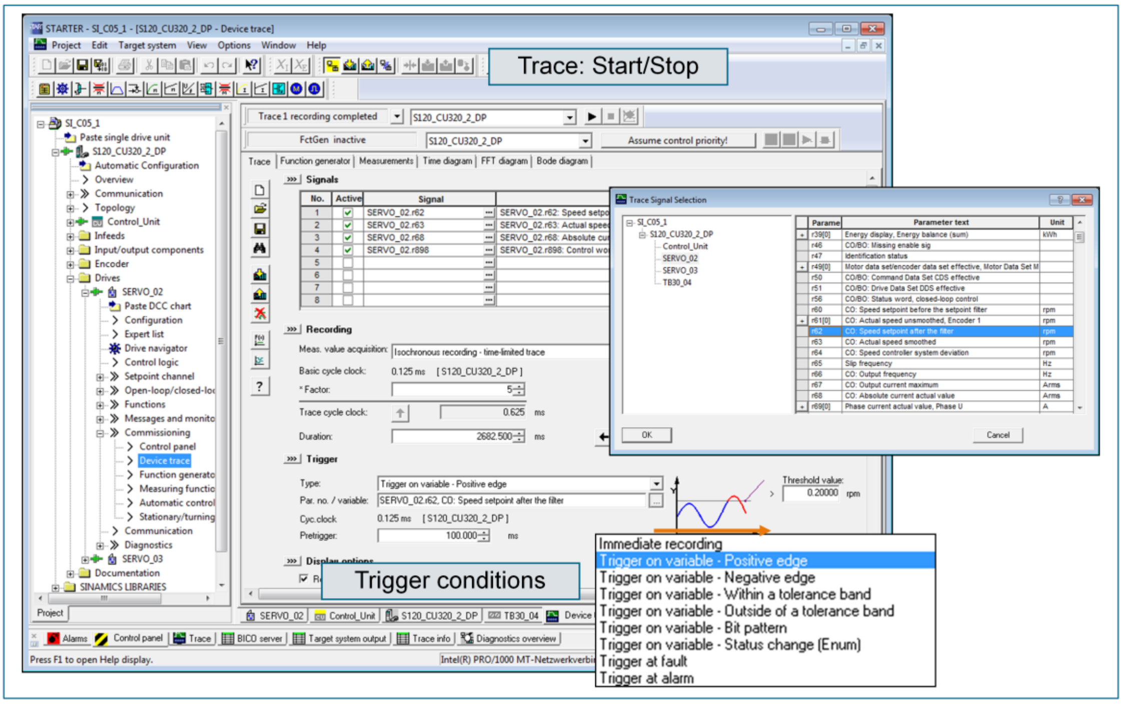
Trace The trace is a graphical tool for recording signals. Teher eare two traces Trace 1 and Trace 2. For each trace (8 signals can be recorded.
The signals are selected line by line by selecting the drive object and in it, the required parameter.

Recording The trace signals are output typically in the current controller clock cycle or in a multiple thereof (trace clock cycle) that is set via the "Factor". This means that a finite recording time can be specified in the trace memory on the Control Unit.

With this setting, a trace can be activated and recorded without an online connection for reading in later online. If an endless trace is selected, recording will continue until the trace function is stopped. An uninterrupted online connection is required to do this, since the main memory of the PG is used as the trace memory.

Trace function
Signal selection and trigger



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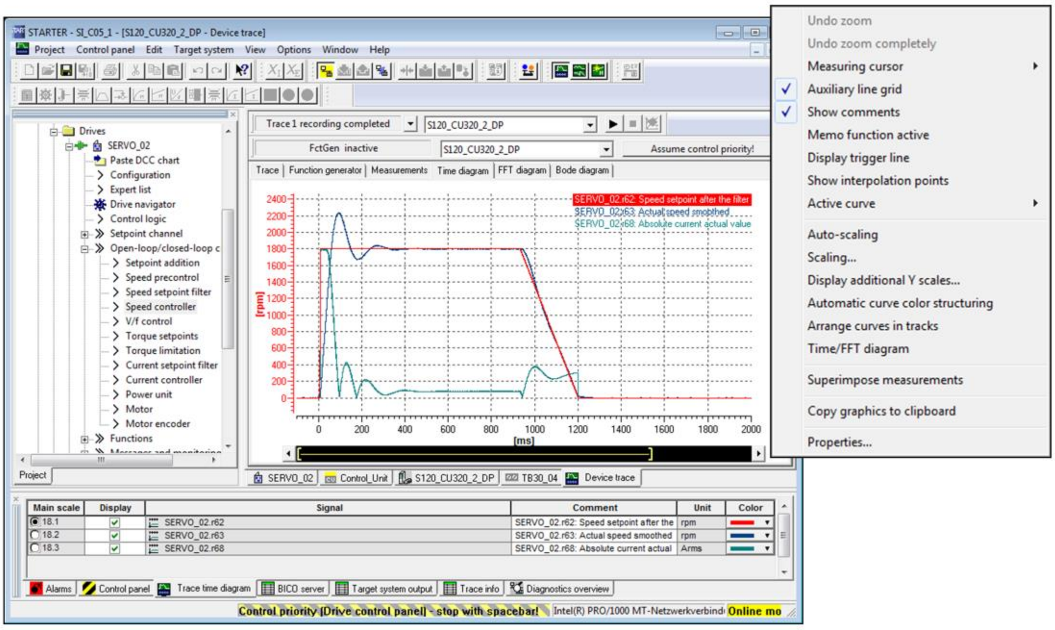
Trigger	This is used to specify the signal and, where applicable, the binary signal that will start the trace. When binary signals are used as trigger conditions, it is also necessary to mask the required bit and its level. A pretrigger time can also be defined.
Display options	Additional settings can be made here for signal display. It is advisable to select "Repeated measurement" when the signals are scaled. These settings will then be available for all further measurements.

Trace function
Measurements



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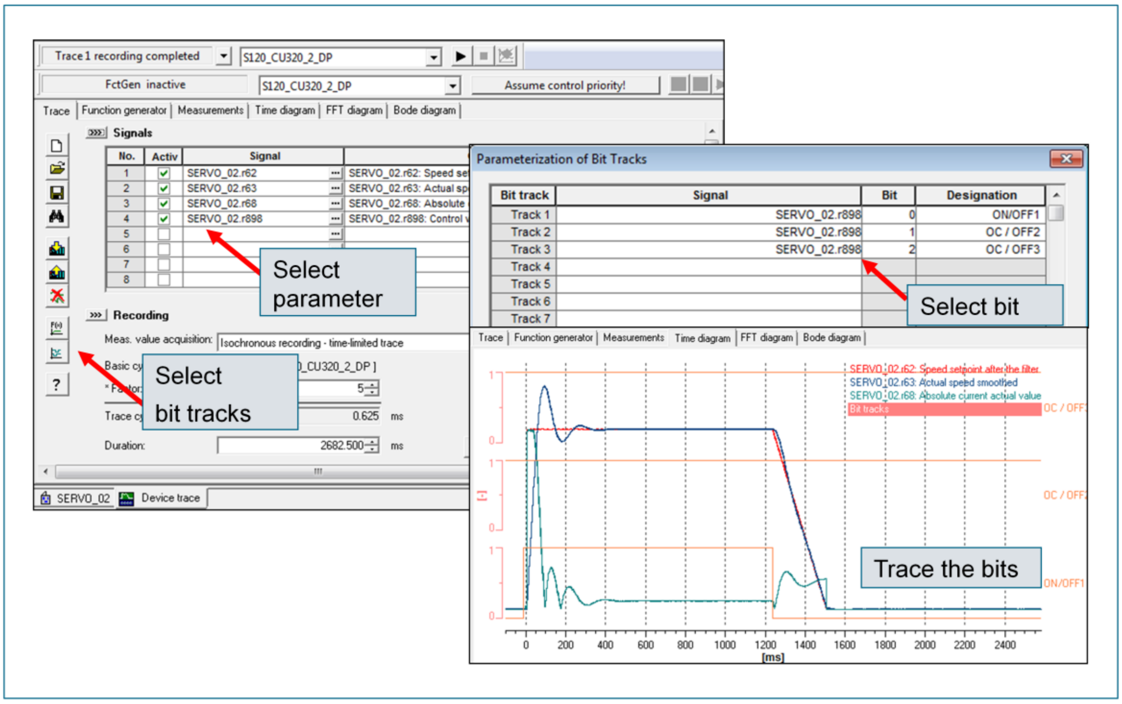
Scaling

In the standard setting for the trace, the recorded signals are presented in the full screen height. If more than one signal with the same physical variable is recorded, such as speed setpoint and actual speed value, actual value over-shoots may cause a scaling difference in the y-axis. To ensure comparability, the function "scaling" can be used to adapt the grid for one signal to that of the other signal.

In the example here, "Curve 4.1" (speed setpoint) is scaled in the y direction in the same manner as "Curve 4.2" (speed actual value). To ensure that this setting is also available for the next measurement, the function "Repeated measurement" must be activated in the trace settings.

Trace function
Signal selection for bit tracks



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Bit tracks

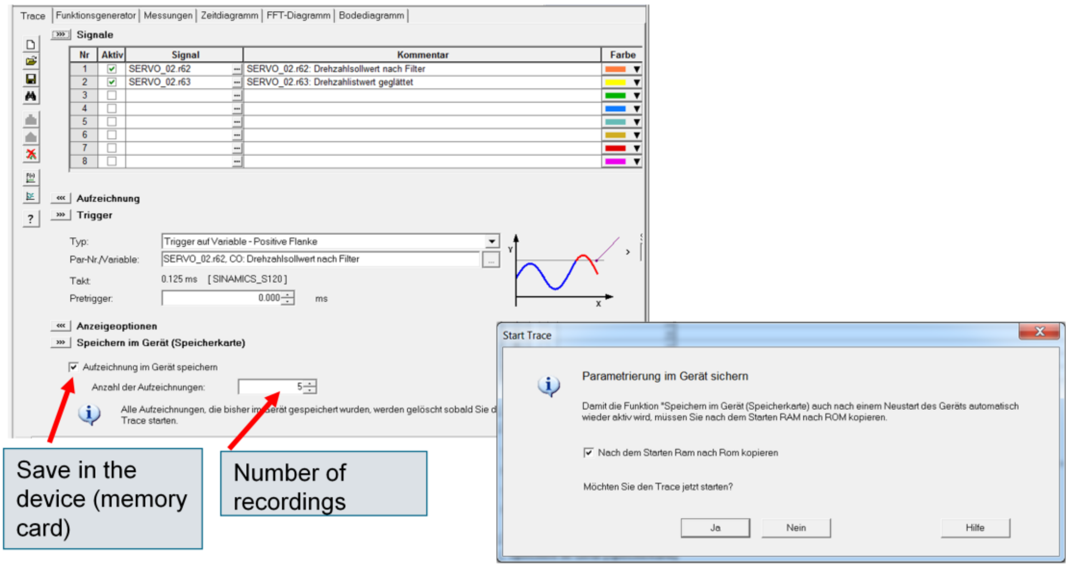
The device trace allows the status of the individual bits to be traced.
The procedure is as follows:

1. Select signal that contains the bit to be traced,
e.g. r898 (control word of the sequence control)

2. Select the "Select bit tracks" button. In the "Parameterization of bit tracks" table, select the signal word and enter the bit signal to be traced in the "Bit" column.

3. Start the trace.

Trace function
Save recording in the device



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Write recording to device

This is where you activate automatic storage of measurements. The trigger is activated automatically again at the end of a recording if the Number of recordings is greater than zero. The measurements are written to the memory card in directory /USER/SINAMICS/DATA/TRACE as ACX files.

If Copy RAM to ROM has been activated during the download of the parameterization, the activation is also retained after restarting the controller. This setting is only possible for a time-limited trace.

You can either read out the measurements with a card reader via the Web server. In Trace, on the Measurements tab, select the ACX data you have read out with the Open measurements button.

Note

The recorded ACX files contain less information than TRC files. The following information is omitted from ACX files:

Designation of the object

Parameter information (read/write parameters, number of indices)

Units of measurement

If applicable, use the comment field on the Measurements tab to add this information.

number of recordings

After activating Write recording to device this is where you set the number of recordings. The size of the ring buffer depends on the device and is dimensioned for at least five measurements.

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Exercises

- Exercise 1: Enable signals
- Exercise 2: Control via terminal signals
- Exercise 3: Device trace: Tracing of signals

Safety information

Please note that:

- The course instructions have been produced for:
  - A course held by a course leader
  - Activities carried out on special training equipment
- The training equipment is operated under laboratory conditions.
  In case of doubt, always ask your course leader – particularly when handling components that carry electrical current or which can move.
- When carrying out work on equipment, the safety information in the associated product documentation must always be observed!
  The training documents alone are not sufficient.

Exercise 1: Enable signals
Traversing drives via the control panel

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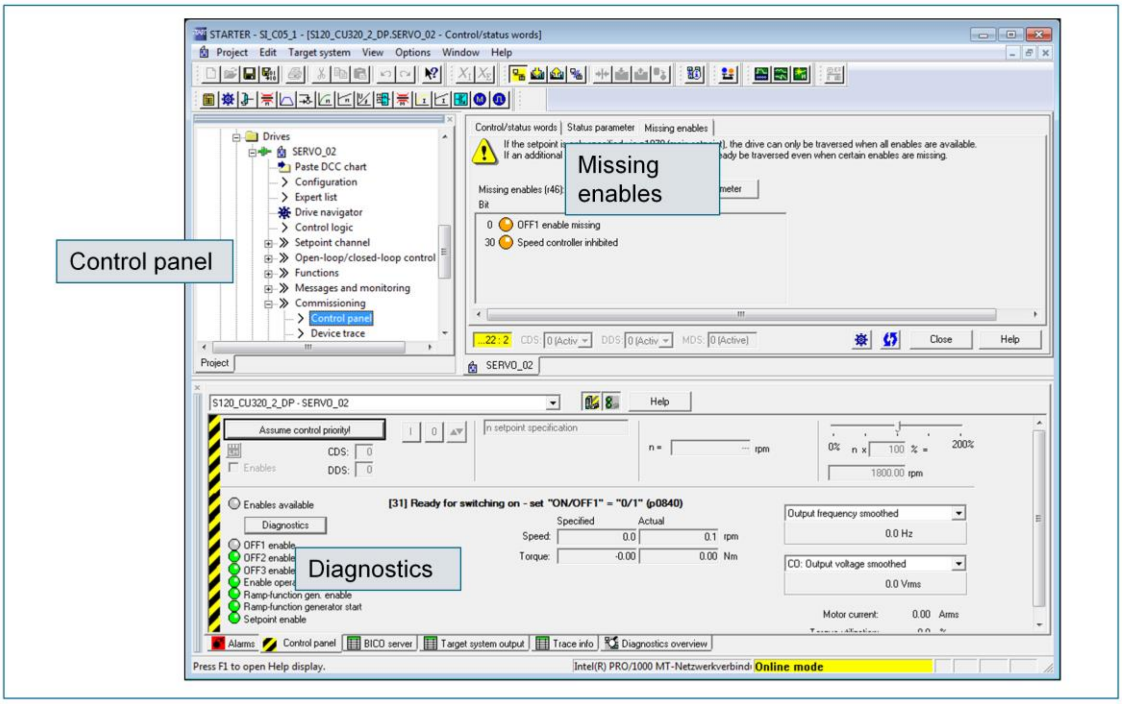

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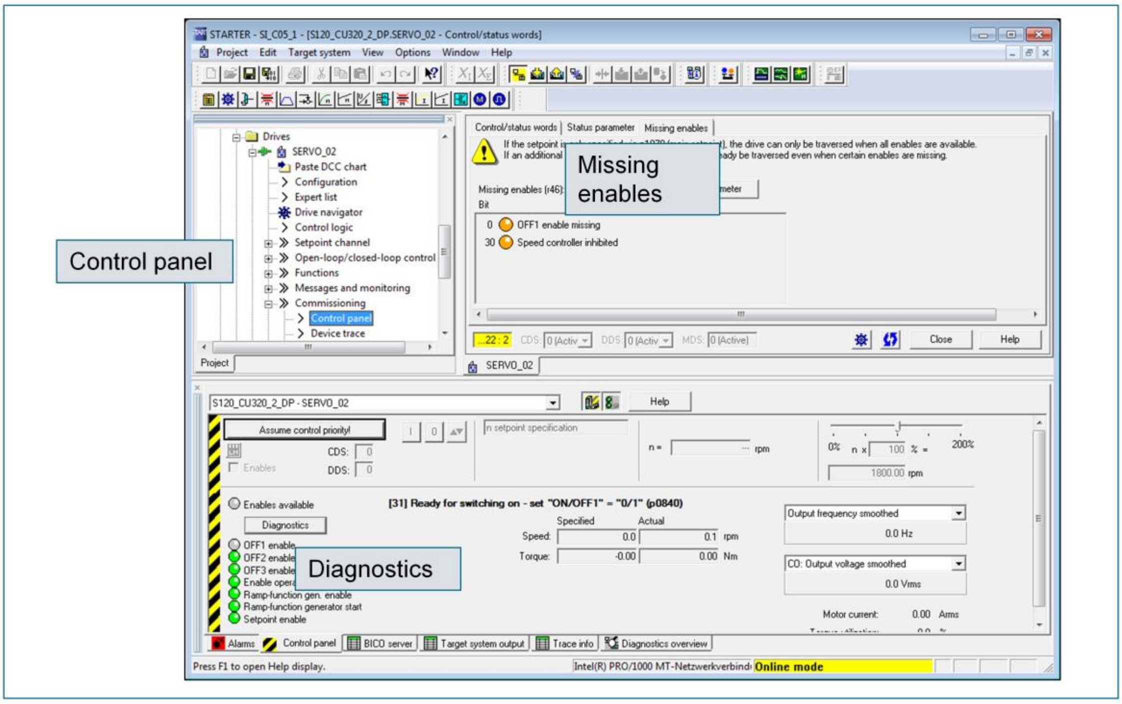
Task The two drives should first be traversed using the control panel. Open your "S120_Servo_1" project and go online.

1. Open the control panel.

Exercise 1: Enable signals
Traversing drives via the control panel



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2. The diagnostic area should now also be shown.
   The "Diagnostics" button opens a further screen that shows the missing enables.

   Which signals are missing?

   ……………………………………………………………………………………

   Use the "Assume control priority" button to traverse the drive via the control panel.
   Which missing signals are now shown?

   ……………………………………………………………………………………

   Set the enables in the "Enables" selection field.
   Which missing signals are now shown?

   ……………………………………………………………………………………

   Start the drive using the green button.
   Which missing signals are now shown?

   ……………………………………………………………………………………

   How does the drive respond to the enable signal?

   ……………………………………………………………………………………

   Enter a setpoint of 100 rpm and start the drive. Stop the drive and return the control priority.

Exercise 2: Control via terminal signals
Control word of the sequence control

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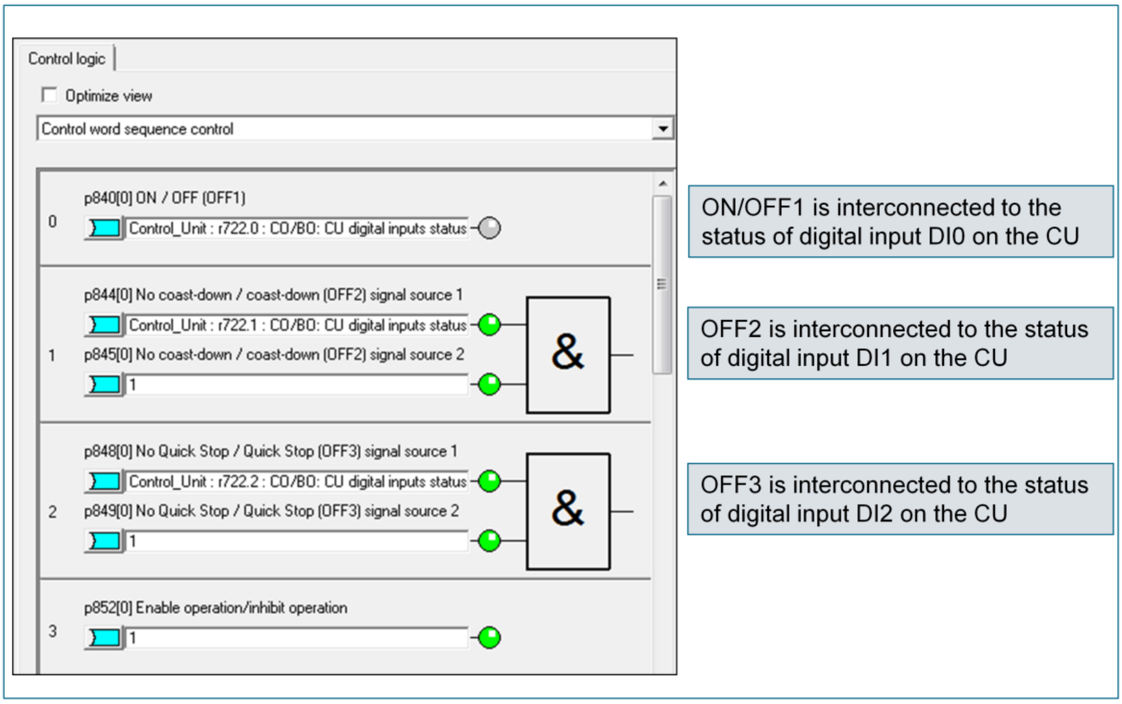

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Starting basis

The two drives should no longer be traversed via the control panel, but via the operator box. In addition to the control signals, a speed setpoint must also be specified for the two drives.

Task

After configuring the Servo_02 and Servo_03 drives, most of the control signals for operating the drives are already pre-assigned "1". Now change the pre-assignment of the control word of the sequence control, so that you can control the drives via the operator box:

1. To do this, select
   >> Drives > Servo_02 > Control logic
   There, you can further assign the control signals in a very straightforward and transparent way, without having to open the expert list.

2. Select the "Control word sequence control".

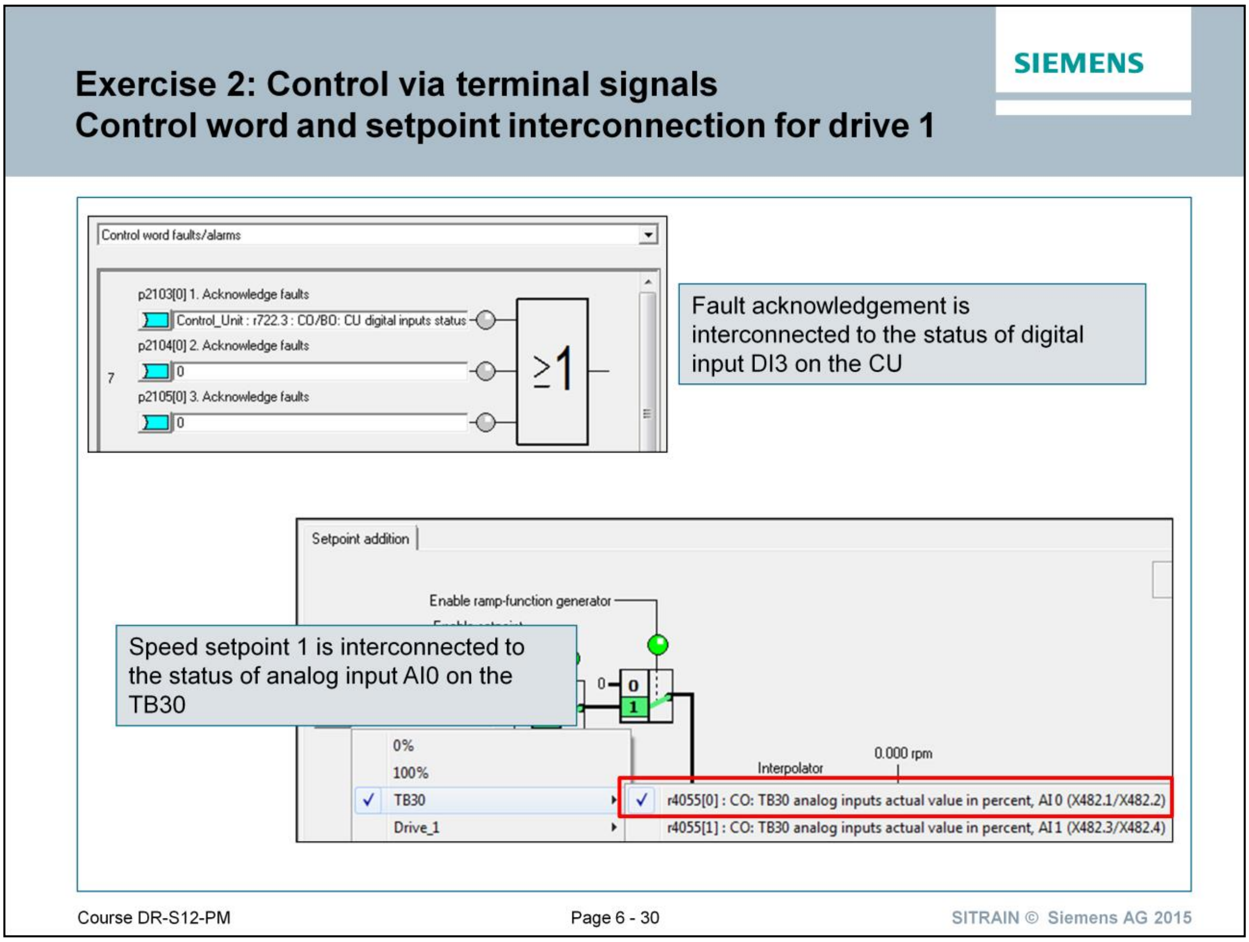
3. Connect the ON/OFF1 signal to switch 0:
   >> p840[0] = CU_S_004: DI 0 = r722.0
   ➔ SERVO_02, p0840[0] BI : ON/OFF1 = CU_S_004, r0722: Bit 0

4. Parameterize the OFF2 signal to switch 1 on the operator box:

   ……………………………………………………………………………………

5. Parameterize the OFF3 signal to switch 2 on the operator box:

   ……………………………………………………………………………………



Task

Also change the pre-assignment of the "Control word faults/alarms", so that you can acknowledge faults using the operator box.

Select analog input AI 0 of the operator box as speed setpoint source:

1. Select the "Control word faults/alarms".

2. Connect the signal "1. Acknowledge faults" to switch 3 of the operator box:

   ………………………………………………………………………………

3. Is analog input AI 0 interconnected corresponding to the factory setting?

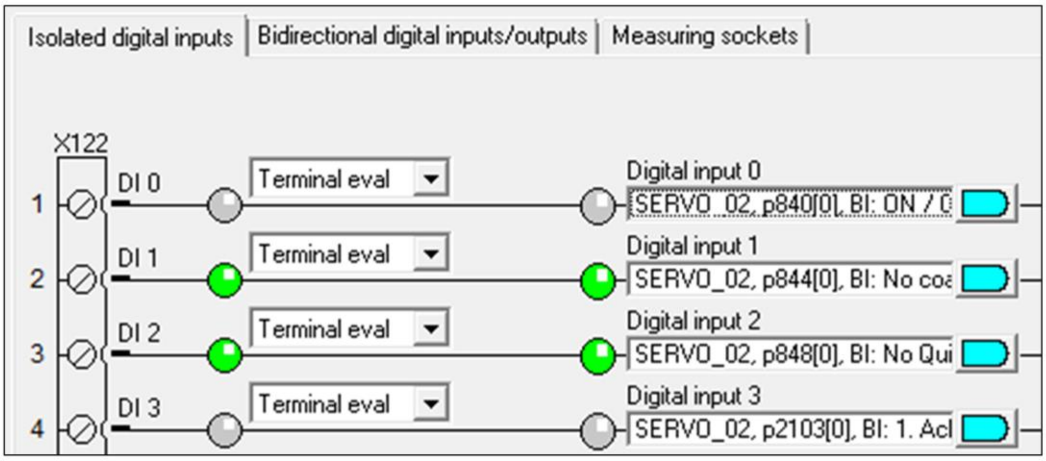
   ………………………………………………………………………………

4. Interconnect the setpoint source "speed setpoint 1" to potentiometer AI 0 of the operator box. To do this, open the screen form:
   >> Drives > Servo_02 > Open-loop/closed-loop control > Setpoint addition
   SERVO_02, p1155[0] CI : Speed setpoint 1 = TB30_04, r4055[0]

5. Start the SERVO_02 drive using the operator box and specify the speed using potentiometer AI 0.

6. Monitor the online values in the "Control logic" and "Setpoint addition" screen forms.

Exercise 2: Control via terminal signals
Control word and setpoint interconnection for drive 2



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Task

For SERVO_03, establish the corresponding BICO interconnections starting from the input terminals:

1. In the project navigator
   >> CU_S_004 > Inputs/outputs > Isolated digital inputs

2. Use digital inputs DI 4 .. 7 (X132) to control SERVO_03:
   DI 4 ON/OFF1:

   ………………………………………………………………………………
   DI 5 OFF2:

   ………………………………………………………………………………
   DI 6 OFF3:

   ………………………………………………………………………………
   DI 7 1. Acknowledge faults:

   ………………………………………………………………………………

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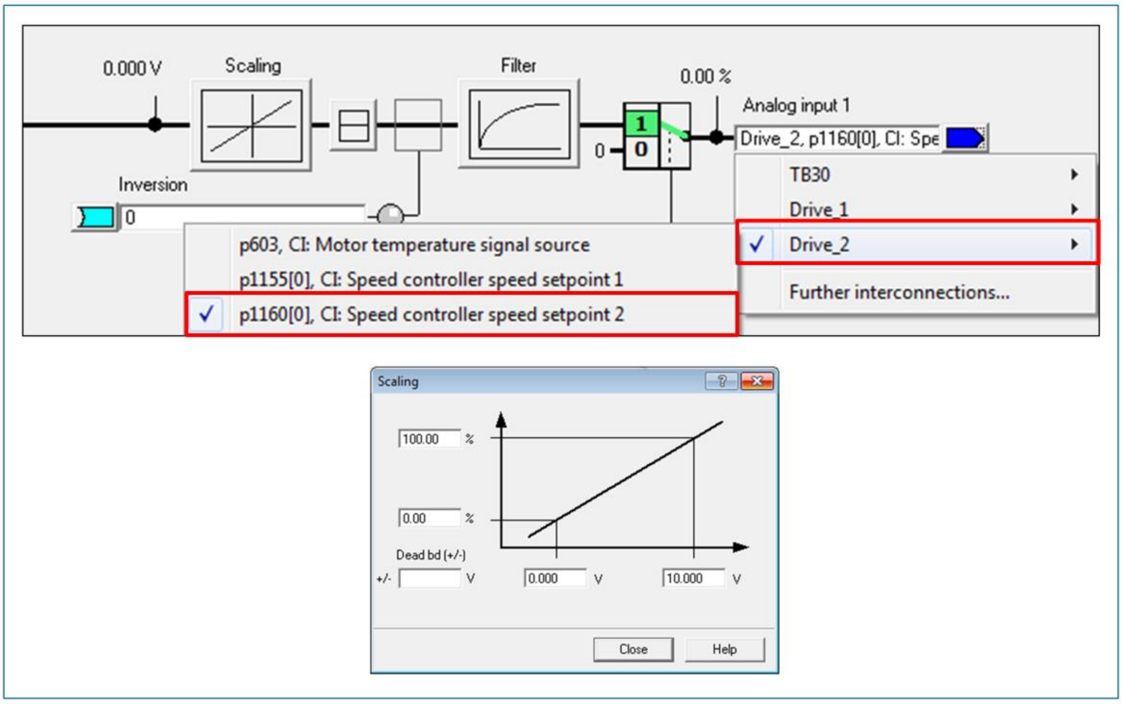
Exercise 2: Control via terminal signals
Control word and setpoint interconnection for drive 2



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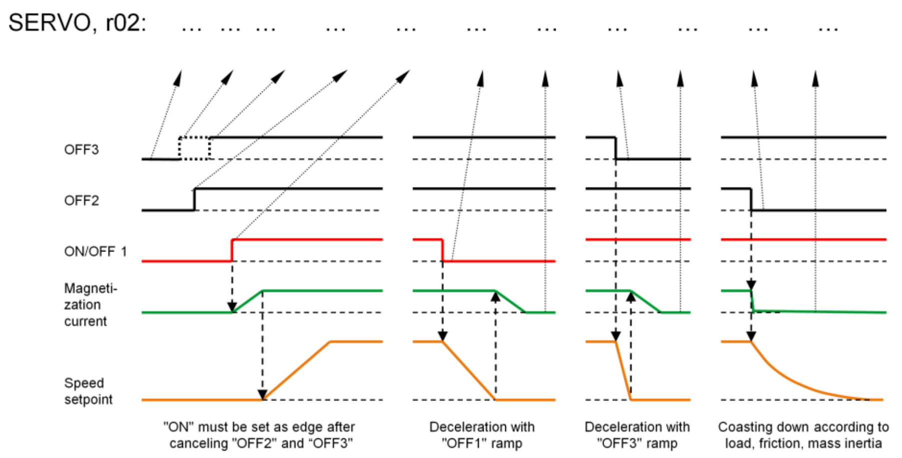
3. In the project navigator, open
   >> *CU_S_004* > *TB30_04* > *Inputs/outputs* > *Analog inputs*

4. Assign the parameters for analog input AI 1 (Terminals X482: 3/4) to enter the speed setpoint for SERVO_03:
   AI 1 n_set:

   ………………………………………………………………………………

5. Check the scaling of the analog input.
   The scaling defines the assignment between the voltage and
   a percentage value.
   In our example:
   -10V corresponds to -100%
   10 V corresponds to 100%
   This means that no absolute value is assigned to the voltage; rather, a percentage value that is converted to an absolute value using the corresponding reference value.

Exercise 2: Control via terminal signals
Checking the signals



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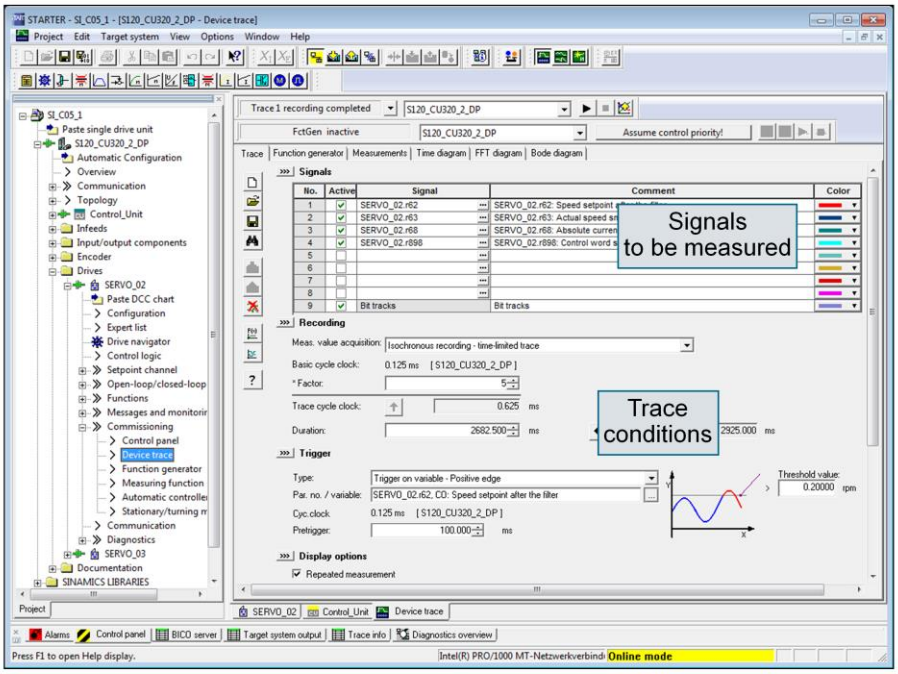
Task Test the switch-on and switch-off behavior of both drives based on the following diagram.

1. Set the switches for OFF2 and OFF3 to "1", before you start the drive with a rising edge at the ON/OFF1 signal
2. Now set the ON/OFF1 signal back to "0".
3. Switch on the drive again, and this time set signal OFF2 to "0" and monitor the response.
4. Switch on the drive again, and this time set the OFF3 signal to "0" and monitor the response.
   What difference did you notice?

   ……………………………………………………………………………………
5. Once you have completed the test, save the online changes to the CF card (ROM), to the PG and to the hard disk.
6. This tested project is used as the starting point for further exercises.
   Therefore archive the project.

Exercise 3: Tracing the signals
Device trace



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Task

Use the trace to record the speed setpoint, actual speed value and actual current value in a defined period

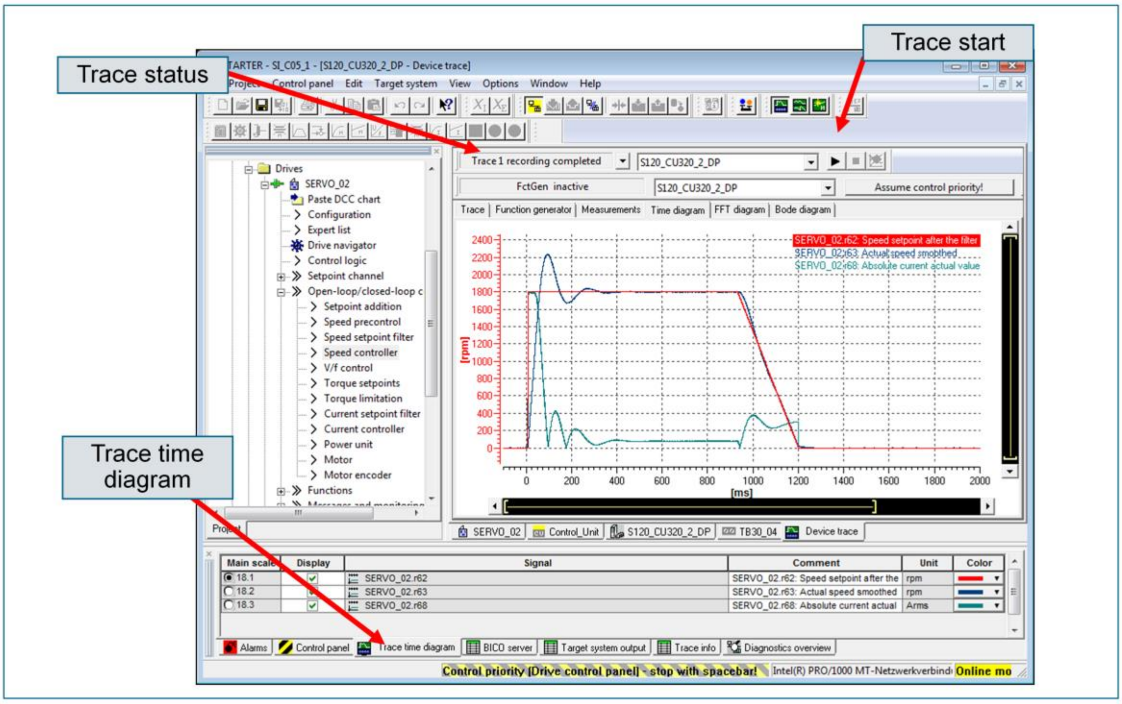
Make the settings to trace the speed setpoint, speed actual value and current actual value using the trace function:

1. Open the trace:
   >> Drives > SERVO_02 > Commissioning > Device trace
2. Parameterize trace 1 for the following signals:
   - Speed setpoint after the filter (r62)
   - Speed actual value (r63)
   - Current actual value (r68)
3. Select for recording:
   - Measured-value acquisition: time-limited trace
   - Recording duration: 6 seconds (6000 ms)
     Possibly with the entered recording duration displayed in red. To do this, activate the arrow key "Trace cycle clock" to automatically align the trace cycle clock to the size of the measured value memory. The recording time is then displayed in black.
4. Define the trigger:
   - Type: Trigger on variable – Positive edge
   - Parameter no./variable: Servo_02, speed setpoint (r62)
   - Threshold value 0,1 rpm
   - Pretrigger: 100 ms
5. Select as display options:
   - Repeated measurement

Note

If the parameterization is realized offline, then it must still be transferred to the drive (the parameterization is downloaded).

Exercise 3: Tracing the signals
Measurement and display



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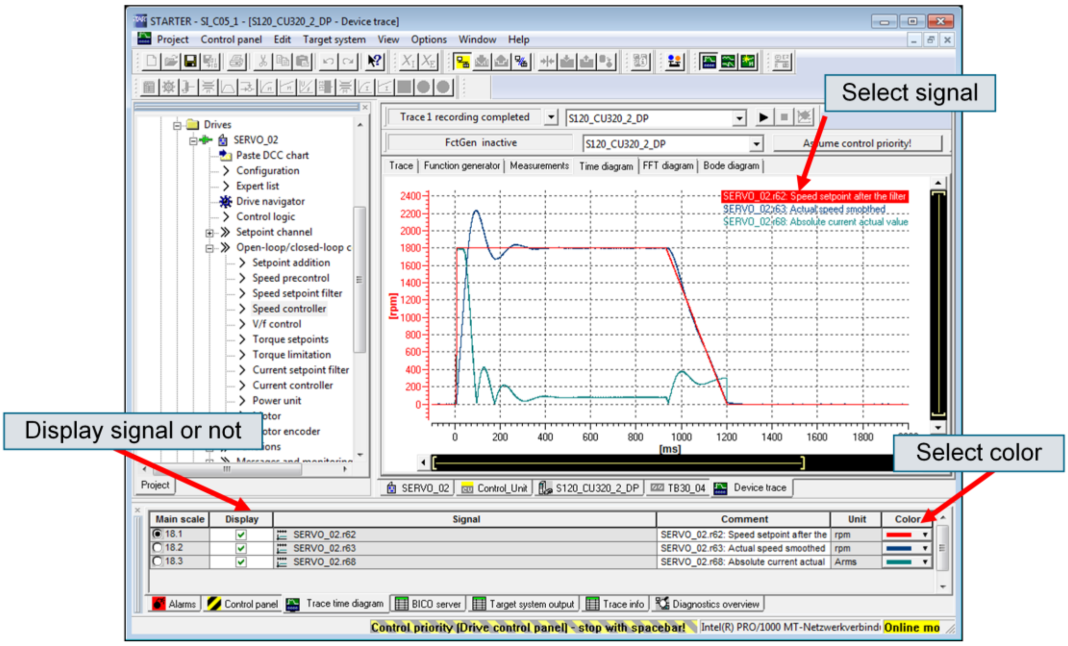
Task Record a trace:

1. Enter a speed setpoint of n_{set} < 1000 rpm.
2. Start trace 1 using the "Triangular" button.
3. Monitor the feedback "Trace 1 waiting for trigger".
4. Switch on the drive.
5. Increase the speed setpoint.
6. Monitor the feedback "Trace 1 in progress".
7. After completion of the recording and data transfer to the PC, the signals are displayed.

Exercise 3: Tracing the signals
Measurement and display



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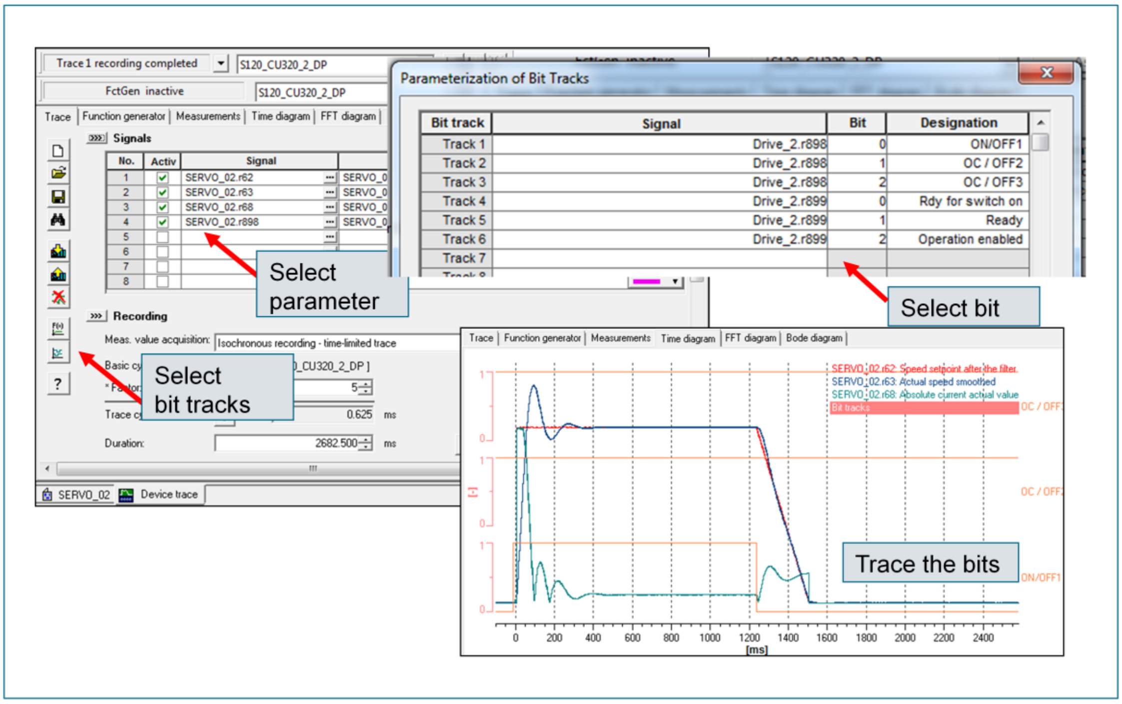
Task Test some of the options for post processing the signals:

1. Select the "Time diagram“ tab.
   - The axis labeling is assigned when a signal name is selected.
   - When the axis labeling is selected, the signal can be shifted in the y direction.
   - *>> using the right mouse key > Scaling*
     scale the speed setpoint (r62) just like the speed actual value (r63).
   - By selecting a signal section (with the left mouse key pressed), the size of a signal section can be increased.
   - With the right-hand mouse key
     - the zoom factor can be reduced or undone
     - measurement cursors for time and amplitude axes can be displayed
     - the trigger line can be displayed.

2. Select the "Trace time diagram“ tab at the bottom of the screen.
   - Under "Display", signals can be shown or hidden in the time diagram.
   - Under "Comment", the signal name can be changed.

Exercise 3: Tracing the signals
Tracing bit signals of the status word



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Task Record the selected bit tracks while the drive is being switched on.

1. Add two signals to the trace:
   - Control word of the sequence control (r0898)
   - Status word of the sequence control (r0899)

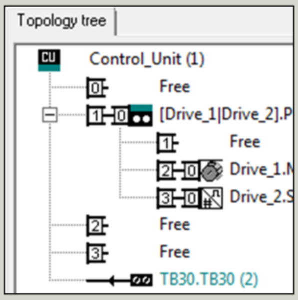
2. Select the bit tracks icon.

3. Select the signal and bit to be traced from the table:
   - Servo_02.r0898 Bit 0 On/Off1
   - Servo_02.r0898 Bit 1 OC/Off2
   - Servo_02.r0898 Bit 2 OC/Off3
   - Servo_02.r0899 Bit 1 Ready for switch on
   - Servo_02.r0899 Bit 2 Ready
   - Servo_02.r0899 Bit 3 operation enabled

4. Start the trace.

5. Switch on the drive using the operator box
   (not using the control panel or function generator).

6. Monitor the recorded signals.



Chapter 7

Topology

Course DR-S12-PM

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Learning Targets

- You will know the rules of the DRIVE-CLiQ topology
- You will be able to identify the firmware version of the components
- You will know the differences between the set and actual topology
- You will be able to change DRIVE-CLiQ connections
- You will be familiar with the rules for replacing modules

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DRIVE-CLiQ
Overview

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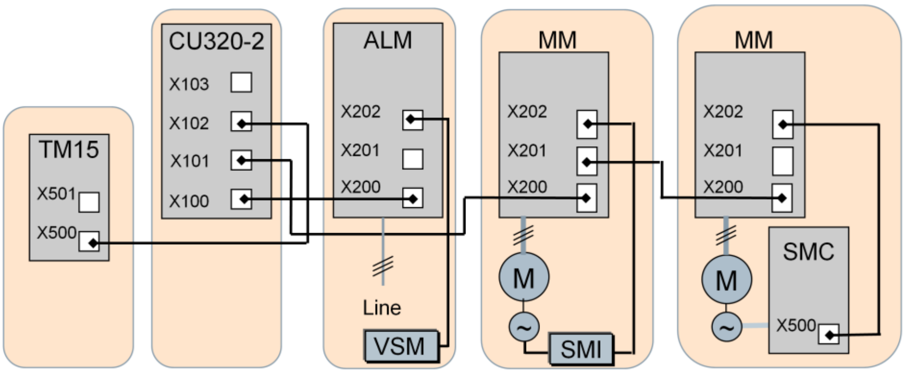

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DRIVE-CLiQ DRIVE-CLiQ is the digital interface between SINAMICS components

The SINAMICS S120 components, including the motors and encoders, are interconnected via a joint serial interface called DRIVE-CLiQ.

All communication-capable components have one or more ports for the DRIVE-CLiQ cables.

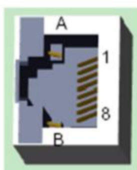
The communication is based on Ethernet technology with 100 Mbit/s.

Topology The topology describes the ports used to connect the components.

DRIVE-CLiQ
Connection wiring

DRIVE-CLiQ cables
Gray: 2 x 2 x 0.22

DRIVE-CLiQ cables
Motion Connect
Green: with 24 V
2 x 2 x 0.22 + 1 x 2 x 0.38



PIN	Signalname	PIN	Signalname
1	TXP	6	RXN
2	TXN	7	reserved, do not use
3	RXP	8	reserved, do not use
4	reserved, do not use	A	+ (24 V)
5	reserved, do not use	B	M (0 V)

Note:
Terminals A and B are used for the supply of the measuring system evaluation only. These terminals are short-circuit proof.

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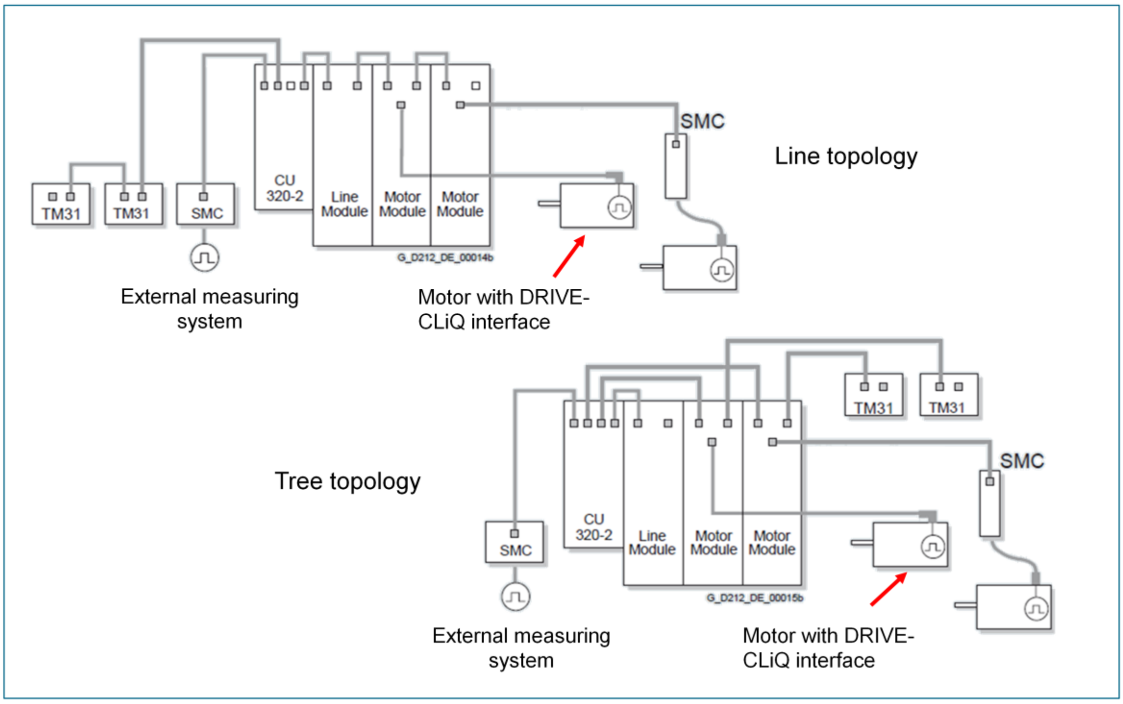
Cable The standardized form of the cable and plug engineering reduces the range of parts and storage costs.

Plug-in connectors The DRIVE-CLiQ plug-in connections forward the 24 V DC voltage to the encoder supply via two additional contacts.

Encoder evaluations are available for third-party motors or retrofit applications for converting standard encoder signals to DRIVE-CLiQ.

DRIVE-CLiQ
Line or tree topology



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Line topology The components are arranged in a line provided that this does not violate any DRIVE-CLiQ rules.

Tree topology The components are connected in separate branches originating from the CU.

If components are deactivated, in order to remove components from the machine, for example, this can only be done for components at the end of the branch.

If components are deactivated within a line, the components that follow in the line can also no longer be accessed.

DRIVE-CLiQ
Wiring rules

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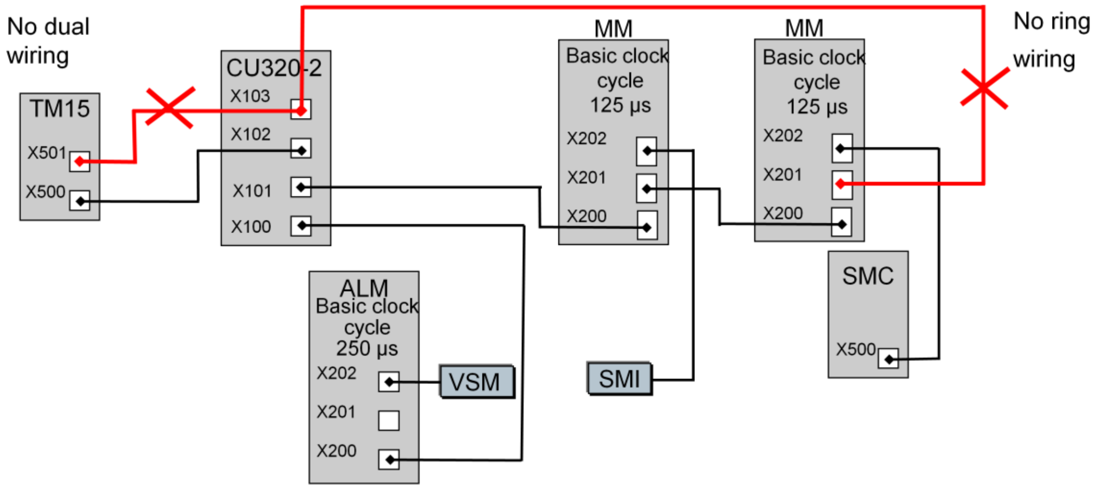

When wiring components with DRIVE CLiQ, the following rules apply among others:

- No ring wiring, no double wiring
- The maximum number of nodes on one DRIVE-CLiQ line is 14
- The maximum Motor Modules on one DRIVE-CLiQ line is 8
- The maximum number of Terminal Modules is 16

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DRIVE-CLiQ rules

A comprehensive set of rules apply for wiring components with DRIVE-CLiQ. Some of the most important rules are listed below:

- The following applies for booksize format:
  - In the servo and vector U/f control modes, only one Line Module may be connected to the Control Unit. In the vector mode, a maximum of three further Line Modules may be connected in parallel (i.e. a total of 4 Line Modules).
  - In the servo mode, Line Modules and Motor Modules can be connected to the same DRIVE-CLiQ line.
  - In the vector mode, the Line Modules and Motor Modules must be connected to separate DRIVE-CLiQ lines.
- The following applies for chassis format:
  - Line Modules (Active Line, Basic Line, Smart Line) and Motor Modules must be connected to separate DRIVE-CLiQ lines.
  - Motor Modules with different pulse frequencies (frame sizes F, G, H, J) must be connected to separate DRIVE-CLiQ lines.
- The sampling times p0115[0] (p4099 for TM) of all components that are connected to a DRIVE-CLiQ line must be divisible by one another with an integer result.

  The sampling time corresponds to the current control cycle for a drive object. The further cycles such as speed controller cycle, setpoint channel, position controller cycle, etc. can be configured at the drive object.

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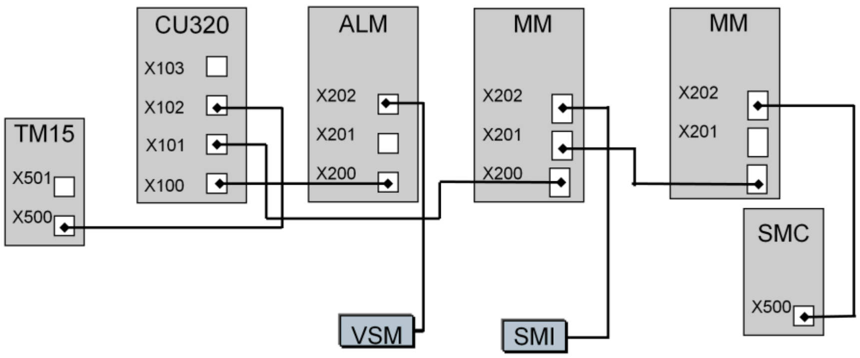
DRIVE-CLiQ
Recommended rules



- Port X100 of the CU connected to X200 of the infeed (Line Module)
- Port X101 of the CU connected to X200 of the Motor Module
- Port X201 of the Motor Module connected to X200 of the next Motor Module
- Motor encoder connected to X202 of the associated Motor Module
- Additional Terminal Modules or Sensor Modules connected directly to free DRIVE-CLiQ ports of the CU

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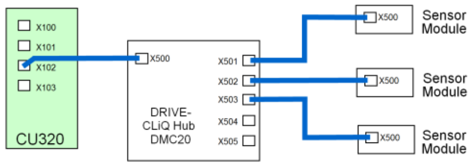
Recommended rules

The following rules should be observed to ensure reliable operation:

- The DRIVE-CLiQ cable from the Control Unit should be connected to X200 on the first booksize power unit or X400 on the first chassis power unit.
- The DRIVE-CLiQ connections between the power units must each be connected from interface X201 to X200 and/or from X401 to X400 on the follow-on component.
- A single Line Module should be connected directly to the X100 DRIVE-CLiQ socket of the Control Unit.
- Several Line Modules should be connected in a line.
- If the X100 DRIVE-CLiQ socket is not available, the next higher DRIVE-CLiQ socket should be used.
- The motor encoder should be connected to the associated power unit.
- The motor encoder for the first drive of a Double Motor Module should be connected to the associated DRIVE-CLiQ socket X202.
- The motor encoder for the second drive of a Double Motor Module should be connected to the associated DRIVE-CLiQ socket X203.
- Only one final node should ever be connected to free DRIVE-CLiQ ports of components within a DRIVE-CLiQ line (e.g. Motor Modules wired in series), e.g. one Sensor Module or one Terminal Module without forwarding to additional components.
- If possible, Terminal / Sensor Modules of direct measuring systems should not be connected to the DRIVE-CLiQ line of Motor Modules but rather to free DRIVE-CLiQ ports of the Control Unit.

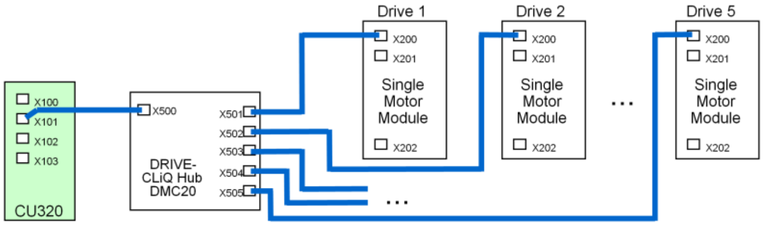
DRIVE-CLiQ Hub
Design of DME20 and DMC20

Signals from more than one encoder can be collected by the DMC20 DRIVE-CLiQ Hub and forwarded to the Control Unit on a single DRIVE-CLiQ cable.



DME20

The DRIVE-CLiQ Hub DMC20 allows individual DRIVE-CLiQ nodes to be removed without disrupting data exchange of the remaining nodes via the DRIVE-CLiQ line.



DMC20

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DMC20, DME20

The DMC20 and DME20 DRIVE-CLiQ Hub Modules are used to implement the point-to-point distribution of a DRIVE-CLiQ line. It is possible to connect two DRIVE-CLiQ Hub Modules in series (cascade connection).

With the DMC20/DME20, an axis grouping can be expanded by 4 DRIVE-CLiQ sockets for additional subgroups.

The component is ideal for applications which require DRIVE-CLiQ nodes to be removed in groups, without interrupting the DRIVE-CLiQ line and, therefore, data exchange.

Interfaces DMC20

The DMC20 DRIVE-CLiQ Hub Module in degree of protection IP20 is designed for mounting in control cabinets.

The following are located on the DMC20 DRIVE-CLiQ Hub Module:

- 6 DRIVE-CLiQ sockets for connecting 5 DRIVE-CLiQ nodes

The status of the DMC20 DRIVE-CLiQ Hub Module is indicated via a multi-color LED.

Interfaces DME20

The DME20 DRIVE-CLiQ Hub Module in degree of protection IP67 is designed for mounting outside control cabinets.

The following are located on the DME20 DRIVE-CLiQ Hub Module:

- 6 DRIVE-CLiQ sockets for connecting 5 DRIVE-CLiQ nodes

DRIVE-CLiQ Hub
Topology

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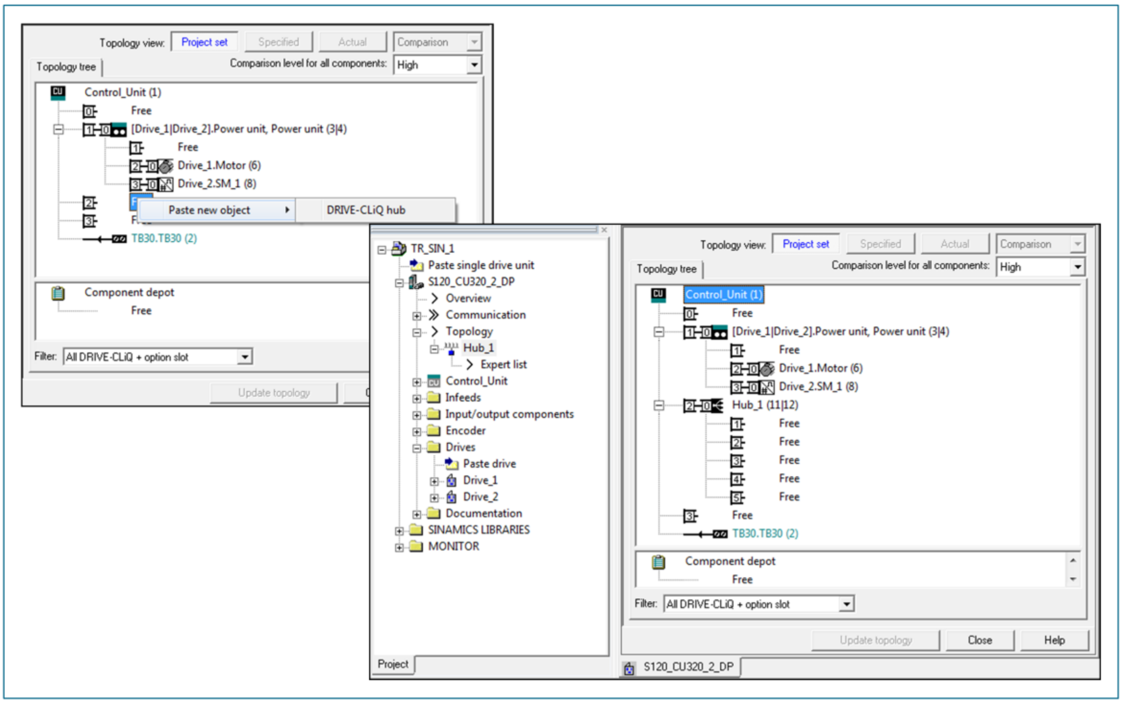

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Adding a DRIVE-CLiQ Hub

The DRIVE-CLiQ Hub is added in the "Topology" screen. Then, the components can be connected to the ports.

The hub occupies two component numbers. It is not an autonomous drive object and does not have to be configured.

DRIVE-CLiQ rating plates
Electronic rating plates

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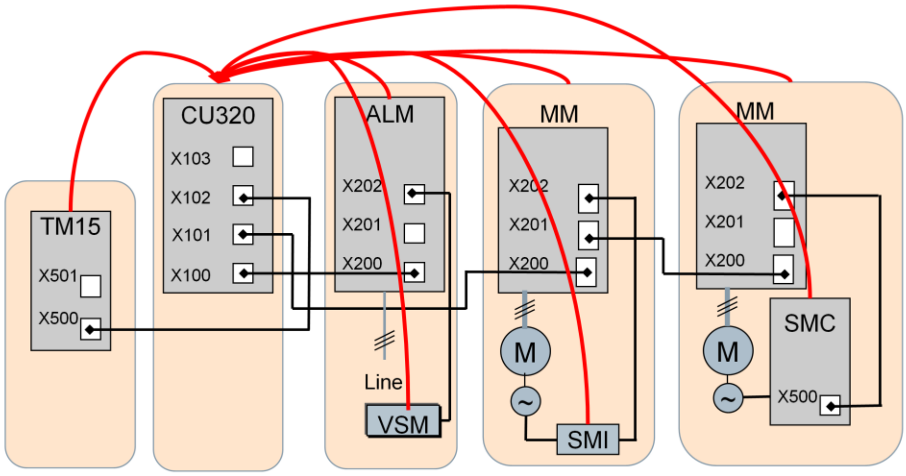

- All modules connected via DRIVE-CLiQ have an electronic rating plate.
- The technical data is automatically uploaded to the Control Unit.
- There is no need for manual input of rating plate data.

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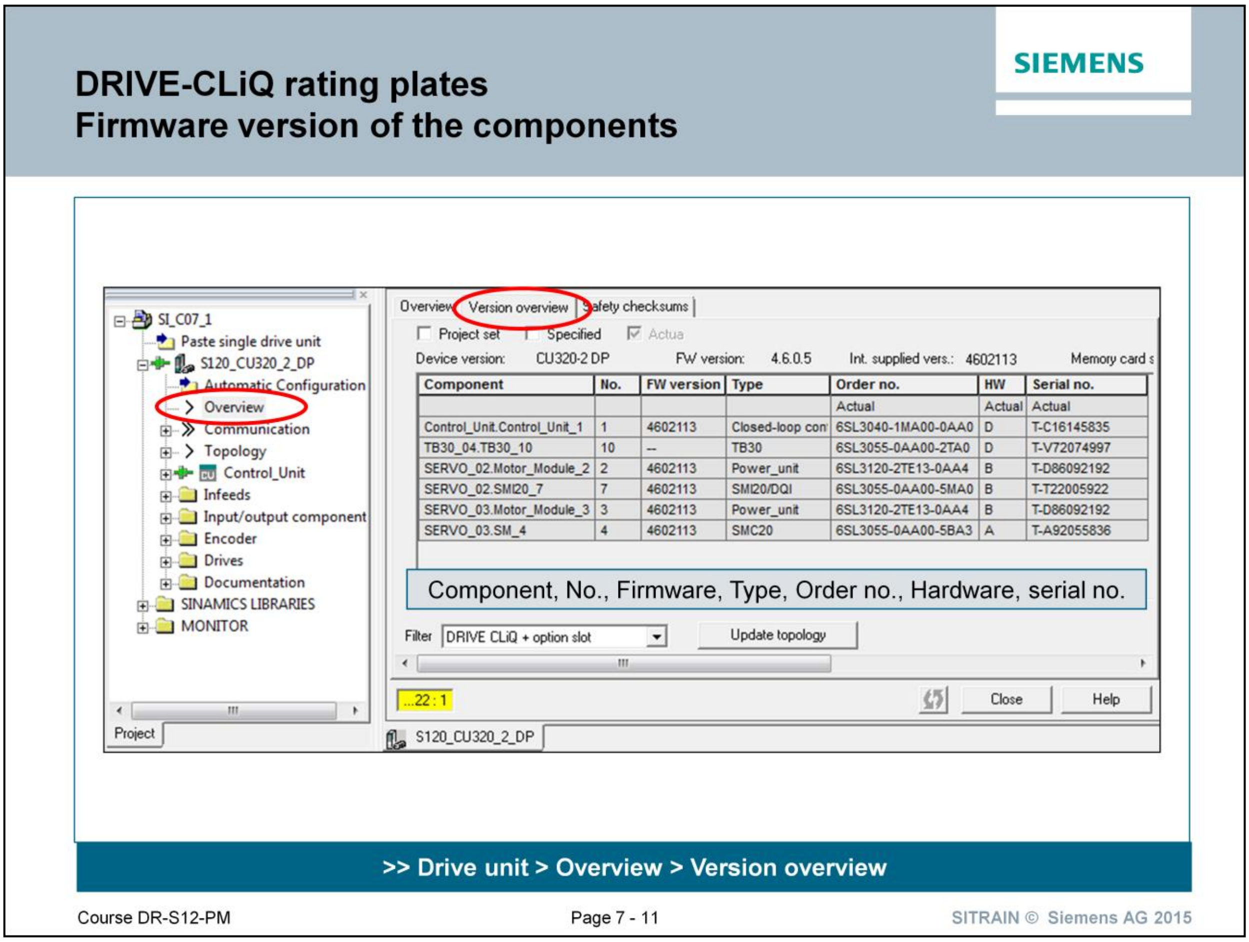
Rating plate

All DRIVE-CLiQ components have a separate electronic rating plate:

- This electronic rating plate contains all the relevant technical data about that particular component.
- For motors, for example, these data include the parameters of the electric equivalent circuit diagram, the current controller data and characteristic values for the built-in motor encoder. These data are automatically read via DRIVE-CLiQ by the Control Unit and need not be input during commissioning or after a component is exchanged.
- In addition to the technical data, the rating plate includes logistical data (manufacturer ID, order number, and globally unique ID).
- Since these values can be read electronically both on site and also by remote diagnostics, unambiguous identification of all components used in a machine can be performed at any time, thus simplifying service.



Overview

Information about the individual components of the drive system is displayed in the "Overview" dialog in the "Version overview" tab.

In online mode, in addition to the components, the component number, Order No., hardware version and serial number are displayed as well as the firmware versions of the individual DRIVE-CLiQ components in particular after clicking on the "Update topology" button.

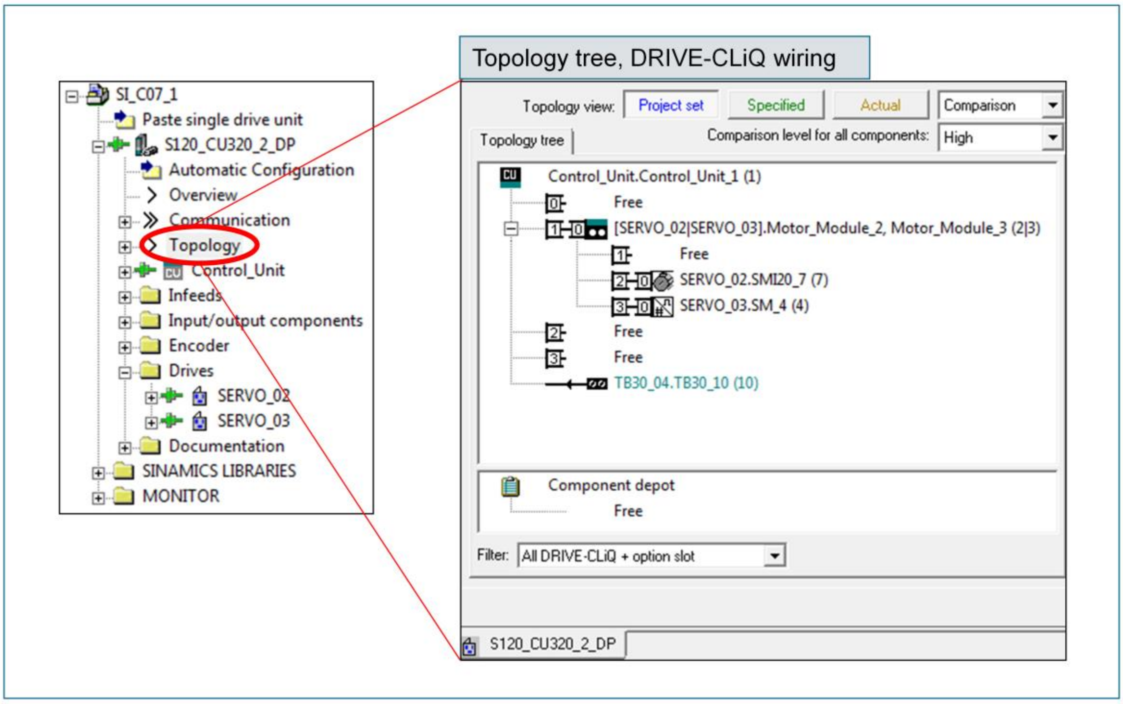
For the correct functioning of the DRIVE-CLiQ communication, all components must have the same firmware version as the Control Unit.

Version overview

In this window, information about the individual components of the drive system is displayed. On the basis of this information, the components can be clearly identified. A firmware update can also be activated from the CF card.

- Component: Name of the drive component
- No.: Component number
- FW version: Firmware version of the drive component
- Order no.: Order number of the drive component in short form
- HW version: Hardware version of the drive component
- Serial No.: Serial number of the drive component.

Topology
Interconnection information for components



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Structure The topology is shown as a wiring tree. The Control Unit is the first element of the tree. All components are attached to the CU. The terminal designations can be picked off via the tooltip.

Topology
Project set / target (specified) / Actual topology

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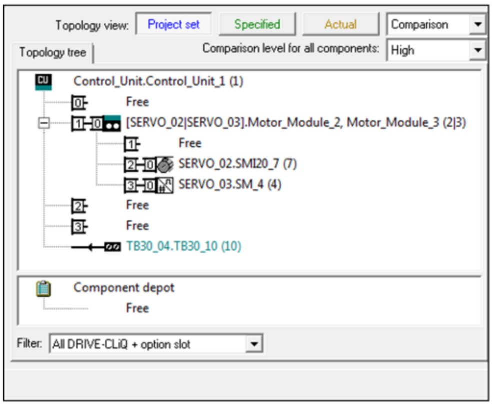
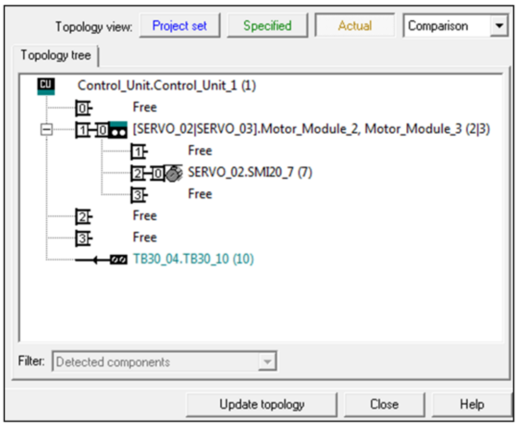
Project set topology



Project actual topology



A startup is performed only when specified topology = actual topology

- Project set: Current configuration in the STARTER project (RAM of the PG/PC)
- Specified: Configuration stored in CU
- Actual: The current hardware topology acquired by the system

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Project set topology The project set topology corresponds to the topology of the offline project.

Specified topology The target (specified) topology is stored on the CompactFlash card in the Control Unit and is loaded to RAM during power-up of the Control Unit and then compared to the actual topology.

The set topology can be specified in two ways and saved on the CompactFlash card:

- Via STARTER by creating the offline configuration and then loading it to the drive unit
- Via quick commissioning (automatic configuration) by reading the actual topology and writing as set topology to the CompactFlash card.

Actual topology The actual topology is the DRIVE-CLiQ hardware wiring that is actually used. When the drive system components are started up, the actual topology is detected automatically via DRIVE-CLiQ.

Monitoring When the supply voltage is turned on, the actual topology is compared with the set topology. 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 rating plates with the set topology stored on the CF card.

If, during the startup, components are detected that cannot be assigned to any configured component, they will be displayed in the actual topology with component numbers greater than 200.

Topology
Compare project set / specified / Actual

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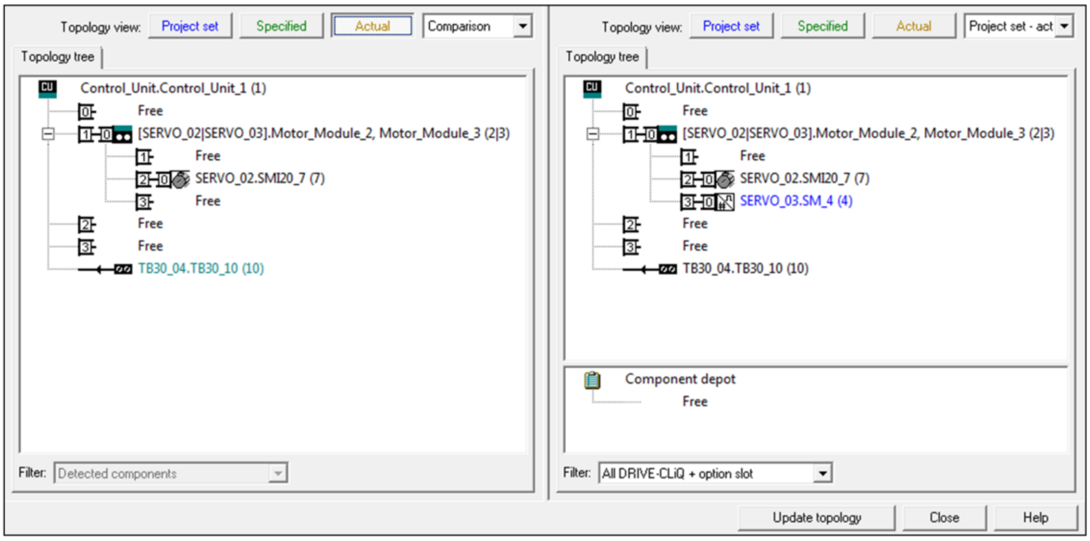
Compare project set with actual



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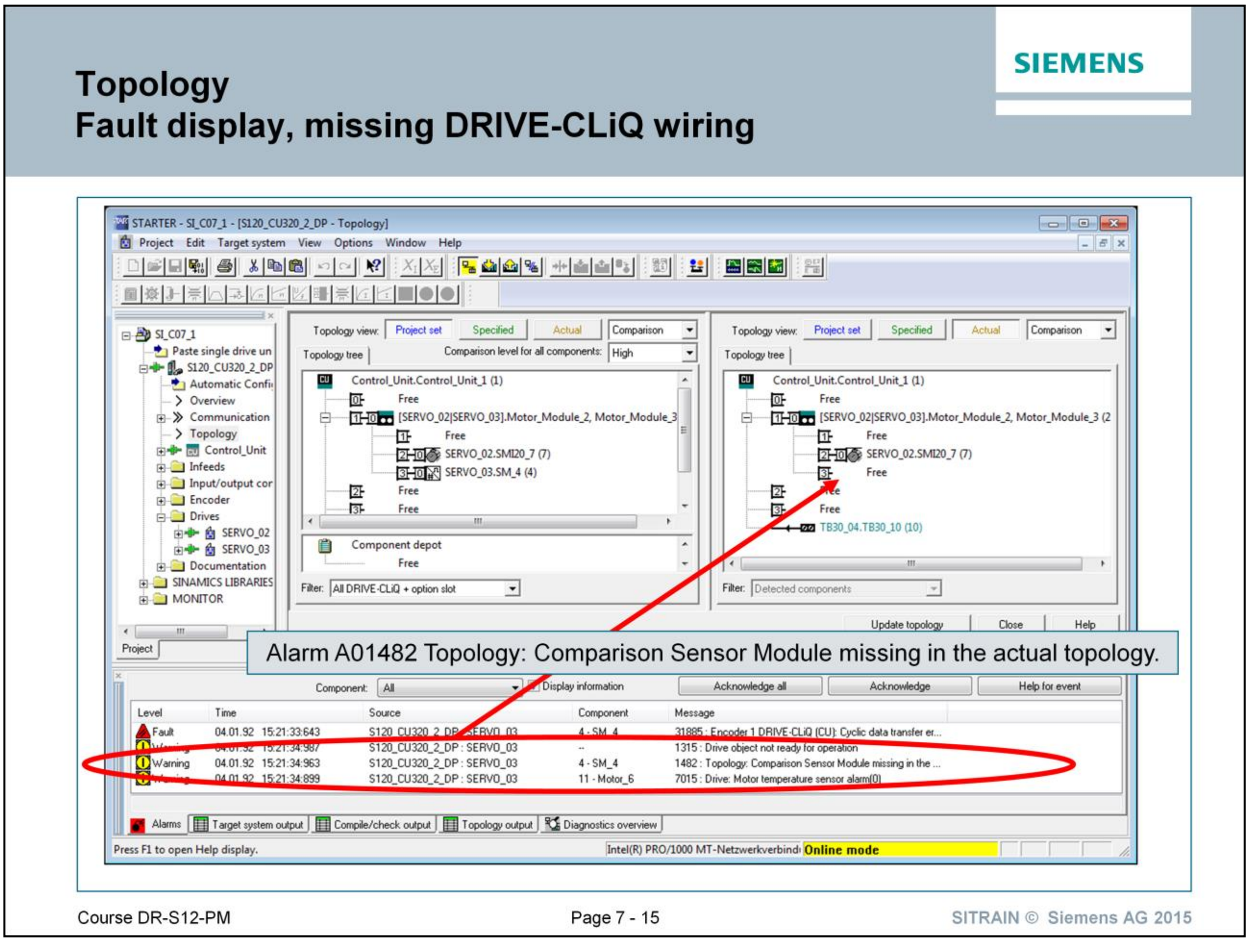
Comparison

The topology view can also be used to compare two different topologies:

- Project set with specified
- Project set with actual
- Specified with actual



Change

If differences are present in the topology (i.e. differences in the set/actual interconnection), the user can compare the project set topology (offline topology) and the set topology (topology on the memory card of the drive) with the actual topology (actual interconnections).

Should there be differences in the topology, the project set topology can also be changed by moving the required drive objects with drag-and-drop to the required DRIVE-CLiQ interfaces.

Topology error

A topology error always occurs when the configured interconnection information and the actual interconnection differ.

Topology errors must be remedied. Otherwise, the configured drive objects will not operate properly. A topology error is displayed with an appropriate error message in the Alarm window.

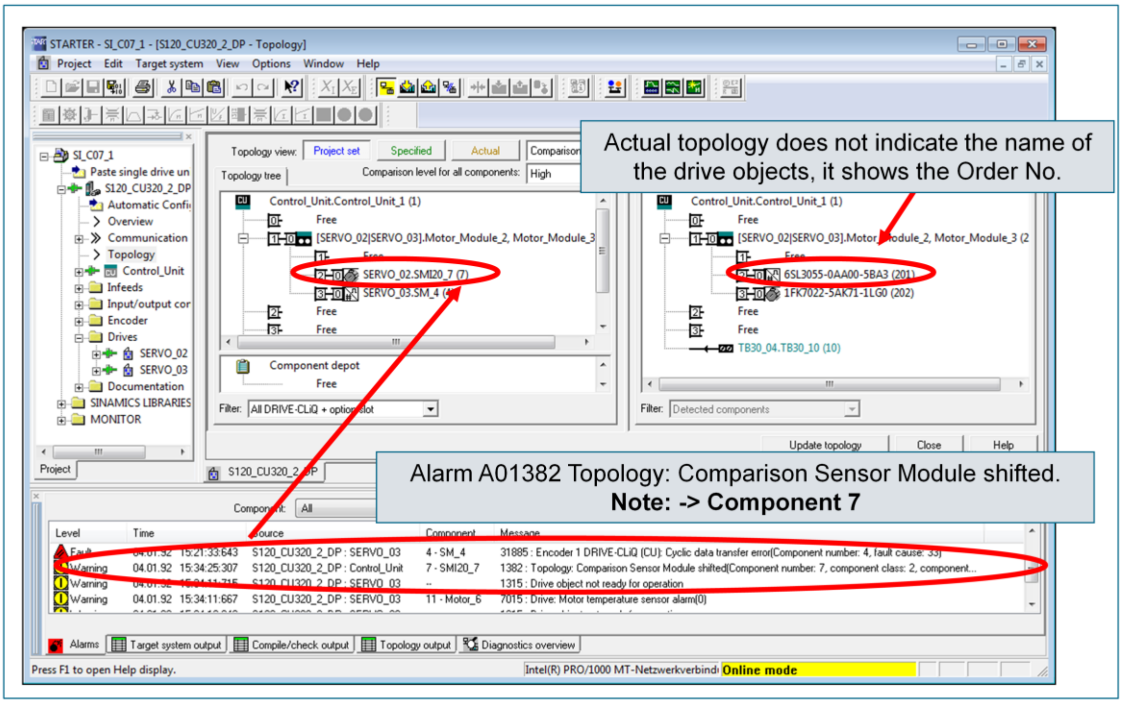
Timestamp and logical analysis

In most cases, the system will generate several alarms when a fault occurs, since the fault may have a variety of effects.

For example: The DRIVE-CLiQ cable to the Sensor Module of the "Transport_blue" drive " has been removed.

Decisive in this case is the alarm *A01482 Topology: Comparison Sensor Module missing in the actual topology.* However, in the case of the error message *F07016 Drive: Motor temperature sensor fault* error message is only a secondary error message.

Topology
Fault display, wrong DRIVE-CLiQ wiring



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Message Alarm A01382 Topology: Comparison Sensor Module shifted.

Cause The topology comparison has detected a shifted Sensor Module in the actual topology compared to the set topology.

Startup of the drive system is halted. In this state, the drive control cannot be enabled.

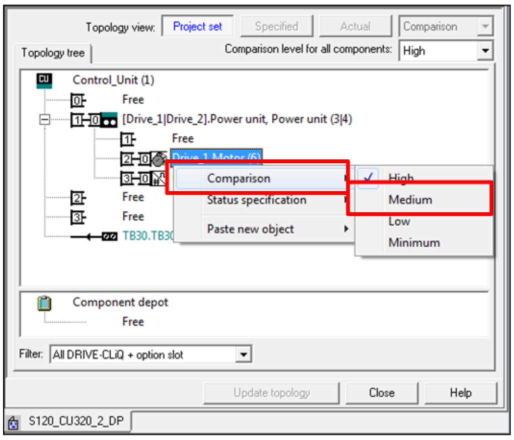
Remedy Adapt the topology:

- To undo the change to the actual topology, change the DRIVE-CLiQ cables.
- Commissioning software: Go online, perform an upload of the drive unit, adapt the topology offline and perform a download of the modified project.
- Rectify topology fault automatically (p9904 = 1):
  → Accept the actual topology in the set topology

Topology
Comparison quality for topology comparison

Four levels determine the quality of the topology comparison:

- High: of the entire electronic rating plate
  - Component type,
  - Order number,
  - Manufacturer,
  - Hardware version (e.g. "A"),
  - Serial number (e.g. "T-P30050495")
- Medium: of the component type and order number ("SMC20", "6SL3055-0AA0-5BA0")
- Low: of the component type (e.g. "SMC20")
- Minimum: of the component class (e.g. Sensor Module or Motor Module)



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Comparison quality

When comparing the set and the actual topology and when replacing a module, the configured comparison quality is used. The data of the electronic rating plate stored in the module are used.

The electronic rating plate contains the following information:

- Component class (e.g. Sensor Module or Motor Module)
- Component type (e.g. "SMC20")
- Order No. (e.g. "6SL3055-0AA0-5BA0")
- Manufacturer (e.g. SIEMENS)
- Hardware version (e.g. A)
- Serial number (e.g. "T-P30050495")

The comparison quality is divided into the following levels:

High:	Compares the entire electronic rating plate including serial number
Medium:	Compares the component type and the order number
Low:	Compares the component type
Minimum:	Compares the component class

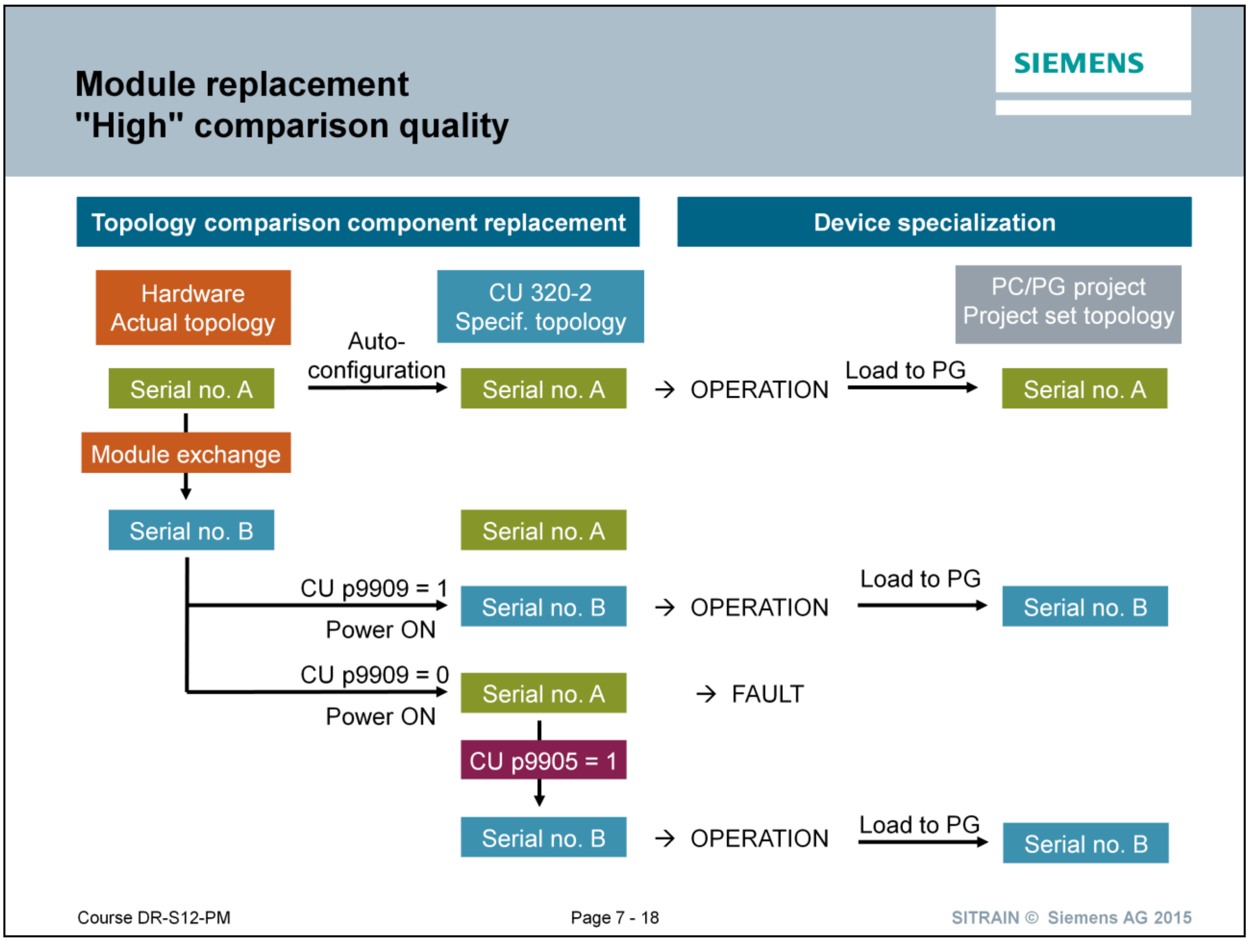
The comparison quality can be set in the window of the set topology via the shortcut menu (right-click) of the desired component. The comparison quality is saved in the parameter CU: p9908.

Example

If the "Medium" comparison quality is set for the input module, the module can be replaced by a new module with the same order number without an error message being issued. A difference is also not displayed in the topology comparison.

Note

The default setting of the comparison quality is "High". The comparison of the serial number must be activated by additionally setting parameter p9909 = 0 however.



Replacement

If the topology comparison for component replacement is active (CU: p9909 = 1), safety considerations rule out swapping of two components in an existing topology, for example to prevent unintentional wrong connection of DRIVE-CLiQ cable or motor cables in the case of a false diagnosis.

CU parameter: p9909

Topology comparison, component replacement

CU: p9909 = 1 automatically adopts the serial number and the hardware version of the newly replaced component from the actual topology to the set topology and stores it in non-volatile memory.
For the exchanged components, the following data on the electronic rating plate must match:

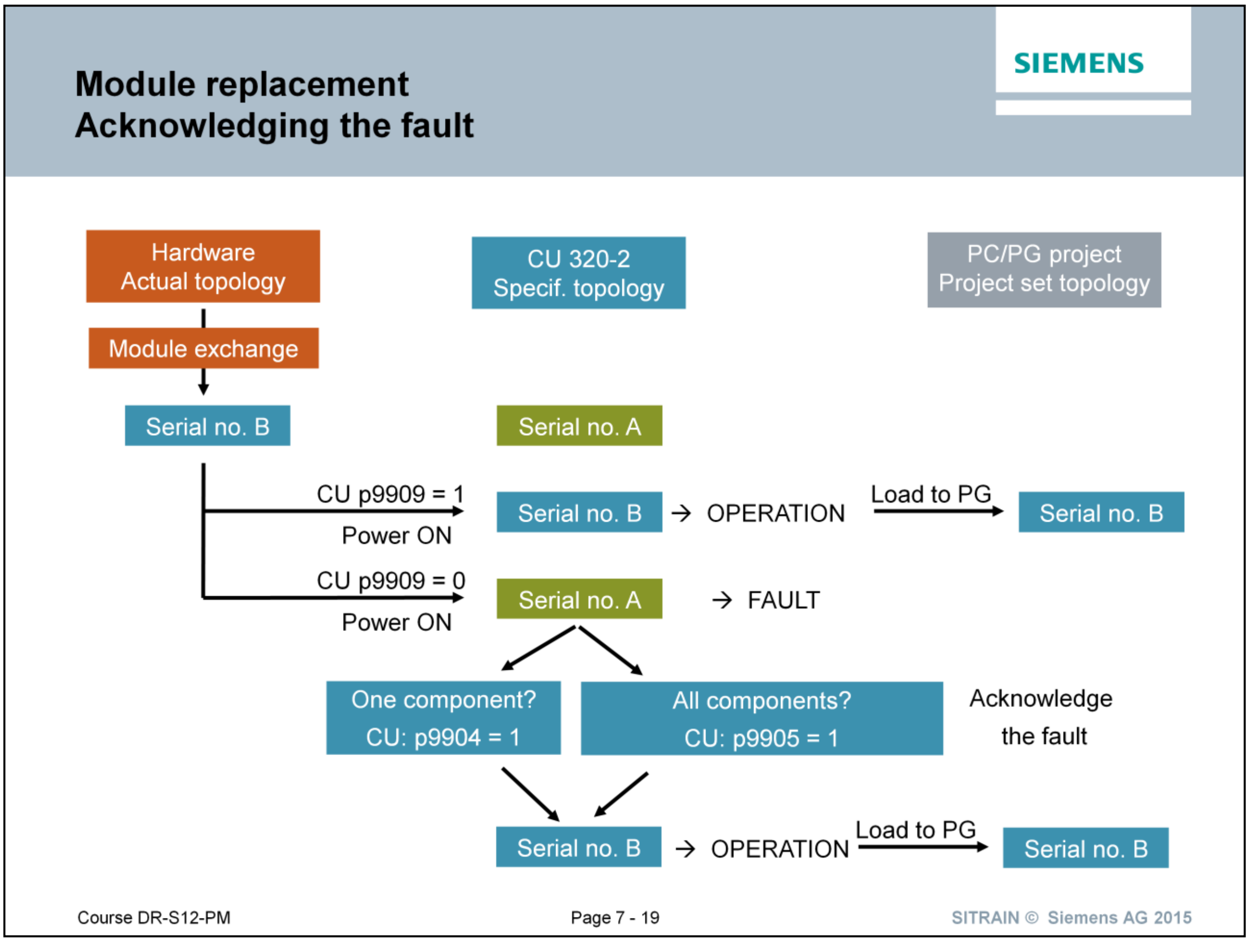
- Component type (e.g. "SMC20")
- Order No. (e.g. "6SL3055-0AA0-5BA0")

For CU: p9909 = 0, the serial number and hardware version are not adopted automatically and an error message is generated.

Acceptance must be carried out via CU: p9905 = 1.

Series commissioning

Irrespective of the parameter assignment CU: p9909 (= 1 / = 0), the serial number of the hardware (actual topology) is accepted in the specified topology after downloading a project from the PG/PC.



CU: p9904

If only one fault occurred during the comparison of the actual topology and the set topology that can be acknowledged, this parameter can be used to start a new comparison with acknowledgment of the fault in the set topology.

Acknowledgeable differences:

- Topology comparison, component shifted
- Topology comparison shows one component that has a different serial number
- Topology comparison shows one component that is connected differently

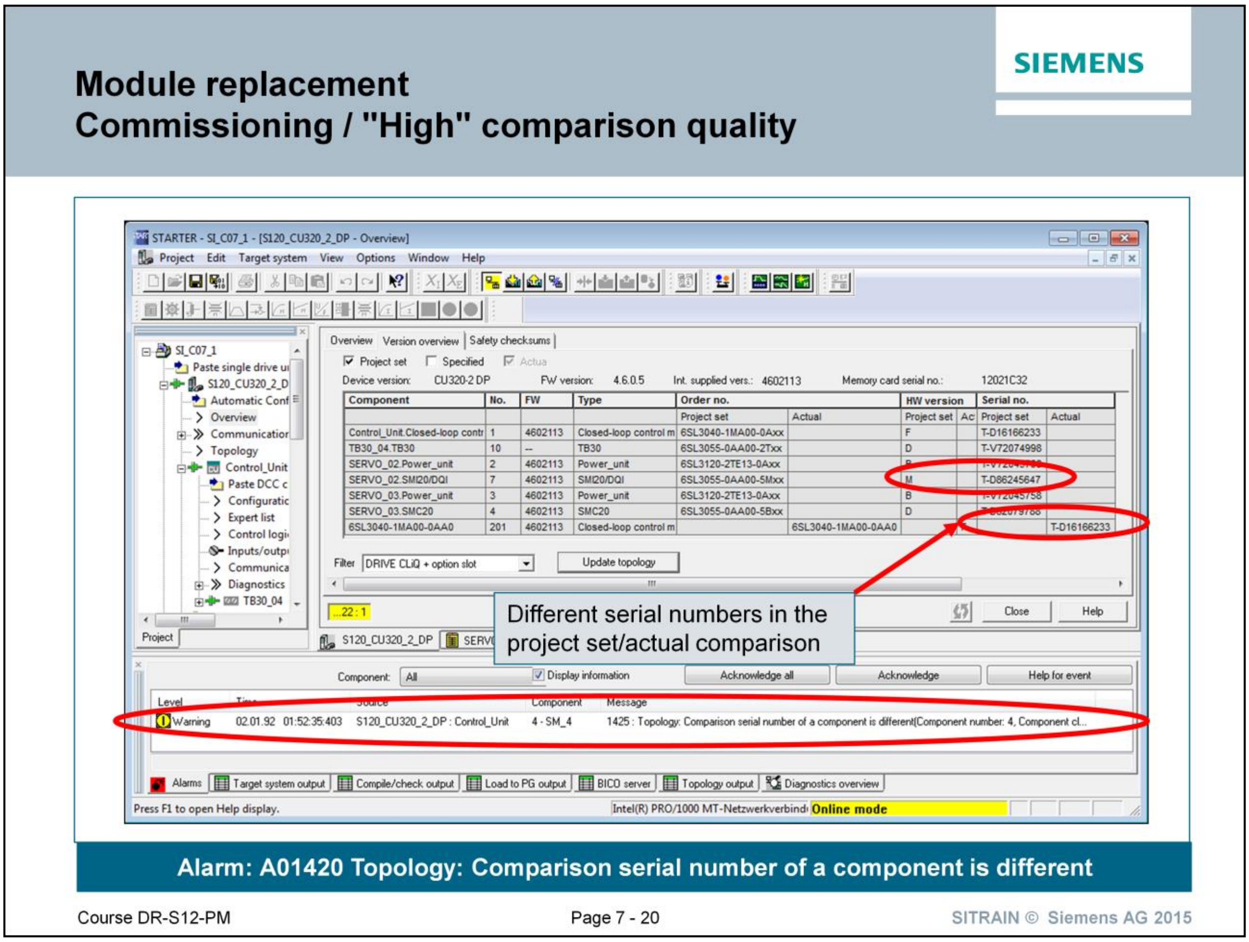
CU: p9905

With CU: p9905 = 1, the serial numbers and the hardware versions of all components in the actual topology are accepted in the specified topology and a new comparison started.

For this device specialization, the components of the set topology may differ from those of the actual topology only in the serial numbers.

With CU: p9905 = 2, the serial numbers, the hardware versions and the order numbers of all components in the actual topology are accepted in the specified topology and a new comparison started.

For this device specialization, the components of the speciified topology may differ from those of the actual topology only in the serial numbers and order numbers.



Different serial number

If a different serial number was determined when the drive unit was started, an alarm is issued. Startup of the drive system is halted. In this case, the drive control will not be enabled.

The following error message is issued:

Alarm: A01425 Topology: Comparison serial number of a component is different

Remedy

Adapt the topologies:

- Change the actual topology to match the set topology.
- Load the actual topology that matches the set topology (commissioning software).
  - Acknowledgeable via
    CU: p9904 or CU: p9905.
  - Acknowledgeable via
    CU: p9905 and can be deactivated via CU: p9906 or
    CU: p9907/p9908.

Module replacement
With identical order number

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Prerequisites

- Suitable replacement component with identical order number is available
- The serial number is not contained in the stored set topology
- Topology comparison component replacement active CU P9909 = 1

Procedure

- Remove the old component, install the new component
- Switch on the voltage supply, during startup the serial number of the new component is automatically transferred to the set topology and saved on the CF.
- If necessary, call the "Load to PG" function

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Overview

The procedure for the replacement of a DRIVE-CLiQ component depends principally on whether or not the new component has a different order number.

If the order number is identical, after the replacement, it suffices to transfer the data from the electronic rating plate of the component to the specified configuration.

If the order numbers differ, the STARTER project must be modified appropriately and then downloaded to the target device.

Replacement with same order number

The replacement of a component with the same order number generally requires no tool support, if:

- The serial number of the new replacement component is not contained in the stored specified topology of the Control Unit.
- Topology comparison component replacement active CU: p9909 = 1.
  With this setting, during the startup, the new serial number of the spare part is automatically transferred from the actual topology to the target (specified) topology and saved in the non-volatile memory. The last or last two digits of the order number (depending on the component type) are not checked, as the HW version, for example, is encoded in these positions.
  This mechanism is also suitable when several components are replaced.

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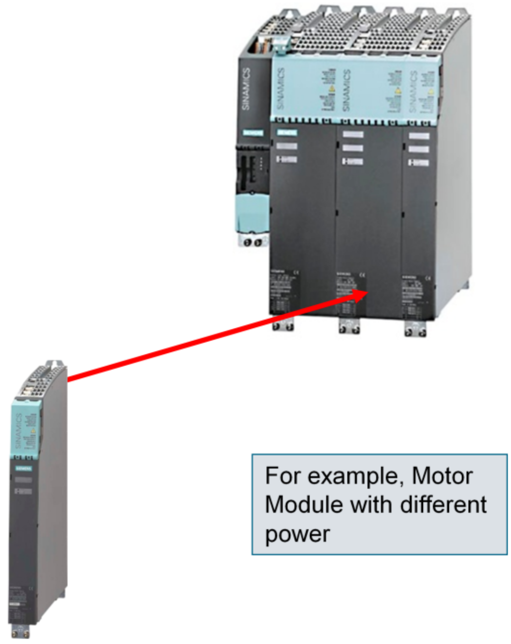
Module replacement
With different order number

Prerequisites

- Replacement component with different order number is available

Procedure

- Switch off the power, remove the old component, install the new module
- Switch on the power, the following message appears: A01420 Topology: Comparison one component is different
- Download project from SINAMICS to the PG
- Reconfigure the affected drive, select the current components
- Download the project to the SINAMICS, the A01420 alarm disappears
- The new order number is now stored in the SINAMICS main memory and "Copy RAM to ROM" must be used to transfer it to the CF card.



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A PG with the STARTER software loaded is always required to replace a DRIVE-CLiQ component with different order numbers, e.g. Motor Modules with different power ratings.

Procedure

For the replacement of a component with a different order number, proceed as follows:

1. Switch off the power supply, remove the defective component and install the new component. Ensure that the correct wiring is made (information is contained in the appropriate manuals).

2. Switch the power supply on again. After the system startup, the alarm "A01420 Topology: Comparison one component is different" will be displayed.

3. Establish with the STARTER an online connection to the SINAMICS, download the SINAMICS project data to the PG and store the data on the hard disk.

4. Reconfigure the affected drive. Select the correct current component in the appropriate configuration screen.

5. Download the changed SINAMICS project to the target system. The A01420 alarm disappears (it can be acknowledged). After the download, the serial number of the new component is stored in the SINAMICS main memory.

6. Use "Copy RAM to ROM" via CU: p0971 = 1 or CU: p0977 = 1 to transfer the values from the main memory of the SINAMICS to the CF card.
   The module replacement has then been completed.

Firmware update
Automatic update

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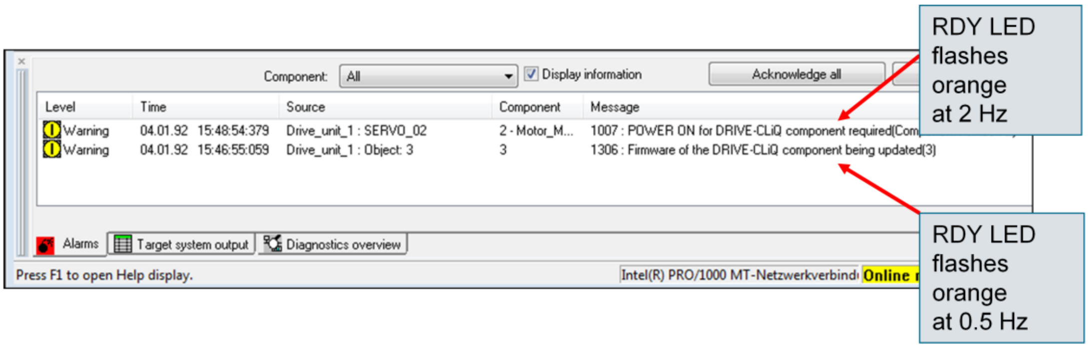
Automatic upgrading/downgrading

- For firmware version SINAMICS V2.5 and higher, the DRIVE-CLiQ components are automatically upgraded/downgraded upon startup to the status of the firmware version that is present on the CF card.
- Power ON Reset is required after a firmware update
- NOTICE: Prior to Power On Reset, be sure to call the "RAM To ROM“ function



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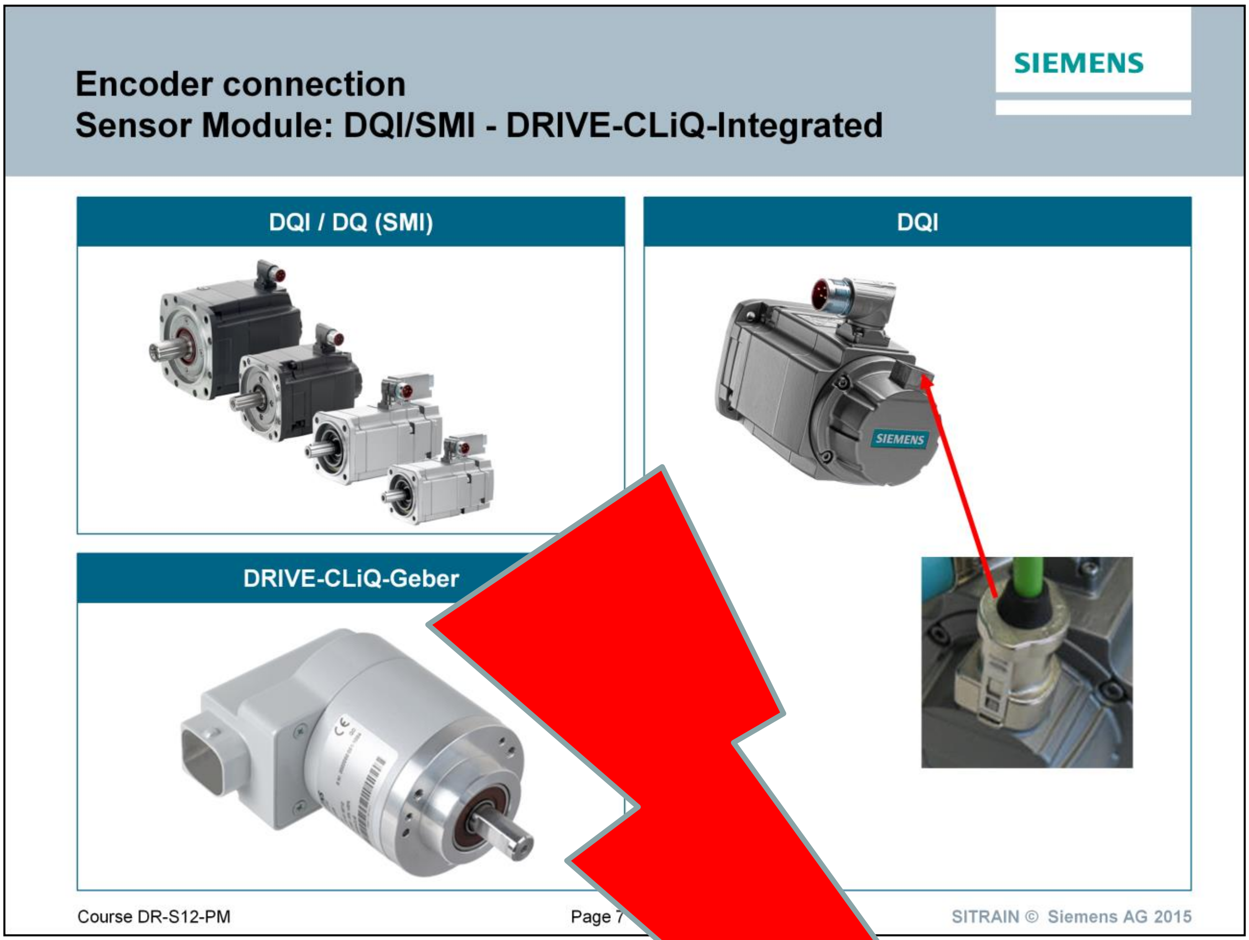
For firmware SINAMICS 2.5 and higher, the system automatically upgrades/ downgrades the DRIVE-CLiQ components upon startup to the status of the firmware version that is present on the CF card.

Components which cannot be downgraded to the components' firmware version on the CF card (e.g. old firmware on the card and new components to which the old firmware cannot be loaded) retain their firmware status. The resulting firmware version combinations are system-tested and released.

An upgrade/downgrade operation in progress is indicated on the components by a 0.5 Hz red-green flashing LED and on SINAMICS CU320-2 by a 0.5 Hz yellow-flashing Ready LED.

A successfully completed firmware upgrade/downgrade is indicated on the components by flashing at a frequency of 2 Hz and on the SINAMICS CU320-2 by yellow/green flashing at 2 Hz. After the upgrade/downgrade is completed, the power must be cycled off and back on (POWER OFF/ON). The automatic upgrade/downgrade function can be deactivated via parameter p7826 in the STARTER.



DQI / DQ (SMI) Geber mit DRIVE-CLiQ-Schnittstel

DQI: Bei der DQI-Schnittstelle ist der D LiQ-Anschluss direkt am Geber.

DQ (SMI): Bei der DQ-Schnittstelle /E-CLiQ-Anschluss über einen separaten Stecker angeschlossen. D nt sich SMI (Sensor Module Integrated).

DRIVE-CLiQ-Geber ist ein Absolutwertgeber (Absolute Encoder) mit rter DRIVE-CLiQ-Schnittstelle.

Encoder Overview

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Encoder without DRIVE-CLIQ-interface						
Inkremental encoder	IC2048S/R	IN2048S/R	HTL2048S/R			
Absolute encoder	AM2048S/R	AM512S/R	AM32S/R	AM16S/R		
Resolver	2-polig	6-polig	8-polig			

Encoder with DRIVE-CLIQ-interface						
Inkremental encoder	IC22DQ	IN22DQ				
Absolute encoder Singleturn	AS24DQI	AS20DQI	AS22DQ			
Absolute encoder Multitiurn	AM24DQI	AM20DQI	AM22DQ	AM20DQ	AM16DQ	AM15DQ
Resolver	R15DQ	R14DQ				

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abbreviations

the abbreviation starts with the letters for the encoder type. Followed by the resolution.

encoder without DRIVE-CLiQ: steps per turn

encoder with DRIVE-CLiQ: number of bits and DQ

encoder without DRIVE-CLiQ-interface

Type resolution / interface

AM xxxxS/R resolution: xxxx signals per turn

AS

IC

IN

HTL

encoder with DRIVE-CLiQ-interface

AM xxDQ resolution: xx bit (2 to the power of xx)

IC

AS

IN

R

with

AM: Absolute encoder Multiturn

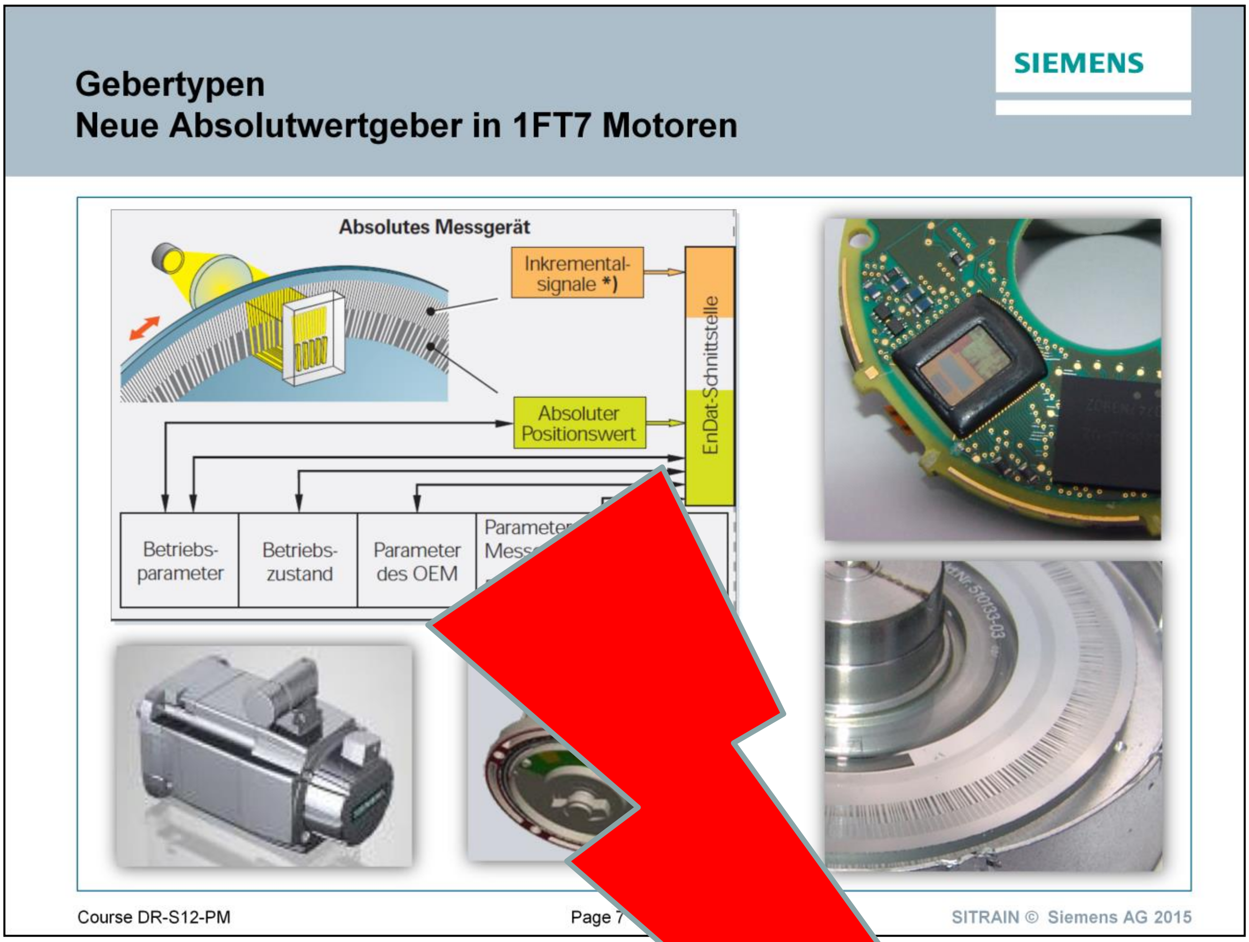
AS: Absolute encoder Singleturn

IC: Incremental encoder sin/cos with elctronic commutation C- und D- track

IN: Incremental encoder sin/cos without electronic commutation

HTL: Incremental encoder with HTL-Signal

R: Resolver



Hinweis Multiturngeber haben immer noch [illegible] etriebe wie zuvor und machen damit die Umdrehungsauswertung. L[illegible] ie Hallsensoren sind nun in einem Chip und nicht mehr diskret au[illegible]

Absolutwertgeber

Encoder AS20DQI : Absolutwertgeb[illegible] gleturn
(Auflösung 10485[illegible] tern 512 S/R)

Encoder AM20DQI : Absolutwertgeber 20 Bit S[illegible] rn
(Auflösung 1048576, Geberin[illegible] 512 S/R)
+ 12 Bit Multiturn mit 4096 Umd[illegible] ungen.

Encoder AS24DQI : Absolutwertgeber 24 Bit Singleturn
(Auflösung 16777220, Geberintern 2048 S/R)

Encoder AM24DQI : Absolutwertgeber 24 Bit Singleturn
(Auflösung 16777220, Geberintern 2048 S/R)
+ 12 Bit Multiturn mit 4096 Umdrehungen.

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Encoder replacement
1FT7 / 1FK7 G2 synchronous servomotors

Replacing an encoder module

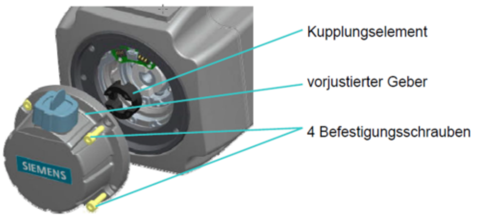
- Replacing an encoder module with DRIVE-CLiQ interface with a replacement part without programmed electronic type plate

Disassembly

- Disconnect the motor
- Remove the four encoder fixing screws
- Remove the old encoder and coupling element

Installation

- Attach the new coupling element onto the encoder shaft
- Align the coupling element with the coupling half on the motor
- Attach the new encoder at this position on the motor shaft
- Mount the new encoder using the 4 screws (tightening torque: 2.5 - 3 Nm)



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Using an empty (non-programmed) encoder module as replacement part
For SINAMICS SW 4.3 and higher, it is possible to use an empty, non-programmed encoder module as a spare part. This allows spare parts held locally to be used as a quick way to restore motor operation.

After mechanical replacement using an identical encoder type, the drive is operational again.

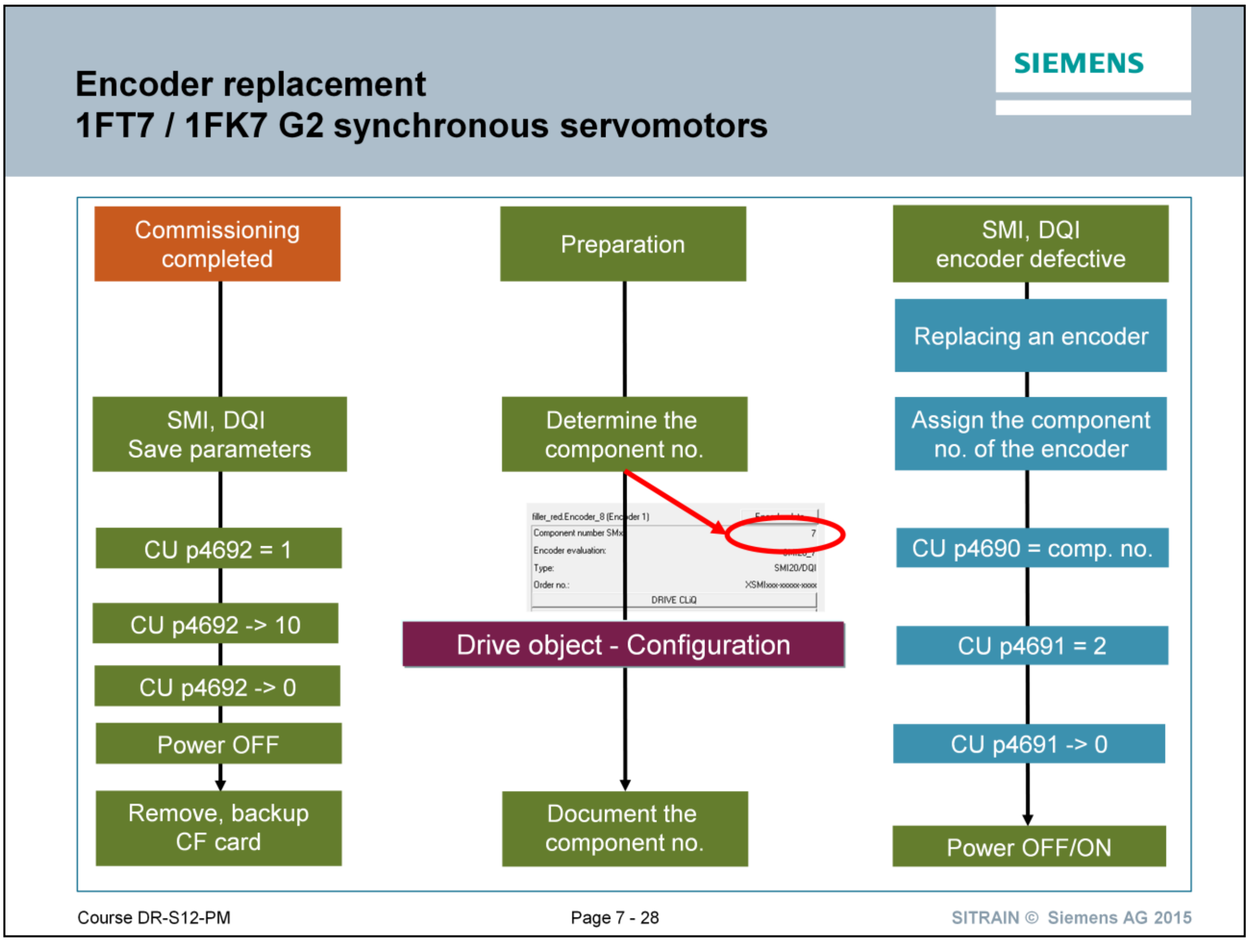
We recommended that the drive is not permanently left without a programmed encoder module, but that the encoder module is programmed at a later time. In the meantime, after the drive has powered up, alarm "1840 - component found without motor data" is output.

NOTE

Sensor Modules, encoders and KTY are electrostatically sensitive devices! Neither hands nor tools that could be electrostatically charged should come into contact with the connections.

Only identical encoder types may be used.

Conversion to a different encoder type may only be carried out in the motor factory or in a SIEMENS Service Center. In this case, the rating plate, and possibly other components of the motor, must be replaced.



Prerequisites

For writing the electronic rating plate

- SINAMICS firmware version, from V2.5 or higher
- Commissioning has been completed (all component numbers are less than 200)
- There is an empty encoder module of the same type available.

Loading the electronic type plate into the encoder module:
The data are loaded after mechanical replacement and the system then started up by setting the parameters.

- Parameter p4690 is used to define for which component number the data of the electronic type plate should be backed up. This component number is written to p4690.
- Parameter p4691 is set to "2" to start the write operation. The data saved at the transfer point "/USER/SINAMICS/DATA/SMI_DATA/" are written to the module.
- If the operation was successful, the parameter changes back to "0".
- After the system has been restarted, the drive involved is again ready for operation.

Backing up electronic rating plates for all motors:

- Data backup is started by setting CU parameter p4692 to "1".
- After the data have been successfully backed up, parameter p4692 automatically returns to "10" -> "All data successful".
- The data are saved on the system CF card under the defined storage path "/USER/SINAMICS/DATA/SMI_DATA/".

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Exercises

- Exercise 1: Topology error – incorrect port
- Exercise 2: Topology error – component is missing
- Exercise 3: Deactivating and activating components
- Exercise 4: Deactivating and activating drive objects
- Exercise 5: Data backup to the CompactFlash card
- Exercise 6 (otional): replacement of the DQI-Encoder
- Exercise 7 (optional): conversion to the DQI motor

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Safety information

Please note that:

- The course instructions have been produced for:
  - A course held by a course leader
  - Activities carried out on special training equipment
- The training equipment is operated under laboratory conditions.
  In case of doubt, always ask your course leader – particularly when handling components that carry electrical current or which can move.
- When carrying out work on equipment, the safety information in the associated product documentation must always be observed!
  The training documents alone are not sufficient.

Exercise 1: Topology error – incorrect port
Messages

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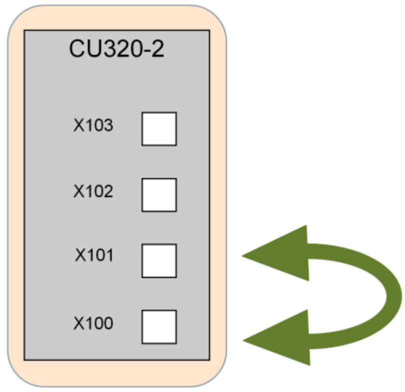

Displays and messages for topology errors	
Component	**Display / significance**
CU320-2 DP / LED: RDY	
BOP operating display / CU_S_004: r0002	
STARTER alarms	

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Task

Change the connection of the DRIVE-CLiQ cable at the CU 320-2 DP and analyze the displays at the unit itself and in STARTER:

1. Dearchive the "S120-Servo_1" and open it.
2. Download the data to the target device and test the project by traversing both drives.
3. Switch off your training equipment.
4. At the CU 320-2 DP, change over the DRIVE-CLiQ cable from port "X101" to port "X100".
5. Switch on the drive unit and go online. Note the messages.
   CU320-2 DP / LED RDY (display/significance):

   …………………………………………………………………………………
   BOP operating display / CU_S_004: r0002 (display/significance):

   …………………………………………………………………………………
   STARTER alarms (display/significance):

   …………………………………………………………………………………

   …………………………………………………………………………………

Possible countermeasures

The following countermeasures are possible:

- Manual adaptation of the set topology to the actual wiring
- Automatic adaptation of the set topology to the actual wiring
- Correct the actual wiring

Exercise 1: Topology error – incorrect port
Manual adaptation of the set topology

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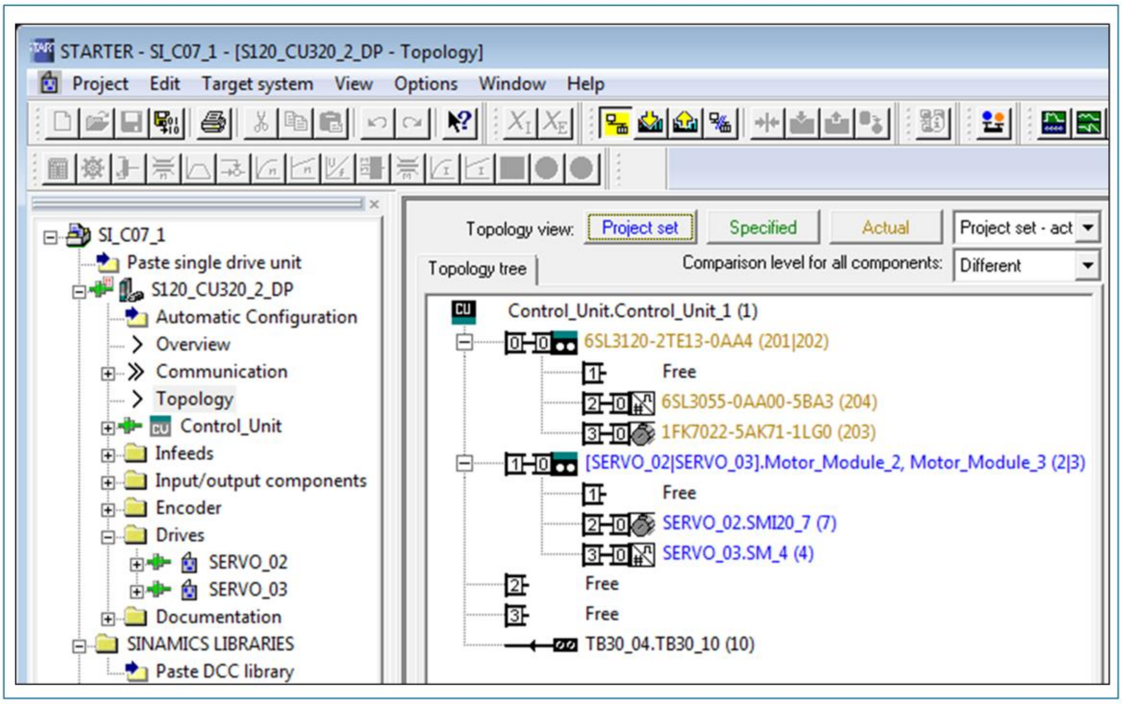

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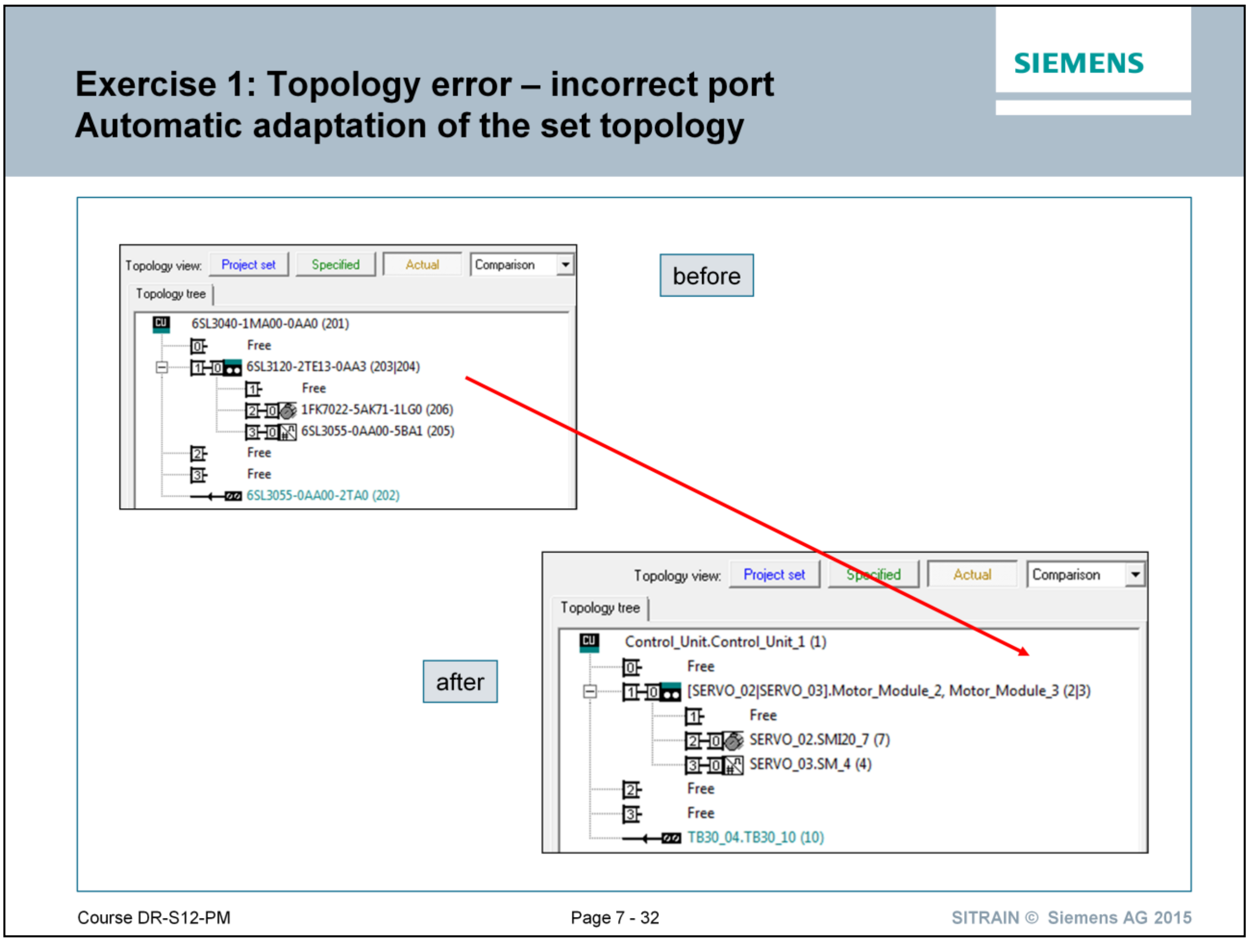
Task

Manually adapt the set topology in the project to the actual wiring of the DRIVE-CLiQ connections:

1. Open the topology
   >> *Topology*
2. Compare the following
   - Actual topology of the online view and the
   - project set topology of the offline view
3. Using the mouse, in the project set topology, move the Double Motor Module from port "X101" to port "X100" of the CU 320-2 DP.
4. Check whether this move can also be made in the set topology:

   ………………………………………………………………………………
5. Save the project to the hard disk.
6. Transfer the modified project set topology in the CU 320-2 DP using "Download to target device" and backup the data in a non-volatile fashion using "Copy RAM to ROM".
7. Response of the CU320-2 DP:

   ………………………………………………………………………………
8. Switch off your training equipment.
9. For the next exercise, change over the DRIVE-CLiQ cable of the CU 320-2 DP from port "X100" back to port "X101".



Task

Now, automatically adapt the specified topology in the project to the actual wiring of the DRIVE-CLiQ connections:

1. Open the topology
   >> *Topology*
2. Compare the following
   • Actual topology of the online view and the
   • project set topology of the offline view
3. Start the routine "Acknowledge topology comparison" via the Expert list of the CU_S_004: p9904 = 1
4. Response (after approx. 20 seconds):

   ………………………………………………………………………………
5. Start the process "Copy RAM to ROM".
6. Interpret the information of a "Set -- actual comparison":

   ………………………………………………………………………………
7. Start the process "Update topology".
8. Interpret the information of a "Project set -- actual comparison":

   ………………………………………………………………………………
9. Load the project to the PG/PC and start "Update topology" again.
10. Interpret the information of a renewed
    "Project set -- actual" comparison:

    ………………………………………………………………………………

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Exercise 2: Topology error – component is missing

LED			Status	Comment
RDY	DP	OPT		
Red	Orange	Orange	Reset	Hardware reset RDY LED lights up red, all other LEDs light up orange
Red	Red	Off	BIOS loaded	–
Red 2 Hz	Red	Off	BIOS error	• Error occurred while loading the BIOS
Red 2 Hz	Red 2 Hz	Off	File error	• Memory card not inserted or defective • Software on memory card not present or corrupted
Red	Orange Flashing light	Off	FW loading	RDY LED lights up red, PN LED flashes orange without fixed frequency
Red	Off	Off	FW loaded	-
Off	Red	Off	FW checked (no CRC error)	
Red 0.5 Hz	Red 0.5 Hz	Off	FW checked (CRC error)	• CRC invalid

For details refer to SINAMICS S120 "Control Units" and "Power units" Manuals from FW 4.3

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Task

Simulate the failure of a DRIVE-CLiQ node by interrupting the DRIVE-CLiQ communication:

1. Switch on your training equipment.

2. Interrupt the DRIVE-CliQ connection for the Double Motor Module at port "X203" to the SMC20 encoder interface.

3. Interpret the status messages of the LEDs regarding display and significance:

   CU320-2 DP / LED RDY:

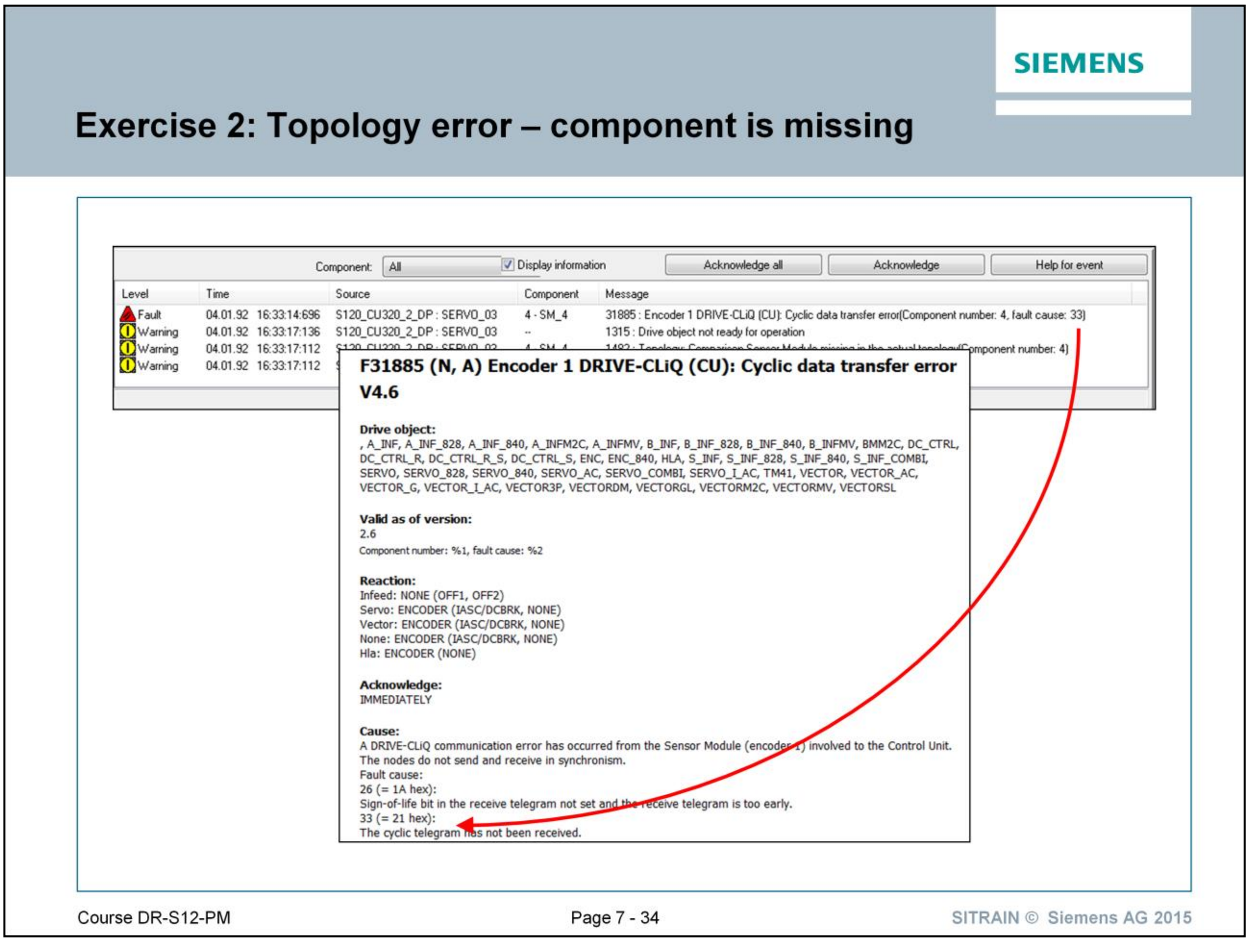
   ……………………………………………………………………………………

   SMC20 / LED RDY:

   ……………………………………………………………………………………

   Double Motor Module / LED RDY:

   ……………………………………………………………………………………



4. Note down the fault and alarm messages and the associated descriptions (as bullet points):

   BOP 20:

   ………………………………………………………………………………………

   STARTER:

   ………………………………………………………………………………………

   ………………………………………………………………………………………

   ………………………………………………………………………………………

   ………………………………………………………………………………………

5. Reinsert the DRIVE-CLiQ connection into port "X203" of the Double Motor Module.

6. Monitor the alarm messages.

7. Can the faults be acknowledged after re-establishing the DRIVE-CLiQ connection (after approx. 30 seconds)?

   ………………………………………………………………………………………

Exercise 3: Deactivating/activating components
Status assignment via topology

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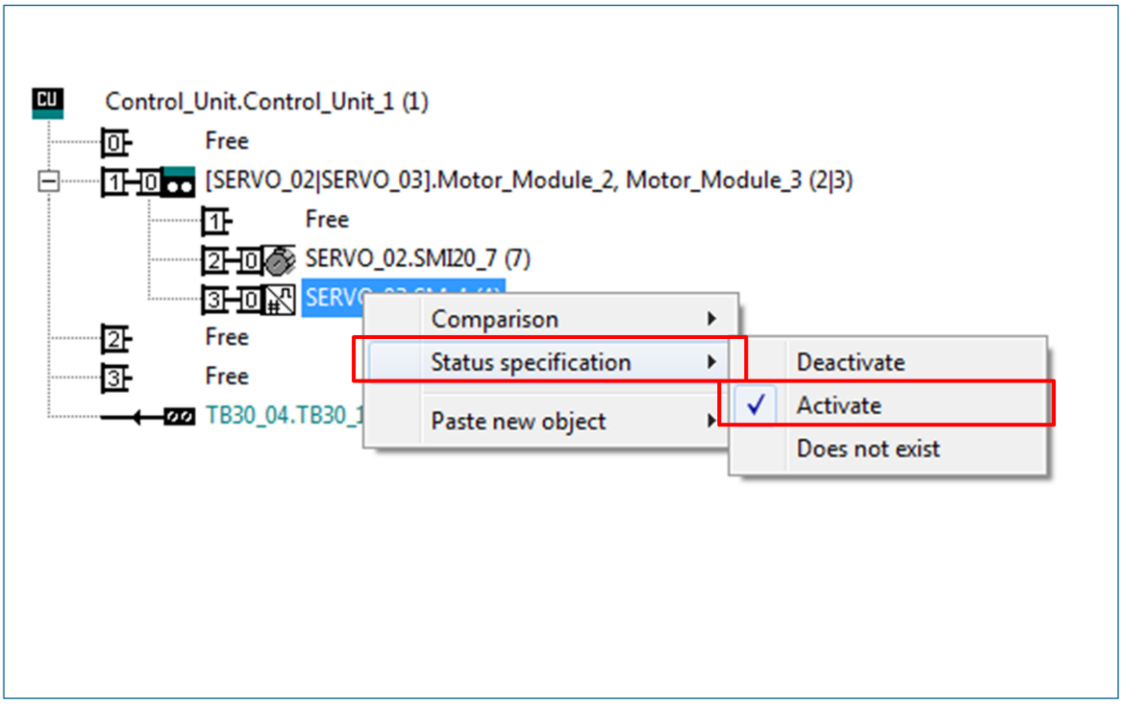

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Task

You can deactivate and activate DRIVE-CLiQ components in the graphic of the set topology or in the expert list of the drive object (e.g. power unit: p125, encoder interface: p145).

1. In the set topology, deactivate the DRIVE-CLiQ component "SERVO_03, SMC20":
   >> right mouse click > *Status specification* > *Deactivate*
2. To do this, remove the DRIVE-CLiQ connector from the Double Motor Module port "X203".
3. How does the drive unit respond?: LED RDY on the CU 320-2 DP, Double Motor Module, SMC 20:

   ……………………………………………………………………………………
4. Which messages appear in STARTER and on the BOP 20:

   ……………………………………………………………………………………
5. Switch the SERVO_03 to closed-loop control.
6. How does the drive unit respond?: LED RDY on the CU 320-2 DP, Double Motor Module, SMC 20:

   ……………………………………………………………………………………
7. Which messages appear in STARTER and on the BOP 20:

   ……………………………………………………………………………………
8. Now restore the initial state by inserting the DRIVE-CLiQ cable into port "X203" of the Double Motor Module and then activate "SERVO_03, SMC20" in the offline mode.

Exercise 4: Deactivating/activating objects
Status assignment via expert list

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	Parameter	Data	Parameter text	Offline value SERVO_03
	All	A	All	All
1	p105		Activate/de-activate drive obj...	[0] De-activate drive object
2	p125[0]	P	Activate/de-activate power u...	[1] Activate component
3	p145[0]	E	Activate/de-activate encoder ...	[0] De-activate component
4	r2		Drive operating display	[42] Switching on inhibite...
5				

Course DR-S12-PM Page 7 - 36

Task Deactivate the drive SERVO_03:

1. Go to the object SERVO_03 in the expert list.
2. Deactivate the object using parameter p105:

   p105 = ……………………………………..

3. What is shown on the operating display:

   SERVO_03, r2 = ……………………………………..

4. Response after opening the DRIVE-CLiQ connection at port "X203":

   ………………………………………………………………………………

5. Response after switching-on SERVO_03:

   ………………………………………………………………………………

6. Now restore the initial state and test the drive.

Note Objects can only be deactivated and activated in the Expert list of the particular object.

Exercise 5: CompactFlash card
Removing it in operation

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If the CompactFlash card is removed when the device is switched on, the CU generates the alarm “A1100 / CompactFlash card removed“; the device continues to work properly.

However, if the CompactFlash card is reinserted during operation, no more data can be saved. In this case, the alarm can only be acknowledged using a Power ON reset.

Never withdraw the card during a write operation (flashing LED RDY) from the CU320-2. If this is done, then the data structure on the card can be damaged, which means that the card can no longer be used.

Task

Investigate the behavior of the drive when removing and inserting the CompactFlash card!

1. Start the drive servo_02.
2. With the drive operational, remove the flash card from the CU

   Drive response: ……………………………………..

   LEDs / BOP display: ……………………………………..
3. Reinsert the card.

   Drive response: ……………………………………..

   LEDs / BOP display: ……………………………………..
4. Choose: Copy RAM to ROM

   Message: ……………………………………..

Note

Generally, damaged files can be deleted using quick formatting (Type FAT 16). The boot loader is retained after quick formatting. The image of the CompactFlash card, previously saved via Explorer, can then be copied back to the CompactFlash card.

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Exercise 5: CompactFlash card
Backing up using a card reader

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Task Backup the parameterization on the CompactFlash card using a card reader and Windows Explorer!

1. Connect the card reader to your PG/PC.

2. Open Windows Explorer and select the directory with the CompactFlash card.

3. Copy the entire content of the card into any Windows folder, e.g. "Course".

4. Delete the entire content of the card for the next exercise.

5. Before you remove the CompactFlash card from the PG/PC, use “Safely remove hardware“ (at bottom right of screen) to allow the CompactFlash card to be removed.

Note With simple data deletion, the invisible “Boot Loader“ is not deleted. This means that the card can still be used for SINAMICS S120.

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Exercise 5: CompactFlash card
Powering up without a CompactFlash card

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Task Investigate how the drive powers up if there is no CompactFlash card or just an empty one!

1. Switch on your drive unit without a CompactFlash card (if all LEDs light up red, perform a Power ON reset again).

2. Note the states of the LEDs at the CU:

   RDY: . . . . DP1: . . . . OPT: . . . .

3. Switch off the drive unit.

4. Insert the empty CompactFlash card.

5. Switch on your drive unit with deleted card.

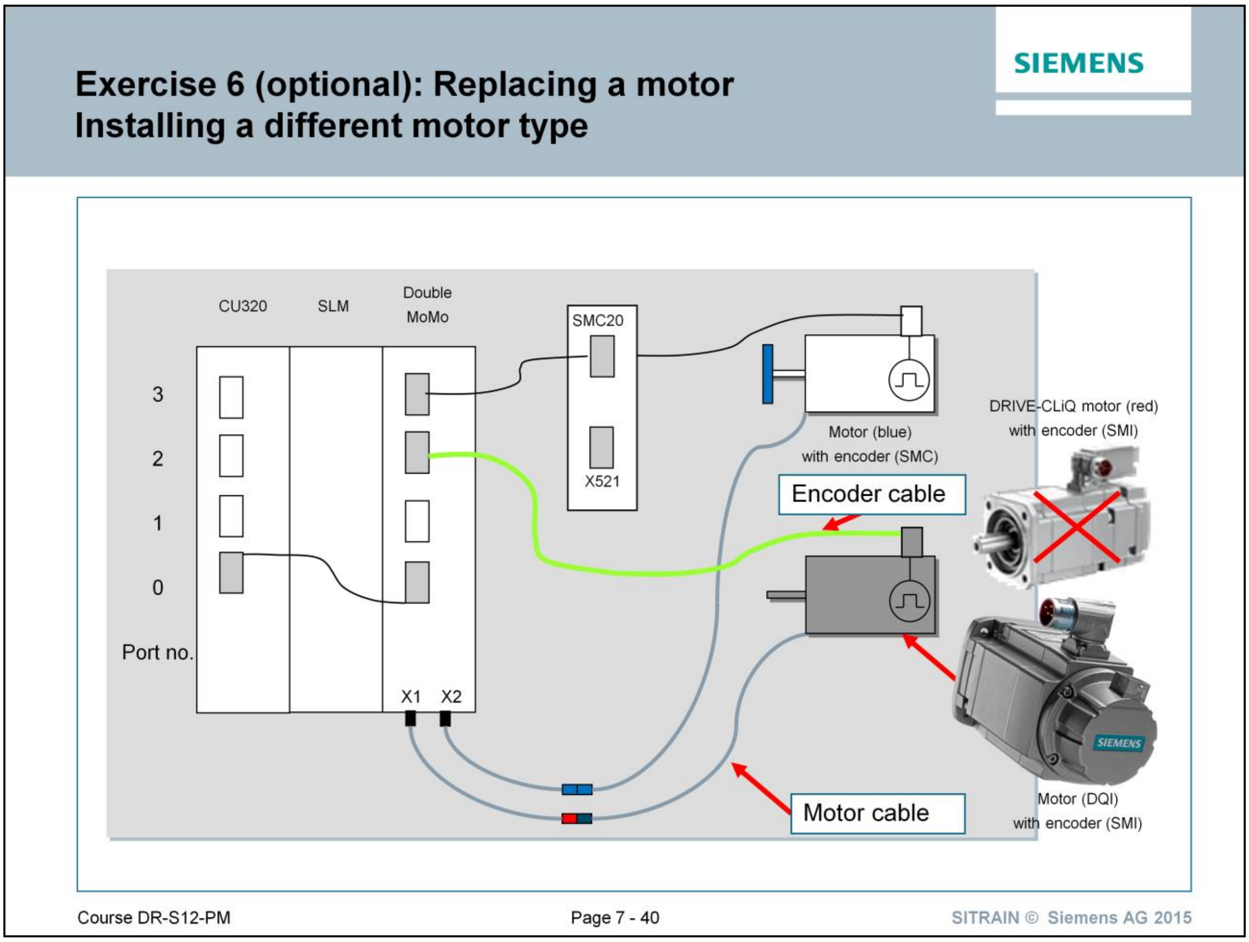
6. Note the states of the LEDs at the CU:

   RDY: . . . . DP1: . . . . OPT: . . . .

7. Note the states of the LEDs at the Motor Module:

   RDY: . . . . DC: . . . .

8. Then ensure that an executable structure is written to your CompactFlash card, and reinsert this back into your CU 320-2.

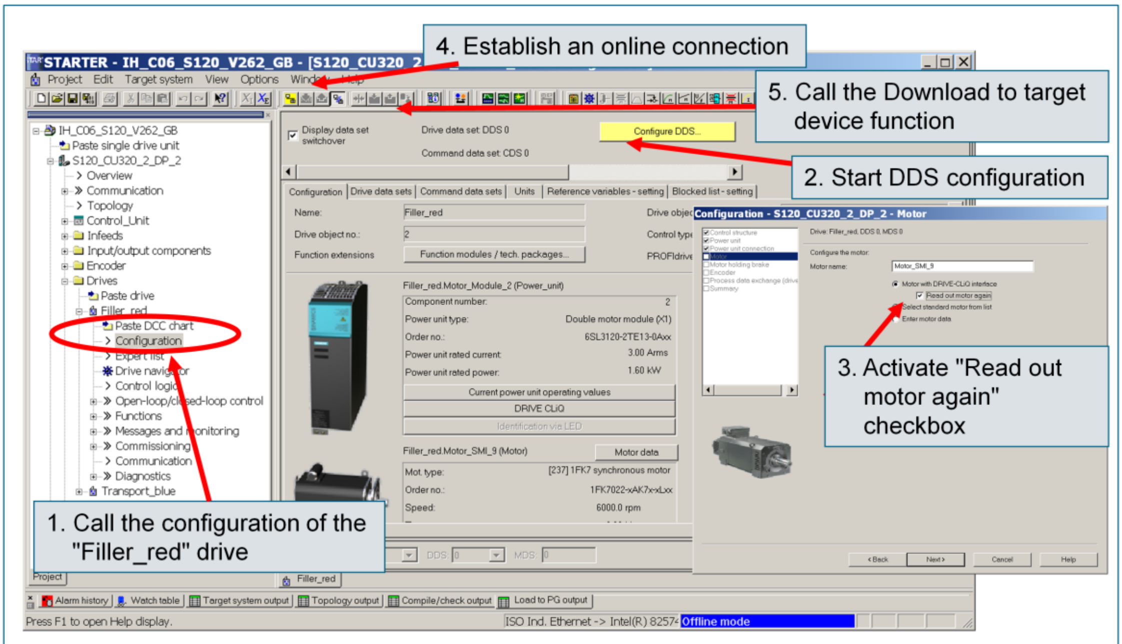


Change the HW configuration of your training case with the power supply switched off so that you can use the DQI motor from the maintenance case:

1. Changes on the motor module:
   - Remove the DRIVE-CLiQ plug from port 2 (X202).
   - Use the DRIVE-CLiQ cable supplied to connect the encoder of the DQI motor to port 2 (X202) of the Motor Module.
   - Use the supplied motor cable to connect the DQI motor to terminal X1 on the Motor Module.

2. Switch the power supply to the training case on again.

Exercise 6 (optional): Replacing a motor
Output the motor/encoder data



Drive unit -> Drive object -> Configuration

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Task After replacing the motor, the motor/encoder data must be read out from the DRIVE-CLiQ rating plate and stored in the project.

1. Open the project and switch to offline mode and open the configuration view of the "Filler_red" drive.
2. The next step is to start the "DDS configuration" (DDS: Drive Data Set) of the drive.
3. Select "Read out motor again" in the motor data configuration.
4. Save the project.
5. Switch into online mode.
6. Which alarm message is present?

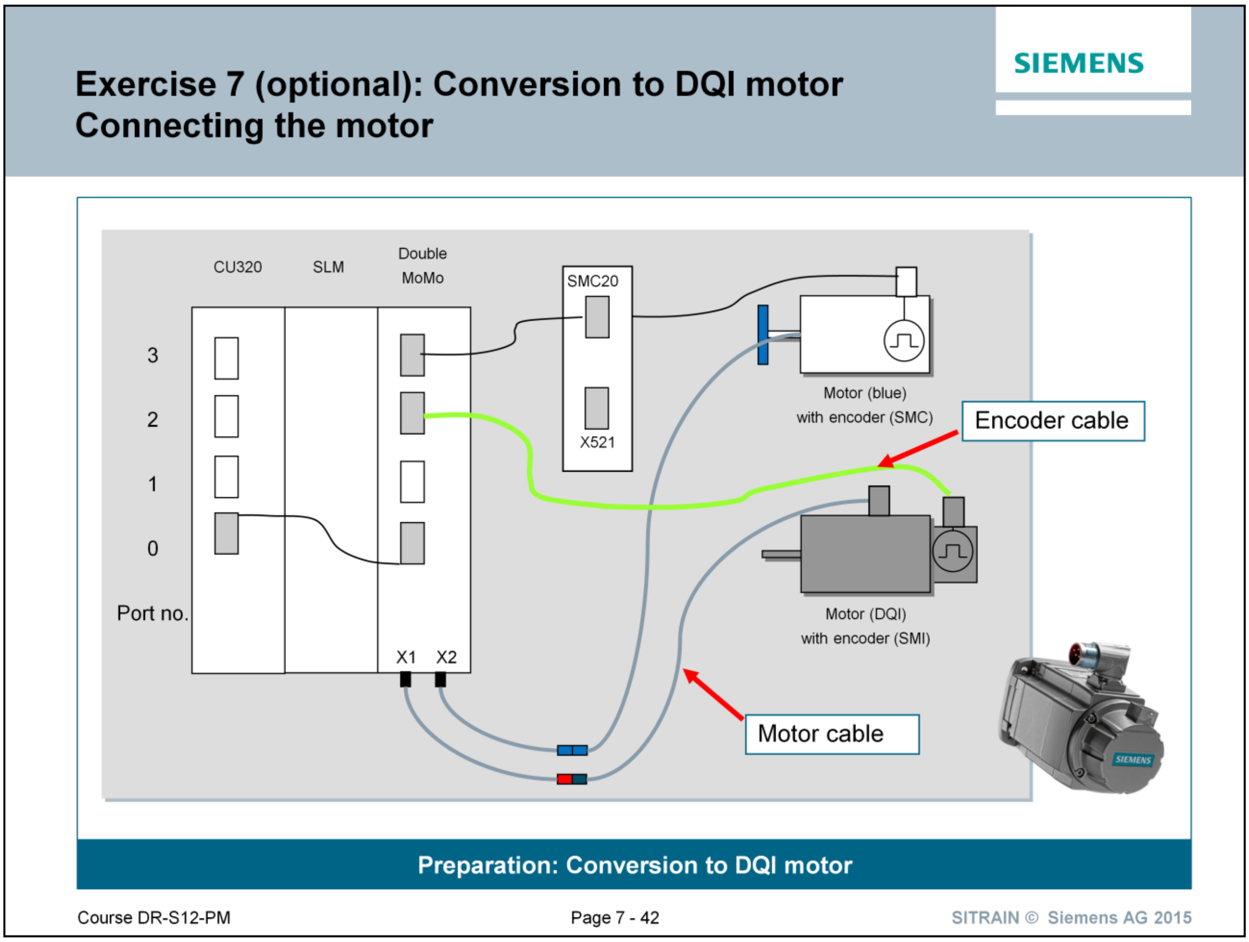
   ………………………………………………………………………………………
7. Then perform a download, followed by "Copy RAM to ROM".
8. Load the output motor/encoder data back to the programming device ("Load project to PG" function).
9. The "Configuration" screen of the drive lists the components for this drive object.

   Note the order number of the motor, the SMI and the encoder type:

   ………………………………………………………………………………………

   ………………………………………………………………………………………

   ………………………………………………………………………………………
10. Switch the SINAMICS power supply off and then on again.
11. Test the newly installed motor.



Task

A DRIVE-CLiQ motor encoder has failed and is to be replaced.

To do this, the encoder will be replaced with a non-programmed encoder and the saved motor data transferred to the new encoder.

Preparation

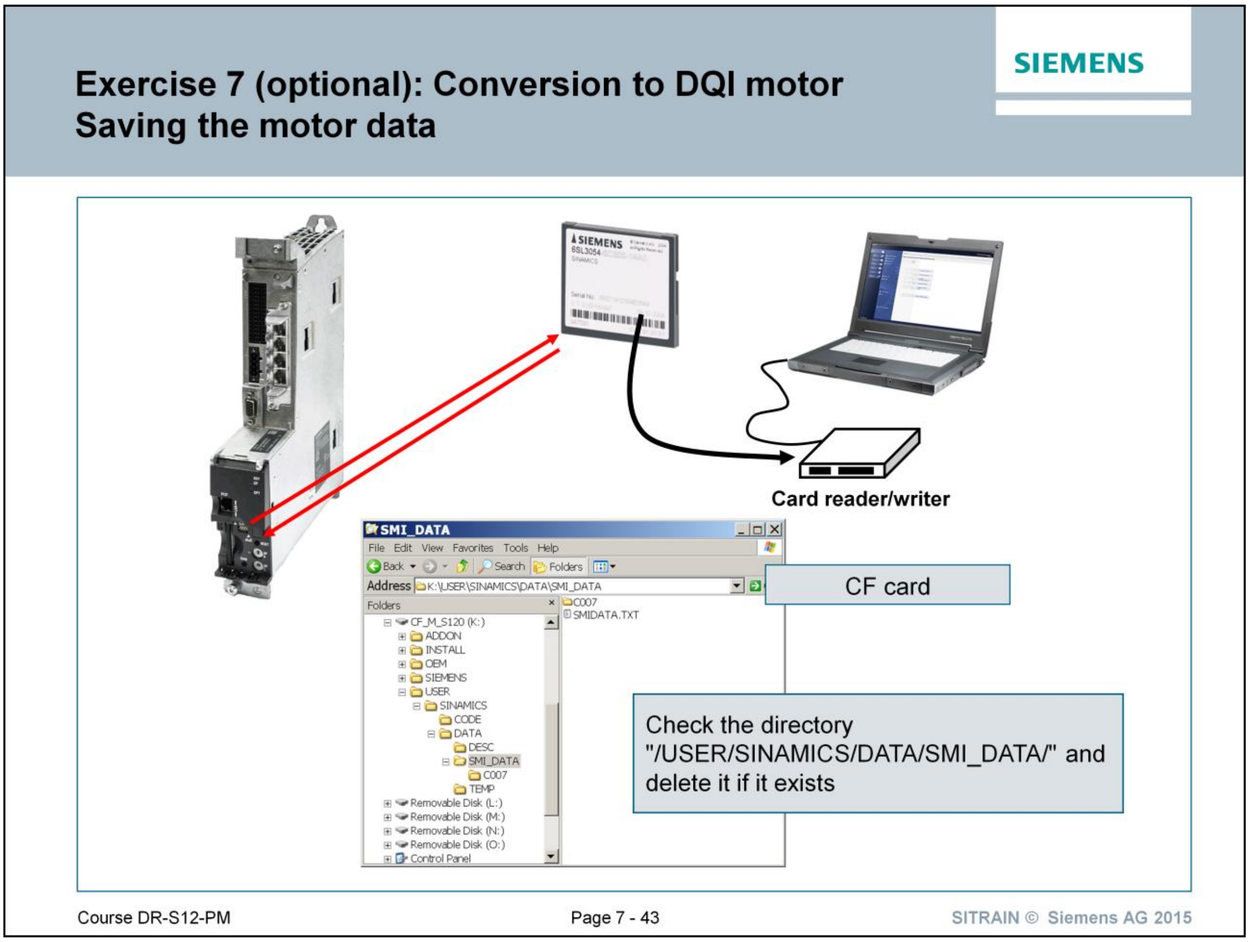
Change the HW configuration of your training case with the power supply switched off so that you can use the DQI motor from the maintenance case:

1. Changes on the motor module:
   - Remove the DRIVE-CLiQ plug from port 2 (X202).
   - Use the DRIVE-CLiQ cable supplied to connect the encoder of the DQI motor to port 2 (X202) of the Motor Module.
   - Use the supplied motor cable to connect the DQI motor to terminal X1 on the Motor Module.

2. Open the project in additional exercise 4 or retrieve and open the training project "IH_C071_S120_HMI_V46_GB". Your trainer will tell you the directory.

3. Save the project, perform a download and then carry out "Copy "RAM to ROM".

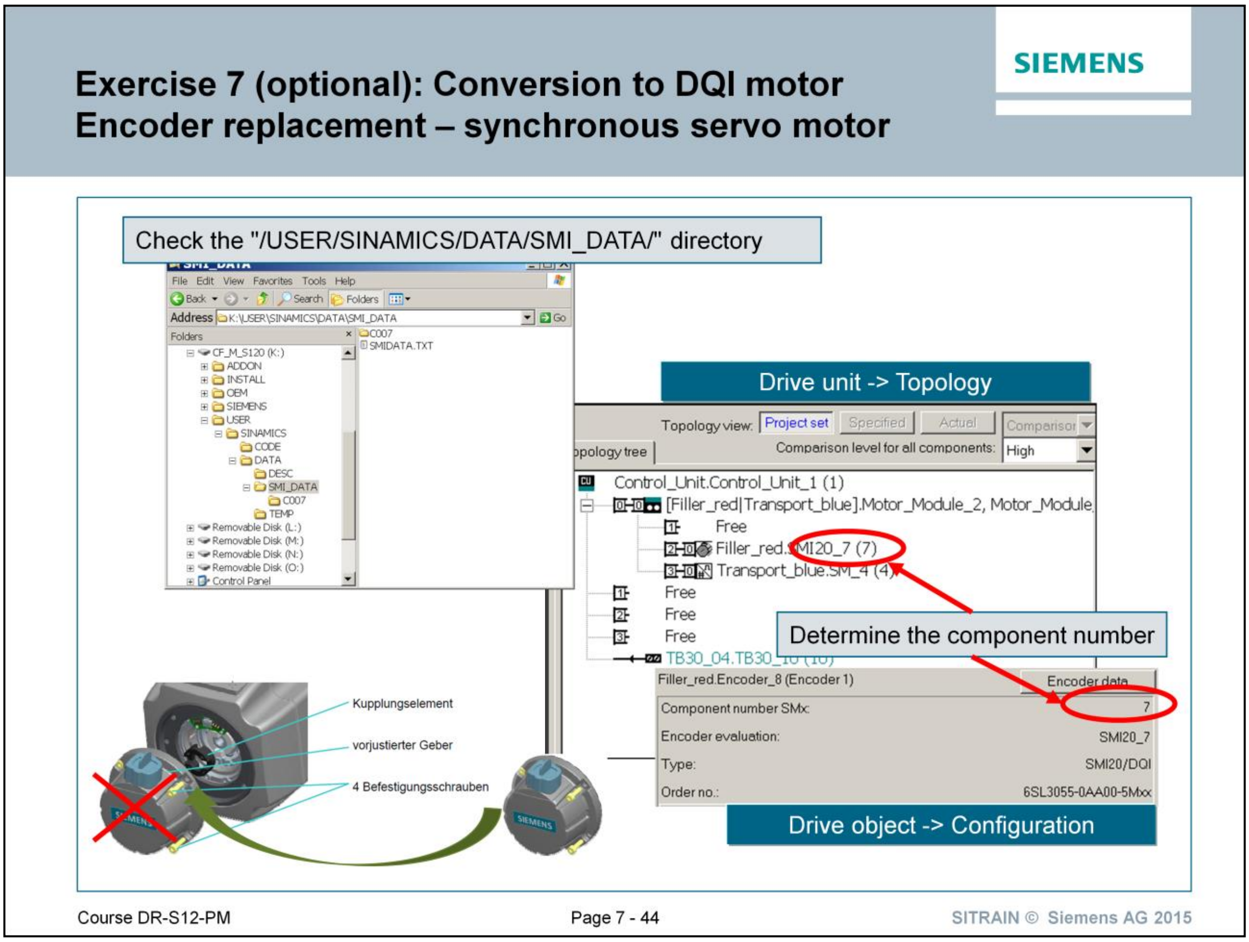
4. Switch off the SINAMICS supply voltage.



Task

To meet the prerequisites for this exercise, delete any motor data present on the CF card:

1. Switch off the SINAMICS S120 supply voltage.
2. Remove the CF card from the SINAMICS S120 and insert it into a card reader.
3. Check the directory "/USER/SINAMICS/DATA/SMI_DATA/" on the CF card.
4. If the directory "SMI_DATA" exists, delete it.
5. Insert the CF card back into the SINAMICS S120.
6. Switch on the supply voltage of the SINAMICS S120.
7. Open the project and switch to online mode.



Task Backup the motor data of the DQI motor.

Then change the motor encoder mechanically

To back up the settings, proceed as follows:

1. Switch to the online mode of the STARTER project.
2. Open the Control Unit expert list.
3. Set parameter CU p4692 = 1 and you will receive the feedback in parameter p4692. The parameter is then automatically set to 10: "All data saved successfully".
4. Switch off the drive unit, remove the CF card and use the card reader to check whether the back up of the motor data to "/USER/SINAMICS/DATA/SMI_DATA/" has been successful.
5. Switch to the topology view in the offline STARTER project. Now determine the component number of the DRIVE-CLiQ encoder (see example = 7). Which component number have you determined?

   ……………………………………………………………………………………

6. Switch off the supply voltage to SINAMICS.
7. Replace the DQI motor encoder.
   - To do this, loosen the 4 fixing screws
   - Remove the encoder
   - CAUTION:
     Sensor Modules, encoders and KTY are electrostatically sensitive devices! Neither hands nor tools that could be electrostatically charged should come into contact with the connections!
   - Install the new encoder.

Exercise 7 (optional): Conversion to DQI motor
Deleting the motor data

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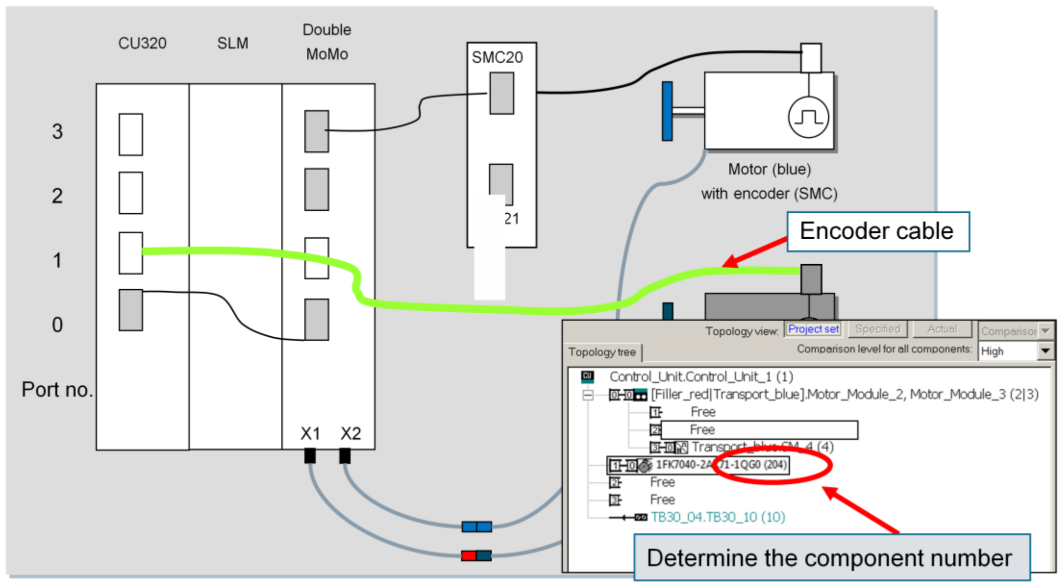

Delete encoder: Connect the Drive-CLiQ cable to a non-assigned port

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Task To meet the prerequisites for this exercise, delete any motor data present on the DQI encoder module.

1. Insert the encoder connecting cable of the DQI motor to a non-assigned DRIVE-CLiQ port.

2. Switch on the SINAMICS supply voltage.

3. Switch into online mode in the STARTER project.

4. Open the topology view of the drive unit.

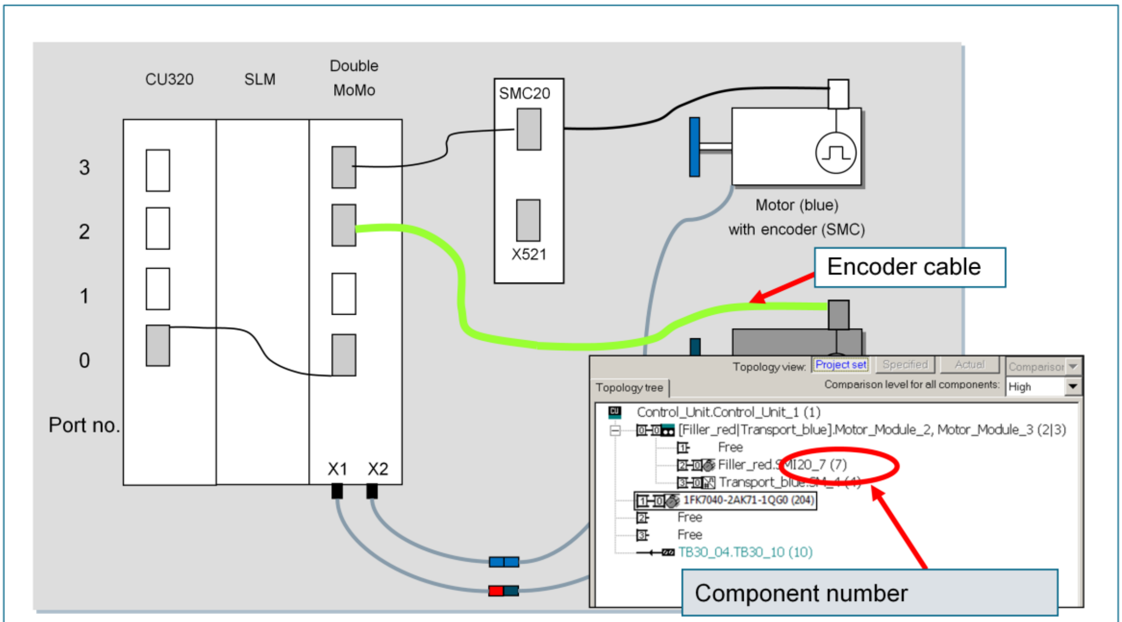
5. Read out the component number of the DQI encoder module in the topology (see example = 204).
   Which component number have you determined?

   ………………………………………………………………………………………

6. Now open the CU expert list and set the parameters in the following order:
   - p4690 -> Entry of the component number determined above (in the example = 204).
   - p4691 -> Action: 30 -> "Delete SMI data".
   - p4691 -> Message: 35 -> "Delete SMI data, confirmation required".
   - p4691 -> Action: 30 -> "Delete SMI data"
   - p4691 -> Message: 36 -> "SMI data deleted, Power On required for comp.“

7. Switch off the supply voltage to SINAMICS.

Exercise 7 (optional): Conversion to DQI motor
Writing the motor data



Geber löschen: Drive-CliQ Kabel an einen nicht belegten Port legen

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Task The motor data stored on the CF card must be transferred to the DQI encoder:

1. Reconnect the DRIVE-CLiQ cable to its original port.

2. Switch on the SINAMICS supply voltage.

3. Which warning is displayed?

   ………………………………………………………………………………..

4. Open the CU expert list and set the parameters in the following order:
   - p4690 -> Entry of the original component number
     (in the example = 7)
   - p4691 -> Action: 2 -> "Load SMI data"
   - p4691 -> Message: 9 -> "SMI data loaded, Power On required for comp.“

5. Switch the SINAMICS supply voltage on and off.

6. Test the motor function.

Note The Projekte_de\CF-Card contains a copy of the CF card with valid encoder data. Your trainer will tell you the directory.

Learning Targets 2
Overview 3
Frame sizes 4
Structure power unit 5
Communication modules 6
Line Module 7
Motor Module 12
Power Module 13
SINAMICS S150 16
Power unit cooling 17
Option DC coupling 18
Braking Module 19
Line and motor-side components 20
Cable lengths 21
Voltage sensing 22

Learning Targets

- You will know the structure of chassis power units
- You will know the structure of S120 control cabinets
- You will know the structure of blocksize power units

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Overview
Types

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Power units	AC/AC-device

• Line Modules
  • Basic Line Modules
  • Smart Line Modules
  • Active Line Modules
• Motor Modules
	• Power Modules
	  • Blocksize
	  • Chassis

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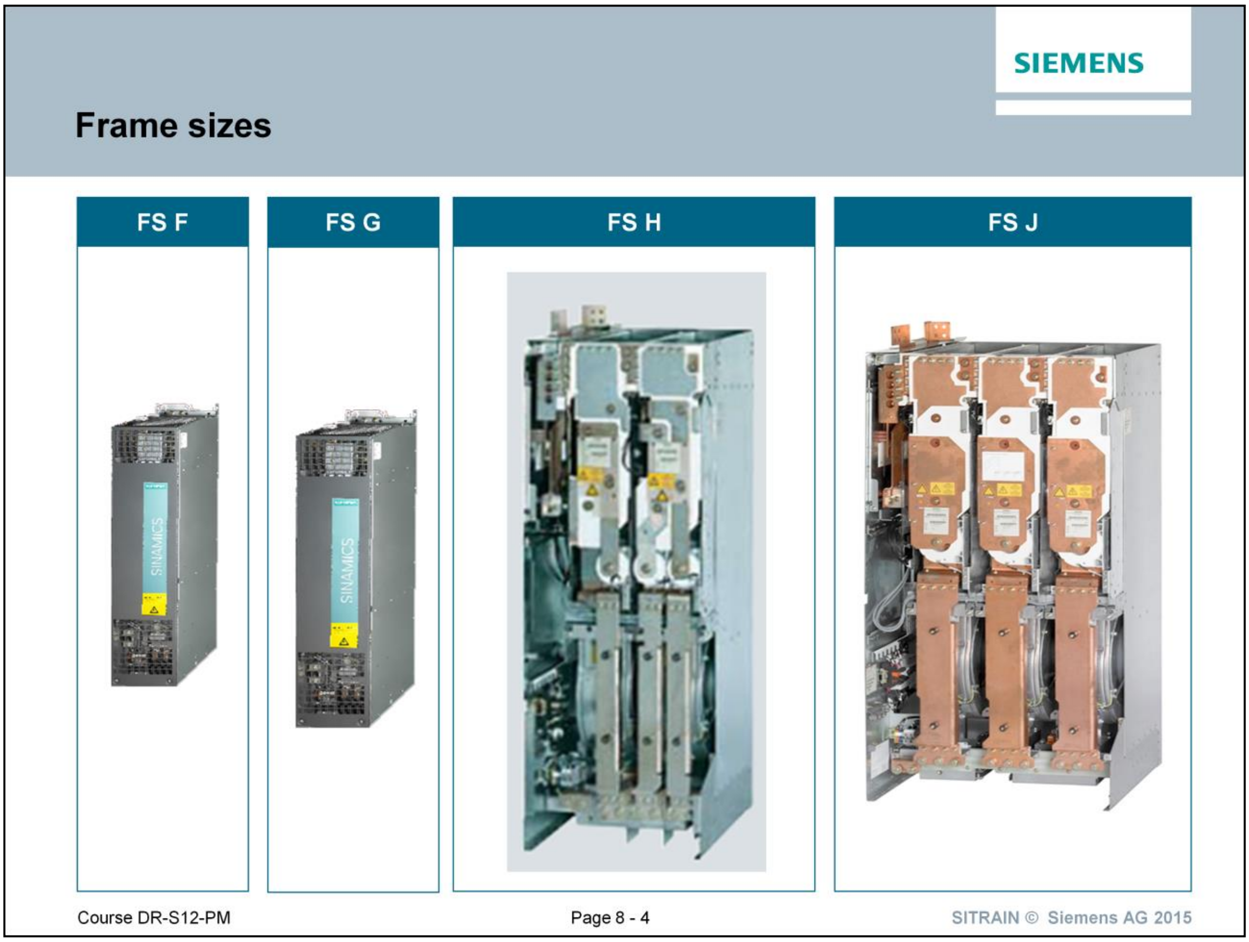

Frame sizes

SINAMICS power blocks as built-in units or cabinet units are offered in the following sizes:

- Frame size F (FS F): 1 short power block
- Frame size G (FS G): 1 long power block
- Frame size H (FS H): 2 long power blocks
  (phase 1 on power block 1, phases 2 and 3 on power block 2)
- Frame size J (FS J): 3 long power blocks
  (phase 1 on power block 1, phase 2 on power block 2, phase 3 on power block 3)

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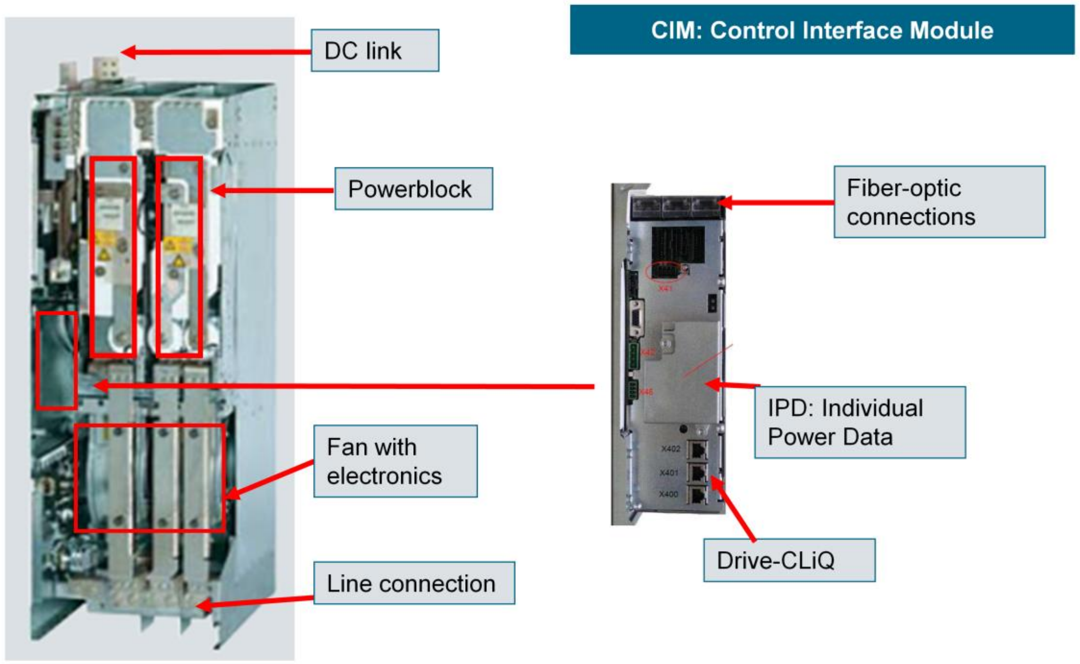
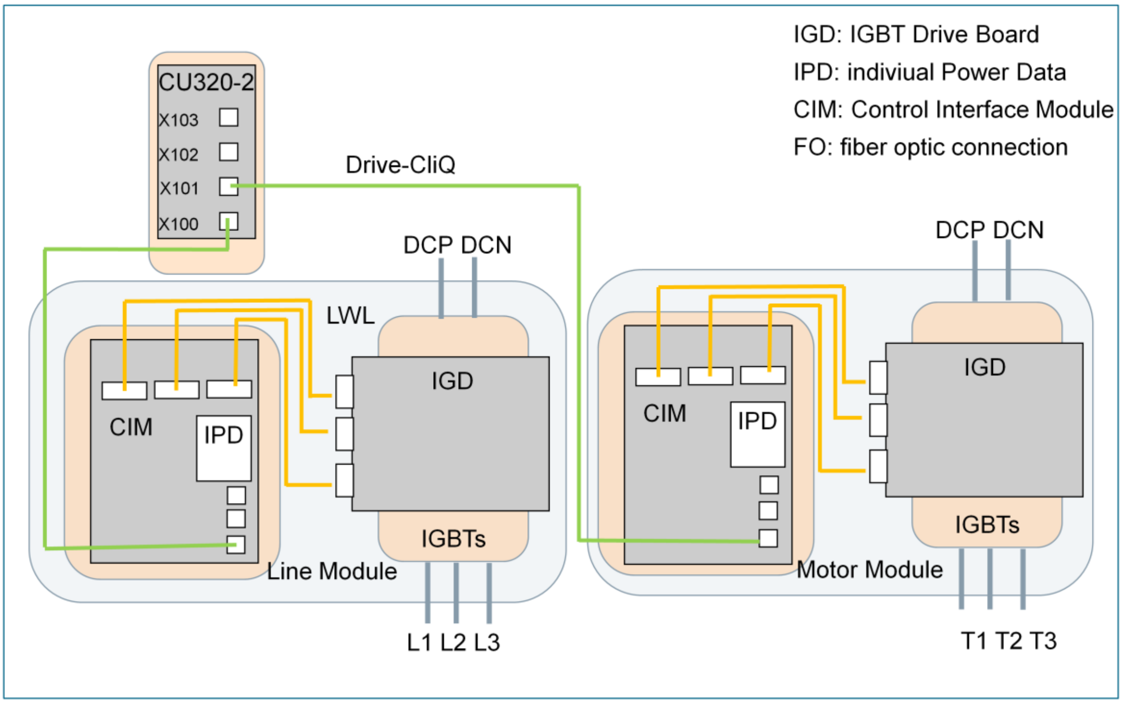
Structure power unit



Communication modules



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Line Module
Basic Line Module BLM

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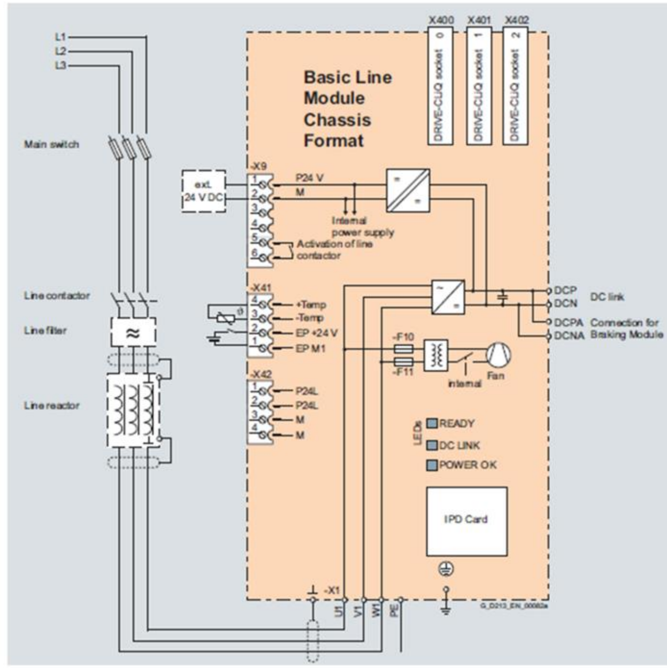

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Basic Line

Basic Line Modules are used for applications in which no energy is returned to the supply or where the energy exchange between motor and generator axes takes place in the DC link.

The connected Motor Modules are pre-charged via the thyristor gate control. The thyristors are always fired at a delay angle of 0° in operation.

Basic Line Modules are designed for connection to grounded TN/TT systems and non-grounded IT systems. In a Basic Line Module in chassis format, a Braking Module of the corresponding size can be installed to support generating mode of the drive system in combination with an external braking resistor.

Design

The Basic Line Modules in chassis format feature the following connections and interfaces as standard:

- 1 power connection
- 1 connection for the 24 V DC electronics power supply
- 1 DC link connection (DCP, DCN) for supplying the connected Motor Modules
- 1 DC link connection (DCPA, DCNA) for connecting a Braking Module
- 1 temperature sensor input (KTY84-130 or PTC/Pt100)
- 3 DRIVE-CLiQ sockets

The status of the Basic Line Modules is indicated via two multi-color LEDs.

Line Module
Smart Line Module SLM

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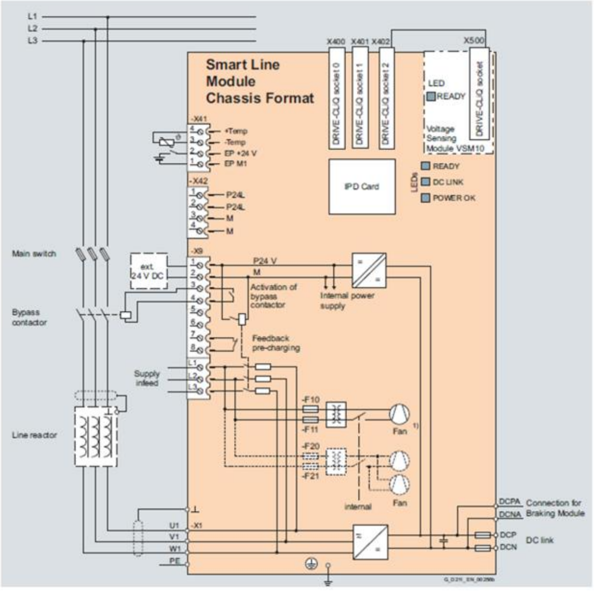

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Smart Line

Smart Line Modules are non-regulated feed/feedback units with 100 % continuous regenerative feedback power. The regenerative feedback capability of the modules can be deactivated by means of parameterization.

Smart Line Modules are designed for connection to grounded TN/TT and non-grounded IT systems.

The DC link is pre-charged via integrated pre-charging resistors.

The associated line reactor is absolutely essential for operating a Smart Line Module.

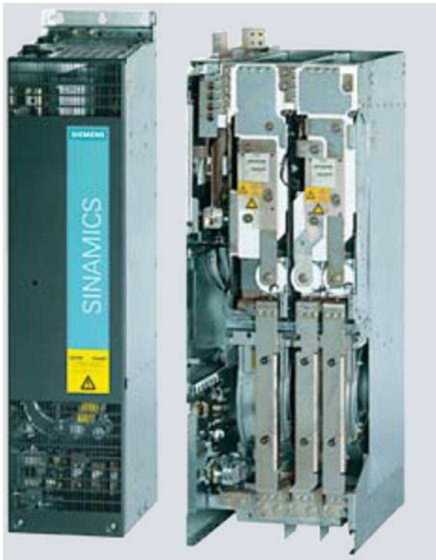
Design

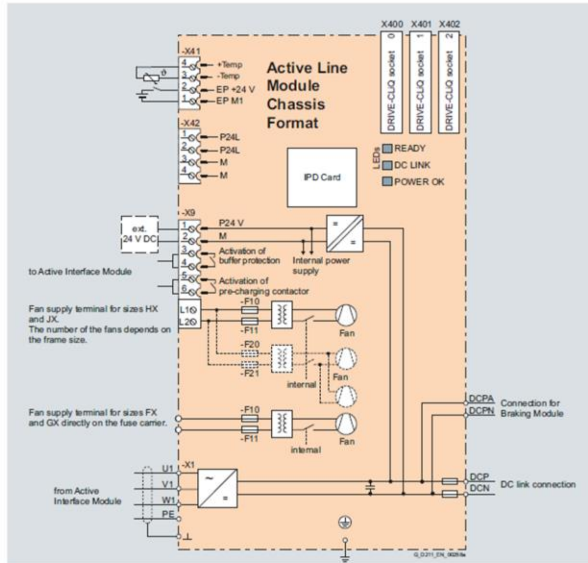
The Smart Line Modules have the following interfaces as standard:

- 1 power connection
- 1 connection for the 24 V DC electronics power supply
- 1 DC link connection (DCPA, DCNA) for connecting a Braking Module
- 3 DRIVE-CLiQ sockets
- 1 PE (protective earth) connection (2 connections for frame sizes HX and JX)

The status of the Smart Line Modules is indicated via two multi-color LEDs.

Line Module
Active Line Module ALM





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Active line

The self-commutated feed/feedback units (with IGBTs in infeed and regenerative feedback directions) generate a regulated DC link voltage. This means that the connected Motor Modules are decoupled from the line voltage. Line voltage fluctuations within the permissible supply tolerances have no effect on the motor voltage.

Active Line Modules can if necessary feed a prespecified fundamental reactive current (capacitive or inductive) to the supply system so as to support simple compensation tasks.

Active Line Modules are designed for connection to grounded TN/TT and non-grounded IT systems.

In order to operate an Active Line Module, it is absolutely essential to use the appropriate Active Interface Module.

Design

The Active Line Modules in chassis format feature the following connections and interfaces as standard:

- 1 power connection
- 1 connection for the 24 V DC electronics power supply
- 1 DC link connection (DCP, DCN) for supplying the connected Motor Modules
- 1 DC link connection (DCPA, DCNA) for connecting a Braking Module
- 1 temperature sensor input (KTY84-130 or PTC/Pt100)
- 3 DRIVE-CLiQ sockets
- 2 PE (protective earth) connections

The status of the Active Line Modules is indicated via two multi-color LEDs.

Line Module
Active Interface Module AIM

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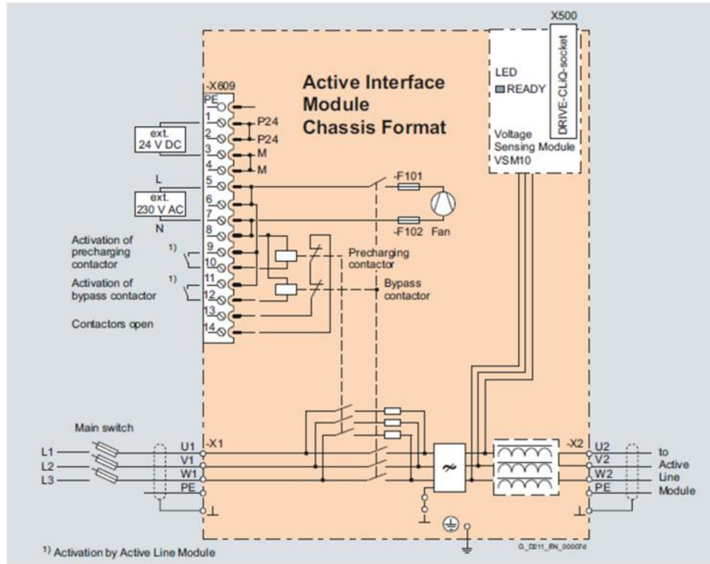

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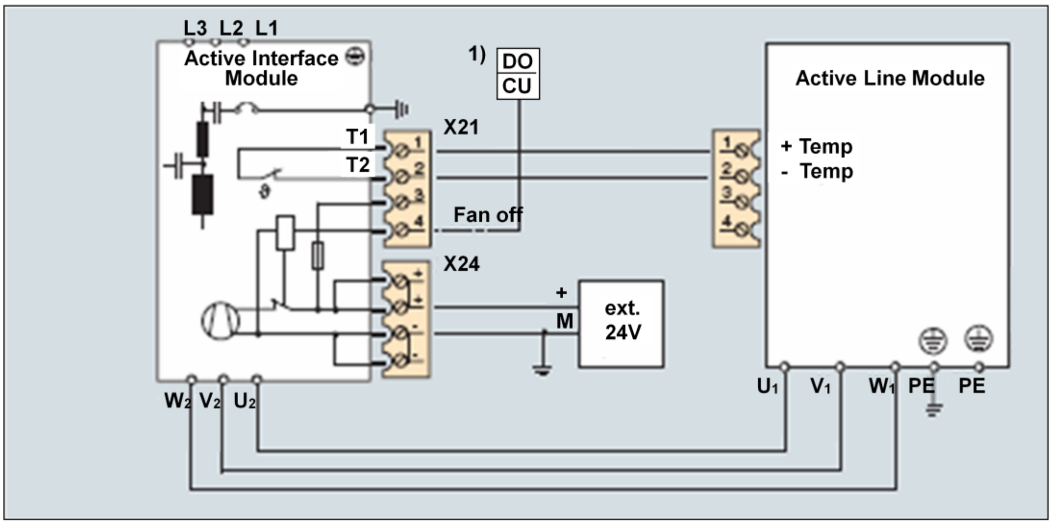
Active Interface

Active Interface Modules are used in combination with Active Line Modules in chassis format. Active Interface Modules contain a Clean Power Filter with basic RI suppression reactor, the pre-charging circuit for the Active Line Module, the line voltage sensing circuit and monitoring sensors. The bypass connector is an integral component in types FI and GI, thereby making the module very compact. The bypass contactor must be provided separately for frame sizes HI and JI.

The vast majority of line harmonics are suppressed by the Clean Power Filter.

Line Module
connection between AIM and ALM



Connection

The Active Interface Module requires a 24 V DC supply for operation of the integral fan. The fan rotates after the 24 V DC supply is applied and can, if necessary (service life, noise), be shut off fom the Control Unit over the "Fan off" input. It is only permitted to switch off the fan when the infeed of the drive system is not operating, otherwise the Active Interface Module will overheat.

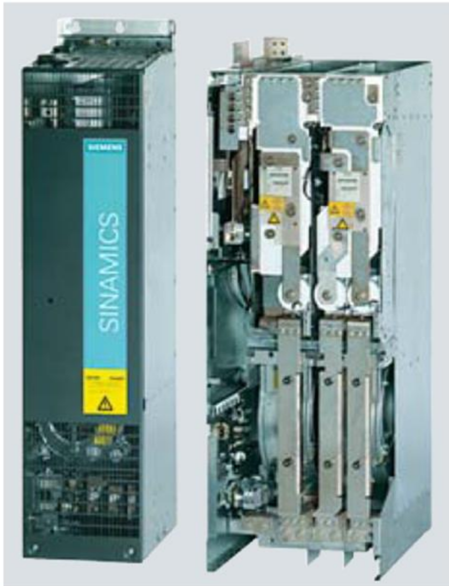
The thermostatic switch installed in the Active Interface Module is evaluated over the connected Active Line Module.

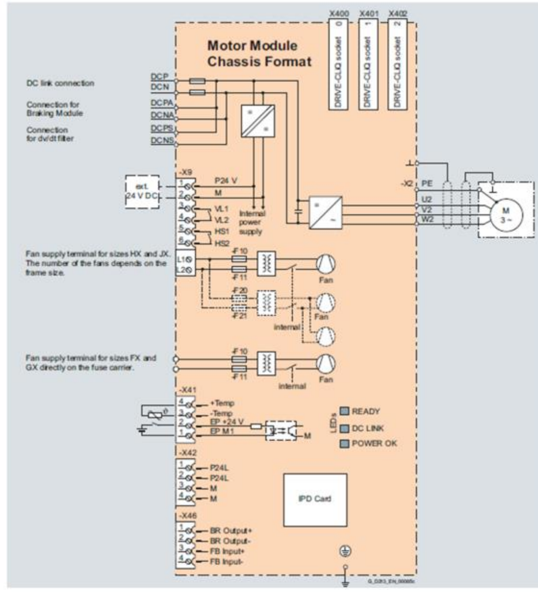
The power cables between the Active Interface Module and Active Line Module must be shielded if limit values for interference suppression are to be complied with. The cable shield can be routed over the shield connection plate (option) to the Active Interface Module or Active Line Module.

Depending on the position of the Active Interface Module in the drive system, additional DRIVE-CLiQ cables may be required. If it is separately installed next to the left side of the Control Unit and Active Line Module, no additional DRIVE-CLiQ cables are required.

If the Active Interface Module is placed between the Control Unit and Active Line Module, the DRIVE-CLiQ cables supplied with the Active Line Modules are suitable for setting up a line topology, i.e. Active Line Module and all Motor Modules in series on one DRIVE-CLiQ line.

Motor Module





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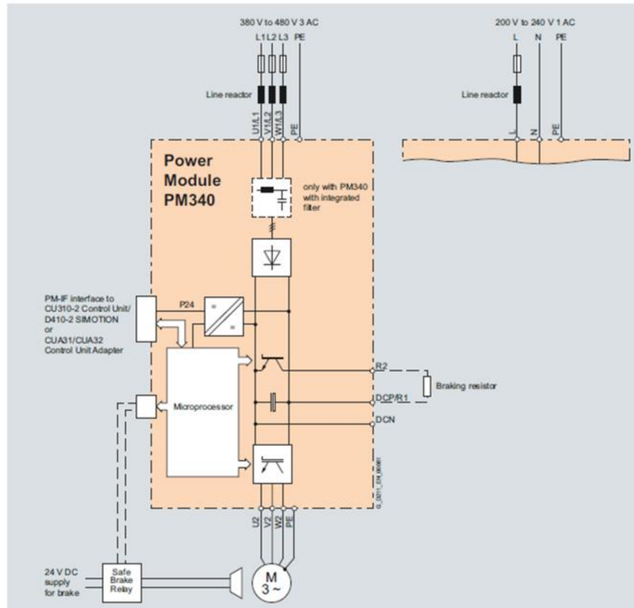
Motor Module

The Single Motor Modules in chassis format feature the following connections and interfaces as standard:

- 1 DC link connection (DCP, DCN) for connecting to the supply DC busbar
- 1 DC link connection (DCPA, DCNA) for connecting a Braking Module
- 1 electronics power supply connection
- 3 DRIVE-CLiQ sockets
- 1 motor connection
- 1 safe standstill input (enable pulses)
- 1 temperature sensor input (KTY84-130 or Pt100 two-wire, or PTC)
- 1 connection for Safe Brake Adapter
- 1 PE (protective earth) connection

The status of the Motor Modules is indicated via two multi-color LEDs.

Power Module
Blocksize PM340 (AC/AC-Gerät)



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Power Module

The PM340 Power Modules in blocksize format feature the following connections and interfaces as standard:

- Line connection
- PM-IF interface for connection of the PM340 Power Module and CU310-2/SIMOTION D410-2 Control Unit or CUA31/CUA32 Control Unit Adapter. The PM340 Power Module also supplies power to the CU310-2/SIMOTION D410-2 Control Unit or CUA31/CUA32 Control Unit Adapter by means of an integrated power supply
- Terminals DCP/R1 and R2 for connection of an external braking resistor
- Motor connection made with screw-type terminals or screw studs
- Control circuit for the Safe Brake Relay for controlling a holding brake
- 2 PE (protective earth) connections

Power Modules without integrated line filter can be connected to grounded TN/TT and non-grounded IT systems.

Power Modules with integrated line filter are suitable only for connection to TN systems with grounded star point.

The integrated Braking Unit (Braking Chopper) is rated with the capability to continuously utilize the external braking resistor.

The temperature of the external braking resistor must be monitored to provide protection against thermal overloading.

Power Module
Chassis (AC/AC-device)

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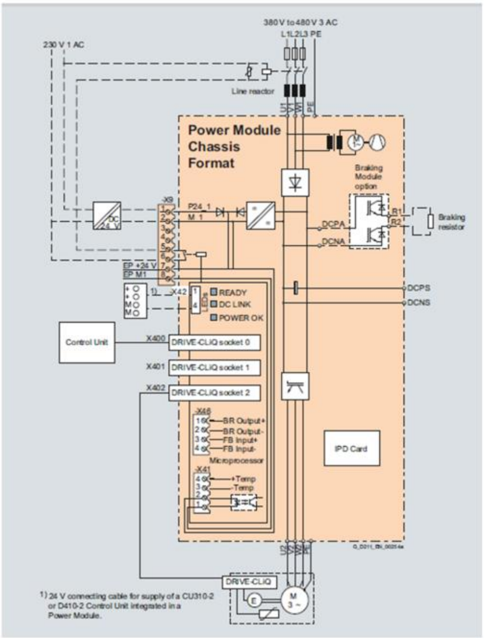

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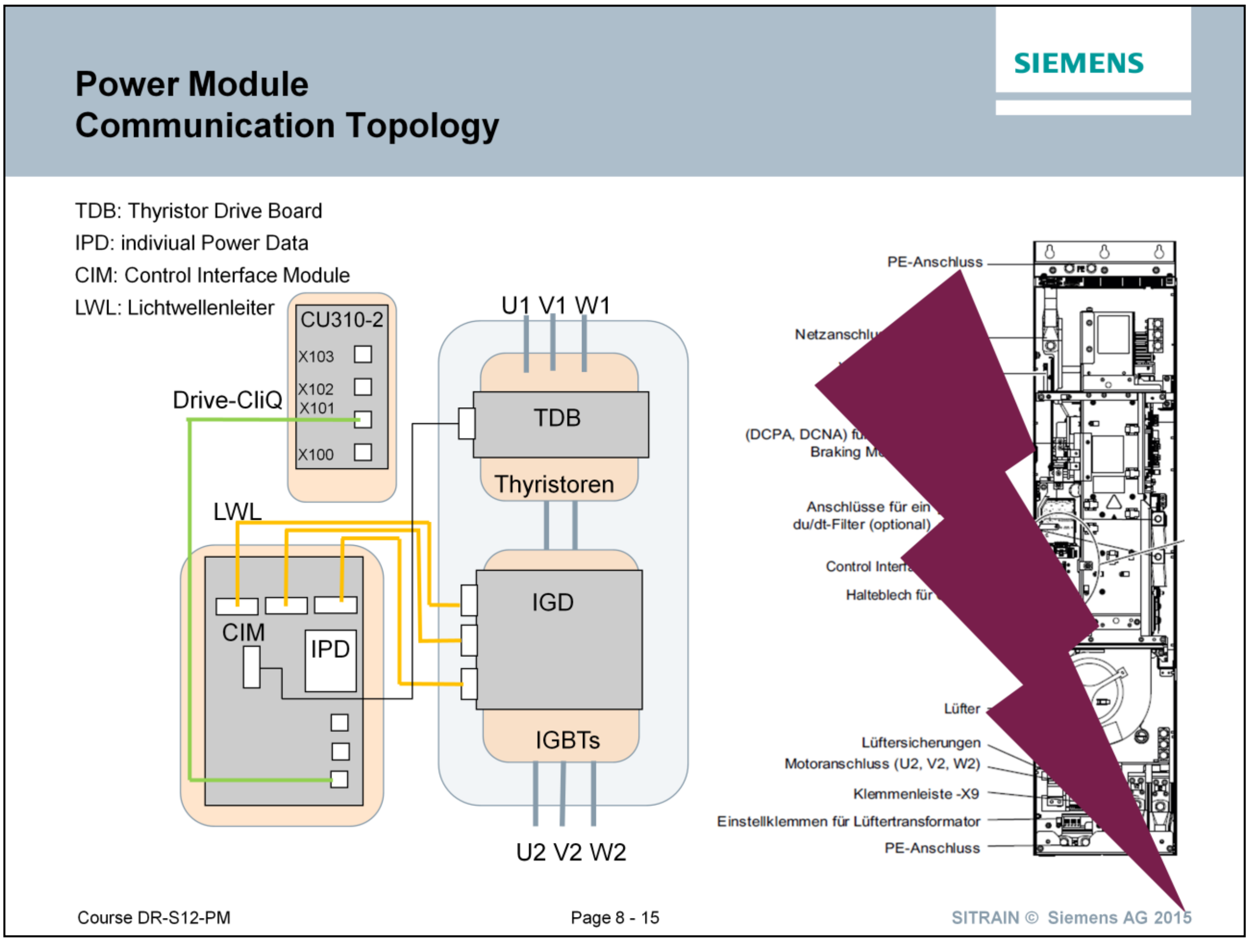
Power Module

The Power Modules in chassis format feature the following connections and interfaces as standard:

- 1 power connection
- 2 DC link connections for options, e.g. Braking Modules
- 3 DRIVE-CLiQ sockets
- 1 safe standstill input (enable pulses)
- 1 temperature sensor input (KTY84-130 or PTC/Pt100)
- 1 electronics power supply connection
- 1 motor connection
- 1 connection for Safe Brake Adapter
- 2 PE (protective earth) connections

The CU310-2/SIMOTION D410-2 Control Unit can be mounted in Power Modules of chassis format.



Abkürzungen

TDB: Thyristor Drive Board
IPD: Indiviual Power Data
CIM: Control Interface Module
LWL: Lichtwellenleiter
IGD: IGBT Drive Board

Control Unit

Als Control Unit kann sowohl die CU310-2 (nur Einzelantrieb) als auch die CU320-2 eingesetzt werden.

SINAMICS S150
Cabinet

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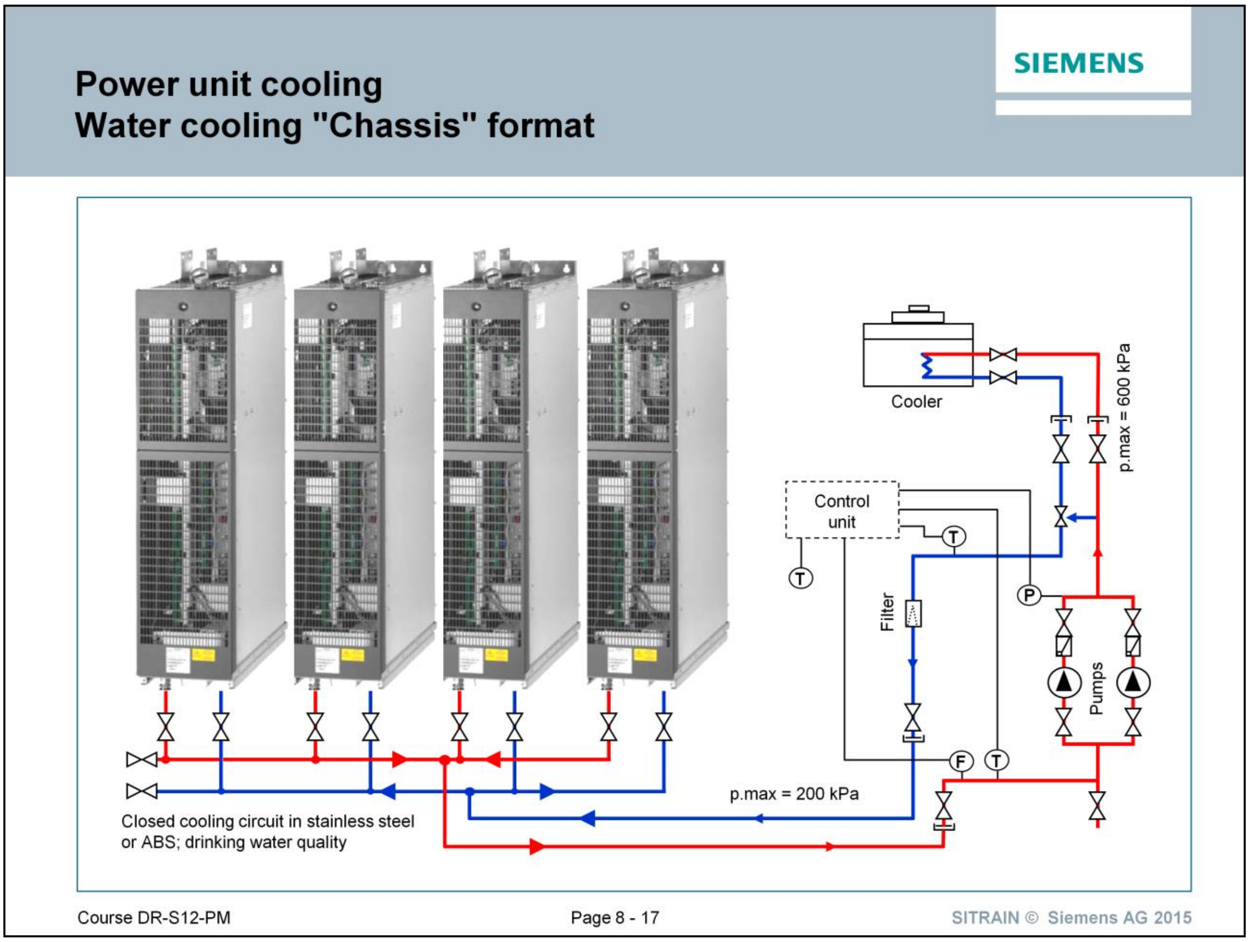

Water cooling	For very high power and in some cases with extremely compact designs, liquid-cooled converters are often preferred. Particularly at higher ambient temperatures. the cooling capacity of the air flow is not sufficient and a liquid-cooled converter is used in these case. Installation altitudes higher than 2000 m above sea level, air-cooled converters require derating (refer to catalog for details) – i.e. an appropriate power reduction, which is why liquid-cooled converters are expedient here.
General conditions	Liquid-cooled converters always require a heat exchanger (cooler) to accommodate the heat of the power semiconductors in the primary circuit and forward it to a secondary circuit. The liquid in the primary circuit must satisfy special requirements for conductivity (refer to the Commissioning Manual for details).

Option DC coupling
SINAMICS S120 cabinet module

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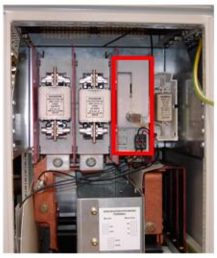
DC-Ankopplung für Chassis



Disconnector

Three stage isolator (disconnector) with two switching position (0 – 1)

0 open:	switching contacts are open
1 pre-charging	pre-charging resistor is switched-in
	pre-charging is completed after approx. 0.5 sec
operation (run)	The third switching stage is automatically selected with the ON signal for the inverter

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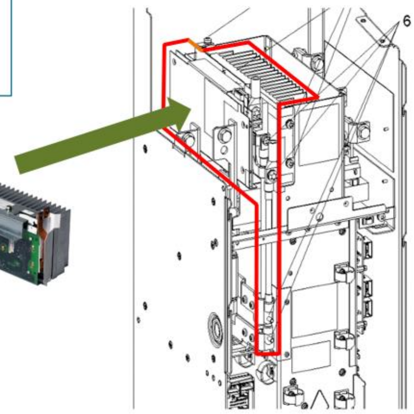
Braking Module

Braking Module (braking unit and braking resistor)

- Module operates autonomously
- When triggered, the DC-link energy is converted into heat loss via an external braking resistor
- Chassis:
  - 25 kW continuous braking power (125 kW peak power)
  - 50 kW continuous braking power (250 kW peak power)



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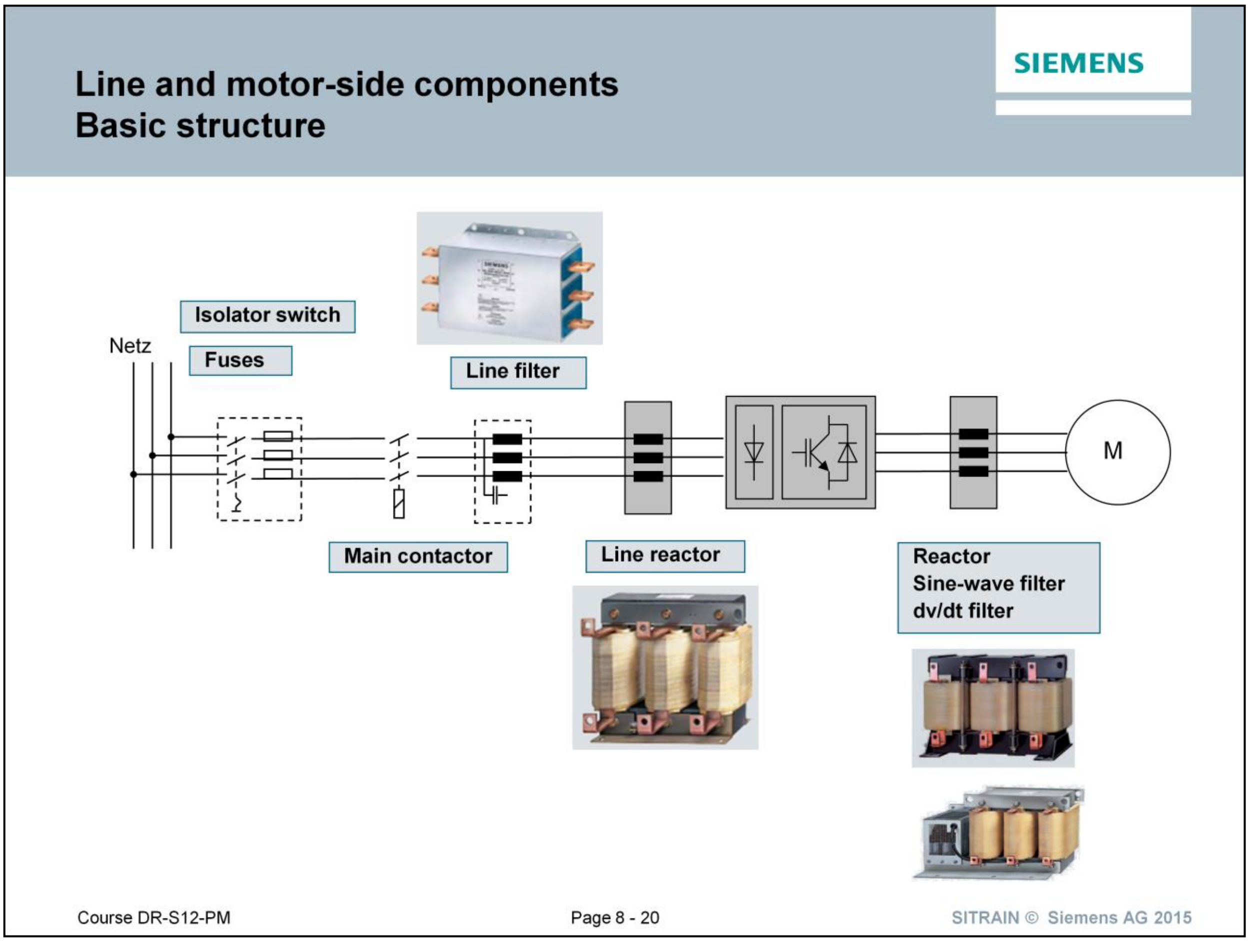
Braking Modules and braking resistors fulfill the following function:

- Conversion of DC link energy to heat loss in the external braking resistor
- Because the Smart and Active Line Modules are feedback-capable, Braking Modules and braking resistors are not required for normal operation.

These components must only be provided if a machine must specifically be stopped at power failure (regenerative feedback no longer possible).

Installation

- The Chassis Braking Module is built directly in to a power block of a Motor Module and does not require additional space in the control cabinet.
- The external braking resistor is installed outside of the control cabinet to prevent unnecessary heating of the converter cabinet.



dv/dt filter

The voltage gradients are reduced to dV/dt < 500 V/us

- This limits the voltage peaks to < 1000 V with Voltage Peak Limiter (VPL)
- No special insulation required in the motor with 500/690 V converters
- No insulated motor bearings required
- Edge modulation is possible (higher output voltage)

Sine-wave filter

Voltage gradients dV/dt are reduced to << 50 V/µs

- This reduces the voltage peaks to 1.1*√2*Vline
- No insulated motor bearings required
- Unshielded cables are possible (from EMC viewpoint)
- Minimization of noise, fewer losses in the motor
- Edge modulation is not possible
- Current derating must be considered
- Sine-wave filters are only available for max. 250 kW (380 – 480 V) or for max. 132 kW (500 – 600 V)
- Pulse frequency must be limited to 4 kHz (400 V, < 250 kW) or 2.5 kHz
- Output frequency must be limited to 150 Hz

Motor filter

Reduction of the rate of increase of voltage dv/dt from approx. 3–6 kV/us to approx. 500 V/us

- This reduces the current spikes, but
- the voltage spikes are not reduced

Cable lengths
Overview

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DRIVE-CLiQ cables	
• Standard within the cabinet	70 m
• MOTION-CONNECT 500	100 m
• MOTION-CONNECT 800plus	50 m

Power cables Chassis / Cabinet	
• Any combination (with or without reactor; with/without sine-wave filter; with/without dV/dt filter 1))	
• Shielded	300 m (525 m) 2)
• Unshielded	450 m (785 m) 2)

Encoder cable		
• SMC10 encoder:	Resolver	130 m for 2-pole resolvers 50 m for multi-pole resolvers
• SMC20 encoder:	Sin/Cos, absolute	100 m
• SMC30 encoder:	HTL, TTL HTL with A+/A- …	100 m 300 m

1) With "dV/dt filter + VPL" (Voltage Peak Limiter) as output filter
2) With two reactors in series; second reactor is only possible outside the cabinet

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Application area

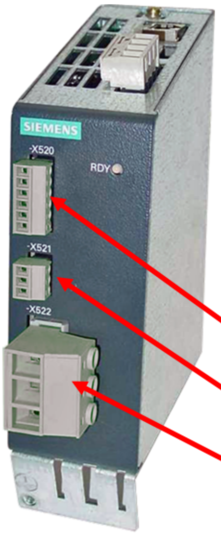
The DRIVE-CLiQ cables MOTION-CONNECT 500 are suitable for wiring up DRIVE-CLiQ components (the connectors have IP 20 degree of protection at both ends).

The DRIVE-CLiQ cables MOTION-CONNECT 800 have additional 24 V DC cores. Therefore they are suitable for connecting Sensor Module Integrated motors.

On the motor side the cables have a DRIVE-CLiQ connector in degree of protection IP 67.

Voltage sensing
Voltage Sensing Module (VSM)

- The Voltage Sensing Module is used to accurately record the line voltage curve.
- The VSM10 is integrated as standard in Active Interface Modules in "chassis / cabinet" format.
- In the Active Line Module in “Booksize“ format, the VSM10 can be optionally implemented (in addition to the VSM10 function already integrated) to support fault-free operation under unfavorable supply conditions (wide voltage variations, temporary interruptions).
- “Bypass applications" (synchronization between motor and grid) can be implemented only if a VSM10 is installed.



Analog inputs / temperature sensor input

100 V inputs (phase-to-phase)

690 V inputs (phase-to-phase)

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Function

The VSM10 can detect the exact line voltage characteristic and supports fault-free operation of Line Modules when power supply conditions are unfavorable, e.g. with severe voltage fluctuations or short-time interruptions. The phase differential voltage can be measured, either grounded or isolated.

The VSM10 is integrated in chassis format Active Interface Modules and in the chassis format Smart Line Modules. It can be used optionally with all booksize format Active Line Modules and 16 kW or 36 kW Smart Line Modules.

Design

The VSM10 has the following connections and interfaces:

- 1 connection for direct line voltage detection up to 690 V
- 1 connection for line voltage detection using voltage transformers, maximum voltage 100 V
- 2 analog inputs (reserved for resonance monitoring in Active Interface Modules in chassis format)
- 1 temperature sensor input (KTY84-130 or PTC) for thermal monitoring of the line reactors
- 1 DRIVE-CLiQ socket
- 1 connection for the electronics power supply via the 24V DC supply connector
- 1 plug-in jumper for either grounded (delivery state) or isolated measurement
- 1 PE (protective earth) connection

The status of the VSM10 is indicated by a two-color LED.

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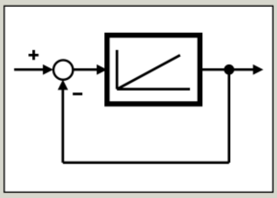

Chapter 9

Closed loop control structure servo mode

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Learning Targets

- You will be familiar with the servo and vector operating modes
- You will be familiar with the operating principles of speed, current and torque control
- You will be able to optimize the closed-loop control with automatic measurements
- You will be able to check this setting with the step response

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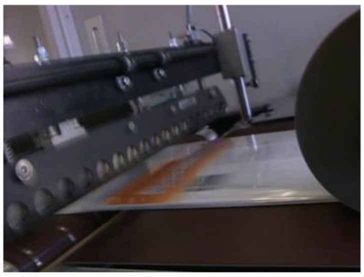
Applications

Paper machine

Filling plant

Foil packaging



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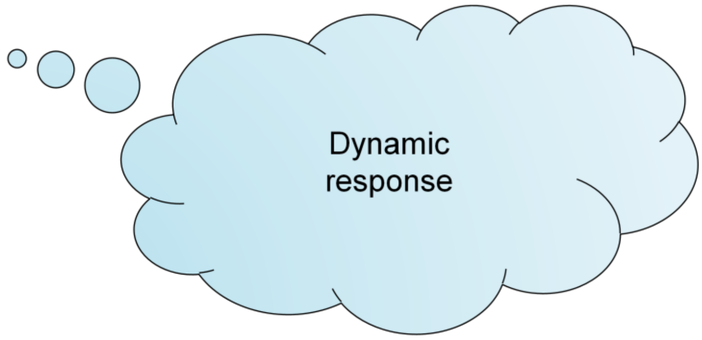
Notes

Requirements of the drive

Drive should be…

- be dynamic
  - Torque, inertia
- Drive should follow a specified speed
- Drive should retain a specified state
- Drive should compensate disturbances



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How does a drive system become dynamic? Mechanical prerequisites

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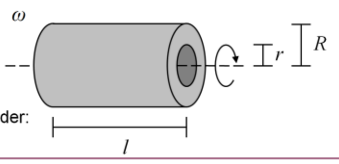
Dynamic motor

- high torque, M ~ (r, l, Φ, L)
- small moment of inertia, J ~ (r4, ρ, L)
- small radius, longer
- several small motors instead of one large one

$$M = J \cdot \frac{\Delta\omega}{\Delta t}$$

Low load moment of inertia

Hollow cylinder:

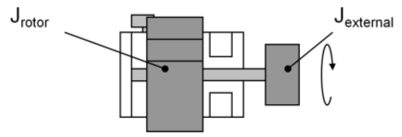


$$J = \frac{1}{2} \cdot \rho \cdot \pi \cdot l \cdot (R^4 - r^4)$$

$$J = \frac{1}{2} \cdot m \cdot (R^2 + r^2)$$

Rigid connection

- short, thick shaft
- torsionally rigid coupling
- no gearbox



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How does a drive system become dynamic?
Electrical prerequisites

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Small time constant in the winding

- Winding: low inductance

High pulse frequency

- but: Losses, derating

High inverter power

- Overload capability for motor

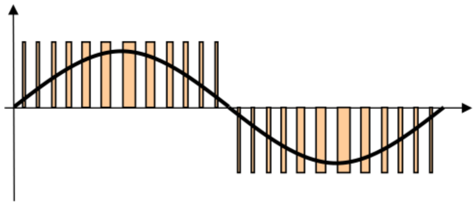
Short sampling time

- Simple control structure
- Few functions
- Simple setpoint preparation
- Accuracy

DC link

- Voltage reserve
- Dynamic infeed and/or regenerative feedback capability

Voltage at the power unit's output



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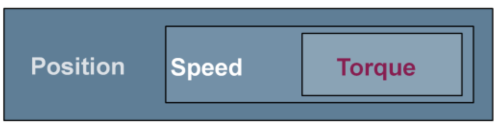
Different operating modes
Servo or Vector

Servo	Vector

• Small motor moment of inertia
• High mechanical strength
• Short sampling time
• High PWM frequency
• Fast response
• Simple motor model
• Moment of inertia: Typical: Jload / Jmotor < 1 ... 10
• Ratio of total moment of inertia to motor torque is small
• Precise encoder is a must
• Mainly superimposed controller: Position controller, pressure controller, etc.
	• High torque
	• Complex motor model
	• High power and speed control quality
	• Comprehensive speed functionality
	• Moment of inertia: Typical:
	J_{load} / J_{motor} < 10 … 3000
	• Ratio of total moment of inertia to motor torque is large
	• Possibly without encoder
	• Large outputs
	• Setpoint channel:
	  • Setpoint smoothing,
	  • Precontrol for acceleration, friction

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Different operating modes
Servo or Vector

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	Servo control	Vector control
Grundprinzip	Basic modell, Very high processing speed	Sehr präzises Modell Normal processing speed
Speedcontrol	✓	✓
Torque control	+	+++
	+++	+
dynamic	+++	+
Field weakening area	1:3	1:5
Max output frequncy	+++	+
Application Low frequency	Encoder necessary	Without encoder from stillstand
Typ. Power range	< 100 kW	Up to several MW
Rigidity	High	Standard
Output voltage	Space vector modulation	Space vector modulation with pulse edge modulation
Energy efficiency	++	+++
Application	For Motion Control and clock control application ▪ Machine tool application ▪ Motion Control ▪ Synchronous mode, Interpolation	Focus on torque contor • Winder ▪ Rope and hoisting applications ▪ centrifuge

= type of control has advanteages

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Closed-loop control structure Servo mode

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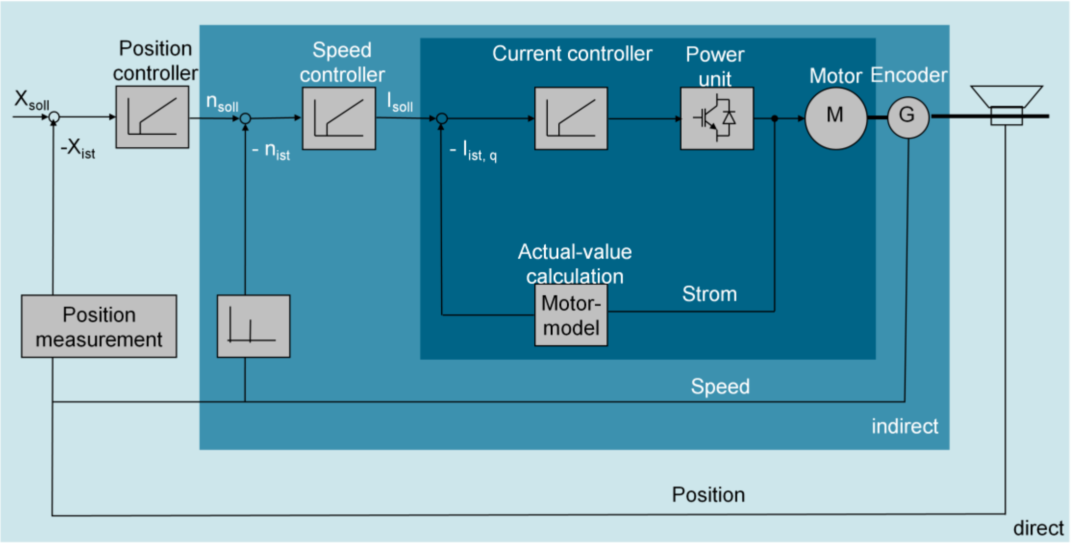

Simplified block diagram

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A cascade control comprising several integral control loops is used to control the drives.

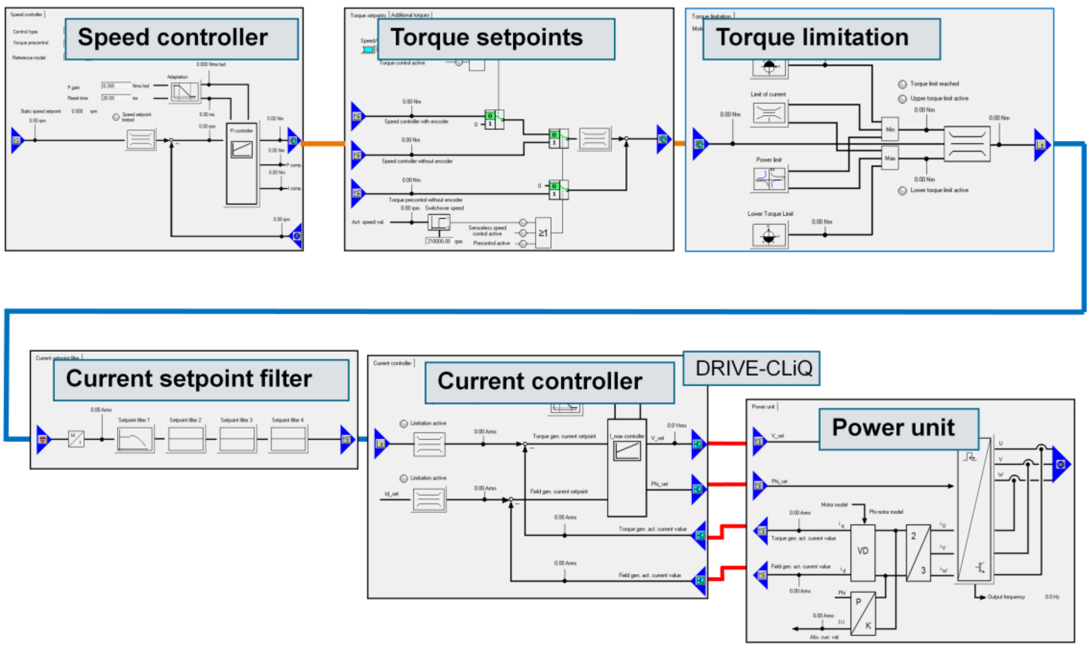
The control loops viewed from inside to out are as follows:

- Current/torque controller
- Speed controller
- Position controller/technology controller

Cascaded control loop structures have the advantage that they can be put into operation stepwise from inside to out.

This closed-loop control structure is fixed and is adapted to the particular application via the parameterization.

Closed-loop control structure
Speed and current control: Overview



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Overview

The closed-loop control structure is displayed in several screens in the STARTER.

The signal characteristics in the control structure are displayed by moving from one screen to the next.

The functions shown here are processed in the CU:

- Speed controller
- Torque setpoints
- Torque limitation
- Current setpoint filter
- Current controller

The function referred to here with "Power unit" is performed in the Motor Module.

Closed-loop control structure
Speed controller

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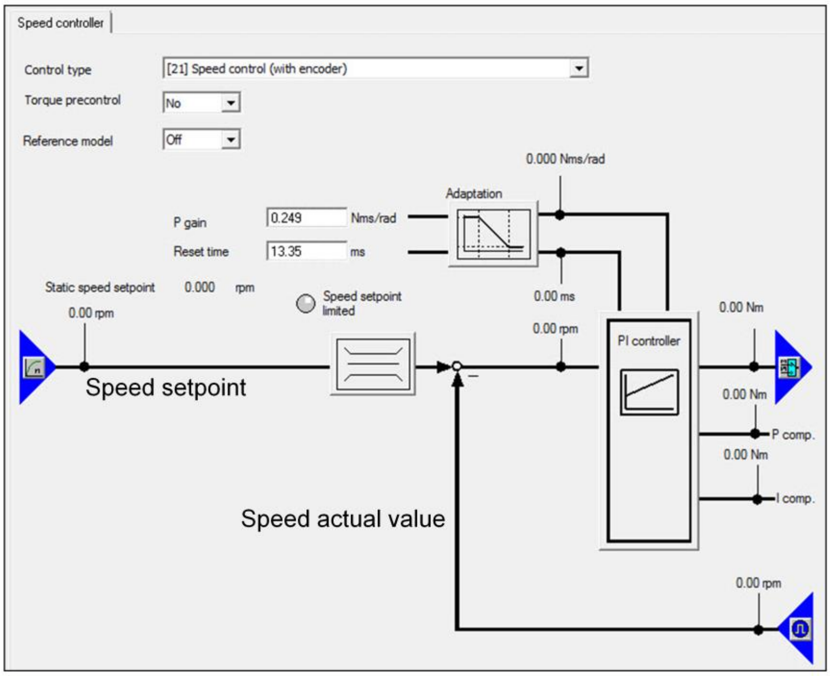

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Speed controller The speed controller controls the motor speed using the actual values from the encoder (operation with encoder) or the calculated actual speed value from the electric motor model (operation without encoder).

Speed setpoint Several sources are available for the speed setpoint:

- Fixed setpoint (when setpoint channel is enabled)
- Motorized potentiometer (when setpoint channel is enabled)
- Analog input of the TB30 or TM31
- Via PROFIDRIVE (via PROFIBUS or PROFINET telegram)
- Position controller output

Actual speed value The actual speed value is output from the motor encoder or it is calculated in encoderless mode from the electric motor model.

Adaptation Speed-dependent adaptation of control parameters gain factor Kp and the integral time Tn is possible.

Closed-loop control structure
Torque setpoints

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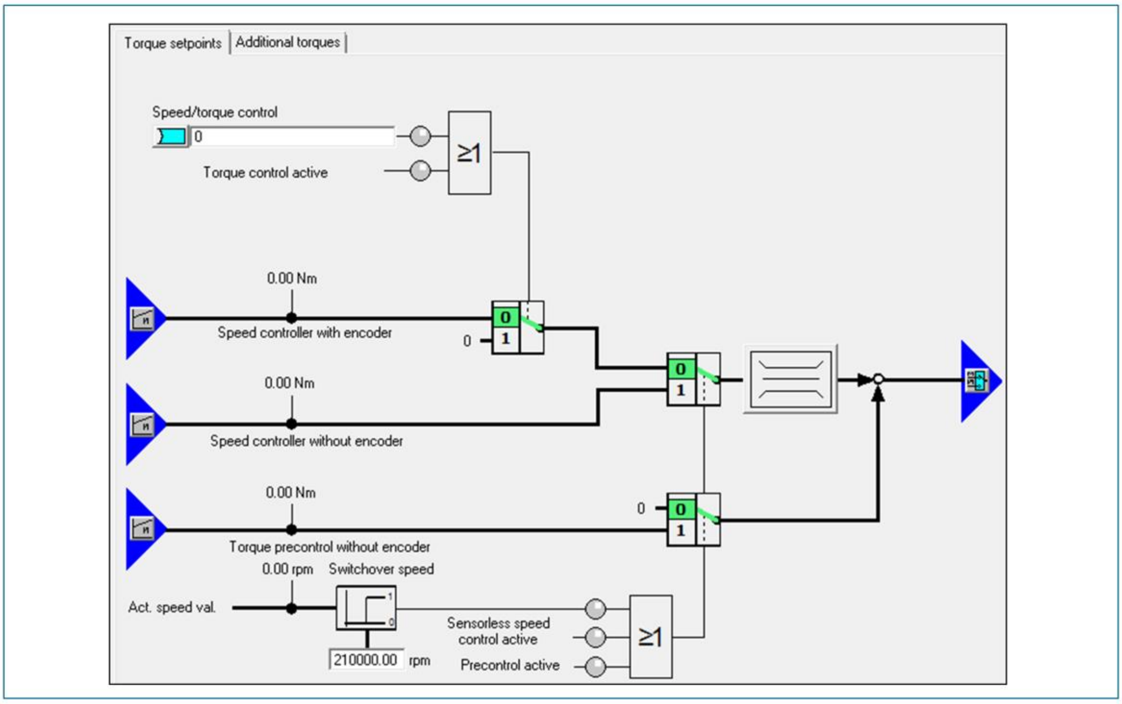

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Torque setpoints

The source of the respective torque setpoint mainly depends on the closed-loop control function selected. In speed-controlled mode, the speed controller calculates a torque that it supplies to the function "Torque setpoints".

In torque-controlled mode, the torque setpoint is wired directly to a supplementary torque 1, 2 or 3. In position-controlled mode, in some cases, a torque offset is generated by a torque pre-control which is also wired to a supplementary torque 1, 2 or 3.

Closed-loop control structure
Torque limitation

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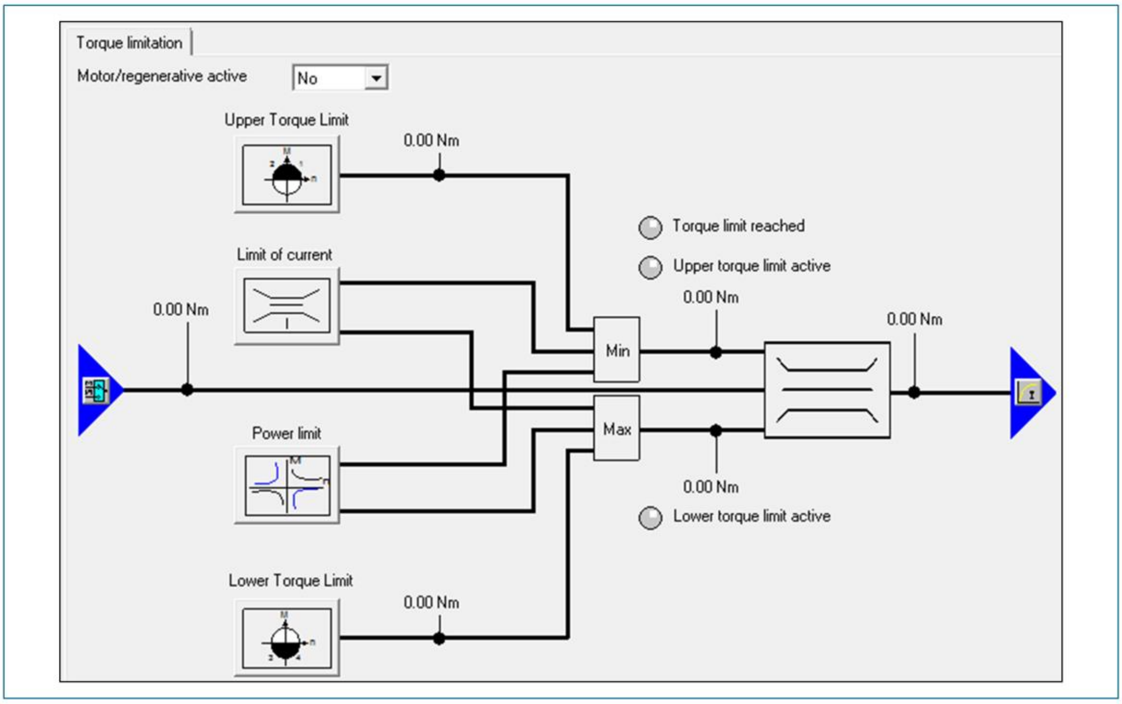

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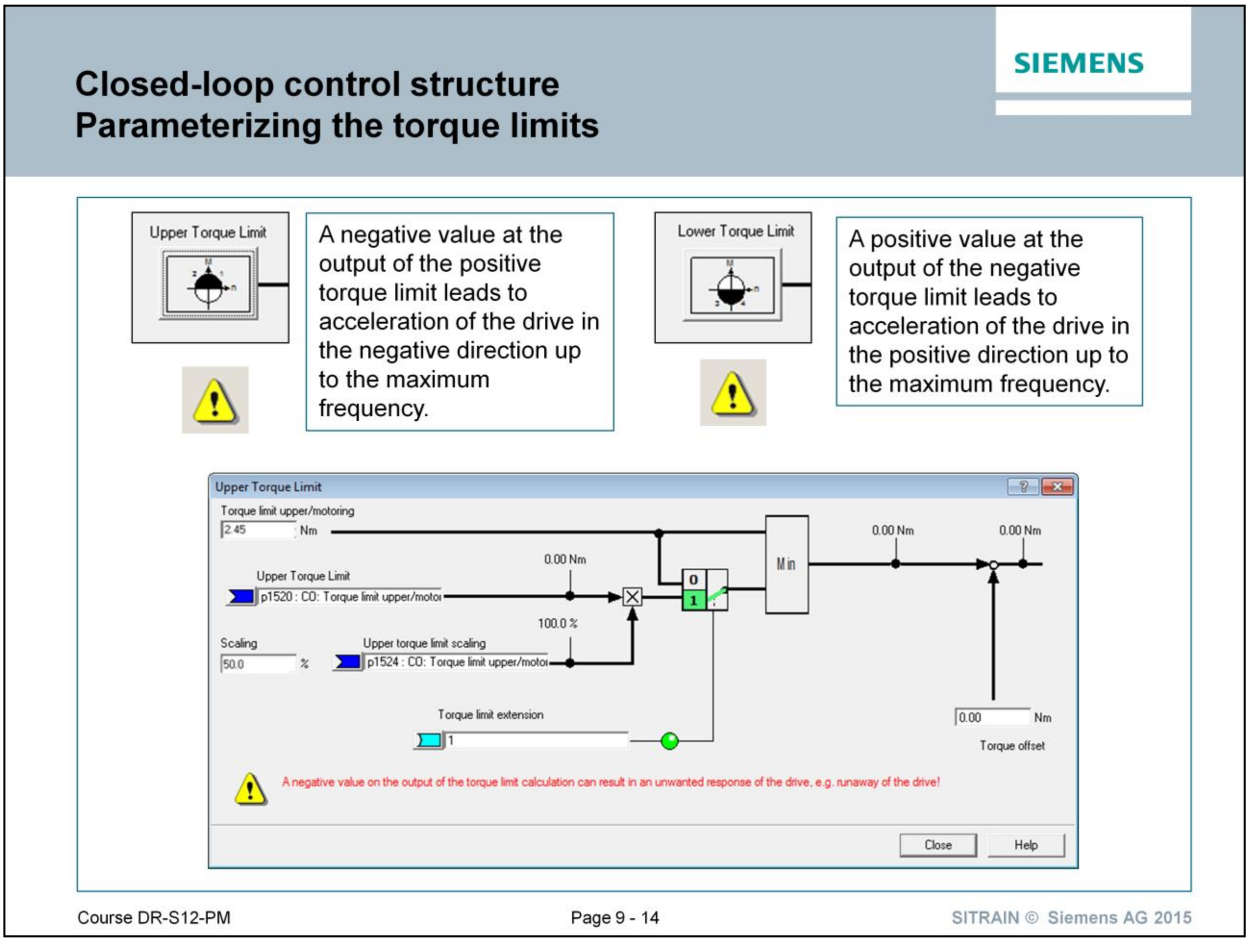
Limits The torque setpoint can be limited by the following characteristics:

- Upper torque limit
- Lower torque limit
- Current limit
- Power limit

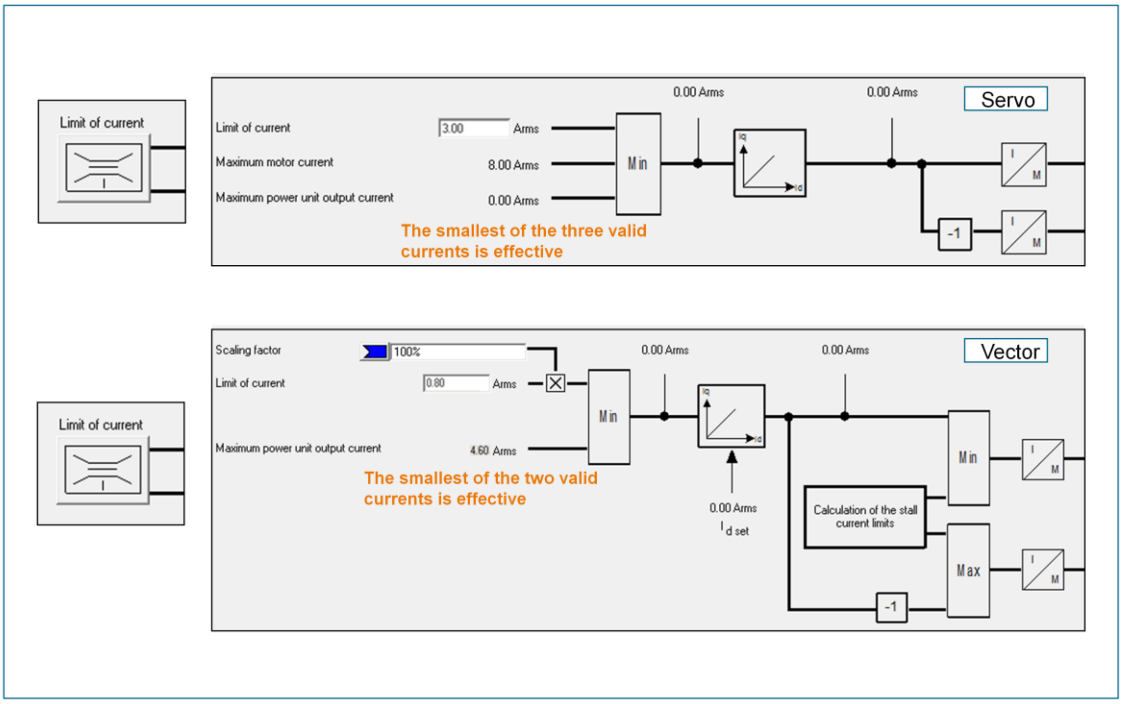
Protection The torque limits and current limits serve to protect the mechanical equipment, the motor and the power units.



Torque limit (upper) The "Upper torque limit" must be specified as a positive value in Nm, otherwise the motor will be accelerated up to its maximum speed.

Torque limit (lower) The "Lower torque limit" must be specified as a negative value in Nm, otherwise the motor will be accelerated up to its maximum speed in the negative direction.

Closed-loop control structure
Parameterizing the current limit



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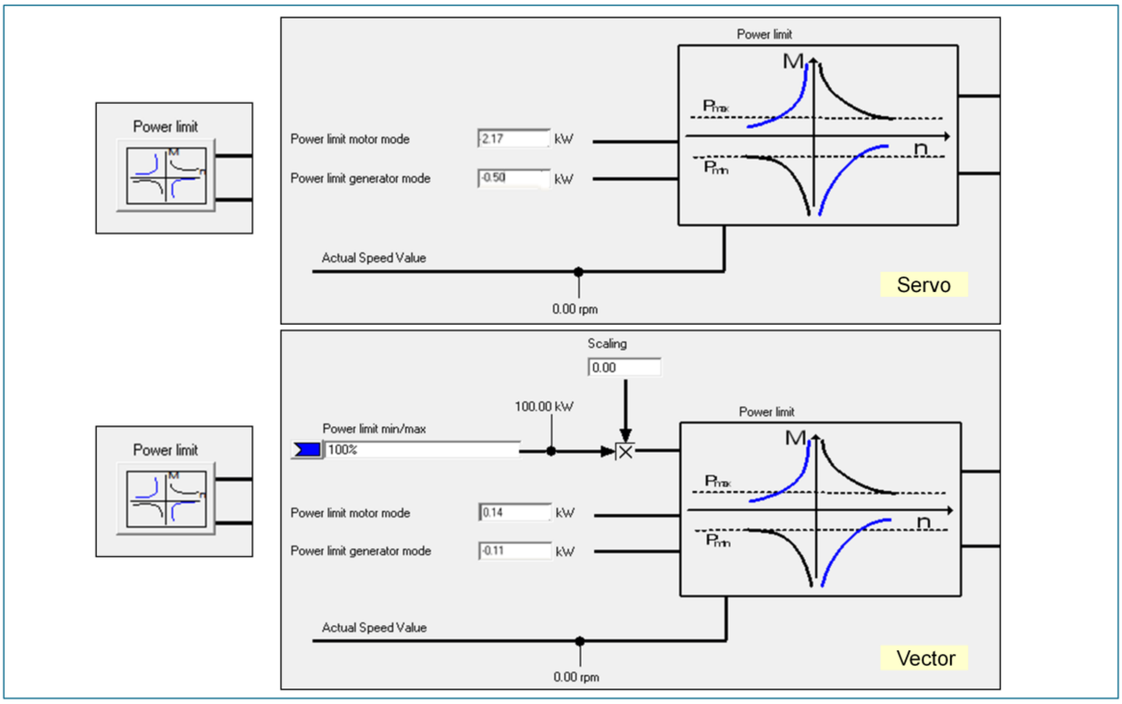
Current limit

Depending on the operating mode, the effective current limit is formed as a function of the following characteristics:

- Current limit
- Maximum motor current
- Maximum possible current of the power unit (Motor Module)

Closed-loop control structure
Parameterizing the power limits



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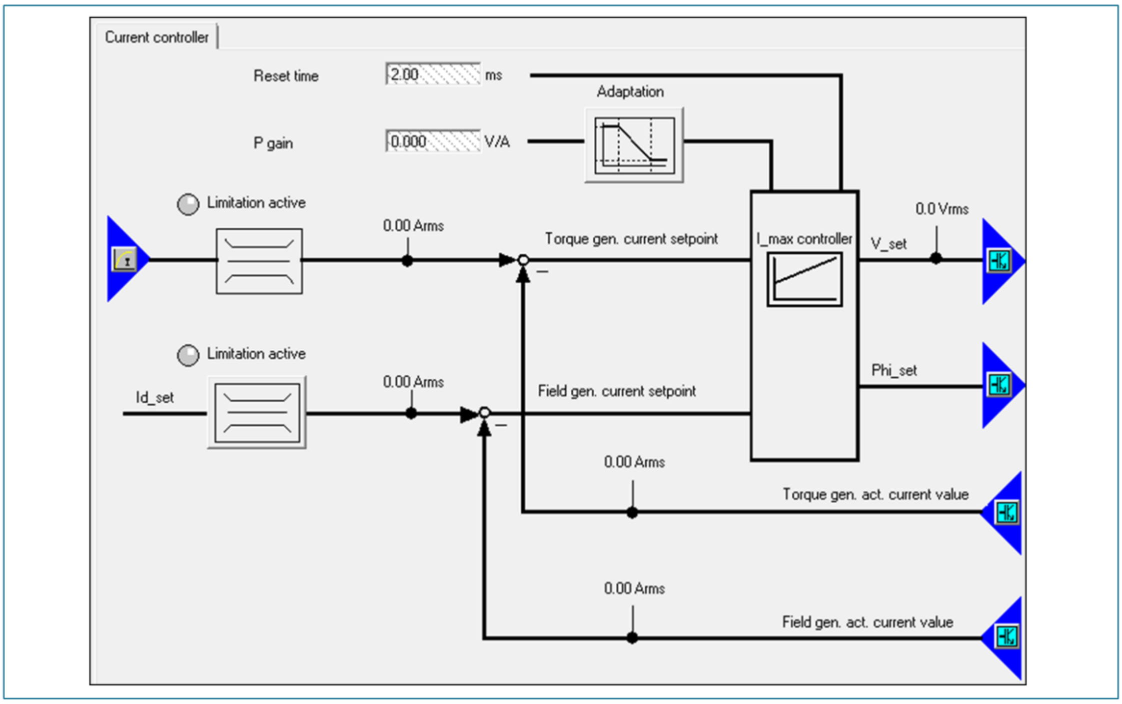
Power limits A separate power limit can be specified in kW for motor mode and generator mode.

Closed-loop control structure
Current controller



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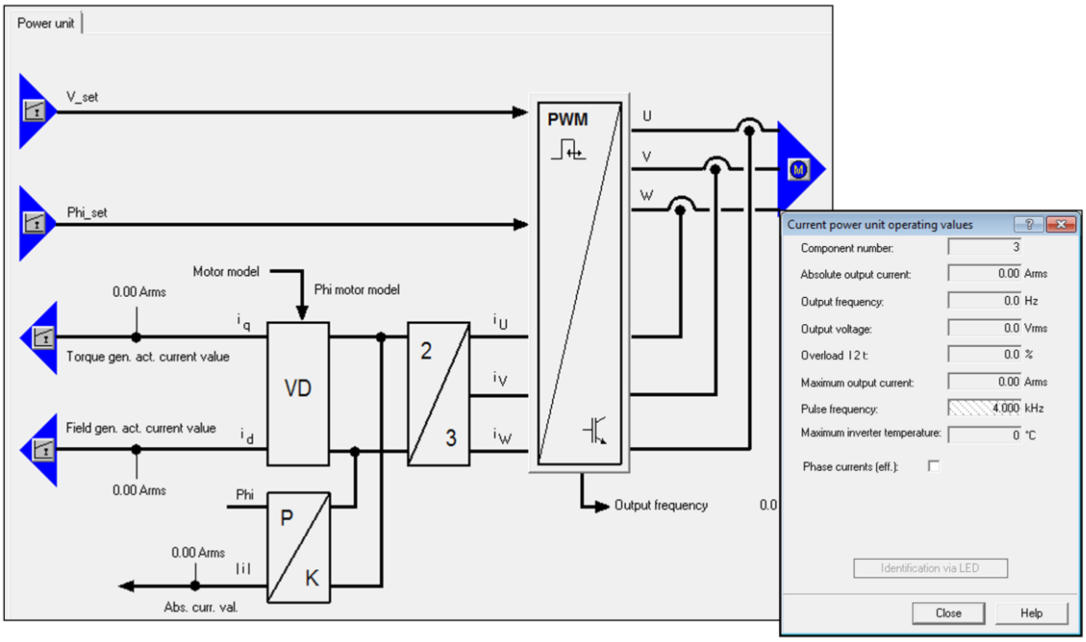
Current controller The current controller is designed as a closed-loop PI controller that controls a torque generating current setpoint and a field-generating current setpoint.

Current setpoint The torque generating current setpoint is determined from the torque setpoint. The field generating current setpoint is determined by SINAMICS itself.

Actual current value The actual current value is determined by the current transformers on the Motor Module and, within the context of the motor model, resolved into a torque generating current setpoint Iq and a field generating current setpoint Id. The actual current values are available to the CU via the DRIVE-CLiQ connection and therefore also to the current controller.

Adaptation The P gain of the current controller can be reduced (depending on the current) by means of current controller adaptation. Current controller adaptation can be deactivated with the setting p1402.2 = 0.

Closed-loop control structure
Power unit



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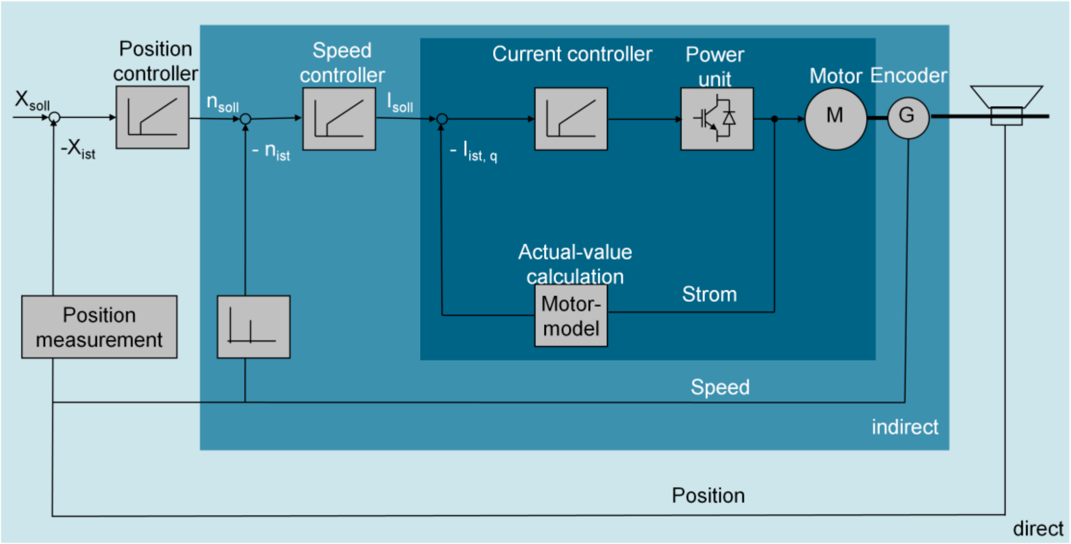
Power unit Information for the power unit is displayed here. The current or voltage flow within the power unit is displayed graphically. You can enter the power unit operating values and show the rms phase currents under PWM (Pulse Width Modulation) .

Controller optimization
Overview



- Adaptation of controllers to the controlled system
- Adaptation to the application
- Optimum control response

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Optimization

In a control loop, it is necessary to adapt the controller to the controlled system in order for the controller to satisfy the requirements.

As a cascade control, the closed-loop control is made up of the following controllers:

- Current/torque controller
- Speed controller
- Position controller

The manipulated variable of the higher-level control loop is the command variable for the lower-level control loop in this context.

Cascaded control structures are put into operation from inside to out. The higher-level control loop is not closed and set until the lower-level control loop is working properly.

Advantages of cascade control

Step-by-step commissioning of the control loops from inside to out (Current → Speed → Position); independent settings. Lower-level controllers form an equivalent time delay for the higher-level system and therefore influence the command variable dynamics of the entire system.

This disadvantage can be compensated by precontrol of the lower-level control loop. Simple limitation of the inner controlled variables by limiting the command variables of the outer controller.The effects of nonlinearities are limited. The higher-level controller has a controlled system with less nonlinearity.

Reduced delay times through compensation in the lower-level control loop.Disturbance values are immediately responded to and more quickly compensated in the lower-level controller.

Controller optimization
Core objectives

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Dynamic response

is defined by

- Short rise time in the time domain
- Large bandwidth in the frequency domain

achieved by

- Large controller gain k.P
- Short sampling time t.Ab

Stability

is defined by

- Minimal overshoot in the time domain
- Large phase reserve in the frequency domain

achieved by

- Small controller gain k.P
- Large integral time T.N

Accuracy

is defined by

- Minimal following error in the time domain
- High gain at low frequencies in the frequency domain

achieved by

- Large controller gain k.P
- Dynamically acting integral controller performance; small integral time T.N

Ruggedness

is the ability to assure stability and dynamic response despite a change in the

controlled system (due to aging, temperature-dependent factors).

It requires a compromise between dynamic response, stability and accuracy.

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Core objectives

Controller optimization is based primarily on the requirements of the respective application. Whereas for drilling and milling, demanding requirements are placed on surface quality, for bottling, packing and conveying, a highly dynamic response and high speed are required.
Disturbance variables arising in the process must be responded to in the same manner.

This means that a common optimization strategy cannot produce the desired result.
The core objectives are therefore:

- Dynamic response
- Stability
- Accuracy
- Ruggedness

Controller optimization
Description of the transfer behavior

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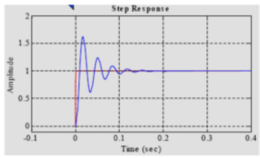
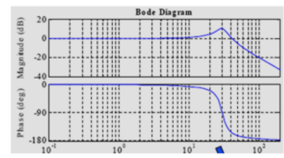
Methods for describing the dynamic transfer behavior

Time range
- Description by differential equation
- Description by step response



Frequency range
- Description by frequency response
  - Frequency response equation (algebraic)
  - Bode diagram (graphical)



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Transfer behavior

The transfer behavior describes the dependence of an output signal on an input signal.

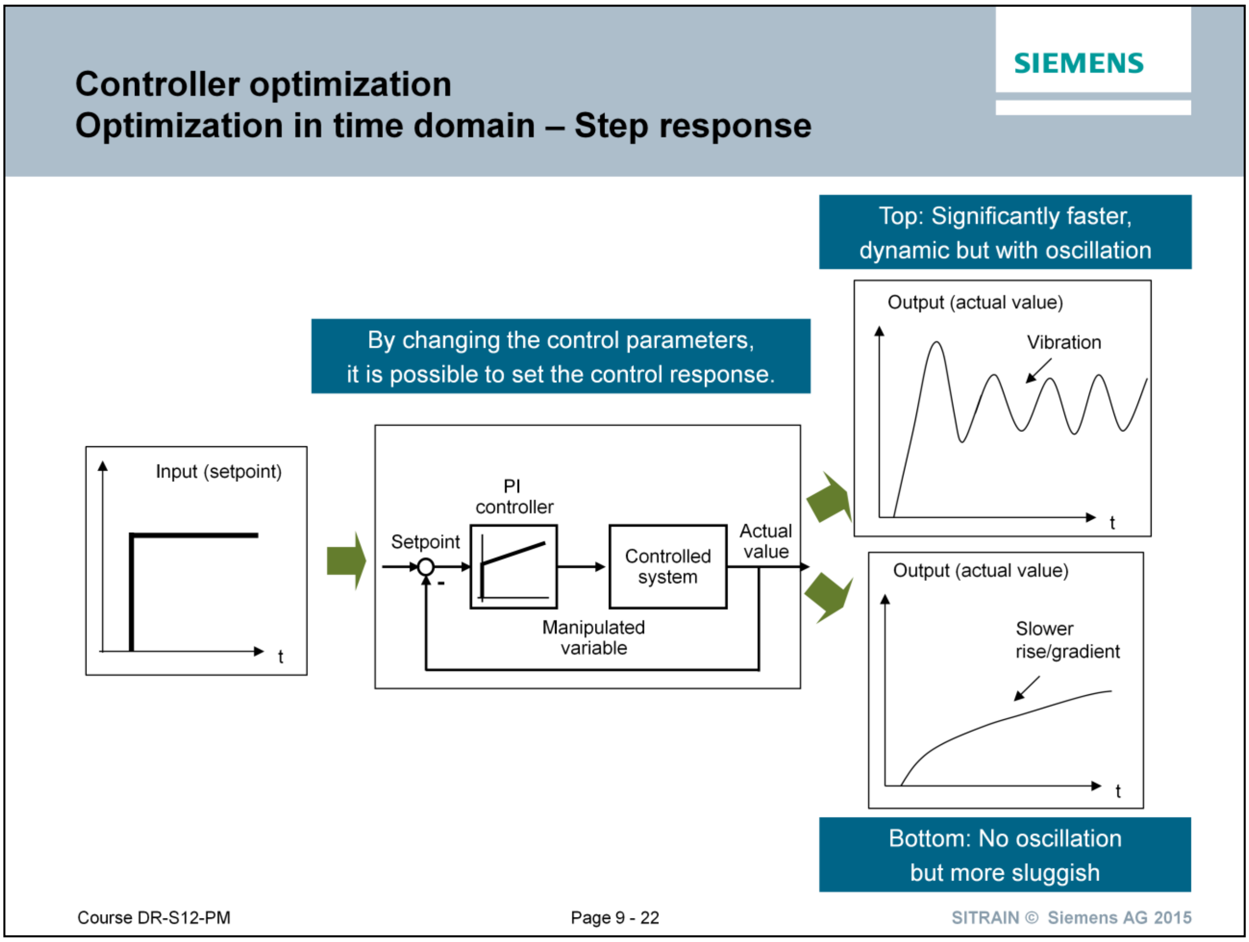
This transfer behavior can be described as a function:
as a quotient of a function of the output signal and of the input signal.

The transfer behavior can be analyzed by means of:

- Step response:
  Many applications have a simple system (rigid system, two mass oscillators), where this analysis is sufficient
- Frequency response analysis:
  Required for complex systems (e.g. multi-mass oscillators)

Transfer function

The transfer function is unknown in most cases.



Step response

The controller optimization in the time domain can be carried out via an analysis of the step response. In this context, a setpoint step is applied to the controller input and the actual value traced.

The controller is modified by changing control parameters so that the actual value reaches the setpoint as desired.

Optimization

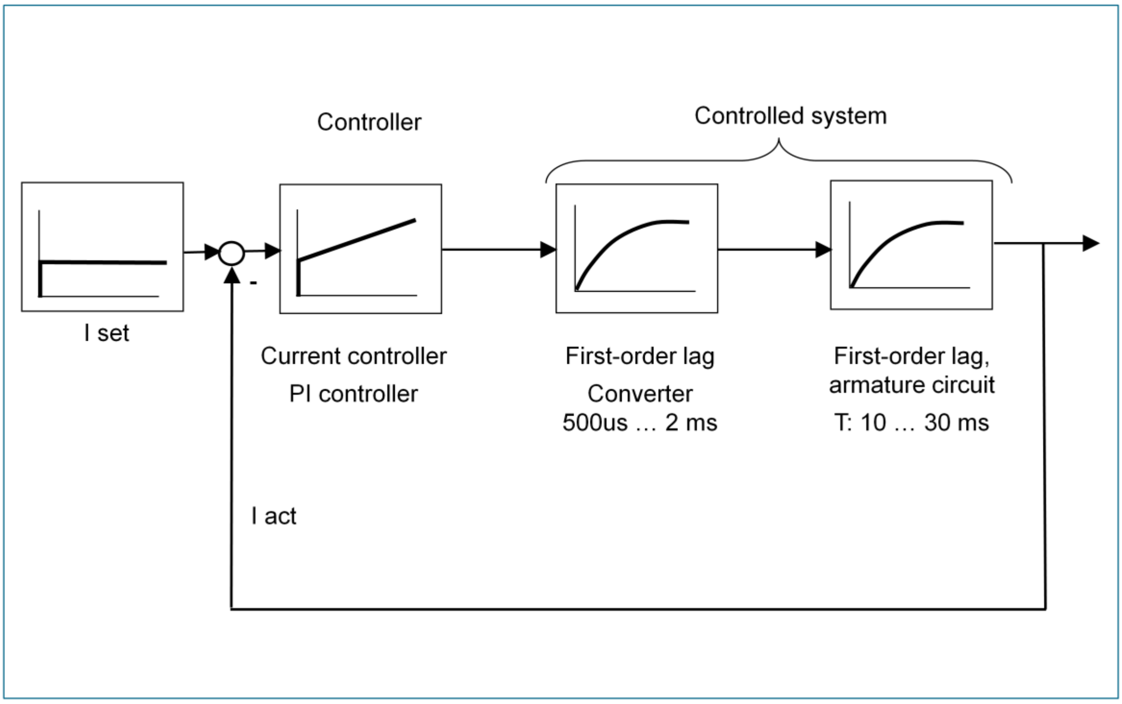
When optimizing a PI controller via a step response, several steps are required. The P component should always be optimized first.

On starting optimization, the I component must therefore be set extremely low to enable the required effect of the P component to be identified:
➔ Set Tn to a large value

The controlled response must then be observed with step-by-step increases in Kp. As soon as the actual value begins to oscillate slightly, Kp must be reduced by approximately 50% to allow sufficient scope for optimizing the I component.

As soon as Kp has been set optimally, to optimize the I component, Tn is reduced step-by-step until a small oscillation occurs again in the actual value. Then it is recommended that Tn is increased to double the value to give the control loop sufficient stability despite the highly dynamic response.

Current controller
Current controller and controlled system



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Current controller The current controller is responsible for ensuring that the required current flows through the motor despite all lags.

Controlled system Put simply, the controlled system comprises two lag elements.

1. Converter lag:
   - Switching delays
   - Delays in current measurement
   - Sampling times

2. Motor delays
   - Delay time due to motor inductance

Note The delay time of the converter is small compared to the delay time in the motor.

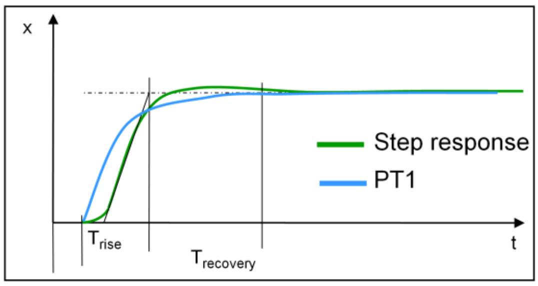
Current controller
Requirements for the current controller

- Implement the required current/torque setpoint as quickly as possible
- No relevant disturbance variables

-> Optimization acc. to control response

-> Short rise time

-> No overshoot (similar to PT1 response)



Optimization as per absolute value optimum (BO)

Requirements

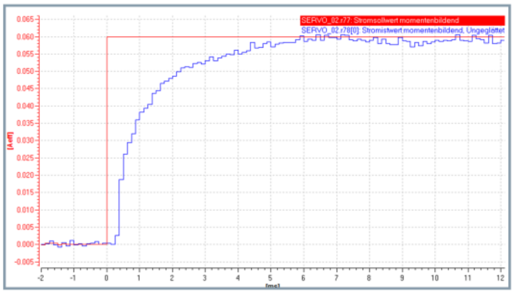
The actual value should quickly follow the setpoint. The controller is optimized to the control response. The typical optimization method here is the absolute value optimum, where a small overshoot up to 4.3% is permissible. This method represents an appropriate compromise between dynamics and stability.

Disturbances

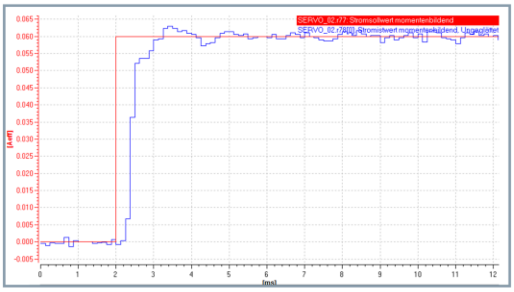
The compensation of disturbances is not relevant in the current controller. Possible disturbances in current control loop: Fluctuations in the DC link voltage. Since these disturbances are slower than the current controller cycle, they can be neglected here.

Current controller
Measurement of step response

P gain: 23.088 V/A Reset time: 2 ms



P gain: 45 V/A Reset time: 0.3 ms



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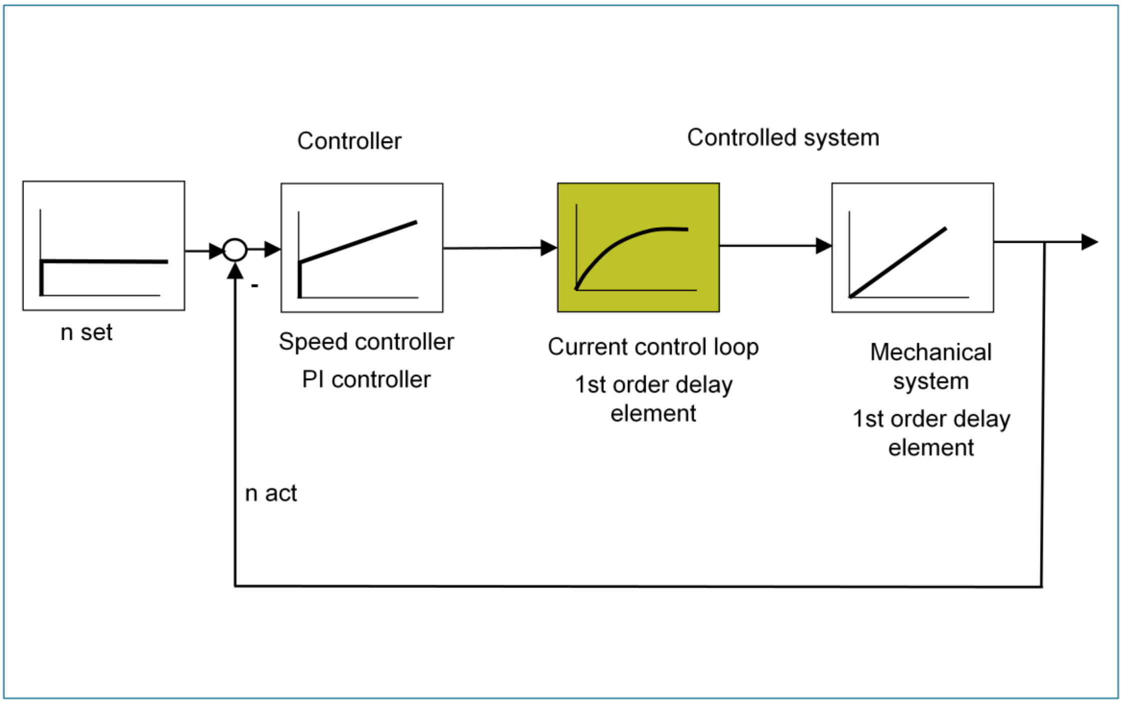
SIEMENS motor With SIEMENS motors that have a DRIVE-CLiQ connection or can be selected from the list of SIEMENS motors in the STARTER, the rated motor data and the equivalent circuit diagrams are already available. The current controller is pre-optimized at the factory in this case.



Speed controller The speed controller controls the required speed at the motor.

Controlled system Put simply, the controlled system comprises two lag elements.

- Current controller lag:
  - The current controller is displayed simply as a first-order lag element with a lag time that results from the lag times of the current control system
- Lag in the mechanical system
  - is described by the mechanical time constant

Components I component: motor, mechanical system (poss. 2 I components)

Equivalent time constant for current controller (appox. 3 ms as PT1)

Equivalent time constant for speed sensing (calculated or measured) 100 ms

Speed controller
Requirements

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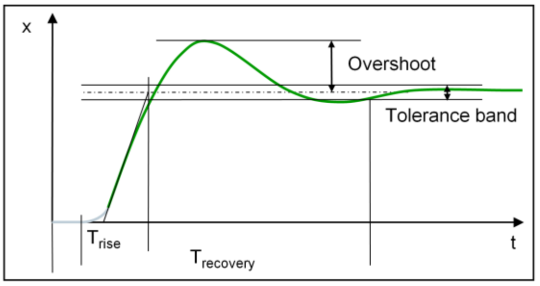
- Reach the required speed fast
- Compensate for disturbances
- Purely variable-speed drives, e.g. pumps and fans
- Continuous changes in load, pressure, load surges

-> Optimum tolerance



Optimization: Symmetrical optimum (SO)

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Requirements

The speed controller must react quickly to changes in the specified speed. At the same time, it must compensate for disturbance variables fast.

Disturbance variables are, for example:

- Load changes
- Pumps

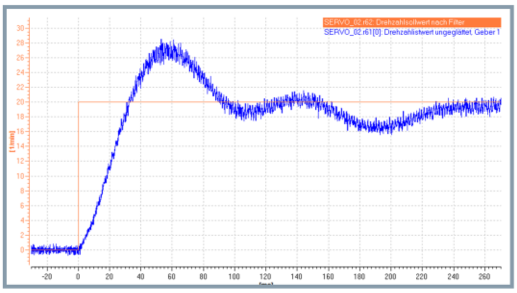
In this way, the speed controller is also set to match the disturbance compensation:
Optimum command variables (superimposed position controller): BO

Optimum disturbance variables from process, load changes: SO

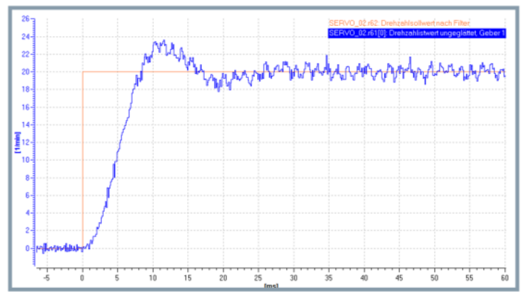
The reaction to the change in disturbance variable is analyzed.
Characteristic response to change in command variable for speed controller: 43% overshoot

Speed controller
Controller optimization – Step response

P gain: 0.012 V/A Reset time: 10 ms



P gain: 0.1 V/A´Reset time: 2.5 ms



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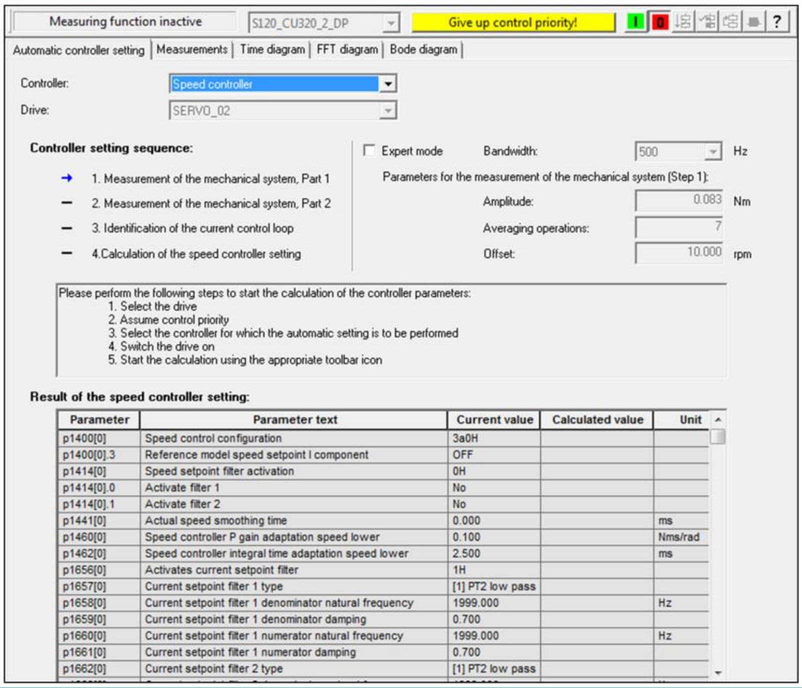
Speed controller
Automatic controller setting



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In the Automatic Controller Setting screen form, you can configure an automatic setting of the speed controller for SINAMICS drive units. The necessary steps for this calculation can be controlled from this screen. The calculated parameter values of the speed controller are displayed and can then either be rejected or adopted for the drive.

Features

The automatic speed controller setting has the following features:

- Damping resonance effects in the speed-controlled system
- Automatic setting of the gain factor Kp and the integral time Tn of the speed controller

Note

The speed setpoint filter and the reference model are not adapted by the automatic speed controller setting.

Technology controller
Overview

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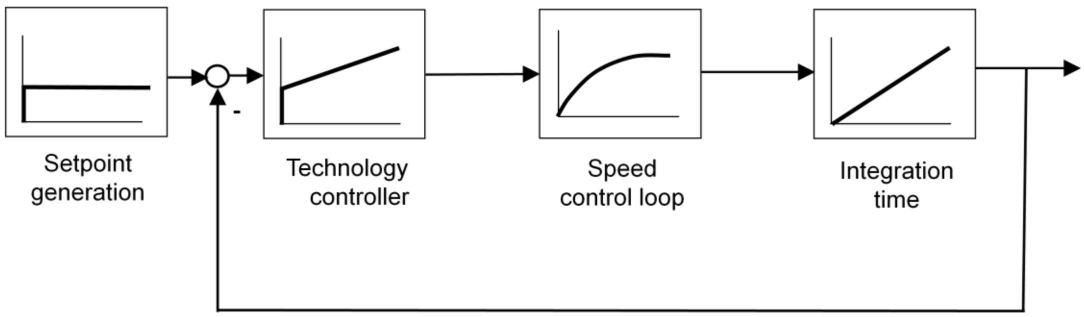

- Position
- Pressure
- Tension
- Fill level
- Flow rate

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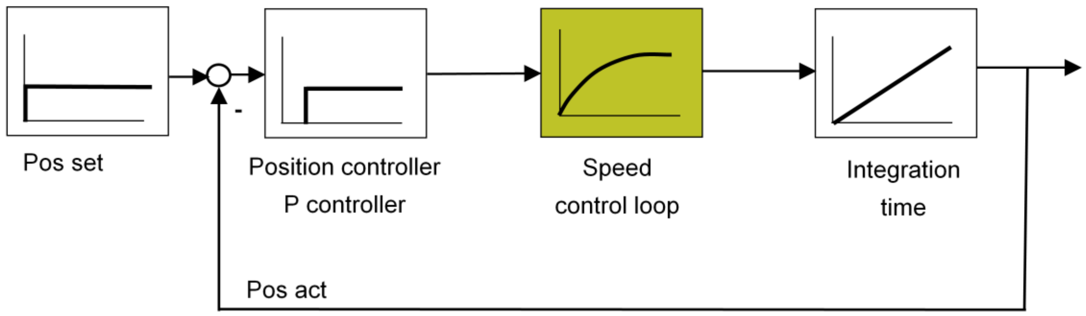
Technology controller The technology controller can be used as a superimposed controller, e.g.:

- Position controller
- Pressure controller
- Tension controller
- Fill level controller
- Flow controller

Technology controller
Position controller as an example



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Position control

The position controller has the task of moving the drive to a specified target position. The precondition for this is that the actual position is sensed by an encoder. The measurement of the actual position is indicated as the integration of the velocity in the signal flow.

The position controller is often set up as a P controller, since the system already has an integration element.The gain factor of the position controller is called the Kv factor.

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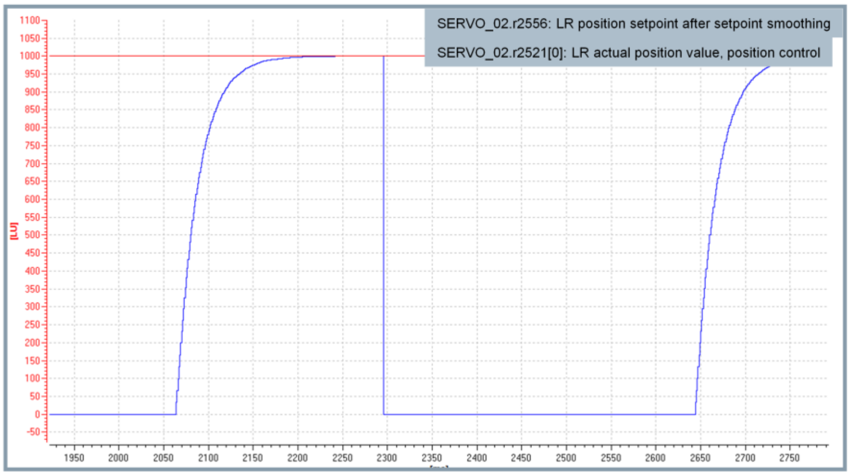
Position controller
Controller optimization – Step response



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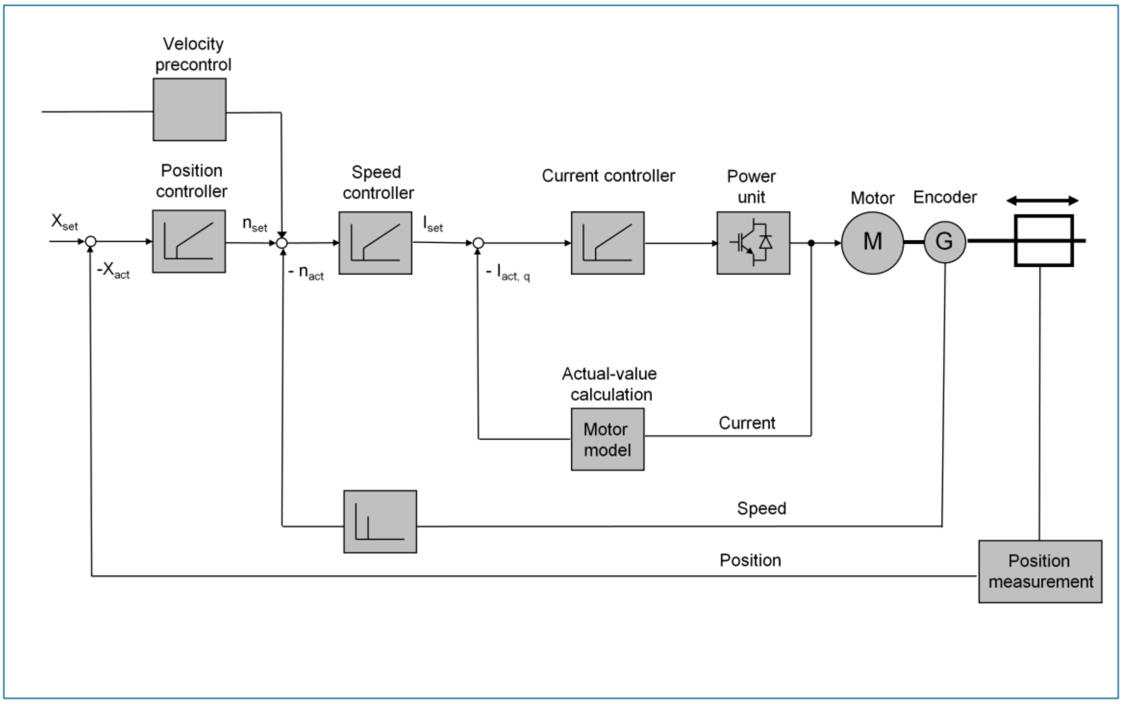
Optimization The position controller is designed so that the drive does not overshoot beyond the specified end position.

Precontrol
Velocity precontrol



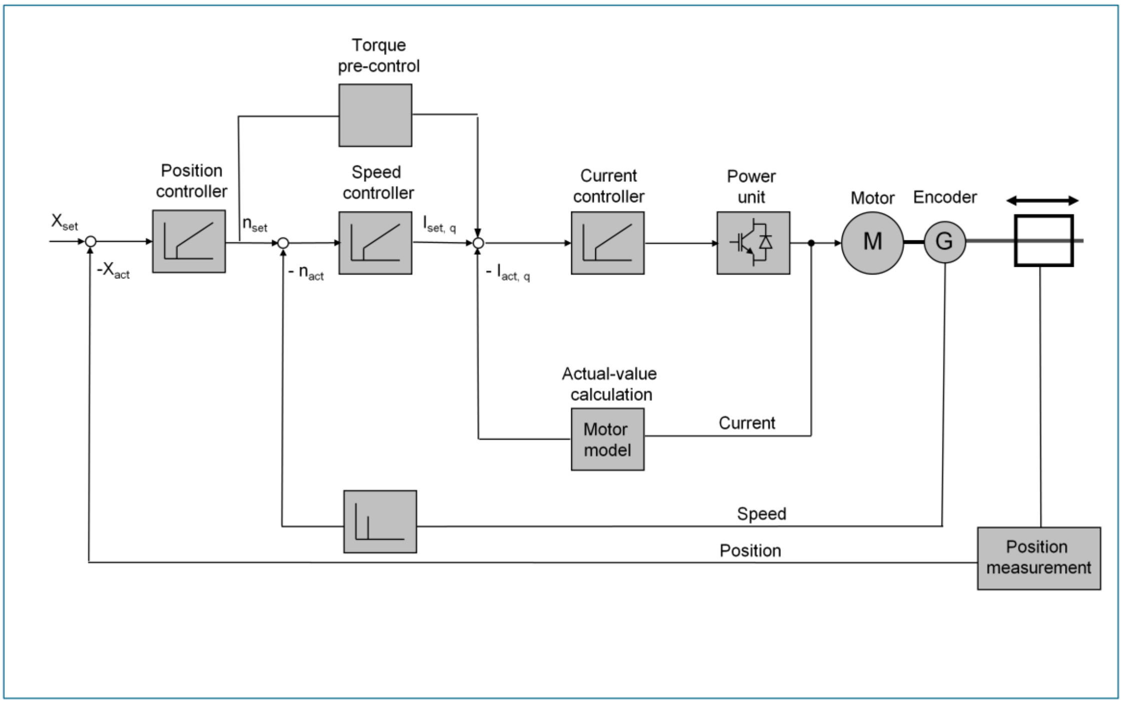
Precontrol

The conventional position control concept (P controller) always requires a deviation (following error = FE) between position setpoint and actual position value. This deviation can lead to an unwanted axis behavior, such as contour errors, poor dynamics (performance characteristics during rise time).

The task of the precontrol is to compensate these disadvantages. The precontrol calculates the axis (setpoint) velocity directly from the position setpoints by differentiation, multiplies it with the KPC factor, then transfers it directly to the position controller output. In the best case, the precontrol setpoint will cause the axis to move at the velocity calculated by the interpolator.

If the actual axis position were immediately returned to the position controller, the following error would be 0. The position controller would then only have to deal with the task of correcting disturbance-induced fluctuations of the real actual axis position.

Precontrol
Torque precontrol



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Torque precontrol The innermost control loop can also be precontrolled by specifying the acceleration or the torque on the current controller. The precontrol can also be used to specify the motor torque setpoints.

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Exercises

- Exercise 1: Current controller optimization with step response
- Exercise 2: Stationary measurement
- Exercise 3: Speed optimization with step response
- Exercise 4: Automatic controller optimization
- Exercise 5 (optional): Frequency response measurement

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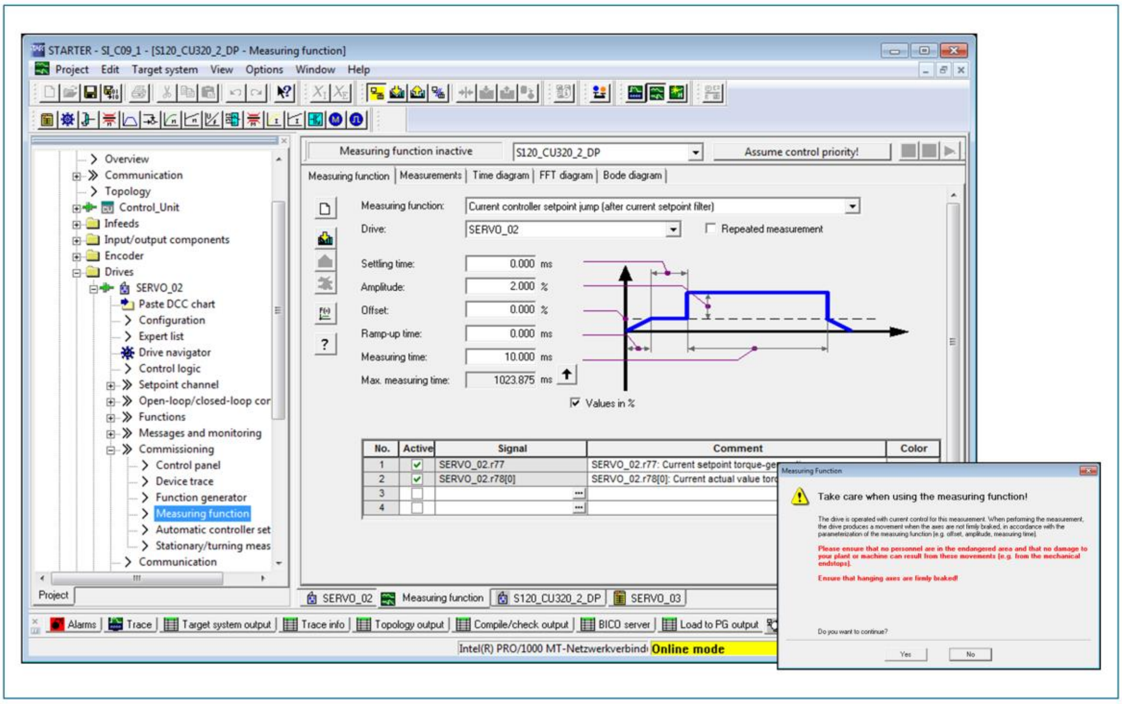
Safety information

Please note that:

- The course instructions have been produced for:
  - A course held by a course leader
  - Activities carried out on special training equipment
- The training equipment is operated under laboratory conditions.
  In case of doubt, always ask your course leader – particularly when handling components that carry electrical current or which can move.
- When carrying out work on equipment, the safety information in the associated product documentation must always be observed!
  The training documents alone are not sufficient.

Exercise 1: Current controller optimization with step response



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Task

The settings for the current controller have been pre-assigned automatically by the software on the basis of the motor order number selected.

The task here is to check the settings on the basis of the measuring function.

1. Dearchive the project "S120_Servo_1", load the data to the CU and test the drives.

2. Select the measuring function via the "Commissioning" directory in the "Servo_02" drive object.

3. The following parameters should be set:
   - Measuring function: Current controller setpoint change
   - The other parameters are set automatically but may be modified for measurement.
   - The recorded parameters are also selected automatically.

4. The measurement must be started via the setpoint change.

5. Select the "Assume control priority" button and start the measurement by pressing the green button.

Exercise 1: Current controller optimization with step response

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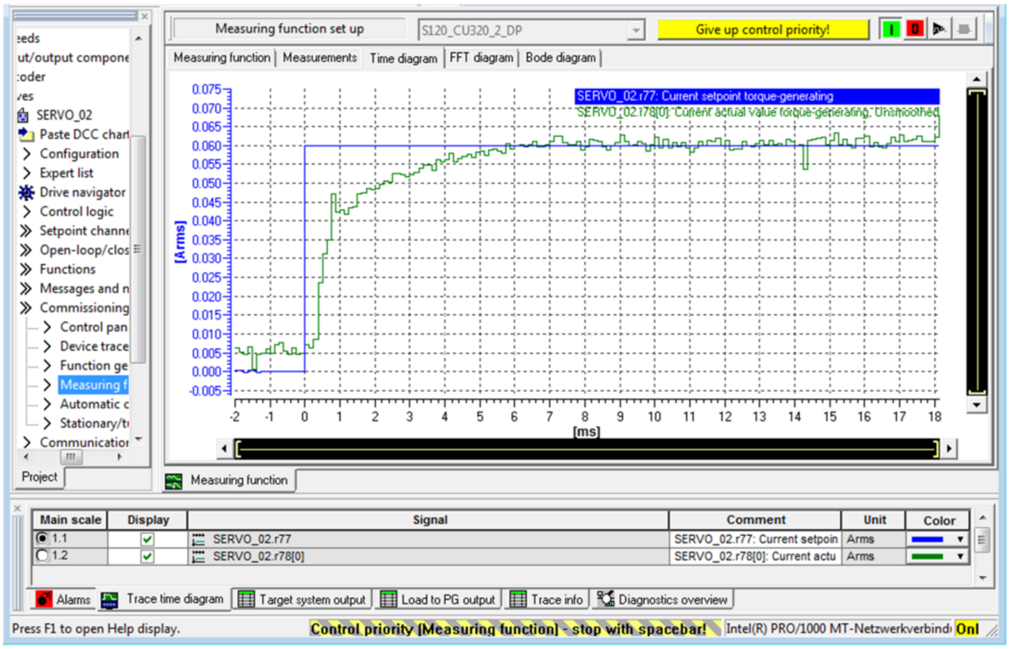

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Result The result of the measurement is shown in the time diagram. Measure the rise and recovery time.

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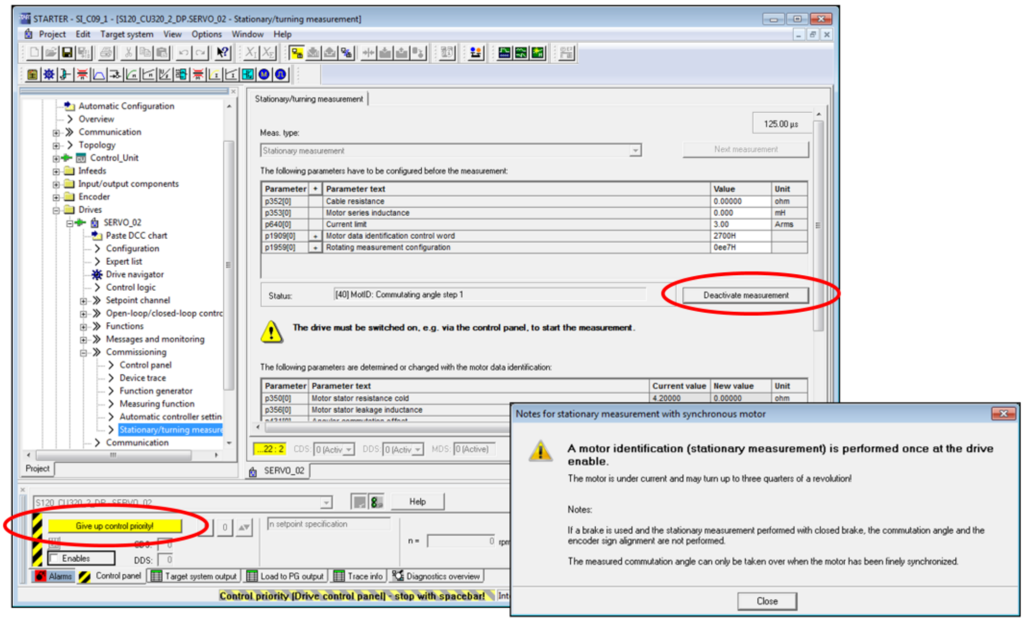
Exercise 2: Stationary measurement
Selection, start via control panel



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Task

For third-party motors, the electrical parameters can be determined by stationary measurement. This method of determining the motor parameters must be carried out prior to current controller optimization.

If Siemens motors are used, current controller optimization can be carried out without measurement of the motor parameters.

1. Select the stationary measurement in the following way:

   >> *Servo_02* > *Commissioning* > *Stationary/turning measurement*

   and then perform the following steps:

2. Select the measuring mode: >> *stationary measurement*

3. Activate the measurement by pressing the button "Activate measurement". The control panel is automatically opened for this drive.

4. In the opened control panel, press the button "Assume control priority!“ and accept the safety note

5. Set the "Enables" check mark, and then press the "green" button to start the measurement.

Exercise 2: Stationary measurement
Accept new values

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The following parameters are determined or changed with the motor data identification:

Parameter	Parameter text	Current value	New value	Unit
p350[0]	Motor stator resistance cold	4.20000	4.63366	ohm
p356[0]	Motor stator leakage inductance	5.50000	8.26728	mH
p431[0]	Angular commutation offset	0.00	0.00	°
p408[0]	Rotary encoder pulse number	512	476	
p410[0]	Encoder inversion actual value	0000H	0000H	
p1715[0]	Current controller P gain	23.088	34.704	V/A
p1717[0]	Current controller integral-action time	2.00	2.00	ms

Accept values

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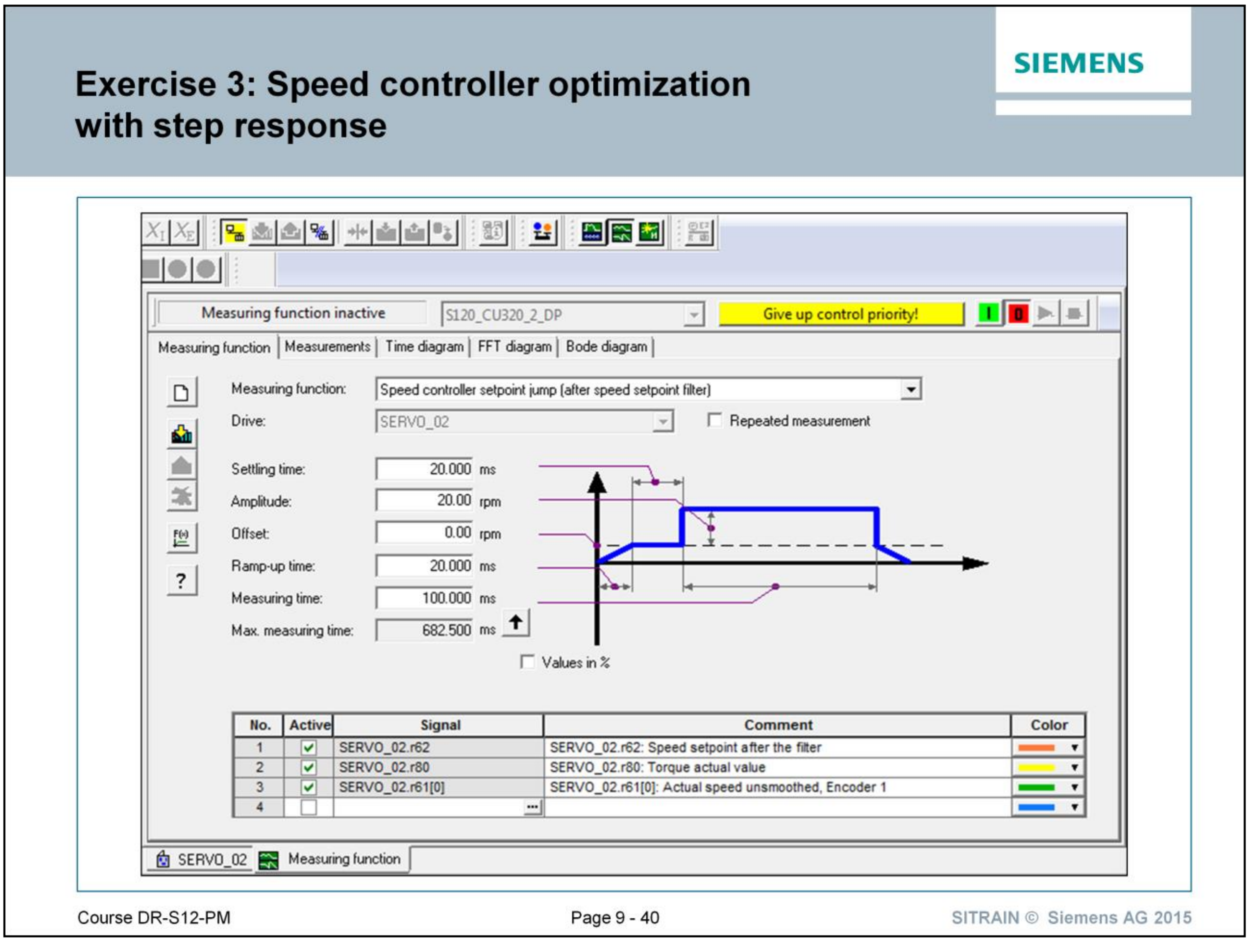
Result The measurement has been performed and the measurement results with the stored values are then shown in a table.

6. Accept the data determined in the stationary measurement:
   >> *Accept values*

The values are accepted but not saved to ROM. To retain the values after switch-on, the data must be saved to ROM and downloaded to the PG and saved on the hard disk.

Note The current controller only operates with the new values after the determined values have been accepted.

If the values are not accepted, then the current controller continues to operate with the previous values.



Task

The settings for the speed controller have been pre-assigned automatically by the software.

The task here is to check and optimize the settings on the basis of the measuring function.

1. Select the measuring function via the "Commissioning" directory in the "Servo_02" drive object.

   The following parameters should be set:

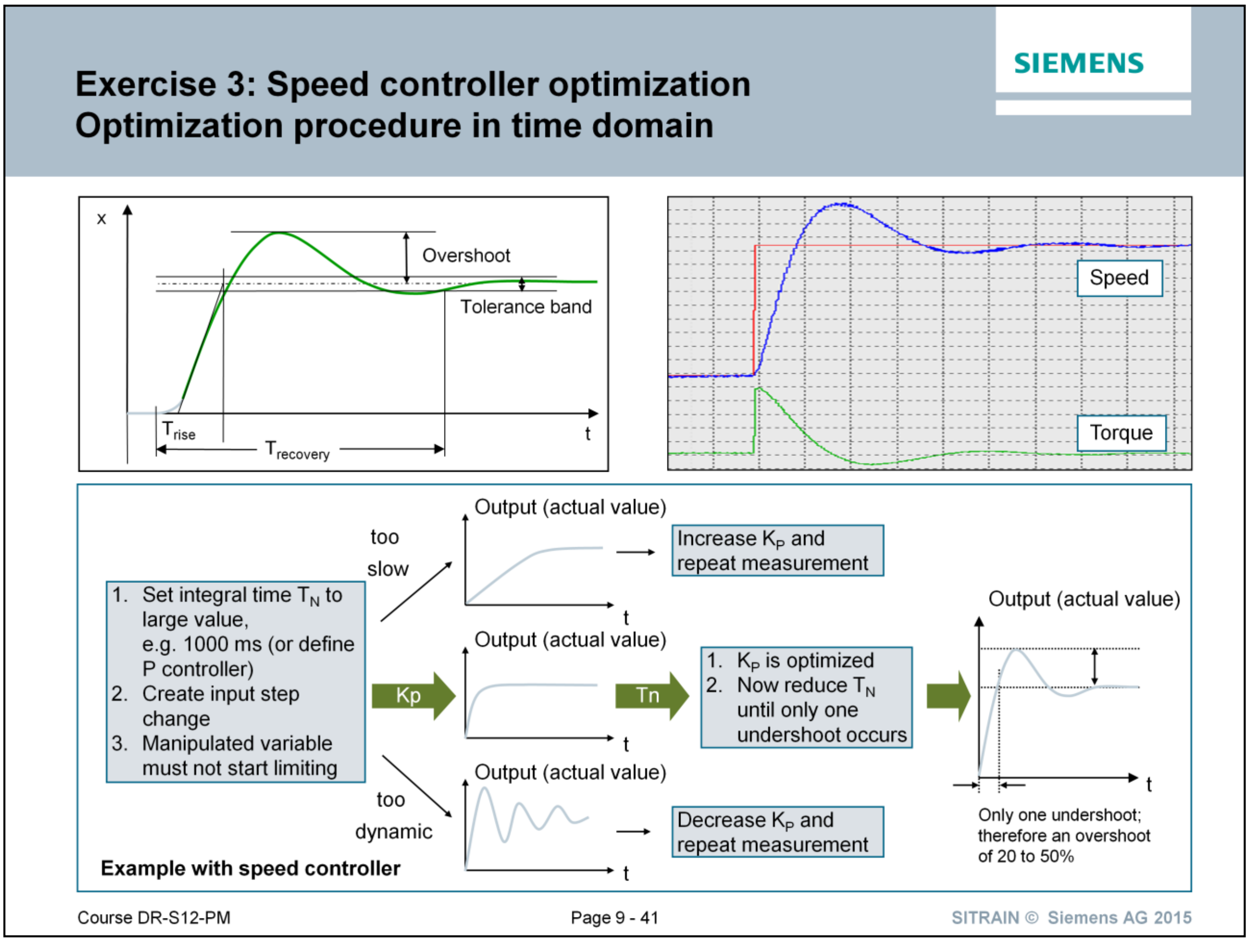
   Measuring function: "Speed controller setpoint jump (after speed setpoint filter)"

   The other parameters are set automatically but may be modified for measurement.

   The recorded parameters are also selected automatically.

2. The measurement must be started via the setpoint change.

   Select the "Assume control priority" button and start the measurement by pressing the green button.



Basic procedure

The PI controller consists of a proportional (P) component and an integral (I) component. The question therefore arises as to which component should be optimized first.

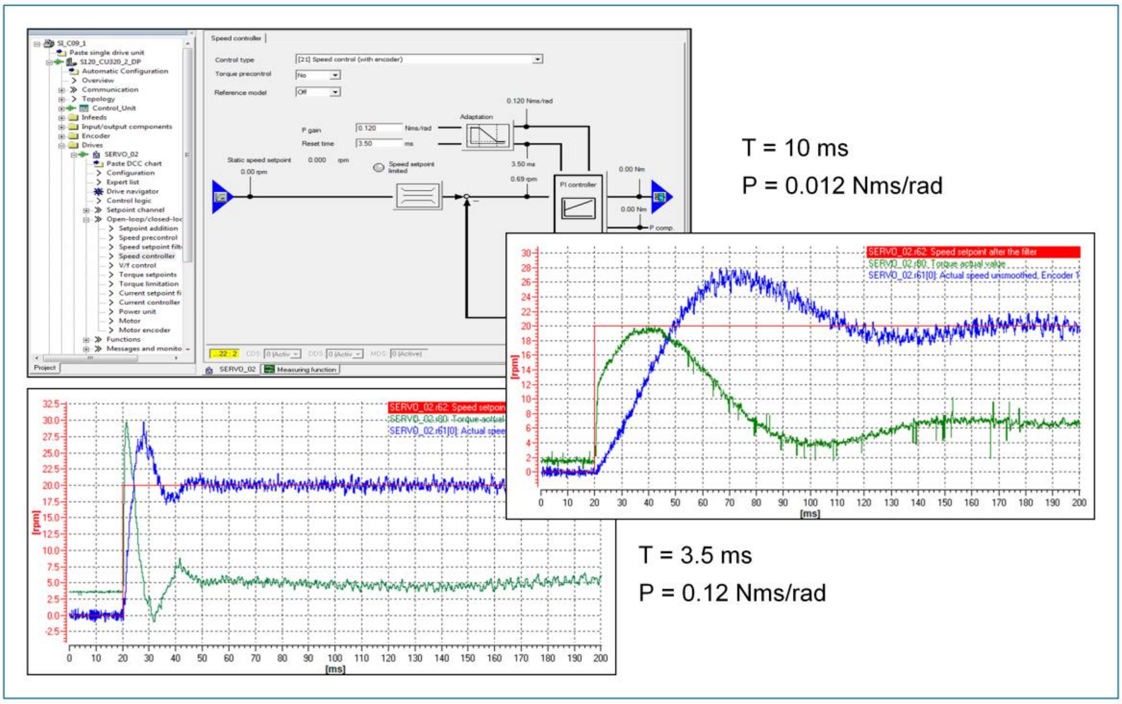
The P component has an immediate effect on the setpoint/actual value comparison, but the I component has a delayed effect due to its time constant, so you must always begin by optimizing the P component.

On starting optimization, the I component must therefore be set extremely low to enable the required effect of the P component to be identified:
➔ Set Tn to a large value.

Then apply the setpoint step change to the controller and observe the controlled response. If the change in actual value is still extremely slow, increase Kp step-by-step. If the actual value starts to oscillate, reduce Kp accordingly.

As soon as Kp has been set optimally, to optimize the I component, Tn is reduced step-by-step until the first undershoot occurs in the actual value.
If necessary, with a further reduction in Tn, the height of the first overshoot can be reduced.

Exercise 3: Speed controller optimization with step response



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Task The speed controller parameter P gain and integral time must be adapted to the mechanical conditions.

Before you carry out automatic optimization to determine this parameter, both parameters should be changed manually and the result evaluated using a setpoint step change.

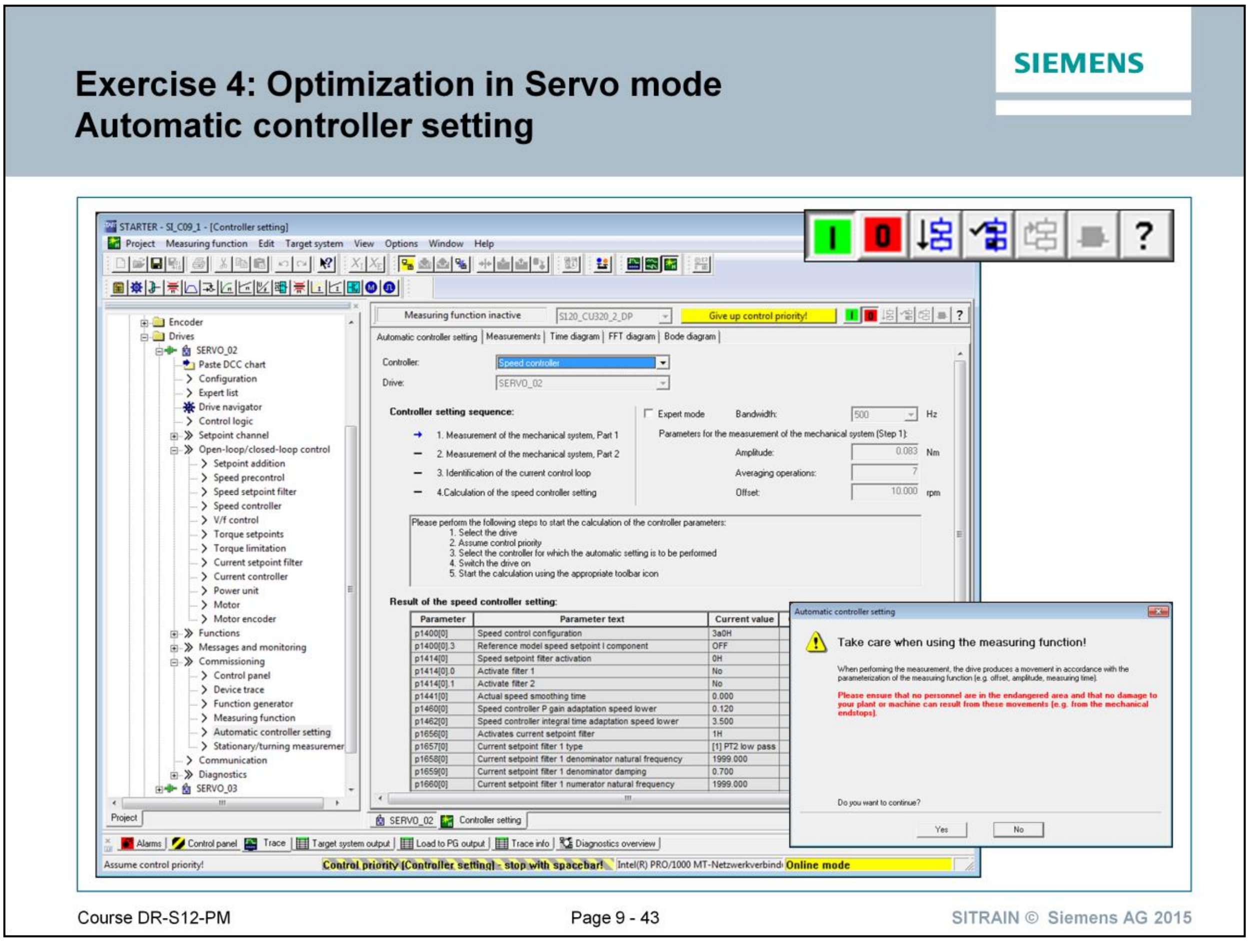
1. Open the screen
   >> Servo_02 > Open-loop/closed-loop control > Speed controller

2. Modify the parameters there
   - P gain and
   - Integral time

3. Then start the measurement.

Note If the STARTER is connected to the drive unit (online mode), the changes to the P gain and integral time parameters are adopted immediately after input.

After optimization, the parameters must be saved to ROM and downloaded to the PG and stored there.



Task

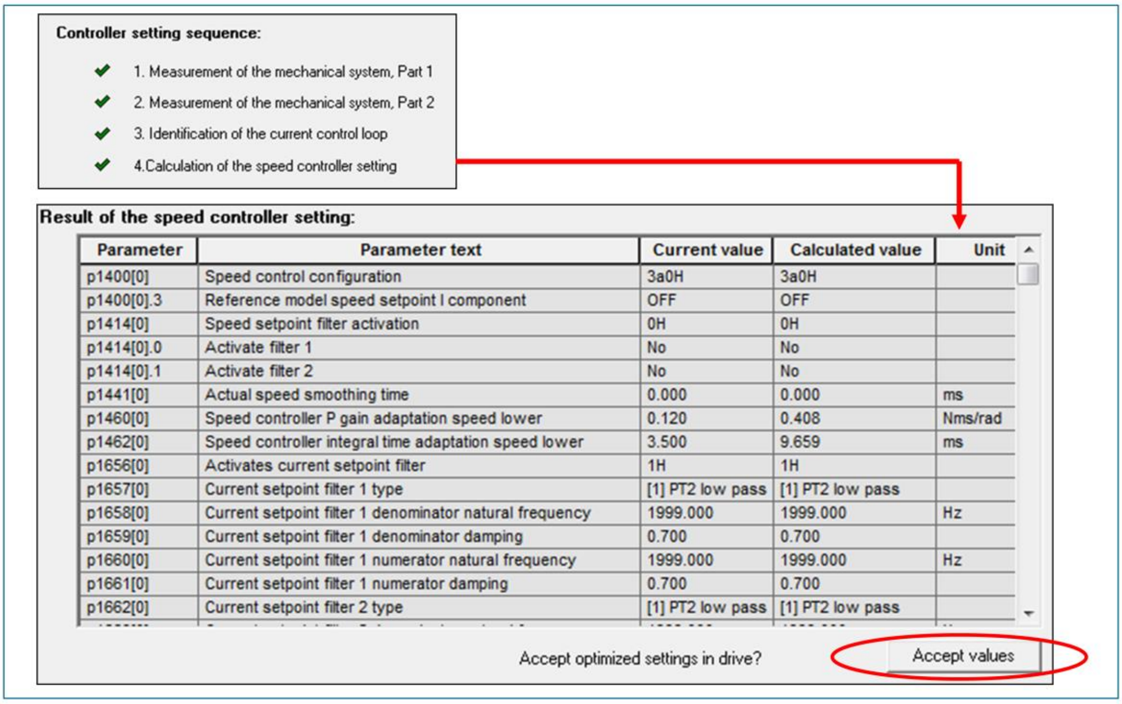
Besides manual setting of the speed controller parameters, it is also possible to carry out automatic controller optimization.

Select the autonomous function provided in the following way:
>> Servo_02 > Commissioning > Automatic controller setting

and then perform the following steps:

1. Assume the control priority for your PC, and observe the safety instructions.
2. Switch-on the selected drive using the "green" button.
3. Press the button "Execute next step“.
4. In step 1, the mechanical system is measured at low frequencies.
5. In step 2, the mechanical system is measured at higher frequencies.
6. In step 3, the current controller is optimized.
7. In step 4, the speed controller is optimized.
8. Analyze, for example, the speed controller parameters "actual value" and "calculated value".

Exercise 4: Optimization in Servo mode
Automatic controller setting



Controller setting sequence:

1. Measurement of the mechanical system, Part 1
2. Measurement of the mechanical system, Part 2
3. Identification of the current control loop
4. Calculation of the speed controller setting

Result of the speed controller setting:

Parameter	Parameter text	Current value	Calculated value	Unit
p1400[0]	Speed control configuration	3a0H	3a0H	
p1400[0].3	Reference model speed setpoint I component	OFF	OFF	
p1414[0]	Speed setpoint filter activation	0H	0H	
p1414[0].0	Activate filter 1	No	No	
p1414[0].1	Activate filter 2	No	No	
p1441[0]	Actual speed smoothing time	0.000	0.000	ms
p1460[0]	Speed controller P gain adaptation speed lower	0.120	0.408	Nms/rad
p1462[0]	Speed controller integral time adaptation speed lower	3.500	9.659	ms
p1656[0]	Activates current setpoint filter	1H	1H	
p1657[0]	Current setpoint filter 1 type	[1] PT2 low pass	[1] PT2 low pass	
p1658[0]	Current setpoint filter 1 denominator natural frequency	1999.000	1999.000	Hz
p1659[0]	Current setpoint filter 1 denominator damping	0.700	0.700	
p1660[0]	Current setpoint filter 1 numerator natural frequency	1999.000	1999.000	Hz
p1661[0]	Current setpoint filter 1 numerator damping	0.700	0.700	
p1662[0]	Current setpoint filter 2 type	[1] PT2 low pass	[1] PT2 low pass	

Accept optimized settings in drive? Accept values

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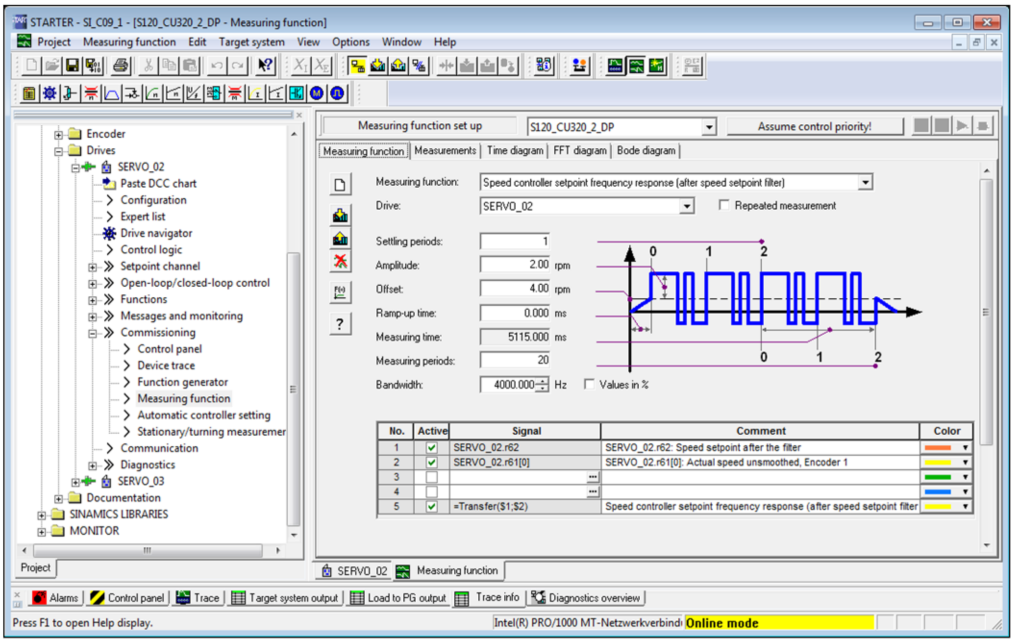
Task Accept the data determined in the automatic controller optimization:
>> Accept optimized settings in the drive? > Accept values

Note The current and speed controllers only operate with these new values after the calculated values have been accepted. If the values are not accepted, then the current and speed controllers continue to operate with the previous values.

Exercise 5 – optional: Frequency response analysis
Select, start



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Additional task

Besides analysis of the closed-loop control using the step response, the drive also provides for frequency response analysis.

In this exercise, a frequency response analysis is to be initiated.

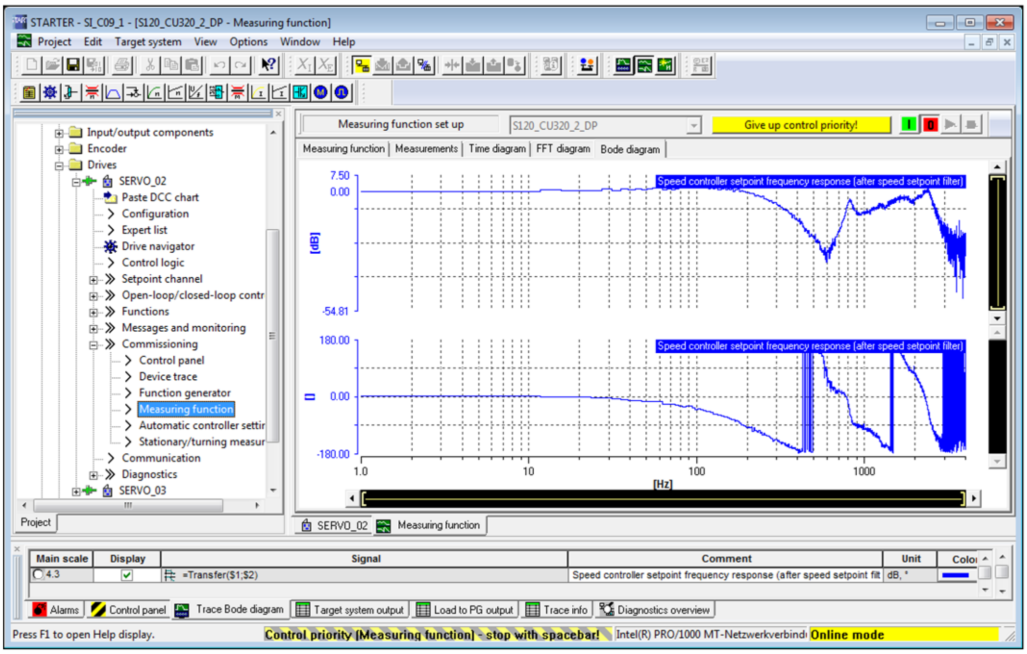
1. Select the measuring function via the "Commissioning" directory in the "Servo_02" drive object.

   The following parameters should be set:

   - Measuring function:
     Speed controller setpoint frequency response (after speed setpoint filter)
   - The other parameters are set automatically but may be modified for measurement.
   - The recorded parameters are also selected automatically.

2. Select the "Assume control priority" button and start the measurement by pressing the green button.

Exercise 5 – optional: Frequency response analysis
Select, start



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Result The result of measurement for the frequency response analysis is shown in the Bode diagram.

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Chapter 10

Closed loop control structure servo mode

Course DR-S12-PM

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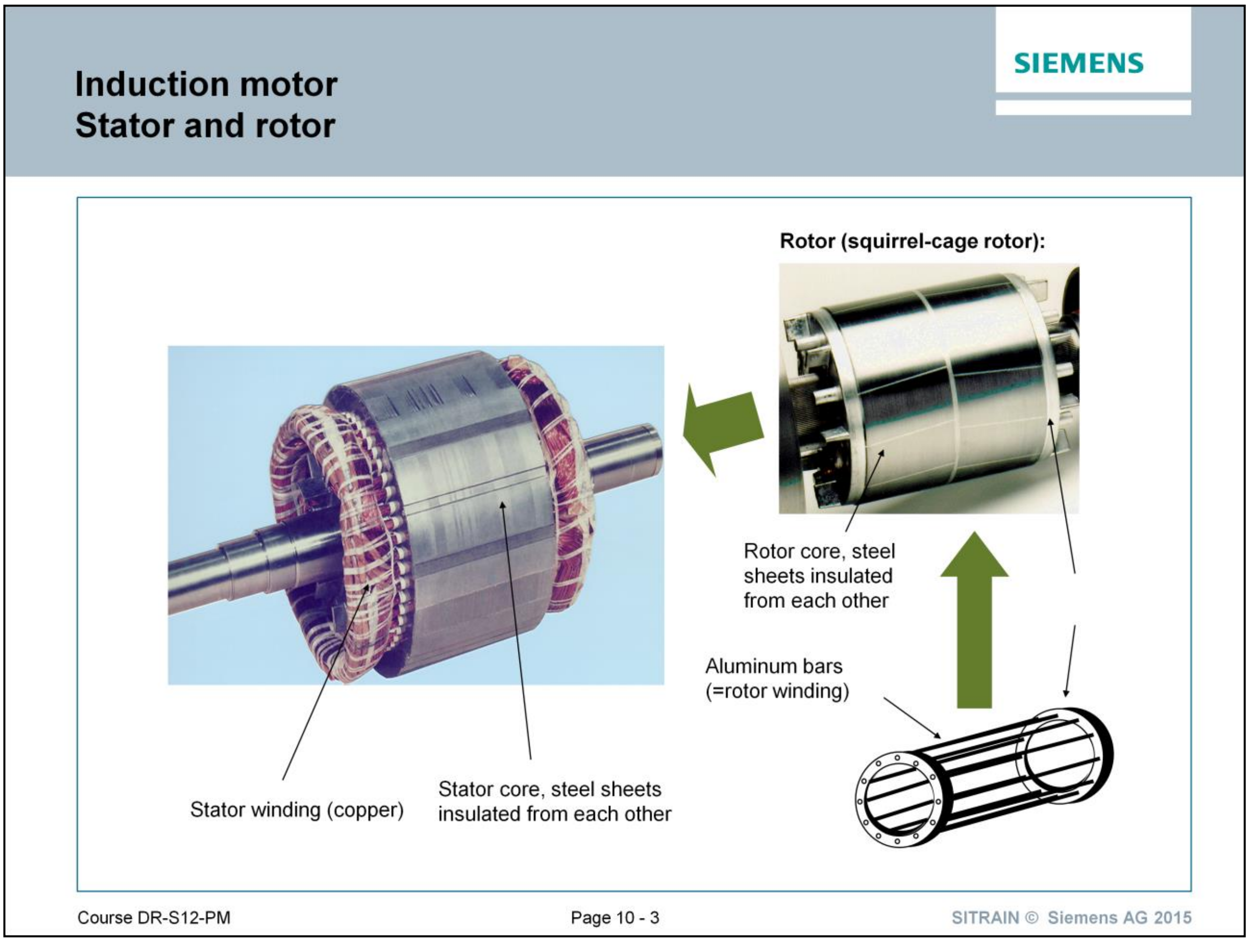
Exercise 3: Stationary measurement 23
Exercise 4: Turning measurement 25
Exercise 5: measuring functions 26

Learning Targets

- You will be familiar with the design of an induction motor
- You will be familiar with the equivalent circuit diagram of an induction motor
- You will be able to commission an induction motor using the rating plate.
- You will be able to optimize the induction motor with stationary and turning measurement



Design

The most important components of the induction motor are:

- Stator
- Rotor

Stator

The stator consists of punched steel sheets, layered to produce the round outer shape of the motor. There are slots on the inside to accommodate the windings.

Rotor

The rotor is also made of punched sheets. These sheets produce continuous, rod-like hollow cavities when placed one on top of the other. These cavities are cast in aluminum and then form the current-carrying rods.

For a short-circuit rotor, the short-circuit rings are also cast in aluminum at both ends. Ultimately, current flows through the aluminum; the sheet serves to conduct the magnetic field lines and for mechanical installation.

In the case of high-efficiency motors, the aluminum is partially or wholly replaced by copper.

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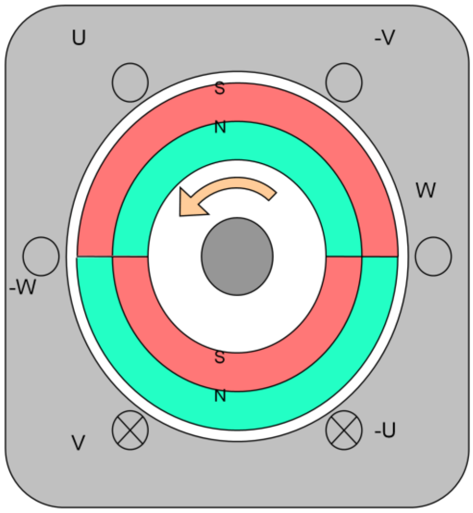
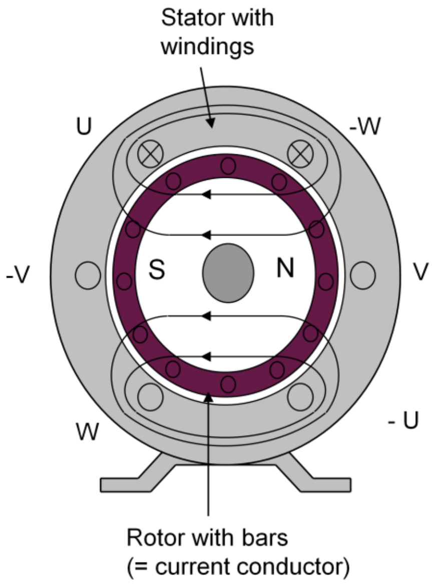
Induction motor
Comparison with synchronous motor

Permanently excited synchronous motor	Induction motor
	

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Lorentz force If electrons move in a magnetic field, they are subject to a force: the Lorentz force.

Force generation This force also acts on a current-carrying conductor. If this conductor has a vertical orientation to the magnetic lines of force, the Lorentz force will also act vertically.

Right-hand rule:

- Thumb - Current direction
- Index finger - Direction of magnetic field
- Middle finger - Direction of force

The dynamic effect causes the motor to rotate.
Depending on the motor type, either the electrical conductors, the magnetic field, or both will rotate:

- Synchronous servo motor: The rotor with magnets rotates.
- Induction motor: The magnetic field and conductors rotate, although at different frequencies

Two components The following are, therefore, always required:

- Magnetic field
- Current-carrying conductor

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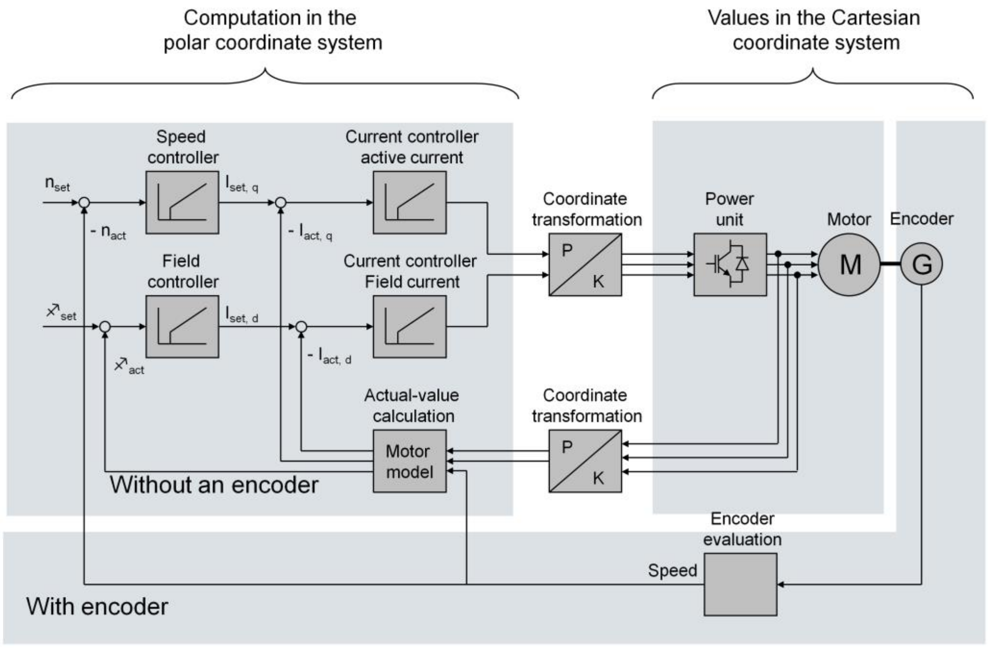
Induction motor
Closed-loop control structure for induction motors



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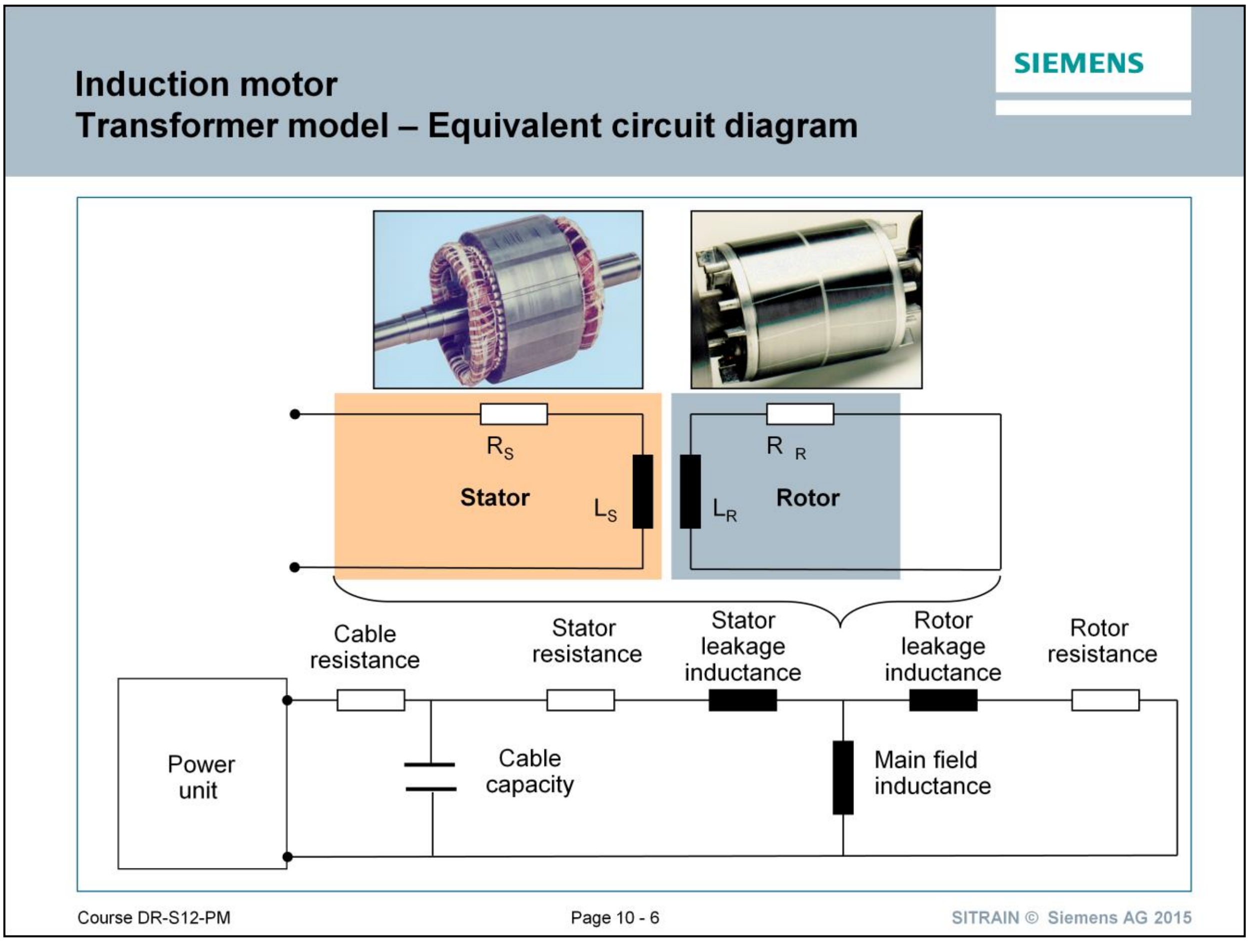
Induction machine

In contrast to permanently excited synchronous machines, for induction machines a field generating current must already be generated in the basic speed range in order to enable any torque at all.

This means that for the closed-loop control of induction machines, non-zero field and torque generating currents must always be specified and controlled.

The field generating current in the induction machine is the magnetization current. The orientation of the rotor flux is calculated in the motor model. This forms the orientation for the rotor coordinate system dq.

The accuracy of the motor model (e.g., influence of the temperature rise and saturation) and that of the current and speed measurements determine the quality of the field-oriented closed-loop control.



Equivalent circuit

The currents in the stator and rotor come up against both ohmic and inductive resistances, where inductances at high frequencies are significant.

The magnetic field generated by the stator is linked to the rotor's magnetic field. This is referred to as main field inductance and is represented as a single component.

In part, these values are largely dependent on the frequency and temperature, meaning that a precise mathematical simulation of the motor can be difficult to achieve.

Parameters in the converter

Practically all modern converters work internally with parameters which contain equivalent circuit diagrams. The values are preassigned automatically during commissioning:

- Calculated from the rating plate data
- Via automatic converter measurements (motor identification), if required

The equivalent circuit diagram data are entered manually in special cases only.

Closed-loop control structure
Overview of speed and current control

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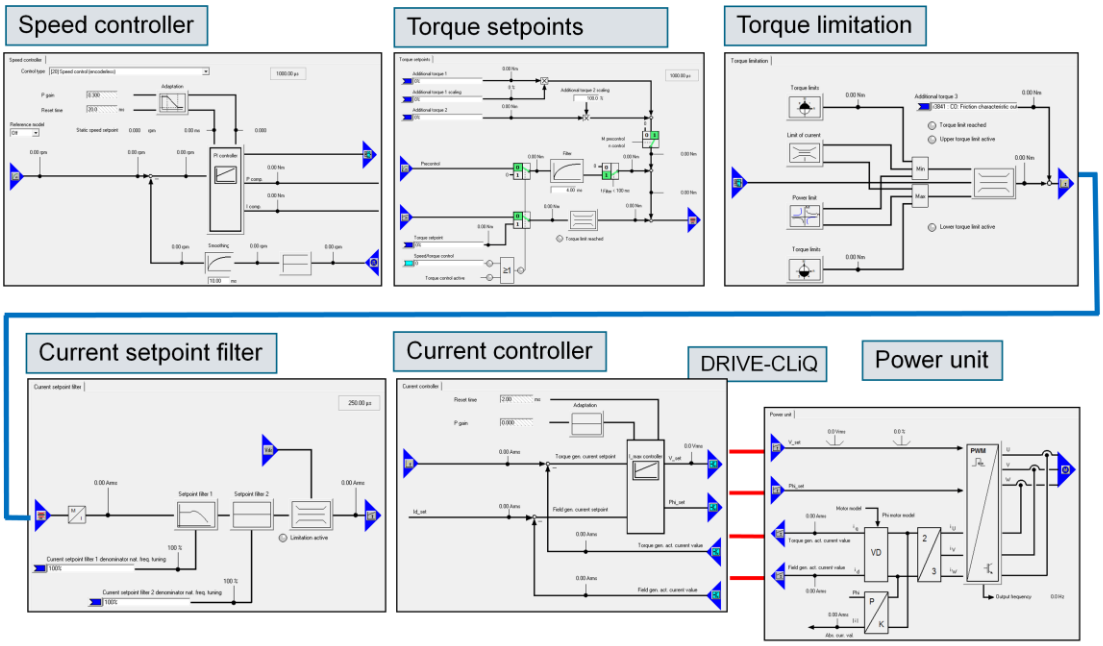

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Steps in the commissioning sequence
Overview

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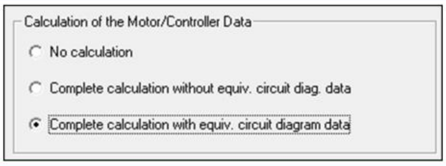
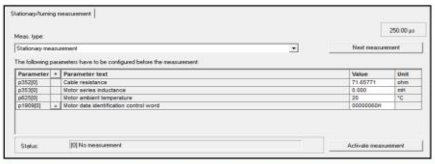
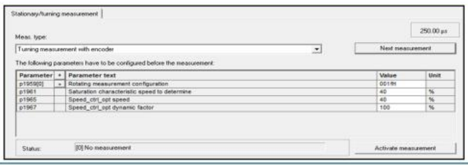
1. Calculate the equivalent circuit diagram data



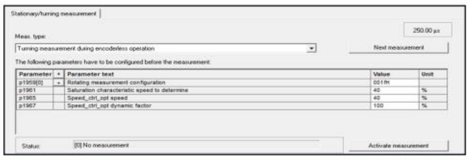
2. Stationary measurement



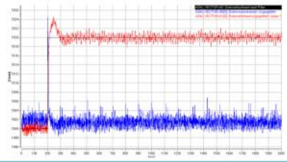
3. Turning measurement



4. Speed controller optimization



5. Test and documentation of the control



6. Back-up of parameter assignments

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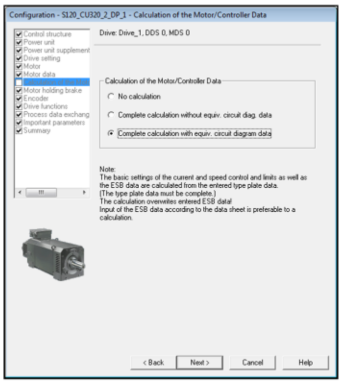
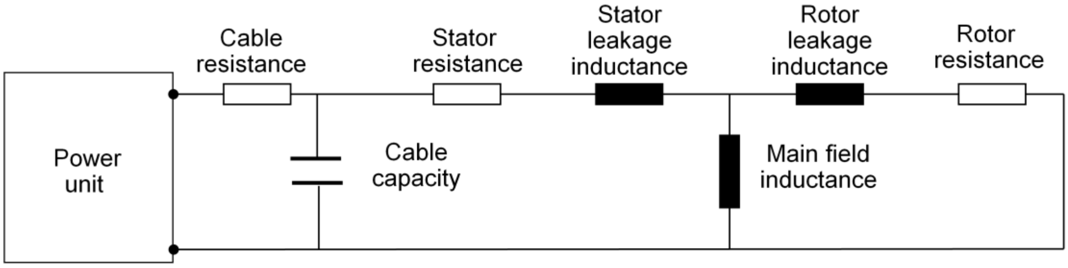
Steps in commissioning sequence
Calculation of equivalent circuit diagram data





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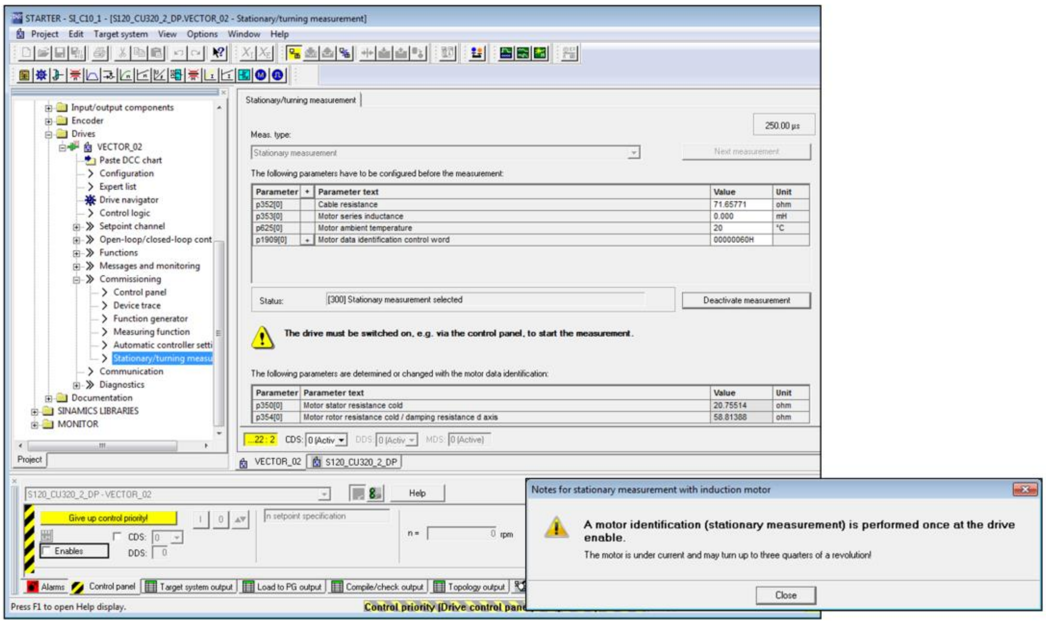
Steps in the commissioning sequence
Stationary measurement



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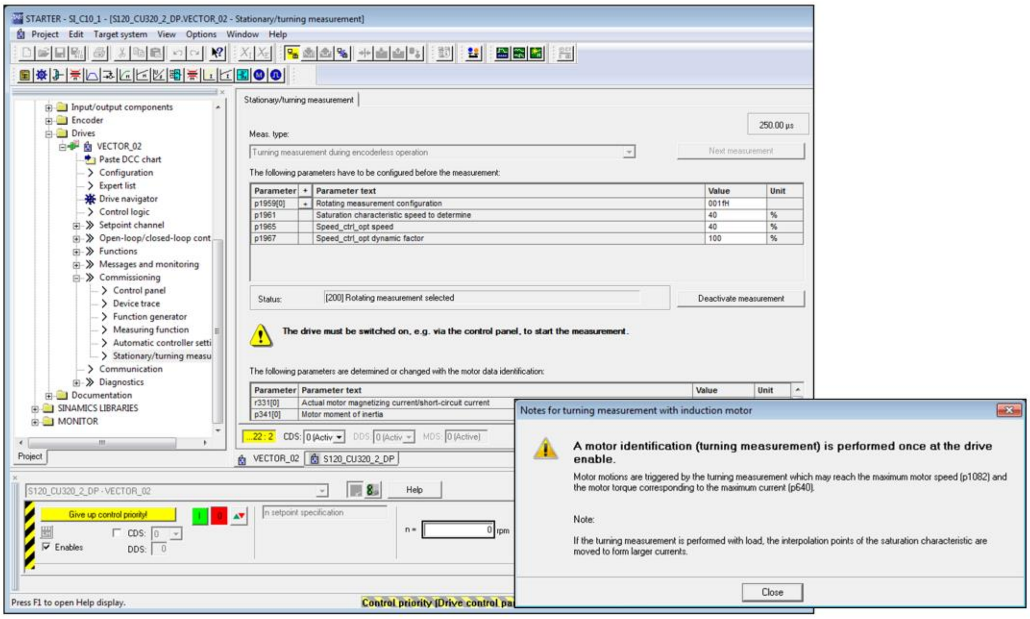
Steps in the commissioning sequence
Turning measurement and speed optimization



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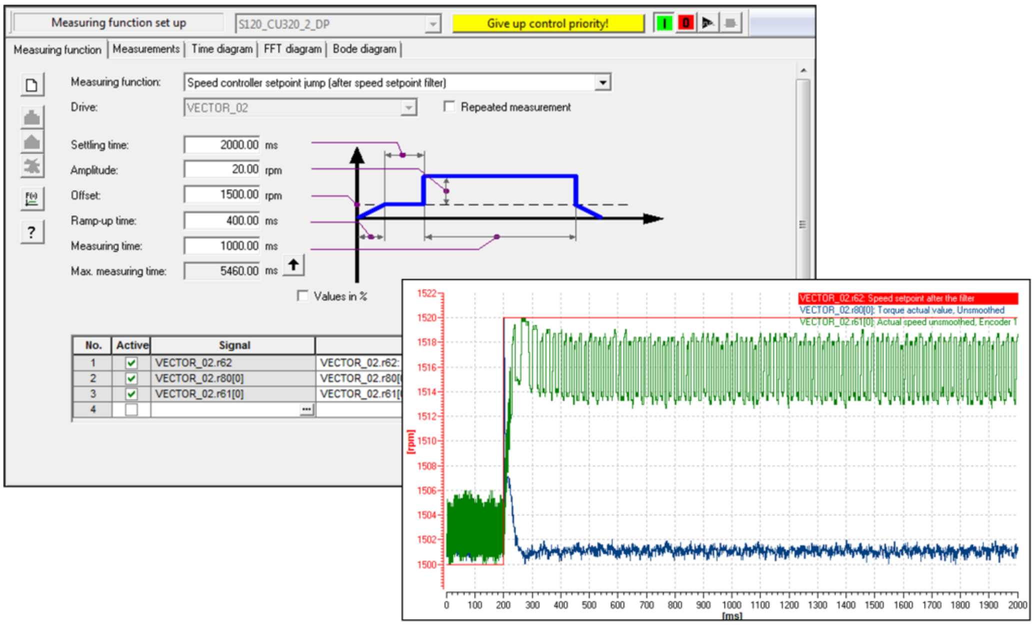
Steps in the commissioning sequence
5. Test and documentation and 6. Save project



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Closed-loop and open-loop control modes

SINAMICS "Vector" mode	
Closed-loop control mode	**p1300**
• Speed control without encoder	20
• Speed control with encoder	21
• Torque control without encoder	22
• Torque control with encoder	23
Open-loop control mode	**p1300**
• With linear characteristic	0
• With linear characteristic and FCC	1
• With parabolic characteristic	2
• With programmable characteristic	3
• For precise frequency drives in the textile sector	5
• For precise frequency drives with FCC	6
• With independent voltage setpoint	19

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

Torque control An operating mode switchover (p1300) can be carried out or a binector input (p1501) used to switch from speed control to torque control mode. All torque setpoints from the speed control system are rendered inactive. The setpoints for torque control mode are selected by parameter assignment.

Linear characteristic Standard (w/o voltage boost)

Linear characteristic with flux current control Characteristic that compensates for voltage losses in the stator resistance for static/dynamic loads (flux current control FCC). This is particularly useful for small motors, since they have a relatively high stator resistance.

Parabolic characteristic Characteristic that takes into account the torque curve of the load (e.g. fans/pumps)
a) Quadratic characteristic (f2 characteristic)
b) Energy-saving, because the low voltage results in smaller currents and losses.

Programmable characteristic Characteristic that takes into account the motor/machine torque curve (e.g. synchronous motor)

Precise frequency drives Characteristic that takes into account the technological particularity of an application (e.g. textile applications).

Open-loop control mode: U/f curve with linear characteristic

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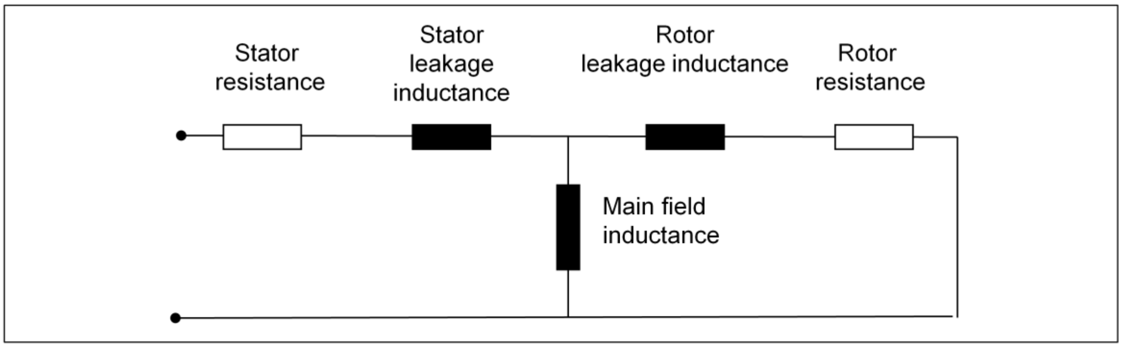

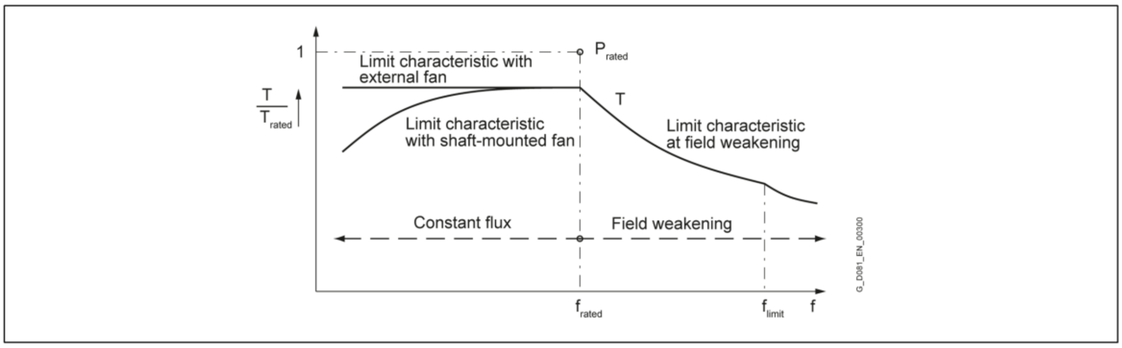

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U/f control

The simplest solution for a control procedure is the U/f characteristic, whereby the stator voltage for the induction motor or synchronous motor is controlled proportionately to the stator frequency. This method has proved successful in a wide range of applications with low dynamic requirements, such as:

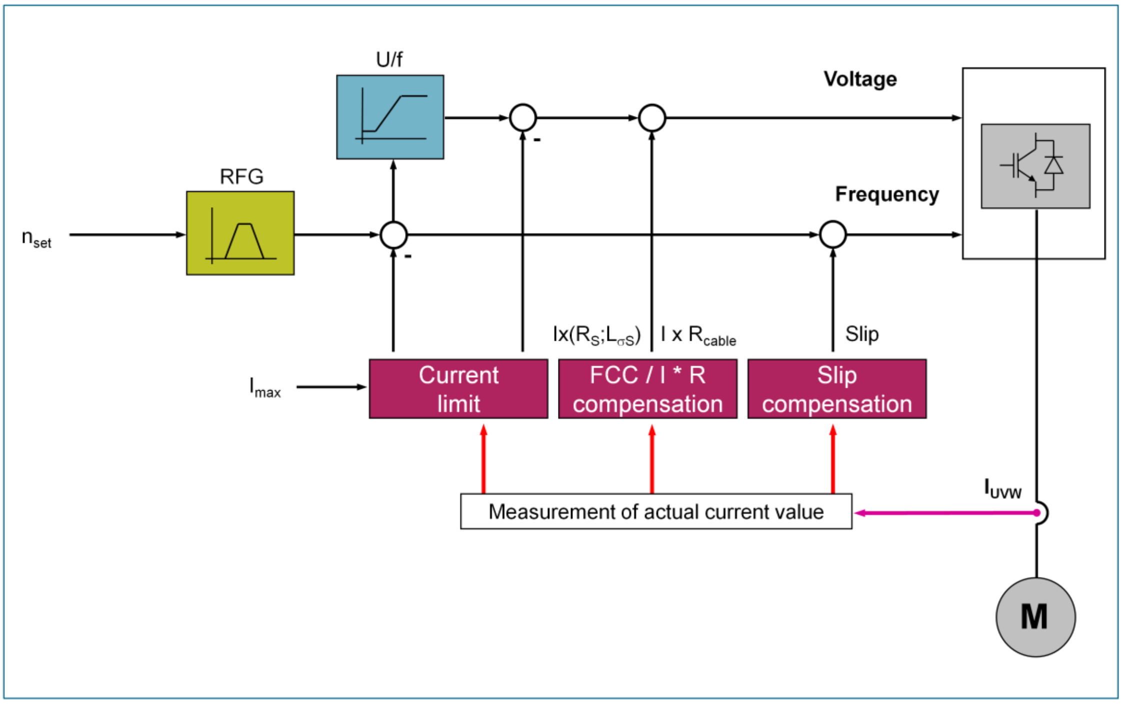
- Pumps and fans
- Belt drives
  and other similar processes.

U/f characteristic

U/f control aims to maintain a constant flux Φ in the motor Whereby this is proportional to the magnetizing current Iµ or the ratio of voltage U to frequency f. The torque M generated by the asynchronous motors is itself proportional to the product (or more accurately, the vectorial product Φ x I) of flux and current.

To generate the highest possible torque at a given current, the motor must operate at a constant, high level of flux. To maintain a constant flux (Φ), therefore, the voltage (U) must be changed in proportion to the frequency (f) to ensure a constant magnetization current (Iµ). U/f characteristic control is derived from these basic premises.

Open-loop control mode: U/f curve
Other options



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Voltage boost

With an output frequency of 0 Hz, the U/f characteristics yield an output voltage of 0 V. The voltage boost must be entered to:

- Magnetize the induction motor
- Maintain the load
- Compensate for the losses (ohmic losses in the winding resistors) in the system or
- Generate a breakaway/acceleration/braking torque.

The voltage boost can be increased permanently (p1310) or during acceleration (p1311).

Slip compensation

Slip compensation is an additional U/f control function. It ensures that the actual speed of induction motors is maintained at a constant level irrespective of the load.

Open-loop control mode: U/f characteristic
U/f control without encoder

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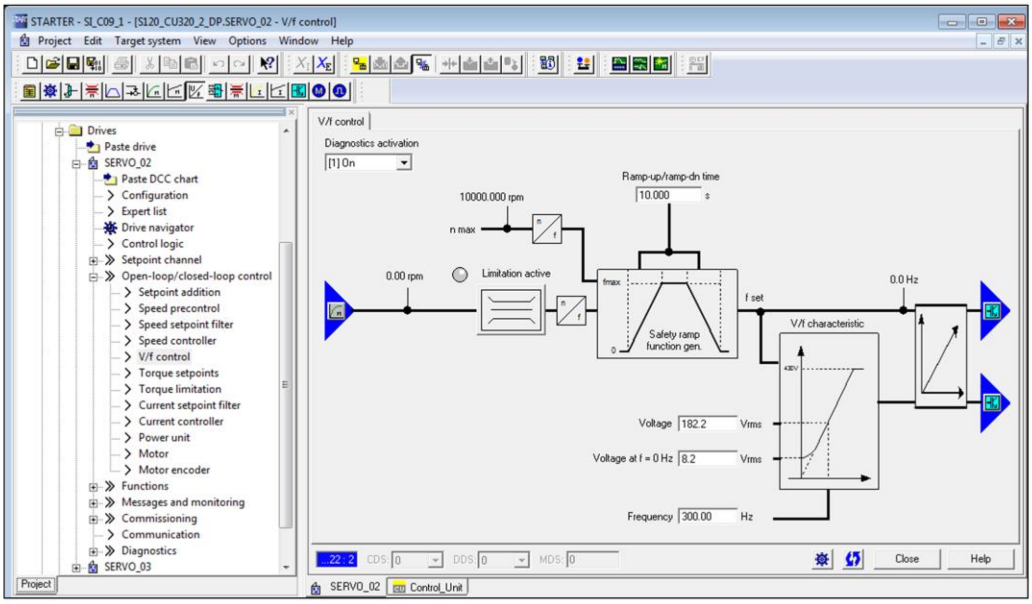

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Description

With U/f control, the motor is operated with an open control loop and does not require speed control or actual current sensing, for example. Operation is possible with a small amount of motor data.

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

- Motor Module
- Power cable between Motor Module and motor
- Motor
- DRIVE-CLiQ cable between Motor Module and motor
- Encoder and actual encoder value

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

- Induction motors
- Synchronous motors

Caution

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

Note

With operation with encoder, the actual speed value from the measuring system is displayed

With operation without encoder, a calculated actual speed value is displayed. The operation of synchronous motors with U/f control is permitted only at up to 25% of the rated motor speed.

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Exercises

- Exercise 1: Setting up training equipment with induction motor
- Exercise 2: Configuration of "Vector" drive object type
- Exercise 3: Stationary measurement
- Exercise 4: Turning measurement

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Safety information

Please note that:

- The course instructions have been produced for:
  - A course held by a course leader
  - Activities carried out on special training equipment
- The training equipment is operated under laboratory conditions.
  In case of doubt, always ask your course leader – particularly when handling components that carry electrical current or which can move.
- When carrying out work on equipment, the safety information in the associated product documentation must always be observed!
  The training documents alone are not sufficient.

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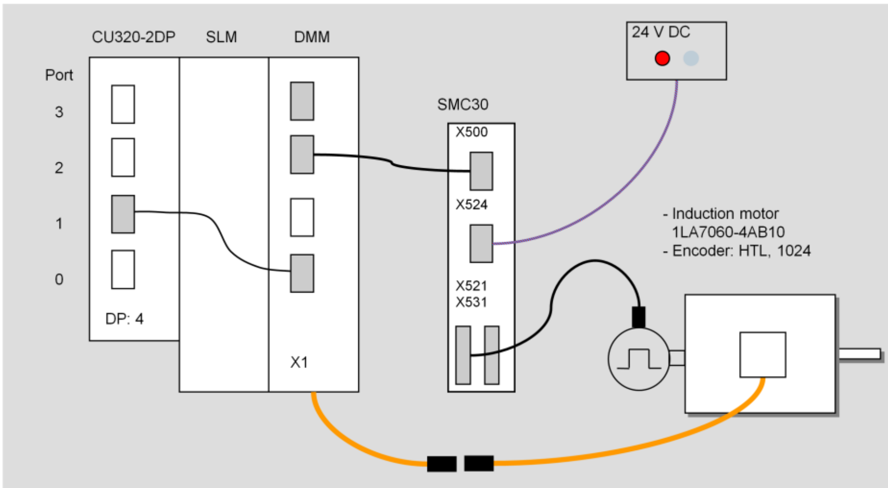
Exercise 1: Setting up training equipment with induction motor
Motor, encoder, Drive CLiQ and power connector



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Task

Change the setup of your training case, so that for the operation of an induction motor (ASM) you have a vector application with:

- 1LA7 induction motor
- HTL 1024 incremental encoder and
- Sensor Module Cabinet SMC30.

Procedure

Perform the following steps as preparation:

1. Turn off the power supply of your training case.

2. Make the following changes at the Double Motor Module:
    - Remove both DRIVE-CLiQ plugs from port X202 and X203.
    - Insert the DRIVE-CLiQ plug of the SMC30 into port X202
    - Disconnect the 1FK7 servo motor from the power connection X1 (open the screw coupling or withdraw the connector)
    - Connect the 1LA7 induction motor with power connection X1 (screw coupling or connector)
    - Connect the 24V supply for the SMC30 at the sockets of the training case prepared for this purpose

3. In Starter, close your existing project, and create a new project for the "Vector" operating mode.

Exercise 1: Setting up training equipment with induction motor
Connection between induction motor and encoder

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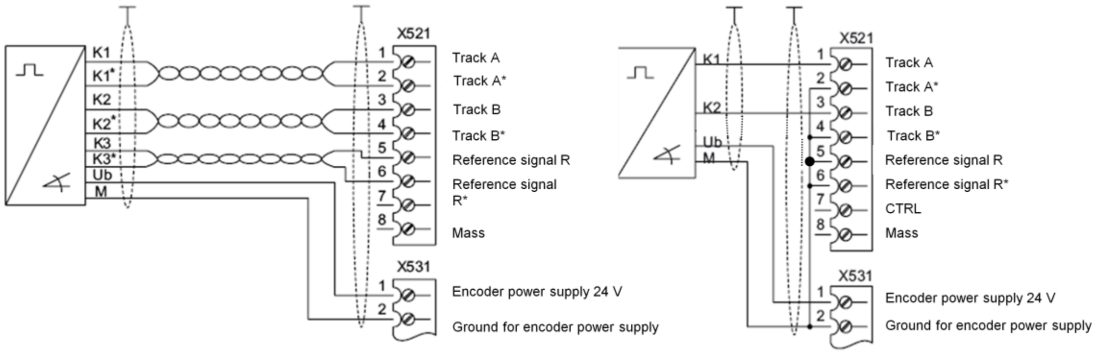

Bipolar encoder connection with
Reference signal: A, A´, B, B´, R, R´
(code number: **3001**)

Unipolar encoder connection: A, B,
(code number: **3009**)

Encoder type	Code number
1024 HTL A/B R	3001
1024 TTL A/B R	3002
2048 HTL A/B R	3003
1024 HTL A/B	3005
1024 TTL A/B	3006
2048 HTL A/B	3007
2048 TTL A/B	3008
1024 HTL A/B unipolar	3009

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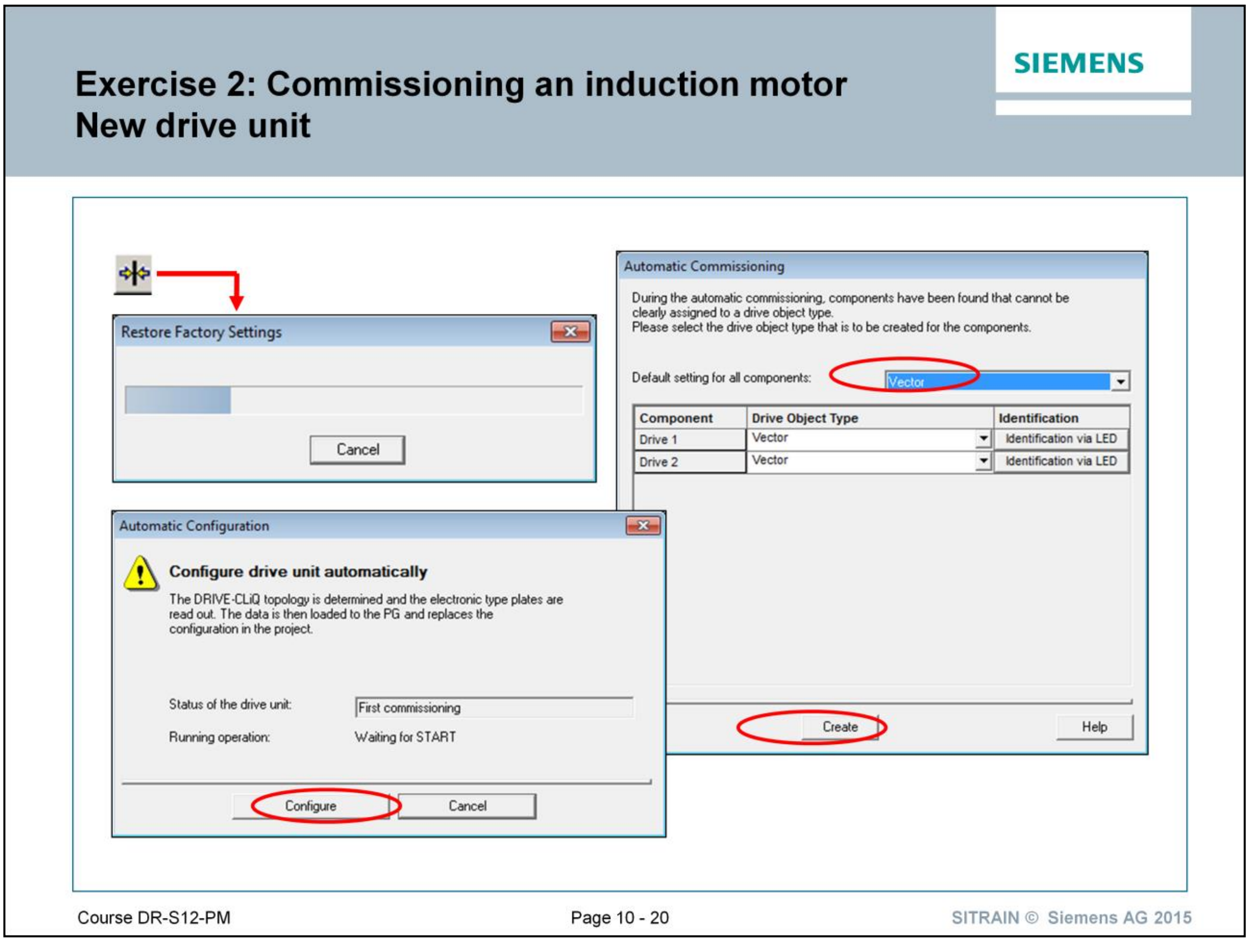
4. Determine the code number of the HTL encoder. Check the assignment of connectors X521 and X531 at the SMC30:

   Are tracks A and B connected with twisted cables?

   ……………………………………………………………………………………

   Is the reference signal connected?

   ……………………………………………………………………………………



Task

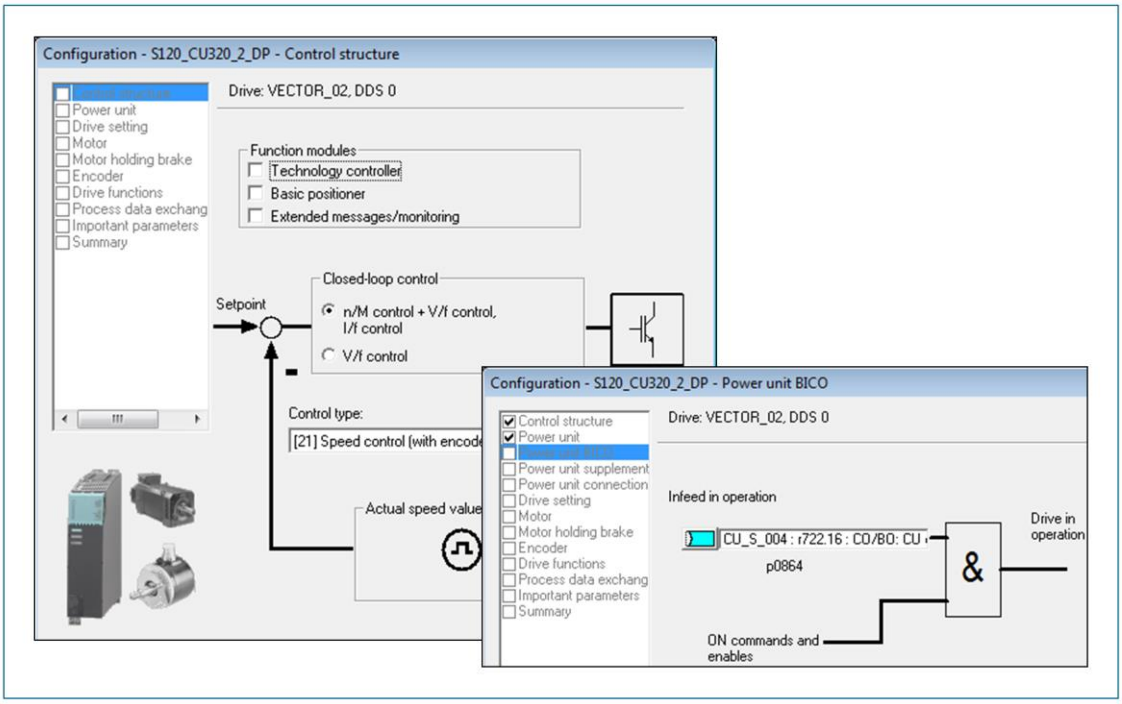
Carry out a first commissioning of your training equipment in the "Vector" operating mode.

Procedure

Work through the following steps:

1. Create a new project with the name "S120_Vector_1'.
2. Use the "Accessible nodes" button to search for the Control Unit in the network.
3. Transfer the node to your project.
4. Establish an online connection to your training equipment.
5. Restore the factory settings.
6. Run through the automatic configuration:
   >> Automatic configuration > Configuring
7. Create the "Vector" object.
8. Go offline to configure the vector drive.

Exercise 2: Commissioning an induction motor Configuration



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Task Configure the VECTOR_02 drive.

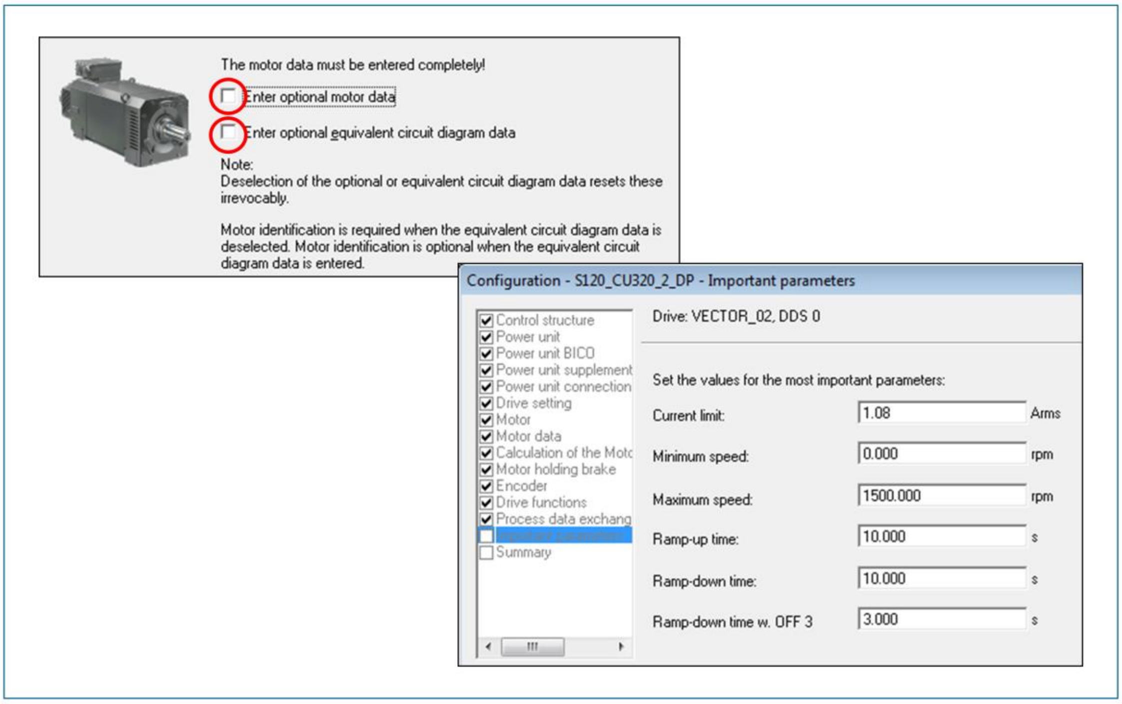
1. Delete the VECTOR_03 drive:
   >> Right mouse click > Delete

2. Configure the VECTOR_02 drive:
   >> Configuration > Configure DDS…

3. Make the following settings:
   - Speed control with encoder
   - Power unit unchanged
   - Signal source for the signal "Infeed in operation":
     >> Digital input DI16 of the CU320-2DP
   - Motor at connection "X1" (connection X2 remains undefined)
   - IEC motor, connection voltage 600 V
     (value is changed later online)

4. Enter the motor data in the delta connection:
   - 1LA7 standard induction motor [17]
   - p304 = 230 V
   - p305 = 0.73 A
   - p307 = 0.12 kW
   - p308 = 0.75
   - p310 = 50 Hz
   - p311 = 1350 rpm
   - p355 = [0] non-ventilated

Exercise 2: Commissioning an induction motor Configuration



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5. Then select:
   - Without entering optional data
   - Without entering the equivalent circuit diagram data
   - Complete calculation **with** equivalent circuit diagram data
   - No motor holding brake
6. Select the HTL encoder that you determined beforehand from the list of standard encoders.
   Note: After completing the configuration, or online, it is possible to change the encoder type via the Expert list: p0010=1 > p400=code >p010=0
7. Then select:
   - Standard drive VECTOR, motor identification: Disabled (0)
   - Free telegram configuration with BICO
8. Enter important parameters, such as a ramp-up time and ramp-down time according to the screenshot above.
9. Then select Finish.
10. Save the project
11. Go online with the drive unit, open the expert list of VECTOR_02 and set the following parameters:
    - p210: 380 V
    - p278: -80 V
    - p340: 1
12. Save the data to ROM, load the data to the PG and save the project on your hard disk.

Exercise 3: Stationary measurement Selection

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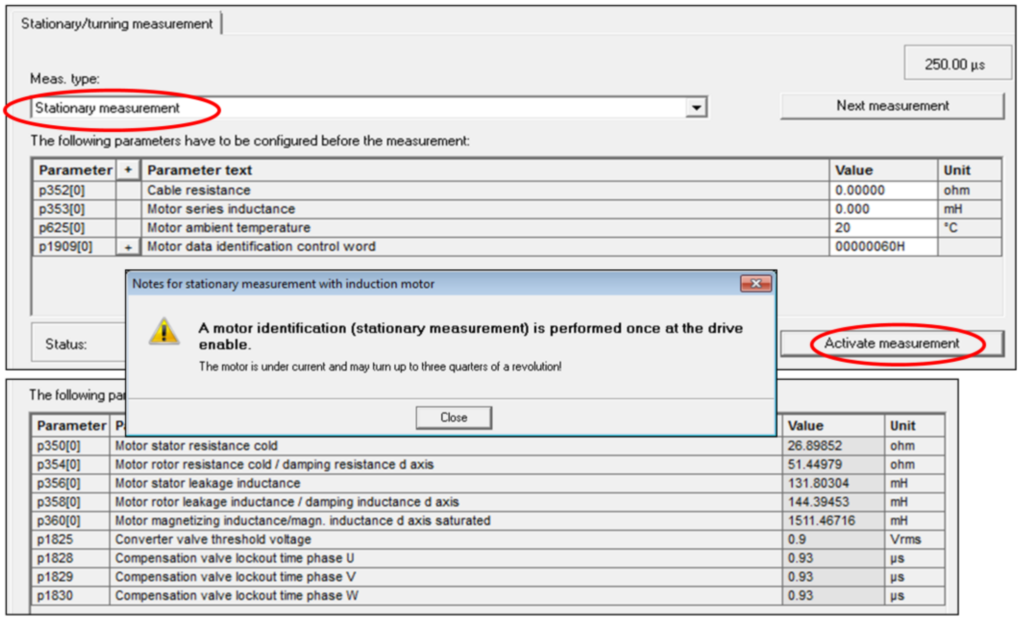

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When configuring the drive, it is possible to pre-select stationary [2] or stationary plus turning measurement [1]. These measurements are then activated when the drive is switched on for the first time (and the second time) without further parameterization.

Task

In this exercise, performance of the stationary and turning measurement is selected via:>> *Commissioning > Stationary/turning measurement*.

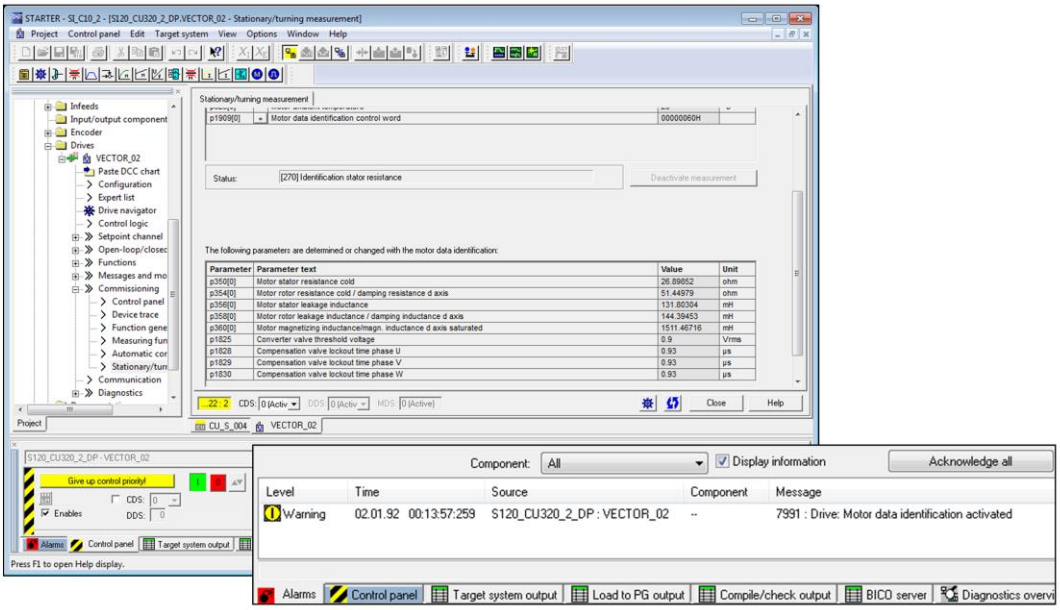
1. Select the Stationary measurement in the following way:
   >> *Vector_02 > Commissioning > Stationary/turning measurement*
   and then carry out the following steps:

2. Select the measuring mode: >> *stationary measurement*

3. To estimate the measurement result, note the following parameters prior to measurement:
   p350: Motor stator resistance
   p356: Motor leakage inductance
   Kp current controller
   Tn current controller

4. Activate the measurement by pressing the button "Activate measurement". The control panel for this drive opens automatically.
   Perform a function test for the new drive.

Exercise 3: Stationary measurement
Control panel



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Task Open the control panel.

Give up the control priority.

1. Compare the values before and after measurement.

2. Save the parameterization to the ROM of the drive, computer and on the hard disk.

3. After motor identification, the drive can be turned by specifying a setpoint. Enter a setpoint of 100 rpm and start the drive.

Exercise 4: Turning measurement Selection

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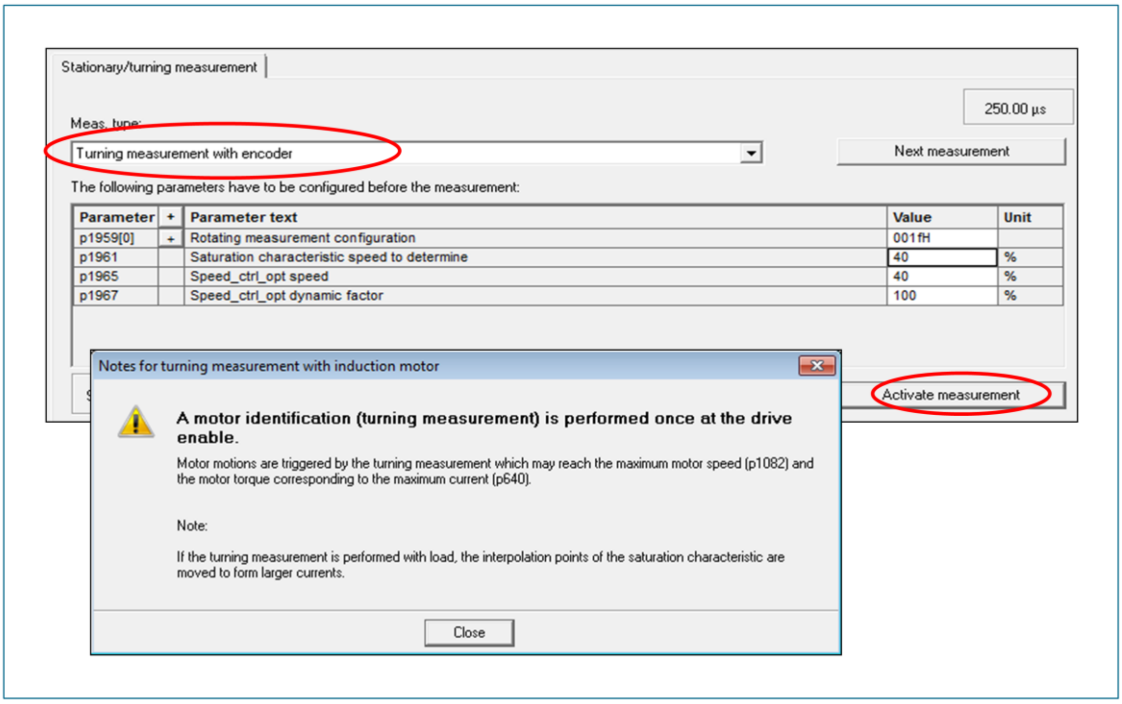

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Task You want to optimize your closed-loop cascade control, comprising current and speed controllers with the stationary and turning measurement.

1. Select the turning measurement in the following way:
   >> *Vector_02 > Commissioning > Stationary/turning measurement*

   and then carry out the following steps:

2. Select the measuring mode: >> *stationary measurement (with encoder)*

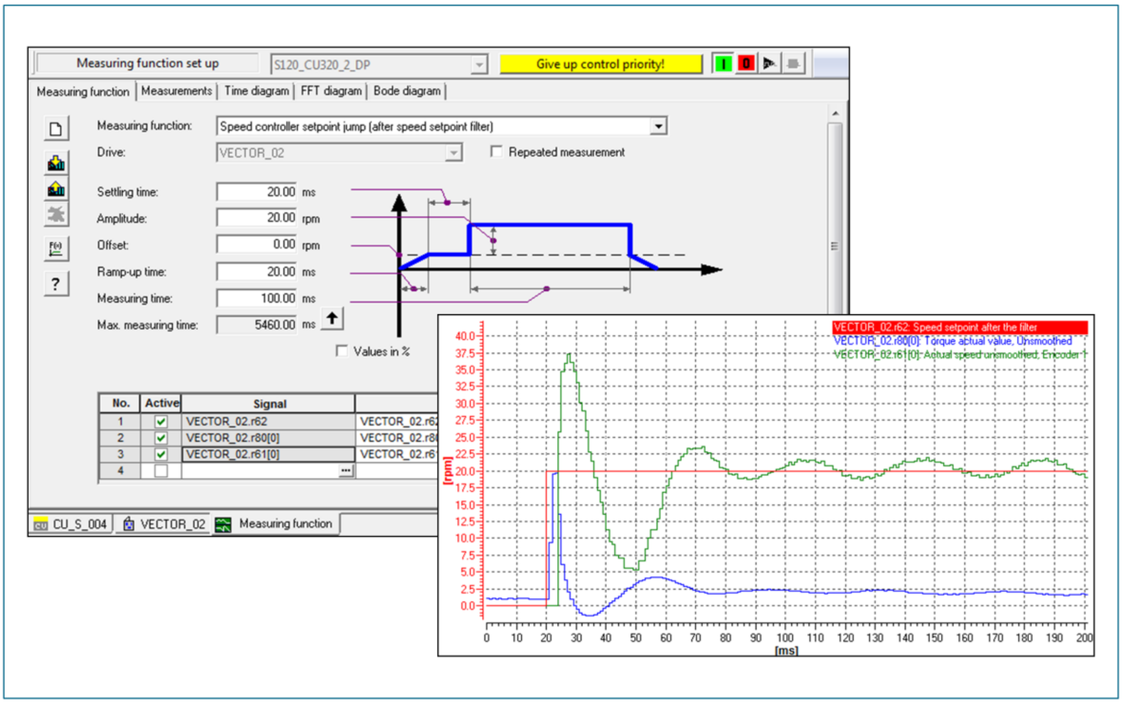
3. Activate the measurement by pressing the button "Activate measurement". The control panel is automatically opened for this drive.

4. In the opened control panel, press the button "Assume control priority!“ and accept the safety note

5. Set the "Enables" check mark, and then press the "green" button to start the measurement.

6. Save the data in Rom and in the project on the harddisk.

Exercise 5: measuring functions
Measurement results



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It makes sense to check the parameters which are measured during stationary and turning measurement. This can be done with the measuring functions.

Task

1. Select the measuring functions in the following way:
   >> *Vector_02 > Commissioning > measuring functions*
   and then carry out the following steps:

2. Select the measuring function: current controller setpoint jump (after filter). The parameters for measuring and the signals for the trace are set. Both can be changed.

3. Activate the measurement by pressing the button “Assume Control priority” an start the measurement wit the green button.

4. The results are shown in the trace.

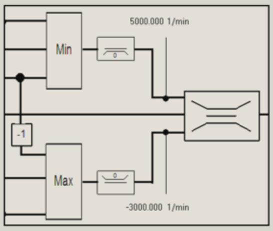
5. Select the measuring function: speed controller setpoint (after speed setpoint filter). The parameters for measuring and the signals for the trace are set. Both can be changed.

6. Activate the measurement by pressing the button “Assume Control priority” an start the measurement wit the green button.

7. The results are shown in the trace.

Chapter 11

Setpoint channel



Course DR-S12-PM

Learning Targets 2
Speed setpoint channel 3
Speed setpoint sources 4
Limits 7
Ramp-function generator 8
Setpoint addition 9
Exercise 1: Setpoint channel and BICO interconnection 11

Learning Targets

- You will know the signal characteristics in the speed setpoint channel
- You will become familiar with the various options for specifying the speed setpoint and how to influence it
- You will be able to parameterize fixed setpoints, the motor potentiometer and the ramp-function generator

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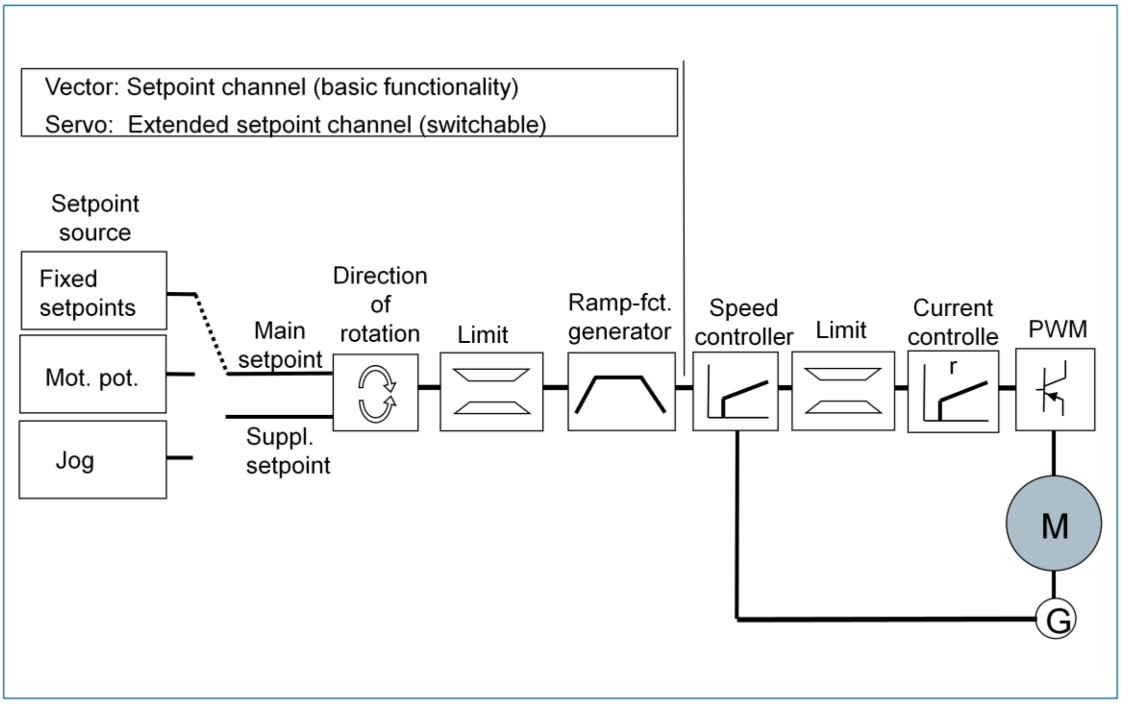
Speed setpoint channel
Overview



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Setpoint channel

The speed setpoint channel is used to prepare a speed setpoint and therefore includes the following functions:

- Main and supplementary setpoint or jog setpoint
- Direction of rotation reversal
- Direction of rotation inhibit
- Limit
- Skip frequencies
- Ramp-function generator

Setpoint sources

The speed setpoint required for speed control can be provided from the following sources within the setpoint channel:

- Fixed setpoint (from the table of fixed setpoints)
- Motor potentiometer (with manual/automatic switchover)

In addition, the following setpoint sources are available irrespective of the setpoint channel:

- Analog input (e.g. from TB30 or TM31)
- PROFIDRIVE (via PROFIBUS or PROFINET)

Note

In "Vector" mode, the speed setpoint channel is an elementary part of the closed-loop control structure; while in "Servo" mode, the speed setpoint channel must be enabled during configuration.

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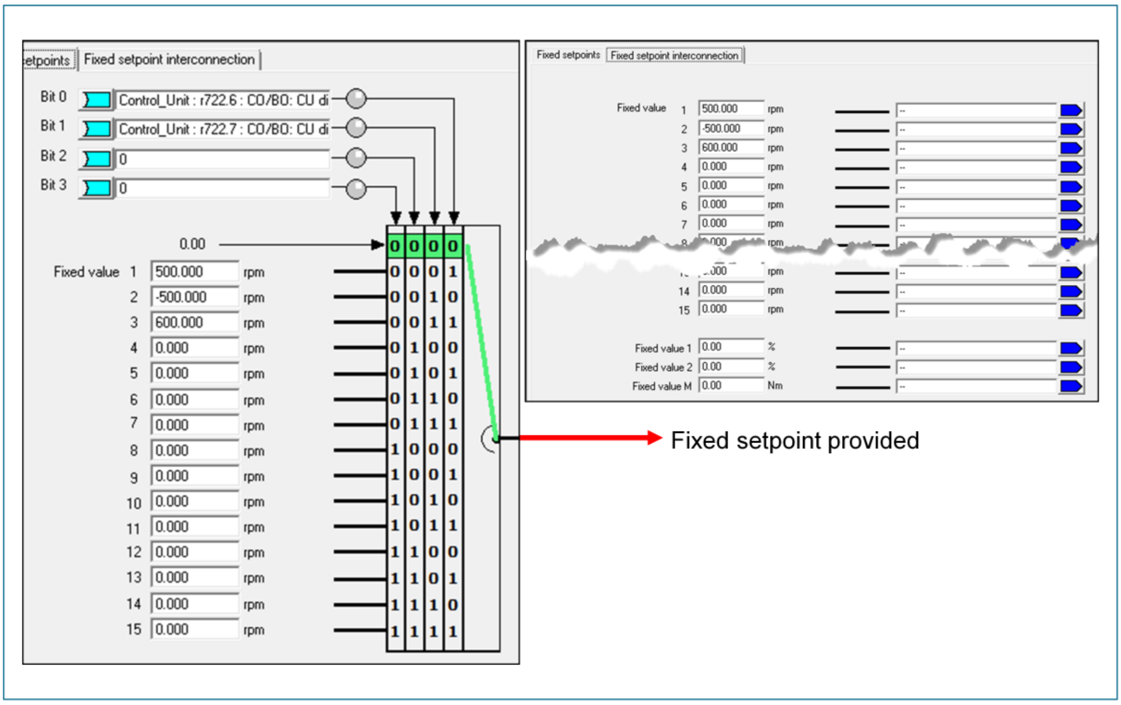
Speed setpoint sources
Fixed setpoints



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Fixed setpoints

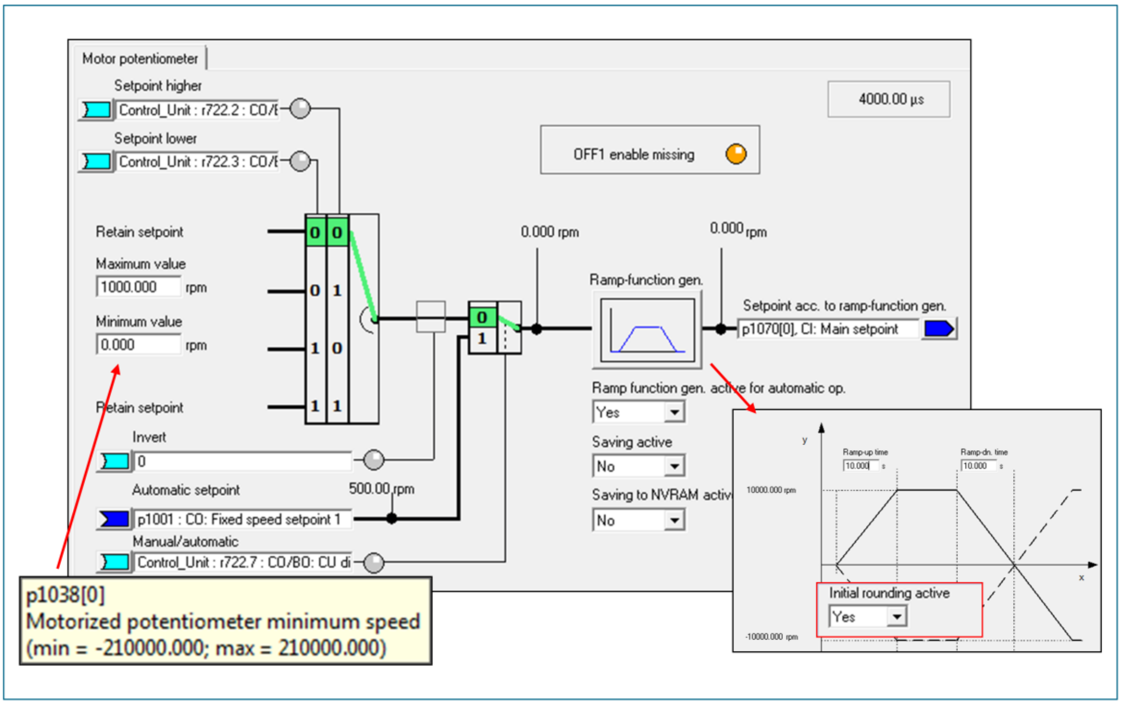
16 different fixed setpoints are available for speed setpoint input, whereby fixed setpoint 0 is preset with the value "0". This is also the factory preset for the main setpoint (p1070).

The four control bits p1020 … p1023 can be used to select the 15 freely selectable fixed setpoints p1001 … p1015 and "0".

The selected fixed setpoint r1024 can be connected, but also the individual values p1001 … p1015.

The number of the fixed setpoint that is switched through is indicated via r1197.

Speed setpoint sources
Motorized potentiometer



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Using the buttons "Setpoint higher" and "Setpoint lower", a speed setpoint between the "Maximum value" and "Minimum value" can be provided. The gradient is defined by the ramp-function generator available here.

Note

During offline configuration, value assignment is initially disabled for a series of appropriately marked parameters, e.g. for parameter p1038 (see shaded field).

Typically, these values can be changed online immediately, but offline they can only be changed after an upload, when the CU has finished calculating.

As soon as parameter p340 = 1 (full calculation) is set the two parameters p1037 (maximum value) and p1038 (minimum value) are cross-hatched in gray and cannot be changed. These two parameters can only be changed as required when the calculation has finished.

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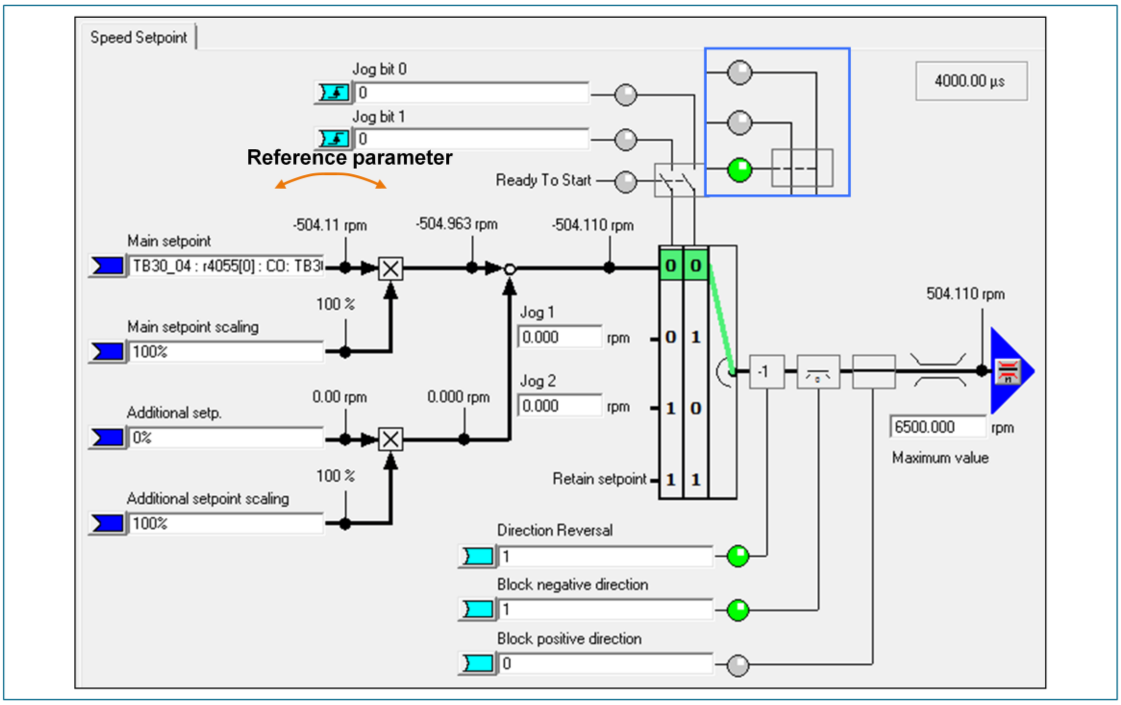
Speed setpoint sources
Main and supplementary setpoint, jog setpoints



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Main setpoint The speed setpoint source is connected with this parameter (p1070).

Supplementary setpoint Alongside the main setpoint, parameter p1075 makes an additional input available via which, for example, a speed setpoint offset can be connected. In various application cases, the supplementary setpoint is used as an alter-native to the main setpoint and it is appropriately weighted by the two scaling parameters p1071 and p1076 or even completely switched off (scaling: 0%).

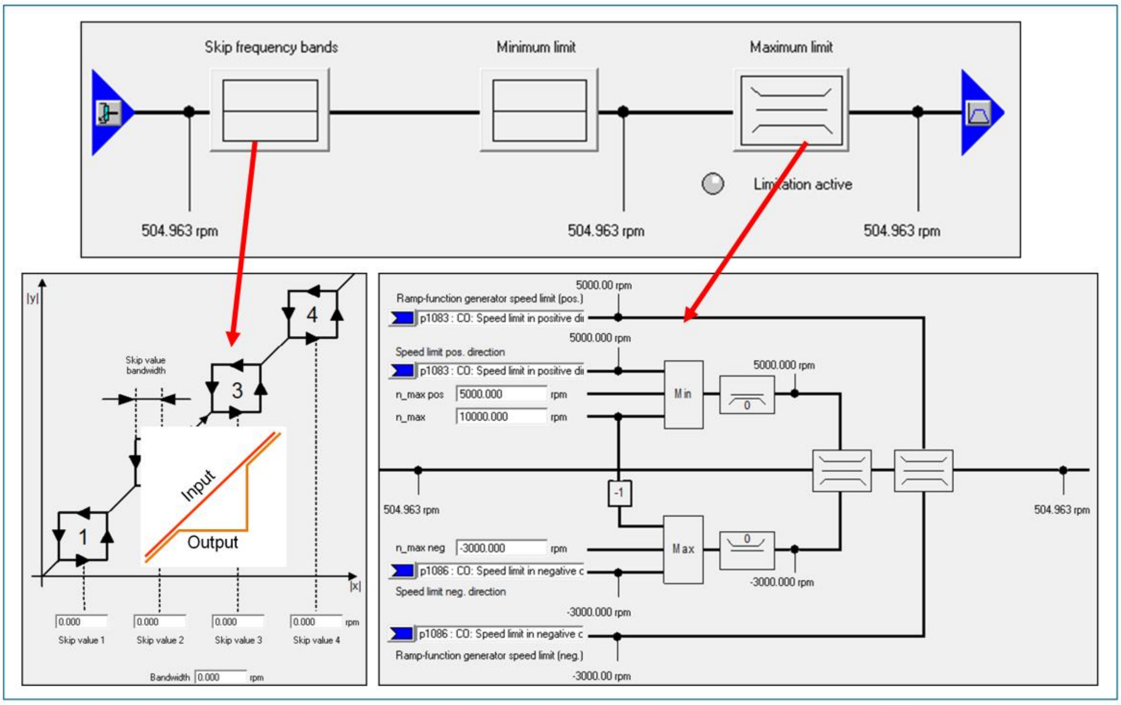
Direction reversal When this is activated the direction can be reversed.

Negative direction inhibit When this is activated, the setpoint for the motor is inhibited in the negative direction (e.g. for pumps that may only be operated in the positive direction!).

Positive direction inhibit When this is activated, the motor is inhibited in the positive direction.

Note If both directions of rotation are inhibited simultaneously, the motor can only operate at speed "0".

Limits



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Skip frequency bands These are used to suppress unfavorable speed ranges, such as resonant speeds. A total of 4 skip frequency bands can be defined with the same hysteresis band width.

Minimum limit Minimum speed at which this motor will operate following speed controller enable.

Maximum limit This limits the speed in the positive and negative directions of rotation.
As the criterion for this, the max. motor speed (p1082), that is effective as a limit in both directions, is entered as well as an individually adjustable limit for the positive direction (p1083) and a limit for the negative direction (p1086).
The most limiting in the applicable direction is effective at the output for the maximum limit.

Ramp-function generator
Basic and extended

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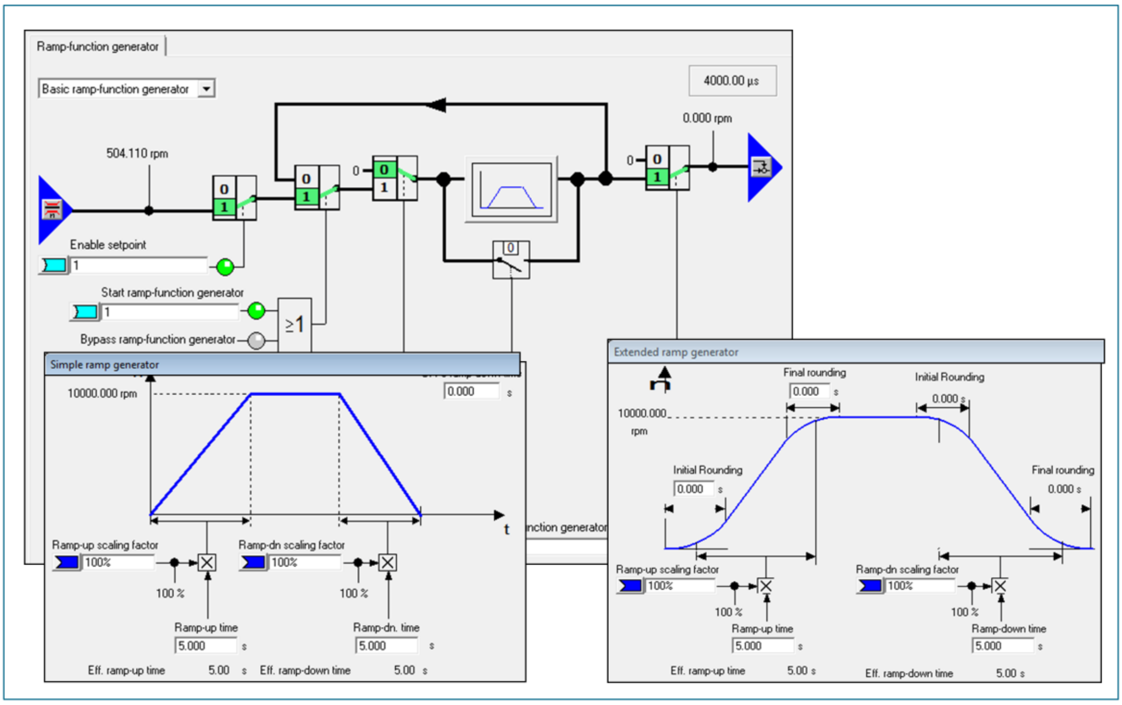

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The basic ramp-function generator is defined by the following parameters:

- Ramp-up time (p1120)
- OFF1 ramp-down time (p1121)
- OFF3 ramp-down time (p1135)

These parameters reference the maximum speed for this motor (p1082).

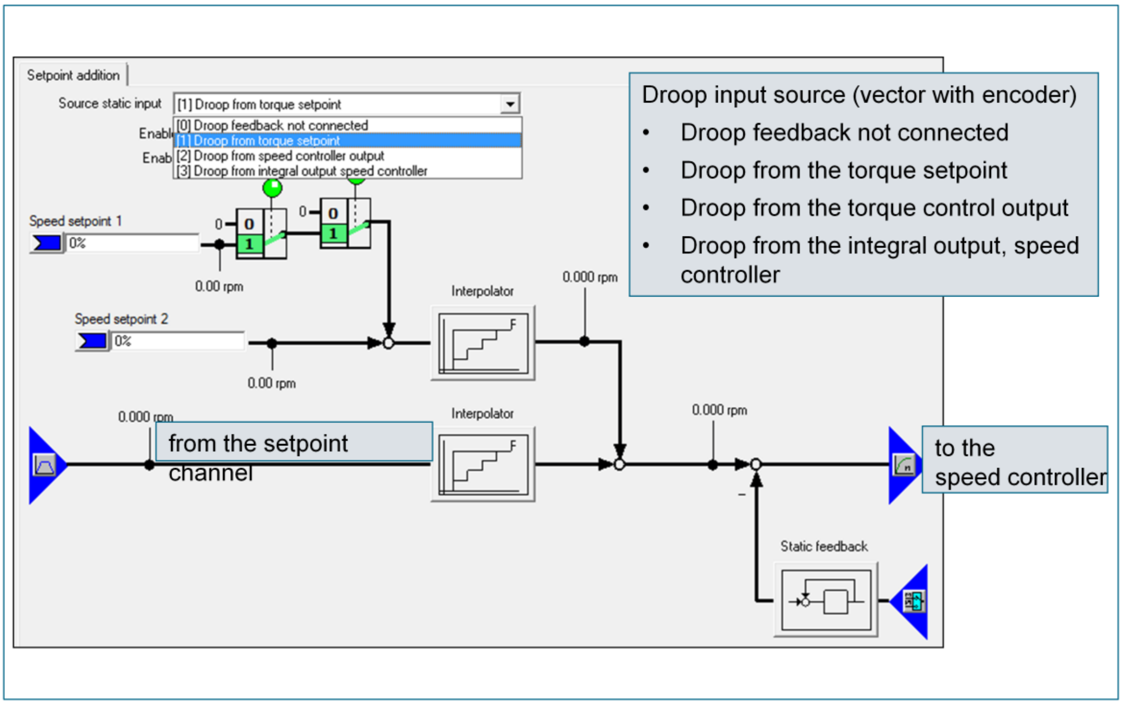
Extended ramp-function generator

In contrast to the basic ramp-function generator, in the case of the extended ramp-function generator, additional time constants are available for initial rounding and final rounding. Additional rounding parameters are available for a quick stop with OFF3.

Bypass ramp-function generator

The control bit "Bypass ramp-function generator" is used to switch off the ramp-up and ramp-down functions as well as the rounding of the ramp-function generator. It must, however, be checked beforehand whether this is permitted for the connected mechanical system.

Setpoint addition
Speed setpoints 1 and 2, droop input



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Setpoint addition

Apart from the speed setpoint conditioned by the speed setpoint channel, two additional speed setpoint offsets can be connected if required by means of speed setpoint 1 (p1155) and speed setpoint 2 (p1160).

This possibility is frequently used with speed precontrols or static speed offsets.

Exercises

- Exercise 1: Parameterizing the setpoint channel and BICO interconnection

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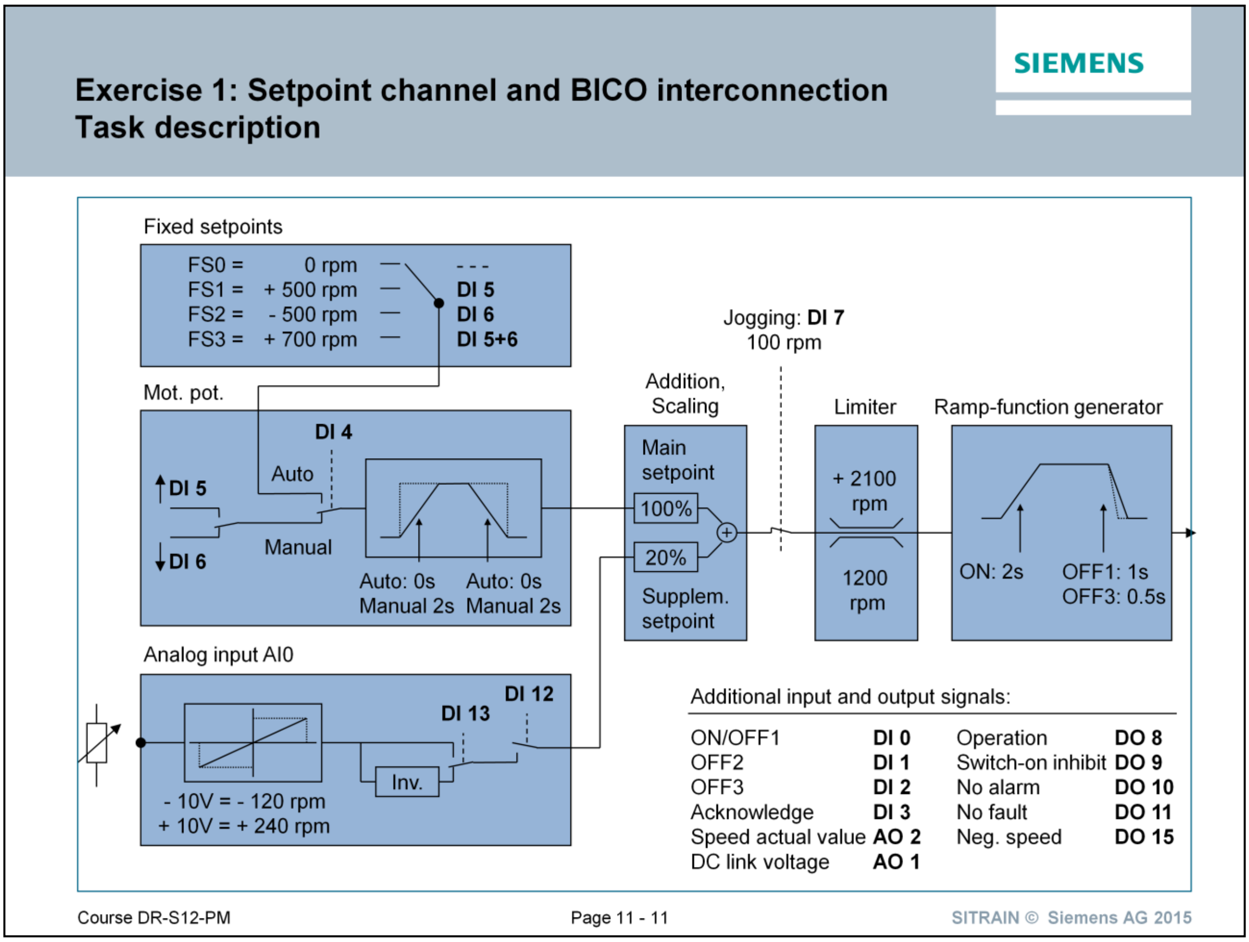
Safety information

Please note that:

- The course instructions have been produced for:
  - A course held by a course leader
  - Activities carried out on special training equipment
- The training equipment is operated under laboratory conditions.
  In case of doubt, always ask your course leader – particularly when handling components that carry electrical current or which can move.
- When carrying out work on equipment, the safety information in the associated product documentation must always be observed!
  The training documents alone are not sufficient.



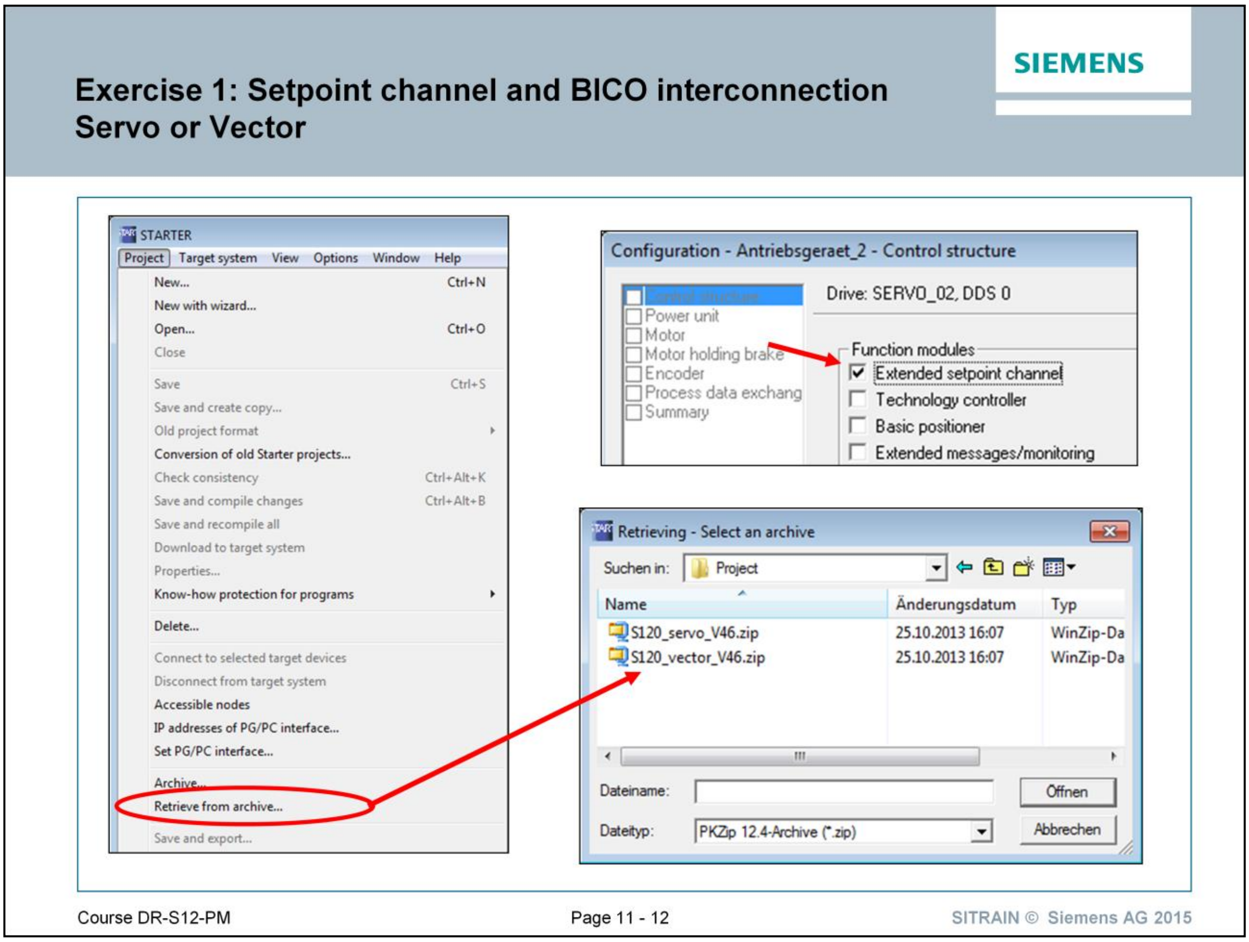
Description

You can use this exercise to train your skills in interconnecting signals using BiCo technology.

In the task, fixed setpoints, motorized potentiometer, analog setpoints as well as control and status bits are interconnected with one another in a complex fashion.

Note

You can use the overview above, or follow the detailed task description on the next slides.



Operating mode

Perform this exercise, depending on the requirement in the "Servo" or "Vector" operating mode. When required, dearchive the appropriate project in the automatically recommended directory:
Project > Dearchive: Select project > Open

- "Servo" operating object: Project "S120_SERVO_V46.zip"
- "Vector" operating object: Project "S120_VECTOR_V46.zip"

Note

In the menu “Drive Navigator“ of the “Servo“ object, up until now the speed controller is supplied with the selected setpoint. Up until now, the "Extended speed setpoint channel" has not been enabled in your configuration.

The reason for this is the applicable operating mode "Servo" in which the setpoint channel is inhibited initially and must be enabled specifically.

1. If you wish to work with the Servo operating mode, select
   >> Servo > Configuration> Configure DDS > Function module: Extended setpoint channel

2. Save the change in your project, go online, transfer the project to the target device and save the configuration permanently in a non-volatile fashion.

3. Check the result:
   The drive navigator has been extended to include the “setpoint channel“ functionality.

4. Speed setpoint source:
   As the speed setpoint source was previously directly interconnected from TB30 to speed setpoint 2 (p1160), this interconnection must be disconnected, and the speed setpoint interconnected from the TB30 to the main setpoint (p1070) at the input of the setpoint channel.

Exercise 1: Setpoint channel and BICO interconnection
Control commands and jogging

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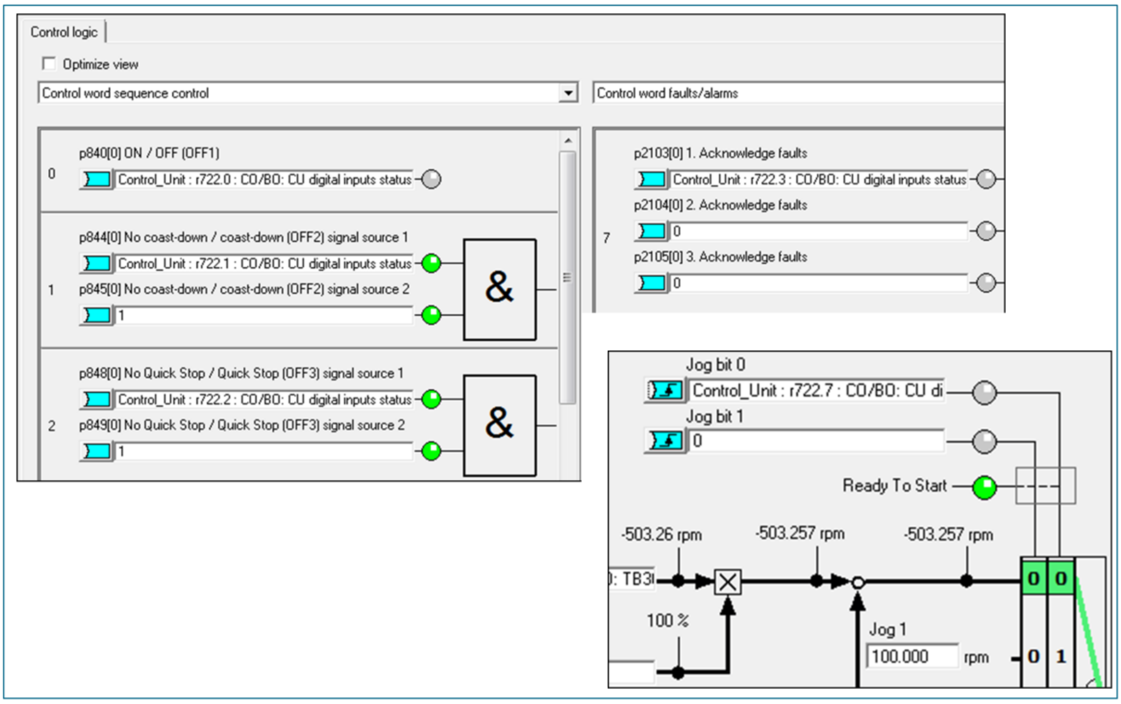

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Task To start, establish a simple function in order to test the operation of the drive.

1. Parameterize the following control commands using the switches on the operator box.
   - ON/OFF 1 via: DI 0
   - OFF 2 via: DI 1
   - OFF 3 via: DI 2
   - Acknowledge via: DI 3

2. Parameterize the "Jog" function:
   - Select jog via: DI 7
   - Jog setpoint: 100 rpm

3. Test the function

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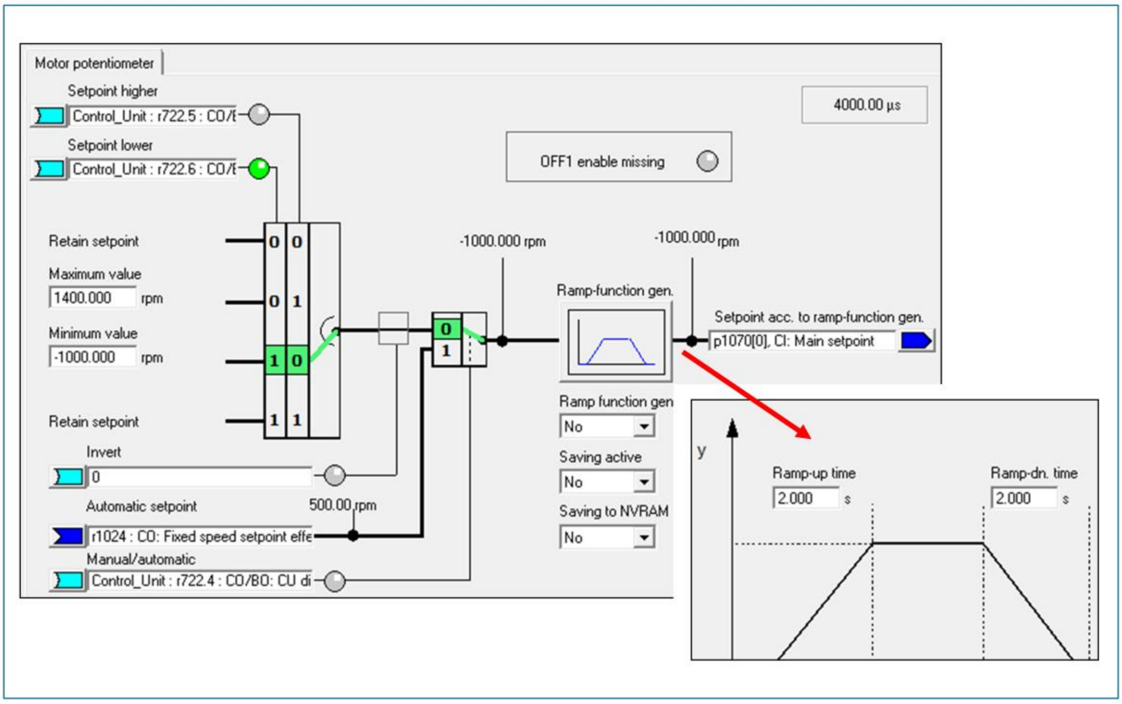
Exercise 1: Setpoint channel and BICO interconnection Motorized potentiometer



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Task

Assign parameters to the motorized potentiometer function to perform the following tasks:

1. Define the digital inputs to operate the motorized potentiometer MOP:
   - MOP raise: DI 5
   - Motorized potentiometer MOP lower: DI 6
   - Select the automatic setpoint: DI 4

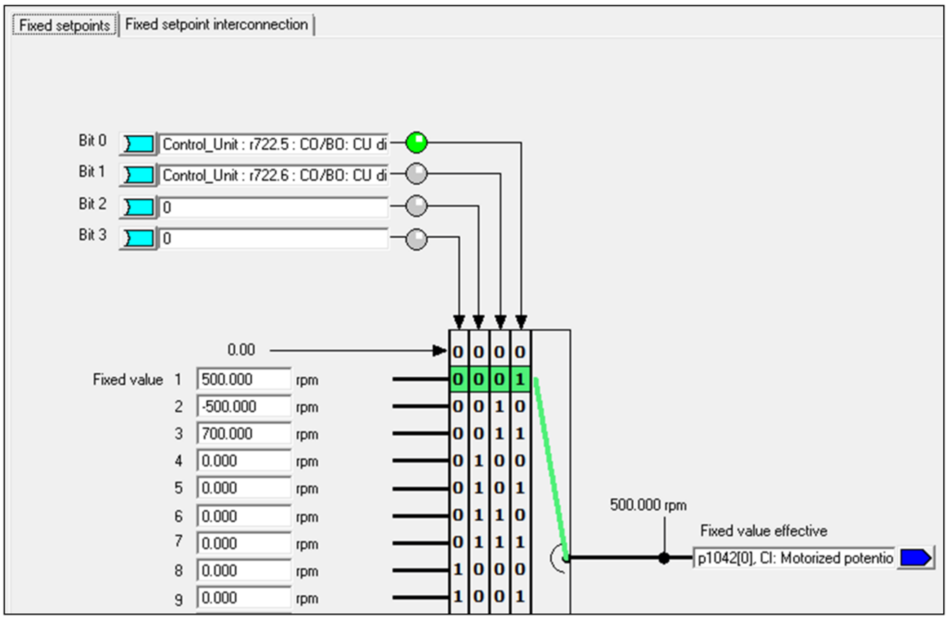
2. Enter the limits for manual operation:
   - Control range: from -1000 rpm to +1400 rpm
   - Ramp-up time RUT: 2s without rounding
   - Ramp-down time RDT: 2s without rounding

3. Enter the ramp-up and ramp-down times for automatic operation:
   - Ramp-up time RUT: 0s
   - Ramp-down time RDT: 0s

4. Incorporate the motorized potentiometer into the setpoint channel:
   - Motorized potentiometer output as main setpoint (p1070)
   - Automatic setpoint from "Fixed speed setpoint" active (r1024)"

5. Test the parameterized functionality

Exercise 1: Setpoint channel and BICO interconnection Fixed setpoints



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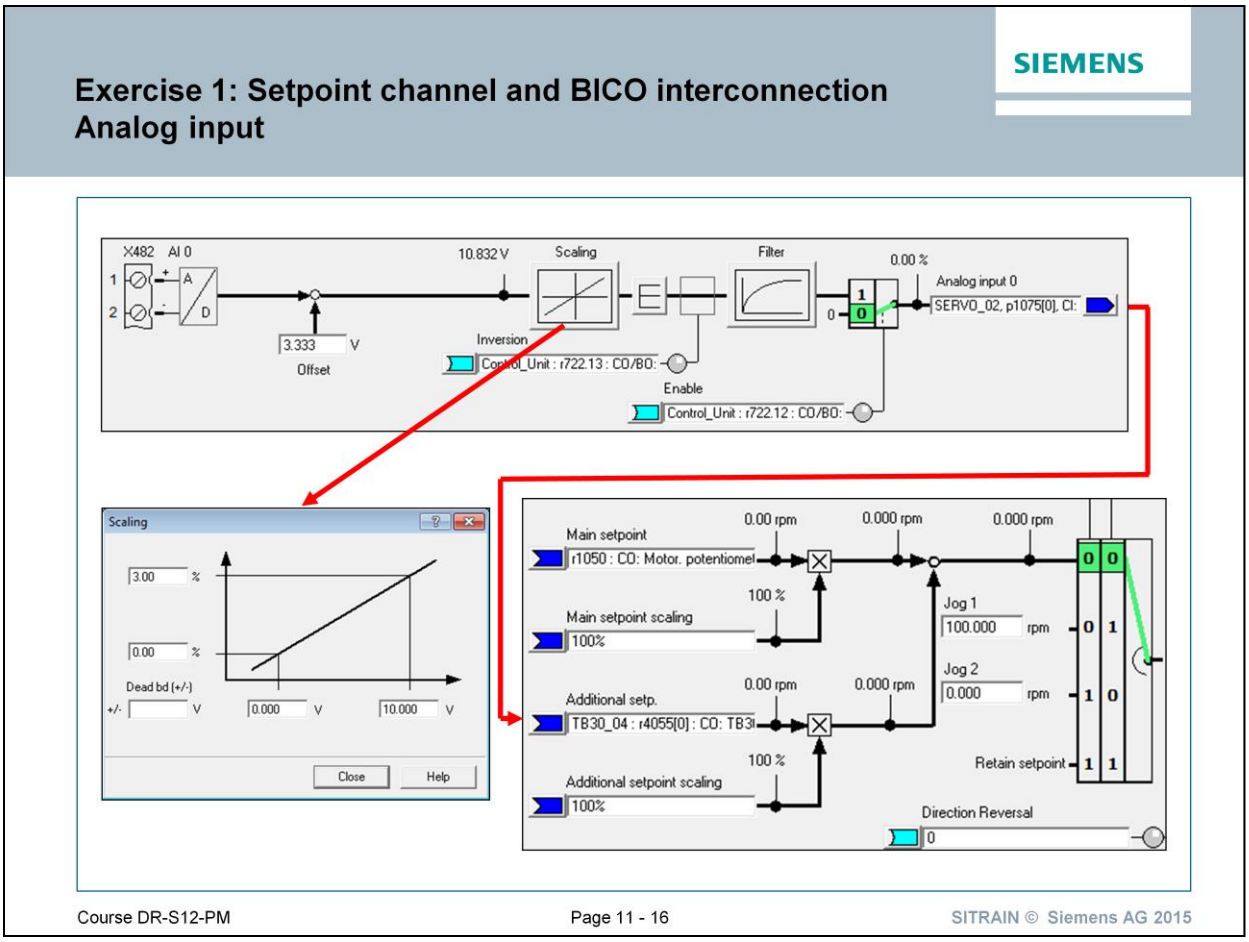
Task Define the selection and values for the fixed setpoints as follows:

1. Enter the following setpoints:
   - Fixed setpoint 0 0 rpm
   - Fixed setpoint 1 +500 rpm
   - Fixed setpoint 2 -500 rpm
   - Fixed setpoint 3 +700 rpm

2. Parameterize the following binary logic operation to select the fixed setpoints:
   - Fixed setpoint 0 DI 5 = 0 DI 6 = 0
   - Fixed setpoint 1 DI 5 = 1 DI 6 = 0
   - Fixed setpoint 2 DI 5 = 0 DI 6 = 1
   - Fixed setpoint 3 DI 5 = 1 DI 6 = 1

3. Test the parameterized functionality



Task Incorporate analog input 0 (AI0) as supplementary setpoint and scale the signal:

1. Incorporate the analog input:
   - Analog input 0 (AI0) as supplementary setpoint:
   - Switch-in or switch-out using: DI 12
   - Sign reversal of the analog input using: DI 13

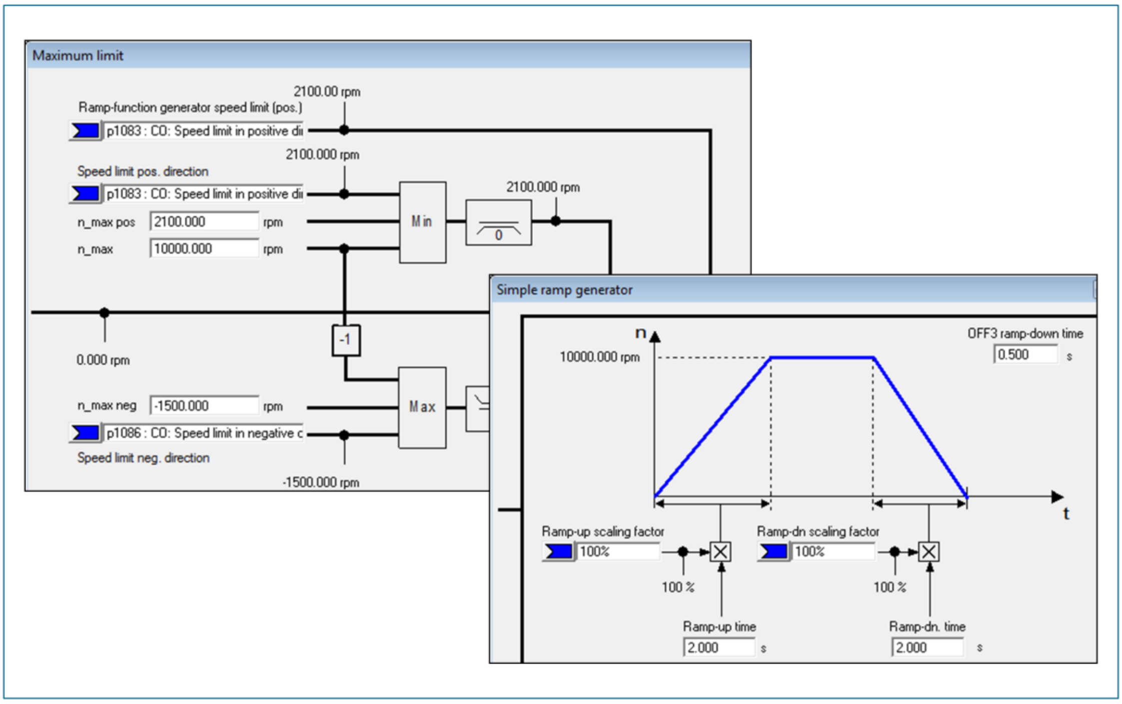
2. Scale the analog input as specified below. You can find the reference values in p2000 – p2003.
   - -10 V corresponds to -120 rpm
   - +10 V corresponds to +240 rpm

   With p2000 = 6000 rpm:
   - -120 rpm corresponds to -2%
   - +240 rpm corresponds to +4%

   This means:
   - -10V corresponds to -2%
   - +10V corresponds to +4%

3. Test the function of the analog input.

Exercise 1: Setpoint channel and BICO interconnection
Limits



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Task Parameterize the following limits to protect the mechanical system against overload, sudden acceleration and resonant frequencies.

1. Enter the following limits:
   Speed range from -1500 rpm up to +2100 rpm

2. Parameterize the ramp-function generator:
   - Ramp-up time: 2s
   - Ramp-down time: 1s
   - Ramp-down time for OFF3: 0.5s

3. Skip (suppress) the following speed range:
   from +700 rpm to +750 rpm

4. Test the functionality by entering a setpoint via analog input 0 (AI 0).

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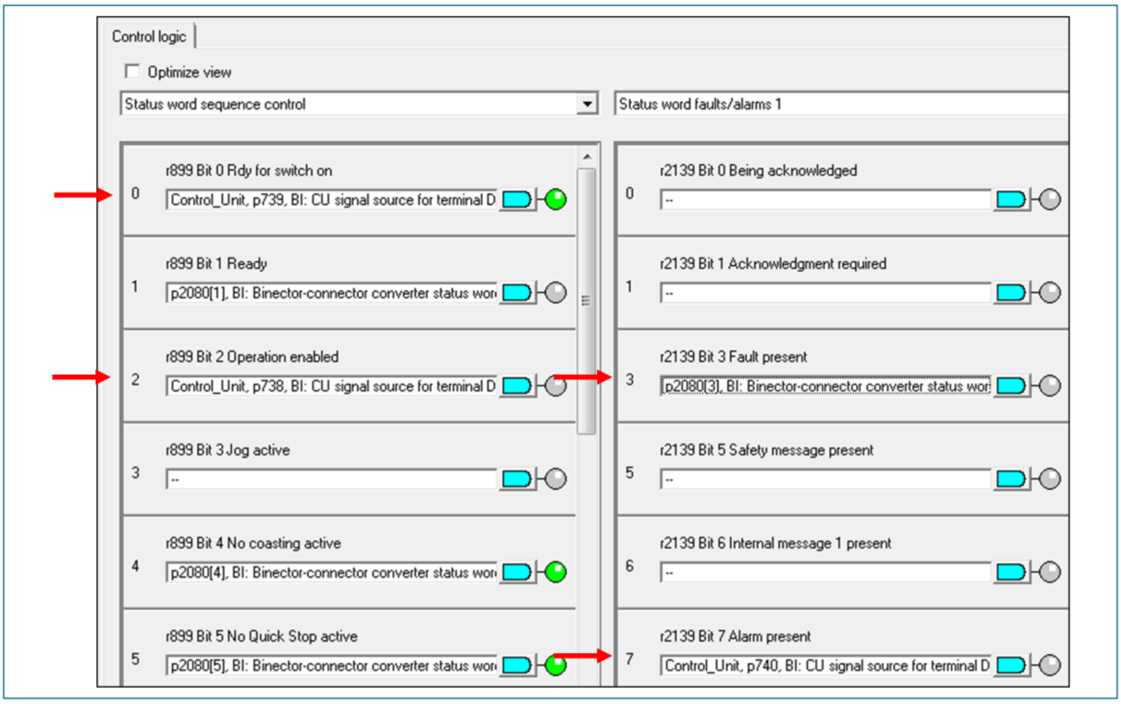
Exercise 1: Setpoint channel and BICO interconnection
Status signals and analog output



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Task

In order to receive feedback regarding the drive status, route the following signals to the binary and analog outputs.

1. Parameterize the important status signals to energize the LEDs of the operator box:
   - Operation enabled: DO 8
   - No alarm: DO 10
   - Ready to switch on: DO 9
   - No fault: DO 11
   - Negative speed: DO 15

2. Parameterize analog output 0 (AO 0) to display speed actual value n_{act}:
   - n_{act} = - 1500 rpm -> AO 0 = 0 V
   - n_{act} = +1500 rpm -> AO 0 = 10 V

3. Parameterize analog output 1 (AO 1) to display the DC link voltage $U_{DC\ link}$:
   - $U_{DC\ link}$ = 0 V ➔ AO1 = 0 V
   - $U_{DC\ link}$ = 500 V ➔ AO 1 = +10 V

4. Test the parameterized functionality.

Exercise 1: Setpoint channel and BICO interconnection Saving and archiving

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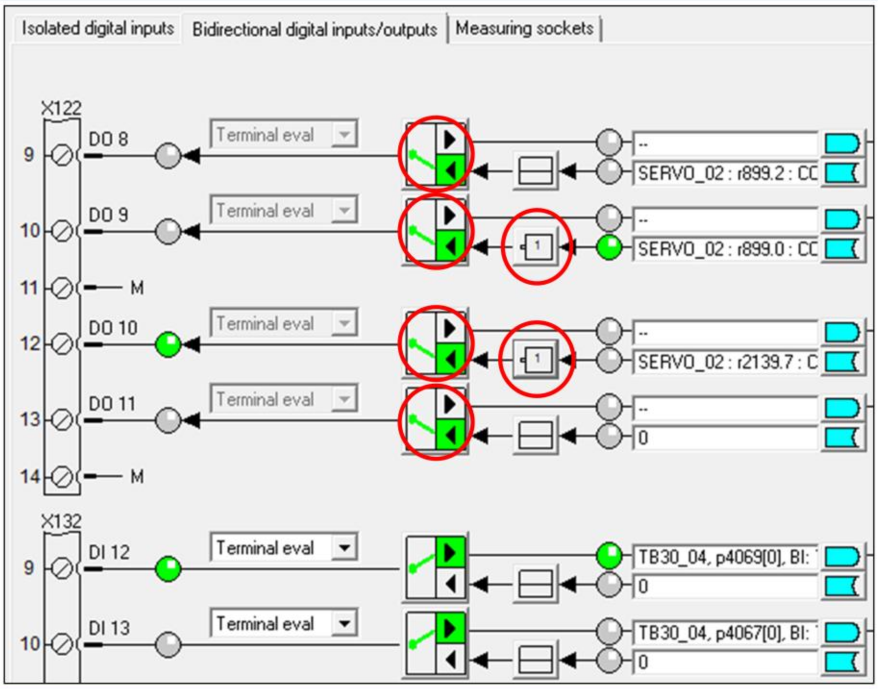

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Task Back up your parameterization and archive your project.

1. Take appropriate steps to ensure that your online changes are still effective even when the 24 V DC supply is reconnected to the CU320-2DP:

   ……………………………………………………………………………………

2. Also ensure that your offline project at the PG/PC also has the changes made online:

   ……………………………………………………………………………………

   ……………………………………………………………………………………

3. Save the current project and archive it under a different name:
   >> Project > Archive ...

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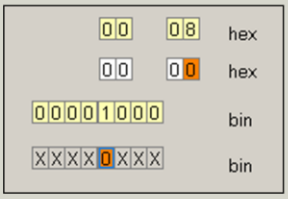

Chapter 12

Diagnostics

Course DR-S12-PM

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Learning Targets

- You will be able to use the LEDs and the status display of the BOP20
- You will be able to work with fault memory and alarm history
- You will be able to compare parameter sets and objects
- You will be able to change fault reactions and trigger to faults
- You will be able to read out error messages with the web server

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LEDs on DRIVE-CLiQ components
CU320-2 during booting

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LED			Status	Comment
RDY	DP /PN	OPT		
Red	Orange	Orange	Reset	Hardware reset RDY LED lights up red, all other LEDs light up orange
Red	Red	Off	BIOS loaded	–
Red 2 Hz	Red	Off	BIOS error	• Error occurred while loading the BIOS
Red 2 Hz	Red 2 Hz	Off	File error	• Memory card not inserted or defective • Software on memory card not present or corrupted
Red	Orange Flashing light	Off	FW loading	RDY LED lights up red, PN LED flashes orange without fixed frequency
Red	Off	Off	FW loaded	-
Off	Red	Off	FW checked (no CRC error)	
Red 0.5 Hz	Red 0.5 Hz	Off	FW checked (CRC error)	• CRC invalid

CU320-2 DP

CU320-2 PN

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The individual states during the booting procedure are indicated by means of the LEDs on the Control Unit.

- The duration of the individual states varies.
- If an error occurs, the booting procedure is terminated and the cause is indicated on the LEDs. Remedial action in the event of an error: Insert the appropriate memory card with the correct software and parameterization.
- Once the unit has successfully booted, all the LEDs are switched off briefly.
- Once the unit has been booted, the LEDs are driven via the loaded firmware.

RDY (Ready) Signals the operating status of the CU and the complete drive system

DP (Profibus DP) Only active during cyclic PROFIBUS DP communication and signals the status of communication via the PROFIBUS DP onboard interface of the CU

OPT (Option board) Only active when the option board is inserted in the CU and signals the status of this board.

BIOS This is boot loader 1 that is checked subsequently during booting of the CU.

Firmware The firmware for the CU and all connected DRIVE-CLiQ components is stored on the CF card and is checked during initialization.

LEDs an DRIVE-CLiQ-Komponenten CU320-2 nach Hochlauf, RDY LED

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LED	Farbe	Zustand	…che	Abhilfe
RDY (READY)	–	AUS	…ung fehlt oder ist außerhalb …bereichs.	Stromversorgung überprüfen
	Grün	Dauerlicht	Die K… …etriebsbereit und zyklische DRIVE-CL… …ation findet statt.	–
		Blinklicht 0,5 Hz	Inbetri…	–
		Blinklicht 2 Hz	Schreiben auf S…	–
	Rot	Blinklicht 2 Hz	Allgemeine Fehler	Parametrierung/Konfiguration überprüfen
	Rot/ Grün	Blinklicht 0,5 Hz	Control Unit ist betriebsbere… Es fehlen aber Software-Lizenze…	Lizenzen nachrüsten
	Orange	Blinklicht 0,5 Hz	Firmware-Update der angeschlossenen …VE-CLiQ-Komponenten läuft	–
		Blinklicht 2 Hz	Firmware-Update der DRIVE-CLiQ-Komponenten ist abgeschlossen. Warten auf POWER ON der jeweiligen Komponente.	POWER ON der jeweiligen Komponente durchführen
	Grün/ Orange oder Rot/ Orange	Blinklicht 2 Hz	Erkennung der Komponente über LED ist aktiviert (p0124[0]). **Hinweis:** Die beiden Möglichkeiten hängen vom Zustand der LED beim Aktivieren über p0124[0] = 1 ab.	–

CU320-2 DP

CU320-2 PN

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RDY Betriebszustand - READY = GRÜN
Die Komponente ist betriebsbereit und die zyklische DRIVE-CLiQ-Kommunikation findet statt oder die Control Unit wartet auf die Erstinbetriebnahme.

DP Betriebszustand - PROFIdrive zyklischer Betrieb = GRÜN
Zyklische Kommunikation findet statt.

OPT Betriebszustand OPTIONBOARD = GRÜN
Option Board ist betriebsbereit.

LEDs on DRIVE-CLiQ components
CU320-2 cyclic mode, DP LED

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LED	Color	Status	Description, cause	Remedy
DP1 PROFIdrive cyclic operation	-	Off	Cyclic communication has not (yet) taken place. **Note:** The PROFIdrive is ready to communicate when the Control Unit is ready to operate (see LED RDY).	–
	Green	Continuous light	Cyclic communication is taking place.	–
		0.5 Hz flashing light	Full cyclic communication has not yet taken place. Possible causes: • The controller is not transferring any setpoints. • During isochronous operation, no global control (GC) or a faulty global control (GC) is transferred by the controller.	–
	Red	Continuous light	Cyclic communication has been interrupted.	Remedy fault
	Orange	2 Hz flashing light	Firmware CRC error.	Make sure that the memory card has been inserted properly Replace the memory card Replace Control Unit Carry out a POWER ON

CU320-2 DP

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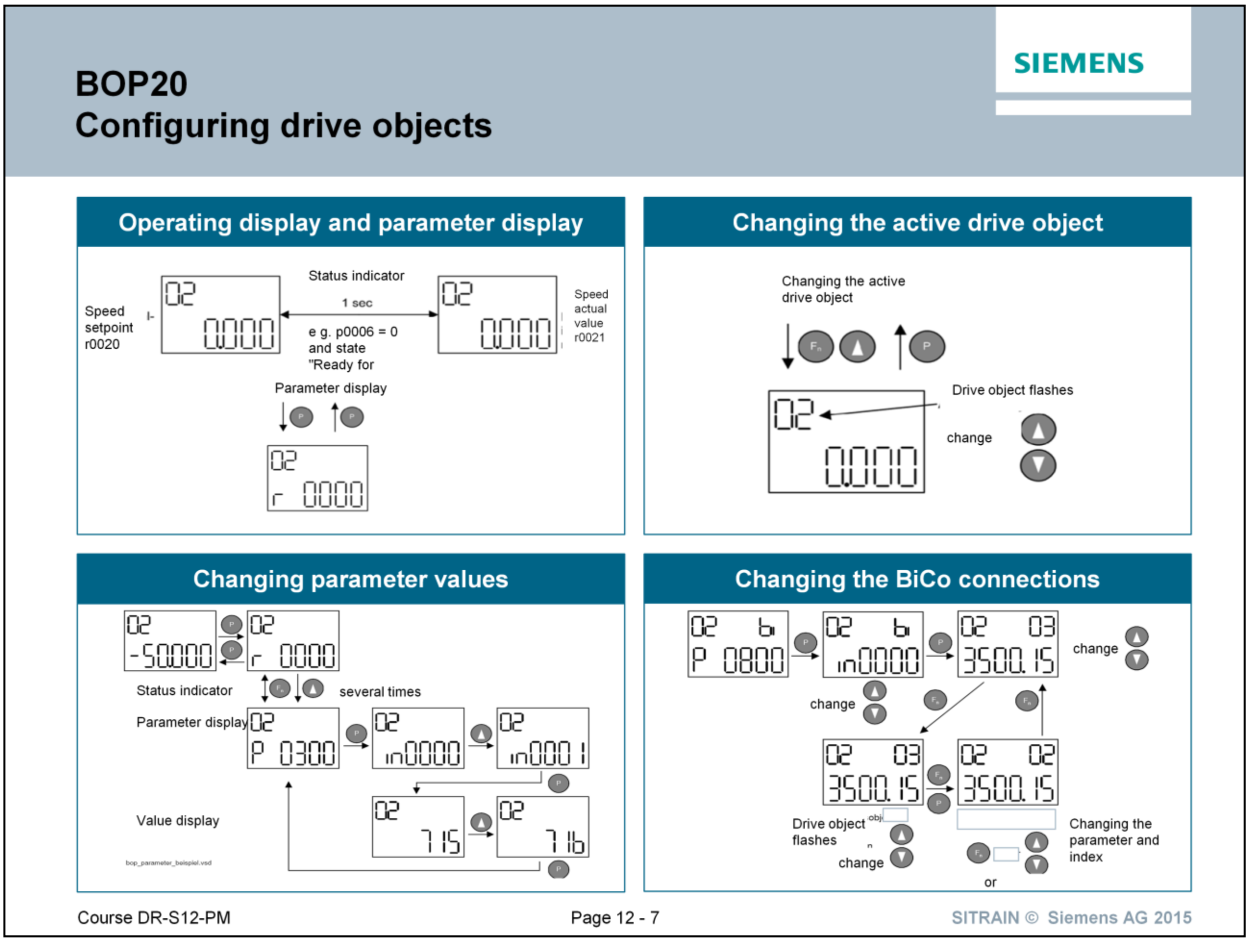
RDY Operating status – READY = GREEN
The component is ready and cyclic DRIVE-CLiQ communication takes place or the Control Unit waits for first commissioning.

DP Operating status – PROFIdrive cyclic mode = GREEN
Cyclic communication takes place.

OPT Operating status OPTIONBOARD = GREEN
Option board is ready for operation.

CU loader The CU loader is located on the Control Unit. It corresponds to the BIOS of a PC.

CU loader The CF loader is located on the CF card. It handles start-up of the Control Unit and transfer of the required files after switch-on.



Parameters

The parameters are selected in the BOP20 using the number.
The parameter display is reached from the operating display by pressing the "P" key.
Parameters can be searched for using the arrow keys.
The parameter value is displayed by pressing the "P" key again.
You can toggle between the drive objects by simultaneously pressing the keys "FN" and the arrow keys.
You can toggle between r0000 and the parameter that was last displayed by pressing the "FN" key in the parameter display.

Value display

To switch from the parameter display to the value display, press the "P" key.

In the value display, the values of the adjustable parameters can be increased and decreased using the arrow. The cursor can be selected using the "FN" key.

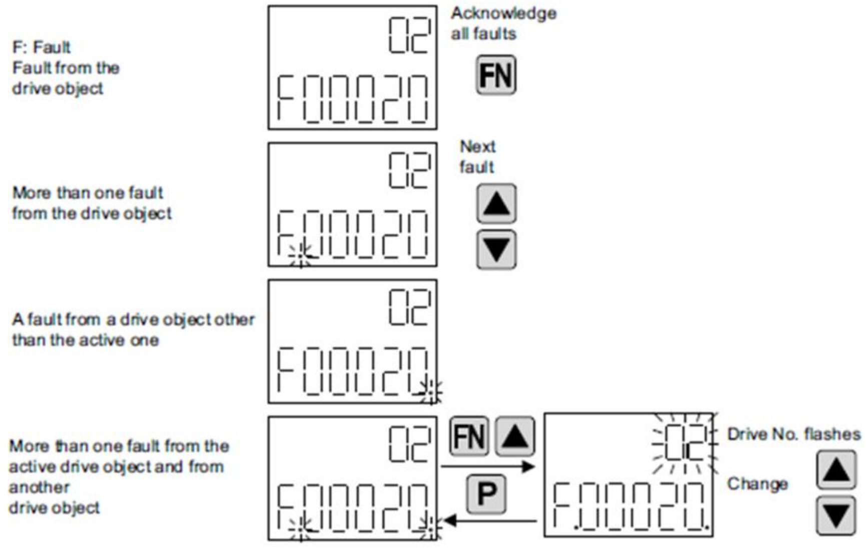
Prerequisite

The corresponding access level must be set properly.
For our example, p0003 = 3.

Procedure:

- Press the "P" key.
- Press the arrow keys, select parameter p0013
- Press the "P" key.
- Press the arrow keys 4 times -> Select index 4
- Press the "P" key.
- Press the "FN" key 3 times -> Select hundred input position
- Press the arrow keys 3 times -> Enter 3 hundred value
- Press the "P" key.

BOP20
Fault diagnostics and display



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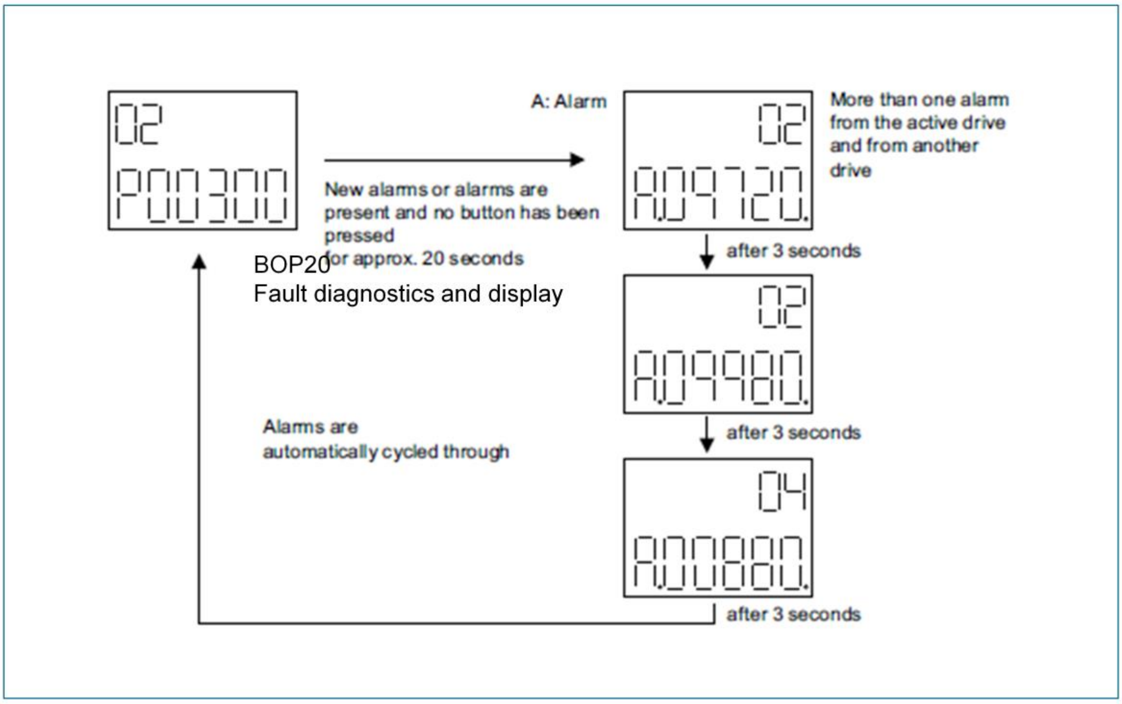
BOP20
Warning diagnostics and display



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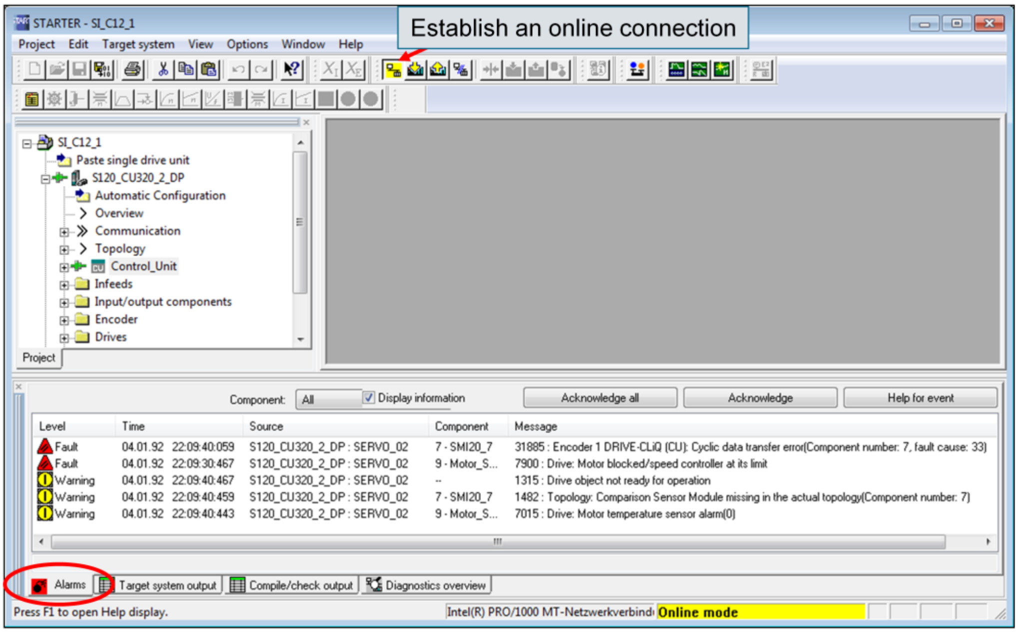
Diagnostics
Alarm display in detail view



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Message display Faults and alarms are displayed in the detail view of the workbench in the STARTER. To do this, STARTER must be in ONLINE mode. You can then activate display for alarms and messages in the "Alarms" tab in the detail view.

The fault and alarm display provides information about the origin and type of faults and alarms that are present.

Level "Level" displays the type of information.

- Information: General information.
- Fault: General fault states (e.g. in the communication to the drive).
- Alarm: Fault states relating to the technology object.

Time The time and date stamp of the fault or information/alarm is displayed.

Source The device or technology object where the fault or information/alarm has occurred is displayed.

Message The fault or information/alarm text is displayed in plain text. The fault or alarm text generally contains additional information.

For a description of the additional information, please refer to the online help.

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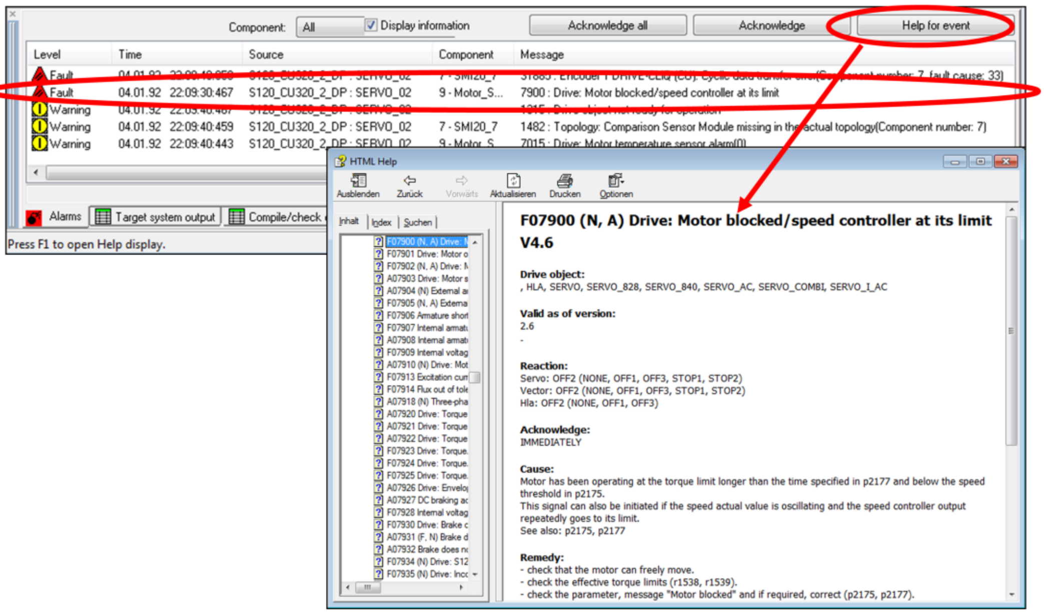
Diagnostics
Faults and alarms



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Faults

Faults are indicated with Fxxxxx (fault) and generally result in a fault response.

- Must be acknowledged once the cause has been remedied.
- Status via Control Unit and LED RDY.
- Status via PROFIBUS status signal ZSW1.3 (fault active).
- Entry in the fault buffer.

Alarms

Alarms are identified by Axxxxx (alarm).

- They have no further effect on the drive unit.
- The alarms are automatically reset once the cause has been remedied. No acknowledgement is required.
- Status via PROFIBUS status signal ZSW1.7 (alarm active).
- Entry in the alarm buffer.

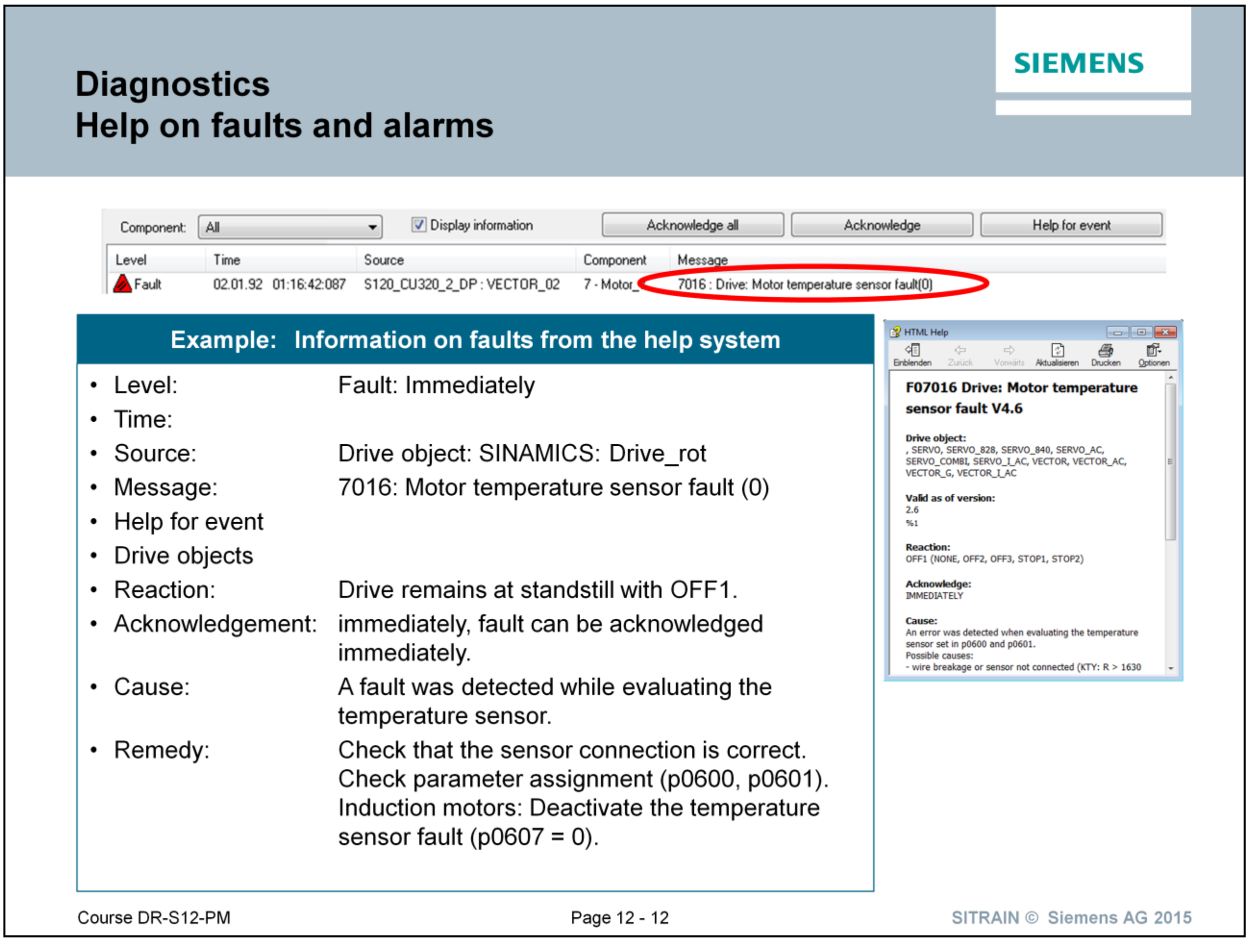
General properties

- Triggering on selected messages possible
- Initiation of external alarm/fault 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.

- Acknowledge faults with "POWER ON"
  - Switch the drive on/off (POWER ON)
  - Press the RESET button on the Control Unit
- Acknowledge faults with "IMMEDIATE"
  - Using the PROFIBUS control signal
  - Using an external input signal
  - Via BOP/AOP
- Acknowledge faults with "PULSE INHIBIT"



Reaction A variety of reactions are possible for faults, e.g.: OFF1, OFF2 or OFF3.

The default reaction is indicated. Reparameterization can be used to select a fault reaction from the options stated in brackets.

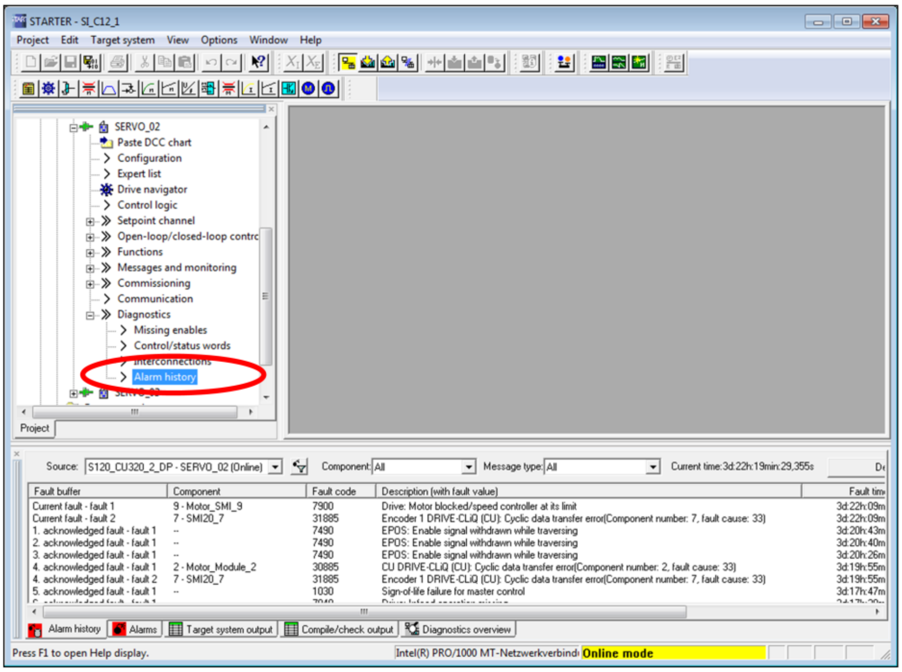
Acknowledgement Faults can be acknowledged on one drive object or on all drive objects as follows:

- Acknowledging by setting parameter: p3981 = 0 --> 1
- Acknowledging via binector inputs:
  - p2103 BI: 1. Acknowledge faults
  - p2104 BI: 2. Acknowledge faults
  - p2105 BI: 3. Acknowledge faults
- Acknowledging via a PROFIDRIVE control signal: STW1.7 = 0 -> 1 (edge)
- Acknowledge all faults via p2102 BI: Acknowledge all faults
  All of the faults on all of the drive objects of the drive system can be acknowledged using this binector input.

Note:

- These faults can also be acknowledged by a POWER ON operation.
- If this action has not eliminated the fault cause, the fault will continue to be displayed after acknowledgment.

Faults and alarms
Alarm history



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Fault/alarm memory Each drive object has its own fault memory for faults and alarms, which is stored in non-volatile memory. This fault memory has a length of 64 lines, which are displayed in the detail view via Diagnostics > Alarm history.

Fault memory The fault memory is 64 lines in length and has the following structure:

- Current fault: Lines 0 to 7 with parameters r945[0] … r945[7]
- 1st acknowledged fault: Lines 8 to 15 with parameters r945[8] … r945[15]
- …
- 7th acknowledged fault: Lines 56 to 63 with parameters r945[56] … r945[63]

Actual fault The currently active faults that have neither been rectified nor acknowledged.

Acknowledged fault When the cause of the fault has been rectified and the fault has been acknowledged, these fault alarms are moved to the next acknowledged fault case. It is therefore possible to save up to 7 previous fault cases in addition to the current fault case. If a further fault case arises, the previous contents of the 7th acknowledged fault are lost. This behavior corresponds to that of a shift register with 8 stages.

Alarm memory The alarm memory is 64 lines in length and has the same structure as the fault memory.

Active alarms Lines 7 to 0 contain the currently active alarms, whereby the latest alarm is in line 7 and the oldest active alarm is shown in line 0.

Alarm history The alarms that have returned to normal are shown in lines 8 to 63 with the latest alarm in line 8 and the oldest in ascending order from line 9.
If the alarm memory is full up to line 63 and another alarm is output, these entries are shifted by one line such that the old contents of line 63 are lost.

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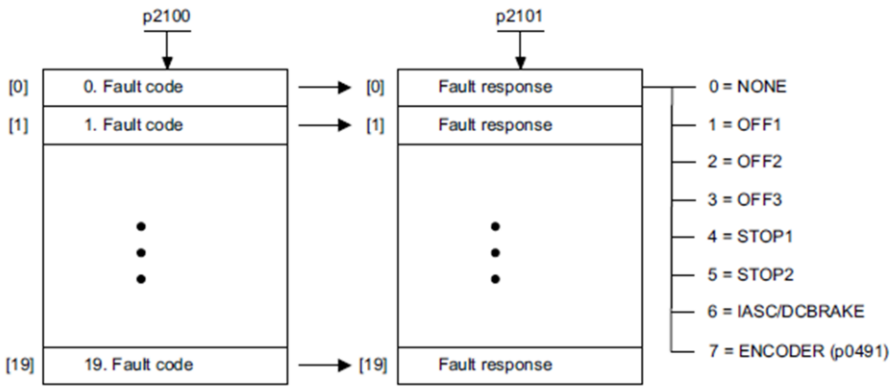
Faults and alarms
Configuration of the fault reaction

p2100	p2101
• Setting the fault number for fault response • Selecting faults for which the fault reaction should be changed	• Setting the fault response for the selected fault



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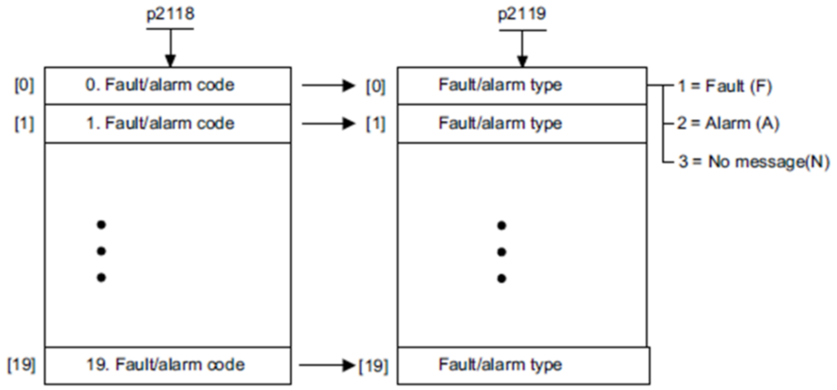
Fault response

Every fault is assigned to a predefined fault response. This is assigned in the online help for the respective fault. In some cases, it is also possible to define another fault response.

For this purpose, the fault code must be specified in parameter p2100[x] and the required fault response in parameter p2101[x].
Up to 20 fault codes can be entered and different fault responses can be defined for each. The extent to which these changes affect other drive objects and functions should be clarified with the person responsible in Siemens Customer Support.

Faults and alarms
Configuration of the message type

p2118	p2119
• Setting the message number for message type, for which the type of message is to be changed	• Setting the message type for the selected fault or warning



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Alarm or fault

If a response defined as an alarm should trigger a fault with a fault response, you can enter the alarm code in parameter p2118[x] and select the entry "Fault" in the corresponding p2119[x] parameter. A total of 20 changes are possible for each drive object.

Faults and alarms
Configuration of the fault acknowledgement

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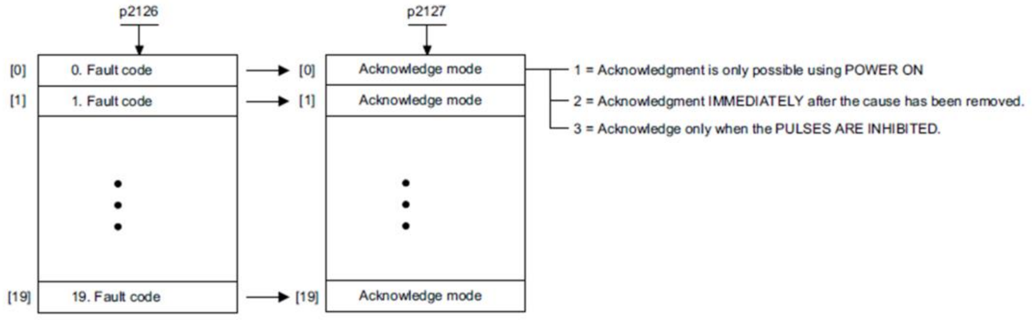
p2126	p2127
• Setting the fault number for the acknowledgement mode • Selecting faults for which the type of acknowledgment is to be changed	• Setting the type of acknowledgement for the selected fault



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Acknowledgement

The acknowledgement response can also be changed in some circumstances. To do this, you must enter the fault code in parameter p2126[x] and select the acknowledgement response in the corresponding p2127[x] parameter.

Faults and alarms
Trigger word for faults and alarms

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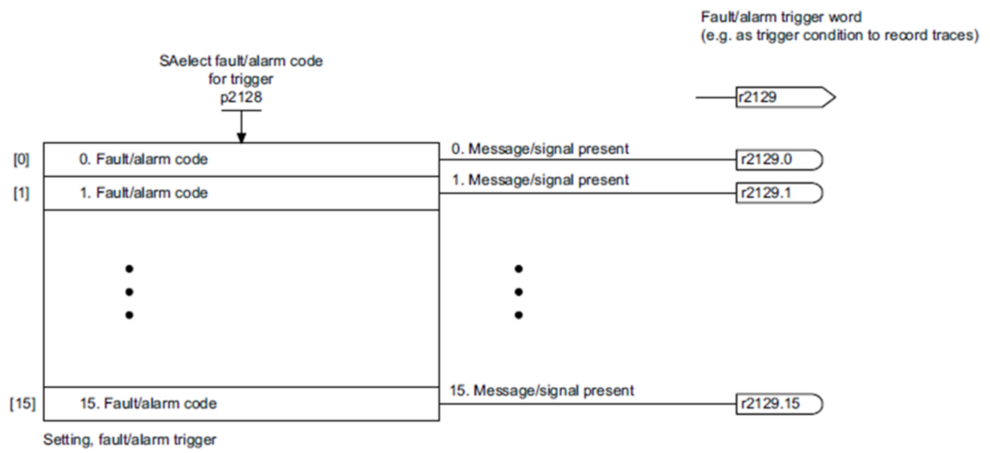
p2128	p2127
• Selecting fault/alarm code for trigger • Selecting faults or alarms that can be triggered	• Trigger word for faults and alarms • Trigger signal for the selected faults and signals



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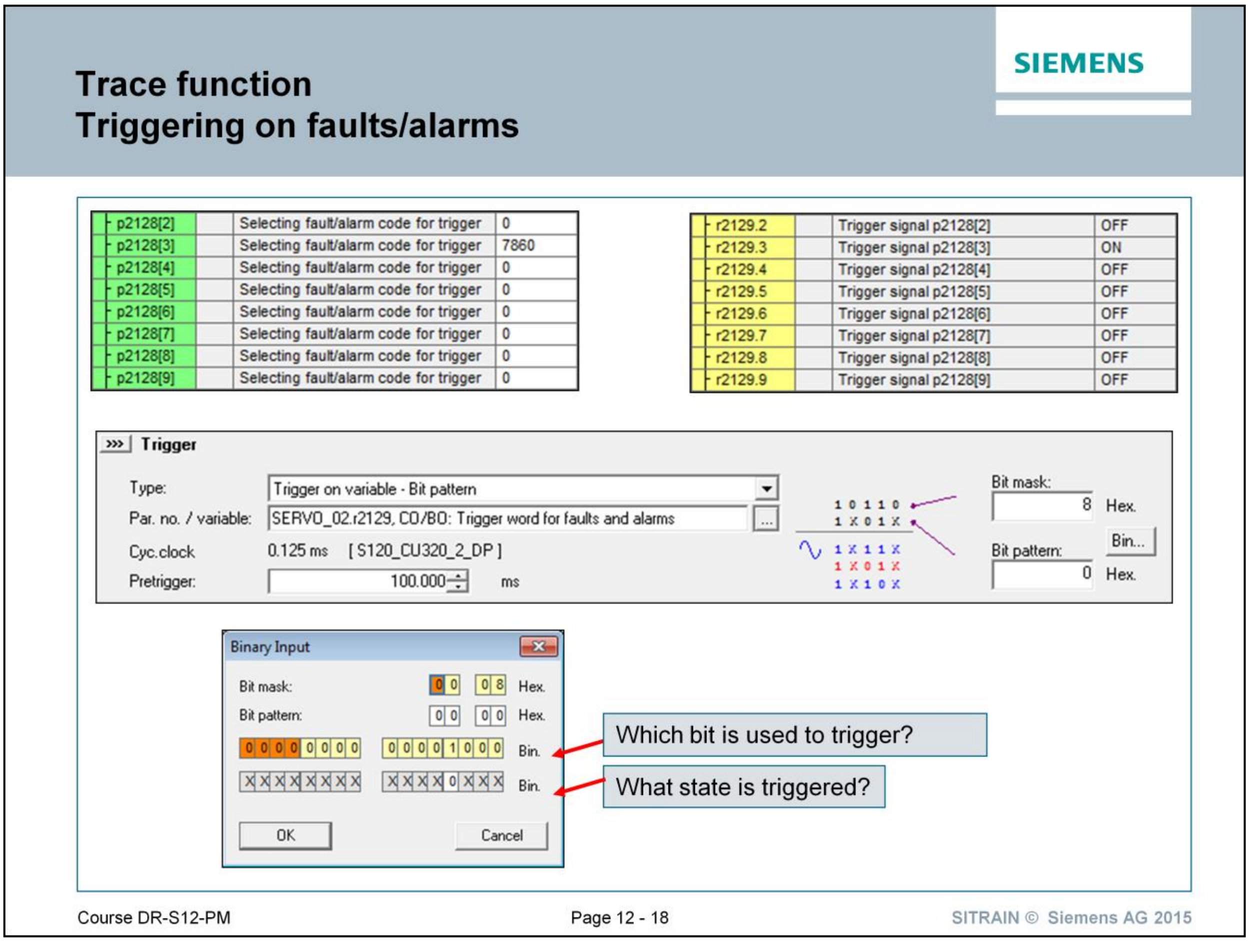
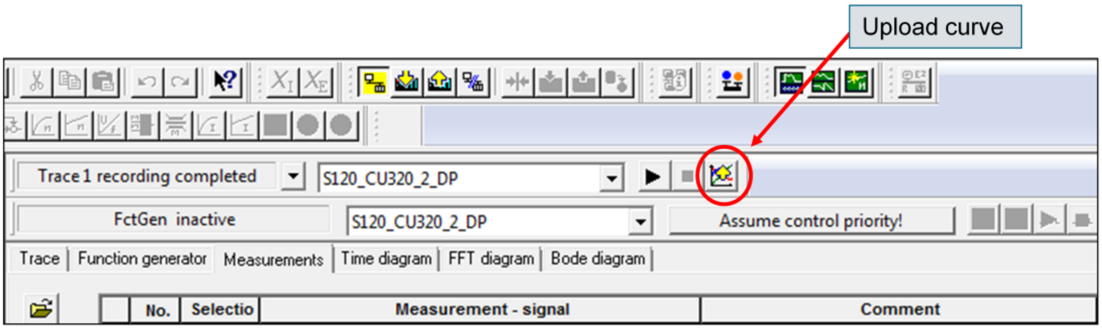
Trigger word

Parameter p2128[x] can be used to individually assemble a trigger word with up to 16 faults and alarms. A "1" signal will then be output in parameter r2129 at the respective bit position as soon as the associated fault or alarm has occurred.
This means that triggering is possible in response to a specific fault or alarm.



Triggering By assigning trigger word parameters for the faults and alarms, it is possible to start a trace whenever a particular fault/alarm occurs.

Trace function
Upload curve



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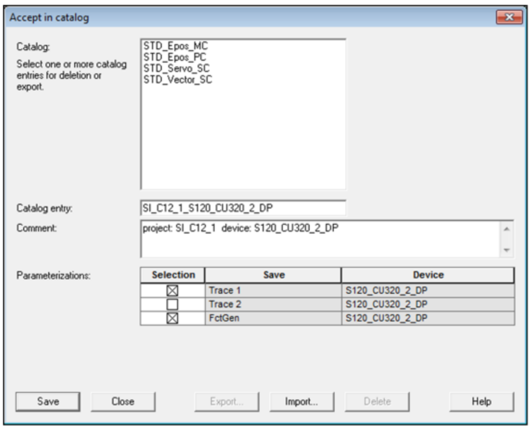
Upload curve

Click Upload curve to load the device trace curves recorded and saved in the target system to the STARTER. This function can be used, for example, if a trace recording in the target system was started by a user program or if certain error states occur.

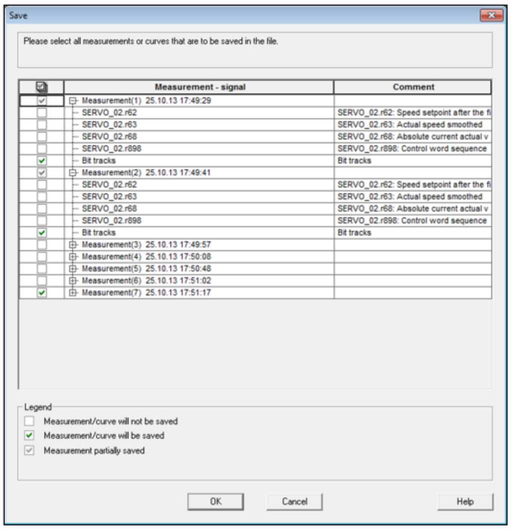
While the device trace is being recorded, a connection between the STARTER and the target system is not necessary. These recorded curves can be loaded to the target system when required. Only the last measurement can be loaded.

Trace function
Parameterizing and saving measurements

Saving the parameterization



Saving measurements to a file
(for example: as a *.trc, *.csv, *.xls, *.txt graphic)



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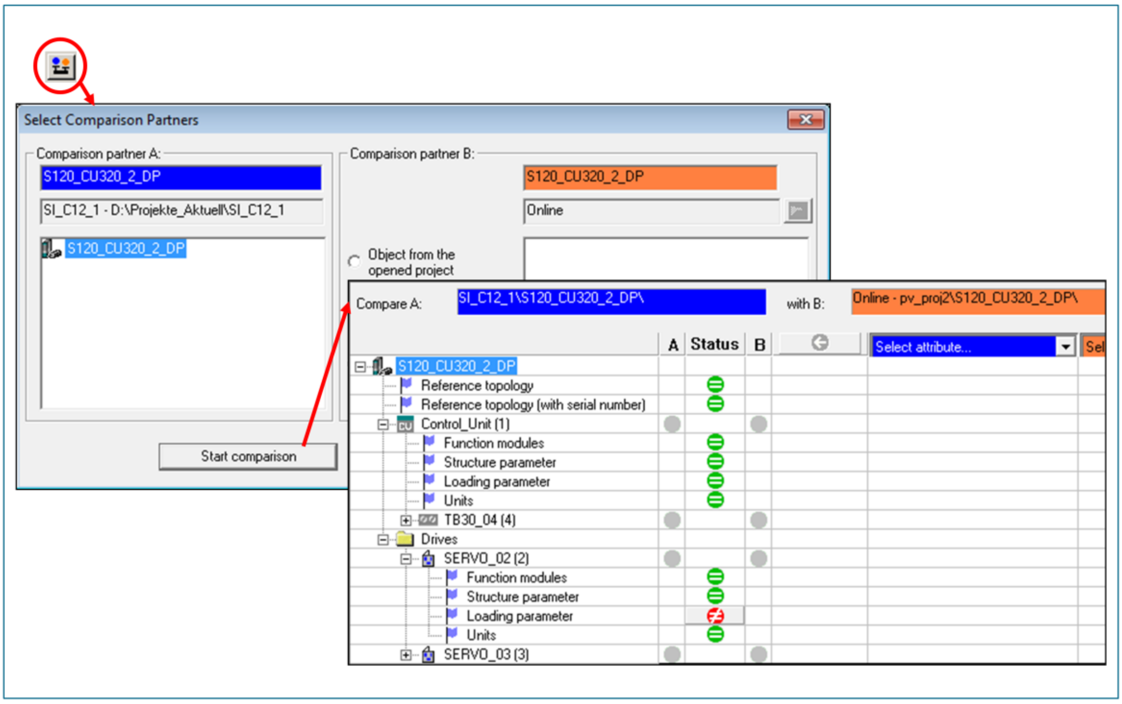
Project comparison
Performing an offline/online project comparison



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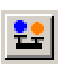
Project comparison

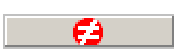


Project comparison is activated in Starter using the button.

This allows difference in the project to be shown:

- Differences in the topology
- Differences in the function modules
- Differences in the load parameters
- Indication that drive objects are missing.

Offline/online data



Differences in the load parameters are indicated by the following symbol: By double-clicking this button, the parameters can be displayed with their differences in a detail view.

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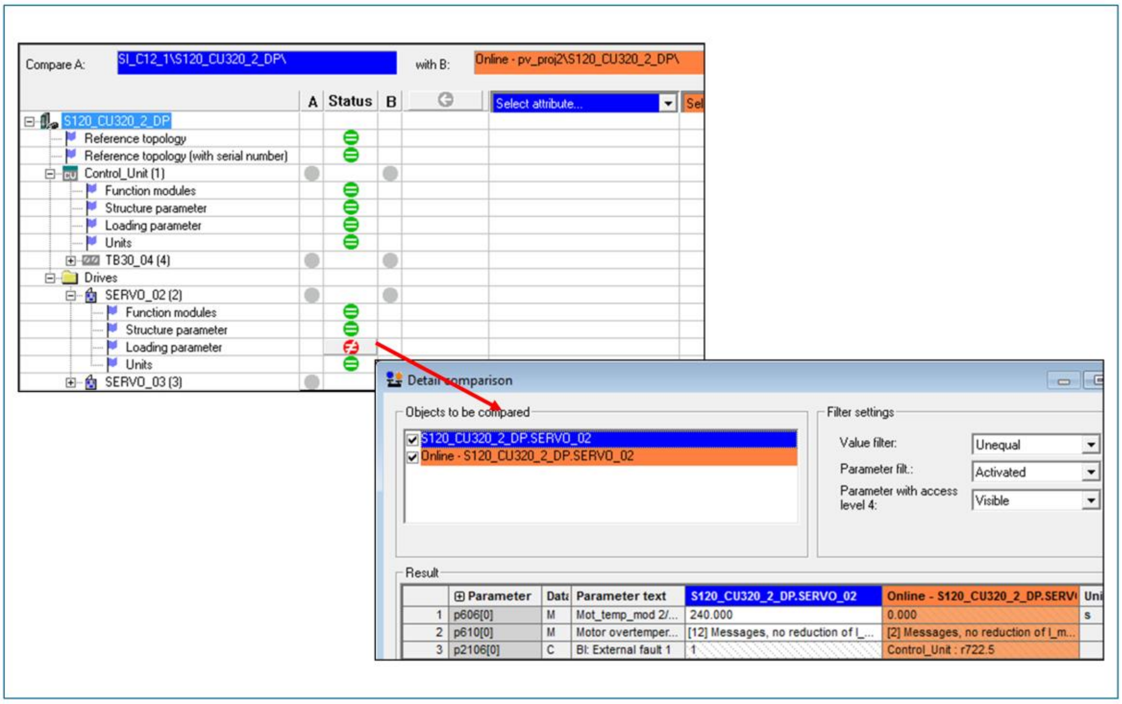
Project comparison
Performing an offline/online project comparison



Detail comparison The different parameters of this drive object are displayed in this view.

Project comparison
Expert list: Start comparison

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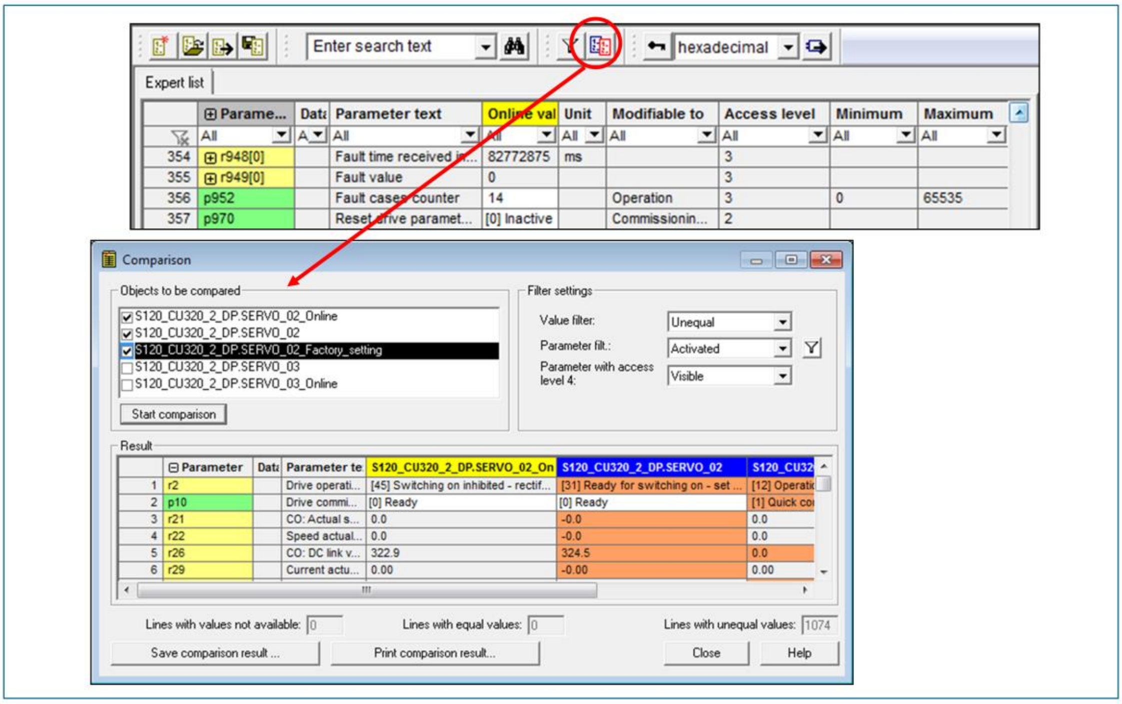

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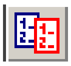
Parameter comparison Within a drive object, differences between parameters can also be determined using the comparison function of the expert list.

Online/offline data The question often arises as to what differences exist in the parameters between the online and offline data.. This can be established in Starter from the expert list using the following button:



You can suppress the read parameters, if required, by setting the display filter. Parameters that differ are displayed with a red background.

Project comparison
Expert list: set filter

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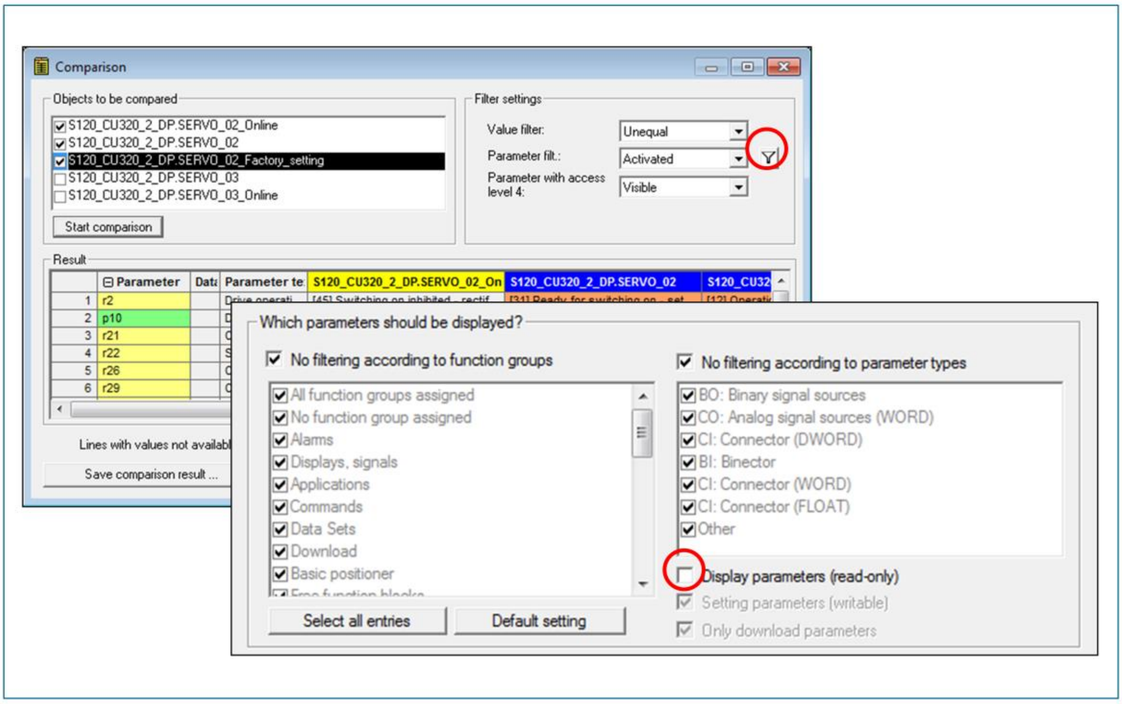

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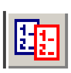
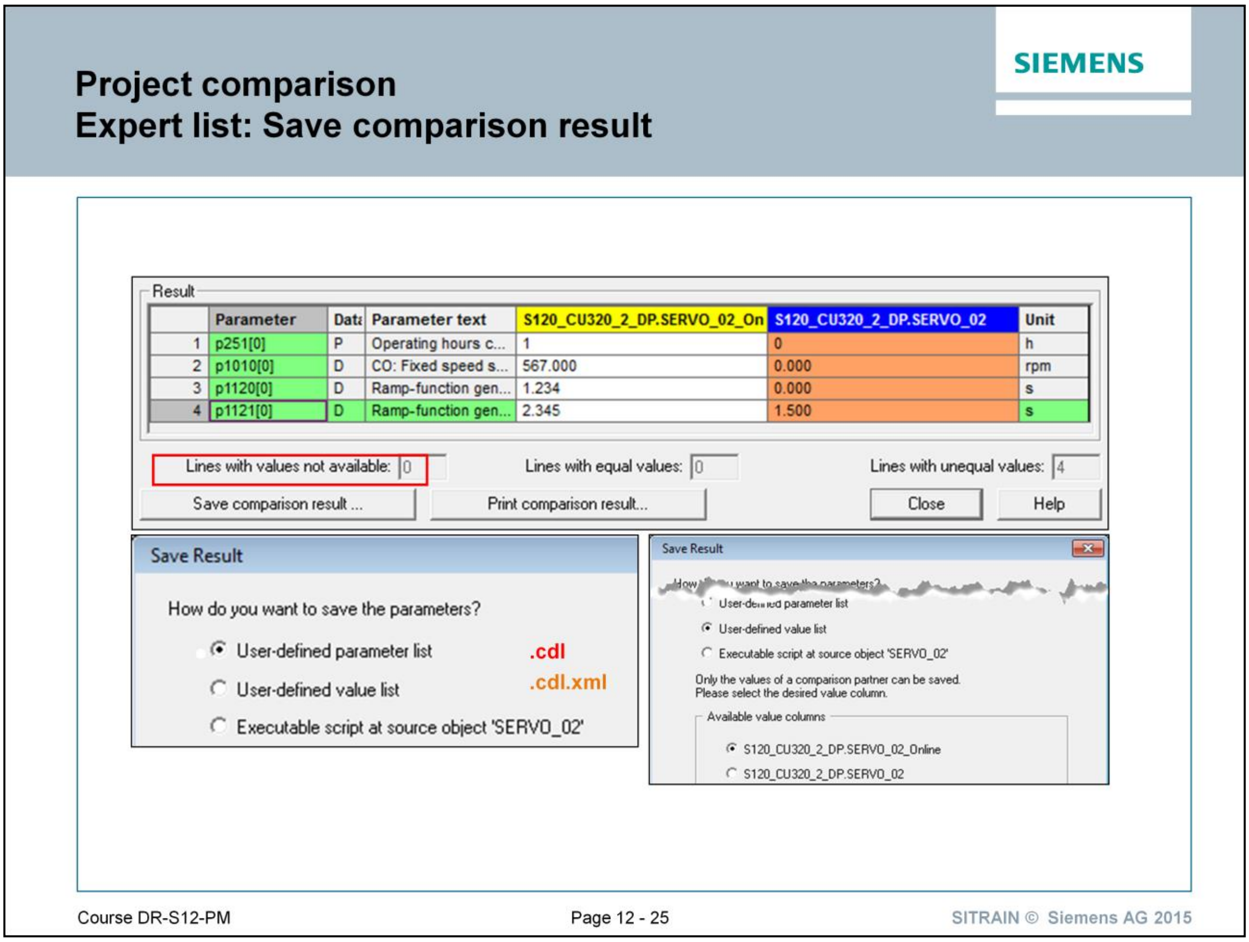
Parameter comparison Within a drive object, differences between parameters can also be determined using the comparison function of the expert list.

Online/offline data The question often arises as to what differences exist in the parameters between the online and offline data.. This can be established in Starter from the expert list using the following button:



You can suppress the read parameters, if required, by setting the display filter. Parameters that differ are displayed with a red background.



Comparison result

The result of the parameter comparison can be saved and processed in the following way:

- Save as user-defined parameter list
- Save as user-defined value list
- Save as executable script on the source object …

User-defined parameter list

Contains the parameter numbers for all parameters with differences, in accordance with the filter function selected

User-defined value list

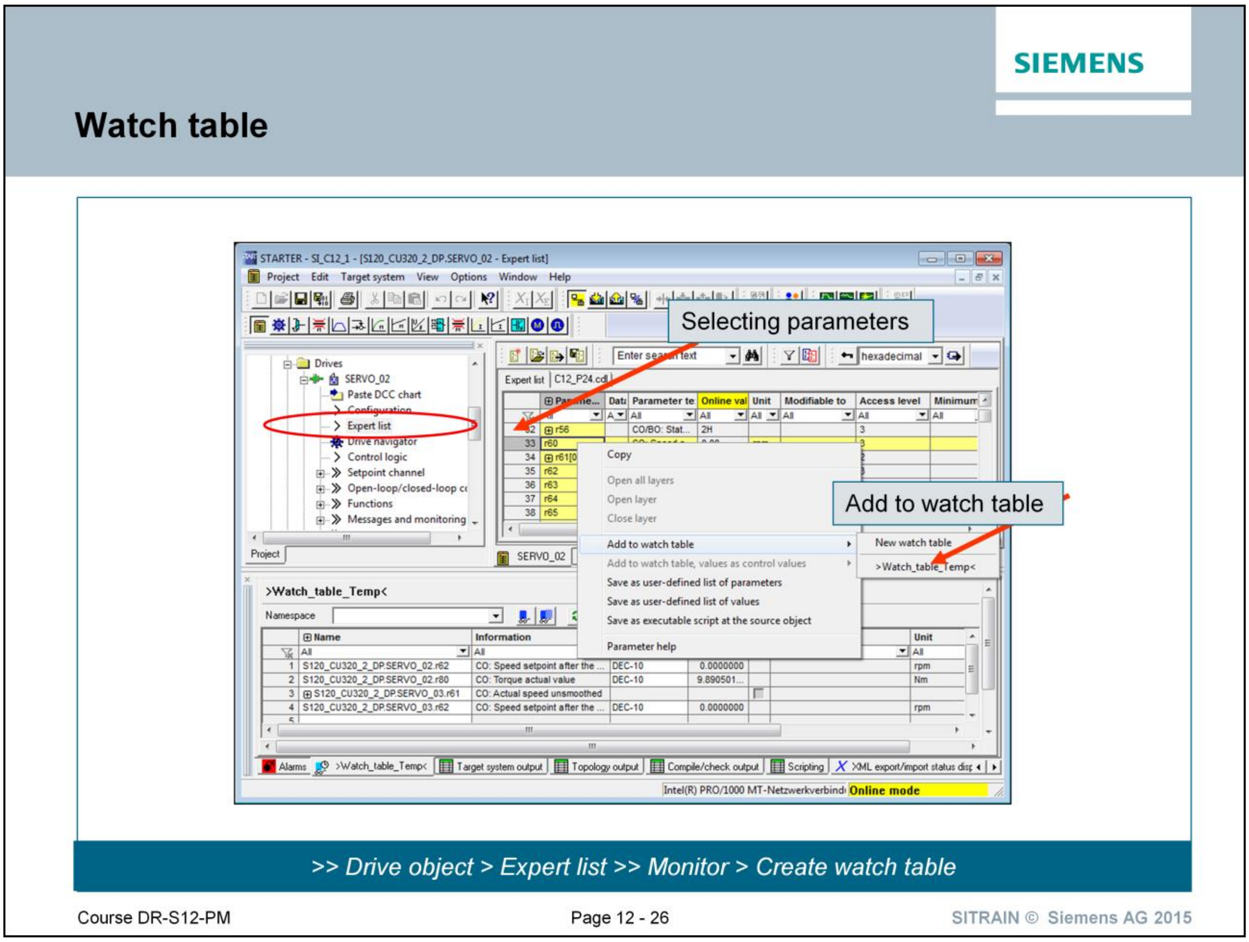
Contains the parameter numbers and the assigned values complete with their physical dimensions, e.g.:

Name	Value	Type	Unit
p1121[0]	7,0	VT_R4	s
p1135[0]	2,0	VT_R4	s

From an opened value list, the parameters saved there can be transferred selectively back to the expert list.

Executable script

A script file is generated for this object that can be executed offline or online. The script file can be expanded and changed as required. Exporting and importing is also possible. This means that the script file is accessible to other drive objects.



Watch table

In order to make working with lists more transparent and easier to configure and also to be able to display larger quantities of data in a structure, you have various options for laying out the lists and adapting them to the relevant conditions.

Create watch table

To create a watch table, proceed as follows:

1. Mark the MONITOR element in the project navigator.

2. Select
   >> *Insert* > *Watch table* in the menu.

3. Enter the name of the watch table.

4. Click OK to confirm.

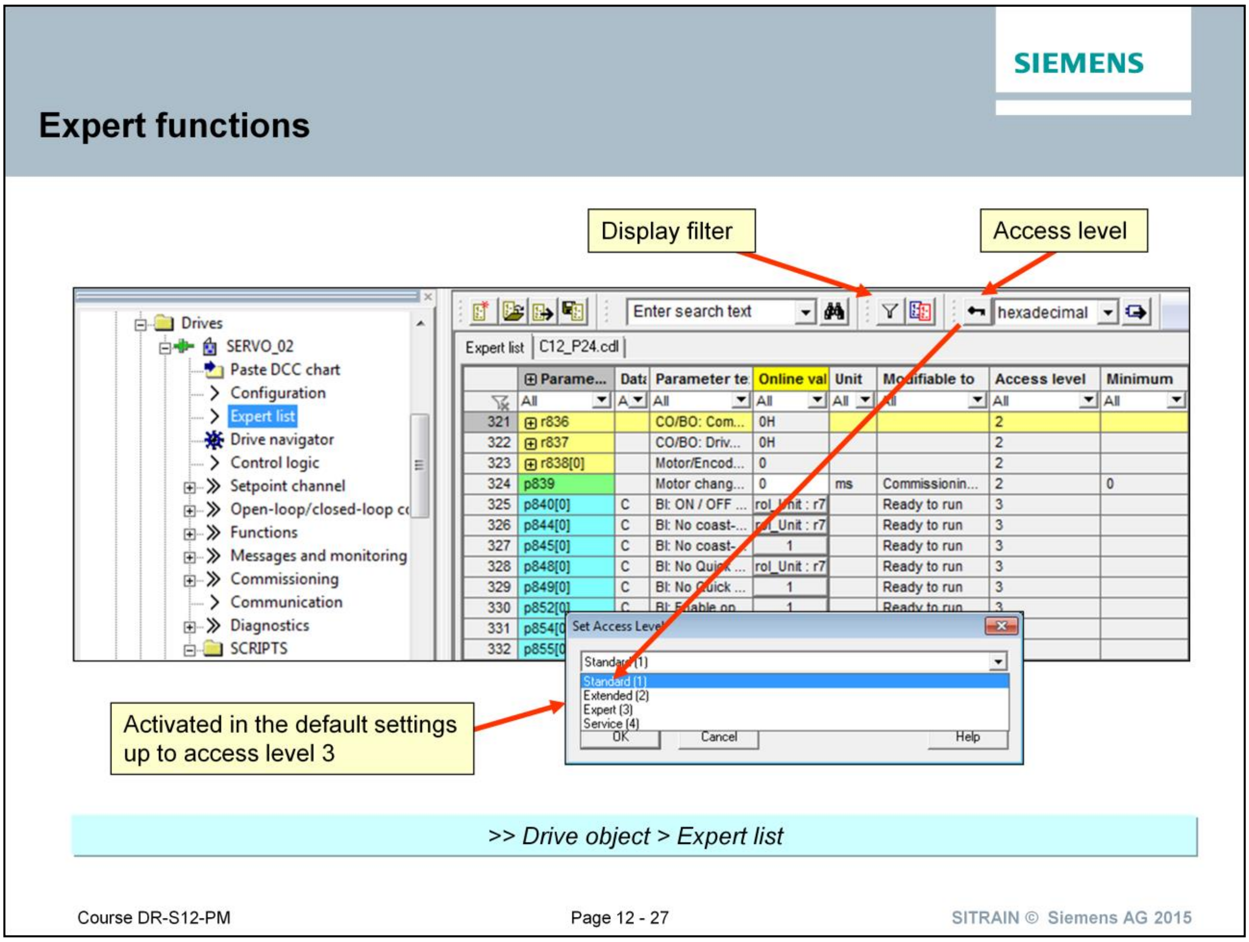
Fill the watch table

There are several ways of filling a watch table: You can edit directly in the watch table, you can insert variables using copy&paste or you can take these over directly from other lists or from the program editors:

1. In the project navigator, select the element whose variables are to be loaded into the watch table. The variable tables are displayed in the symbol browser.

2. In the symbol browser, select the lines with the variables which are to be transferred to the watch table by clicking the line numbers.

3. In the context menu (right-click), select
   >> *Add to watch table* > *<watch table name>*

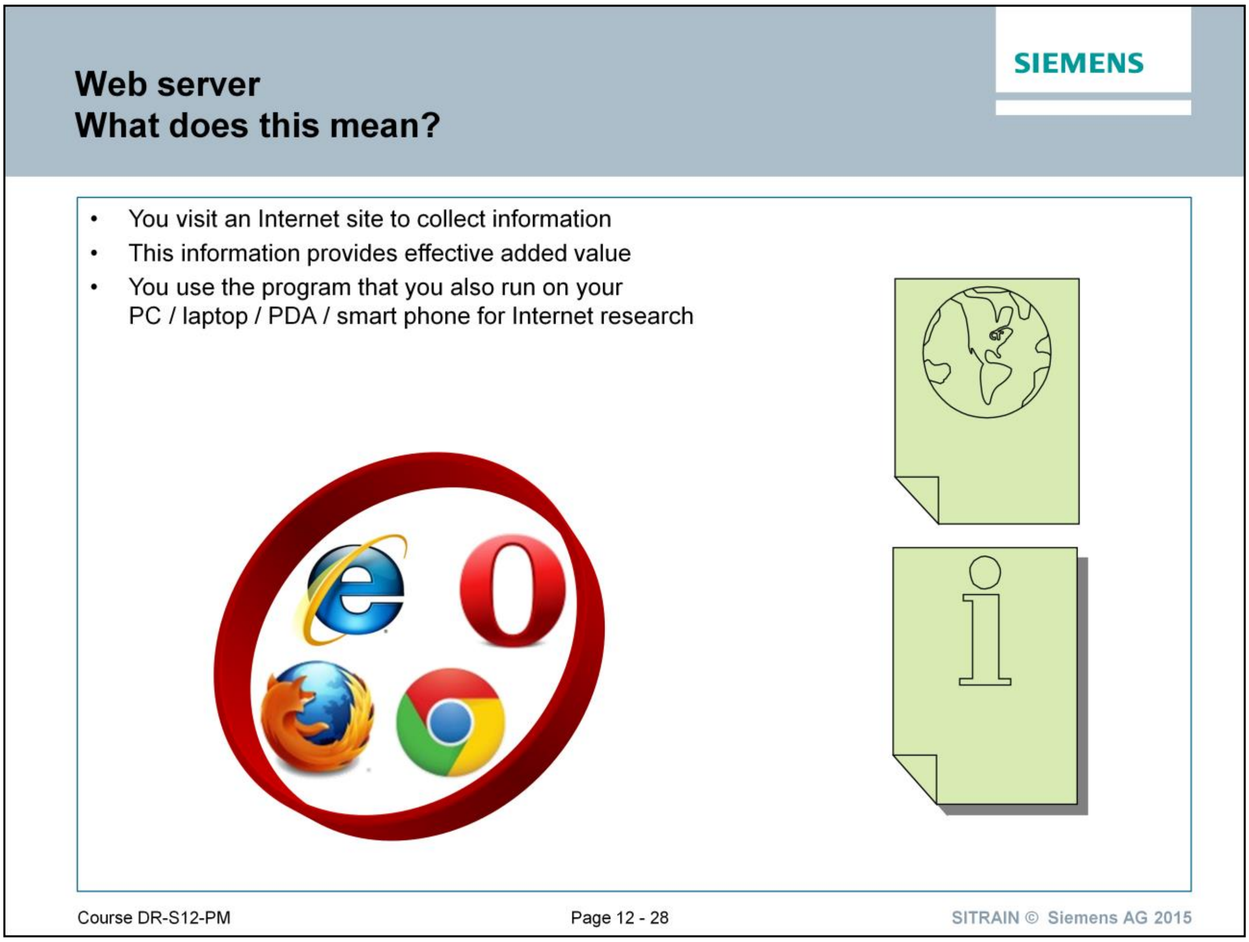


Parameter List The data entered in the screens is stored in SINAMICS in parameters. Each object has its own parameter list.

Expert List The parameters for the individual objects can be checked/modified via the expert list.
You can access the expert list after selecting the object via the Expert List context menu.
Select object > right mouse click > Expert > Expert list

Access level Various access levels for the BOP can be set in the expert list. A certain number of parameters are shown as appropriate to the authorization.

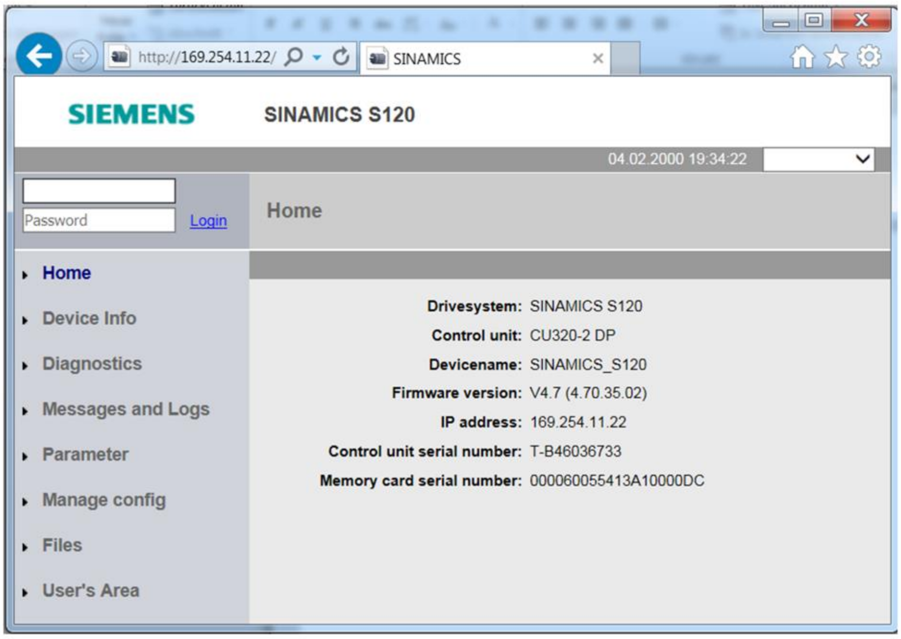
All parameters with access level "Expert" are shown in the expert list. Access level 4 "Service" is intended for the SIEMENS service employees and is password-protected.



Web server A web server is implemented in the SINAMICS runtime as of Version V4.6.

Secure connection You can access the web sites of the SINAMICS S120 via encrypted transfer. The protocol is called HTTPS. You can also implement an authorization using certificates. For information on authorization, please see the SINAMICS documentation.

Web server



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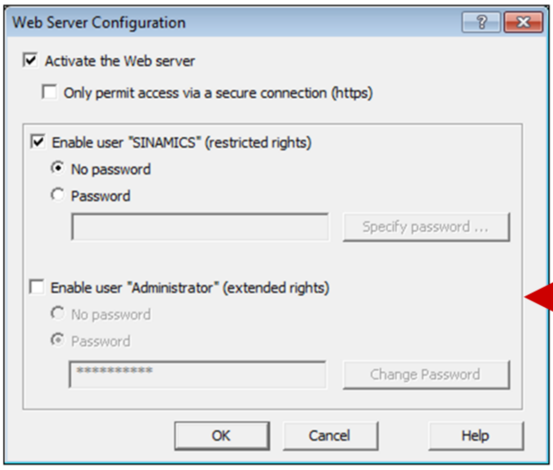
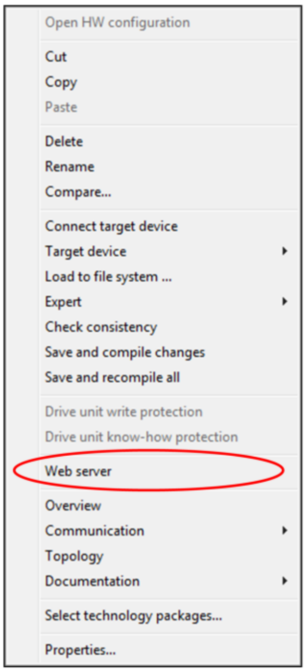
Login Use "SINAMICS" without password to log in.
An administrator login is also available; the password can be changed on the "Setup" page prior to first commissioning.
The STARTER configuration has priority.

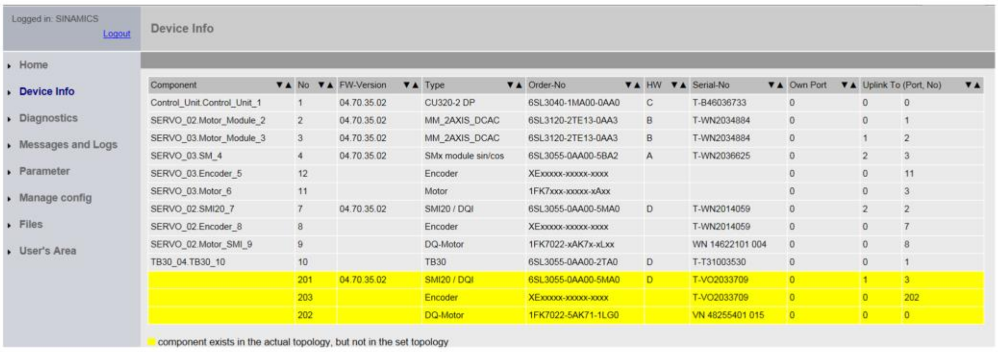
Web server
Activating, password

- You can disable the web server and
- configure the users.
- Call the screen via the context menu for each drive unit.





Web server
Device info



Device Info

Component	No	FW-Version	Type	Order-No	HW	Serial-No	Own Port	Uplink To (Port, No)	
Control_Unit.Control_Unit_1	1	04.70.35.02	CU320-2 DP	6SL3040-1MA00-0AA0	C	T-B46036733	0	0	0
SERVO_02.Motor_Module_2	2	04.70.35.02	MM_2AXIS_DCAC	6SL3120-2TE13-0AA3	B	T-WN2034884	0	0	1
SERVO_03.Motor_Module_3	3	04.70.35.02	MM_2AXIS_DCAC	6SL3120-2TE13-0AA3	B	T-WN2034884	0	1	2
SERVO_03.SM_4	4	04.70.35.02	SMx module sin/cos	6SL3055-0AA00-5BA2	A	T-WN2036625	0	2	3
SERVO_03.Encoder_5	12		Encoder	XExxxxx-xxxxx-xxxx			0	0	11
SERVO_03.Motor_6	11		Motor	1FK7xxx-xxxxx-xAxx			0	0	3
SERVO_02.SMI20_7	7	04.70.35.02	SMI20 / DQI	6SL3055-0AA00-5MA0	D	T-WN2014059	0	2	2
SERVO_02.Encoder_8	8		Encoder	XExxxxx-xxxxx-xxxx		T-WN2014059	0	0	7
SERVO_02.Motor_SMI_9	9		DQ-Motor	1FK7022-xAK7x-xLxx		WN 14622101 004	0	0	8
TB30_04.TB30_10	10		TB30	6SL3055-0AA00-2TA0	D	T-T31003530	0	0	1
	201	04.70.35.02	SMI20 / DQI	6SL3055-0AA00-5MA0	D	T-VO2033709	0	1	3
	203		Encoder	XExxxxx-xxxxx-xxxx		T-VO2033709	0	0	202
	202		DQ-Motor	1FK7022-5AK71-1LG0		VN 48255401 015	0	0	0

component exists in the actual topology, but not in the set topology

Web server
Diagnostics, Tracefiles

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Diagnostics - Service overview

Service overview | Tracefiles

DO	DO-Name	DO-Type/View	Faults / Alarms	Operation display (r2)
1	Control_Unit	SINAMICS S		Betriebsbereit(10)
2	SERVO_02	SERVO		Antriebsobjekt deaktiviert/nicht betriebsfähig(60)
3	SERVO_03	SERVO		Einschaltbereit - "EIN/AUS1" = "0/1" setzen (p0840)(31)
4	TB30_04	TB30 (Terminal Board)		Modul im zyklischen Betrieb(0)

Service overview | Tracefiles

Name	Time
TR000001.ACX.GZ	01.01.1970 00:00:00
TR000002.ACX.GZ	01.01.1970 00:00:00
TR000003.ACX.GZ	01.01.1970 00:00:00
TR000004.ACX.GZ	01.01.1970 00:00:00
TR000005.ACX.GZ	01.01.1970 00:00:00

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Faults / Alarms

The icons are color-coded:

- Yellow – Alarm
- Red – Fault
- Green – OK

Web server
Messages and logs

SIEMENS

Messages

Messages and Logs - Alarms drive

Diagbuffer | Alarms drive

Reset alarms

Time	Type	Drive-Object	Alarm	Component
04.02.2000 19:25:15.261	F	SERVO_02	31885: Geber 1 DRIVE-CLiQ (CU): Zyklische Datenübertragung gestört (Komponentennummer: 7, Fehlerursache: 33)	7
04.02.2000 19:25:15.445	A	Control_Unit	1416: Topologie: Komponente zusätzlich gesteckt (Sensor Module, An Motor Module, Anschluss: X201)	201
04.02.2000 19:25:15.365	A	SERVO_02	7015: Antrieb: Motortemperatursensor Warnung (0)	9
04.02.2000 19:25:15.453	A	SERVO_02	1482: Topologie: Sensor Module nicht gesteckt (Komponente: 7, An Motor Module, Anschluss: Motor Module)	7
04.02.2000 19:25:15.461	A	SERVO_02	1315: Antriebsobjekt nicht betriebsfähig (0)	--

Diagnostics buffer entries

Messages and Logs - Diagbuffer

Diagbuffer | Alarms drive

Nr	Time	Date	Event
1	19:25:15.33	04.02.00	Fault DO 2: Fault number 31885, fault value 0x721
2	18:59:04.30	04.02.00	Ram2Rom performed for DO 0
3	18:58:48.56	04.02.00	Ram2Rom started for DO 0
4	18:58:14.97	04.02.00	Fault DO 2: Fault number 7901, fault value 0x0
5	18:54:11.26	04.02.00	Ram2Rom performed for DO 0

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Web server
Parameters

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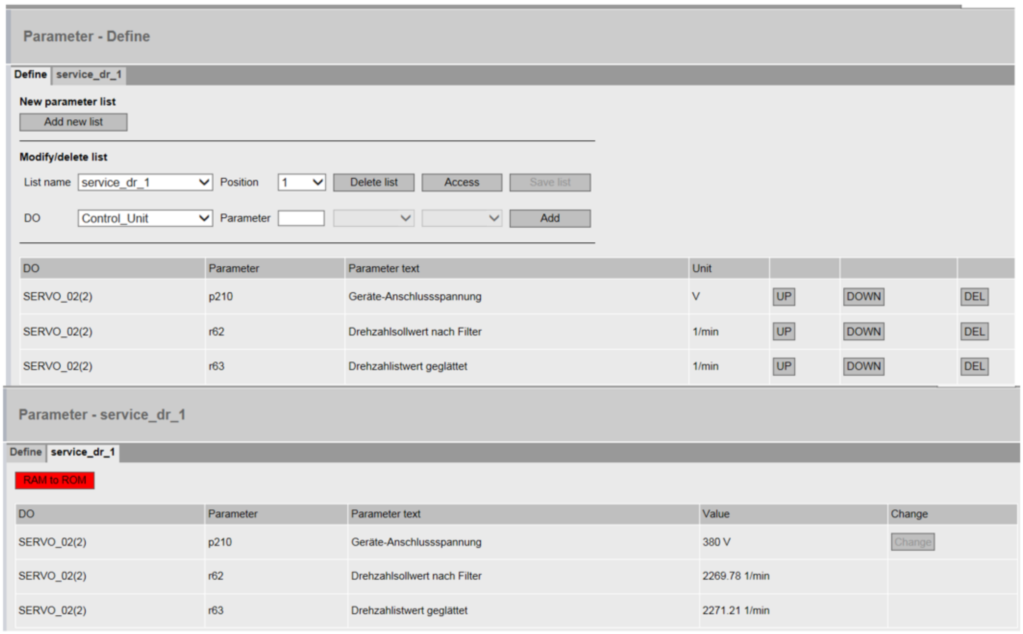

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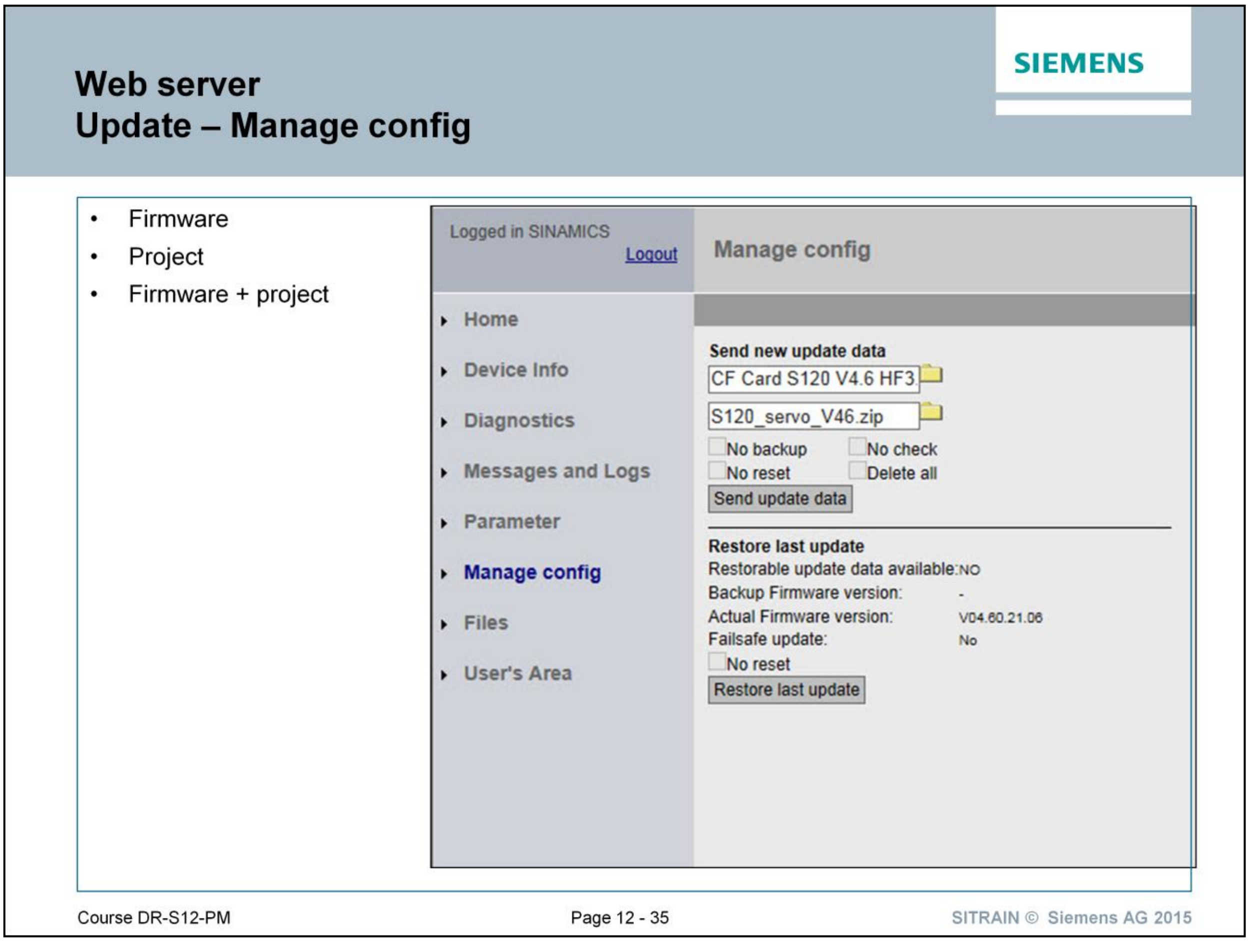
Parameter lists

When you are logged on as "Administrator", you can create parameter lists and sort and modify them.

As administrator, you can also change values. When you are logged on as "SINAMICS", you can monitor the parameter lists. If the administrator has assigned the appropriate rights to the "SINAMICS" user, you can use this login to make changes to parameter lists and parameters.

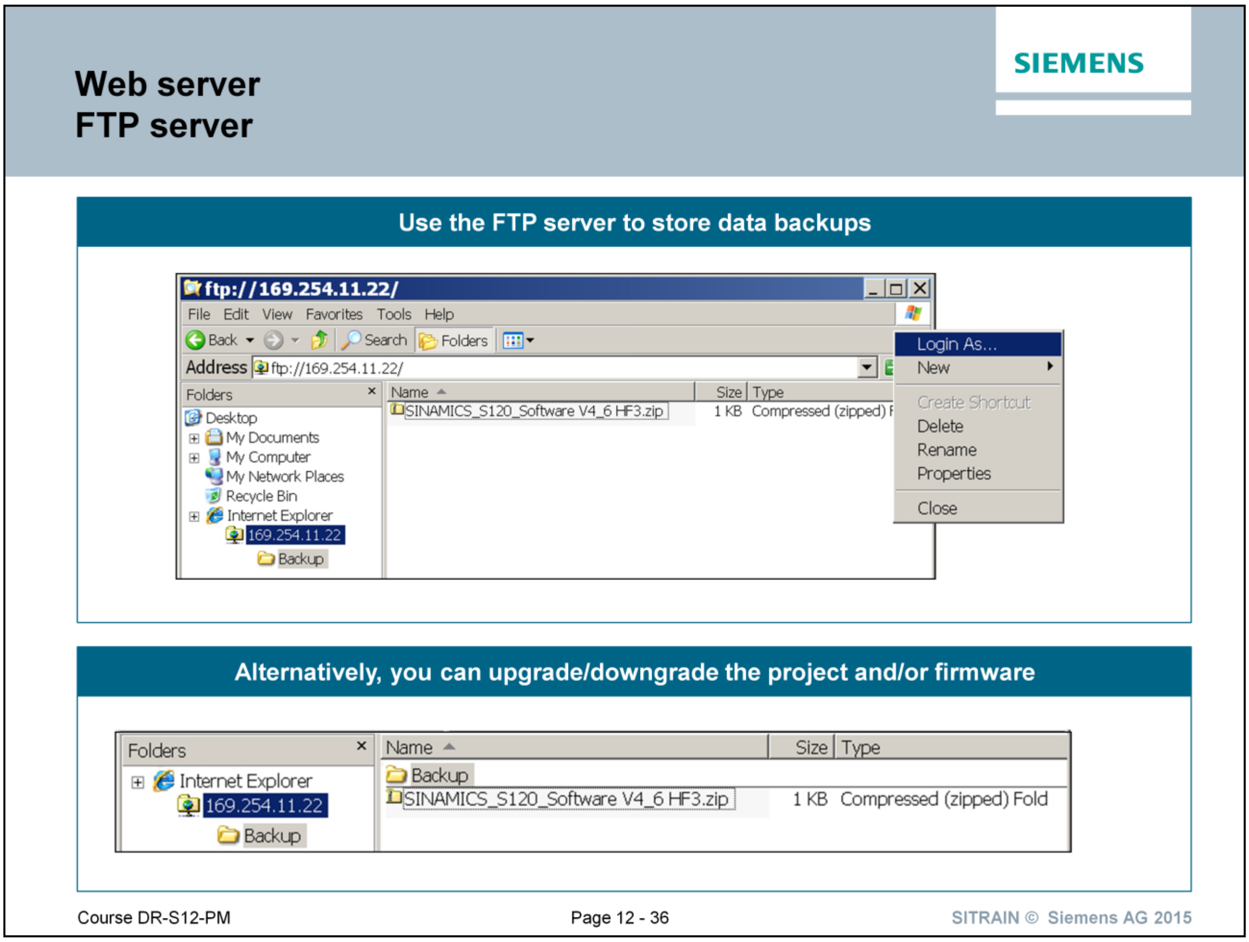


Update Data

You create a zip archive with

- the firmware,
- the project (load to file system) or
- both.

To do this, perform a "Download to file system" in the folder that contains the firmware.



Application You can store backup files in a folder on the CF card (e.g. "Backup").

The data are located in the "Install" folder on the CF card.

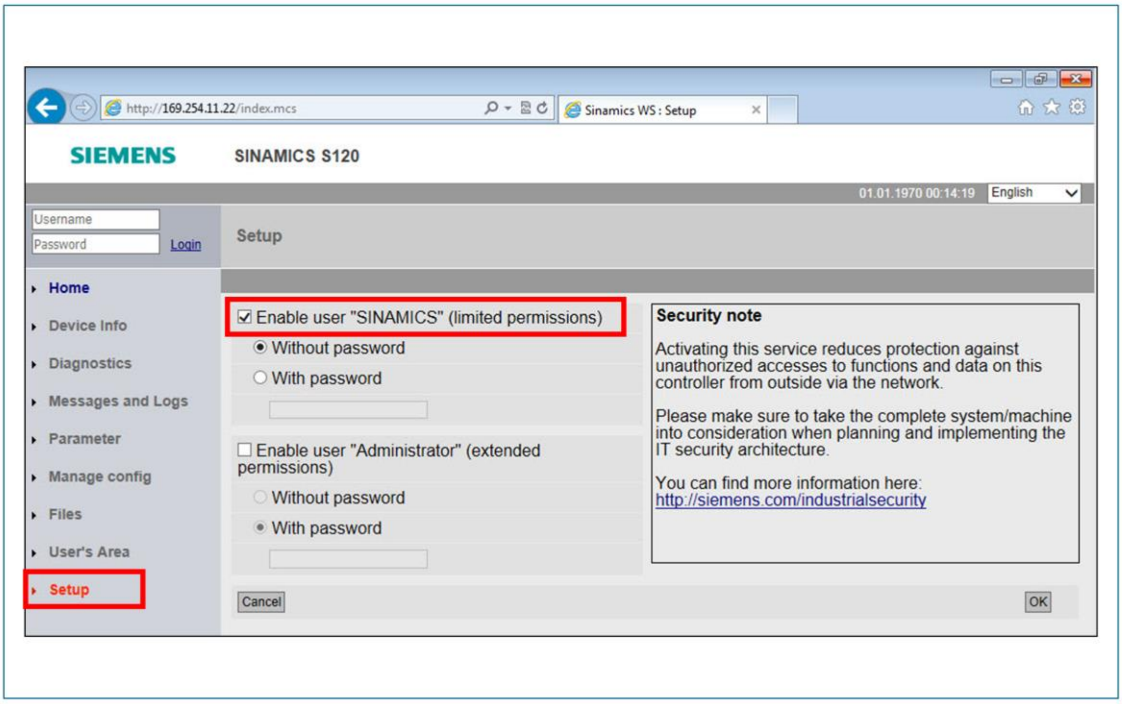
Login The standard login "sinamics" with the password "sinamics" serves as login.

Parameter You can deactivate the FTP server by setting parameter p8908 to "0".

Note A search is made for firmware or project data directly in the zip archive stored at the top directory level during startup of the SINAMICS S120.

The active configuration/parameterization is overwritten directly with the contents of the zip archive.

Web server
How safe is it? Factory settings



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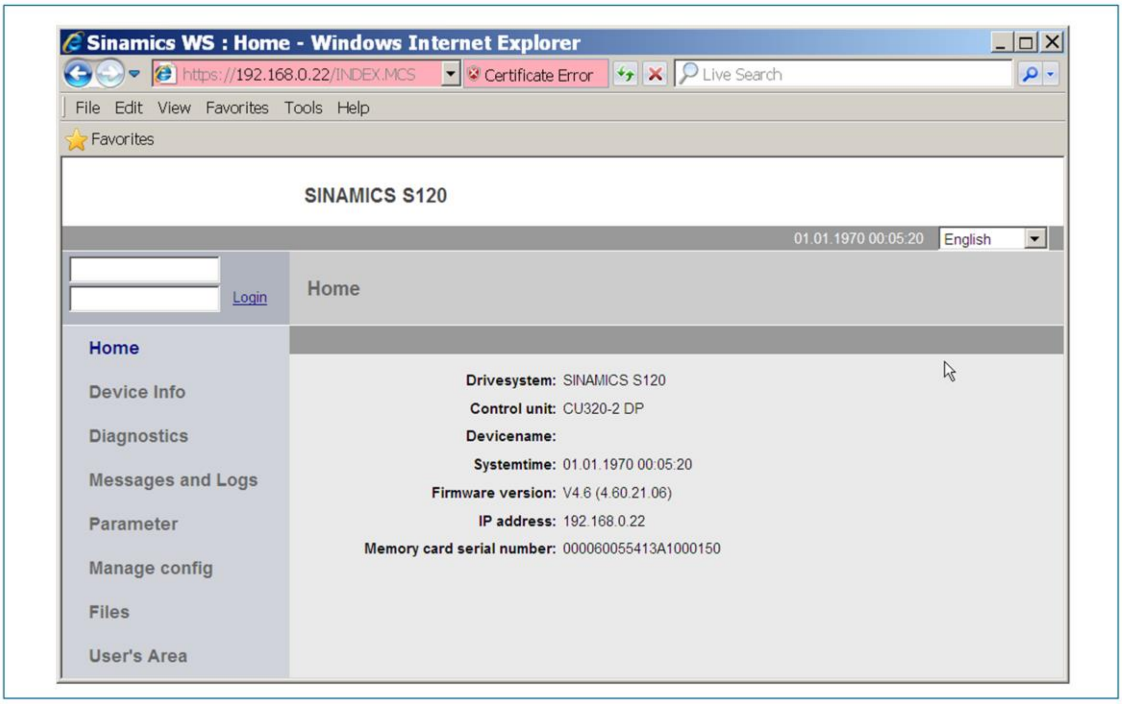
User administration If the SINAMICS S120 Version V4.6 or higher is at factory settings, you can also handle user administration in the web server. Two users are available for activation. Please always assign a password to an administrator! You can use the "sinamics" login with or without password.

Web server
How safe is it? HTTPS



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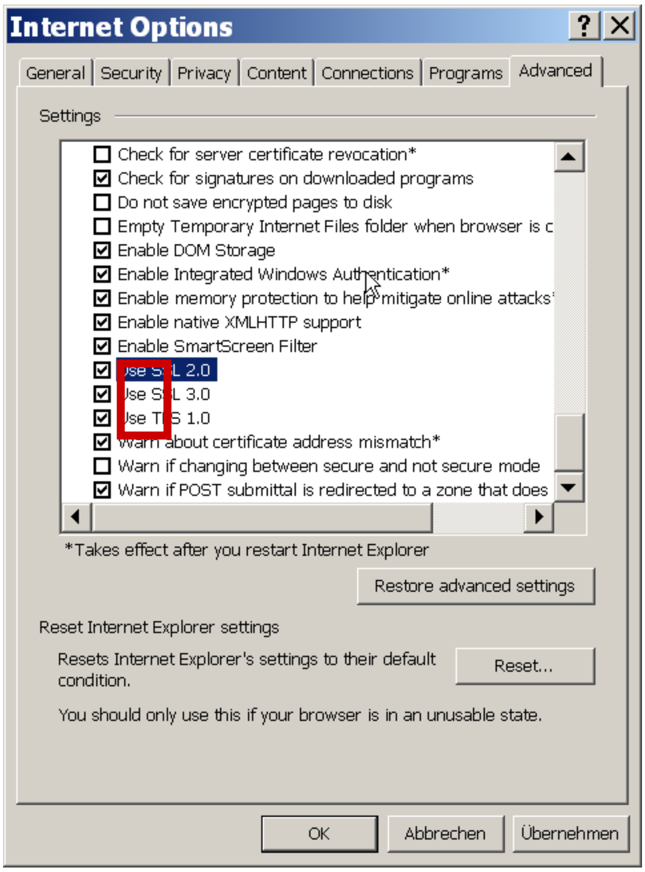
HTTPS You set up an SSL-encrypted tunnel.
The data exchanged are encrypted.
You can import a certificate to do this.

Browser Please activate
"SSL 2.0" in the browser.



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Web server
Which rules apply for networking?

- The SINAMICS is not intended for use as a firewall!
- SINAMICS is a high-performance drive system!
- SINAMICS should not be accessible via the Internet without safety components such as a gateway or firewall.
- The SIEMENS "Defense-in-depth concept" provides support for the topic "Industrial Security" Link: "http://siemens.com/industrialsecurity "

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Industrial Security You can use SCALANCE S products to protect your machine easily and scalably, while nevertheless accessing the components via the Internet.

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Exercises

- Exercise 1: Tracing bit tracks
- Exercise 2: Saving measurements
- Exercise 3: Object comparison
- Exercise 4: Object comparison using the expert list
- Exercise 5: Watch table
- Exercise 6 – optional: Tracing encoder signals
- Exercise 7 – optional: Diagnostics in the power unit

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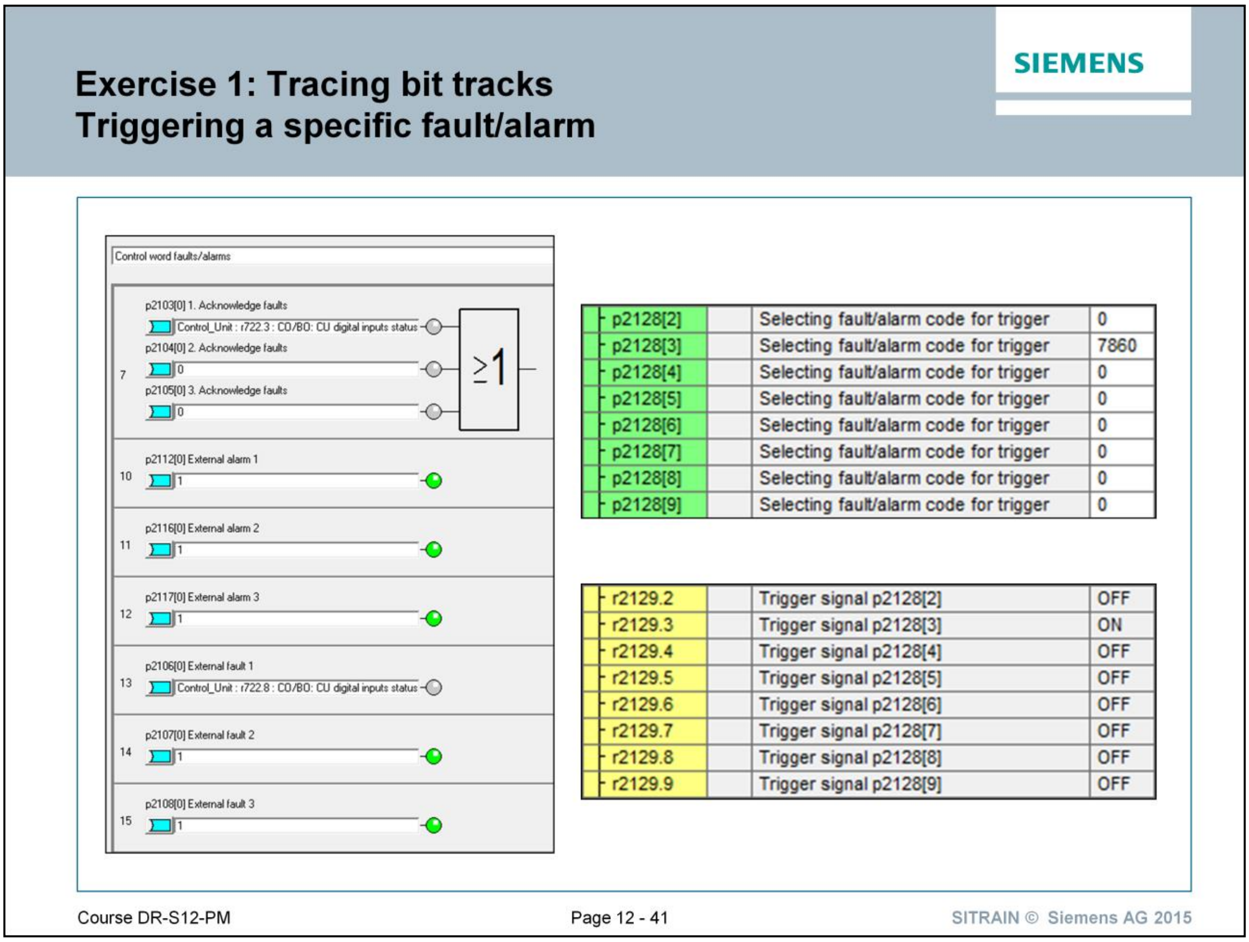
Safety information

Please note that:

- The course instructions have been produced for:
  - A course held by a course leader
  - Activities carried out on special training equipment
- The training equipment is operated under laboratory conditions.
  In case of doubt, always ask your course leader – particularly when handling components that carry electrical current or which can move.
- When carrying out work on equipment, the safety information in the associated product documentation must always be observed!
  The training documents alone are not sufficient.

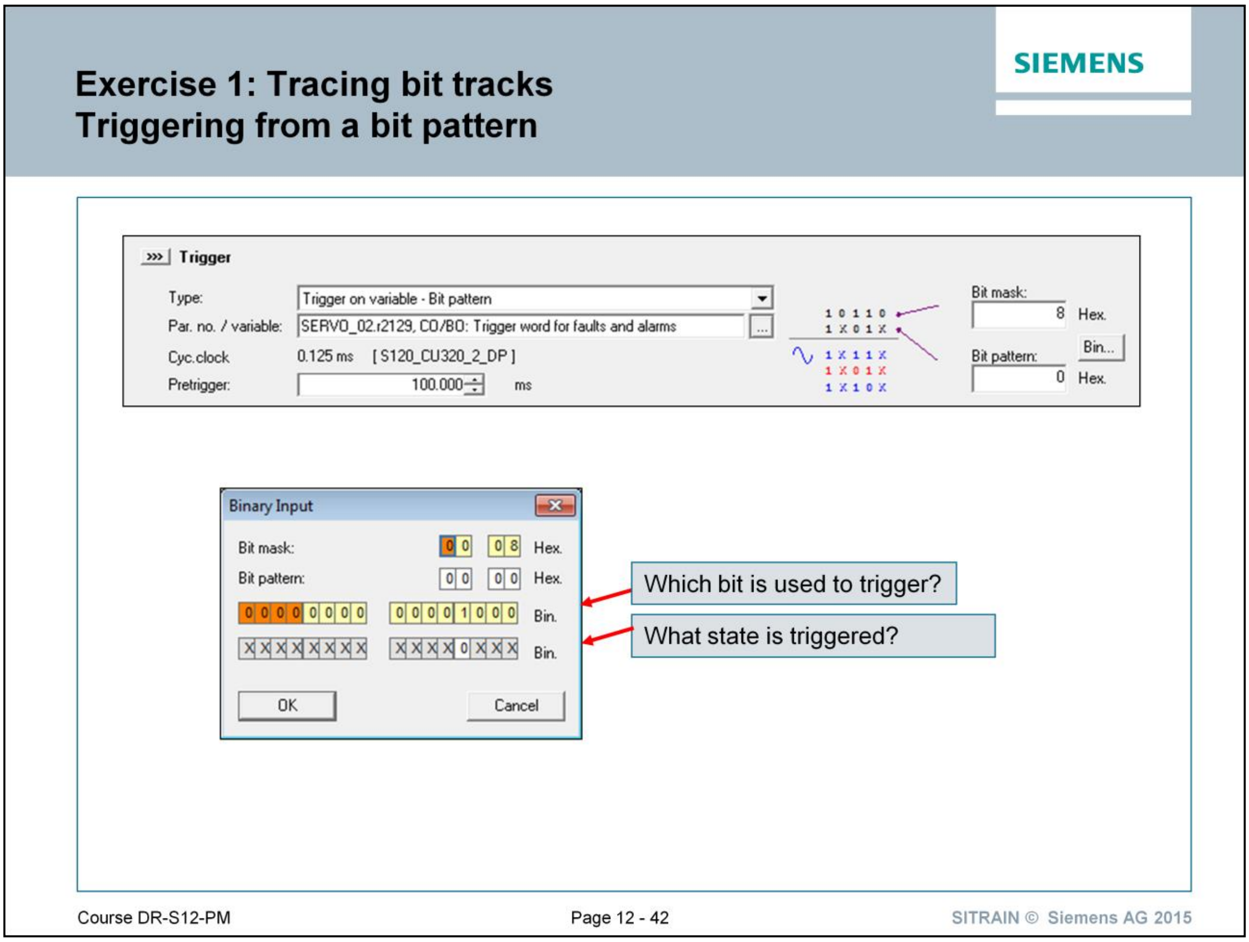


Task Activate a trace recording for a pending fault!

1. Open the archived project "S120_servo_V47", load the data to the drive and test the movement of both motors.

2. Switch on the DI3 and DI7 switches on the operator box and configure switch DI8 for "Servo_02" to simulate an external fault F7860.

3. Enter the fault code "7860" (external fault 1) in p2128[3].
   When this event occurs, bit 3 in r2129 changes from 0 to 1.

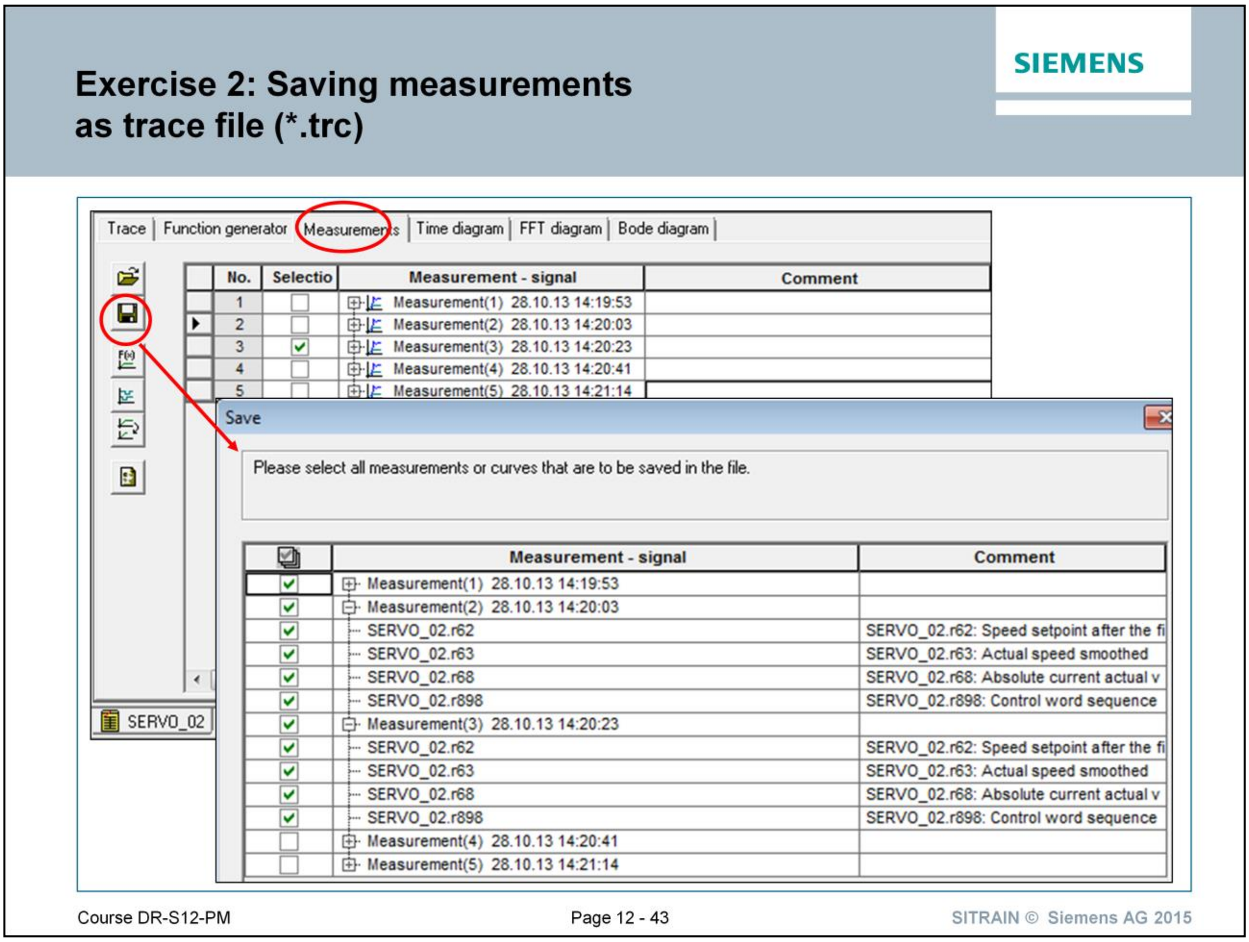


4. For trace 1, as trigger criteria select "bit pattern", and as trigger source, parameter r2129 and a pre-trigger of 90% of the recording time.

5. Then, using the "bin..." button, define the bit mask and the bit pattern, so that the trace is triggered when F7860 (external fault 1) occurs.

6. Start the trace recording and switch the drive on:
   → Trace 1 waits for the trigger signal.

7. Trigger fault message F7860 by switching off switch DI8 (DI8 = 0):
   → The signal recording is started.



Task Save the measurements that you have made. Proceed as follows:

1. Open the "Measurements" tab.

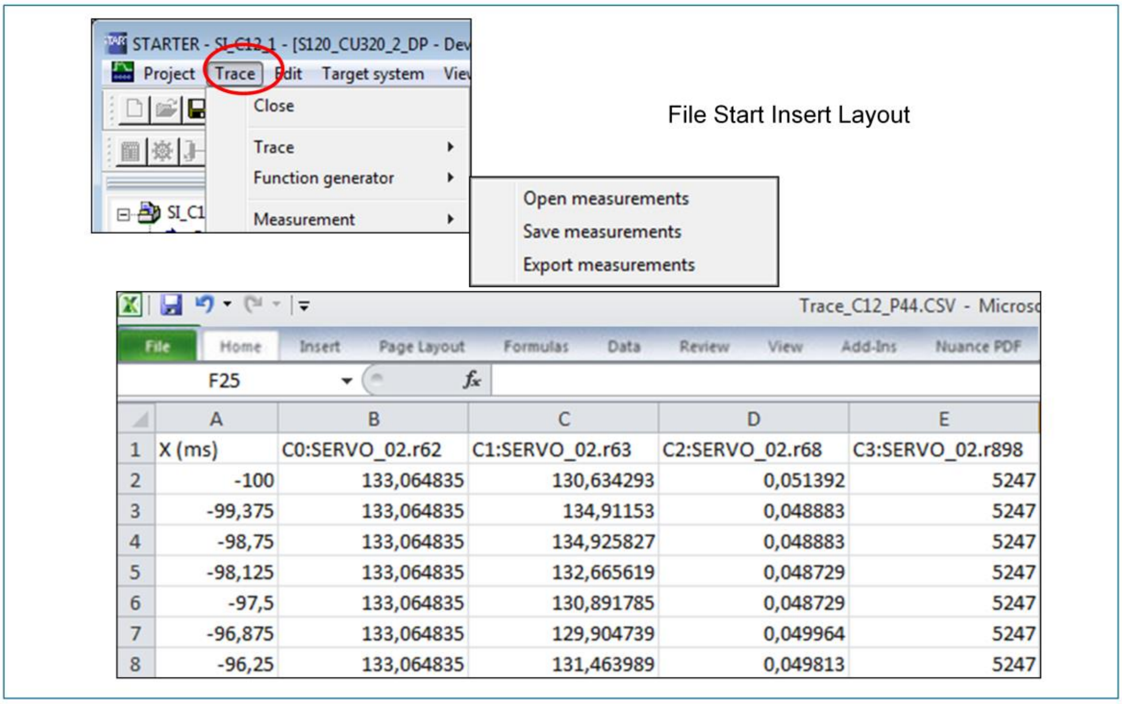
2. Under this tab, press the "Save measurements" button.

3. Allocate a file name and define a storage location:
   >> *Measurements.trc > Save*

4. Now select the measurements to be saved, and exit this window with >> *OK.*

Note In this way, you can save all of the measurements in a common file, or by pressing the "Save measurements" button several times, you can save the measurements in different files.

Exercise 2: Saving measurements
Export to Excel



	A	B	C	D	E
1	X (ms)	C0:SERVO_02.r62	C1:SERVO_02.r63	C2:SERVO_02.r68	C3:SERVO_02.r898
2	-100	133,064835	130,634293	0,051392	5247
3	-99,375	133,064835	134,91153	0,048883	5247
4	-98,75	133,064835	134,925827	0,048883	5247
5	-98,125	133,064835	132,665619	0,048729	5247
6	-97,5	133,064835	130,891785	0,048729	5247
7	-96,875	133,064835	129,904739	0,049964	5247
8	-96,25	133,064835	131,463989	0,049813	5247

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Task If you wish to save measured values in a list form, then proceed as follows:

1. In Starter, open the dialog box to create an export file:
   >> *Trace* > *Measurement* > *Export measurements*
2. Select a file format, allocate a file name and define the storage location:
   >> *Measurements.csv* > *Save*
3. Now select the measurements to be saved, and exit this window with >> *OK.*
4. After they have been successfully exported, the measurements are now available in a list form for archiving or for further processing.

Exercise 3: Object comparison
Within an opened project

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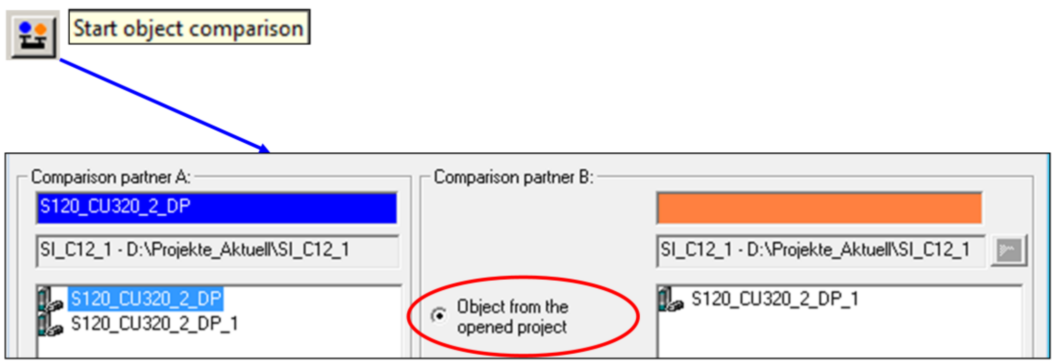

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Task Two similar drive units should be investigated regarding their differences. Therefore, create two different drive units and compare these:

1. Go into the offline mode.
2. In your "S120<-servo_v46" project, create a 2nd drive unit, Sinamics_S120_1:
   >> Right mouse click on Sinamics_S120 > Copy
   >> Right mouse click on S120_V44 > Paste
3. Allocate the Sinamics_S120_1 name
4. In the drive unit Sinamics_S120_1, delete the object TB30_04:
   >> Open CU_S_004 > TB30_04 > Delete
5. Now set the open BICO connections to the factory settings
6. Start the object comparison:
   >> Button "Object Comparison" >
   Comparison partner A: Sinamics_S120
   Comparison partner B: Sinamics_S120_1
   > Start Comparison
7. Interpret the result:

   Topology:

   ……………………………………………………………………………………

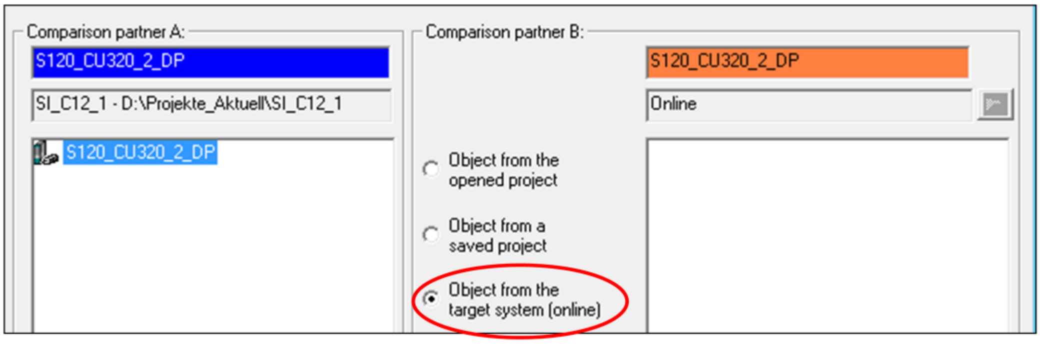
   Objects:

   ……………………………………………………………………………………

   Load parameters:

   ……………………………………………………………………………………
8. Delete the SINAMICS_S120_1 device again from the project:
   >> Right mouse click on Sinamics_S120_1 > Delete

Exercise 3: Object comparison
Between the offline project and target system



Task

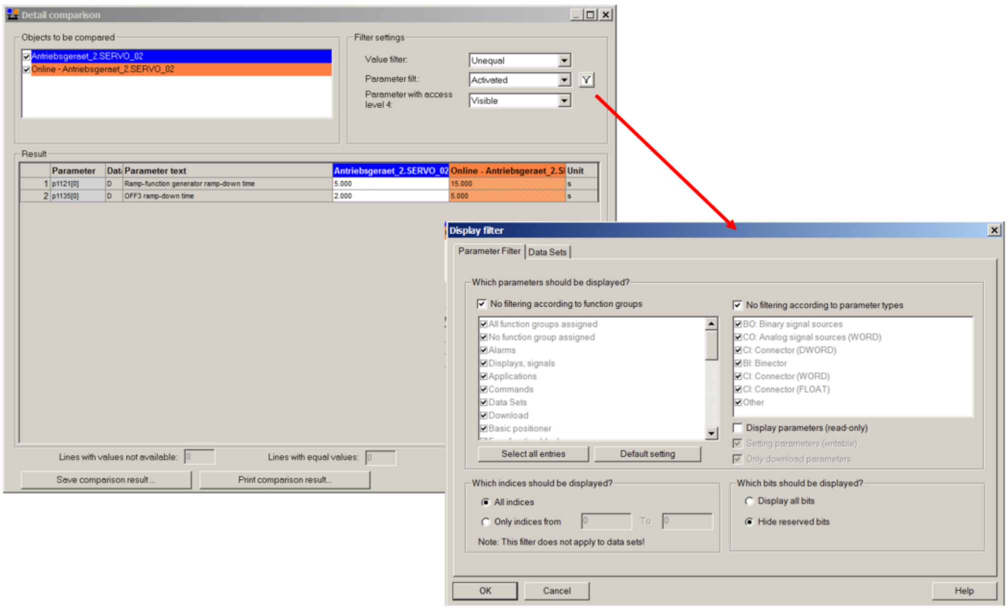
With the online connection to your target system, you want to determine the differences between your offline project and the data in the drive. Make a comparison between your offline project and the target system:

1. From your project, go online with the drive unit
2. Perform a "Download to PG" if the parameter assignment differs.
3. Start the object comparison.
4. Interpret the result:
   - Topology:
   - Objects:
   - Download parameters:
5. Now, in the online mode, in SERVO_02 change the following parameters (without backup RAM to ROM) e.g.:
   - OFF 1 ramp-down time: p1121 = 15.0 s
   - OFF 3 ramp-down time: p1135 =   5.0 s
6. Start the object comparison again:
7. Result:

   ……………………………………………………………………………………

8. Observe how the parameter changes in the detailed comparison of the download parameters are displayed.

Exercise 4: Object comparison using the expert list
Comparison with filter



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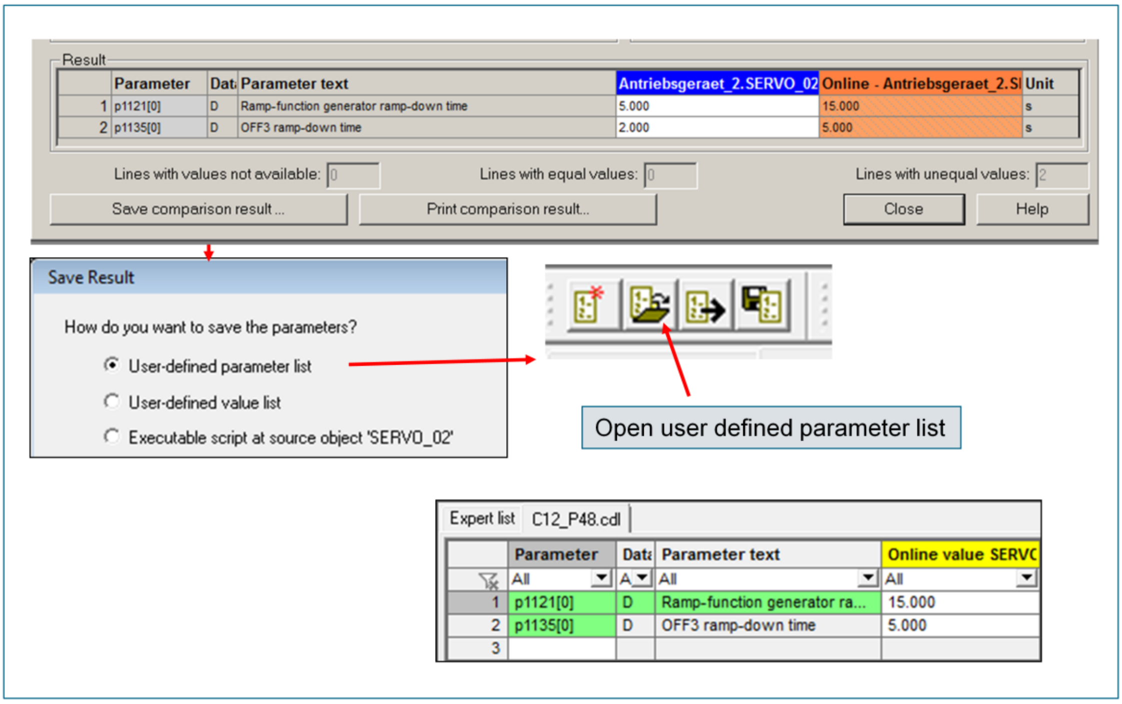
Task In the detailed comparispon the two paraemters casn be seen. Using the filter it may help to have a better view on the parameters.

Exercise 4: Object comparison using the expert list
Saving the parameters: user defined parameter list



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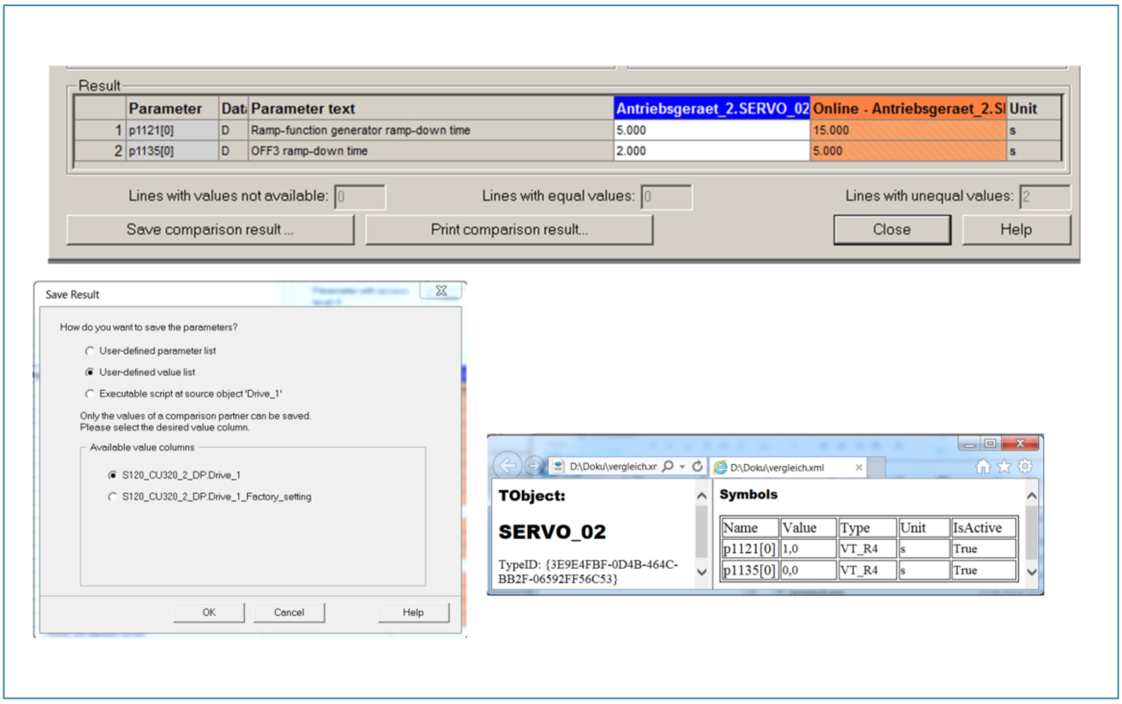
Task

Save the comparison results for "Servo_02" in various file formats for subsequent use:

1. The result of the comparison can bes aved in diferent ways:
   >> *Save comparison result …*
   - as user-defined parameter list (in the format *.cdl)
   - as user-defined value list for the value column “Servo_02_Online“ (in the format *.xml)
   - as executable script at the "Servo_02" object in the "SCRIPTS" folder with the name “Script_1" (in the format *.txt)

2. In the first step select “user-defined parameter list”. After saving the list can be opened in the expert list.

Exercise 4: Object comparison using the expert list saving user defined value list



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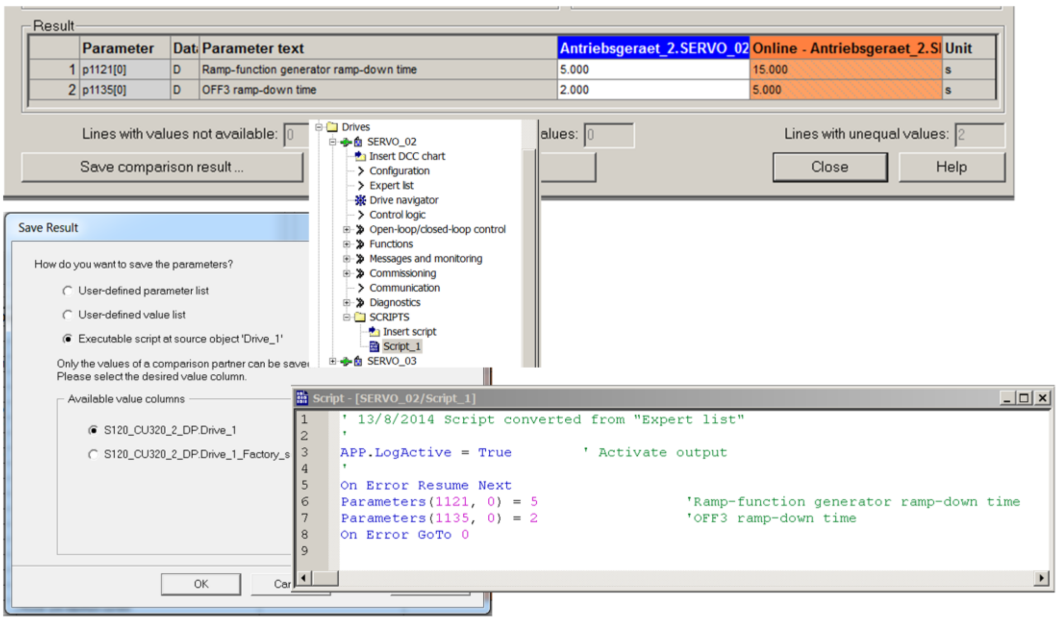
Task

In the next step the comparison should be saved in a user defined value list. Test the principle of operation of a script file, by using both parameters of script file "Script_1" also for "Servo_03":

1. To do this, save the parameter in a “user defined list” and save it on the desktop.

2. The file can be opened and the parameters can be checked.

Exercise 4: Object comparison using the expert list saving: Using the script file



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Task

Test the principle of operation of a script file, by saving the result of the comparison in an executable script.

1. To do this, create a script file by saving the parameters in an “executable script at source abject drive 1”. The script is generated.

2. In the directory drive object you find a directory for the sripts. There the generated scipt file is saved.

Exercise 4: Object comparison using the expert list saving: execute script file

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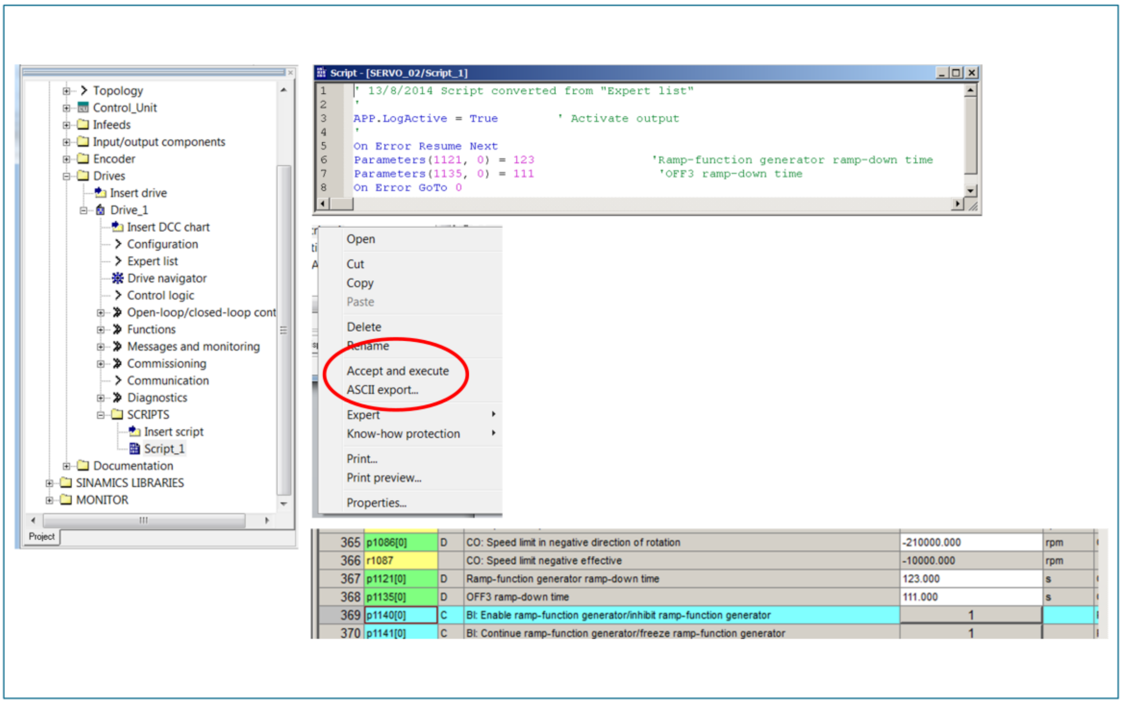

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1. Open the script file and change the values of the parameters and save the file.

2. The script file can be executed by:
   >> With the right mouse key > Accept and execute

3. Check as to whether the two values from the script file have been transferred into the Expert list of the driveobject.

Exercise 5: Watch table
Creating

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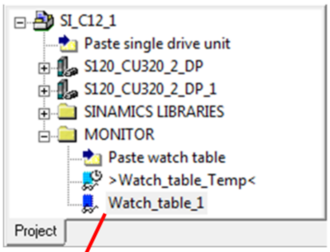

	Name	Information	Display format	Status value		Control value	Unit	Condition	Data type
	All	All	All	All		All	All	All	All
1	*Sinamics S120 Servo_02*								
2	S120_CU320_2_DP.SERVO_02.r63	CO: Actual speed smoothed	DEC-10	0.2861023			rpm		REAL
3	S120_CU320_2_DP.SERVO_02.p1121[0]	Ramp-function generator ram...	DEC-10	15.00000	☑	15.00000	s	oper.	REAL
4	S120_CU320_2_DP.SERVO_02.p1135[0]	OFF3 ramp-down time	DEC-10	5.000000	☑	5.000000	s	oper.	REAL
5	S120_CU320_2_DP.SERVO_02.p2900[0]	CO: Fixed value 1 [%]	DEC-10	0.0000000	☑	0.0000000	%	oper.	REAL
6									
7	Sinamics S120 Servo_03								
8	S120_CU320_2_DP.SERVO_03.r63	CO: Actual speed smoothed	DEC-10	0.006258...			rpm		REAL
9	S120_CU320_2_DP.SERVO_03.p1121[0]	Ramp-function generator ram...	DEC-10	10.00000	☑	2.000000	s	oper.	REAL
10	S120_CU320_2_DP.SERVO_03.p1135[0]	OFF3 ramp-down time	DEC-10	0.0000000	☑	10.00000	s	oper.	REAL
11	S120_CU320_2_DP.SERVO_03.p2900[0]	CO: Fixed value 1 [%]	DEC-10	0.0000000	☑	10.00000	%	oper.	REAL
12									

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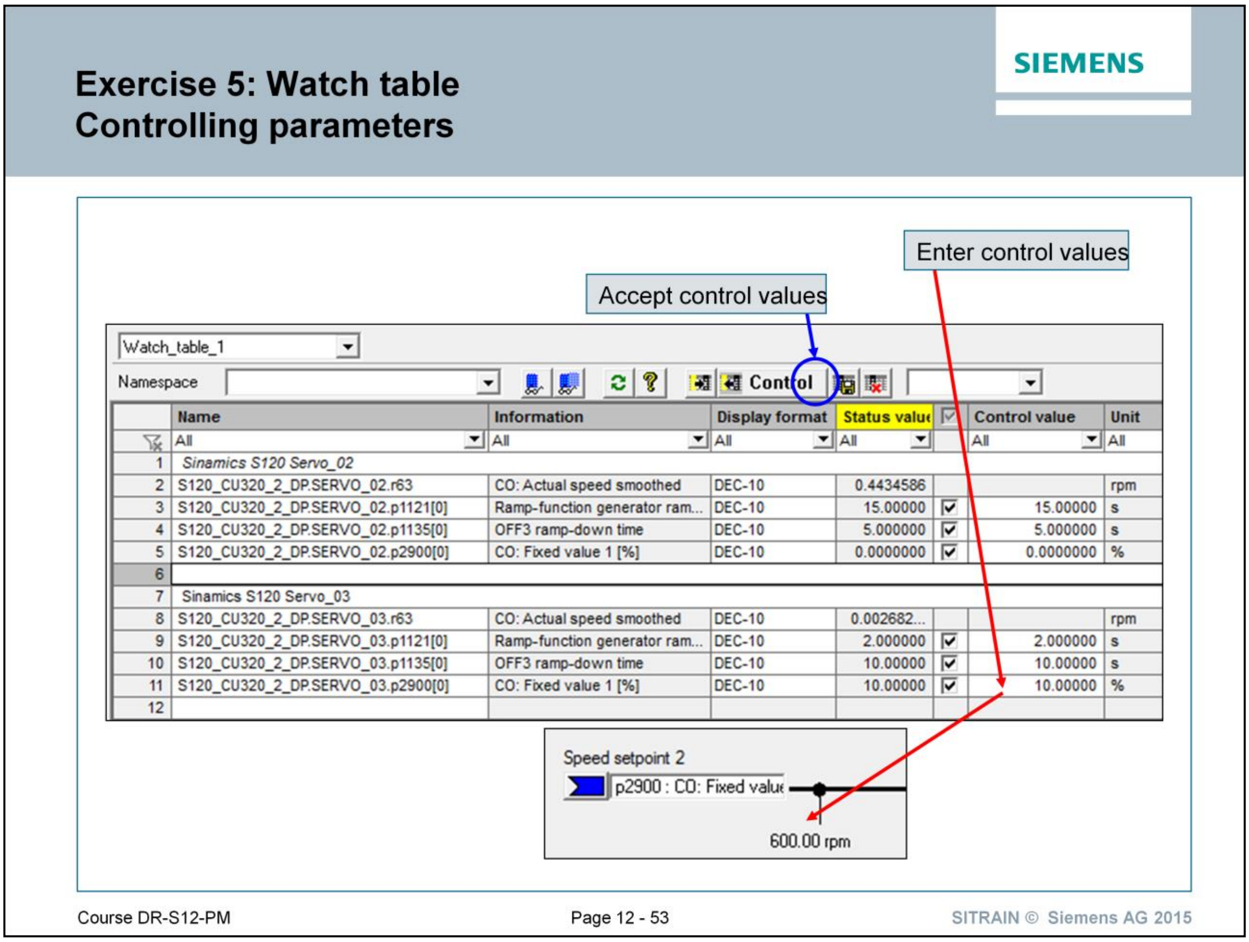
Note Watch tables provide an efficient and transparent way of combining, monitoring and where relevant, controlling parameters from a wide range of Sinamics drive units within the same project in a common table.

Task Create a common watch table for the two "Servo_02" and "Servo_03" drives:

1. Open the Expert lists for the "Servo_02" and "Servo_03" drives.
2. In your project, open the "Monitor" directory
3. Double-click on "Insert watch table"
4. Accept the recommended name "Watch_table_1" and acknowledge the opened window with "OK".
5. In the Expert list, select those parameters that you wish to transfer into the watch table:
   - p2900: Fixed value 1
   - r63: Speed actual value
   - p1121: Ramp-function generator ramp-down time
   - p1135: OFF3 ramp-down time
6. *>> right mouse key > Accept in watch table > Watch_table_1*
7. Establish an interconnection between p2900 and speed setpoint 2 (p1160).



Task Test the watch table and control the drive parameters using the watch table:

1. Open Watch_table_1.

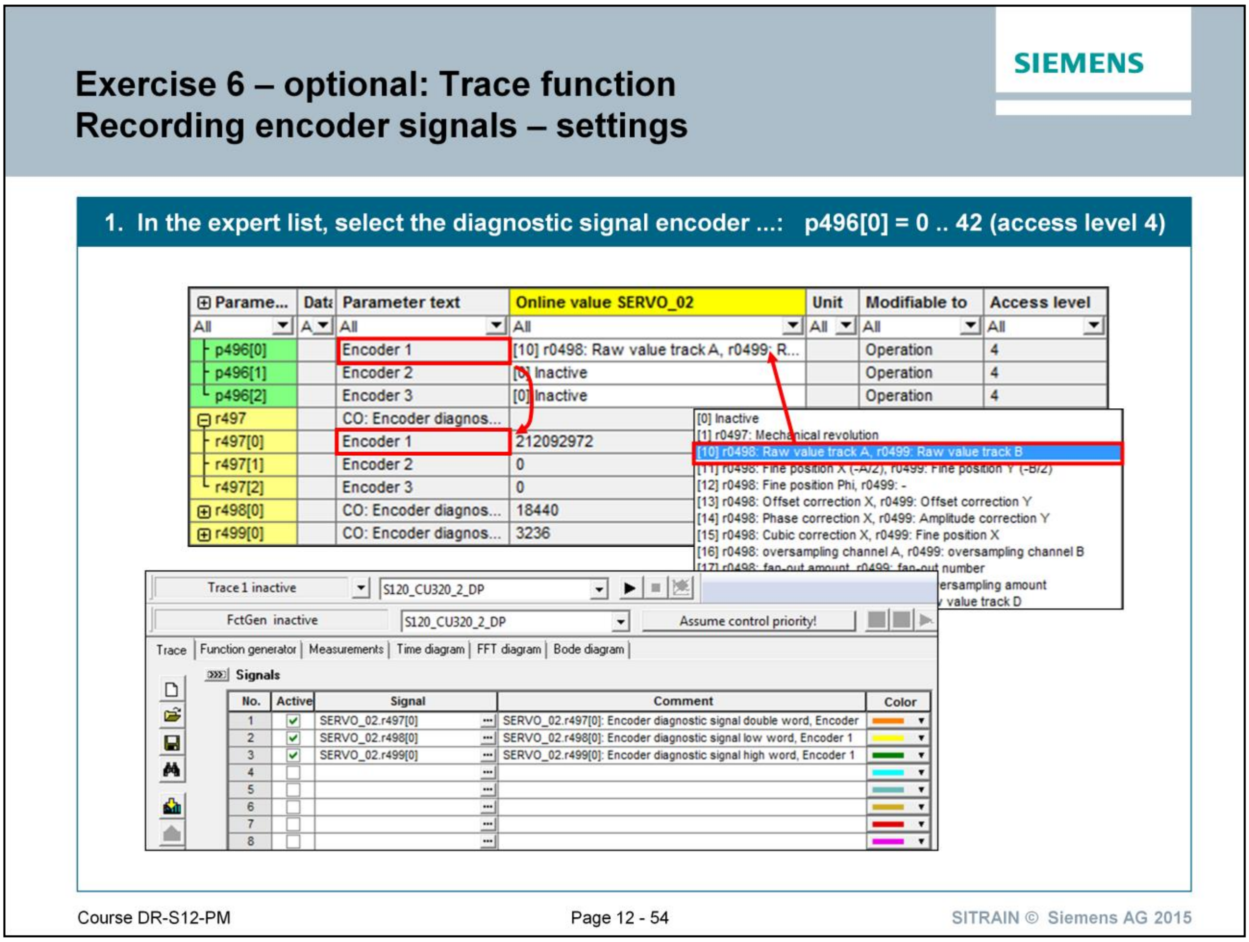
2. Activate the "Control value" column.

3. Here, enter suitable values for parameter p2900 and accept these using the "Accept control values in the online data".

4. Accept these control values using the "Save control value set".

5. Enter a name for the control value set and confirm with "OK".

This means that you can use these control values at any time.



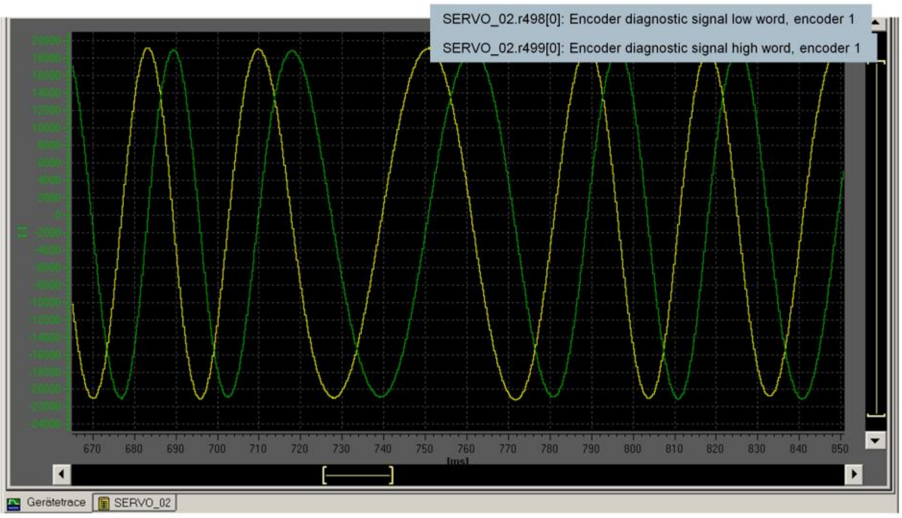
Encoder signals can, in principle, also be recorded using the trace function. However, some supplementary conditions are still relevant here.

- The access level must be set to Level 4 (Service).
- The trace cycle and encoder increments must match; otherwise, the pulse will not be detected.
- In many cases, the encoder signals are displayed as double-words and must be interpreted accordingly.

Task Record the encoder signal.

1. Open the expert list of the drive object.
2. Use parameter p496 to select which signals are to be entered in the following parameters:
   - p497
   - p498
   - p499
3. Open the trace tool and record the parameter.

Exercise 6 – optional: Trace function
Recording encoder signals – result



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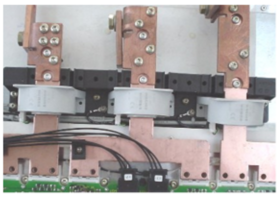
Exercise 7 – optional: Diagnostics in the power unit
Offset for current transducers

Para...	Data	Parameter text	Online value SERVO_02	Unit
All	A	All	All	All
r66		CO: Output frequency	133.88	Hz
r67		CO: Output current maximum	3.00	Arms
r68		CO: Absolute current actual value	0.13	Arms
r69		Phase current actual value		
r69[0]		Phase U	0.17	A
r69[1]		Phase V	0.06	A
r69[2]		Phase W	-0.18	A
r69[3]		Phase U offset	0.05	A
r69[4]		Phase V offset	0.00	A
r69[5]		Phase W offset	-0.03	A
r69[6]		Total U, V, W	-0.00	A
r70		CO: Actual DC link voltage	322.05	V



p0287[0...1] **Ground fault monitoring thresholds / Gnd flt threshold**

A_INF, S_INF, SERVO, SERVO_AC, SERVO_I_AC, VECTOR, VECTOR_AC, VECTOR_I_AC

Can be changed: T	**Calculated:** -	**Access level:** 3
Data type: FloatingPoint32	**Dyn. index:** -	**Func. diagram:** -
P-Group: -	**Units group:** -	**Unit selection:** -
Not for motor type: -	**Scaling:** -	**Expert list:** 1
Min	**Max**	**Factory setting**
0.0 [%]	100.0 [%]	[0] 6.0 [%] [1] 16.0 [%]

Description: Sets the shutdown thresholds for the ground fault monitoring.
The setting is made as a percentage of the maximum current of the power unit (r0209).

Index: [0] = Threshold at which pre-charging starts
[1] = Threshold at which pre-charging stops

Current transducers

SINAMICS acquires the current for each motor phase by means of a current transducer. These current transducers measure the current indirectly using the Hall effect, so an offset can occur as the current transducer ages. SINAMICS therefore saves the offsets for the phase currents in parameters r69[3], r69[4] and r69[5] that the associated current transducer measures despite a pulse inhibit.

This compensation results in the actual flowing phase current being indicated in parameters r69[0], r69[1] and r[2].

As soon as the current offset overshoots a predefined threshold, a ground fault is indicated.

Task

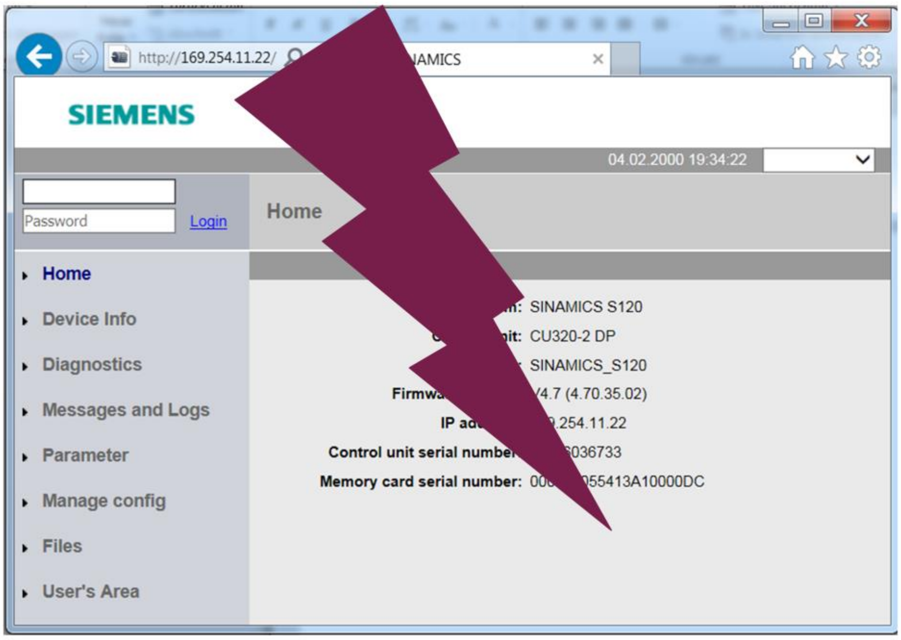
Check the phase current offset when a pulse inhibit is present for a motor object and enter this value as follows:

r69[3] : ……………………………………..

r69[4] : ……………………………………..

r69[5] : ……………………………………..

Übung 8: Diagnose über Webserver



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Webserver

Eine Diagnose kann auch über den integrierten Webserver durchgeführt werden.

Verbinden Sie die Schnittstelle des PG mit der LAN-Schnittstelle (X127) der CU320-2 DP über ein Ethernet-Kabel.

Rufen Sie den Internet-Explorer auf und geben Die IP-Adresse der LAN-Schnittstelle ein (default: 169.254.11.22).

Die Startseite wird angezeigt. Der Account lautet „SINAMICS“ ohne Passwort.

Kontrollieren Sie die Diagnosemeldungen und erstellen ggf. eine Parameterliste.

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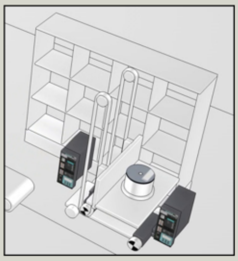

Chapter 13

Basic positioner

Course DR-S12-PM

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Learning Targets

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- You know the basics of closed-loop position control
- You will be able to activate and configure the basic positioner
- You will be able to set a home position
- You will be able to traverse the axis with a traversing program

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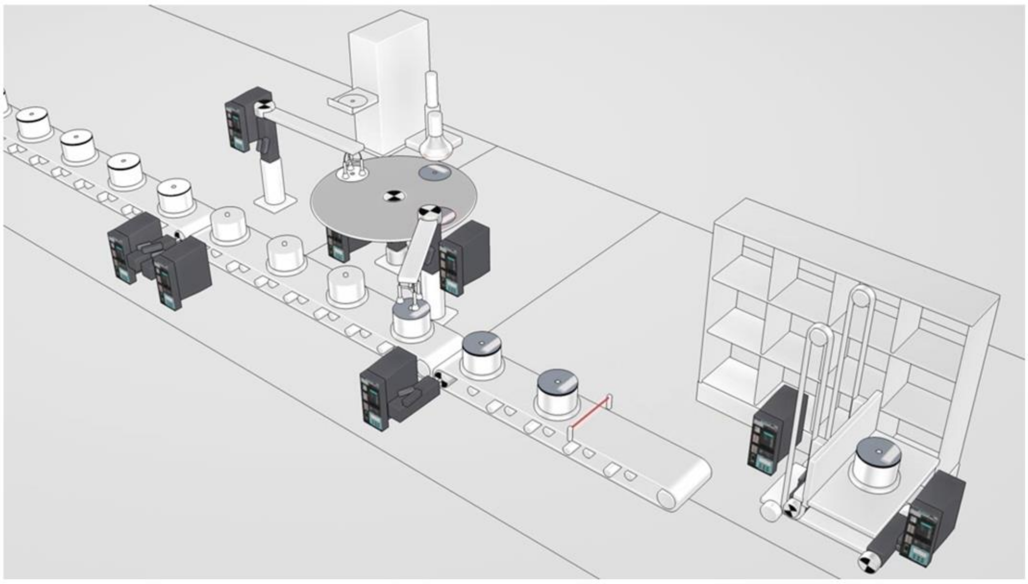
EPOS EPOS = Basic positioner
Depending on the EPOS operating mode, EPOS supplies the position controller with the required position setpoint "s".

Position controller This has the task of establishing the position setpoint received from EPOS. The position controller receives the actual position value from the selected encoder. The position controller supplies the speed setpoint "n" for the series-connected speed controller.

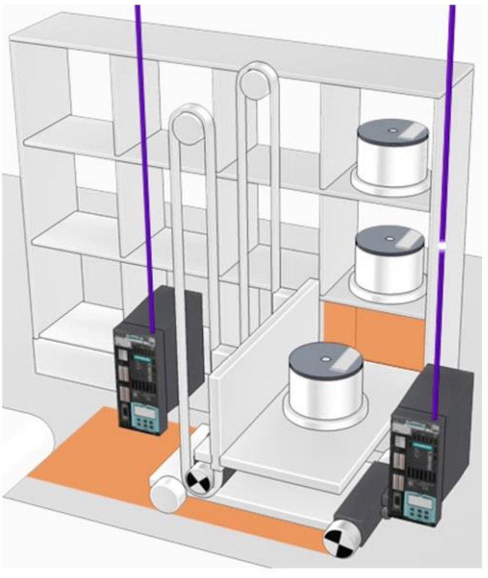
Setpoint input Depending on the selected operating mode, EPOS calculates the position setpoint "s" for the position controller.

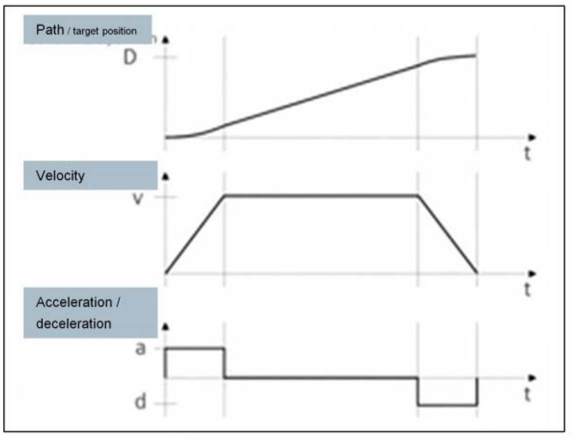
Actual value acquisition The current actual position value is supplied to the position controller via the assigned encoder measurement system.

Positioner application



Traversing profile





Preset

- Target position
- Velocity
- Acceleration/deceleration

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Positioning A positioning request is configured by specifying

- the target position
- the velocity
- the acceleration and
- the deceleration

Rotary and linear axes

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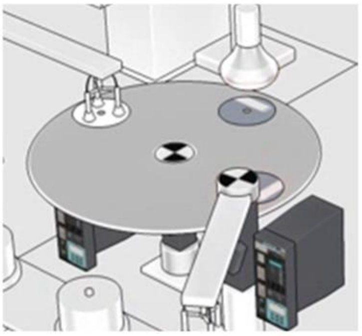
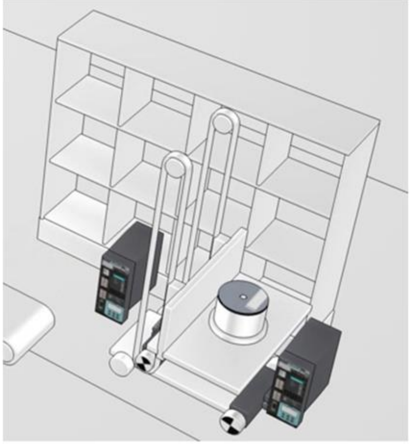
Rotary axis:

- Endless traversing range
- Position setpoints and actual position values as modulo value (i.e. reset to 0° if 360° is overtraveled)
- Motion commands:
  - Travel in a certain direction
  - Travel over the shortest path



Linear axis:

- Defined traversing range
- Limit switch (hardware and/or software limit switch)



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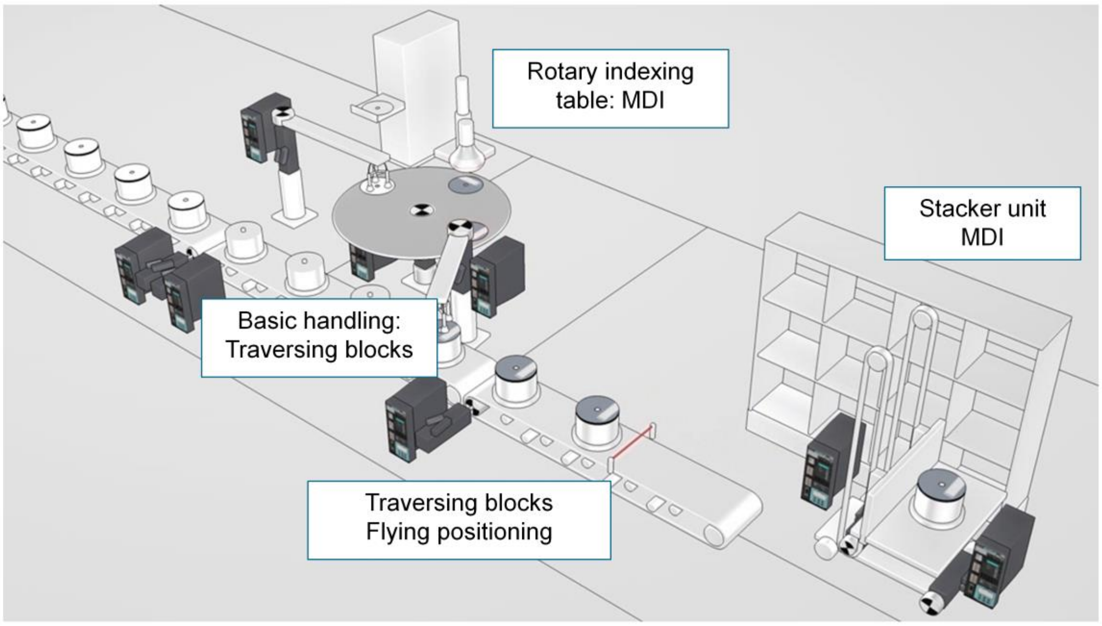
Operating modes
Examples



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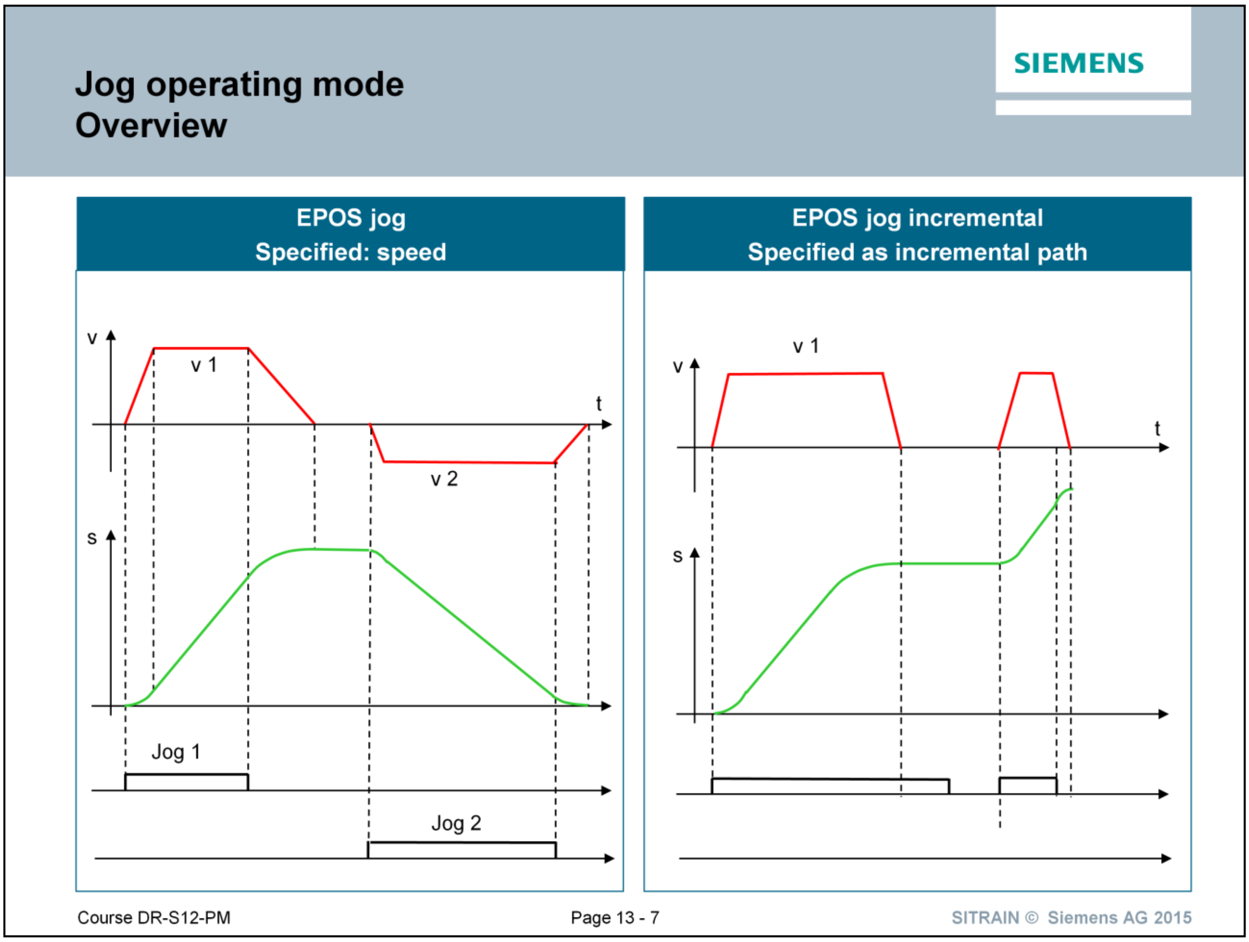
MDI Rotary indexing table in MDI

Direct transfer of the position parameters to the higher-level control:
Target position, velocity, acceleration, deceleration

Basic handling For example, in the traversing block mode via pre-stored motion sequences for easy and fast handling. Traversing blocks contain details of:
Target positions, velocities, accelerations, decelerations

Flying positioning Position conveyor belts dynamically and accurately with the "Homing" mode.

Stacker unit High flexibility in MDI mode by specifying target position, velocity, acceleration, deceleration.



Jog

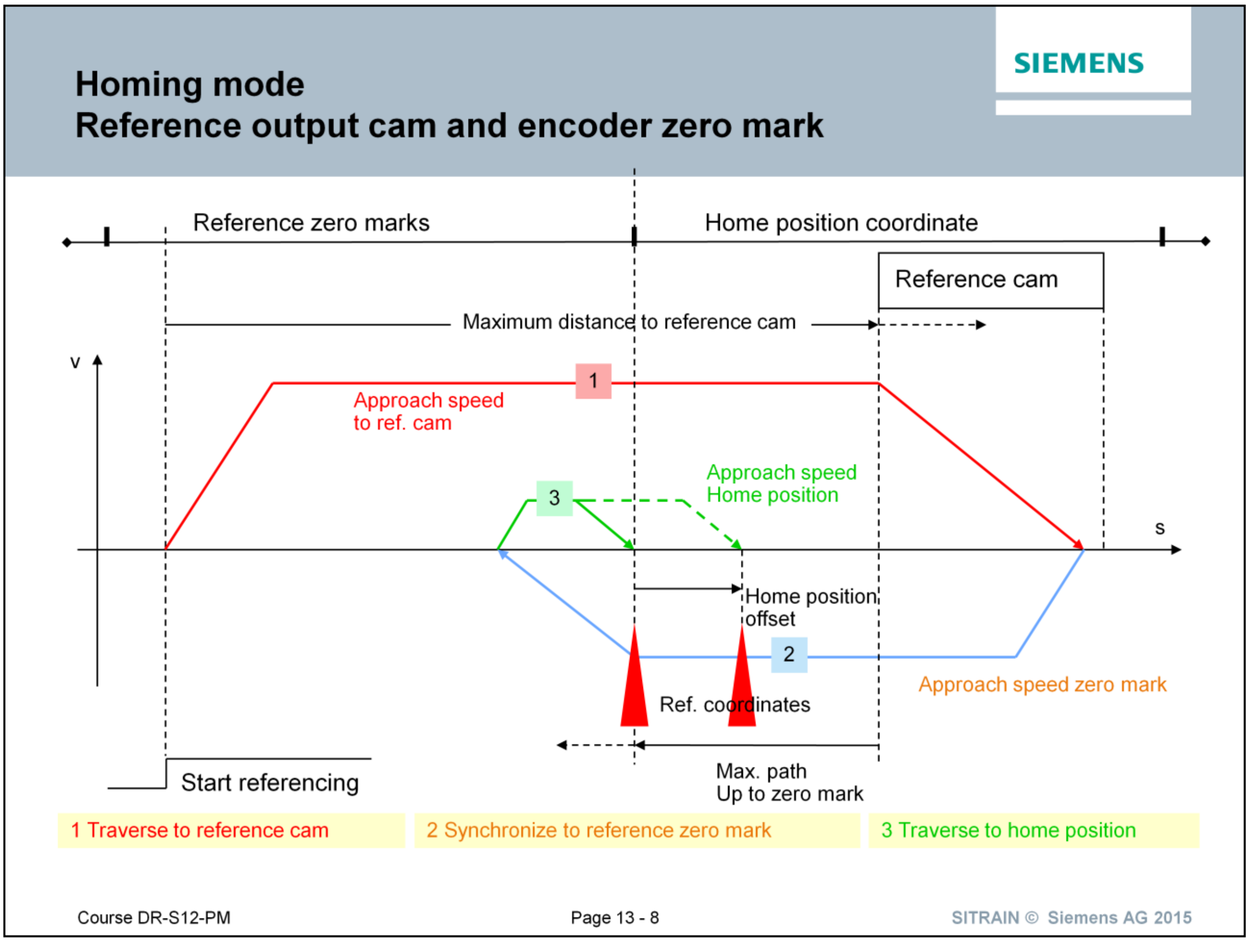
In "Jog" mode, both functions "Position controlled jogging" and "Incremental jogging" are available. The selection is effected via the two digital inputs "Jog 1" and "Jog 2".

Position controlled jogging

Traversing takes place with the assigned setpoint velocity as long as the enable is active for this operating mode.

Incremental jogging

Traversing takes place with the assigned setpoint velocity as long as the enable is active for this operating mode until the number of position increments has been traversed. If the enable is removed prematurely, the axis is halted at the current position.



homing

After a machine has been switched on, for positioning, the absolute dimension reference must be established to the machine zero. This procedure is referred to as referencing ("homing"). The following referencing types are possible:

- Setting the home position (all encoder types)
- With incremental encoder
  - Active referencing
  - With reference cam and encoder zero mark
  - With encoder zero mark
  - With external zero mark
  - Passive/flying referencing
- With absolute encoder
  - Absolute encoder adjustment
  - Passive/flying referencing

For all referencing types, a connector input must be provided to specify the home position coordinates. However, to permanently enter the home position coordinate, an adjustable parameter for this quantity is also required. As standard, this adjustable parameter p2599 is interconnected to connector input p2598.

Home position setting

The home position can be set by a 0/1 edge at the "Set home position" binector input. The current actual position of the drive is set here as the home position using the coordinate specified by the "Home position coordinate" connector input. The setpoint is adjusted accordingly.

Flying

With flying referencing, a 0/1 edge at the binector input can make a correction to the actual position during positioning and thereby compensate for inaccuracies in actual value acquisition. This increases the load-side positioning accuracy.

Homing mode
Absolute encoder adjustment

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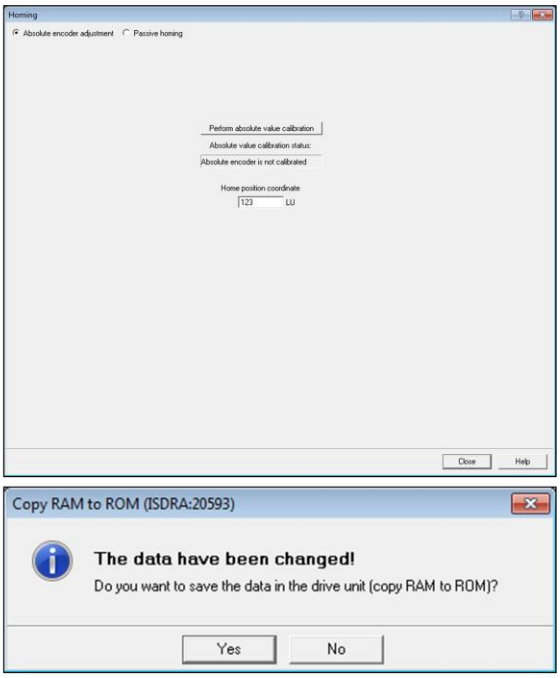

After commissioning/ encoder replacement

- Displayed actual position value = 10000 LU
- Position relative to the machine = 12345 LU
- Perform absolute encoder adjustment
- With home position coordinate = 12345 LU
- Feedback signal
- Absolute encoder is calibrated
- Save the offset in ROM

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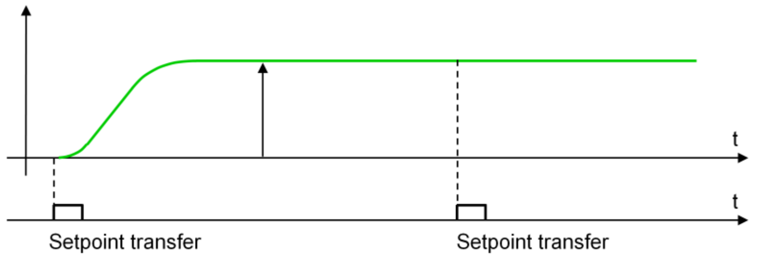
Absolute encoders have to be adjusted during commissioning. After the machine has been switched off, the position information of the encoder is retained.

When "Perform absolute value calibration" is entered, an offset value (p2525) is determined using the home position coordinate. This is used to calculate the actual position value. Performance of adjustment is confirmed in the screen.

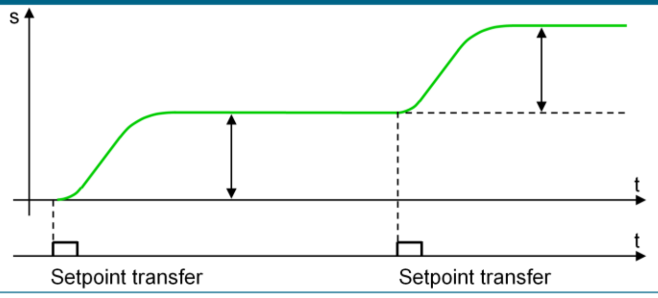
The offset of the encoder adjustment should be saved in a non-volatile fashion (RAM to ROM) to permanently save it.

Direct setpoint specification mode/MDI
Positioning absolute/relative

"Absolute" positioning: Positioning to position setpoint



"Relative" positioning: Traverse path (position setpoint)



With the "Direct setpoint specification/MDI" mode, you can use the predefined dynamic values (velocity, position, acceleration and delay) to perform absolute and relative positioning. Positioning.

Absolute positioning

After setpoint transfer, the basic positioner traverses to the **absolute position** specified in length units (LU). After the next setpoint transfer, this absolute position is approached, or if it has already been reached, it is maintained.

Relative positioning

After setpoint transfer, the basic positioner traverses the **relative path** specified in the length units (LUs). After the next setpoint transfer, this path is traversed again.

Setpoint transfer

A positioning task is not performed until setpoint transfer is triggered with a rising edge.

Traversing blocks mode
Application example

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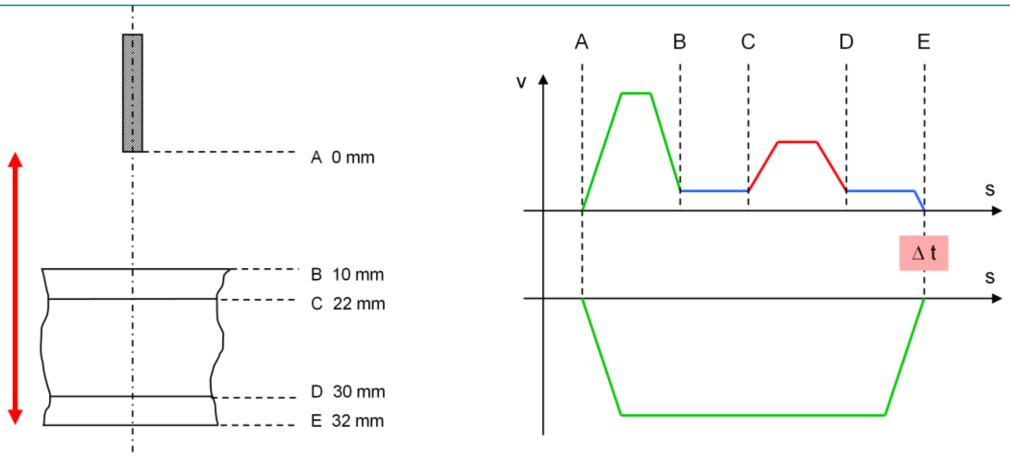

Block 0	A → B	Traverse to position B with velocity 6n and change over on-the-fly		
Block 1	B → C	....	C	n
Block 2	C → D	....	D	4n
Block 3	D → E	....	E	n
Block 4		Wait 500 ms		
Block 5	E → A	....	A	- 6n

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A table top veneered on both sides must be drilled using a milling tool. Describe the vertical motion of the milling tool with a traversing block table. The traversing path is divided into positions A, B, C, D and E and is described with the following traversing profile:

Path A ➔ B: 6-times velocity (pos. direction)

Path B ➔ C: 1-times velocity (pos. direction)

Path C ➔ D: 4-times velocity (pos. direction)

Path D ➔ E: 1-times velocity (pos. direction)

In position E: 500 ms waiting

Path E ➔ A: 6-times velocity (neg. direction)

Traversing blocks mode
Program traversing blocks

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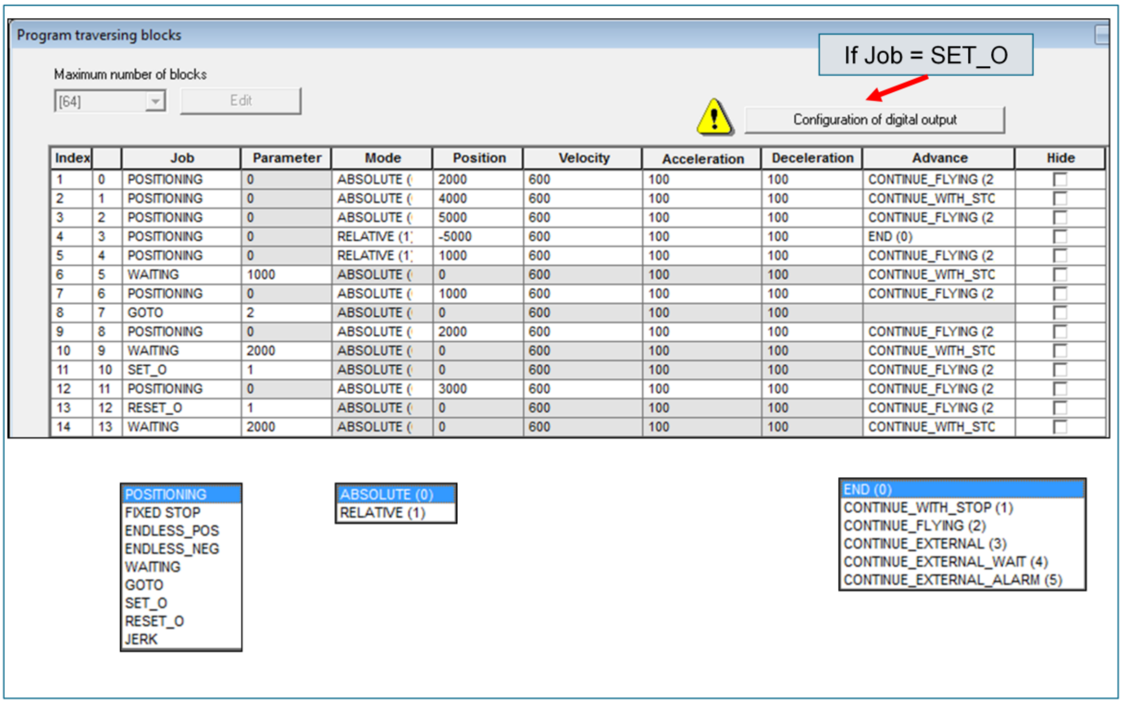

Index		Job	Parameter	Mode	Position	Velocity	Acceleration	Deceleration	Advance	Hide
1	0	POSITIONING	0	ABSOLUTE (	2000	600	100	100	CONTINUE_FLYING (2	☐
2	1	POSITIONING	0	ABSOLUTE (	4000	600	100	100	CONTINUE_WITH_STC	☐
3	2	POSITIONING	0	ABSOLUTE (	5000	600	100	100	CONTINUE_FLYING (2	☐
4	3	POSITIONING	0	RELATIVE (1)	-5000	600	100	100	END (0)	☐
5	4	POSITIONING	0	RELATIVE (1)	1000	600	100	100	CONTINUE_FLYING (2	☐
6	5	WAITING	1000	ABSOLUTE (	0	600	100	100	CONTINUE_WITH_STC	☐
7	6	POSITIONING	0	ABSOLUTE (	1000	600	100	100	CONTINUE_FLYING (2	☐
8	7	GOTO	2	ABSOLUTE (	0	600	100	100		☐
9	8	POSITIONING	0	ABSOLUTE (	2000	600	100	100	CONTINUE_FLYING (2	☐
10	9	WAITING	2000	ABSOLUTE (	0	600	100	100	CONTINUE_WITH_STC	☐
11	10	SET_O	1	ABSOLUTE (	0	600	100	100	CONTINUE_FLYING (2	☐
12	11	POSITIONING	0	ABSOLUTE (	3000	600	100	100	CONTINUE_FLYING (2	☐
13	12	RESET_O	1	ABSOLUTE (	0	600	100	100	CONTINUE_FLYING (2	☐
14	13	WAITING	2000	ABSOLUTE (	0	600	100	100	CONTINUE_WITH_STC	☐

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Traversing blocks Max. 64 traversing blocks per drive

Index No. "-1": Inactive traversing block
0 … 63: Active traversing block

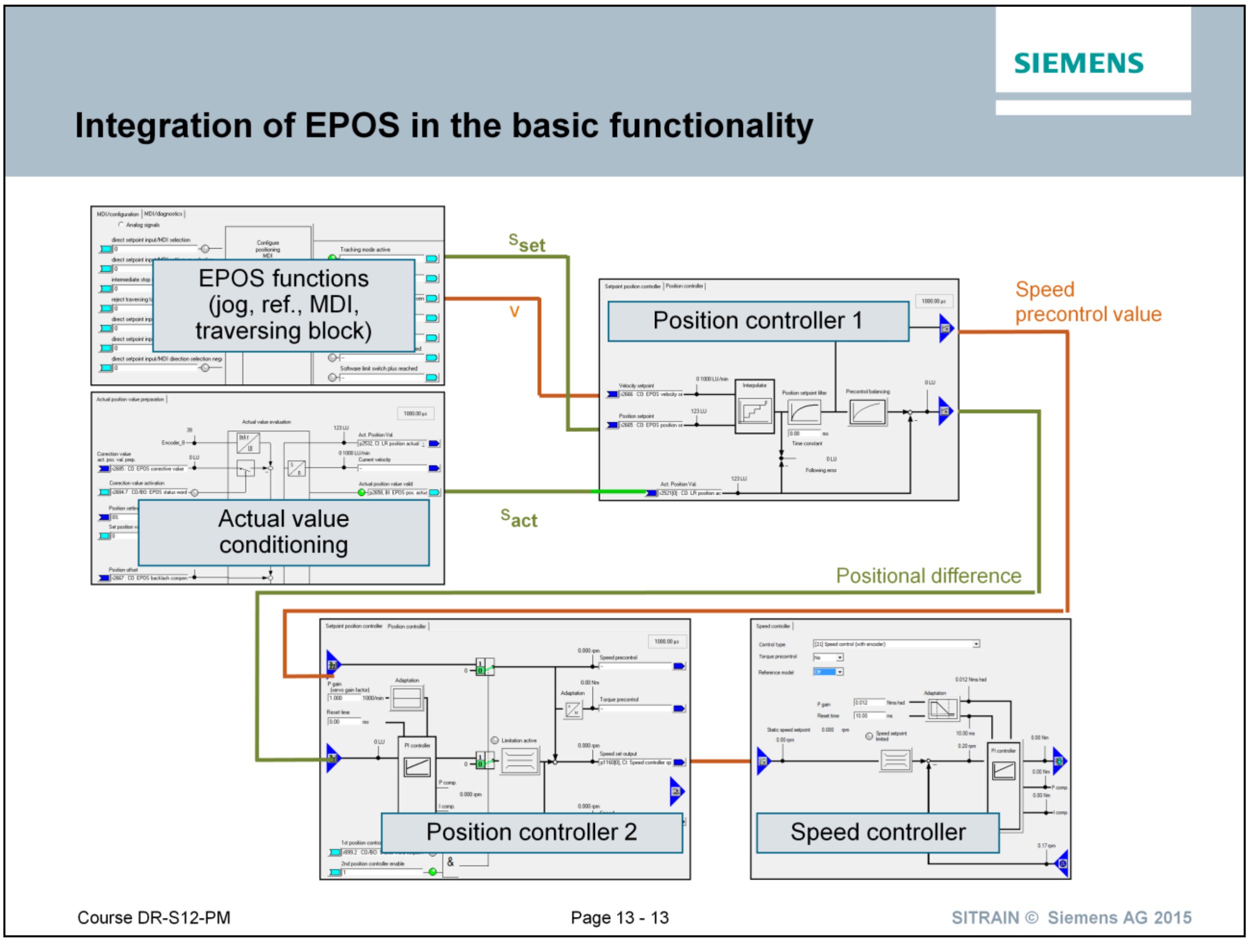
Job Task within the traversing block, e.g. positioning, waiting, goto, …

Parameter This is valid in accordance with the task, e.g.:
WAIT 1000 ms or
GOTO 0 (jump to traversing block No. 0)

Mode Valid according to the job, e.g.:
POSITIONING ABSOLUTE or
POSITIONING RELATIVE

Position Valid according to the job POSITIONING, e.g.:
POSITIONING ABSOLUTE to position 1000000 LU or
POSITIONING RELATIVE by 50000 LU

Advance Specifies the block change criterion for this positioning job, e.g.:
CONTINUE_WITH_STOP,
CONTINUE_FLYING,
CONTINUE_EXTERNAL,
CONTINUE_EXTERNAL_WAIT or
CONTINUE_EXTERNAL_ALARM



Connecting

When the function "Basic positioner" is activated, both the basic positioner and the position controller are enabled.

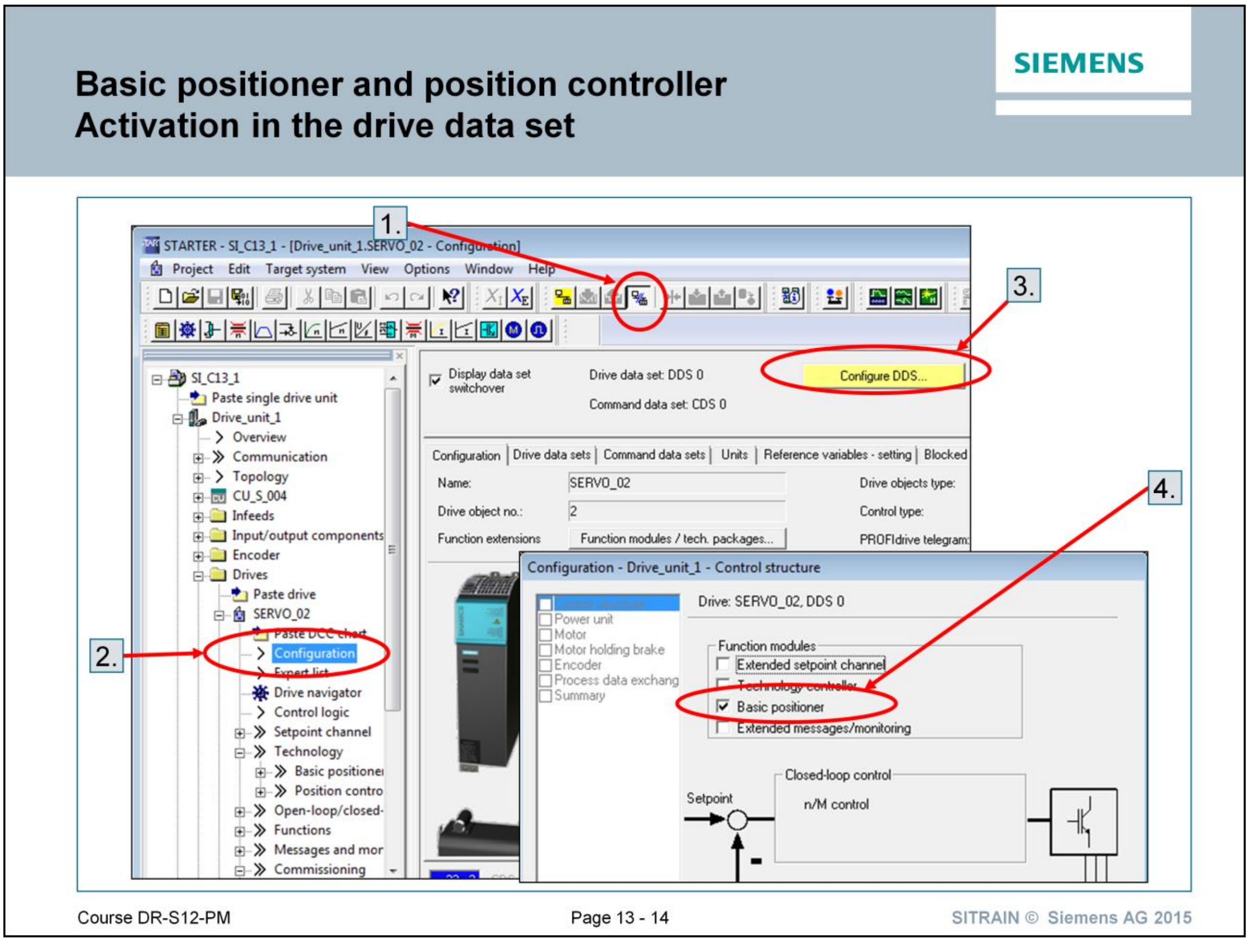
They are connected by the system with the speed controller and current controller in the correct order. This means that the typically used 3-level cascade "Position controller – Speed controller – Current controller" is also available in SINAMICS S120 All the BiCo connections required here are implemented automatically.

Basic positioner

Depending on the selected operating mode, the basic positioner calculates the position setpoint and supplies this to the series-connected position controller on its setpoint input.

Position controller

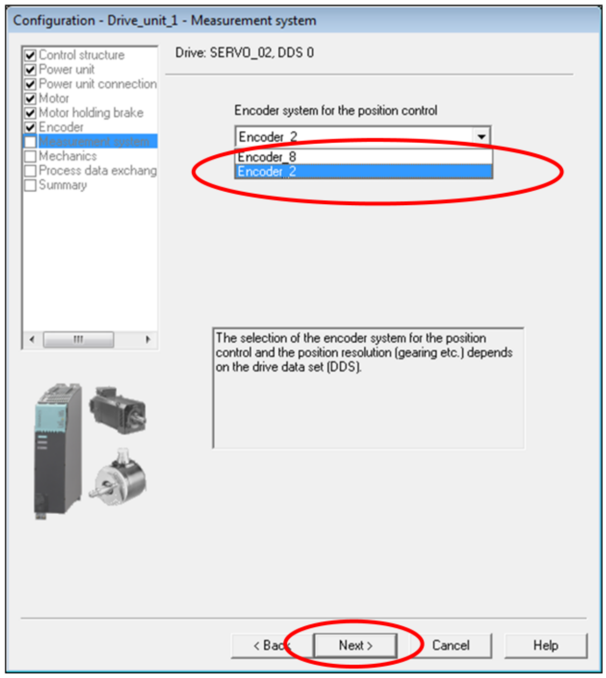
The position controller calculates the speed setpoint from the position setpoint obtained from the basic positioner and the actual position value obtained from the encoder system which it then supplies to the series-connected speed controller on its setpoint input.



Configuration

1. Go offline
2. Inside the desired motor object, select ➔ Configuration
3. Press the "Configure DDS …" button
4. Select the basic positioner (EPOS) and go through the DDS configuration as usual using the "Next" button

Basic positioner and position controller
Selection of the position measurement system



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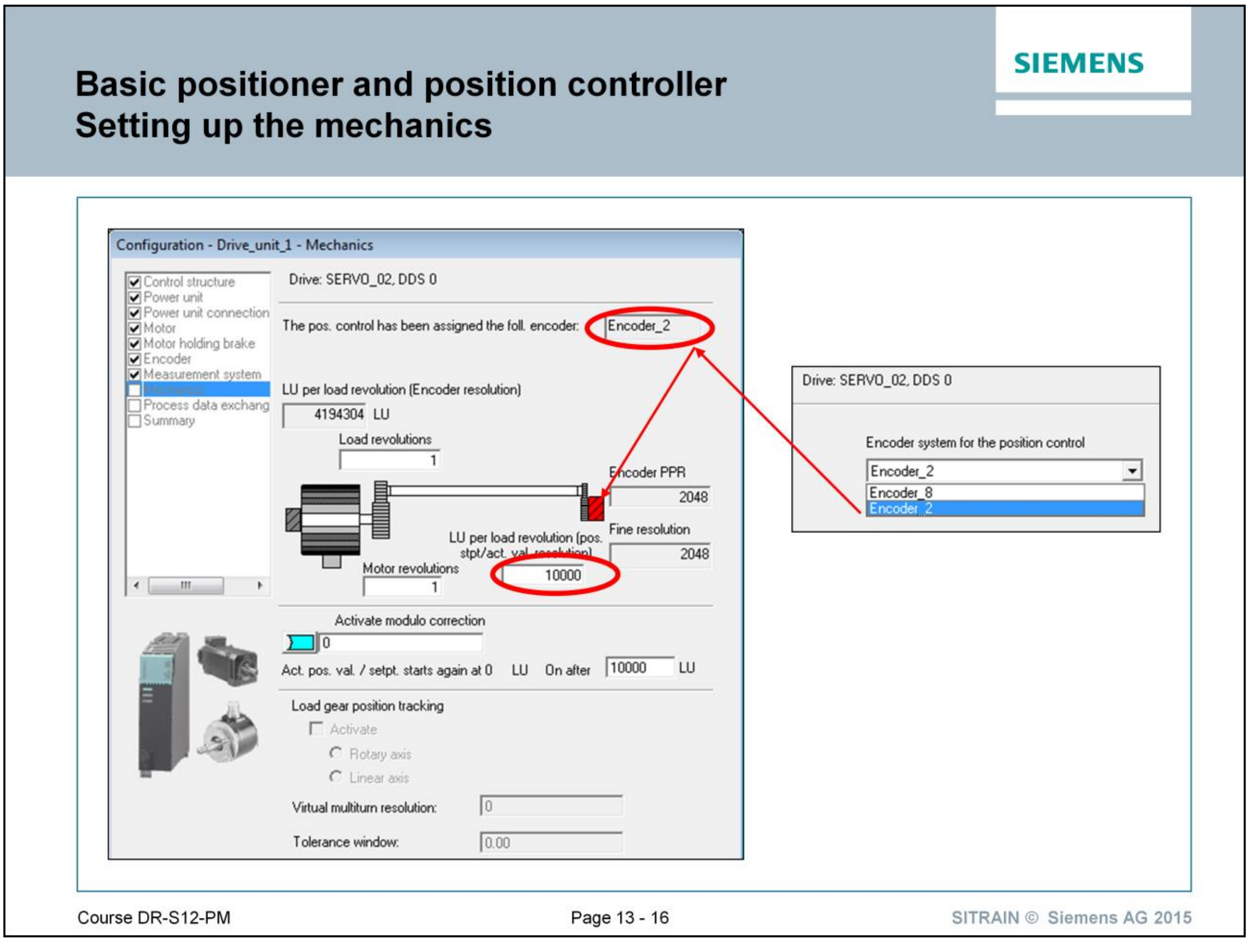
Selection The converter must know which encoder has supplied the actual position values. Select the motor encoder as position measurement system here (indirect position measurement system).

Note The training case does not have an additional position controller; it simply accepts the actual position value from the motor encoder, so it has no direct position measurement system.



Mechanics

For the drive to approach positions autonomously without the higher-level controller, it must calculate actual position values from the encoder signals. When the data set is configured, the relationship between the machine position and the encoder signal must be specified.

LU (Length Unit)

With SINAMICS S120, the position controller and the basic positioner work with a dimensionless variable LU (Length Unit).
For the linear encoder, the relationship between the physical variable and the neutral length unit LU is configured with the parameter p2503 (LU / 10 mm).

Example:
Linear scale, 10 mm must represent 1 µm (i.e. 1 LU = 1 µm)
➔ p2503 = 10000

For a spindle pitch of 10 mm/load revolution (corresponding to 10,000 LU/load revolution), 1 LU = 1 µm resolution.

Conclusion of DDS configuration

Close the DDS configuration now using the "Next" button, switch to Online and load the data for your EPOS into your drive.

Basic positioner and position controller traversing profile limitation

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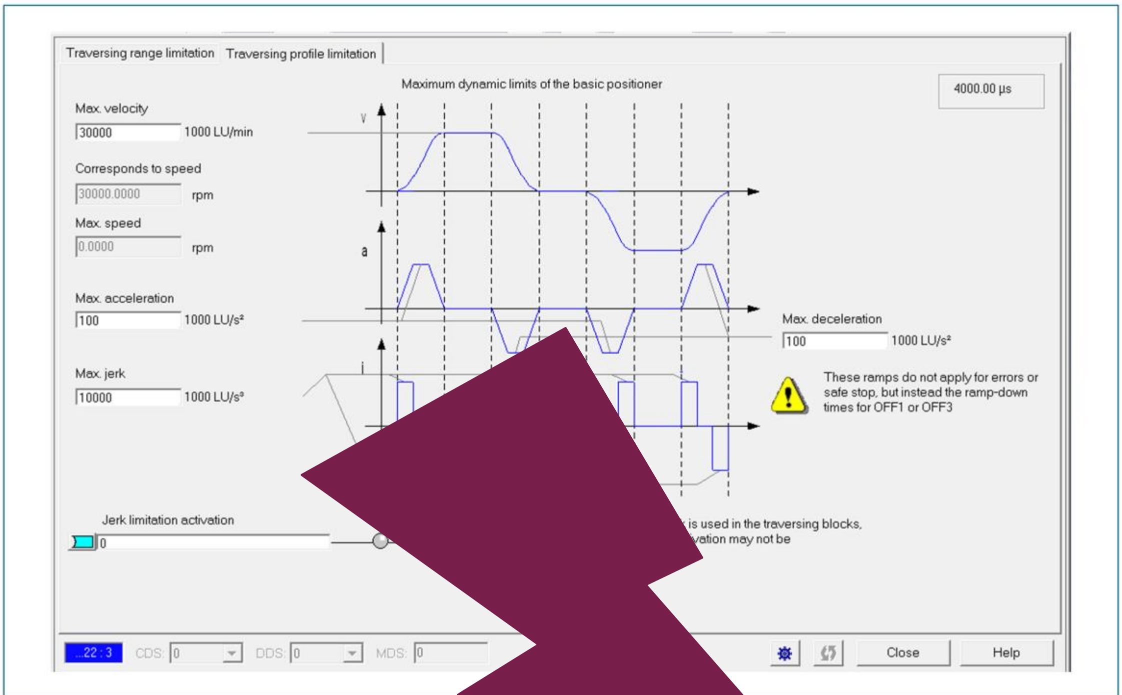

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Mechanik Soll der Antrieb ohne übergeor[illegible] eigenständig Positionen anfahren können, so muss er aus d[illegible]ignalen Lageistwerte berechnen. Deshalb muss bei der Konfiguration d[illegible]atzes die Relation der Maschinenposition zu dem Geber[illegible]en werden.

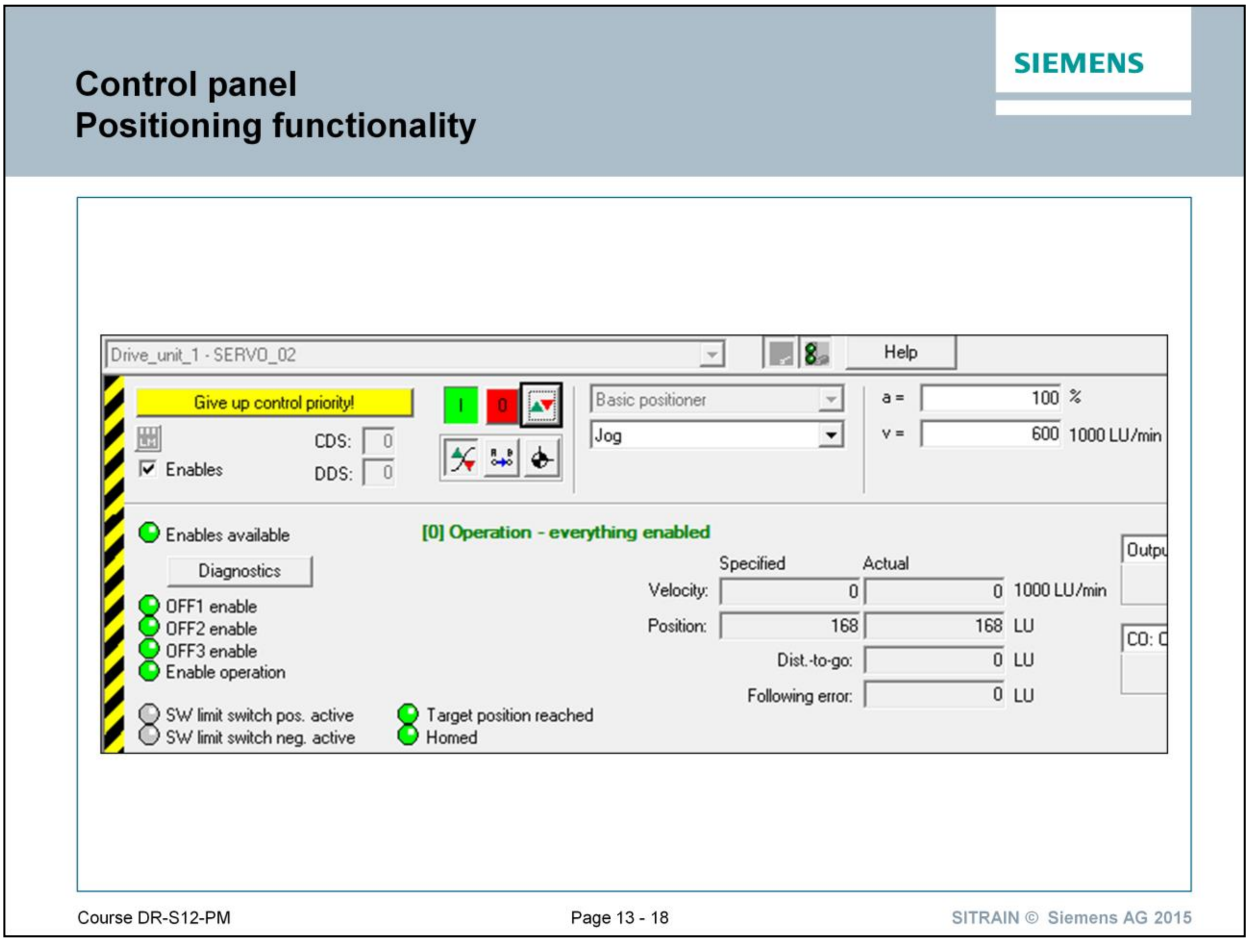
LU (Length Unit) Bei Sinamics S120 arbeiten der Lagereg[illegible] Einfach-Positionierer mit einer dimensionslosen Größe LU (Length Un[illegible]

Beim linearem Geber wird der Zusammenhang zwisc[illegible]der physikalischen Größe und der neutralen Längeneinheit LU über den Par[illegible]eter p2503 (LU /10mm) konfiguriert.

Beispiel:
Linearmaßstab, 10 mm sollen auf 1 µm aufgelöst werden (d. h. 1 LU = 1 µm)
➔ p2503 = 10000

Bei einer Spindelsteigung von 10 mm/Lastumdrehung (entspricht 10.000 LU/Lastumdrehung) bedeutet 1 LU = 1 Micrometer Auflösung.

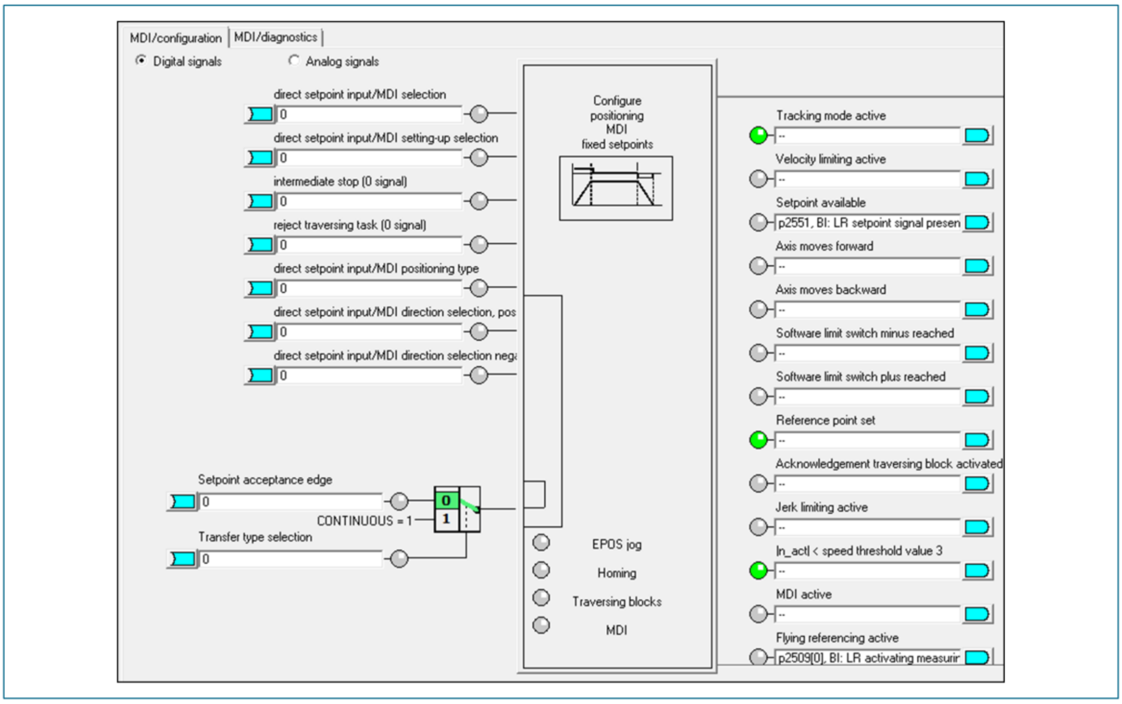
Abschluss der DDS-Konfiguration Schließen Sie nun die DDS-Konfiguration mit der Weiter-Schaltfläche ab, gehen Sie ONLINE und laden Sie die Daten Ihres EPOS in Ihren Antrieb.



Control panel

In addition to specifying the speed, the control panel can also support commissioning of the "Basic positioner" function for a drive with positioning functionality.

BICO interconnections
Example MDI – digital signals



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Interconnection

The operating modes must be adapted to the application using interconnections.

Each mode provides two screens to do this:

- Digital signals for interconnecting binectors
- Analog signals for interconnecting connectors

A third screen is also provided for diagnostics

Digital signals

Depending on the operating mode, different digital signals are offered for further interconnection of the inputs and outputs.

Functions are initiated or selected via the inputs; the feedback signal to the application is issued via the outputs.

BICO interconnections
Example MDI – analog signals

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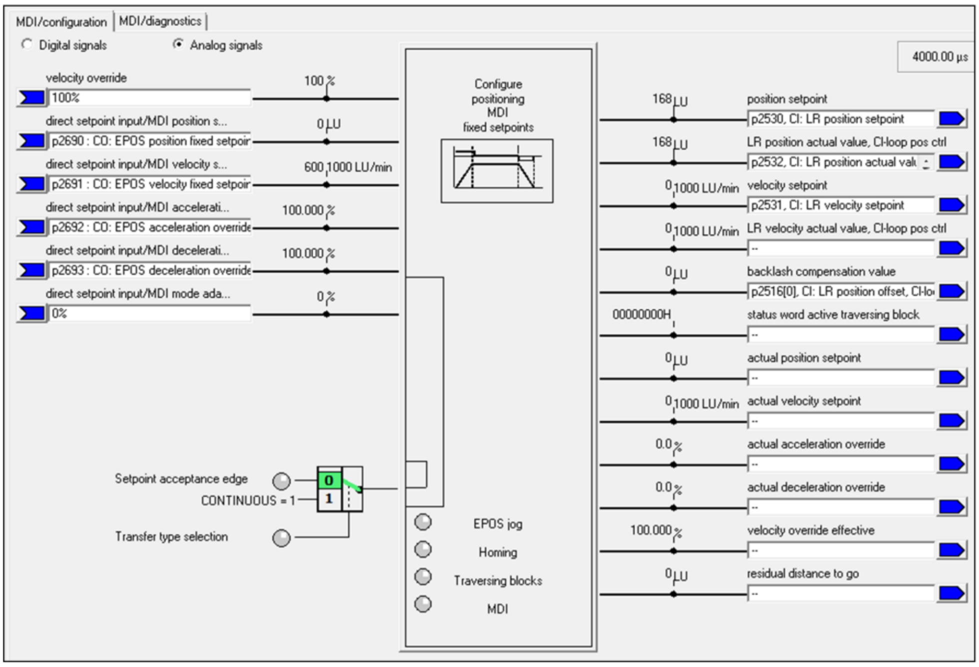

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Analog signals Depending on the operating mode, different signals are offered for further interconnection.

Diagnostic information
Example MDI / diagnostics

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Diagnostics The "Diagnostics" screen lists the diagnostic information that is important for this operating mode.

Exercises

- Exercise 1: Configuration of the basic positioner
- Exercise 2: Set home position
- Exercise 3: Program traversing blocks

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Prerequisites

Status of the device:

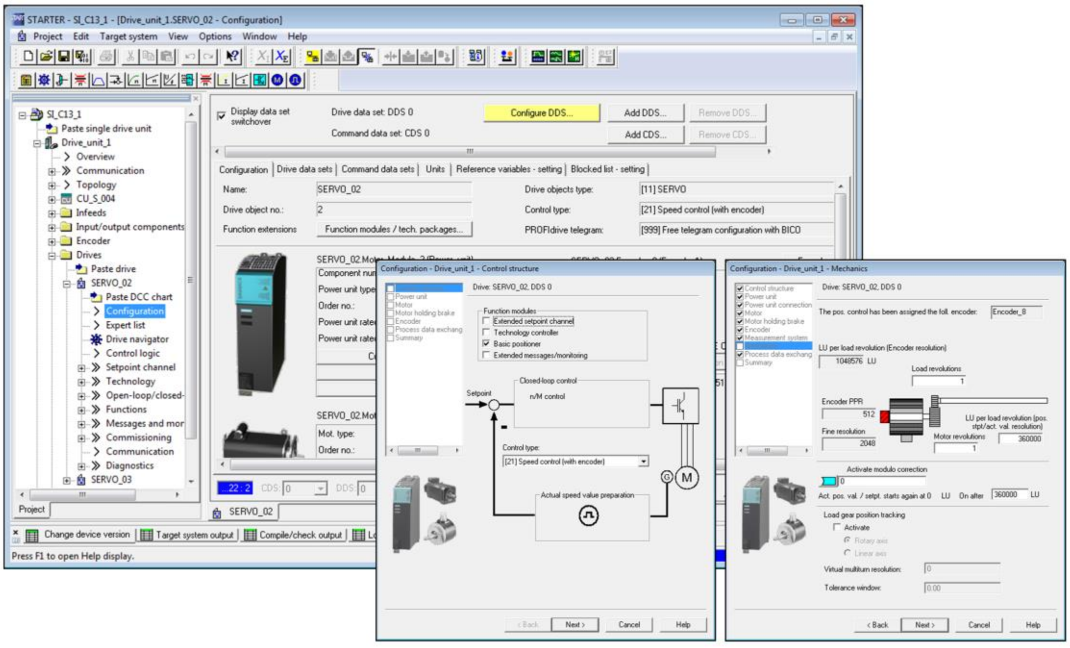
- First commissioning completed

Safety information

Please note that:

- The course instructions have been produced for:
  - A course held by a course leader
  - Activities carried out on special training equipment
- The training equipment is operated under laboratory conditions.
  In case of doubt, always ask your course leader – particularly when handling components that carry electrical current or which can move.
- When carrying out work on equipment, the safety information in the associated product documentation must always be observed!
  The Training Documents alone are not sufficient.

Exercise 1: Configuring the basic positioner
First commissioning



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Preconditions

A project with a "Servo" drive object. For this purpose, use the **"S120_SERVO_1.zip**" project that you archived on the hard disk.

Task

You will implement a basic positioning task using the blue motor ("Servo_03") of your exercise unit. Configure this drive as a basic positioner:

1. Go online and select "Servo_03":
   >> Configuration > Configure DDS…

2. Run through the configuration of the "Servo_03" drive object with the following features:
   - Basic positioner
   - Power, motor and encoder data (already set as for the closed-loop speed control)
   - Gear ratio: Load revolutions/motor revolutions = 1/1
   - Position resolution = 1000 LU per load revolution (LU = Length units)
   - Free telegram configuration with BICO

3. Save your project.

4. Online: Download the extended project to the target device and ensure that the data are consistent in all memory locations used.

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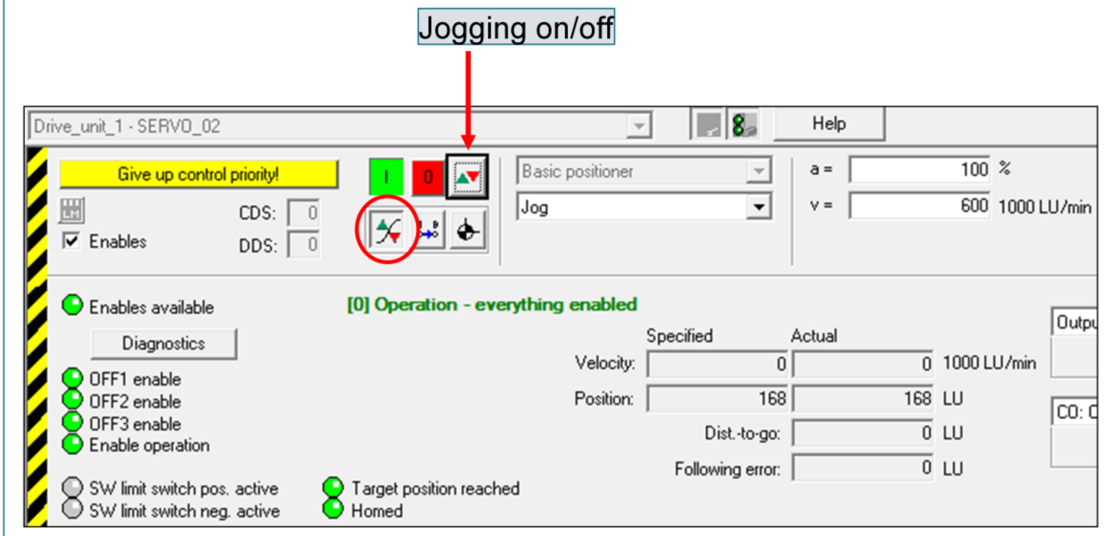
Exercise 1: Configuring the basic positioner
Testing using the control panel



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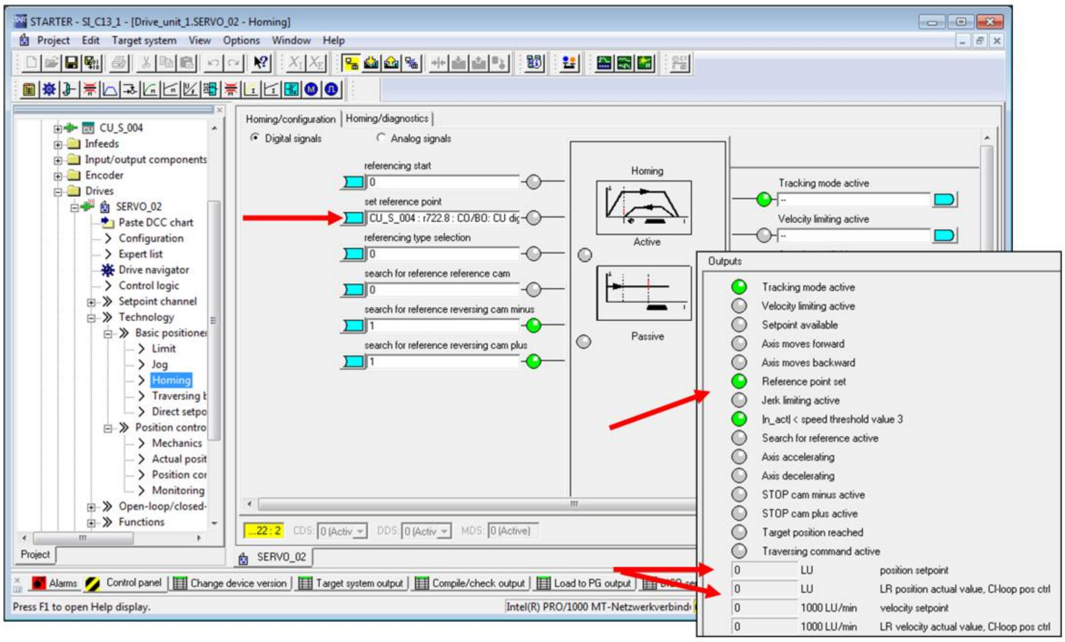
Task Test the drive using the control panel in the speed-controlled and position-controlled mode

1. Under SERVO_03, select the control panel:
   >> *SERVO_03* > *Commissioning* > *Control panel*
2. Use this to test the functions of the "blue axis", initially with the "speed setpoint input".
3. Now select the control panel function "Basic positioner"
4. Assume control priority
5. Set the required enable signals
6. Select the EPos function, "Jogging"
7. Switch on the axis
8. Issue the jog command using the mouse. As long as you issue the jog command, the axis moves with the assigned acceleration (a) and the specified velocity (v).
9. Withdraw the jog command
10. Switch off the axis
11. Give up control priority.

Note As, during the configuration, a rotation 1000 LU (position resolution 1000 LU/U) was assigned, and input of e.g. v = 600 [1000 LU/min] corresponds to a speed of 600 rpm.

Exercise 2: Set home position via DI 8



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Task

On the exercise equipment, it is not possible to realize a reference point approach, therefore the basic positioner must be set to a position of 0 via an externally switched signal:

1. Under the "Servo_03" drive object, open referencing/homing:
   >> Technology > Basic positioner > Homing >
   Homing/configuration > Digital signals.

2. Assign switch DI 8 to the function "Set reference point".

3. Go to the tab "*Homing/diagnostics"*

4. Note the following feedback messages:
   - Reference point set [ ] yes [ ] no
   - Position setpoint/actual position: ……………………………………..

5. Switch on the axis (DI4 = 1), and briefly enter the command "Set reference point" (DI8 = 1).

6. You obtain the following results as feedback signal:
   - LED "Reference point set" = lit/on
   - Position setpoint / position actual value = 0

Note

Without renewed setting or approaching a reference point, the axis position that you have selected is considered to be the "zero" position; for all of the position commands, it is valid as the reference position.

Exercise 3: Traversing blocks
Programming and activating traversing blocks

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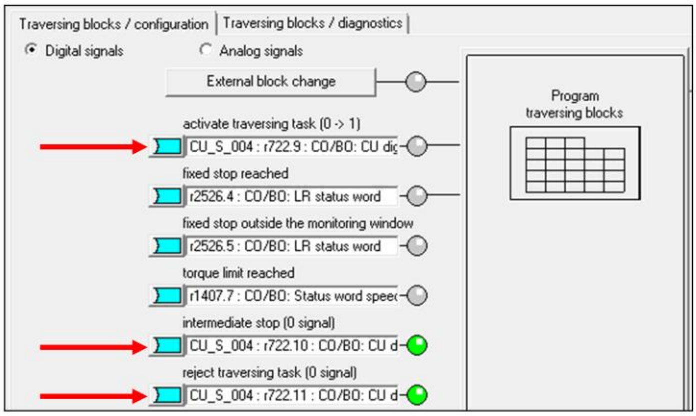

	Job	Parameter	Mode	Position	Velocity	Acceleration	Deceleration	Advance
0	POSITIONING	0	ABSOLUTE (	80000	8000	100	100	CONTINUE_WITH_STOP
1	POSITIONING	0	ABSOLUTE (	100000	4000	100	100	CONTINUE_FLYING (2)
2	WAITING	1000	ABSOLUTE (	0	600	100	100	CONTINUE_WITH_STOP
3	POSITIONING	0	ABSOLUTE (	0	2000	100	100	CONTINUE_FLYING (2)
4	GOTO	0	ABSOLUTE (	0	600	100	100	

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Task

For your positioning task, generate a simple traversing program according to the example described above:

1. Go to the function
   >> *Traversing blocks* > *Traversing blocks/configuration* > *Digital signals*

   Make the following interconnections:
   - DI 9 = Activate traversing task
   - DI10 = Intermediate stop (0 signal)
   - DI11 = Reject traversing task (0 signal)

2. Go to the function >> *Traversing blocks*

   There, program the 5 traversing blocks corresponding to the recommendation above.

3. Activate the traversing task with:
   - DI10 = 1
   - DI11 = 1
   - DI 9 = 0 ➔ 1

   Monitor how the axis tracks the parameterized traversing blocks.

Note

The following options are applicable in order to stop the axis that is now in the endless operating mode:

- Interrupt the traversing task: DI10 = 0
- Reject the traversing task: DI11 = 0
- Switch off the drive: DI4 = 0 (fault message)

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Chapter 14

Drive-based safety functions

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Learning Targets

- You will be familiar with the principle of integrated safety functions
- You will know the "Drive-based Safety Integrated" functions
- You will be able to parameterize and test the "STO" safety function
- You will be able to parameterize and test the "SS1" safety function

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Safety Integrated with SINAMICS

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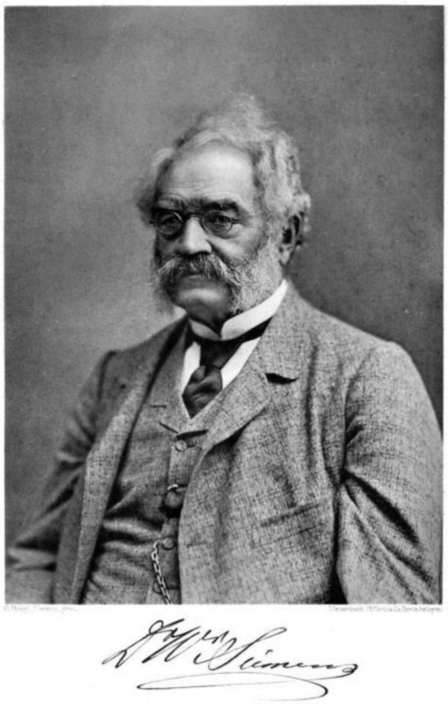
"Accident prevention must not be seen as a regulation under the law, but as a precept of human obligation and financial good sense."



Werner von Siemens, Berlin, 1880

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Background – safety functions
Hazard due to function failures

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Function failures in machines present a potential hazard to

Human

Machine

Process

- For this reason, machines must offer an appropriate level of functional safety.
  The associated regulations are country or region-specific.
- In the European Union, for example, the CE marking is mandatory for all machines on the market.
- By affixing the CE marking, the manufacturer confirms that the machine corresponds to the European Machinery Directive.

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Objective

Manufacturers and operators of technical equipment and products are responsible for safety. This means that plants, machines and other technical equipment must be made as safe as possible in accordance with the latest technology.

Safety systems are designed to minimize potential hazards for both people and the environment by means of suitable technical equipment, but without restricting industrial production and the use of machines more than necessary. The protection of people and the environment must be assigned equal importance in all countries, while it is important that rules and regulations that have been internationally harmonized are applied. This is also intended to avoid distortions in the competition due to different safety requirements in different countries.

Functional safety

From the perspective of the object to be protected, safety is indivisible. The causes of hazards and therefore also the technical measures to avoid them can vary significantly. This is the reason why a differentiation is made between different types of safety - e.g. by specifying the cause of possible hazards. "Functional safety" is involved when the safety depends on the correct function.

The requirements to achieve functional safety are based on the following basic goals:

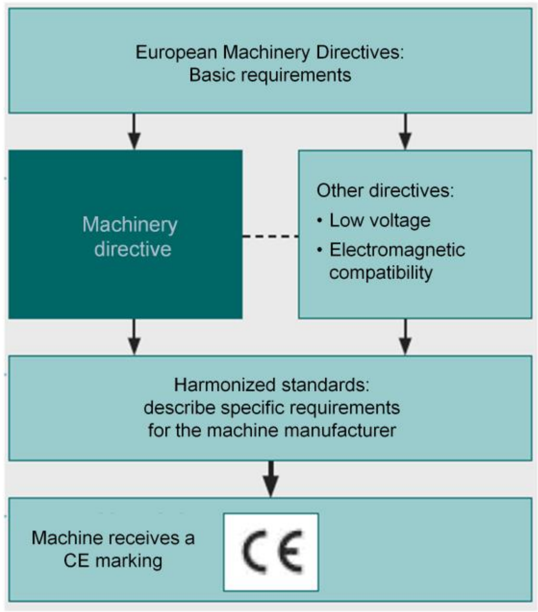
- Avoiding systematic errors
- Controlling systematic errors
- Controlling random errors or failures

CE marking

Machines that, with regard to the machinery directive, are usable, ready to use and operational, receive the CE marking as part of the conformance declaration.

Safety components receive only the EC Declaration of Conformity, but no CE marking!

Safety concept within the EU



Article 137

The EC Directives for occupational safety and for machine use mainly address the users of machines. The level of protection defined in the minimum requirements can be increased through national regulations.

The "Safety and health of workers at work" Council Directive (89/391/EEC) defines minimum requirements for safety in the workplace

In Germany, the requirements are summarized in the German Health and Safety at Work Regulations (BetrSichV).

You will find more information (in German) on the Internet pages of the Federal Institute for Occupational Safety and Health (BAuA) (http://www.baua.de/baua/index.htm)

The European Machinery Directive
Basic safety requirements

The manufacturer is obliged to perform a risk evaluation to identify all hazards that apply to his machines …

- Define machine limits for the intended purpose of the machines
- Assess the hazard that the machine can present
- Assess the risks based on the severity of potential injuries
- Evaluate the risks to establish whether risk minimization is necessary
- Apply protective measures to eliminate hazards

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Objective

At no time may the use of a machine result in danger to people, machines and the environment.

The machine directive helps the machine manufacturer to detect any dangers caused by a machine and adopt the appropriate preventative measures before the machine is marketed. This process is also called hazard assessment that with a risk evaluation results in the necessary protective measures.

The EN ISO 12100 is a standard that the machine manufacturer can apply to establish and define safety measures.

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The relevant standards

Standards

- The standards that have proliferated in various countries in the past are being harmonized and reduced to a small number of European standards.
- After a transitional period, the frequently used EN 954-1 standard was replaced in October 2009.

The remaining relevant standards are

- IEC 61508: Basic standard for functional safety (also covers PLCs, for example)
- IEC 62061: Application standard for machine construction. Covers electrical and electronic safety engineering.
- ISO 13849-1: Application standard for machine construction. Covers electrical, electronic and other technology (e.g. pneumatics, hydraulics).

Successor to EN 954-1

- IEC 61800-5-2: Product-specific standard for electrical drives with integrated safety functions.
- IEC 62061 and ISO 13849-1 are mostly consulted for the risk assessment of machines.
- IEC 61508 and IEC 61800-5-2 on the other hand, are mostly used for safety devices (e.g. also PLCs).

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Harmonized standards The standards that have proliferated in various countries in the past are being harmonized by the two standards organizations CEN (Comité Européen de Normalisation) and CENELEC (Comité Européen de Normalisation Électrotechnique), mandated by the EU Commission to precisely specify the requirements of the EU directives for specific products.

These EN standards are published in the Official Journal of the European Communities and must be included in domestic standards without any revisions.

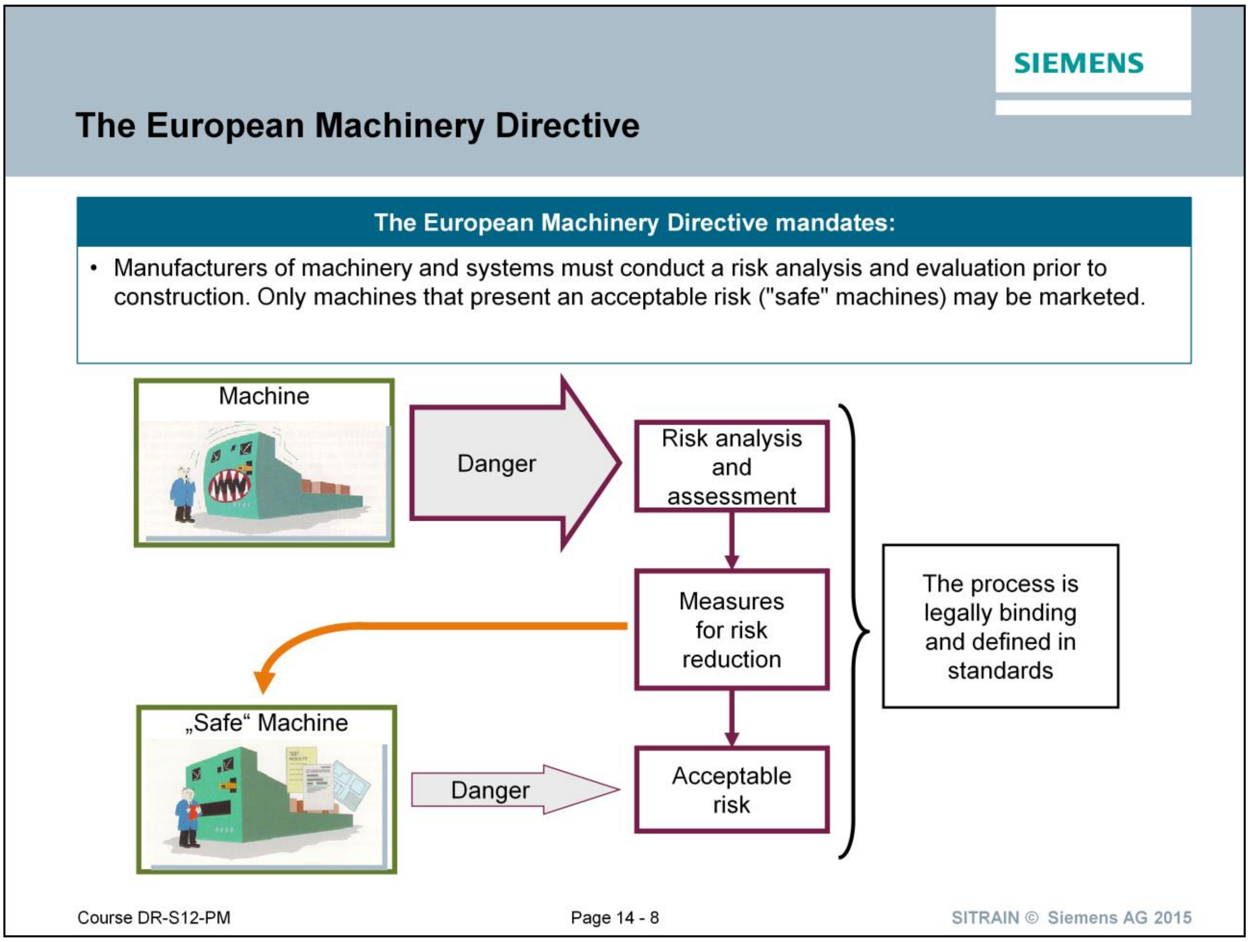
EN 954-1 Obsolete standard - replaced by ISO 13849. It provides only the categories and does not contain any numeric evaluation and so there is no possibility to check a result using a calculation.

ISO 13849-1 This also includes programmable controllers (defined architectures); supplies PLs; during a transition period until 10/2009, both 13849-1 and 954-1 may be used; relevant for machine constructors.

IEC 61508 Is designated as the basic standard for the functional safety; it is not harmonized under MD -> it does not include any presumption of conformity; despite this, it can be used for satisfying European directives when no harmonized standard is available or when it is referenced in a harmonized standard; characterizes the "state-of-the-art"; supplies SILs; relevant for manufacturers of safety devices.

IEC 62061 Harmonized under MD; it is a sector-specific (machine) standard below IEC 61508; includes controllers; supplies SILs as result; relevant for machine builders.

IEC 61800-5-2 Standard for electrical drives; it specifies, for example, the behavior of the machine for STO, SS1, SS2, etc.



Machinery directive

The machinery directive demands from EC member states that only those machine and safety components that meet the safety and health requirements listed in Appendix 1 may be brought to market and operated.

Countries are not allowed to prohibit, limit or hinder the marketing and operation when the manufacturer declares conformity with the basic requirements of the machinery directive.

Objective

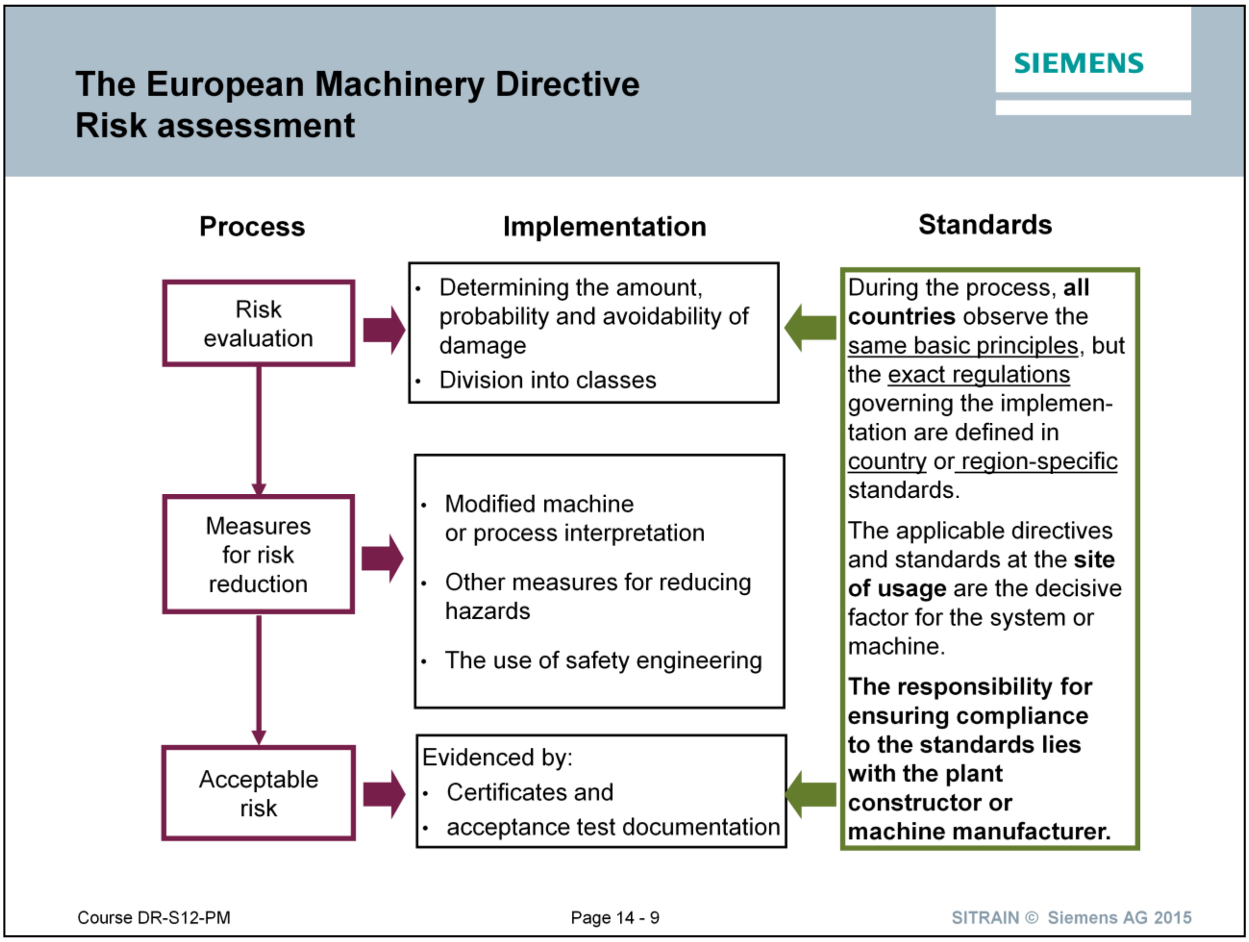
At no time must the use of a machine result in danger to people, machines and the environment.

The machinery directive helps the machine manufacturer to detect any dangers caused by a machine and adopt the appropriate preventative measures before the machine is marketed. This process is also called "hazard assessment" that with a risk assessment results in the necessary protective measures.

The risk assessment is not a process performed after a machine has been built, by testing the risks of the machine that has already been constructed. Dangers that are not detected until at this stage can hardly be removed (or at least minimized), and if at all only at high cost.

The risk assessment considers the complete lifecycle of the machine (even during the design planning stage); in particular:

- The assembly
- The setup mode
- The normal operation
- The maintenance and servicing
- The decommissioning, and finally
- The disassembly



The principle of risk minimization clarifies the responsibilities. In this case the machine manufacturer is the responsible.

Modified design: Example: Steam sterilization instead of sodium hydroxide rinsing

Measures A variety of measures are possible to minimize the risk. For example:

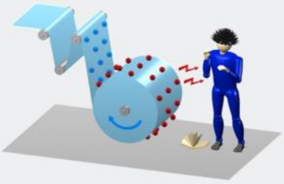
- Rounded edges
- Training of the employees
- Installation of fixed covers
- Information for operators (warning signs, etc.)
- Compact operating instructions

Safety engineering The following devices or functions may be implemented as technical measures:

- Contactless protective equipment (safety light arrays, safety light barriers, etc.)
- Disconnecting protective devices (protective doors, protective covers, etc.), the opening of which is monitored/prevented using safety technology
- EMERGENCY-STOP switching devices
- Two-hand control units
- Drive-integrated safety functions, e.g. SINAMICS drive-based Safety Integrated

What hazards can occur?

The EN ISO 12100 standard states potential dangers with machines.

Mechanical hazards:   	Squeezing, shearing, cutting, cropping, grasping, retracting, trapping, impact, puncture, insertion, etc.
Electrical hazards:  	Injury or death from electric shock or burns
Other hazards: 	Thermal hazards, noise, vibrations, radiation, materials, slipping, tripping, toppling, combinations of hazards, machine operating environment (below ground, mountain railways, etc.)

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EN ISO 12100, "The purpose of this section is to describe the basic dangers and thereby to support the designer in identifying ... hazards."

Definitions

Danger Origin of the damaging impact.

Depending on the current effect, the danger may be active or dormant

Danger area Area where a damaging impact unfurls

Danger situation Situation where an individual is close to a danger; three types:

- Person near a dormant danger
- Person in the vicinity of a dormant danger
- Person near an active danger

Hazard Dangerous situation where an individual is in the area of a dormant danger.

Event Takes places where an individual is exposed to a damaging impact. Risk assessment attempts to record events and derive measures that prevent damage or reduce a risk to a tolerable minimum.

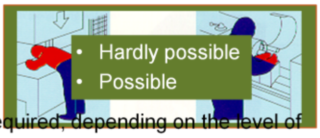
Risk assessment
Assessing the risk and associated safety levels

The level of the risk depends on

Severity of the injury
- Slight (usually reversible injury)
- Serious (usually irreversible injury, including death)

Frequency and/or duration of exposure
- Frequency and duration of the exposure to danger
- Seldom to less frequent and/or the time of the exposure to danger is short
- Frequent to continuous and/or the time of the exposure to danger is long

Possibilities of avoidance
- Possibility of avoiding the hazard or limiting the damage
- Possible under certain conditions
- Hardly possible



Safety level
The exact calculation varies depending on the standard. A certain level of safety is required, depending on the level of the risk. The designations of the safety levels are:
- For EN 954-1: Category B, 1 - 4
- For ISO 13849-1: Performance level a - e (PL)
- For IEC 62061: Safety integrity level 1 - 3 (SIL)
- For IEC 61508: Safety integrity level 1 - 4 (e.g. nuclear power plant)

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Severity Severity of the injury or damage
- Type of the "legal entity" to be protected (persons, objects, environment)
- Type of the injury (for persons) (minor, severe, lethal)
- Injury scope (one/several persons)

Frequency Frequency and duration of the exposure to danger
- Necessity of access (operation, maintenance, repairs, ...)
- Duration of exposure in the danger area (familiarity with the danger)
- Frequency of access, number of persons
- Statistics, accident history, risk comparisons

Avoidance Possibilities of avoidance
- Construction measures
- Supervision of the operation (e.g. also via video surveillance)
- Need for specifically trained personnel

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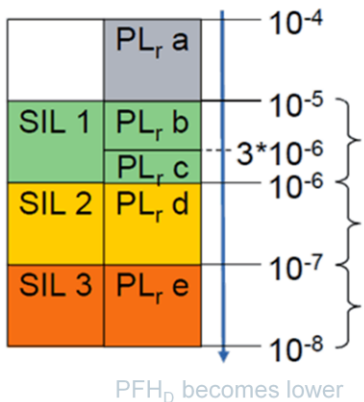
What does a safety level state?

Requirements for safety level: Probability of failure

- EN 62061 and EN ISO 13849-1 describe requirements for the maximum permissible probability of failure of the safety function:
  - Probability of a dangerous failure per hour PFHD
  - The higher the safety level, the lower the PFHD must be



Not more than 1 dangerous failure of the safety function in 10 years

Not more than 1 dangerous failure of the safety function in 100 years

Not more than 1 dangerous failure of the safety function in 1000 years

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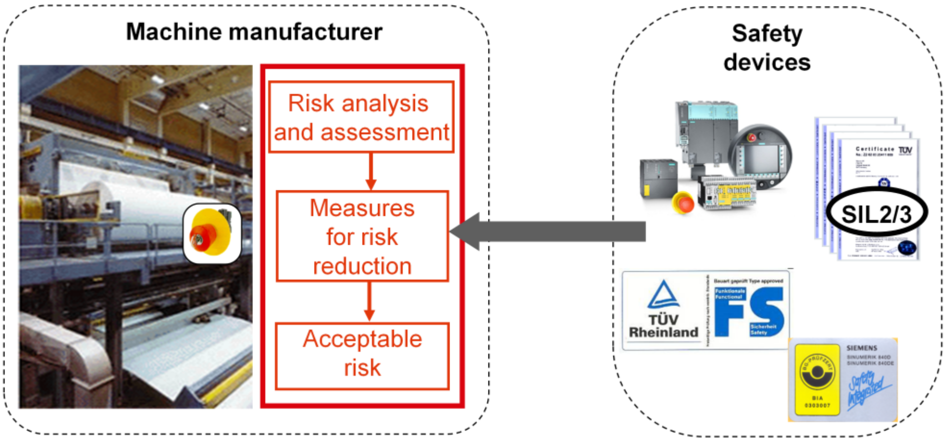
Static variables

Calculated and achieved safety levels that represent the "dangerous failures per period" are always static variables. To put it another way: If a safety level SIL 1 reaches a value $2.7x10^{-5}$ for example, this means that 1.1826 dangerous failures could theoretically occur within 5 years. This does not mean that such a failure will necessarily occur just after 5 years, nor that 4 years will pass without such a failure.

If a fault does occur, this does not means that the next 4 years will go by without anything happening again; similarly, as may be (quite probably) that nothing goes wrong over the next 12 years.

"Safe" machine
Certificates for safety devices

- One efficient way to achieve an acceptable risk is to use **certified** safety devices:



- The safety devices must be certified according to the respective relevant standards.
- They will be given a certificate regarding the safety level that was achieved, SIL 2/3, for example.
- The tests/acceptance tests are conducted by TÜV, BG / BGIA or a similar test center.

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Certified safety devices facilitate acceptance testing.
Siemens drives are certified; e.g. G120 (SIL2), S120 (SIL2, PL d)
Other components for recording and processing (logic) also have certificates.

Certified components do not ensure that the required PL or SIL will actually be achieved. The components for the subsystems can do this when they are integrated accordingly. This is not ensured in conjunction with DETECTING-EVALUATING-REACTING, however. This means:

- Sensor SIL3
- Logic SIL3
- Actuator SIL3 does not mean that the safety function automatically also fulfills SIL3.

Safety system
The principle of safety systems

A safety system always comprises components for:

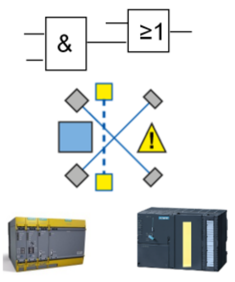
Detecting

- Commands, mode, status of machine and protective devices

Buttons and sensors

Evaluating

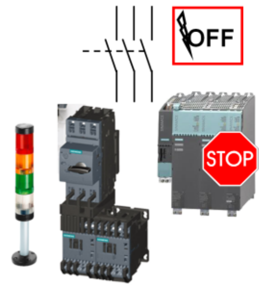
- Recognizing the hazard situation and determining the right reaction



Relay or controller

Reacting

- Carrying out the right reaction
- Contactors, signaling units, power controllers, etc.



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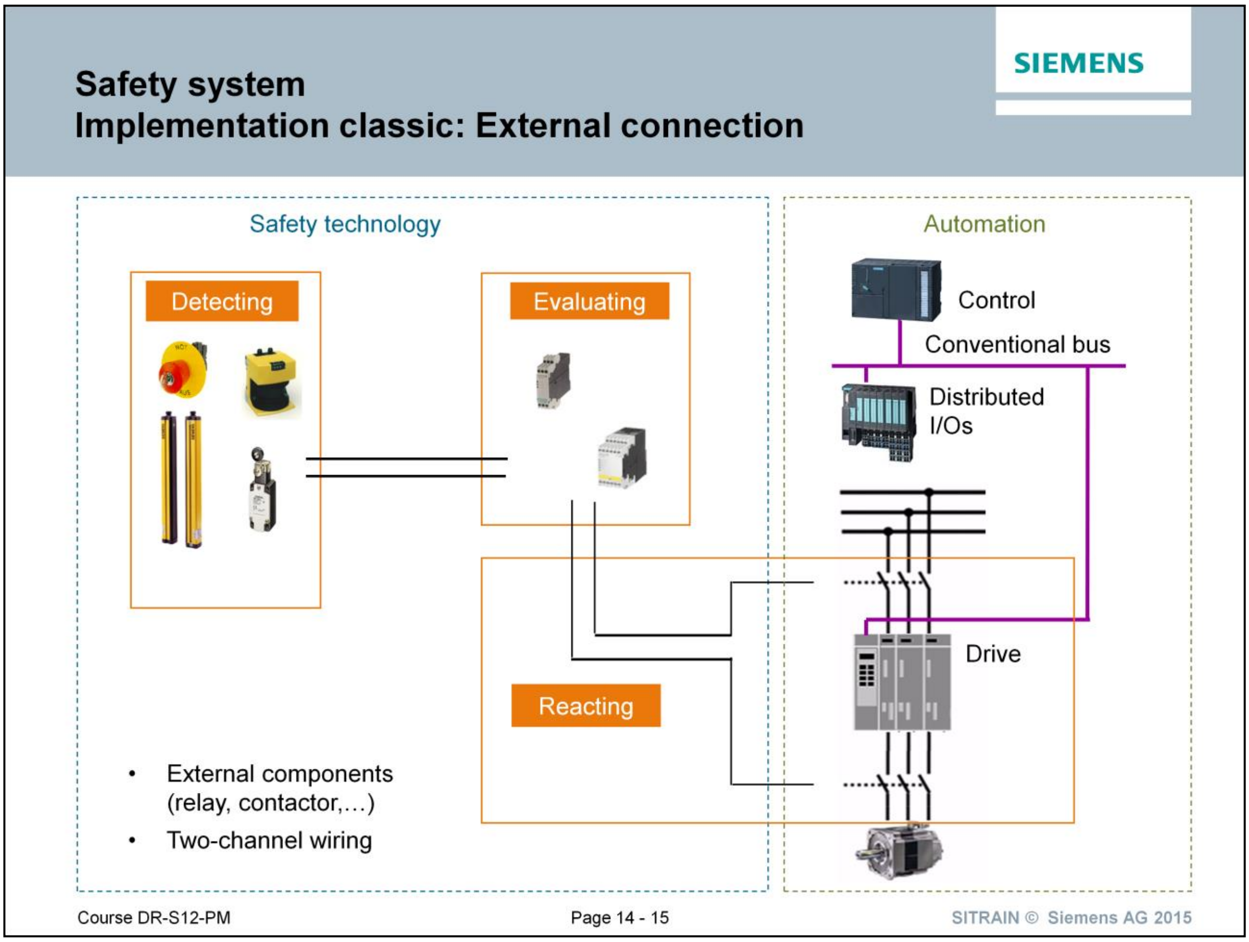
Detecting Can be separated into the subgroups optical sensors (light barriers, light curtains, laser scanners, etc.) and switching technology (emergency-stop button, position switch, etc.).

Evaluating This covers safety relays (3TK28) and controllers with the associated peripheral devices (DIs, DOs and bus systems); a logical interconnection between "detecting" and "reacting" is made here.

Reacting The actuators perform the reactions; in the most simple case, these are lamps and contactors; complex devices such as frequency converters (e.g. S120) may also be used.

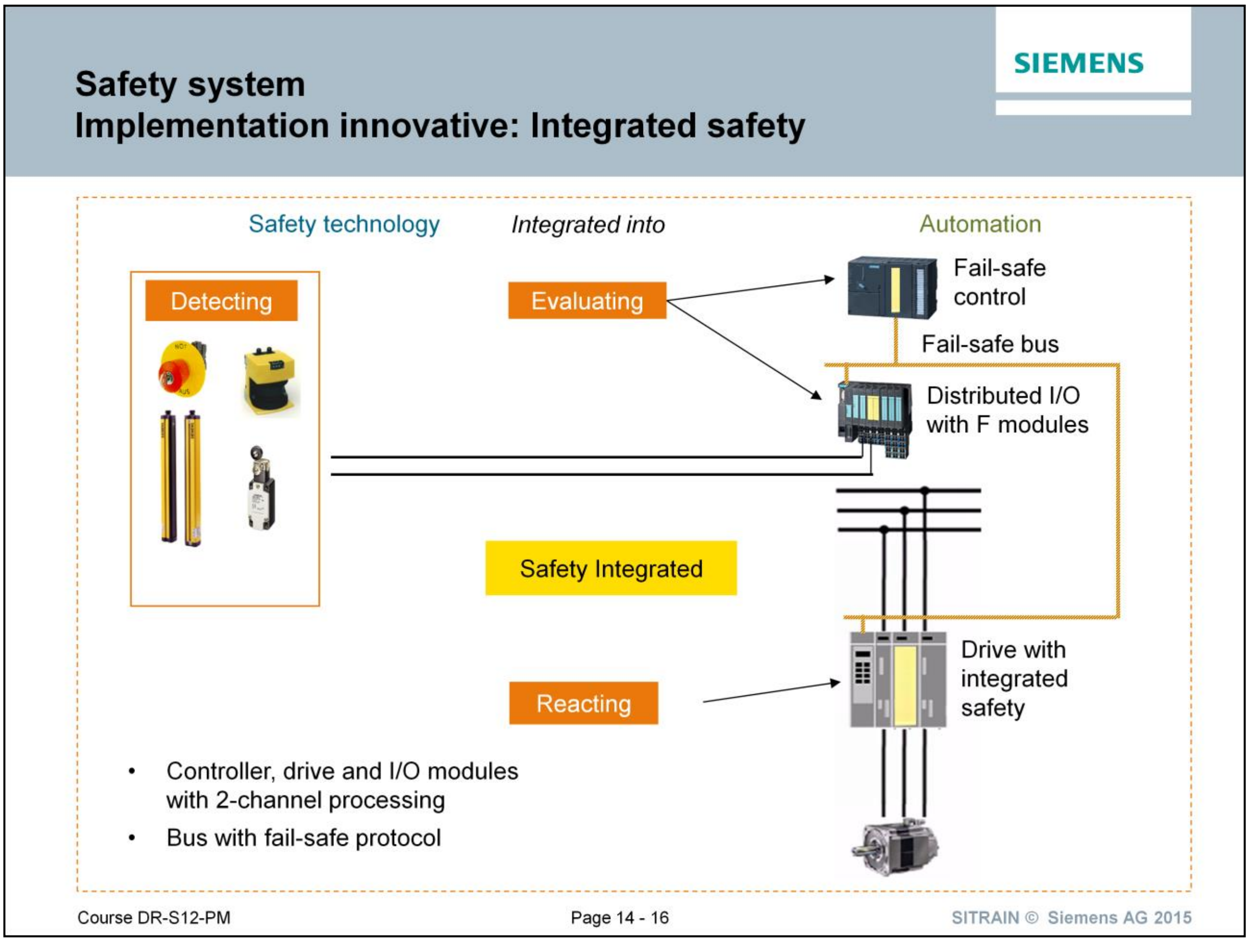


Standard and safety functions are implemented with separate controllers and bus systems. Safety functions can be implemented with safety relays or a fail-safe controller.

Whereas a standard PLC with distributed I/O (ET200S via PROFIBUS DP) controls the standard functions of the system, a safety relay controls the dangerous machine function.

This is the variant that has typically been used in the past because the drives as actuators and controllers featured no safety technology. With this technology, the drive is usually de-energized; sometimes it is first braked along a ramp.

The dangerous machine functions are switched via a positive-action contactor that controls a safety-oriented safety relay. The safety relay receives the associated control signals that are required for the correct shutdown by wiring the appropriate signals from the system (such as those of the operator panel).



Safety Integrated

Safety Integrated is the integral SIEMENS safety concept for the automation and drive technology from SIEMENS. Proven technologies and systems from the automation technology are used for the safety technology. Safety Integrated contains the complete safety chain from encoder and actuator through to the controller, including the safety-oriented communication using standard fieldbuses. Drives and controllers also perform safety tasks in addition to their function tasks. Integrated safety technology promises not only reliable safety but, in particular, increased flexibility and improved productivity.

Standard and safety-relevant stations are coupled using a shared bus system. Because bus-wide fail-safe communication is also possible, the bus can be PROFIBUS, PROFINET (not for SIMOTION D) or a combination of both.

Advantages

The integration of the safety technology in standard automation systems provides the following important advantages:

- More flexibility than electromechanical solutions
- Reduction in wiring
- The coexistence of a standard and a safety program means that only one CPU is required
- Simple communication between the standard and the safety program
- Reduced engineering cost because standard engineering tools are used for the configuration and programming

Overview
Availability of safety functions

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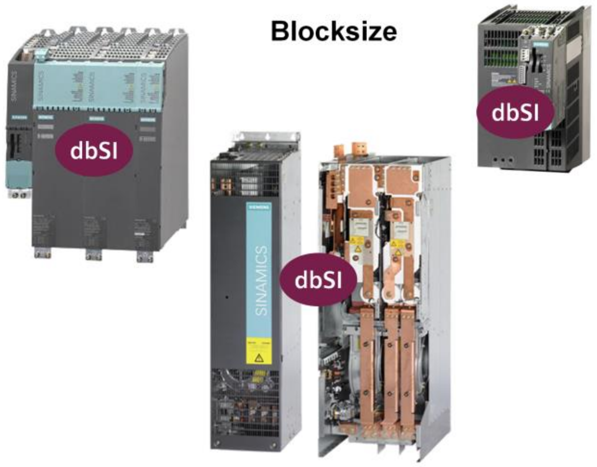
Booksize

☑ all safety functions available

Chassis / Cabinet

☑ all safety functions available

Blocksize



The functions are implemented in accordance with IEC 61800-5-2 (safety functions for drives). They have the following certificates:

- SIL 2 acc. to EN 62061 and
- PL d acc. to EN ISO 13849-1

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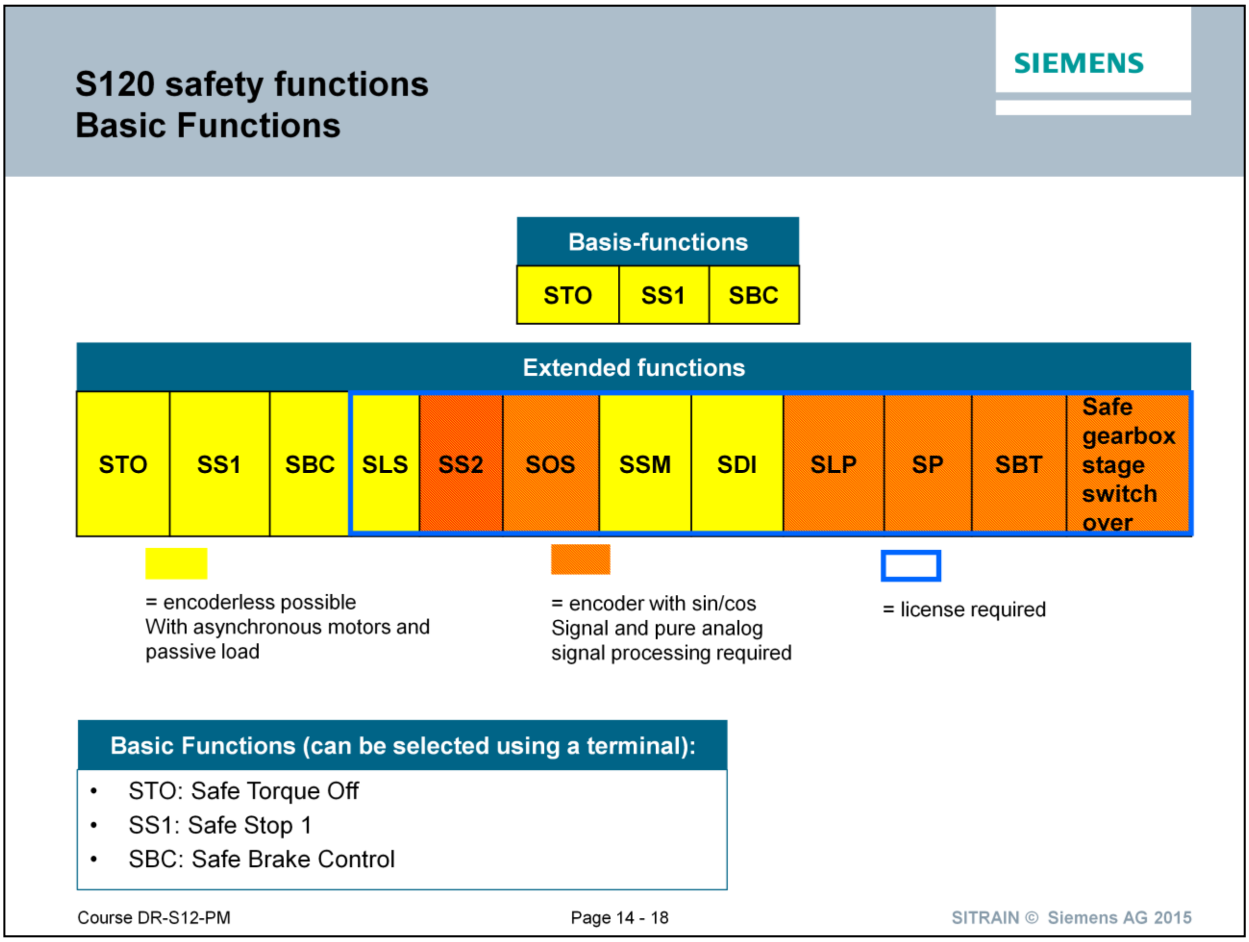
Basic Functions available on all device versions; no additional HW required. Extended Functions on Booksize and Blocksize; for Chassis / S120CM / cabinet units with new hardware and software (since mid 2009), i.e. with power units that have -3 as last digit in the MLFB, SBC with FW ≥4.3.xx, i.e. with CU320-2xx.

These can then be equipped with a DAC-CIM with IPD, which also has the X46 connector for controlling an external "safe brake relay" (digital-analog-converter control interface module with intelligent powerstack data module).



Basic Functions

These safety functions are part of the standard scope of the drive.

- Safe Torque Off (STO): STO is a safety function that prevents the drive from restarting unexpectedly, in accordance with EN 60204-1:2006 Section 5.4.
- Safe Stop 1 (SS1, time controlled): Safe Stop 1 is based on the "Safe Torque Off" function. This means that a Category 1 stop in accordance with EN 60204-1:2006 can be implemented.
- Safe Brake **Control (SBC):** The SBC function permits the safe control of a holding brake. Blocksize Power Modules also require a Safe Brake Relay for this function.

Note

The safety functions listed here conform to:

- Safety Integrity Level (SIL) 2 according to DIN EN 61508
- Category 3 according to DIN EN ISO 13849-1
- Performance level (PL) d according to DIN EN ISO 13849-1

The safety functions correspond to the functions according to DIN EN 61800-5-2.

S120 safety functions
Extended Functions (1)

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Extended functions

STO	SS1	SBC	SLS	SS2	SOS	SSM	SDI	SLP	SP	SBT	Safe gearbox stage switch over

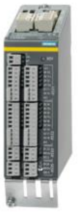
= encoderless possible
With asynchronous motors and passive load

= encoder with sin/cos
Signal and pure analog
signal processing required

= license required

Extended Functions (can be selected with TM54F or F-CPU):

- STO: Safe Torque Off
- SS1: Safe Stop 1
- SBC: Safe Brake Control
- SLS: Safely Limited Speed
- SS2: Safe Stop 2
- SOS: Safe Operating Stop
- SSM: Safe Speed Monitor
- SDI: Safe Direction
- SLP: Safe Limited Position
- SP: Safe Position
- SBT: Safe Brake Test
- Safe gearbox stage switchover



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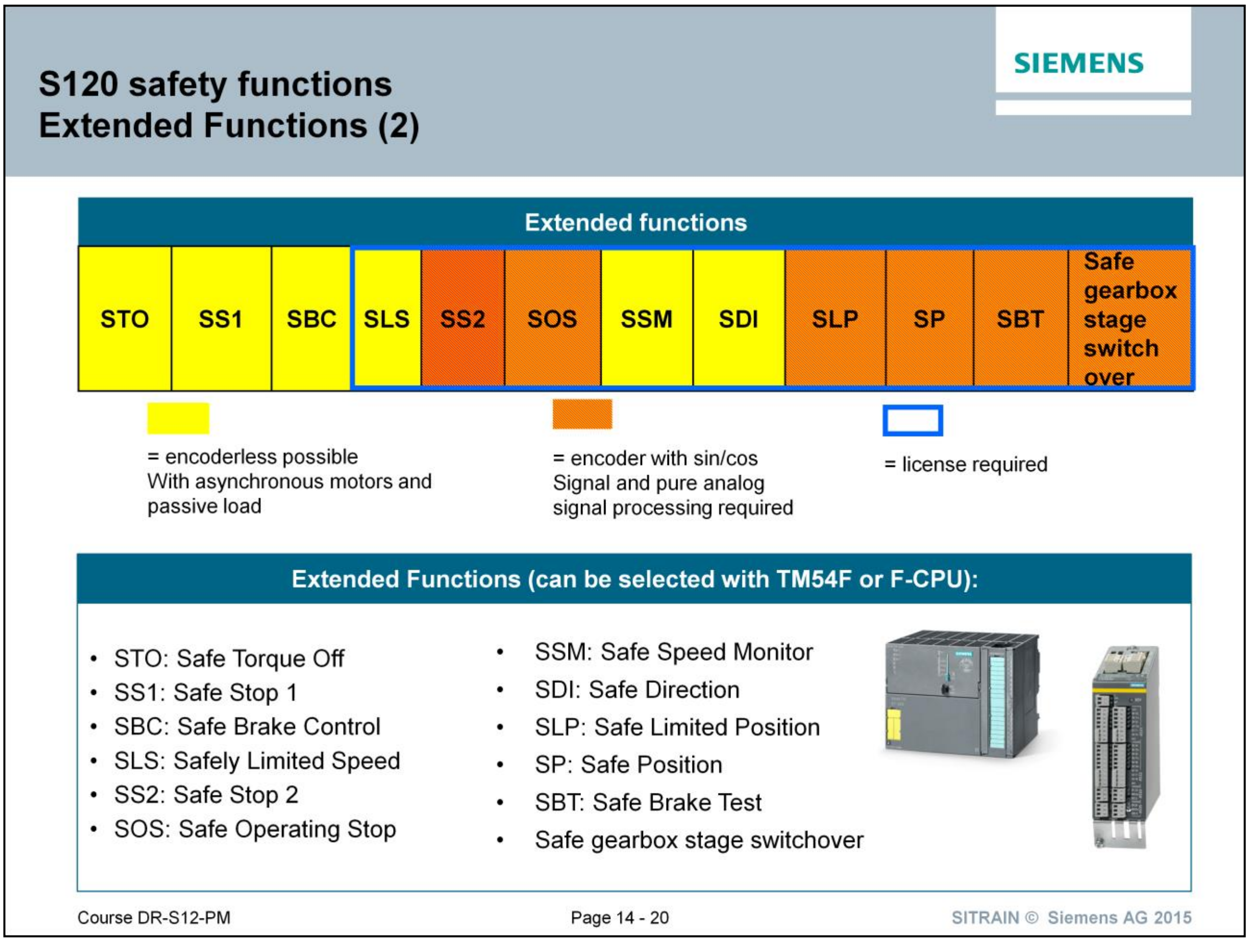
Extended Functions

These functions require an additional safety license: Extended Functions with encoder require an encoder with safety capability:

- Safe Torque Off (STO): STO is a safety function that prevents the drive from restarting unexpectedly, in accordance with EN 60204-1:2006 Section 5.4.
- Safe Stop 1 (SS1, time controlled): Safe Stop 1 is based on the "Safe Torque Off" function. This means that a Category 1 stop in accordance with EN 60204-1:2006 can be implemented.
- Safe Brake Control (SBC): The SBC function permits the safe control of a holding brake. Blocksize Power Modules also require a Safe Brake Relay for this function.
- Safely-Limited Speed (SLS): The "Safely-Limited Speed" (SLS) protects against excessively high drive speeds.
- Safe Stop 2 (SS2): The SS2 function brakes the motor safely with a subsequent transition to "Safe Operating Stop" (SOS).
- Safe Operating Stop **(SOS):** The SOS protects against unintentional movements. The drive is in closed-loop control mode and is not disconnected from the power supply.



- Safe Speed Monitor (SSM): SSM supplies a safe output signal if the drive undershoots a defined speed limitSafe Direction (SDI): SDI is used to safely monitor the direction of motion
- Safe Limited Position (SLP): The SLP function prevents the motor shaft from exceeding the specified position limit(s).
- Safe Position (SP): SLP monitors up to 2 position ranges that are mutually independent.
- Safe Brake Test (SBT): SBT tests the required holding torque of a brake (operational or holding brake).
- Safe gearbox stage switchover: safe gearbox stage switchover allows you to switch between 8 gearbox ratios in operation.

S120 safety functions
Basic Functions using terminals

SINAMICS CU320-2 and CU320

Inputs DI0 – DI7
to terminals X122
and X132

SINAMICS Motor Module Booksize

Safety input Power Module
(EP terminal) X21: 3/4
(EP terminal) X22: 3/4 (DMM)

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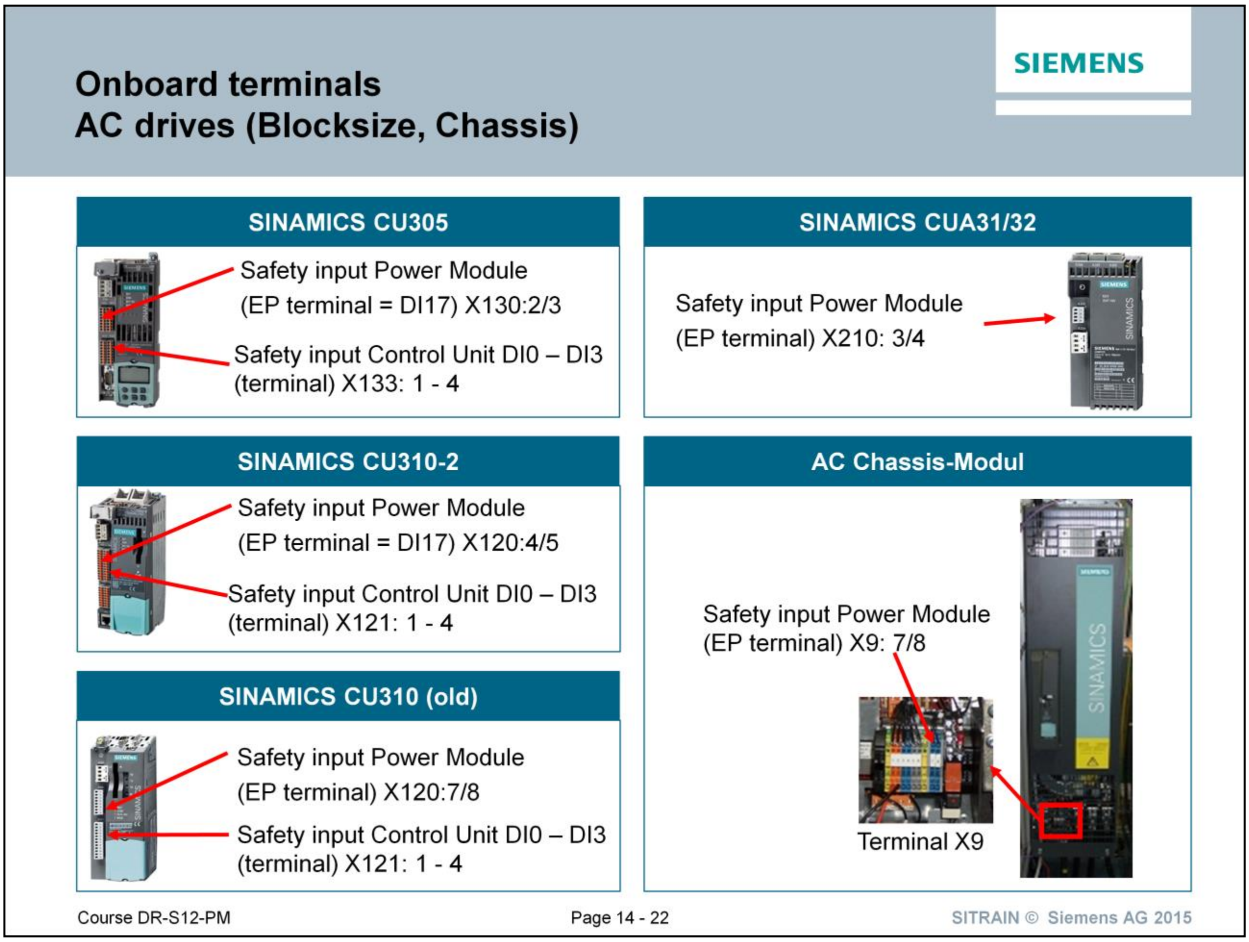
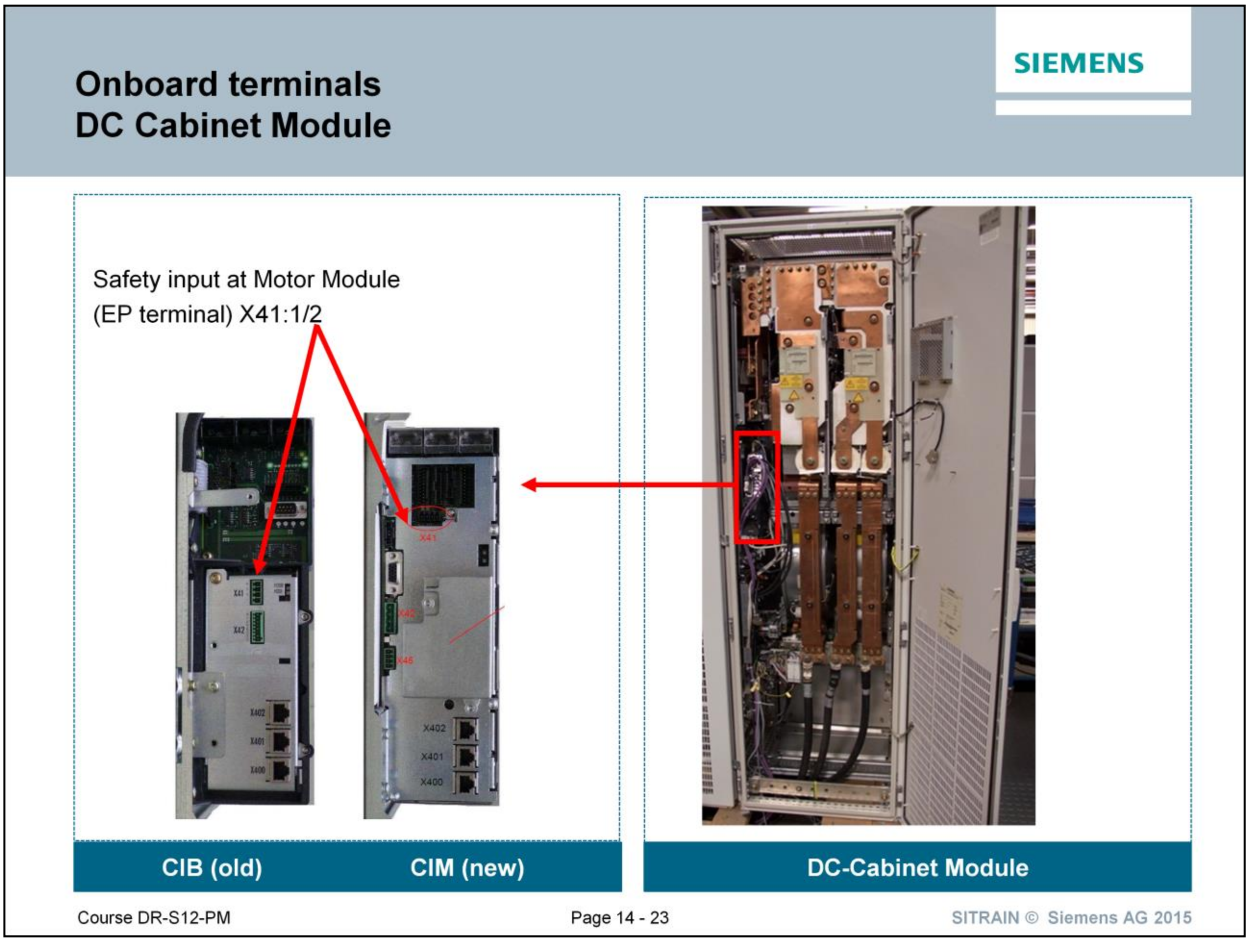
- A safe two-channel digital input is available for the Basic Functions.
- The first channel is a DI of the CU320
  - X122.1 -.4 = DI0 – DI3; X132.1 - .4 = DI4 – DI7
- The second channel is located on the EP terminal of the Motor Module.
  - X21.3 (EP+), X21.4 EP ground
- Both channels must be operated exclusively as equivalent.
- Double Motor Module:
  Observe the assignment of the power connection to the EP terminal
  - Power connection X1 corresponds to EP X21
  - Power connection X2 corresponds to EP X22



- AC drives are operated either with CU310 or with CUA31/32.
- Up to format F, the Power Module is connected via the
  - CU310 (terminals X120.7/.8)
  - CUA3x (terminals X210.3/.4)
- The signals are transferred to the Power Module via PM-IF interface.
- For larger formats (Chassis), the CU310 is connected to the Power Module via Drive-CLiQ
  - Wire the safety signal directly to the MoMo (terminal X9.7/8)
  - The X41 interface is not accessible due to the mounting plate for the CU310 and/or CUA3x.



Cabinet units

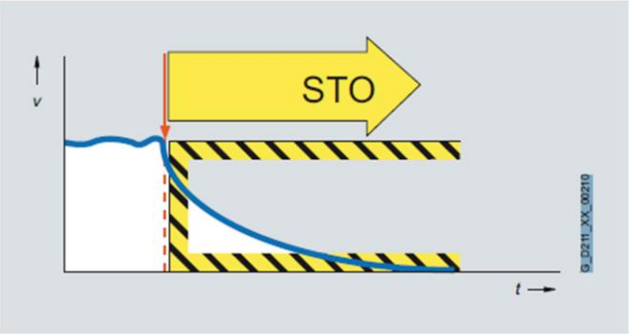
- With Option K82, the safety terminal is wired to the customer terminal strip
- Furthermore, a coupling relay is interconnected
(to trigger with 230V and/or **connect** several Motor Modules over a larger distance)

Chassis

- In the case of the Chassis Module,the same signal is always connected to terminals X41.1 (EP+) and X41.2 (ground).

Note The connection is located on the Control Interface Board (CIB) and/or the Control Interface Module (CIM) at the rear end of the electronic module.

Safe Torque Off (STO)
Function description



The STO function prevents the supply of energy to the motor which can generate a torque.

- STO can be used wherever the drive reaches a standstill by itself due to the load torque through friction in a sufficiently short time or when a "coasting down" of the motor does not have any relevance for safety.
- STO can be implemented wherever an unintended restart of the motor must be prevented.

Safe Torque Off (STO) Control

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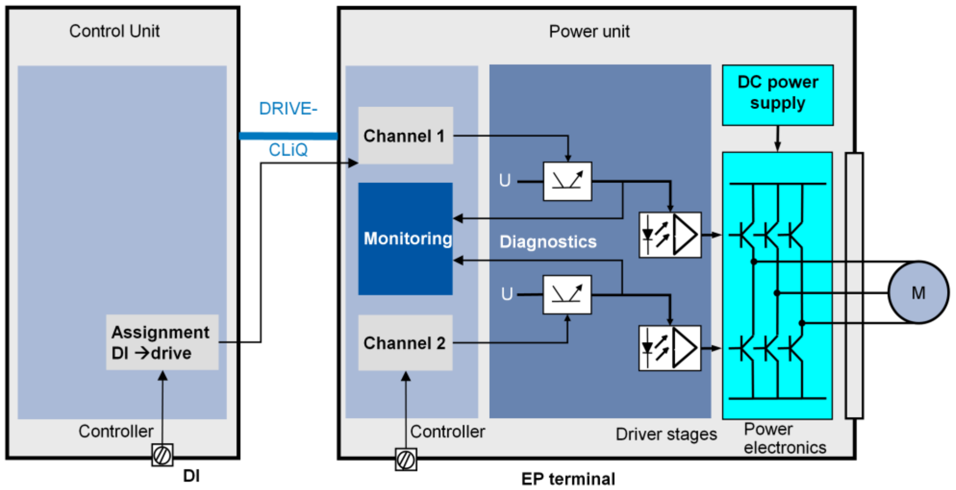
STO operation

- Pulses of the drive are safely "canceled", i.e. torque-producing power supply is safely disconnected
- Control is performed with two channels (independent shutdown paths with internal monitoring)



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Description

In conjunction with a machine function or in the event of a fault, the "Safe Torque Off" (STO) function is used to safely disconnect the torque-producing power supply to the motor.

After selecting the function, the drive unit is in a "safe state". A movement caused by mechanical forces is not prevented but must be implemented with a separate holding brake.

The switch-on inhibit prevents the drive unit from being restarted.

The two-channel pulse suppression function integrated in the Motor Modules / Power Modules is a basis for this function. One channel switches the upper jumper of the power transistors (IGBTs) and the other the lower jumper.

The figure shows only the control via the on-board terminals. Control via PROFIsafe and TM54F is also possible.

When tripped, the motor coasts to a standstill, provided that it is not stopped by the load or a brake.

Features

This function is drive-based, i.e. a higher-level control is not required.

- The function is drive-specific, i.e. it is available for each drive and must be individually commissioned.
- The function enable is made from the appropriate input screens in STARTER.
- The first 8 terminals on the CU320 can be parameterized as required for the "Safe Torque Off" function. Therefore up to 8 axes can be switched independently or in common in the STO.
  The second terminal is always connected to the Motor Module belonging to the drive; for this reason, Double Motor Modules have two terminals (EP = Enable Pulses).

Safe Stop 1 (SS1)
Function description

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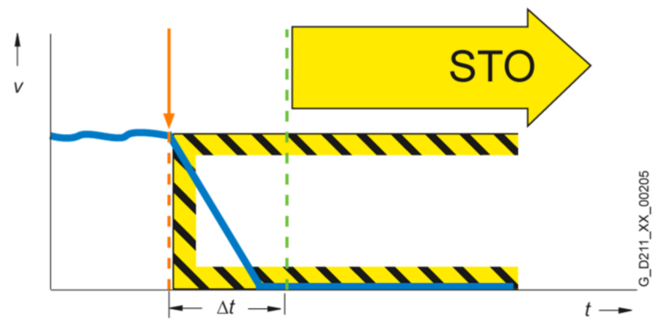

Basic Functions

- Purely time-based; i.e. only the timer whose expiration is the basis for STO activation is implemented with 2 channels (safe).
- Drive is braked along the OFF3 ramp ("non-safe"), there is no monitoring of the brake ramp.

Extended Functions

- Time-based or speed-based transition to STO, i.e. either a defined time has elapsed or the speed is below a defined threshold.
- When SS1 is selected, monitoring for acceleration is performed during the braking phase.

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Note Different implementation of Basic and Extended Functions

Function

- Subsequent state in both cases STO
- In both cases, either braking along the OFF3 ramp or without OFF3
- Different step enabling conditions compared to STO
- Brake ramp is not monitored for Basic Functions.

Brake ramp with OFF3

- Brake ramp (OFF3) and delay time must match
- i.e. it must be possible to brake the drive down to standstill within the delay time
- Factors to consider:
  - Mass inertia
  - Control dynamics of all controllers
  - Dead times such as bus cycles, etc.

Safe Brake Control (SBC)
Functional description

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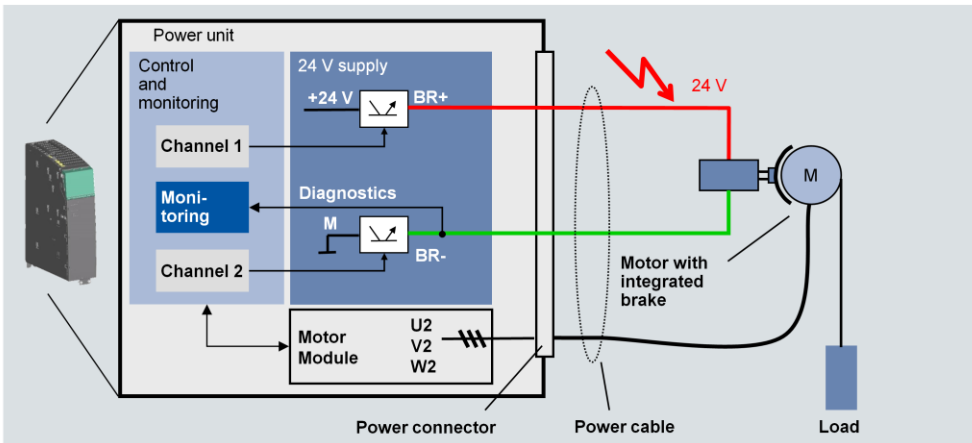
SBC functional description

- Can be activated in combination with STO
- Switching against 24 V and ground
- Only the control of the brake is safe; not the brake itself!



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Description

In conjunction with a machine function or in the event of a fault, the "Safe Torque Off" (STO) function is used to safely disconnect the torque-generating power supply to the motor.

After selecting the function, the drive unit is in a "safe state". A movement caused by mechanical forces is not prevented, but must be implemented via a separate holding brake.

The switch-on inhibit prevents the drive unit from being restarted.

The two-channel pulse suppression function integrated in the Motor Modules / Power Modules is the basis for this function. One channel switches the upper jumper of the power transistors (IGBTs) and the other the lower jumper.

The figure shows only the control via the onboard terminals. Control via PROFIsafe and TM54F is also possible.

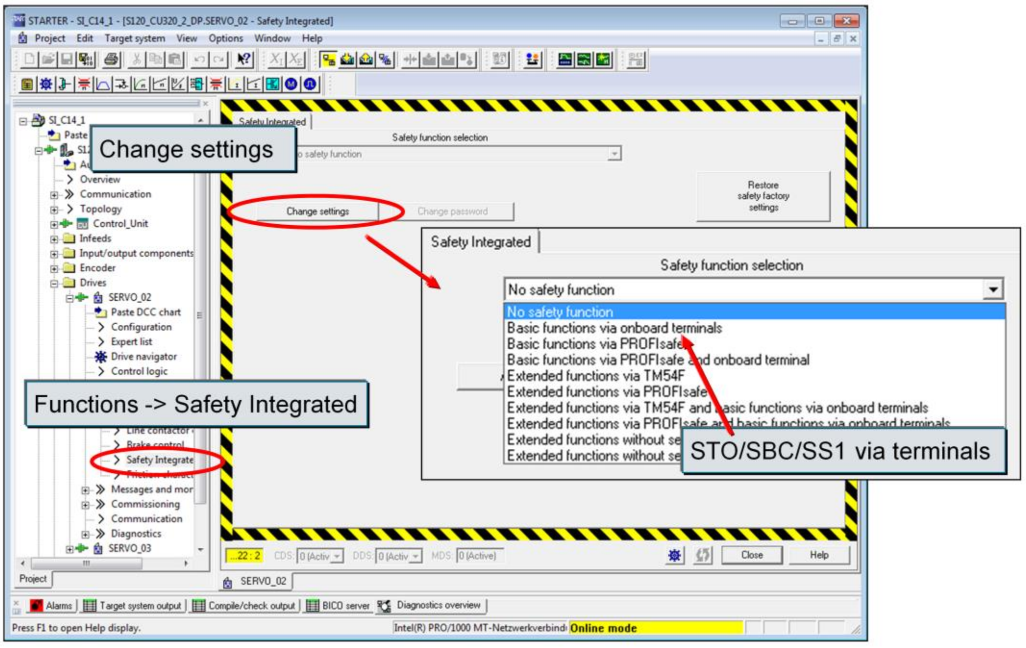
When tripped, the motor coasts to a standstill, provided that it is not stopped by the load or a brake.

Function characteristics

This function is drive-autonomous, i.e. a higher-level controller is not required.

- The function is drive-specific, i.e. it is available for each drive and must be commissioned separately for each drive.
- The function enable is made via the appropriate input screens in STARTER.
- The first terminal on the CU320/CX32 for the "Safe Torque Off" function can be freely parameterized. This means the selected terminal can be used for several drives.
- Because the second terminal is always connected to the Motor Module that belongs to the drive, Double Motor Modules have two terminals (EP = Enable Pulses).

Selection of the basic safety functions



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Selection

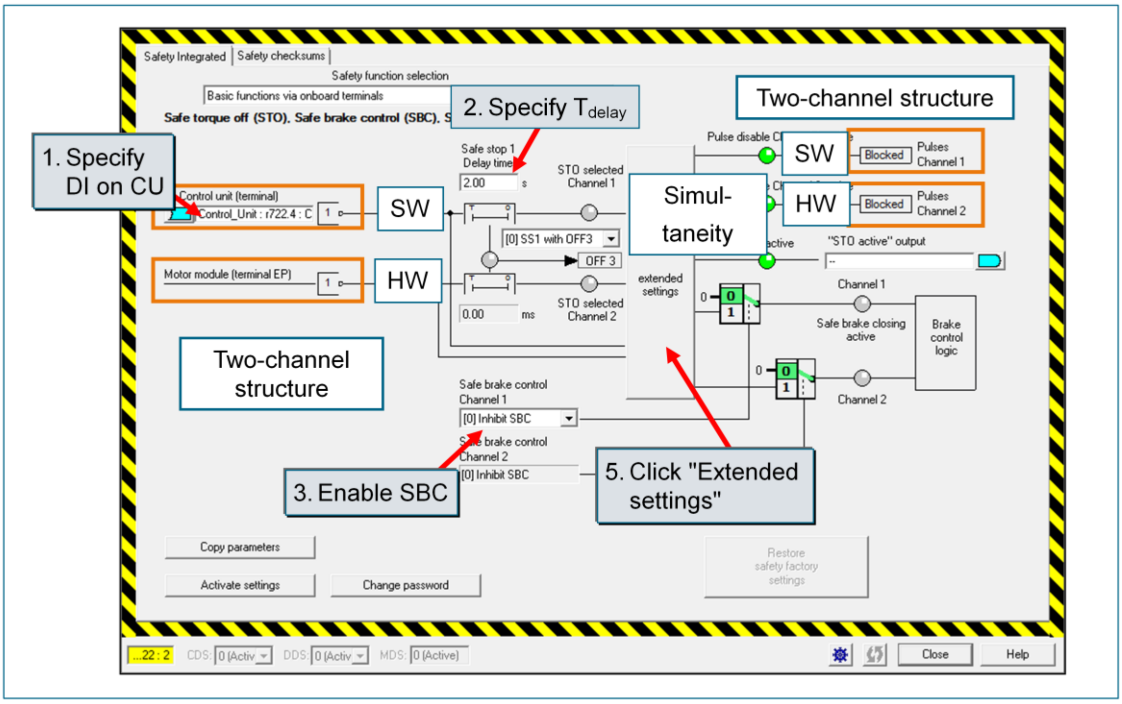
The Safety Integrated functions of the SINAMICS S120 can only be commissioned "online". After establishing an online connection, proceed as follows:

1. First open the associated parameterization screen for each drive object by entering: *SINAMICS_xxx -> Drive_xxx -> Functions -> Safety Integrated*.

2. Click the mouse in the opened parameterization screen on the "Change settings" button.
   The commissioning mode of the Safety I*ntegrated Functions* is now active.
   A change of the parameterization screen is now no longer possible until the commissioning has been completed.
   In addition, the alarm "1698: SI CU: Commissioning active" is output.

3. For commissioning the basic functions, select the "STO/SBC/SS1" entry in the "Select/control" list box with a terminal.
   The screen for setting the parameters of the basic safety functions opens.
   Only the "Activate settings" button can be used to exit the screen and thus the commissioning mode of the safety functions.

Configuration of the basic safety functions



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Two-channel control All the main hardware and software functions for Safety Integrated are implemented in two independent monitoring channels (e.g. control, switch-off signal paths, data management, data comparison).

This means the two control paths of a drive are implemented with the following input channels:

- DI of the Control Unit. One of the DIs 0 … 7 of the CU320 or one of the DI 0…3 of the CU310 can be selected in the screen.
- The Motor Module (EP = Enable Pulses) or Power Module with CUA3x or CU310 that belongs to the drive.

Grouping To ensure that the function works for more than one drive concurrently, the terminals must be grouped as follows:

- 1st channel (CU320/D4xx, etc.): By connecting the binector input to the common input terminal on the drives in one group.
- 2nd channel (Motor Module / Power Module with CUA3x): By appropriately wiring the terminals for the individual Motor Modules/Power Modules with CUA31/CUA32 belonging to the group.

Delay time If a low-signal is detected in both channels, the drive will be braked in accordance with the OFF3 ramp (p1135) and stopped safely (STO) after expiration of the delay time Tdelay (p9652/p9852).

The delay time set must allow the drive to brake down to a standstill within this time. The basic SI functions do not provide any further monitoring of the brake ramp.

SBC A Safe Brake control (SBC) can also be enabled and an output to display the STO state (informative) can be specified within the screen.

Configuration of the basic safety functions

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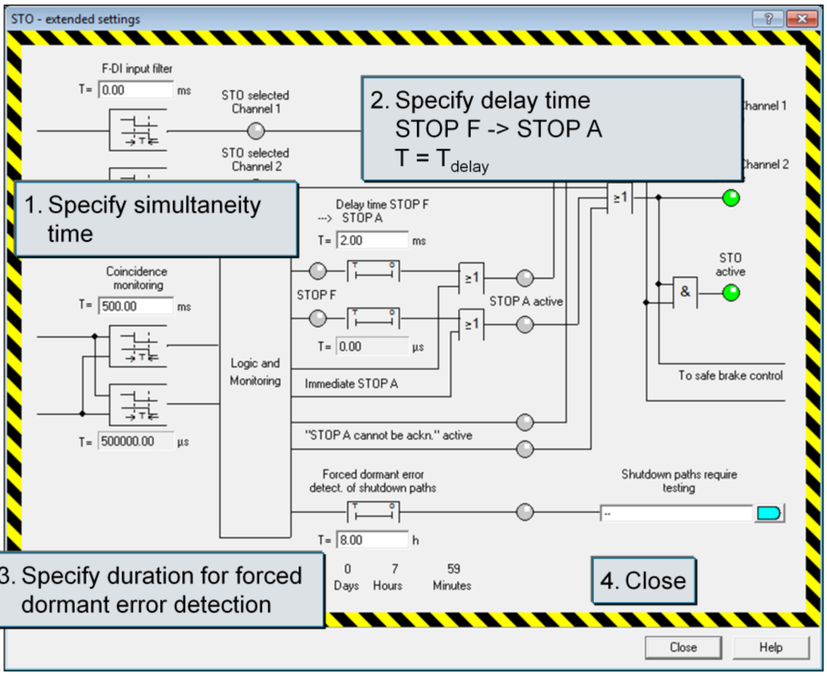

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Extended settings

A click on the block for the "Extended settings" opens the 2nd screen. The discrepancy monitoring time for a data cross-check of the two input channels and a delay time from STOP F to STOP A are configured in this screen. The duration of the forced dormant error detection is also specified.

Simultaneity monitoring

The input of the simultaneity time (e.g. T = 500 ms) is used for the discrepancy monitoring of both input channels. Within this time, the two channels may have different signal levels without a discrepancy fault being initiated.

If, for example, a low signal is detected in only one of the two input channels, an OFF3 braking will also be started. Unlike the Safe Torque Off (STO), after expiration of the delay time Tdelay, the discrepancy fault (STOP F) now initiated after expiration of the simultaneity time causes a transition to STOP A and thus STO again after expiration of the STOP F -> STOP A delay time.

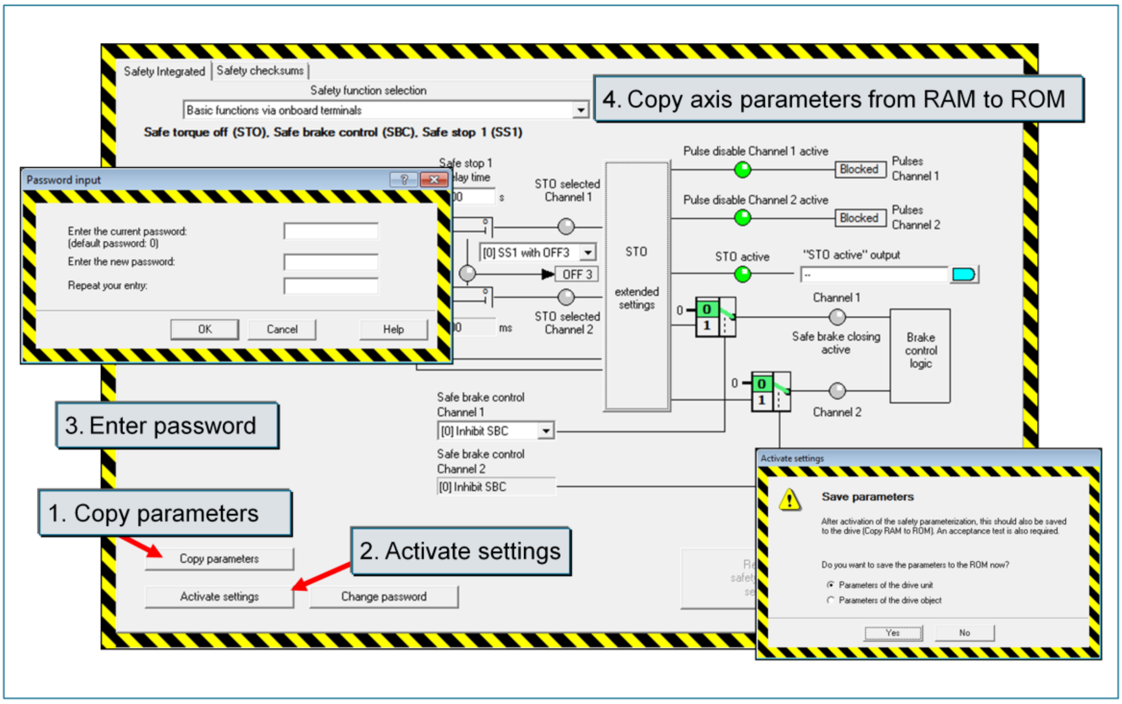
To allow the drive to be braked to a standstill also for single-channel selection, the sum of the simultaneity time (p9650/ p9850) and the STOP F -> STOP A transition time (p9658/p9858) must be dimensioned so that the drive can brake safely to standstill for OFF3.

The following SI faults and alarms are issued for a discrepancy fault:

- 30611: SI MM (or CU) defect in a monitoring channel
- 30600: SI MM: STOP A initiated
- 1500: SI CU: STOP A initiated

These faults can be acknowledged only with "Power on" or after a successful test of the switch-off signal paths (protective door open/closed).

Activation of the basic safety functions



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Forced dormant error detection

To fulfill the requirements of EN 954-1/ ISO 13849-1 and IEC61508 with respect to timely fault detection, the functions and switch-off signal paths must be tested at least once within a defined period to ensure that they function properly. The maximum permissible interval for forced dormant error detection with the Basic and Extended safety functions is 9000 hours or once a year.

After expiration of the time, the alarm "1699: SI CU test of the switch-off signal paths required" is issued.

For the Basic Functions, the concurrent switching of the switch-off signal paths (protective door open/closed) must be made for this purpose.

Copy parameters

After completion of the input in the parameter screens, the "Copy parameters" function must be initiated. This function copies the entered parameters (CU parameters) to the associated storage locations on the Motor Modules (two-channel data storage).

Activate settings

"Activate settings" activates the configured inputs and exits the SI commissioning mode. Prior to the activation, you will be requested to enter the password. The default SI password setting is 0.

You will also be requested to back up data from RAM to ROM. The axis-related backup suffices to save the changed SI parameterization on the CF card. The project can then be downloaded to the PG.

The F1650 (2003) and F30650 (2003) faults will be issued when the commissioning mode is exited. These notify that at least one SI parameter has changed and so an acceptance test is required. The faults can be acknowledged normally.

Acceptance test
Overview

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The machine manufacturer must carry out an acceptance test of the selected 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.

Requirements for the acceptance test

- The machine is properly wired.
- All safety equipment such as protective door monitoring devices, light barriers, emergency-off switches, and limit switches are connected and ready for operation.
- Commissioning of the open-loop and closed-loop control should be completed, since otherwise the ramp-down values can be changed by the altered dynamics of the drive control, for example. These include for example:
  - Configuration of the setpoint channel
  - Position control in the higher-level controller
  - Drive control

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

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Acceptance test

The acceptance test is designed to ensure that the safety functions are correctly parameterized. The measured values are used to check the plausibility of the configured safety functions. The measured values determined are typical and not worst-case values. They represent the behavior of the machine at the time of measurement. These measurements cannot be used, for example, to derive maximum ramp-down values.

Extended safety functions

The acceptance test for systems with Safety Integrated Extended Functions (SI functions) is focused on validating the functionality of Safety Integrated monitoring and stop functions implemented in the drive system. The test objective is to verify proper implementation of the defined safety functions and of test mechanisms (forced dormant error detection measures) and to examine the response of individual monitoring functions to the explicit input of values outside tolerance limits.

Acceptance test
Authorized persons and acceptance report

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Each SI function must be tested and the results **documented and signed in the acceptance report** by an authorized person. The acceptance certificate must be stored in the machine logbook.

In this context, this is **a person who is authorized by the machine manufacturer** and who has adequate professional training and knowledge of the safety functions in order to conduct the acceptance test in a proficient manner.

Note

The information and descriptions regarding commissioning must be carefully observed.

If any parameters are altered by SI functions, the acceptance test must be carried out again and documented in the acceptance certificate.

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Authorized person

An authorized person may therefore also be an employee from another company appointed to carry out tests where the above conditions are met. In a practical sense, this means that e.g. a SIEMENS service technician may by all means be involved in carrying out the acceptance test for the OEM and also sign the acceptance report.

However, a competent employee working for the machine manufacturer is entitled at all times to confirm the validity of the acceptance report; this is generally the company's safety officer.

Acceptance test
Contents of a complete acceptance test

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1. Documentation

(1) Machine description and overview diagram
(2) SI functions for each drive
(3) Description of the safety equipment = Function test, Part 1

2. Function test with a check of each individual SI function used = Function test, Part 2

(1) e.g. "STO" function
(2) e.g. "SLS" function …

3. Completion of the report – documentation of the commissioning and countersignatures

(1) Check the safety parameters
(2) Record the checksums
(3) Verify the data backups
(4) Signatures

4. Appendix – Measurement records for the function tests

(1) Alarm reports
(2) Trace recordings
(3) User-defined value or parameter lists
(4) Screenshots where applicable

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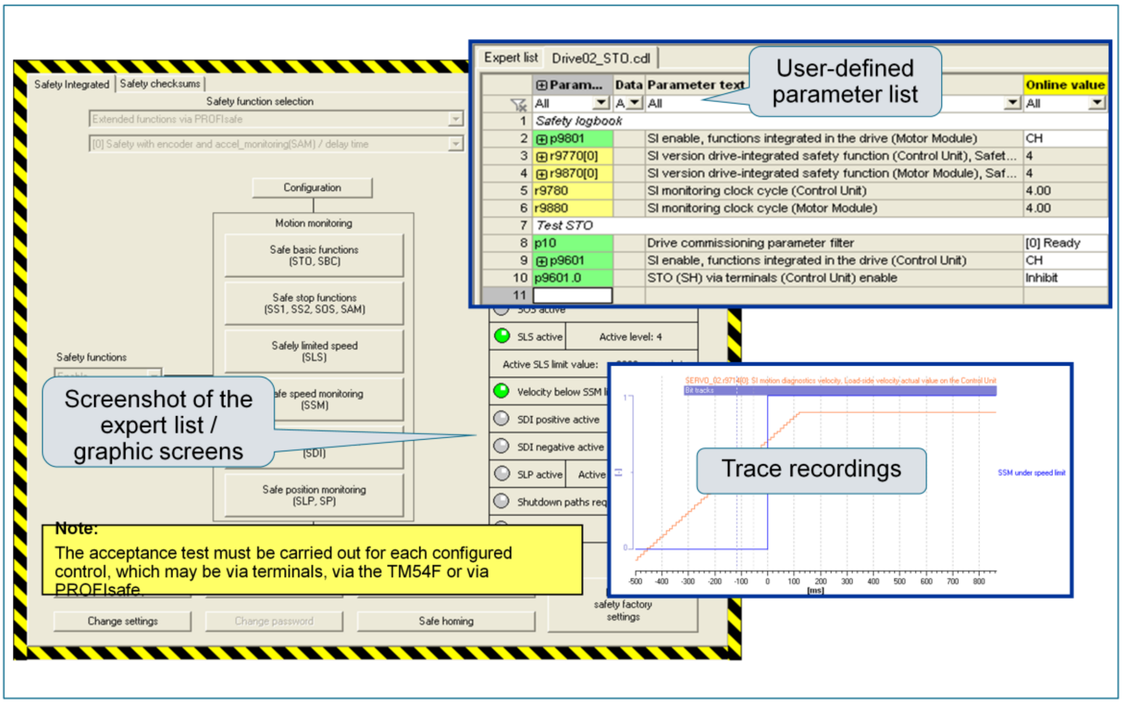
Documentation

Overall acceptance of a machine obviously also includes corresponding documentation of the safety-related mechanical parts, controllers, structures, process description, etc. Particularly strict regulations also apply to machines and plants which fall within the scope of FDA conformity.

Acceptance test
Auxiliary materials for an acceptance test



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STARTER

Parameter lists/value lists created in STARTER simplify the documenting of changes to individual content in parameters which often have to be re-recorded during the acceptance test.

Further appendices can be attached to the acceptance report from the operating manual, machine specifications, etc. A corresponding table of contents must be created with a statement on the number of pages.

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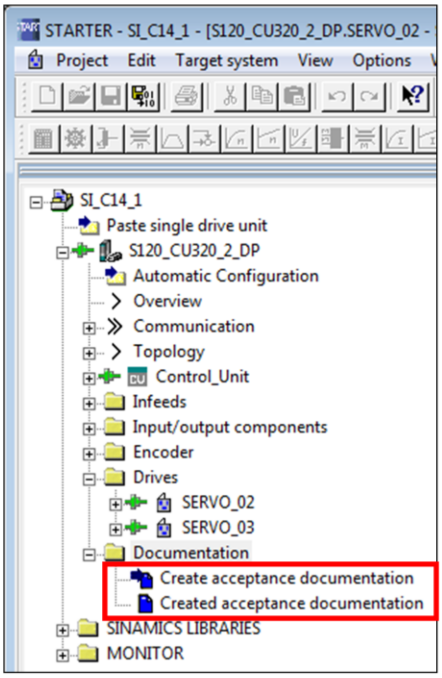
Acceptance test
Acceptance test documentation in the STARTER tool



An acceptance test of the safety settings can be produced under "Documentation". The protocol corresponds to the template provided in the Safety Function Manual.

The user obtains the result in the form of a standard-compliant document where the data for function test Part 1 (system description) are already completed as read out of the online parameterization.

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STARTER The option for producing standard-compliant acceptance test documentation is integrated directly into the commissioning tool.

The document is restricted to the recording of drive-relevant safety parameters; an F-CPU contained in the project or other devices integrated into the structure of the safety system cannot be recorded here.

Function test Part 1 The data for function test Part 1 can be completed online provided that they cover the parameters of the drive unit. This saves a lot of time and avoids any typing errors.

Completion of the report The document produced contains all necessary fields down to the signature screens. It is created as an .rtf document that can also be edited in Microsoft Word, for example.

Acceptance test for changes
Hardware replacement/service work (1)

Which test measures/documentation must be completed when changes/service work/hardware replacements are made to the tested machine?

Measure	Documentation	Function test Part 1	Function test Part 2	Protocol
Replace/update software/reconfigure the PROFIsafe I/O	Supplement HW data/configuration/ software version	Yes, remark limited to replaced/changed components/version/ configuration	No	Supplement, new checksums, countersignature
FW update without new dbSI functions	Supplement version data	No	Only if system clock cycles changed	Supplement, new checksums, countersignature
Replace SMI / SME / SMC / DQI	Supplement HW data/configuration/ software version	Yes with note Limitation to replaced components	Check the safe actual values and the dbSI functions of the drive	Supplement, new checksums, countersignature
Replace power unit (Motor Module)	Supplement HW data/configuration/ software version	Yes, remark limited to replaced/changed components/version/ configuration	Only if system clock cycles changed	Supplement, new checksums, countersignature

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Example document For the acceptance test protocol is provided in the Safety Integrated Function Manual for the relevant drive type.

The details it contains refer exclusively to the dbSI functions of the drives. Further safety-relevant machine components and/or functions must also be tested and/or documented. (e.g settings for HW safety relays, safety light array evaluation devices, safety light barriers, EMERGENCY-STOP switching devices, ASi Safety at work, safety functions and programs, fail-safe controllers, etc.)

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Acceptance test for changes
Hardware replacement/service work (2)

Which test measures/documentation must be completed when changes/service work/hardware replacements are made to the tested machine?

Measure	Documentation	Function test Part 1	Function test Part 2	Protocol
Change to an individual limit value (e.g. SLS limit)	Supplementary SI function of drive	No	Test of the changed limit value	Supplement, new checksums, countersignature
FW update with new dbSI functions	Supplement version data	Yes, for changes	Yes, explicitly the new dbSI functions. The previous ones only if clock cycles have changed.	Supplement, new checksums, countersignature
Standard commissioning with identical dbSI settings	Supplement HW data/configuration/ software version	Yes	Yes	Checksums, Countersignature

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Note

If in doubt, always document, test and describe each change. Verification must be made for work on already tested, accepted machines and systems each time the safety systems are accessed; this verification may take the form of a separate protocol or an appendix to the existing protocol.

The countersignature may also be made in electronic form, e.g. with an entry in the shifts log and later printout with a real signature – the manufacturers must define an appropriate procedure here for their safety officers to regulate the handling of safety passwords.

Exercises

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- Exercise 1: Parameterizing and testing "STO"
- Exercise 2: Parameterizing and testing "SS1"

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Prerequisites

Status of the device:

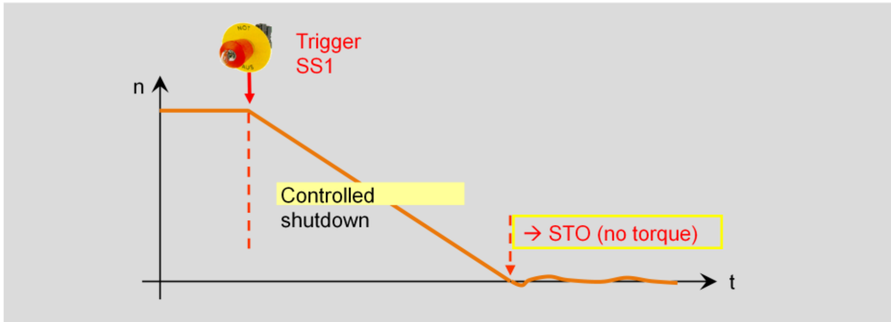
- First commissioning completed

Safety information

Please note that:

- The course instructions have been produced for:
  - A course held by a course leader
  - Activities carried out on special training equipment
- The training equipment is operated under laboratory conditions.
  In case of doubt, always ask your course leader – particularly when handling components that carry electrical current or which can move.
- When carrying out work on equipment, the safety information in the associated product documentation must always be observed!
  The Training Documents alone are not sufficient.

Exercise 1: "Safe Torque Off" (STO) function
Preparation



Basic Function "Safe Torque Off" (STO):

Pulses of the drive are safely "canceled", i.e. the torque-producing power supply is safely disconnected. Control is performed through two channels (independent switch-off signal paths: DI via SW, Enable Pulses via HW) Common DI via CU for all functions. Internal monitoring of both switch-off signal paths.

Basic Function "Safe Stop 1" (SS1):

Purely time-based; i.e. only the timer whose expiration is the basis for STO activation is implemented with 2 channels (safe). Drive is braked along the OFF3 ramp (non-safely), there is no monitoring of the brake ramp.

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Description

Using this exercise, the basic safety functions integrated in the SINAMICS S120 drive are introduced ("drive based Safety Integrated Basic Functions").

You will learn about the following safety functions:

- Safe Torque Off (STO)
- Safe Stop 1 (SS1)

Note

You will get to know the extended safety functions (dbSI Extended Functions), for instance Safe Stop 2 (SS2), Safely Limited Speed (SLS), Safe Operation STOP (SOS) and Safe Position (SPO) as well as generating the acceptance protocol within the scope of the advanced course "DR-SNS-SAF".

Preparation

It is possible to use the "dbSI Basic Functions" with any project that you use in the course, in the "Servo" or "Vector" operating mode.

Select one of your projects, and make sure that the following functions operate:

- DI0: On/off 1 for "Servo_02" ➔ the drive is switched on and switched off
- One of the purely digital inputs of CU320-2 (DI 1 to DI 7) is available and is "deenergized"

Parameterize 5 seconds for the OFF3 ramp (so that you can clearly observe it).

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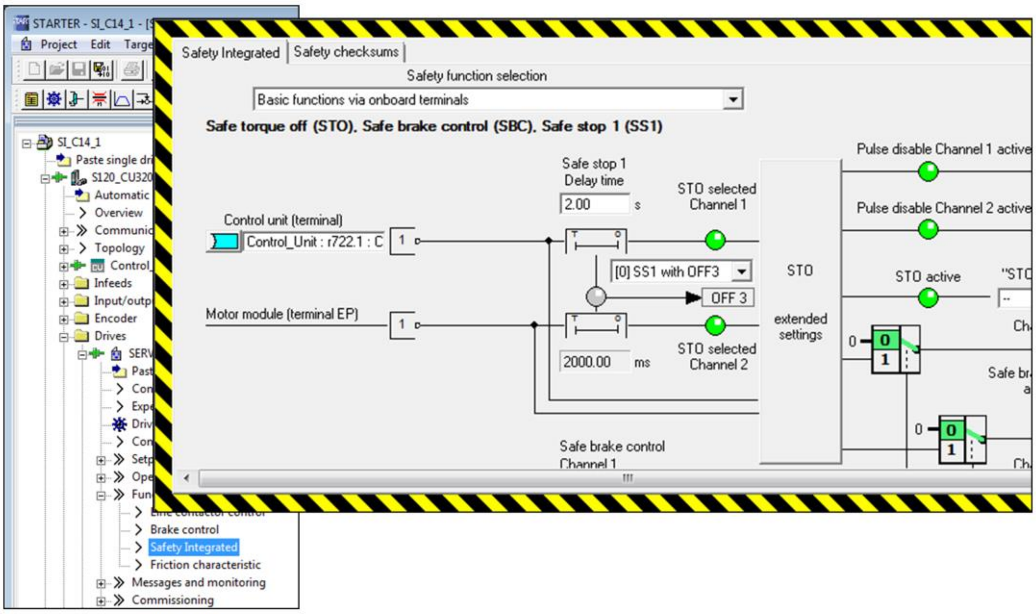
Exercise 1: "Safe Torque Off" (STO) function Parameterization



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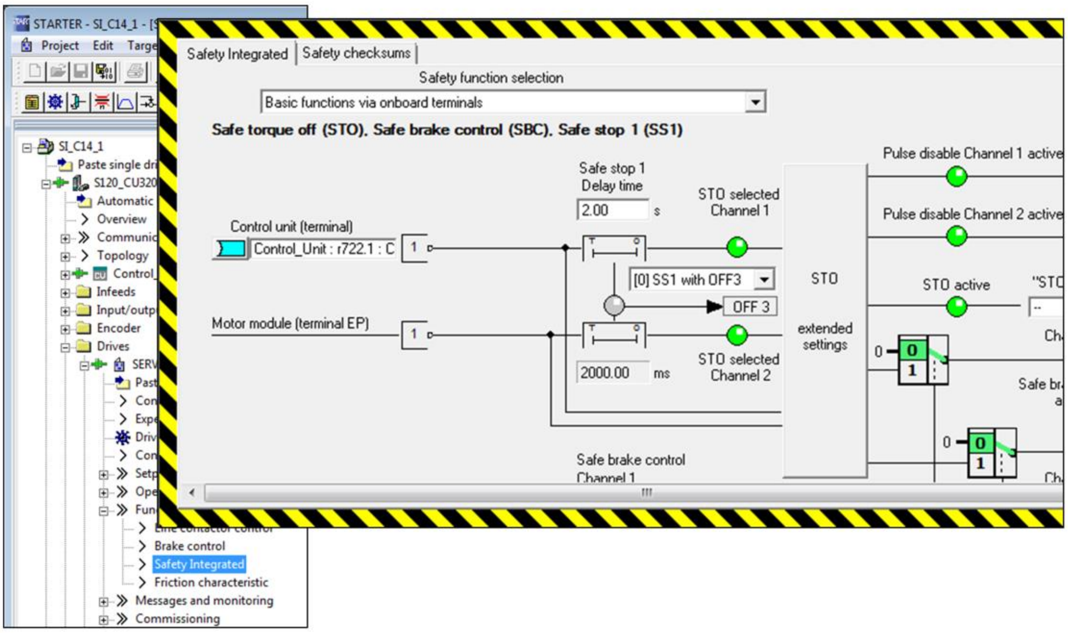
Parameterization

Scroll within your drive object "Servo_02" to the "Safety Integrated" function:
>> Drives > Servo/Vector > Functions > Safety Integrated

1. Activate the menu for the safety functions using the "Change settings" button and enter a password of “0“ (or if required, “1“).
2. Select the variant “STO/SBC/SS1 via terminal“ in the "Safety function selection" (variants with “Motion Monitoring“ are only for dbSI Extended“).
3. Assign the free digital input to the "Control Unit (DI1)“ input, and enter 2 s as the simultaneity monitoring under "Extended settings.
4. Use the "Activate settings" button to activate the settings; if necessary, define the number "1" as password (PLEASE do not use any other number as a password) and save the changed axis parameters.

Exercise 1: "Safe Torque Off" (STO) function Parameterization



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Function test

Presently, both channel 1 and channel 2 signal “Pulse disable active = blocked“: Channel 1 is enabled by the DI of the CU320-2, which you defined. Channel 2 is enabled via “Enable Pulses, EP“ (on the exercise equipment "2-axis case" with the switch located above the line switch).

1. Activate the two switches for the safety channels with a simultaneity of 2 s:
   ➔ A pulse enable is produced in both channels

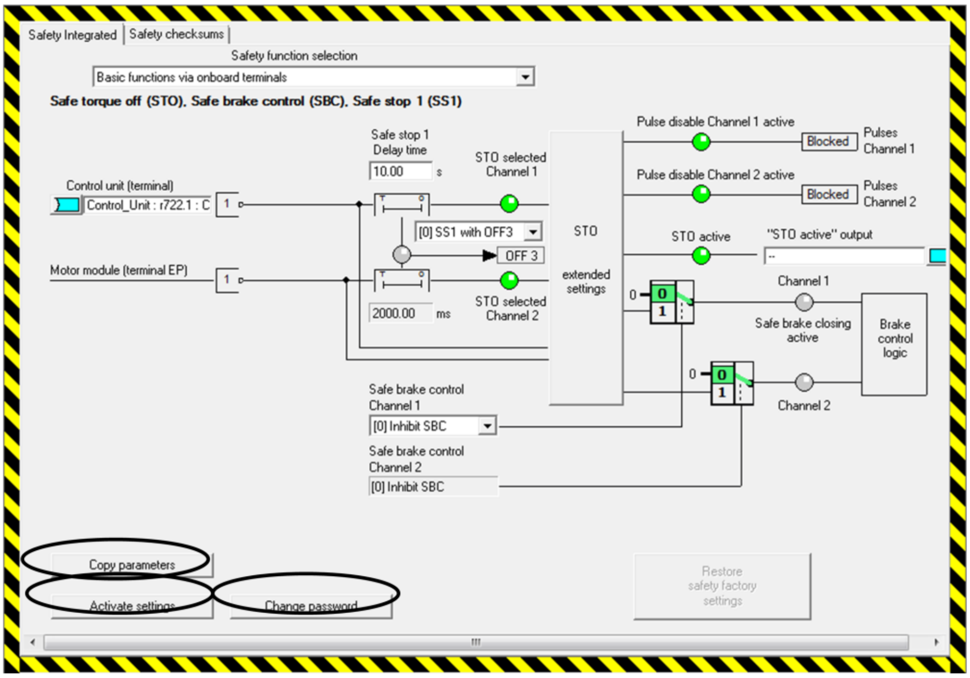
2. Switch on the drive
   ➔ The motor accelerates to the specified setpoint speed.

3. Open the two switches for the safety channels "within 2 s":
   ➔ The pulses are immediately canceled (disabled) in both channels

4. Switch off the drive, close both switches for the safety channels "within 2 s" and switch on the drive
   ➔ The motor accelerates to the specified setpoint speed.

5. Open one of the two switches for the safety channels:
   ➔ The drive is switched off after 2 seconds with the fault messages "STOP A triggered" and "Defect in monitoring channel....".

Exercise 2: "Safe Stop 1" (SS1) function Parameterization



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Task Use the "Change settings" button to obtain access to further parameterization of the safety functions and enter a password of "1".

Assign 10 s as delay time for SS1 in each case.

Use the "Activate settings" button to activate the settings; if necessary, define the number "1" as password (PLEASE do not use any other number as a password) and save the changed axis parameters.

Function test Close the two switches for the safety channels "within 2 s" to obtain the pulse enable for both channels.

1. Switch on the drive
   ➔ The motor accelerates to the specified setpoint speed.

2. Open the switches for the safety channels “within 2 s“
   ➔ The motor decelerates with OFF3 to standstill, after 10 s the pulses for both channels are canceled (disabled)

3. Switch off the drive, close both switches for the safety channels "within 2 s" and switch on the drive
   ➔ The motor accelerates to the specified setpoint speed.

4. Open one of the two switches for the safety channels:
   ➔ The drive is switched off after 2 seconds with the fault messages "STOP A triggered" and "Defect in monitoring channel....".

Power On Reset Acknowledge the pending error messages.

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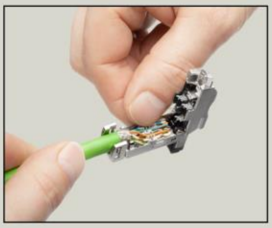

Chapter 15

Communication

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Learning Targets

- You will know the fundamental principle of data transfer between converter and SIMATIC S7
- You will be able to set up communications via PROFIBUS on the basis of a standard telegram

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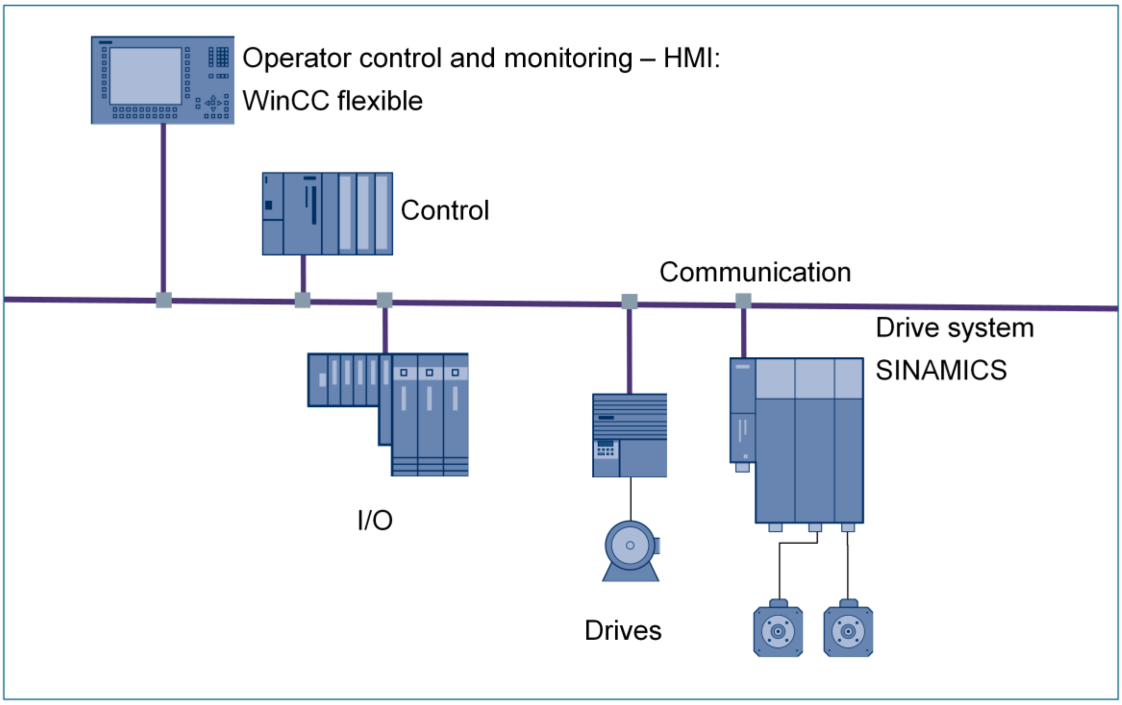
Connection of the components



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Automation

The automation systems require various hardware and software components for the machine control.

- HMI (Human Machine Interface)
- Control
- I/O
- Drives

Communication

The various components in the automation system communicate with each other via networks that are set up as a PROFIBUS network or PROFINET network, for example.

There are often several different networks in an automation system, which are then interlinked via modules that have a routing function.

Forms of communication overview

PROFIDRIVE: via PROFIBUS or PROFINET

OA Link

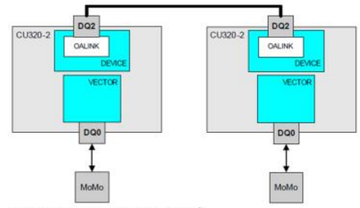
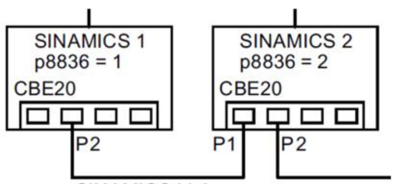


Abbildung 1: Beispiel 1 - DRIVE-CLiQ-Topologie

SINAMICS Link



Connection to panels

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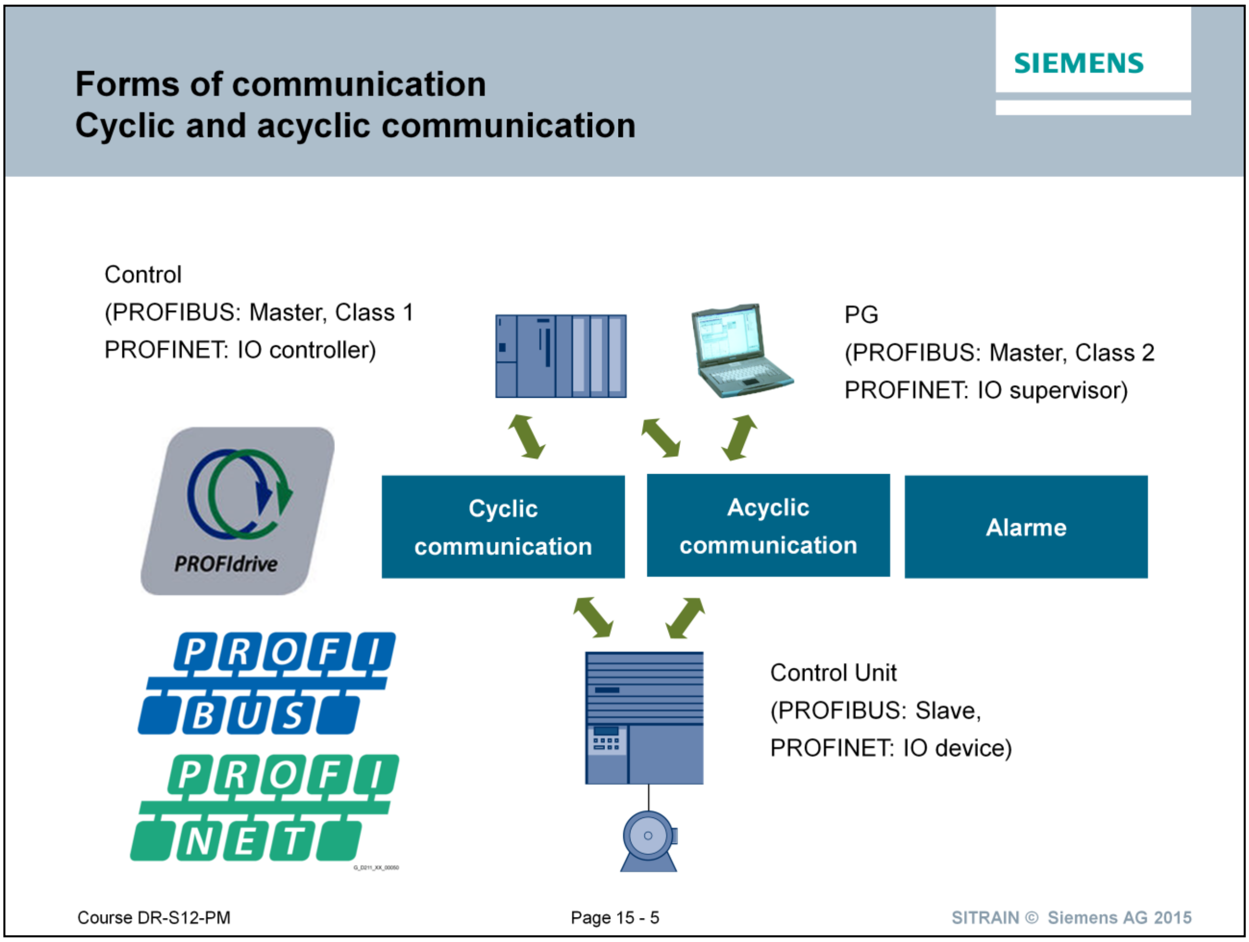


PROFIdrive

With its version of the drive profile PROFIdrive published in September 2005, the PROFIBUS User Organization (PNO) produced an extended standard that is applicable both to PROFIBUS and PROFINET. The long-proven PROFIdrive profile at PROFIBUS is now also available for PROFINET under the same user interface. Separation of the application and communication gives both the manufacturers of devices and users trouble-free access to PROFIdrive applications on PROFIBUS or PROFINET and thus the freedom to select the optimal communication system.

The PROFIdrive drive profile describes the drive interface from the viewpoint of the control application and its mapping to the communication system. It uses six application classes to cover scenarios ranging from simple frequency converters to highly-dynamic servo drives. PROFIdrive has been tried and tested as an application profile for drives that use the PROFIBUS interface for many years now; as of Version 4.0, it is also available for drives with PROFINET communication. This means that drives for PROFIBUS and PROFINET can be implemented using the same profile.

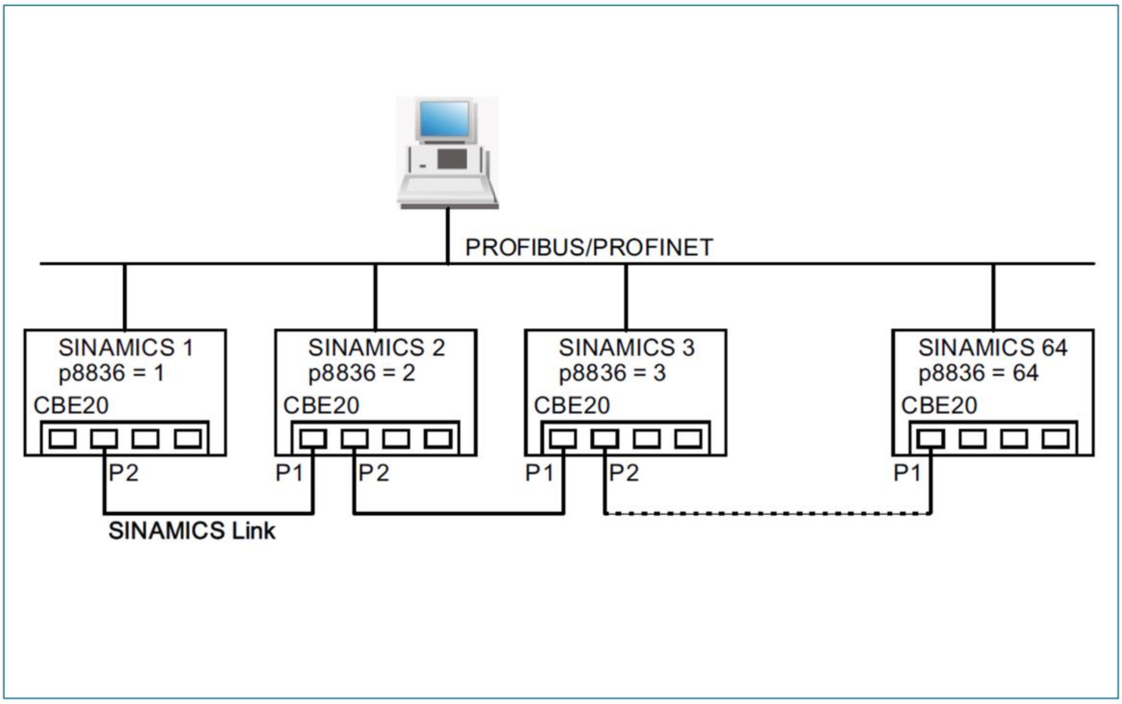
Cyclic communication

In each bus cycle, data are exchanged between the Profibus master/PROFINET controller and the Profibus slave/PROFINET device. This is done typically on the basis of standard telegrams.

Acyclic communication

Only on request are data are exchanged between the Profibus master/ PROFINET controller and the Profibus slave/PROFINET device. This data exchange typically requires several bus cycles until a job is fully processed.

SINAMICS link



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SINAMICS Link

SINAMICS Link enables data to be directly exchanged between several Control UnitsCU320-2 DP or CUD, which for this purpose must be equipped with the CBE20 supplementary module. Other nodes cannot be integrated into this communication. Possible applications include e.g.:

- Torque distribution for n drives
- Setpoint cascading for n drives
- Load distribution of drives coupled through a material web
- Master/slave function for infeed units
- Links between SINAMICS DC-MASTER and SINAMICS S120

OA-Link
Open Application Link

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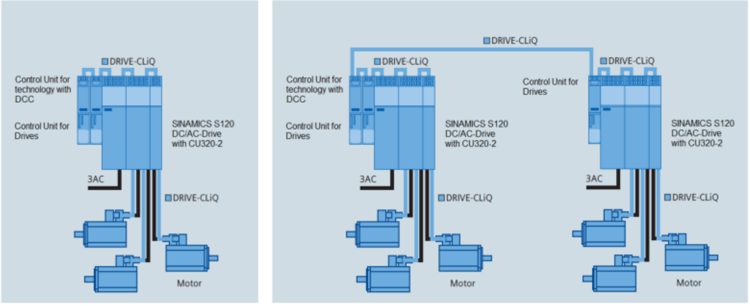
SINAMICS OALINK (Open Application Link)

- Direct coupling of 2 Control Units via the Drive-CLiQ-Ports
- Direct communication relation only between 2 CUs.
- In maximum configuration 3 CUs should be coupled (recommendation)
- In each coupled CU the OA-Application „OALINK“ must be loaded and activated via License (MLFB: 6SL3077-0AA01-0AB0).



Topologische Prinzip Sicht des Open Application Link

User data length:

- 120 Words of user data per connection

Data transmission:

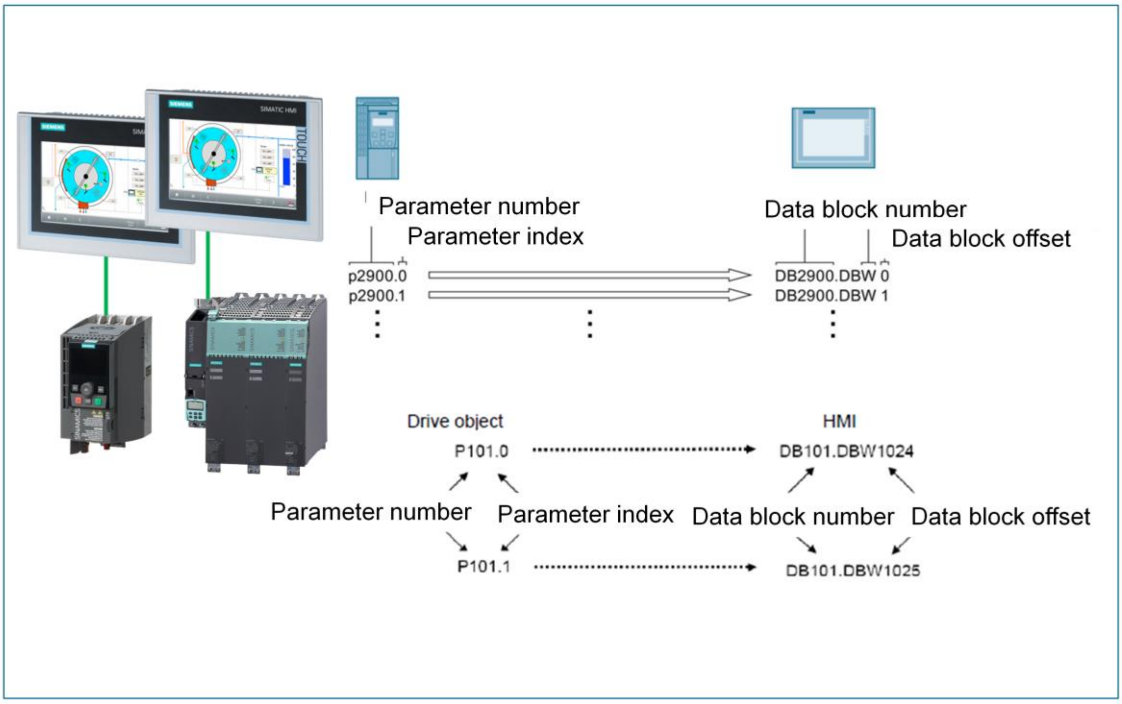
- Cyclical
- Minimum cycle 1ms
- NO isochronous operation

Available in Control Unit:

- CU320-2
- CUD Advanced

Splitting up the calculation power for technology- and drives functions to 2 CUs, especially for DCC applications

Connection of HMI-Panels



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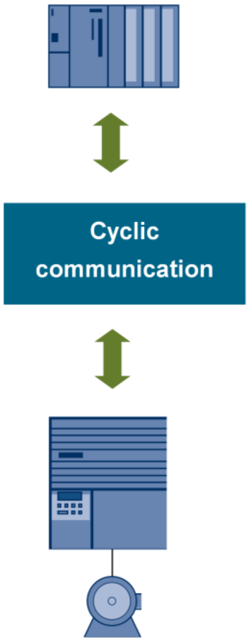
HMI-Panel

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

PROFIDRIVE
cyclic communication

SIEMENS



Cyclic communication

- exchange time-critical process data

Telegramme und Prozessdaten

The receive and send words comprise the following elements:

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

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

Telegrams and process data

When a telegram is selected the drive unit (Control Unit) process data that is transferred is determined.

From the perspective of the drive unit, the received process data represents 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

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.

For example there the following standard can be selected:

1: speed setpoint 16 Bit

2: speed setpoint 32 Bit

3: speed setpoint 32 Bit with 1 encoder for positioning

4: speed setpoint 32 Bit with 2 encoders for positioning

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.

PROFIDRIVE
application classes

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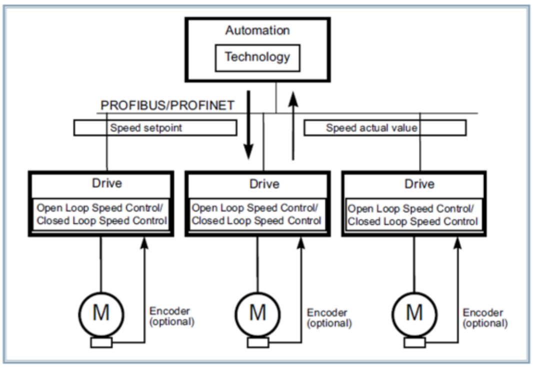
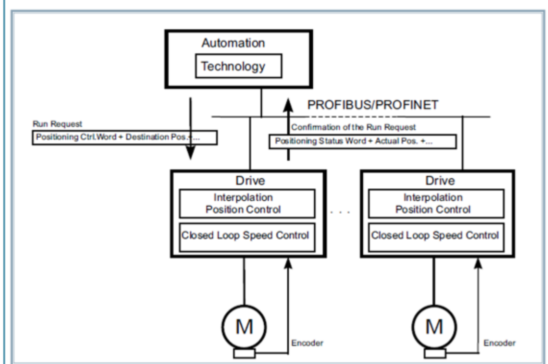
Speed control drive	Position control
	

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Description There are different application classes for PROFIdrive, depending on the scope and type of the application processes. PROFIdrive features a total of six application classes, four of which are discussed here.

Application class 1 In the most basic case, the drive is controlled via a speed setpoint by means of PROFIBUS/PROFINET. In this case, speed control is fully handled in the drive controller. Typical application examples include simple frequency converters for controlling pumps and fans.

Application class 3 In addition to the drive control, the drive also includes a positioning control, which means that it operates as a self-contained single-axis positioning drive while the higher-level technological processes are performed on the controller. Positioning requests are transmitted to the drive controller via PROFIBUS/PROFINET and launched. Positioning drives have a very wide range of applications, e.g. the screwing and unscrewing of caps in a bottle filling plant or the positioning of cutters on a film cutting machine..

Telegram overview
Standard telegrams in SINAMICS

Application class 2: Standard telegram 1 (16-bit nset)

PZD number	1	2
Setpoint	STW 1	NSOLL_A
Actual value	ZSW 1	NISTL_A

Application class 2: Standard telegram 3 (32-bit nset, with encoder)

PZD Nummer	1	2	3	4	5		
Setpoint	STW 1	NSOLL_B		STW 2	G1_STW		
Actual value	ZSW 1	NISTL_B		ZSW 2	G1_ZSW	G1_XIST 1	G1_XIST 2

Application class 3: Standard telegram 9

PZD Nummer	1	2	3	4	5	6	7	8	9	10
Setpoint	STW1	SATZANW	STW2	MDI_TARPOS		MDI_VELOCITY		MDI_ACC	MDI_DEC	MDI_MODE
Actuel value	ZSW 1	Akt Satz	ZSW 2	XIST_A						

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Interfacing When interfacing via PROFIdrive, standardized telegrams in accordance with the PROFIdrive profile are used to transfer all information between the drive system and the SIMATIC. The structure and type of the information being exchanged uniquely defines the number of the telegram.

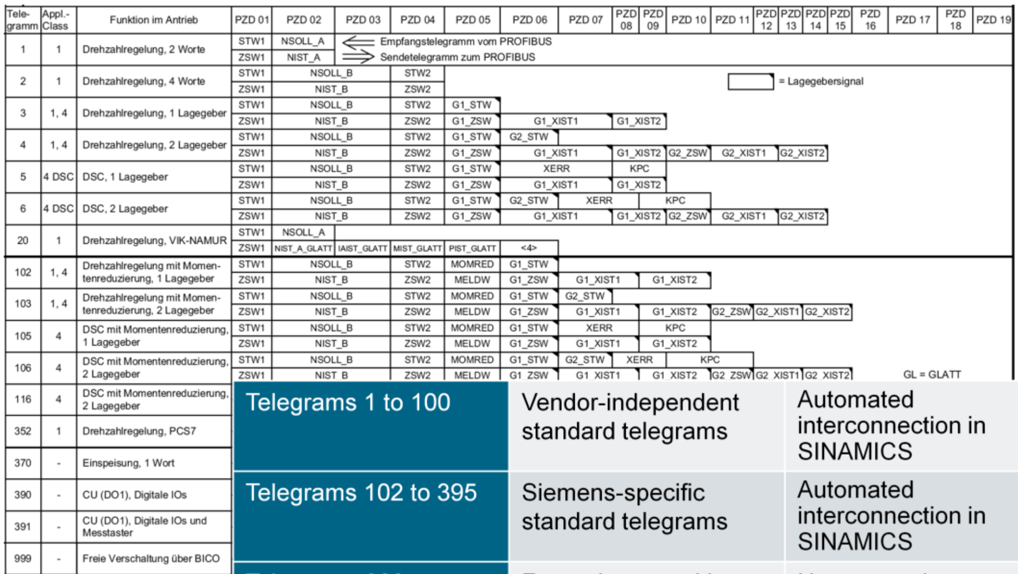
Standard telegram 1 Is designed for simple speed-controlled applications. The telegram has a control and a status word via which the basic functionality regarding activation, deactivation, pulse and controller enable is handled. A 16-bit data word is used for transferring the speed setpoint. The actual speed value is also transferred back from the drive in 16 bits.

Standard telegram 3 Is designed for positioning applications. It also has an encoder control word and encoder status word, as well as a 4-word interface to a measuring system. This encoder control word implements functions, such as homing and measuring input.

Standard telegram 9 Is designed for controlling a positioning axis via MDI positioning.

Telegram overview
Standard telegrams and SIEMENS telegrams

SIEMENS



Telegrams 1 to 100	Vendor-independent standard telegrams	Automated interconnection in SINAMICS
Telegrams 102 to 395	Siemens-specific standard telegrams	Automated interconnection in SINAMICS
Telegram 999	Free telegram with BICO	No automatic interconnection

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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.

Examples for standard telegrams:

- 1 16-bit speed setpoint
- 3 speed setpoint, 32-bit with 1 position encoders
- 4 speed setpoint, 32-bit with 2 position encoders
- 5 speed setpoint, 32-bit with 1 position encoder and DSC
- 7 positioning, telegram 7 (basic positioner)
- 81 encoder telegram, 1 encoder channel

Manufacturer-specific telegrams

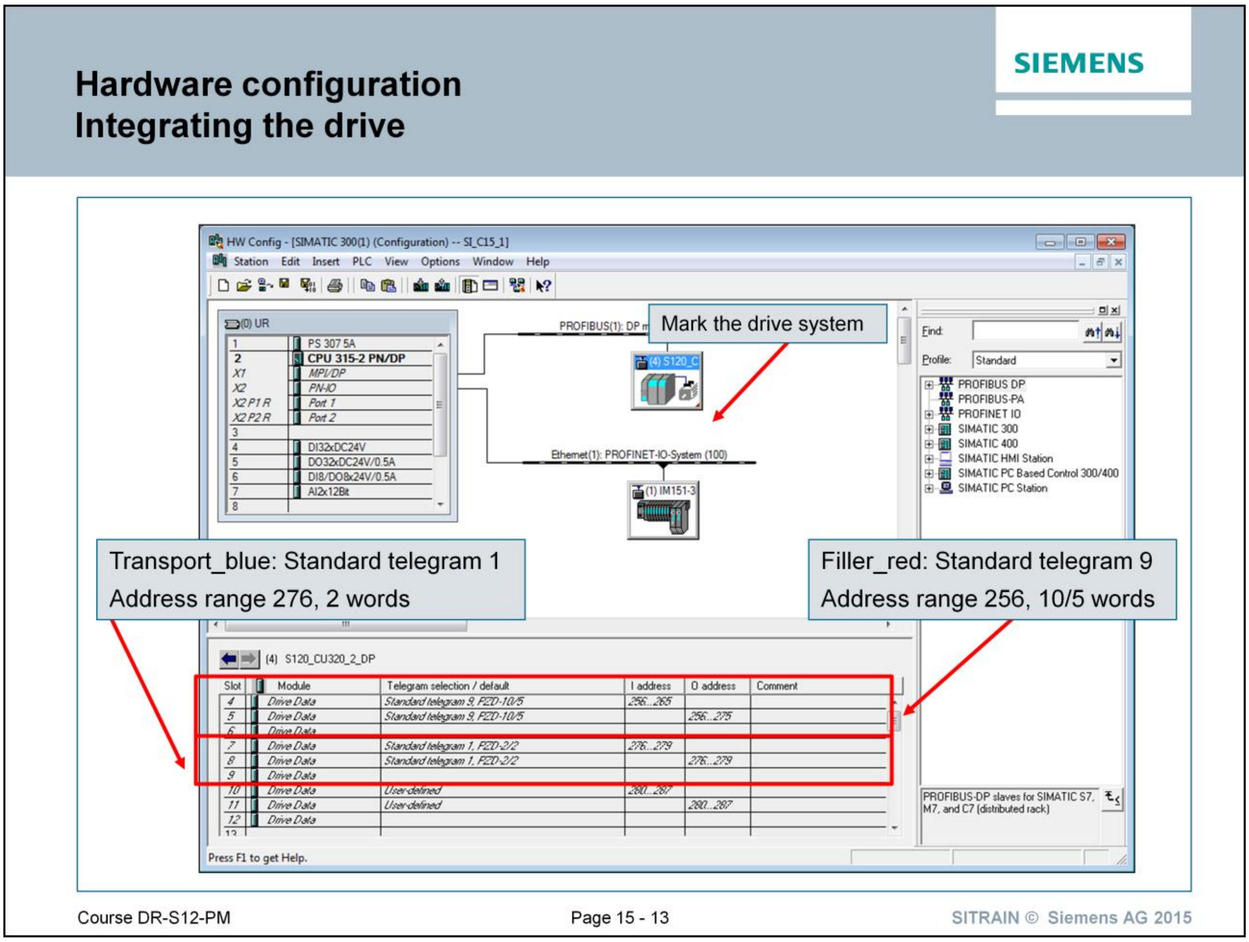
The manufacturer-specific telegrams are structured in accordance with internal company specifications. The internal process data links are set up automatically in accordance with the telegram number setting.

Examples for SIEMENS-specific telegrams:

- 110 positioning, telegram 10 (basic positioner with MDI, override and Xist_A)
- 111 positioning, telegram 11 (basic positioner in MDI mode)
- 118 speed setpoint, 32-bit with 2 external position encoders, torque reduction and DSC, as well as load, torque, power, and current actual values
- 370 infeed
- 390 Control Unit with digital inputs/outputs

Free telegrams

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



Open station To open "HW Config" from STARTER for a station that has already been configured, simply double-click in the project navigator on the desired SINAMICS device.

This step is required when additional HW components should be added subsequently or when changes or checks should be made to previously configured stations or HW components.

Hardware configuration The hardware configuration is made with the "HW Config" editor. The hardware in the project is simulated, e.g.:

- Type of the SINAMICS device
- Type of the I/O modules

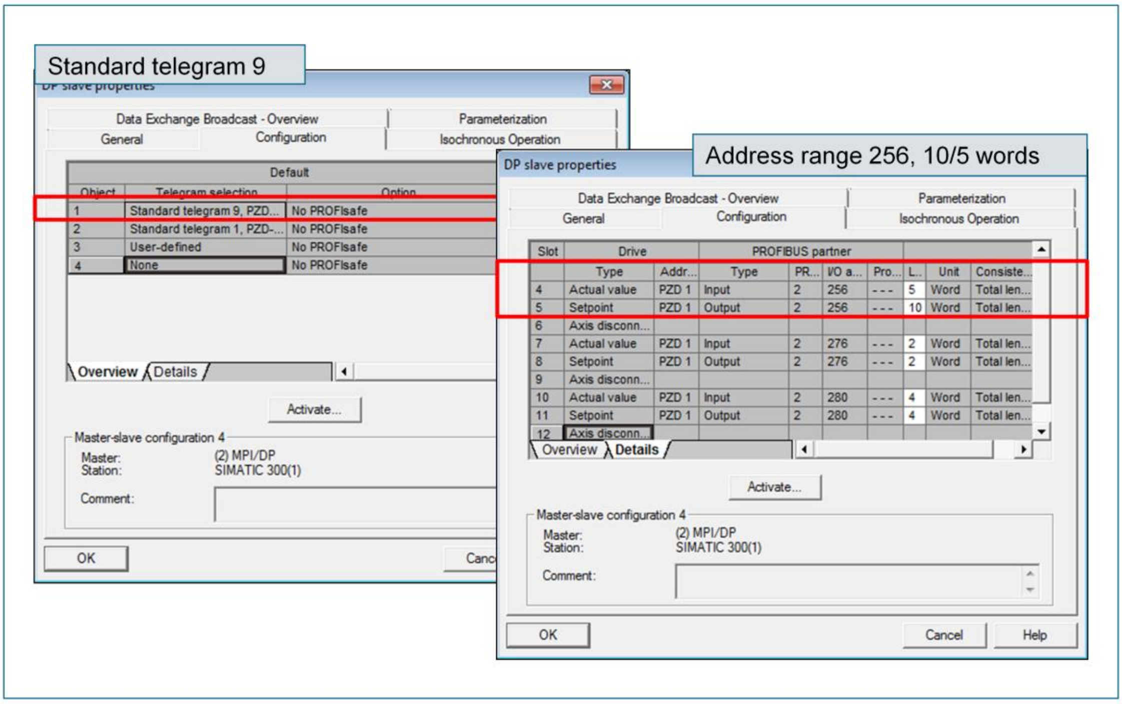
In addition, set the parameters for the entire SIMATIC and SINAMICS project, e.g.:

- Configuration of the SINAMICS devices
- Configuration of the PROFIBUS and assignment of the PROFIBUS hardware
- Configuration of PROFINET and assignment of the PROFINET hardware

HW Config The "HW Config" editor is shown in the above figure: It consists of:

- A "Hardware Catalog" window
- A "two-part work window" that shows the rack or station frame with the CPU inserted in slot 2, as well as detailed information on the selected objects. Further objects can be added and edited from the hardware catalog.

Hardware configuration
Telegram configuration



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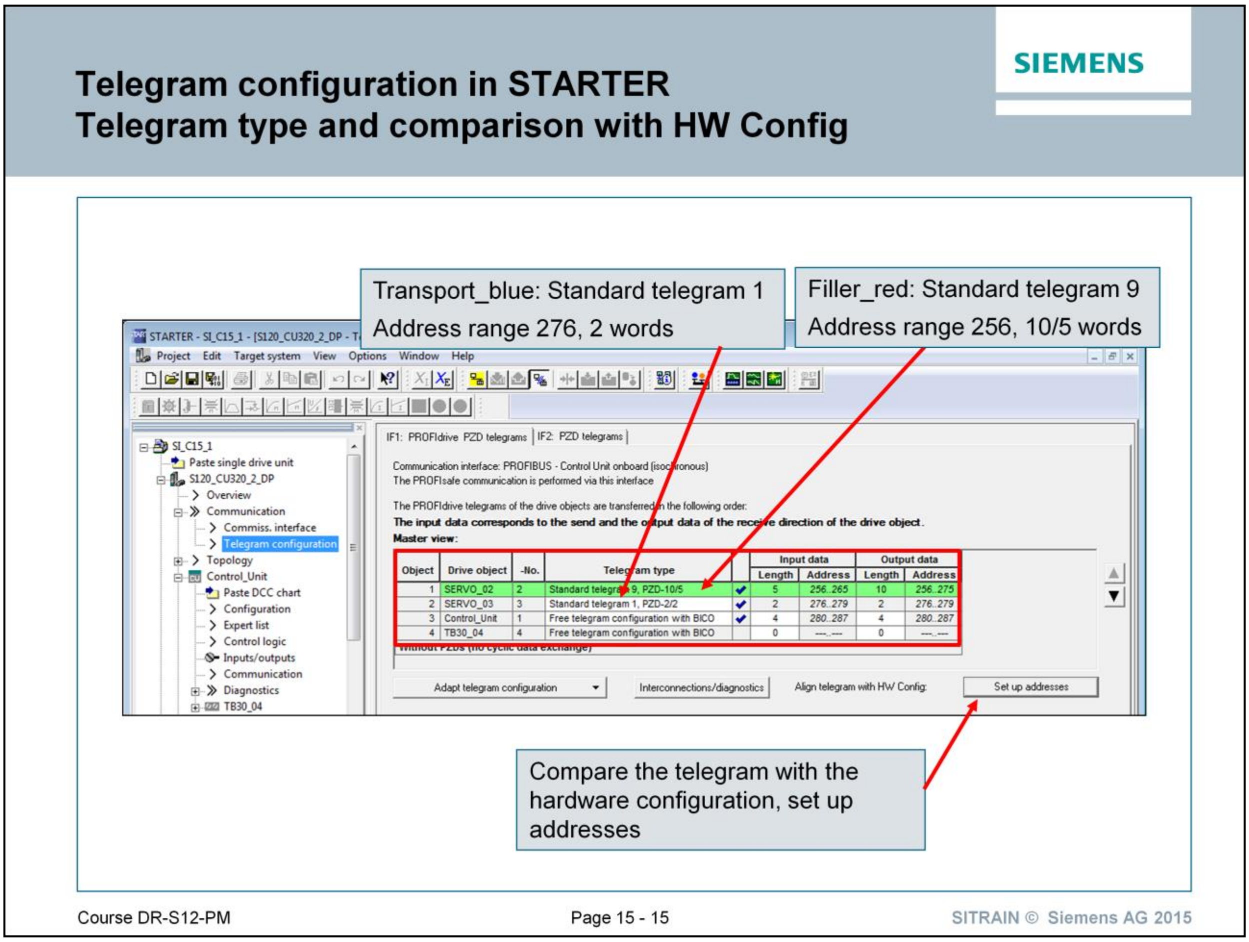
General Data transfer between SIMATIC and SINAMICS for Filler_red drive is carried out via the *Profibus Standard Telegram 9.*

I/O address Output address PAW 256 is used to transfer the process data (control word, setpoint, etc.) to the drive and return the actual values, for example, via the inputs.

The *Standard Telegram 9* is output via output word PAW256 - PAW276 (10 words). The system function SFC 15 is required for transfer.

PROFIBUS master Is the CPU with address 2 in the example shown.



Telegram configuration

Besides the hardware configuration, the telegram configuration is also defined in STARTER.

The following commands can be used to open an overview of the telegrams that are assigned to drive objects:

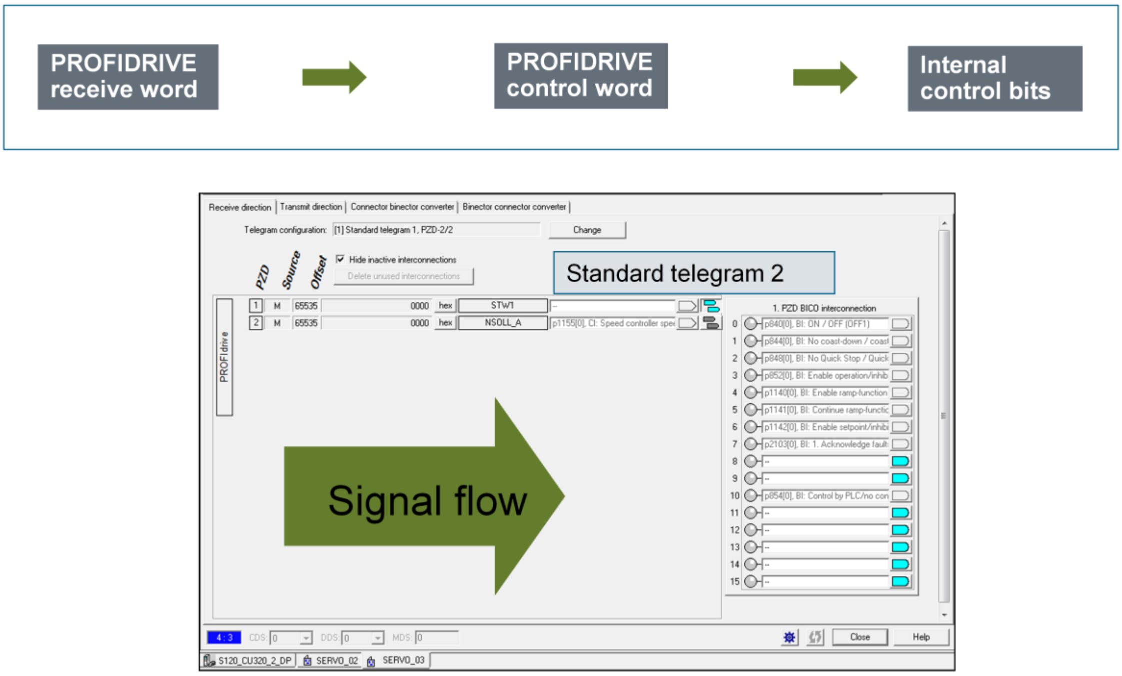
>> Drive unit -> Communication > Telegram configuration

Compare telegram

When the telegrams for the drive objects are defined in the STARTER, it is necessary to enter the communication data in the hardware configuration also. This can be done either manually or using the "Set up address" button. This sets up the I/O ranges in the hardware configuration according to the telegram settings in the STARTER.

Communication
Receive direction, control word

SIEMENS



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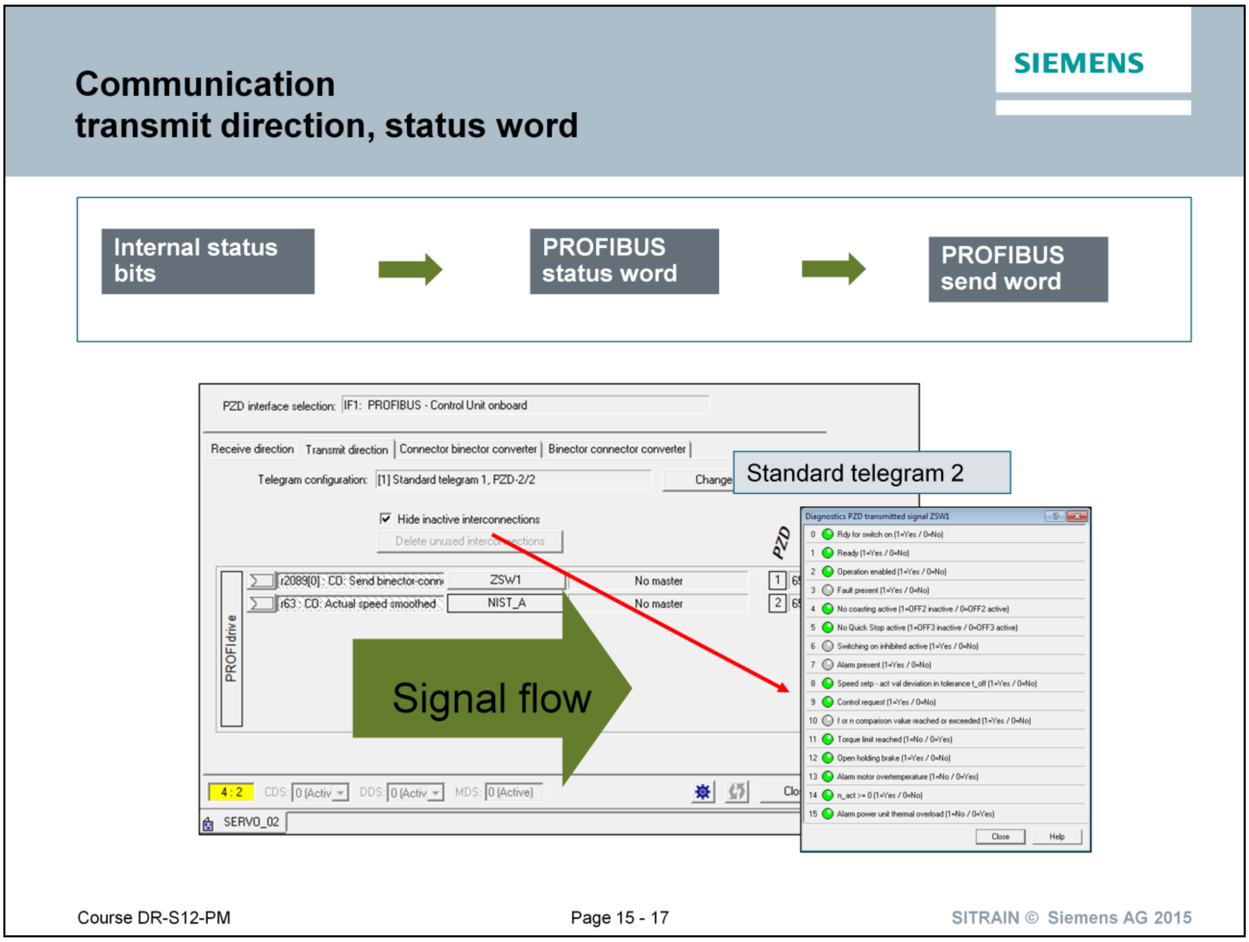
Receive signals

The signals received via Profibus or Profinet can be displayed word-by-word, double-word-by-double-word or even bit-by-bit with Starter in online mode. These signals are provided by appropriately assigned read parameters:

- Word-by-word: r2050[0], r2050[1], …
- Double-word-by-double-word: r2060[0], r2060[1], …
- Bit-by-bit: r2090.0, …, r2090.15, r2091.0, …, r2091.15, …

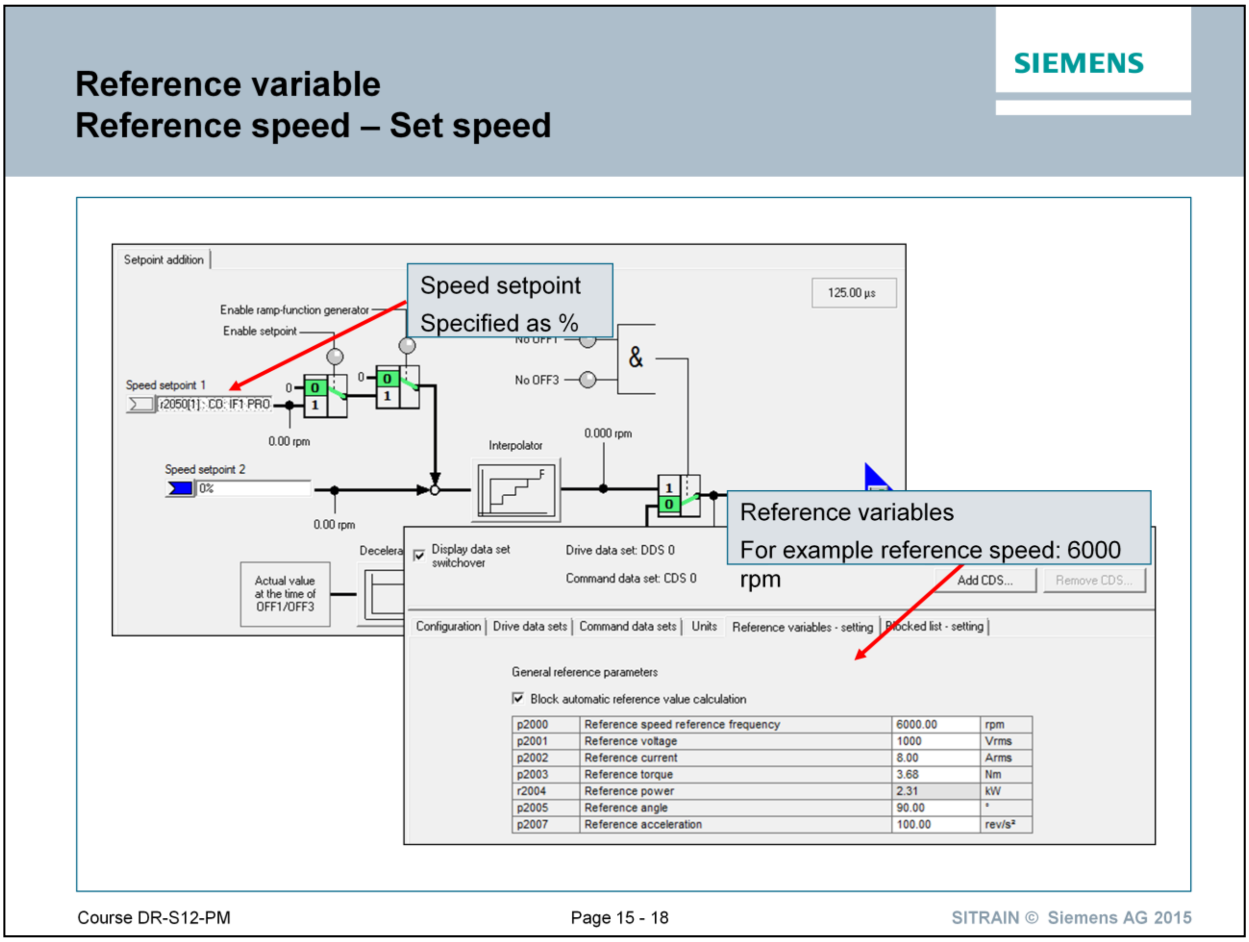
In this way, these signal can also be linked on to other drive parameters of the corresponding format.



transmit signals

The signals sent via Profibus or Profinet can be displayed word-by-word, double-word-by-double-word or even bit-by-bit with Starter in online mode. These signals are provided by appropriately assigned write parameters:

- Word-by-word: p2051[0], p2051[1], …
- Double-word-by-double-word: p2061[0], p2061[1], …
- Bit-by-bit: p2080[0], …, p2080[15], p2081[0], …, p2081[15], …



Reference variables

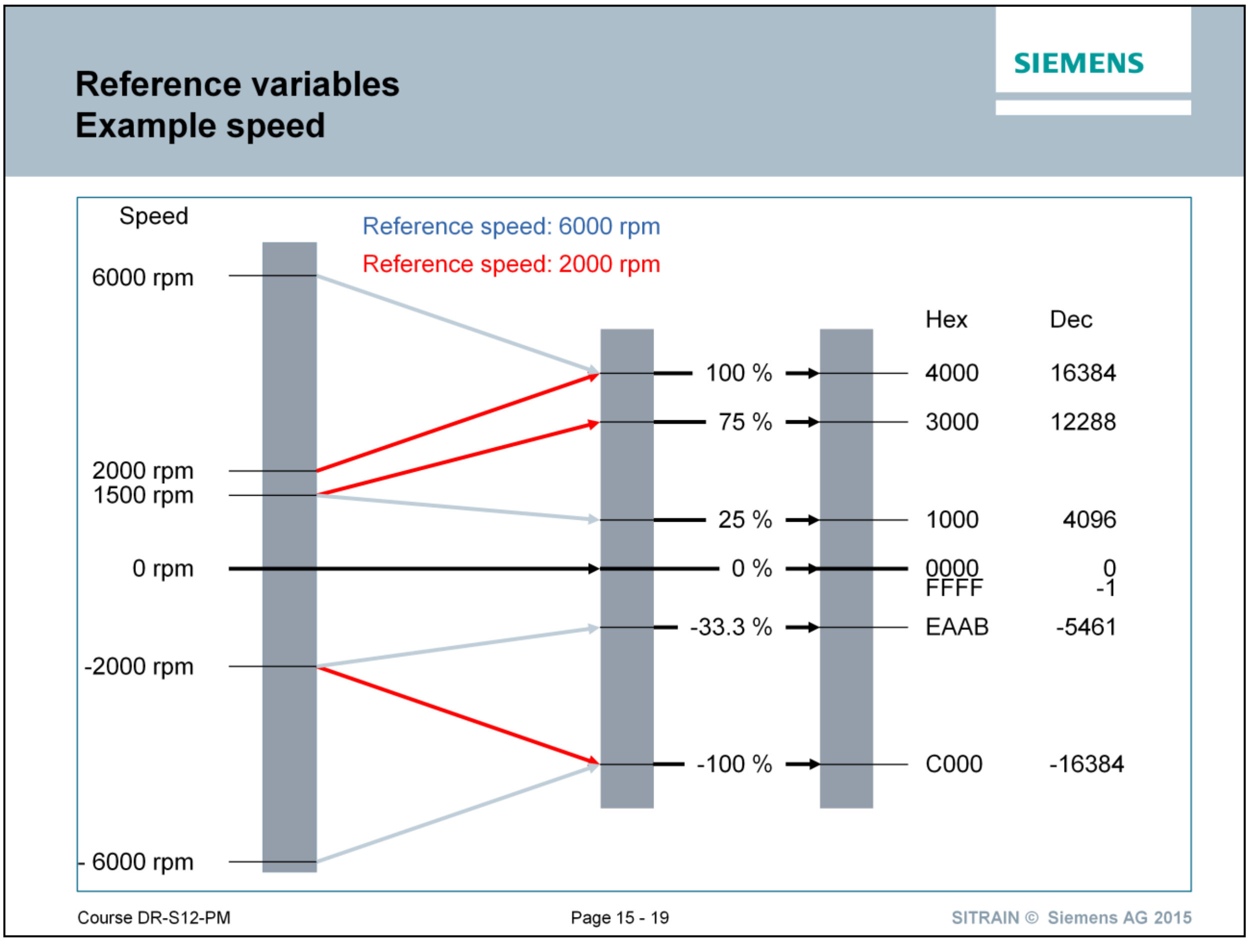
Numerous variables, such as speed, are not specified as absolute values, but as a percentage of a reference variable.

This means that the speed is configured and output as a percentage of the reference speed.

You can specify the following variables:

- Reference speed / reference frequency
- Reference voltage
- Reference current
- Reference torque
- Reference power
- Reference angle
- Reference acceleration

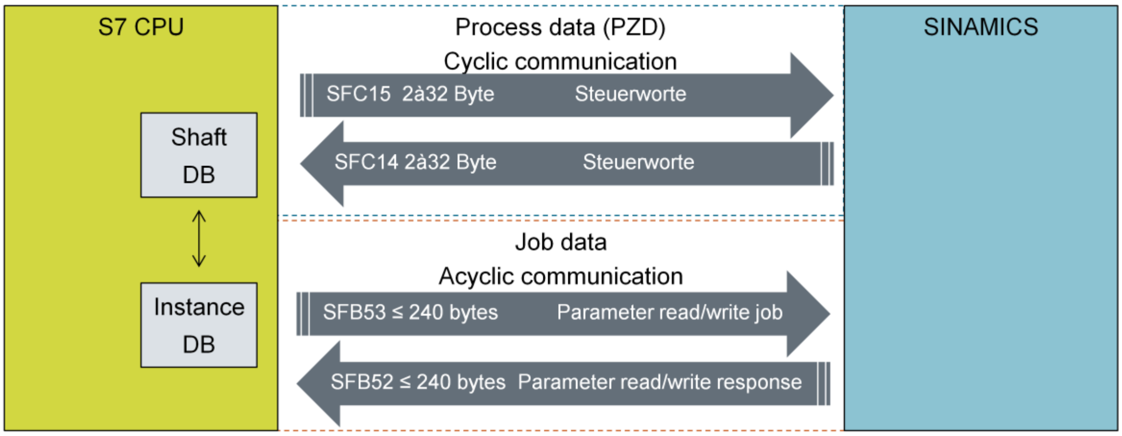
The reference variables are defined during the commissioning phase but may be adapted at any later time.



Conversion If the speed is specified via a higher-level PLC, for example, this value is specified as a percentage of the reference speed.

Cyclic and acyclic communication via system functions

SIEMENS



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Cyclic communication

Cyclic communication is typically performed on the basis of PROFIBUS standard telegrams, whereby a defined number of words are transferred to the slave/device depending on the length of the telegram and a defined number of words are read from the slave/device in each bus cycle.

This cyclic exchange of data is also supported by system functions that enable consistent sending and receiving of several words via the I/Os.

Acyclic communication

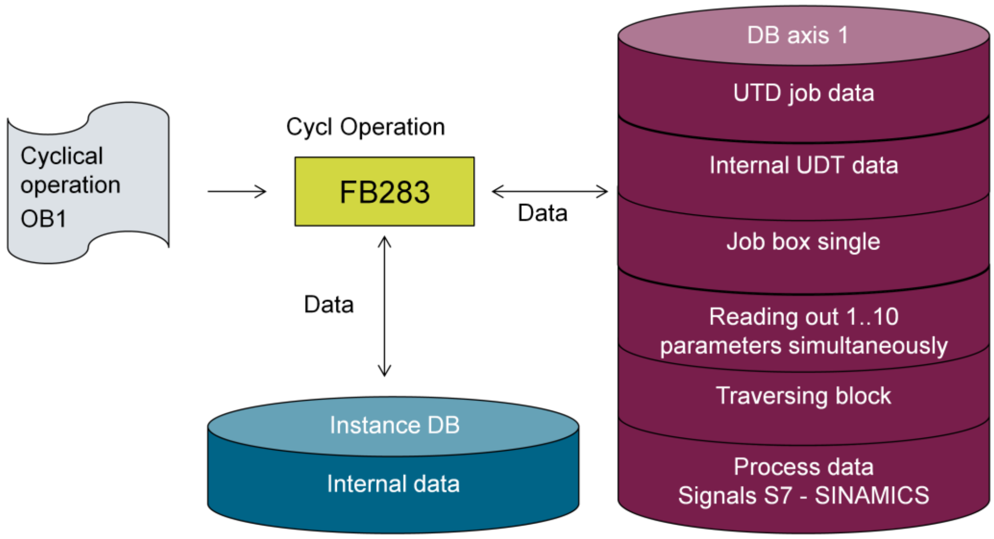
Only upon request, data are exchanged between the Profibus master and the Profibus slave. This data exchange typically requires several bus cycles until a job is fully processed.

This data exchange is supported by system function blocks that carry out processing of the data request.

Cyclic and acyclic communication using FB283

SIEMENS

Operation with one axis



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Acyclic services

Besides the cyclic communication there is also an acyclic communication which tranfers data only if it is necessary e.g. to read out alarms or transfer a new taregt position.

To make it easier there is a toolbox with the FB283 to support the programming of the acyclic communication.

FB283

The SINAMICS toolbox comprises a sample project 'Fb283_Bsp_V2_1.zip', which includes an interface block that allows to conveniently connect the SINAMICS converters to PROFIBUS / PROFINET.

This version supports the following converters:

SINAMICS G120

SINAMICS G120D

SINAMICS G130

SINAMICS G150

SINAMICS S110

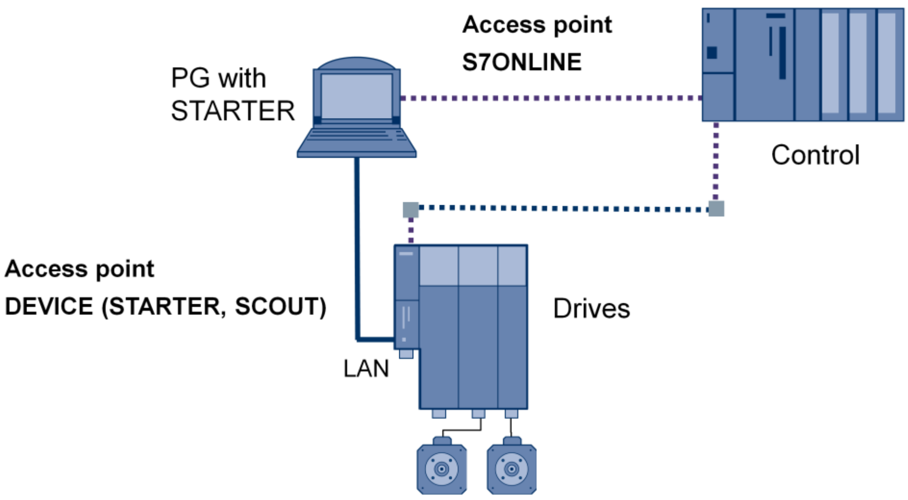
SINAMICS S120

Tasks of the FB283

The function block FB283 allows to transfer all the necessary drive process data. This block is especially suitable for actuating the EPOS functions of the SINAMICS S110 and S120, but it can also be used as a mere speed drive.

Further, the FB283 provides the following functions:
The existing drive parameters can be read or overwritten. The fault buffer can be read out. You can transfer up to 64 traversing blocks with one function trigger. Max. 10 arbitrary parameters can be read / written with one job (e.g. to adapt the product).

Access points
S7ONLINE and DEVICE (STARTER, SCOUT)



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PG connection

The PG/PC connection for the configuring, commissioning and the service can be performed using interfaces on the SINAMICS.

The following interfaces are available:

- 1 PROFIBUS interface DP1 (for CU320-2 DP only)
- 2 PROFINET interfaces PN (for CU320-2 PN only)
- 1 Ethernet interface X127
- CBE20 option module for PROFINET with 4 RJ45 connections
- CBC10 option module for CAN bus

For configuring the interface, STARTER uses the STEP 7 tools HW Config and NetPro.

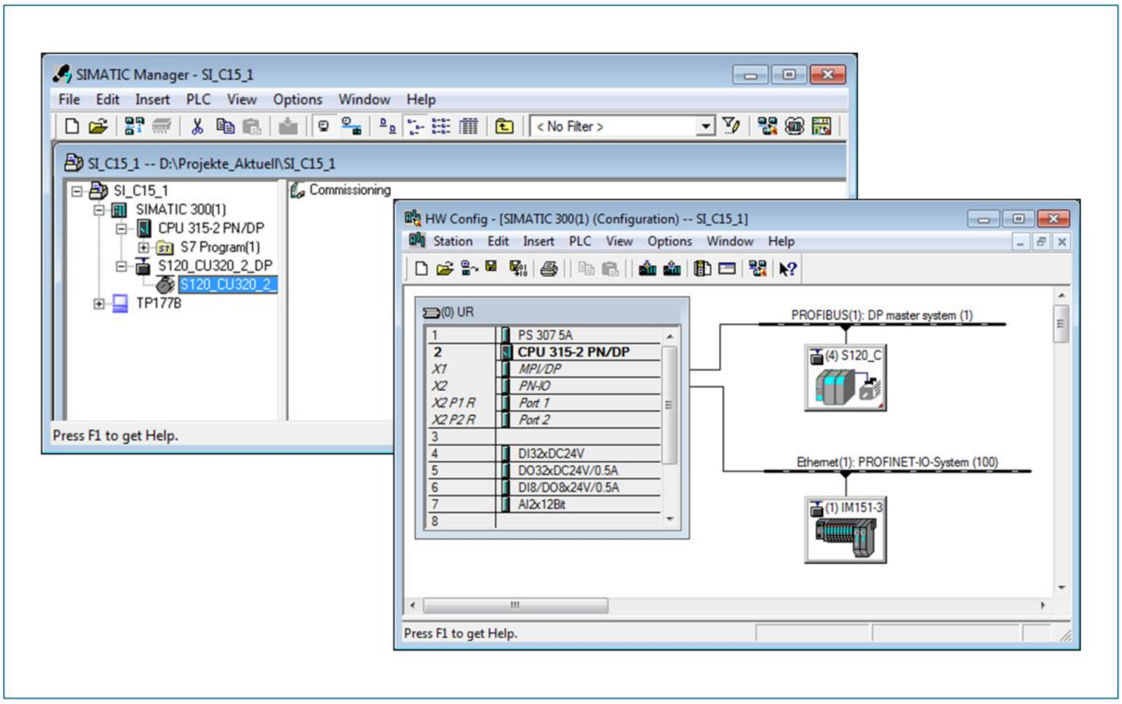
S7ONLINE

The selection S7ONLINE is the key to TIA integration. It enables communication to be established via the system network specified in the project, e.g. via PROFINET/PROFIBUS/MPI, with all directly connected devices, with connected controllers and, with the use of the S7 routing, even to the subordinate drives connected to these controllers. This assumes that the nodes support routing.

DEVICE

The DEVICE selection provides the option of connecting STARTER (STARTER V4.2 and higher) directly to a device either in parallel or alternatively to S7ONLINE, e.g. via the Ethernet interface. In this way, you can communicate quickly with the device without having to make changes to the project settings, either via the system network or via a separate connection in order, for example, to adapt the parameterization or read out the diagnostics information.

S7ONLINE access point
Integration of the drive in the HW Config



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SIMATIC Manager

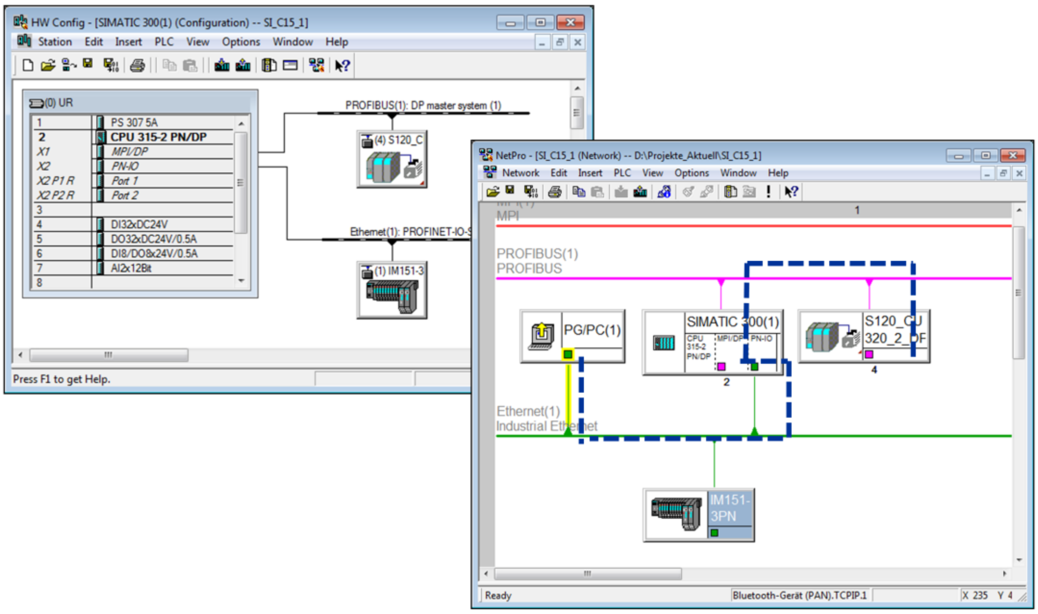
If the drive is operated within an automation system using a SIMATIC, the SIMATIC Manger is used as the central starting point for engineering and service.

If the drive is integrated into the network via the HW Config, this drive is visible as an object in the SIMATIC Manager.

STARTER

Double-click on the drive to open the STARTER. Alternatively, the "Commissioning" button of the STARTER can be used to open it.

Access point S7ONLINE
Integration in NETPRO



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NetPro

The networks and network components of an automation system are shown in NetPro.

Graphic connections are used to define which networks and which connections are to communicate with each other.

In addition to the components like the CPU and the drives, the PCs/PGs are also integrated.

This integration permits, in particular, the access to nodes that are not connected to the same subnet but are only accessible using a gateway (router).

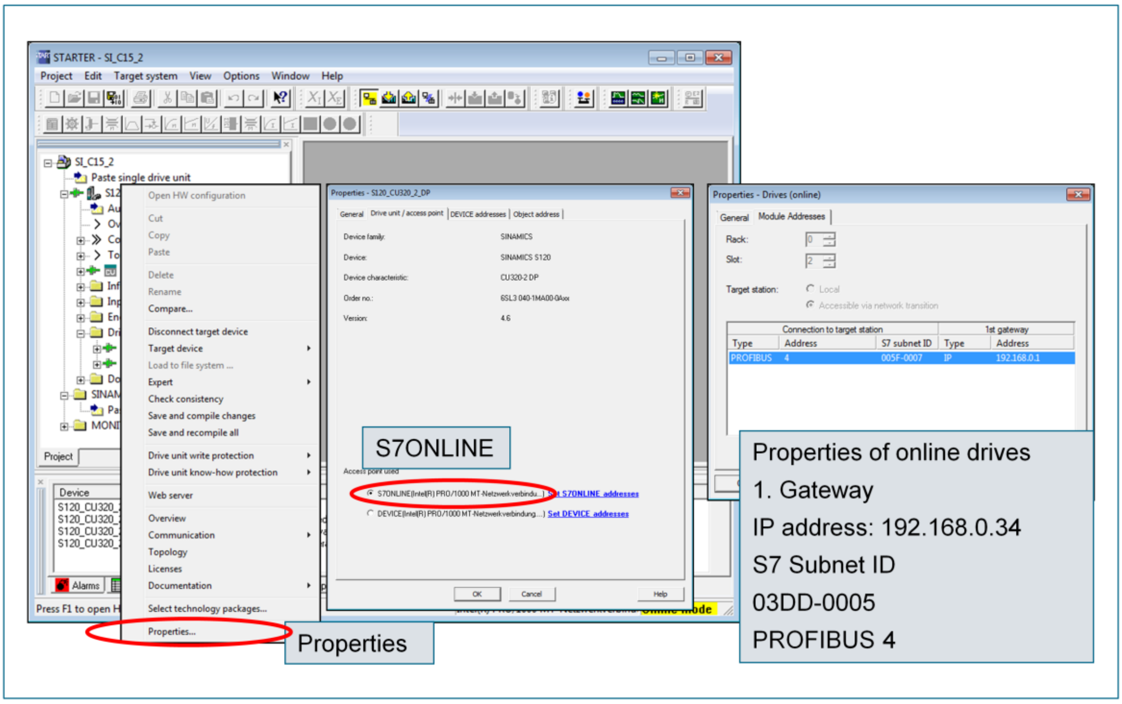
Access point S7ONLINE

The access point of the SIMATIC Manager is S7ONLINE. Configuration can take place via the "Set PG/PC interface" menu if no connection is defined in NetPro.

If a connection is defined as an S7ONLINE connection in NetPro, this connection is highlighted in yellow. Modification via "Set PG/PC Interface…" deletes this yellow connection and the user loses the routing information.

Access point S7ONLINE
S7ONLINE address properties

SIEMENS



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Properties

The context menu of the drive unit can be used to access the "Properties" menu item to hide the properties of the drive unit/access point.

The following information is displayed:

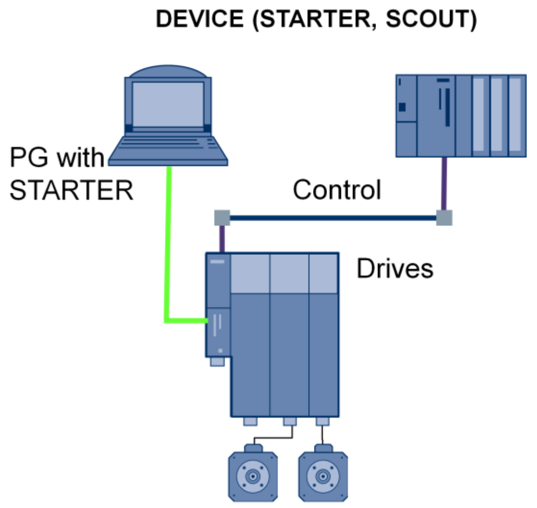
- Device family
- Device
- Device version
- Order number
- Version

and

- Access point in use
  - S7ONLINE
  - DEVICE (STARTER, SCOUT).

"Set S7ONLINE addresses" can be used to show which addresses the target device must have for STARTER to go online.

DEVICE access point



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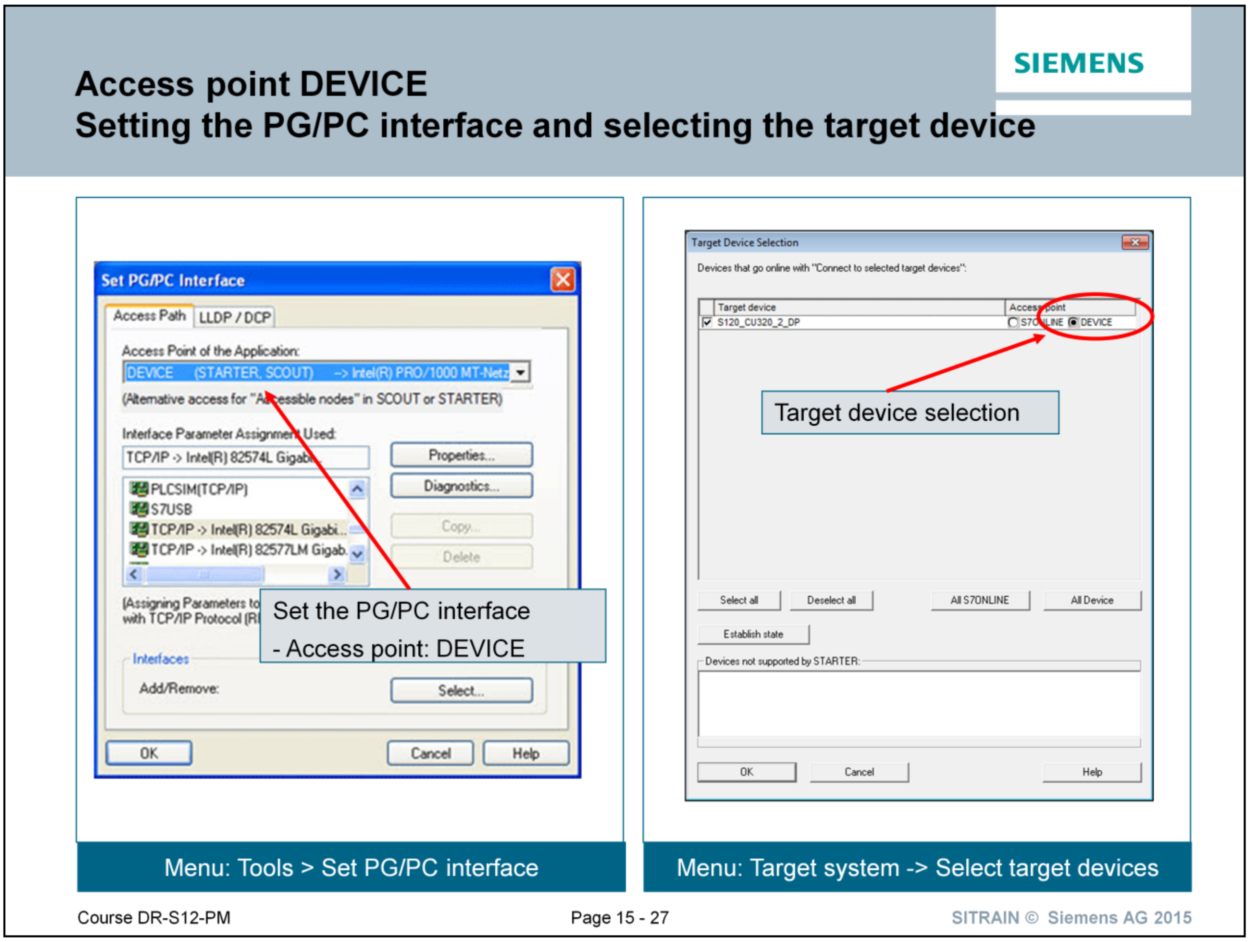


Access point

The access path to the device for the access point DEVICE is configured in the properties dialog of the SINAMICS S120. Here, the interface and addresses to be used to establish the connection are set under the "DEVICE addresses" tab. When starting to establish the connection, the PG/PC attempts to contact the connection partners using these addresses.

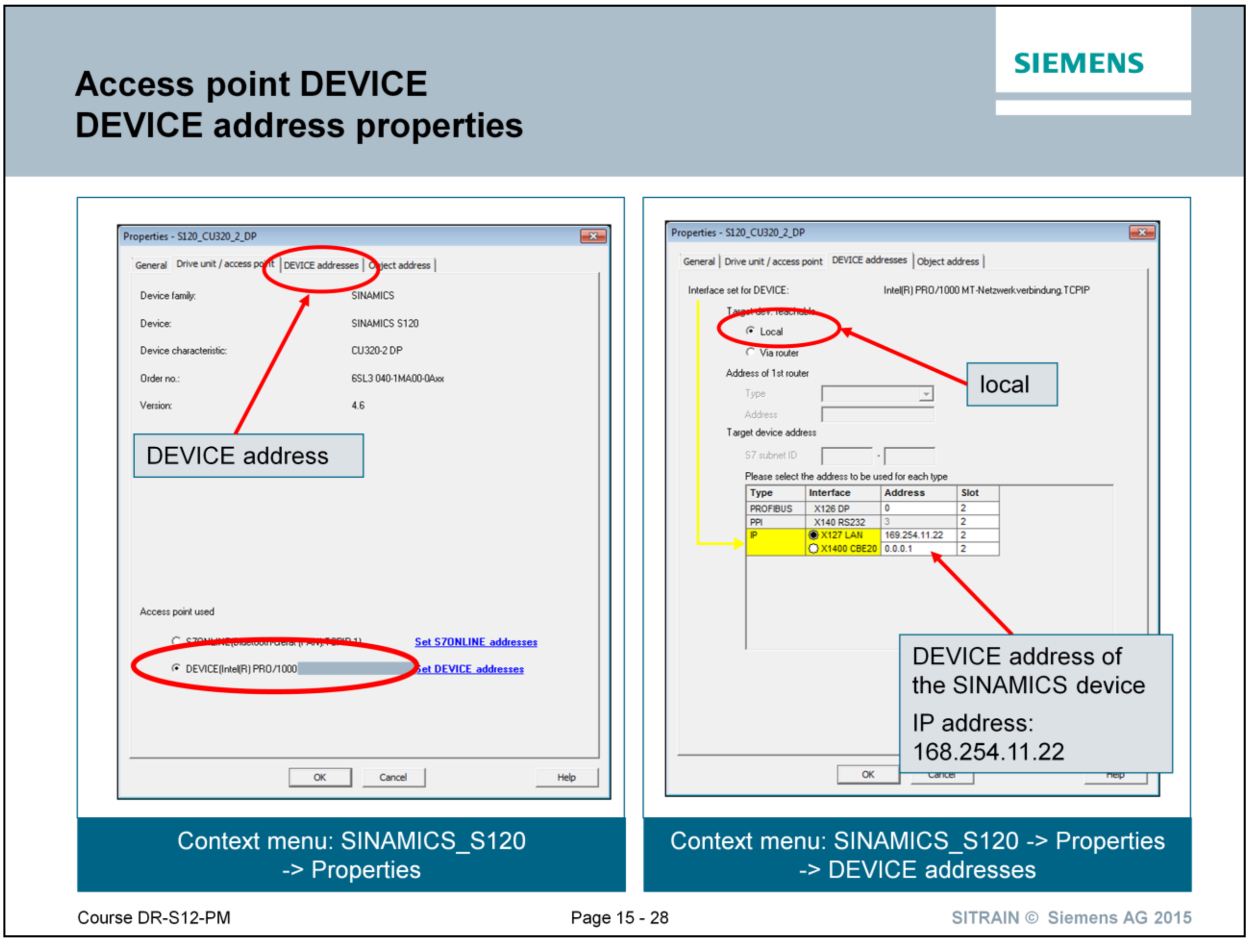
These addresses do not necessarily have to match the addresses configured in HW Config. However, if the PG/PC is locally connected to the SINAMICS then in order to successfully establish a connection, they have to match the actual addresses of the target system.

In the properties dialog, yellow is used to display via which connection (PROFIBUS, Ethernet) the connection should be established. For this display, the settings of the access point DEVICE are evaluated in the dialog "Set PG/PC interface".

PG interface

The PG/PC interface to be used to establish the connection to the target device is specified in the "Set PG/PC Interface" dialog. After selecting the DEVICE access point, in this dialog, in the list box "Access point of the application" the interface drivers to be used must be selected in the list box "Interface parameter assignment used".

When accessing via PROFIBUS, this dialog is also used to set the communication baud rate. When selecting Ethernet communication, i.e. driver: "TCP/IP – Intel® 82…." the IP address of the PG/PC must be set in the properties of the Windows control panel.



DEVICE address

The DEVICE addresses are also displayed in the properties next to the S7ONLINE address.

Use the "Set DEVICE addresses" menu to set which address STARTER uses to set up an ONLINE access to the target device.

If a connection is to be set up to LAN port X127, for example, the matching interface configuration for the DEVICE access point must be set via the "Set PG/PC connection" menu.

Then, the IP address must be entered in the Properties screen.

Finally, "DEVICE" must be selected as the access point in the "Select target device" menu.

It is now possible to establish a connection to the drive via the "Connect target device" button.

Exercises

- Exercise 1: Add to the project
- Exercise 2: Test the project

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Prerequisites

Status of the device:

- First commissioning completed

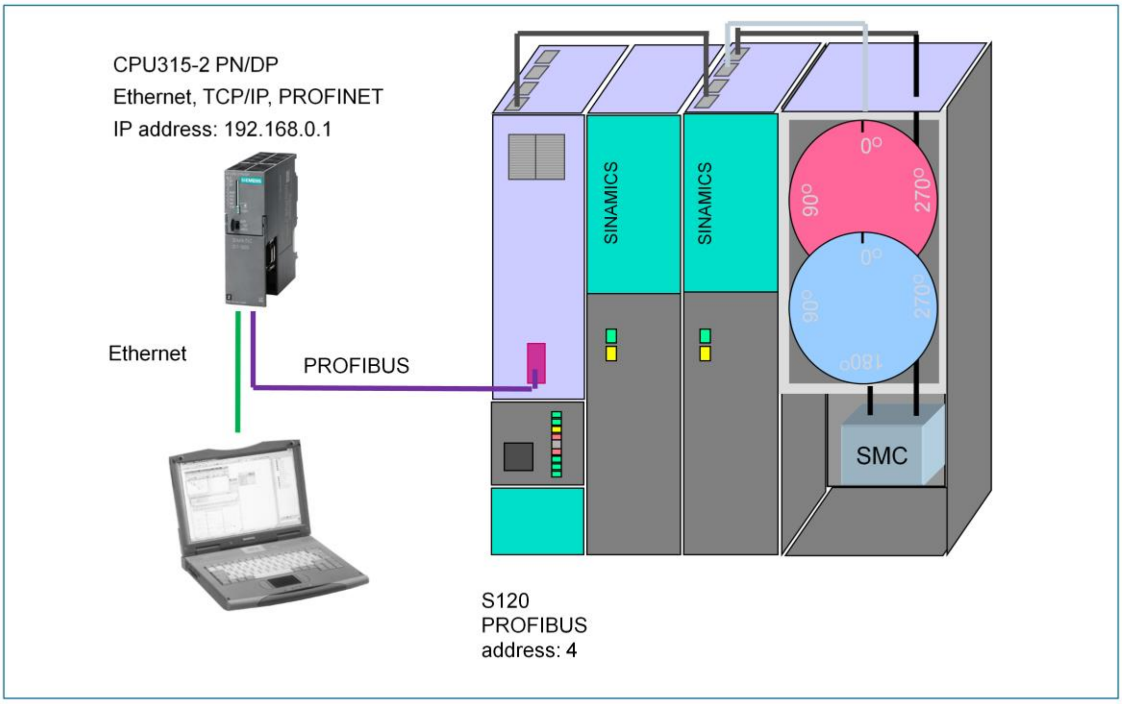
Safety information

Please note that:

- The course instructions have been produced for:
  - A course held by a course leader
  - Activities carried out on special training equipment
- The training equipment is operated under laboratory conditions.
  In case of doubt, always ask your course leader – particularly when handling components that carry electrical current or which can move.
- When carrying out work on equipment, the safety information in the associated product documentation must always be observed!
  The Training Documents alone are not sufficient.

Exercise 1: Add to the project
Training equipment setup

SIEMENS



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Task

This exercise will consolidate your knowledge of the communication between a SINAMICS S120 and an S7-CPU.

Start this exercise with an S7 project to which you add an S120 drive unit. You can then use a variable table to control the drive.

1. In the first step, the drive is to be traversed with a defined configuration. Open the archived project "S120_Servo_1", load the data to the drive unit and test the rotation of the motors.

2. Save the data to the ROM of the Control Unit. These data will be loaded from the drive unit to the drive unit of the S7 project and modified during the course of the exercise.

3. This exercise uses the S7-CPU integrated in the training equipment. This is a CPU315-2 PN/DP that has a PROFIBUS and a PROFINET interface.

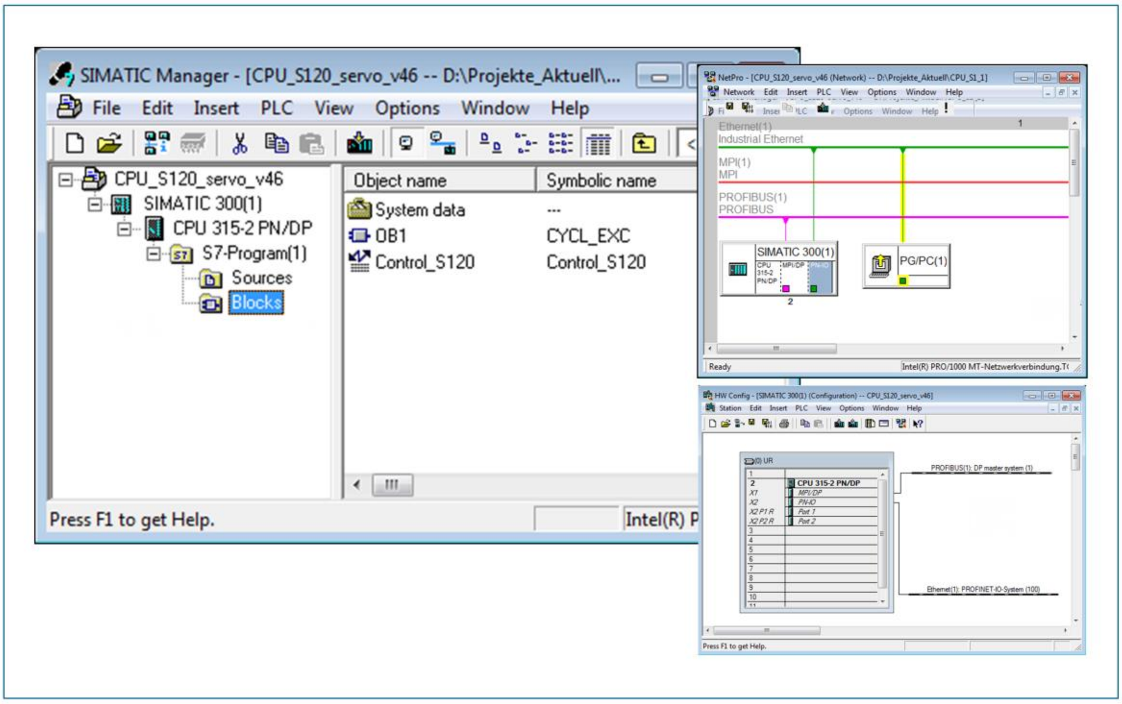
   The PROFIBUS interface integrates the Control Unit of the drive. The CPU communicates with the PG via the PROFINET interface.

   Connect the Control Unit with the PROFIBUS cable.

   Use the Ethernet cable to connect the CPU to the left LAN interface of the PG.

SIEMENS

Exercise 1: Add to the project
Open a project, open the hardware configuration



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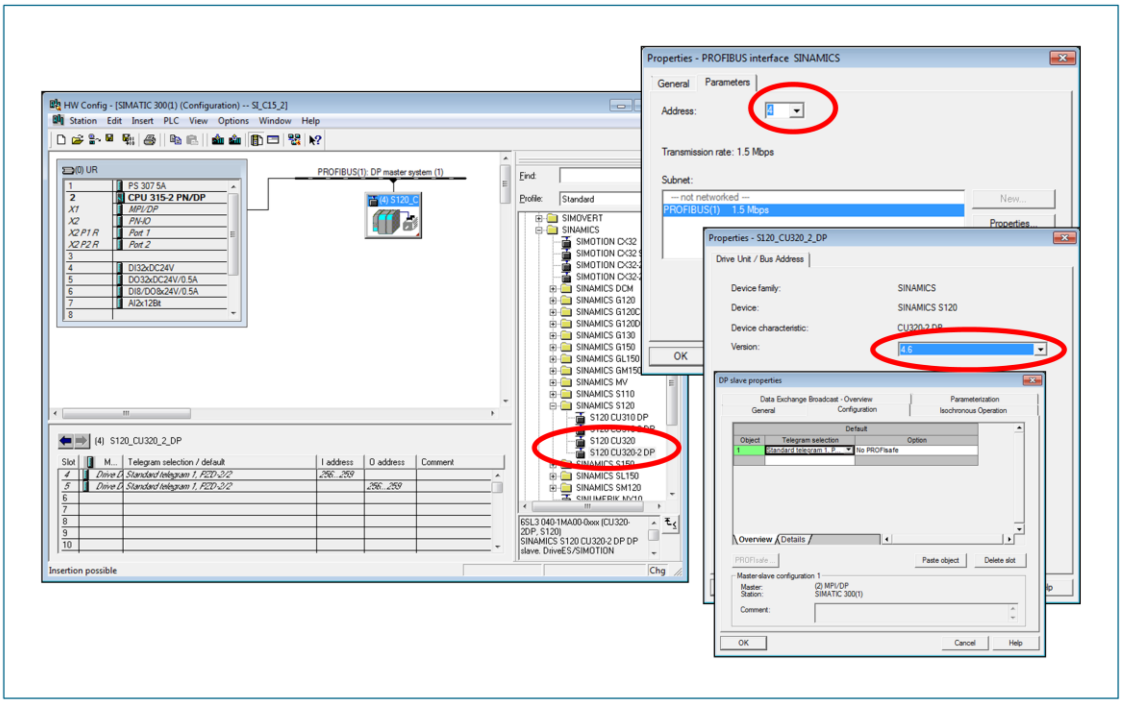
4. Open the SIMATIC Manager.

5. Open the "S120_servo_V46_start" project. This project already has a hardware configuration, the OB1 and a variable table. The PG has been integrated in NetPro.

6. Open the hardware configuration in the project.

Exercise 1: Add to the project
Insert SINAMICS CU320-2

SIEMENS



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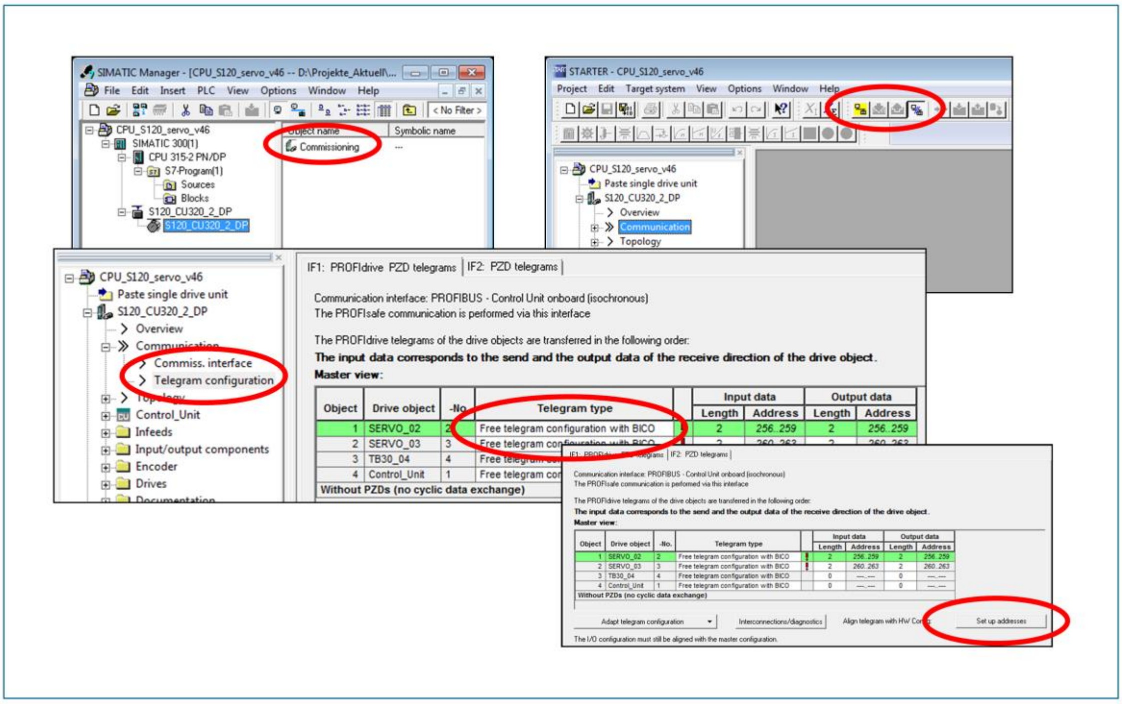
7. The CPU and the central modules are already integrated in the hardware configuration.

8. A PROFIBUS network and an Ethernet network has also been created. Add a CU320-2 DP from the catalog as slave with the following data: PROFIBUS address 4, firmware 4.6. Complete the configuration of the telegrams by clicking "OK".

9. Save and compile the hardware configuration and close the hardware configuration.

10. Open the SIMATIC Manager. After successful compilation of the hardware configuration, a SINAMICS slave has been integrated into the project.

Exercise 1: Add to the project
Go online, upload data, change telegram



11. STARTER must be open in order to commission the drive object:

    >> S120_CU320_2_DP > S120_CU320_2_DP > Commissioning

12. The STARTER project is opened.

13. Go online with STARTER and download the data from the CU 320-2 to the PG, save them and go offline.

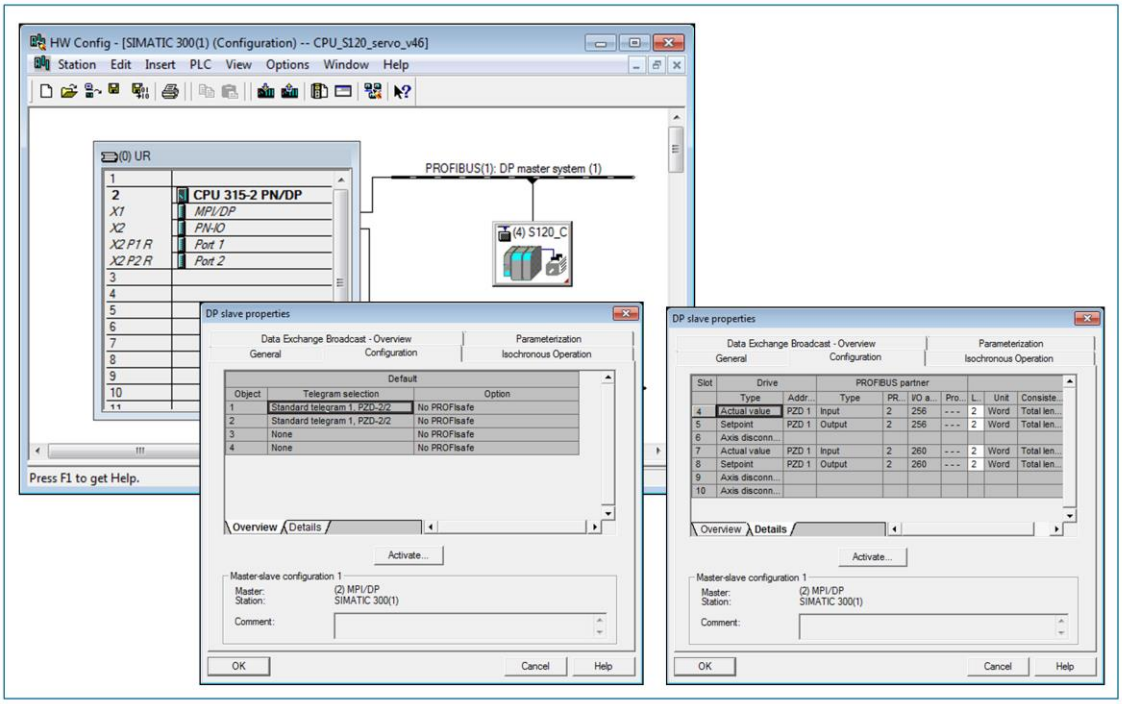
14. The communication between the drive object and the S7-CPU must now be adapted. Open the communication screen.

15. This table shows the objects in the project. You can set which telegram an object uses to communicate with the higher-level controller here. Select the standard telegram 1 for both drive objects. The "Set up addresses" button is used to transfer the telegram settings to the hardware configuration of the S7 project.

16. Save the data in the project, go online and upload the data to the CU. Then save the configuration in ROM.

Exercise 1: Add to the project
Load the hardware configuration

SIEMENS



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17. Open the hardware configuration.

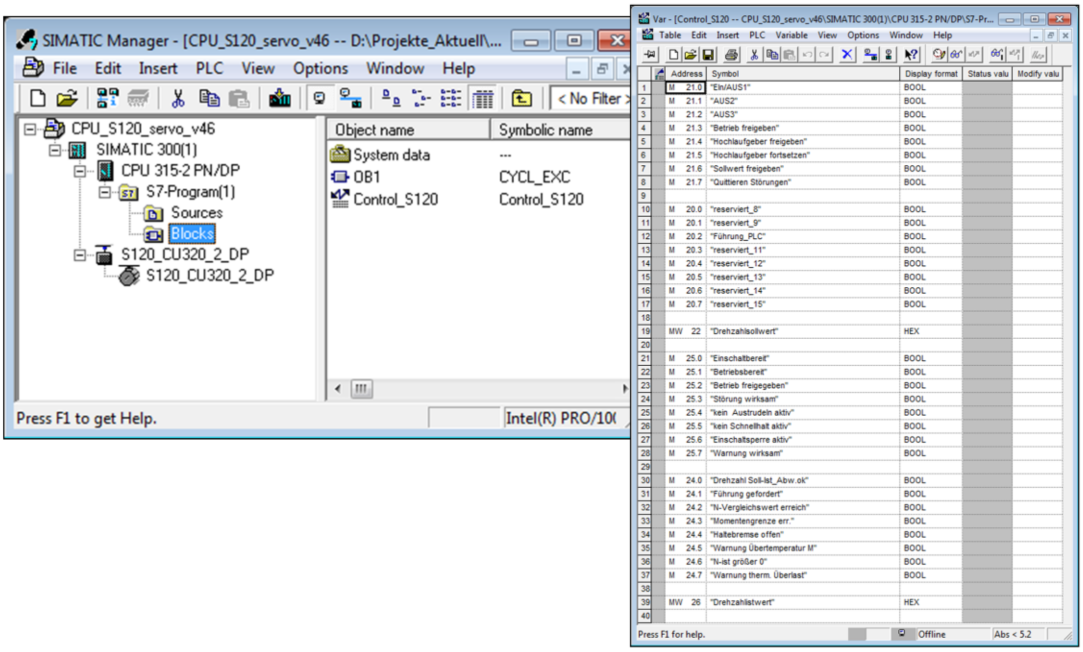
    Double-click on the drive icon to open the window for the DP slave properties. The "Configuration" tab now shows the telegrams entered by the STARTER. Each object has been assigned standard telegram 1. Data exchange takes place via the I/O interface.
    Drive 1: I/O address: P256 – P259
    Drive 2: I/O address: P260 – P263

    The data is grayed out to make clear that these data have been changed by the STARTER. The "Activate" button can be used to change the telegrams; they must then be transferred to the STARTER again.

18. Transfer the hardware configuration to the controller.

Exercise 2: Test the project
Variable table

SIEMENS



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An OB1 object that transfers the data for the first drive from the I/O address to the MW and from the MW to the I/O address is stored in the S7 project.

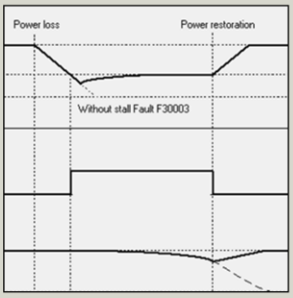
- MW20: PEW 256 MW24: PAW 256
- MW22: PEW 258 MW26: PAW 258

The memory words are listed as symbolic names in the variable table.

Task Now test the communication.

- Open the "Control_S120" variable table
- Set the flag to move the drive.

SIEMENS



Chapter 16

Further drive functions

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Line contactor control	3
Brake control	4
Flying restart	5
Vdc controller	6
Parallel connection of power units	9
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Synchronization and bypass	13
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Parking axis / parking encoder	15
Vertical axis / travel to fixed stop /	16
Technology PID controller	17
Drive Control Chart	18

Learning Targets

- You will become familiar with essential converter functions, such as DC link voltage limiting and kinetic buffering
- You will know the DCC programming language

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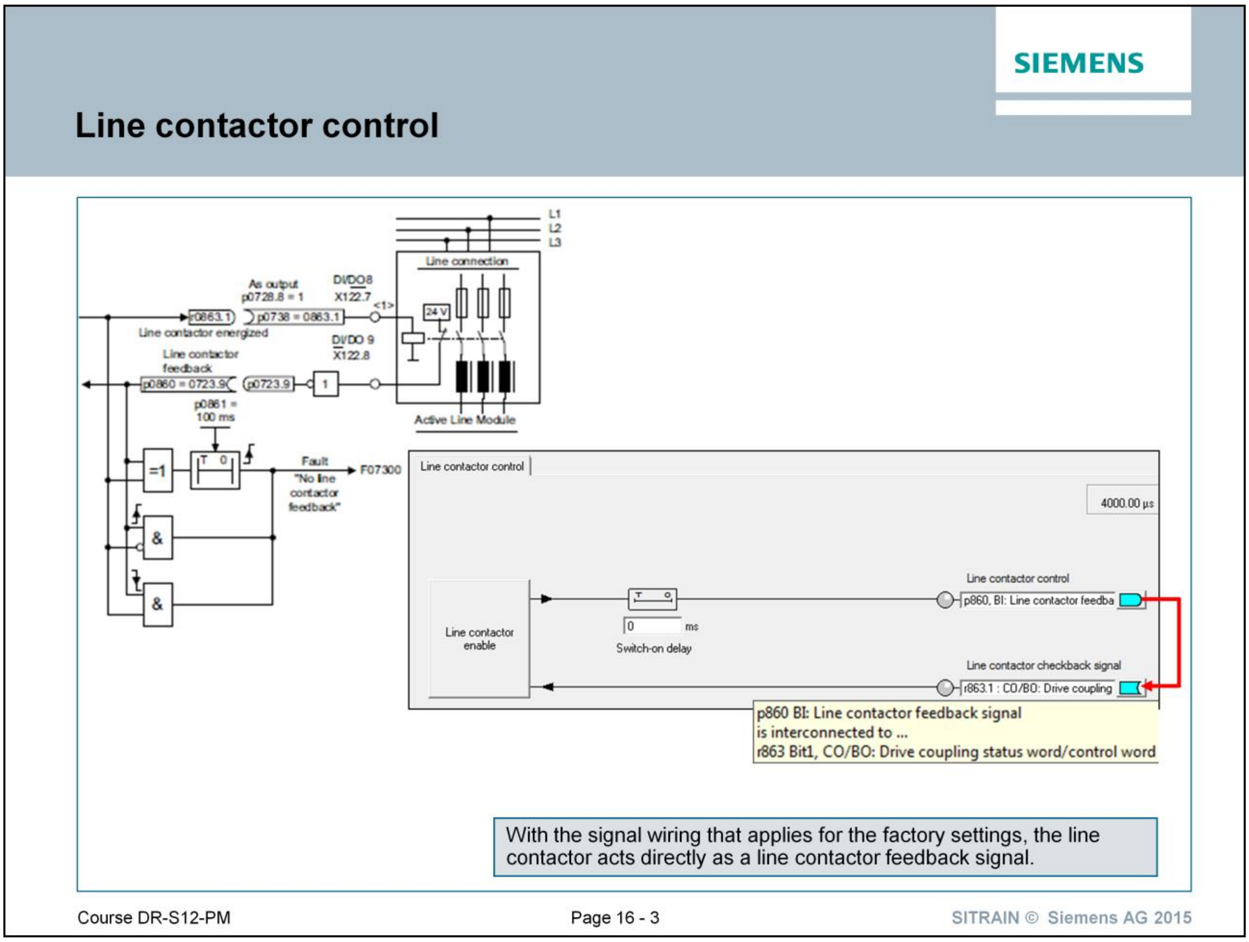


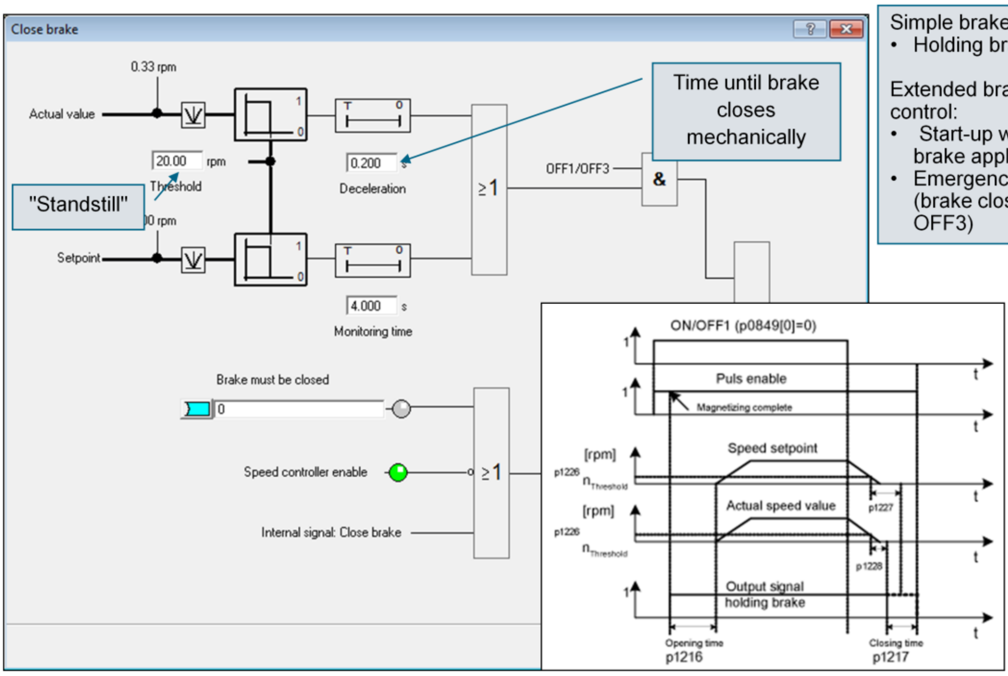
Description

This function can be used to control an external line contactor. Opening and closing the line contactor is monitored by evaluating the feedback contact in the line contactor. The line contactor is used for the electrical isolation of the DC link for the energy supply network.

The line contactor can be controlled using the following drive objects:

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

Brake control



Simple brake control:
- Holding brake

Extended brake control:
- Start-up with brake applied
- Emergency brake (brake closes on OFF3)

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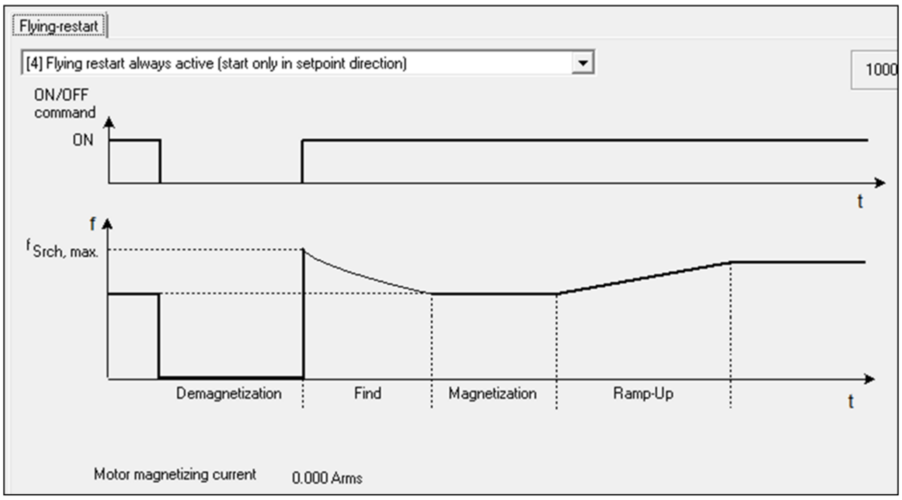
The "extended brake control" function has the following features:

- Forced brake release (p0855, p1215)
- Application of brake for a 1 signal "unconditionally close holding brake" (p0858)
- Binector inputs for releasing/applying the brake (p1218, p1219)
- Connector input for threshold value for releasing/applying the brake (p1220)
- OR/AND block, each with two inputs (p1279, r1229.10, p1229.11)
- Holding and operational brakes can be activated.
- Function for monitoring brake feedback signals (r1229.4, r1229.5)
- Configurable responses (A7931, A7932)
- Application of brake after the "enable speed controller" signal has been canceled (p0856)

Examples

Start-up with brake applied
When the motor is switched on, the setpoint is enabled immediately (providing the required enabling signals have been issued) even if the brake has not yet been released.
Emergency brake
During emergency braking, electrical and mechanical braking should be performed simultaneously. This can be achieved when OFF3 is used as a signal to trigger emergency braking.
Operating brake for crane drives
For hoisting gear with a manual control, it is important that the drive immediately responds when the control lever is moved (master switch). To ensure this, the drive is switched on using the On command (p0840) (pulses are enabled). The speed setpoint (p1142) and speed controller (p0856) are inhibited. The motor is magnetized. The magnetization time required for three-phase motors (1-2 seconds), therefore, no longer applies.

Flying restart



"Flying restart" enables connection to a motor that is already turning
- during coast down
- due to external influences (e.g. fan in air flow).

When connecting, a frequency that matches the actual speed value is set first; after synchronization, the torque is enabled and the drive runs to the speed setpoint.
For operation without encoder (SLVC), the current speed is determined by impressing a search current.

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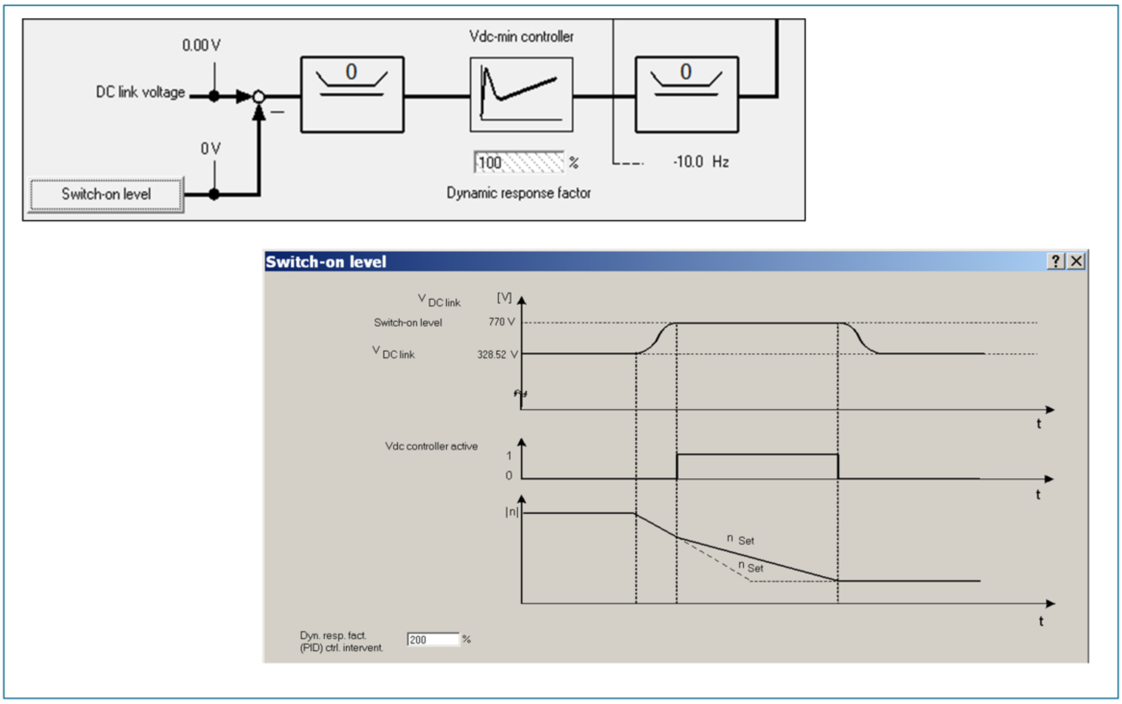
Description

After power on, the "flying restart" function automatically connects a Motor Module to a motor which may already be turning.
The "flying restart" function should be activated via p1200 for any trailing load. This can prevent abrupt loads on the entire mechanical system.
Prior to searching, it is necessary to wait for a demagnetizing time for an asynchronous motor. An internal demagnetization time is calculated. A time can also be entered in p0347. The longer of the two times applies.
In operation without an encoder, a search is carried out for the current speed initially. The search starts at the maximum speed plus 25%. A Voltage Sensing Module (VSM) is required for permanent-magnet synchronous motors.
When operated with encoder (actual speed value is recorded), the search phase is omitted.
For an asynchronous motor, magnetization (p0346) is carried out first immediately after the speed has been determined.
Then the current speed setpoint in the ramp-function generator is set to the current actual speed value.
Ramp-up to the final speed setpoint is carried out from this value.

Example

After a power failure, a fan drive can be quickly reconnected to the running fan motor by means of the "flying restart" function.

Vdc controller
Vdc_max limitation control



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Description

The Vdc_max controller can be used to react to overvoltage of the DC link line-up. In the line-up, one or more drives can be used to relieve the DC link. This can prevent a fault from occurring due to the DC link overvoltage and ensures that the drives are always ready to use.

This function is activated with the configuration parameter (p1240). A reaction can be activated if an overvoltage is present. The torque limits of the motors at which the Vdc controller is active can be affected if discrepancies in the DC link voltage are significant enough. The braking phases are longer for these motors.

Vdc controller
Vdc_min control, Kinetic buffering

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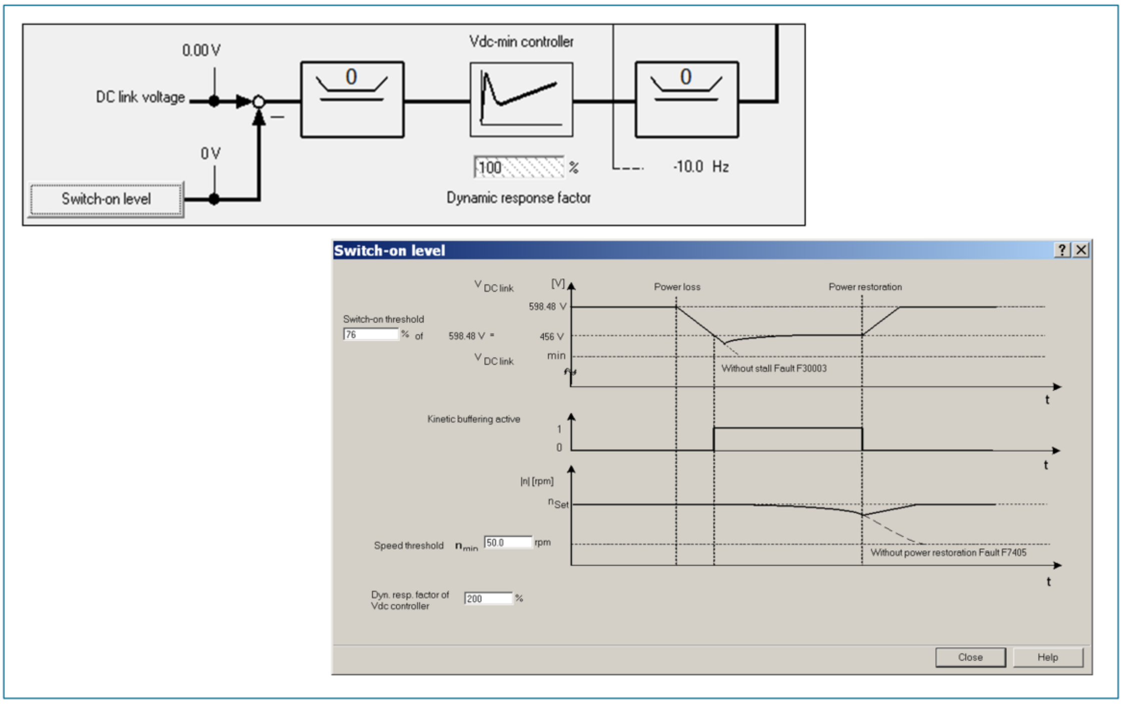

Description

The Vdc_min controller, also referred to as kinetic buffering, can be used to react to undervoltage of the DC link line-up. In the line-up, one or more drives can be used to relieve the DC link. This can prevent a fault from occurring due to the DC link undervoltage and ensures that the drives are still ready to use.

This function is activated with the configuration parameter (p1240). A reaction can be activated if an undervoltage is present. The torque limits of the motors at which the Vdc controller is active can be affected if discrepancies in the DC link voltage are significant enough. These motors can no longer maintain their set speed.

The Vdc_min controller is an automatic P controller that influences the torque limits. It only intervenes when the DC link voltage approaches the "lower threshold" (p1248) and the corresponding controller is activated via the configuration parameter (p1240).

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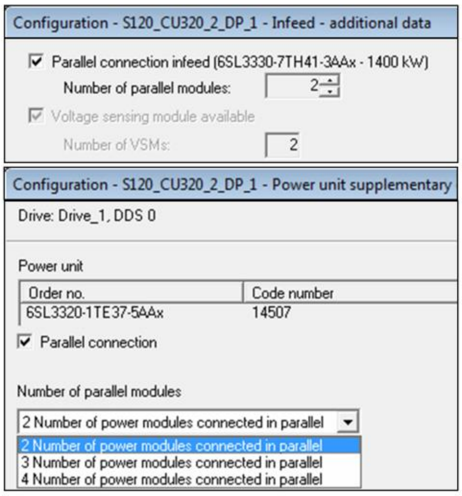
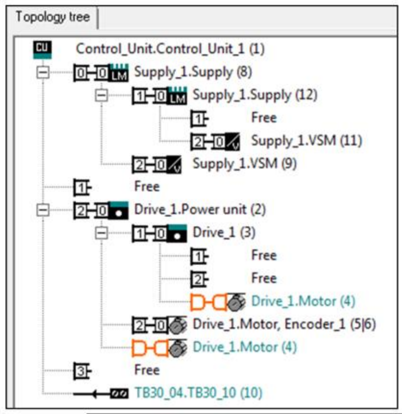
Parallel connection of power units





Component	No.	FW version	Type
Control_Unit.Control_Unit_1	1	4602106	Closed-loop control m
TB30_04.TB30_10	10	--	TB30
SERVO_02.Motor_Module_2	2	4602105	Power_unit
SERVO_02.Motor_SMI_9	9	--	Motor
SERVO_02.Encoder_8	8	--	Encoder
SERVO_02.SMI20_7	7	4602105	SMI20/DQI
SERVO_03.Motor_Module_3	3	4602105	Power_unit
SERVO_03.Motor_6	11	--	Motor
SERVO_03.Encoder_5	12	--	Encoder
SERVO_03.SM_4	4	4602105	SMC20

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Benefits

It can make sense to connect power units (Line Modules and Motor Modules) in parallel for a variety of reasons:

- To boost the converter output if it is not technically or economically feasible to achieve the required output power by any other means.
- To increase availability in cases where it is necessary to maintain emergency operation when a frequency converter develops a fault – and where a reduced power can be tolerated.

Features

The main features of parallel connection are:

- Parallel connection of up to 4 Motor Modules on one motor
- Parallel connection of up to 4 power units on the infeed side (closed/open loop).
- A Control Unit which controls and monitors parallel connections of power units at the infeed and motor ends. In this case, the Control Unit is not capable of controlling any motor or vector axes in addition to the parallel connections.
- Redundant operation:
  Two Control Units which control and monitor parallel connections of power units at the infeed and motor ends. In this case, the Control Units are not capable of controlling any motor or vector axes in addition to the parallel connections.
- The power units connected in parallel must be connected to the same Control Unit.
- With a CU320-2 DP, a maximum of one parallel connection on the line side and one parallel connection on the infeed side can be implemented.
- Components at the line and motor ends for decoupling the parallel-connected power units and for ensuring symmetrical current distribution.
- Simple commissioning, because no special parameterization is necessary. Individual power units can be parameterized and diagnosed (troubleshooting) with p7000 ff.

Redundancy mode for power units

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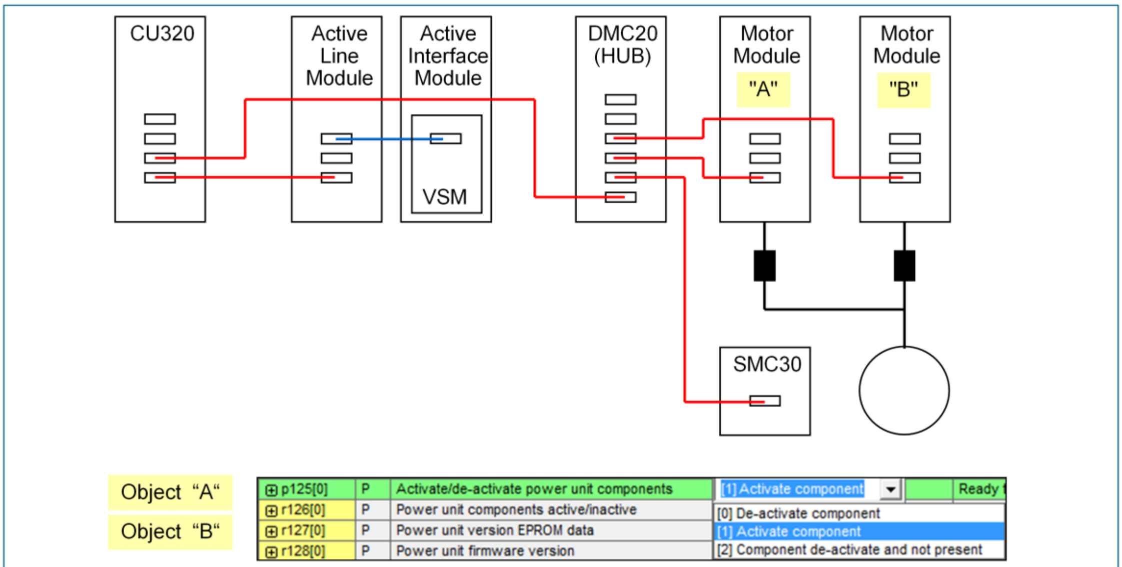

The redundancy mode can be continued despite the failure of a power unit connected in parallel.
Prerequisites: The DRIVE-CLiQ cables of the power units to be replaced are connected in a star-type configuration.

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Description

The redundancy mode can be used to continue operation despite the failure of a power unit connected in parallel.

In order that the failed power unit can be replaced, DRIVE-CLiQ cables must be connected in a star-type configuration – it may be necessary to use a DRIVE-CLiQ HUB Module (DMC20 or DME20). The failed power unit must be deactivated via p0125 or via the binector input p0895, before it is removed. When a replacement power unit has been installed it must be activated accordingly.

Features

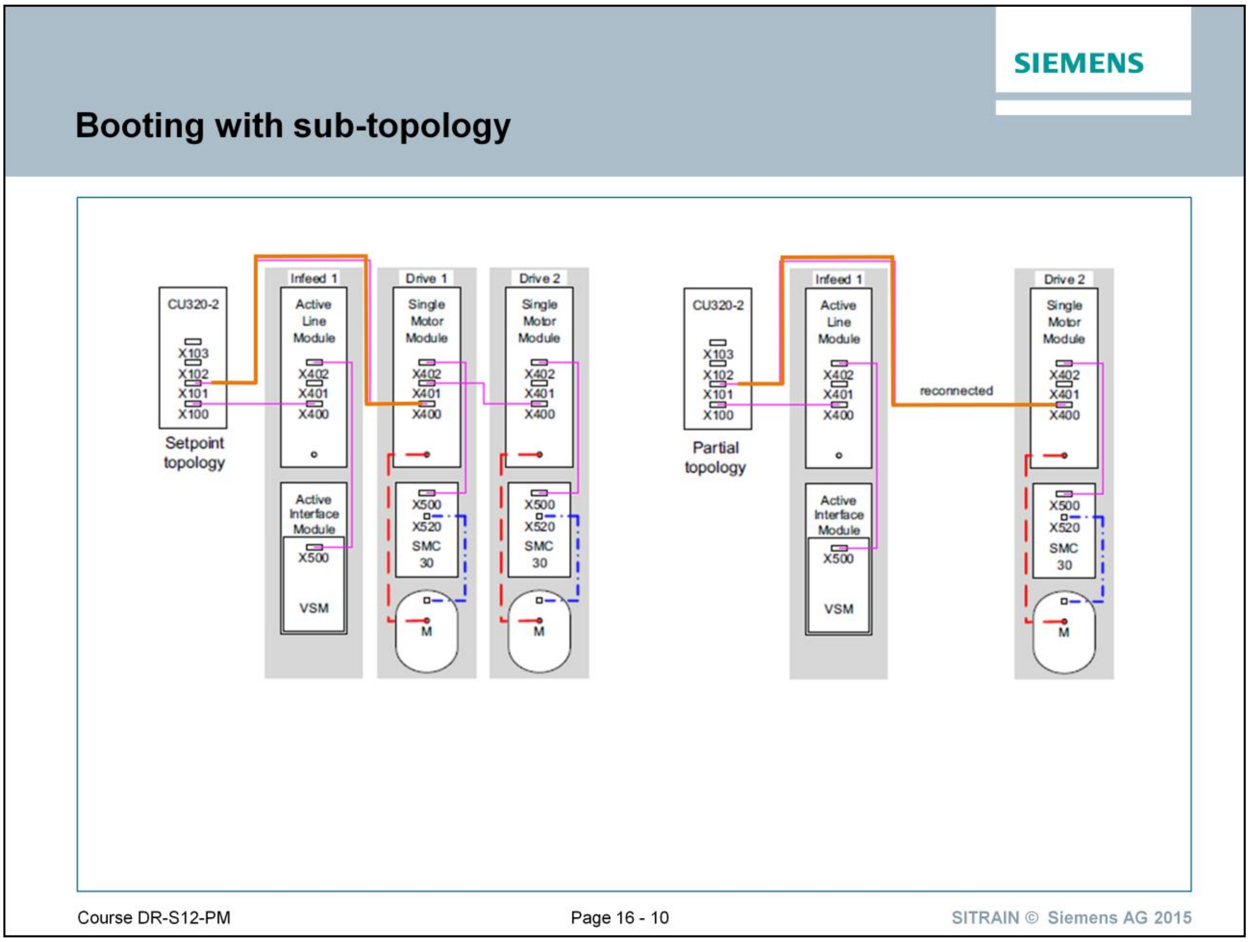
- Redundancy for up to 4 chassis power units
- Power unit can be deactivated via parameter (p0125)
- Power unit can be deactivated via binector input (p0895)

Preconditions

- Parallel connection only works with equivalent (same order number) chassis power units.
- Maximum number of parallel power units is 4
- Parallel connection of power units with suitable power reserves
- DRIVE-CLiQ star topology (possibly a DMC20 or a DME20, refer to the Equipment Manual)
- Motor with one single-winding system (p7003 = 0)
- No STO (Safe Torque off)

Note

Despite this redundancy circuit, the entire plant may shut down when defects develop in a power unit (feedback effects due to absence of electrical isolation).



Removal

With power switched off, remove "Drive 1" and change the DRIVE-CLiQ connection.

After Power ON "Drive 1" is marked as "not operational".

. Messages: "Components missing" and "BiCo connections to inactive objects"

Save specified BiCo connections with p9495=1

Deactivate drive object "Drive 1" with p0105=0/save RAM → ROM

Installation

With power switched off, install "Drive 1" and change the DRIVE-CLiQ connection.

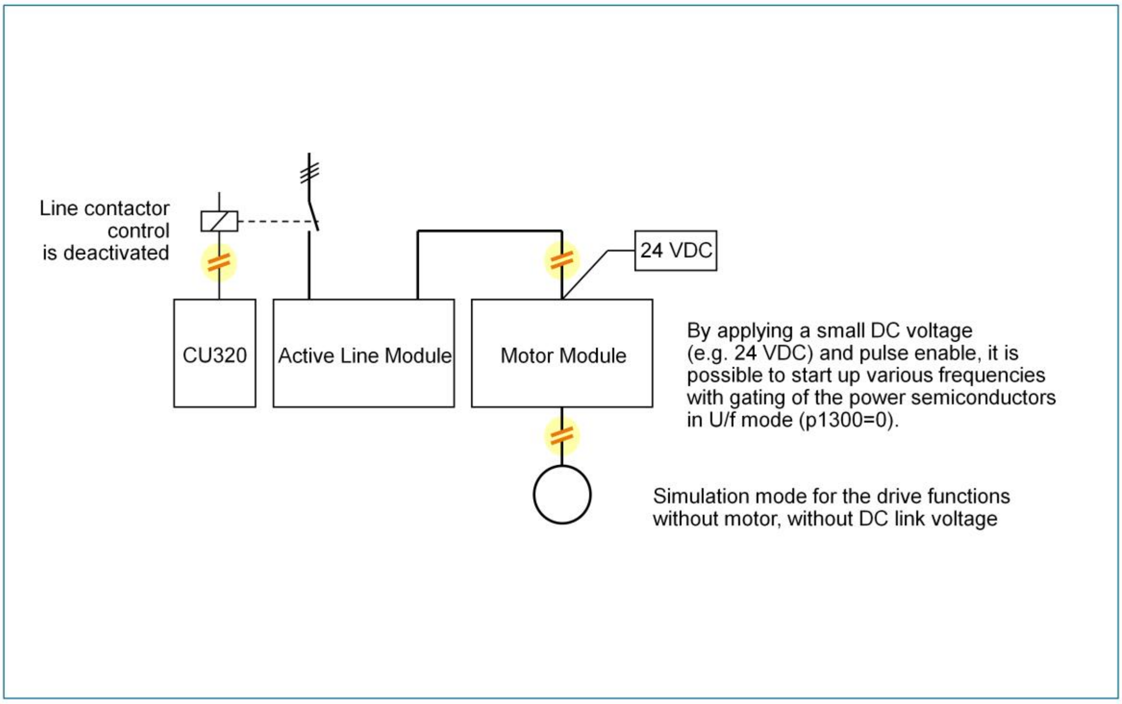
After Power ON the new serial number from "Drive 1" is transferred to the set topology (with p9909=1).

Messages: "Object inactive and operational" and "Disconnected BiCo connections present"

Activate drive object "Drive 1" with p0105=1

Set up BiCo connections again with p9496=1/
save RAM→ROM

Simulation mode



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Description

Simulation mode is predominantly used to simulate the drive without a motor being connected and without a DC link voltage. In this case, it should be noted that the simulation mode can only be activated under an actual DC link voltage of 40 V. If the voltage is higher, simulation mode is reset and fault message F07826 is output.

Simulation mode enables you to test communication with a higher-level automation system. If the drive is also to return actual values, note that it must be switched over to encoderless operation during simulation mode. This means that large parts of the SINAMICS software (e.g. setpoint channel, sequence control, communication, technology function, etc.) can be tested in advance without requiring a motor.

For units with outputs of > 75 W it is recommended to test the activation of the power semiconductors after repairs. To do so, a DC voltage < 40 V is applied to the DC link, and the possible pulse patterns must be tested by the control software.

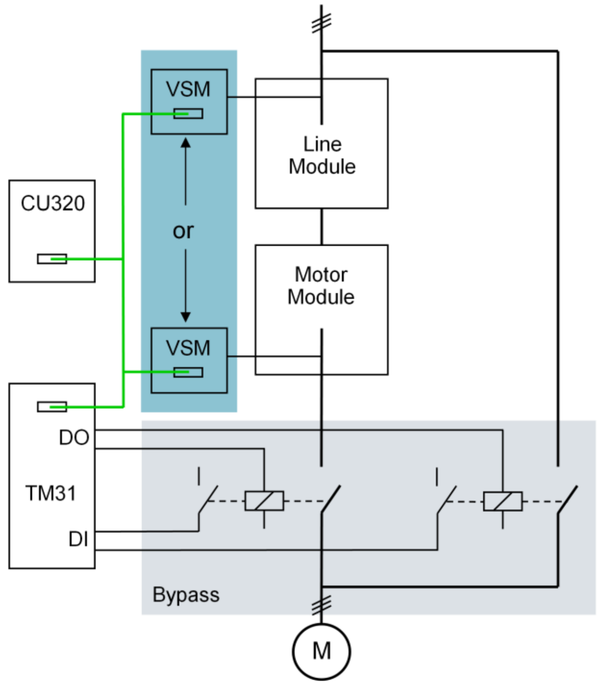
The software must allow enabling of the pulses and the output of various frequencies. This is realized with U/f control or encoderless closed-loop speed control.

The simulation mode is selected with the parameter p1272.

Note

Simulation mode cannot be activated without a power unit. A power unit must be connected via DRIVE-CLiQ.

Synchronization and bypass



P3800[0..n]: Sync-line-drive activation /Sync act
Value 0: sync-line-drive de activated
1: sync-line-drive activated VSM-INT

P1260[0..n]: Bypass-configuration
Value 0: Bypass deactivated
1: Bypass with synchronization and overlap
2: Bypass with synchronization w/o overlap
3: Bypass without synchronization

Select p1260 = 2 or 3 only in connection with flying start function (p1200)

Synchronization and bypass only for SLVC (p1300=20) or U/f (p1300=0...19)

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Description

With the "synchronization" function, the converter phase angle can be synchronized with the line phase angle in order, for example, to switch over (bypass) the motor directly to the mains supply afterwards. A further application is the temporary operation of the motor on the line supply to perform maintenance work at the converter without bringing the system down.
Parameter p3800 activates synchronization and selects actual voltage sensing internally or externally.
In the case of internal actual value sensing (p3800 = 1), the voltage setpoints of the electrical motor model are used for synchronization.
In the case of external actual value sensing (p3800 = 0), voltage sensing is carried out via a VSM that is connected at the line phases.
These voltage values must be transferred to the synchronization via connectors r3661 and r3662.

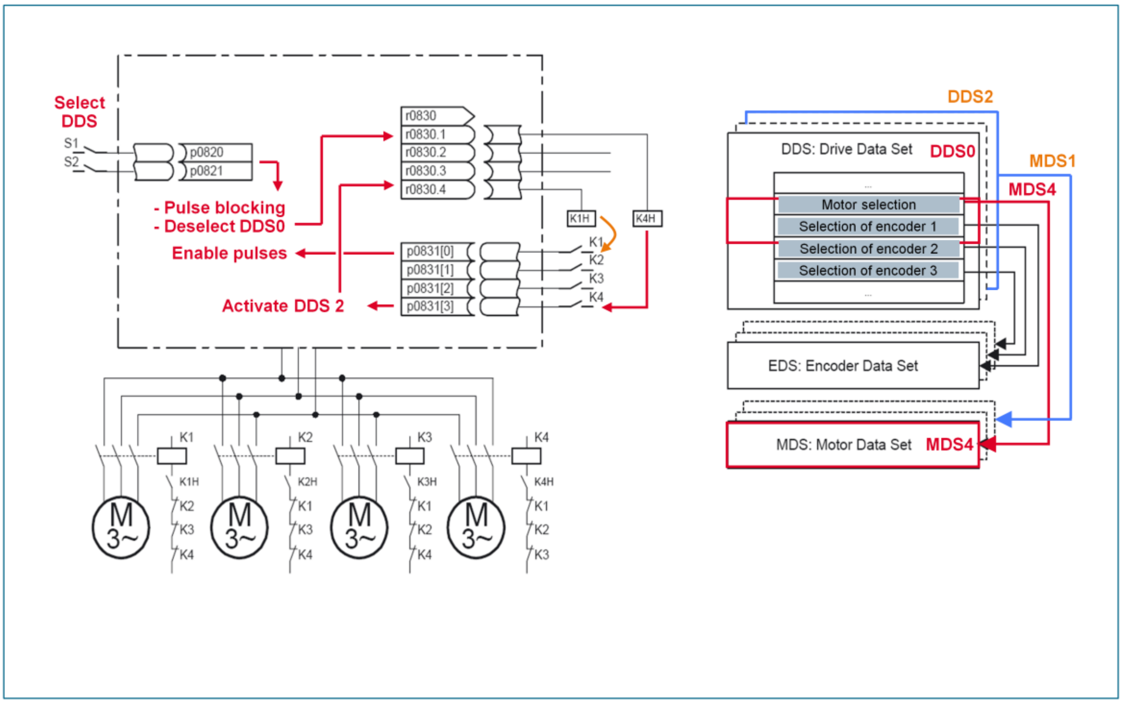
Features

- For asynchronous motors without sensor in “Vector” mode
- Line supply sensing using the Voltage Sensing Module (VSM10) connected to drive object "infeed" or "vector" (p3801)
- Connector inputs for the actual voltage sensing of the motor via VSM10 (p3661, r3662)
- Setting of a phase difference (p3809)
- Can be activated by parameter (p3802)

Preconditions

- Drive object, vector/infeed with connected VSM10
- Asynchronous motor without sensor
- Vector control

Motor change over



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Motor changeover

The motor changeover is used in the following cases, for example:

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

If several motors are operated alternately on one Motor Module, a corresponding number of drive data sets must be created.

Sequence

Trigger pulse blocking by request for a new data set (p0820, 0821).

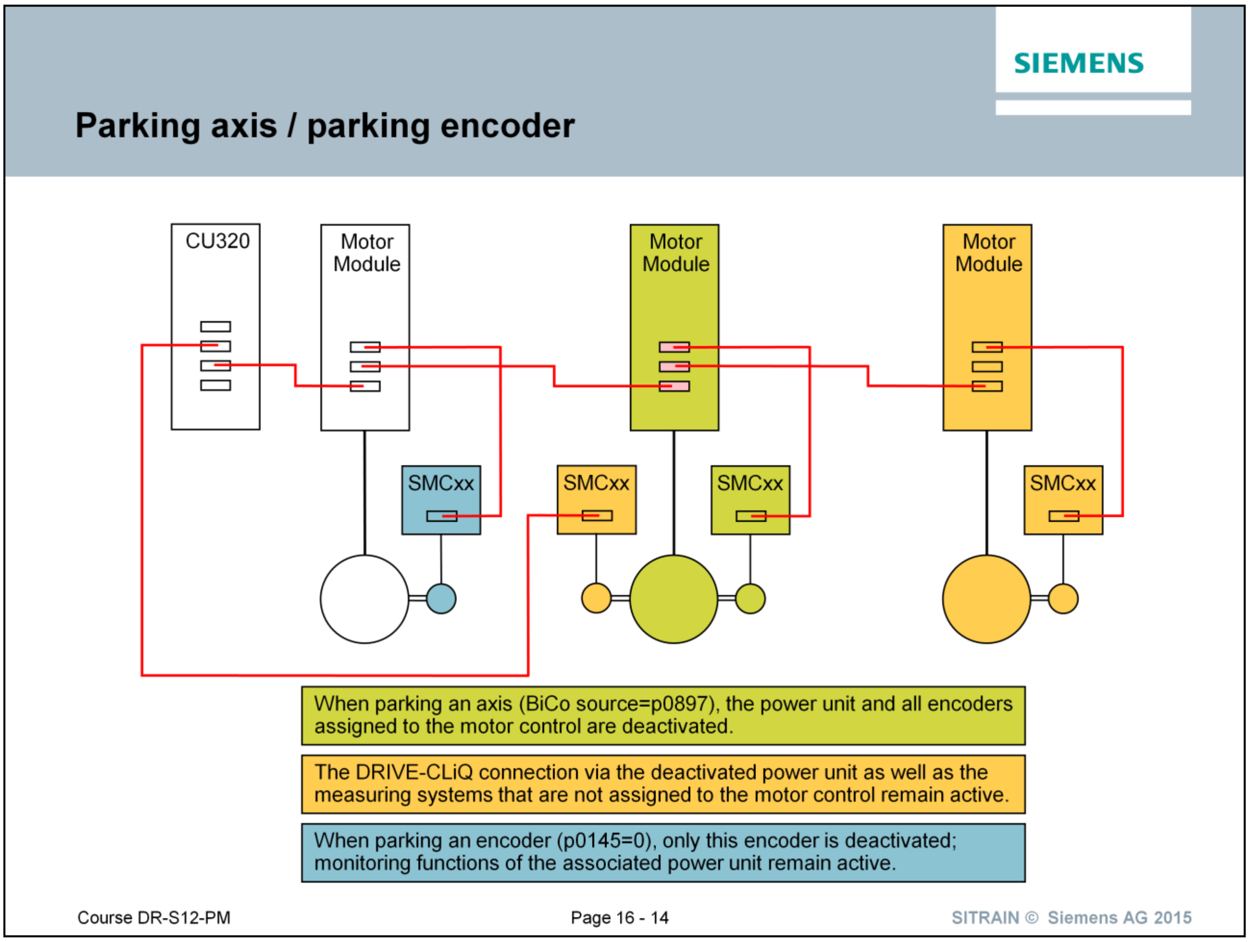
Internal deselection of the current data set deactivates motor contactor K4 (r0830).

On receipt of the feedback information “Contactor open“ and activation of the requested data set, K1 is energized (r0830).

After receipt of feedback information “Contactor K1 closed“, pulse enable is performed.

Note

Using "Vector" mode:
To change to a rotating motor, the "flying restart" function must be activated (p1200).



Parking axis

Monitoring of all encoders and Motor Modules assigned to the "Motor control" application of a drive is suppressed. All encoders that are assigned to the "Motor control" application of a drive are prepared for the "encoder removed" state.

The Motor Module that is assigned to the application "Motor control" of a drive is prepared for the "Motor Module removed" state. When parking an axis, the power unit and all encoders that are assigned to the "motor control" are deactivated.

Parking encoder

Monitoring of a certain encoder is suppressed. The encoder is prepared for the "encoder removed" state.
When parking an encoder, the encoder is deactivated.

Vertical axis / travel to fixed stop / friction characteristic

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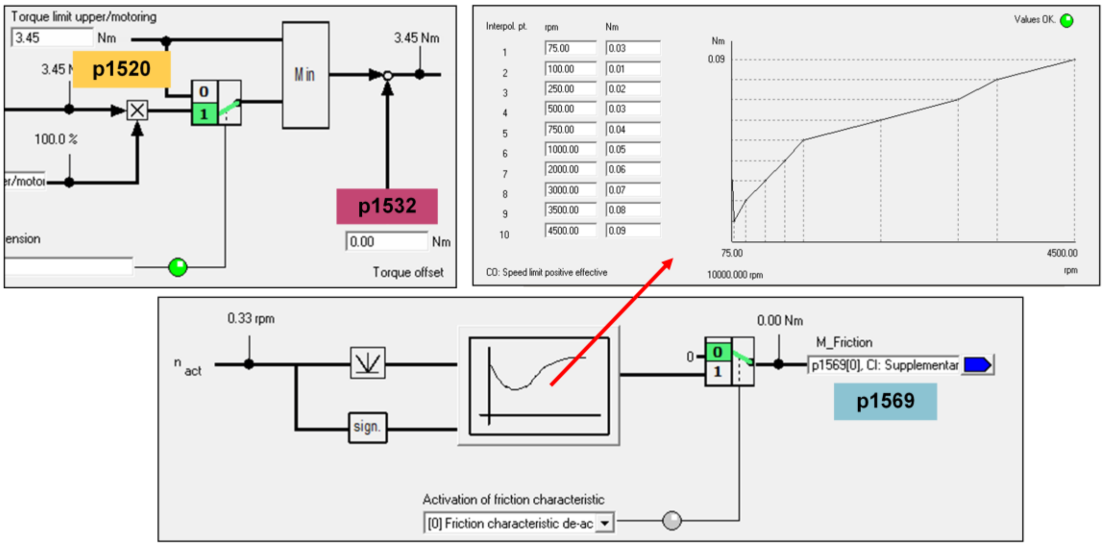

Vertical axis	Electronic weight compensation by offsetting the torque limits (p1532)
Travel to fixed stop	Travel to fixed stop with specified torque (p1520, p1521)
Friction characteristic	Additional torque setpoint coupled as a function of the speed (p1569)

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Vertical axis

With a vertical axis without mechanical weight compensation, electronic weight compensation can be set by offsetting the torque limits (p1532). The torque limits specified in p1520 and p1521 are shifted by this offset value. The offset value can be read in r0031 and transferred in p1532.

To reduce compensation once the brake has been released, the torque offset can be interconnected as a supplementary torque setpoint (p1513). In this way, the holding torque is set as soon as the brake has been released.

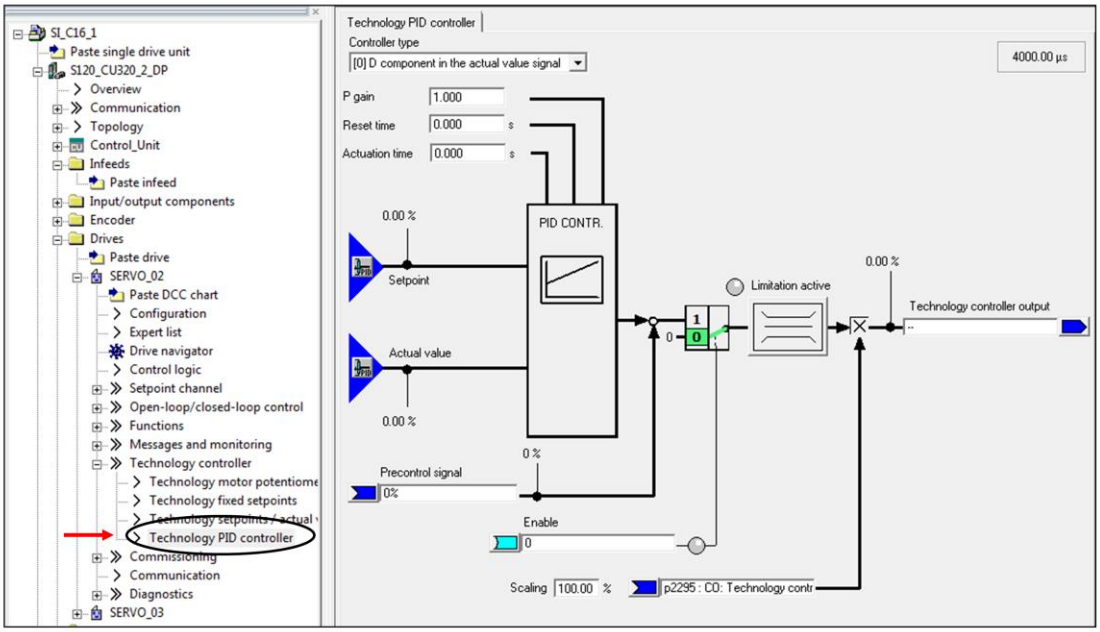
Travel to fixed stop

The "travel to fixed stop" function can be used, for example, to traverse sleeves to a fixed stop against the workpiece with a predefined torque. In this way, the workpiece can be securely clamped. The clamping torque can be parameterized in the traversing task (p2622). A settable monitoring window for fixed stop prevents the drive travelling beyond the window if the fixed stop breaks.
As soon as the axis pushes against the mechanical fixed stop, the control increases the torque in the drive to continue moving the axis. The torque increases up to the value specified in the task and then remains constant.

Friction characteristic

The friction characteristic curve is used to compensate the friction torque for the motor and the driven machine. A friction characteristic allows the speed controller to be precontrolled and improves the control response.
10 interpolation points are used for the friction characteristic. The coordinates of an interpolation point are described by a speed and a torque parameter.
An automatic function supports recording of the friction characteristic (friction characteristic record). A connector output can be interconnected as friction torque. The friction characteristic can be activated and deactivated.

Technology PID controller



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Features

Simple control functions can be implemented with the technology controller, e.g.:

- Liquid level control
- Temperature control
- Dancer position control
- Pressure control
- Flow control
- Simple control without higher-level control
- Tension control

Characteristics

The technology controller features:

- Two scalable setpoints
- Scalable output signal
- Separate fixed values
- Separate motorized potentiometer
- The output limits can be activated and deactivated via the ramp-function generator.
- The D component can be switched to the system deviation or actual value channel.
- The motorized potentiometer of the technology controller is only active when the drive pulses are enabled.

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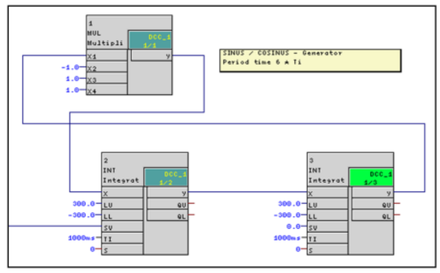
Drive Control Chart
What is SINAMICS DCC?

Graphic configuring tool (DCC editor) also known as CFC editor (SIMATIC / Simadyn / D7-Sys / Masterdrives)

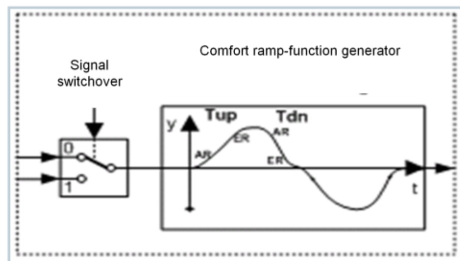
+

Blocks (DCB)
... for closed-loop control, arithmetic operations, logic, ... can be freely used and are graphically interconnectable, as well as multi-instance capable!

DCC (**D**rive **C**ontrol **C**hart)



DCB (**D**rive **C**ontrol **B**locks)



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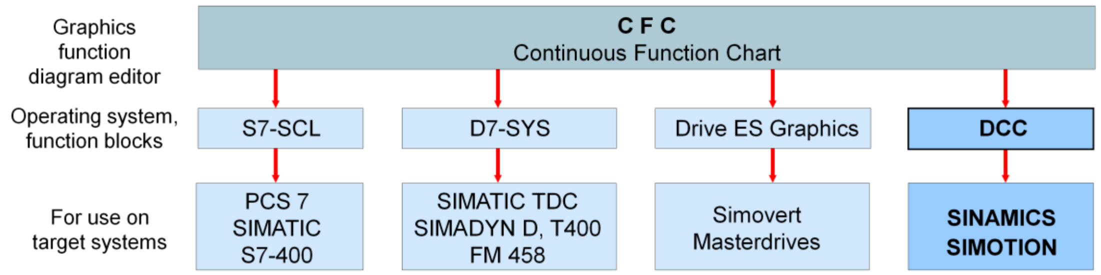
Drive Control Chart
Target systems and software tools

Software products required

- At least STEP7 V5.4 + SP2 and STARTER V4.1 + SP1 or
- At least SIMOTION SCOUT V4.1 + SP1

Software licenses required

- STEP 7 V5.4 and CFC for SINAMICS V7.0 or
- SIMOTION SCOUT V4.1 + SP1 and CFC for SIMOTION V7.0



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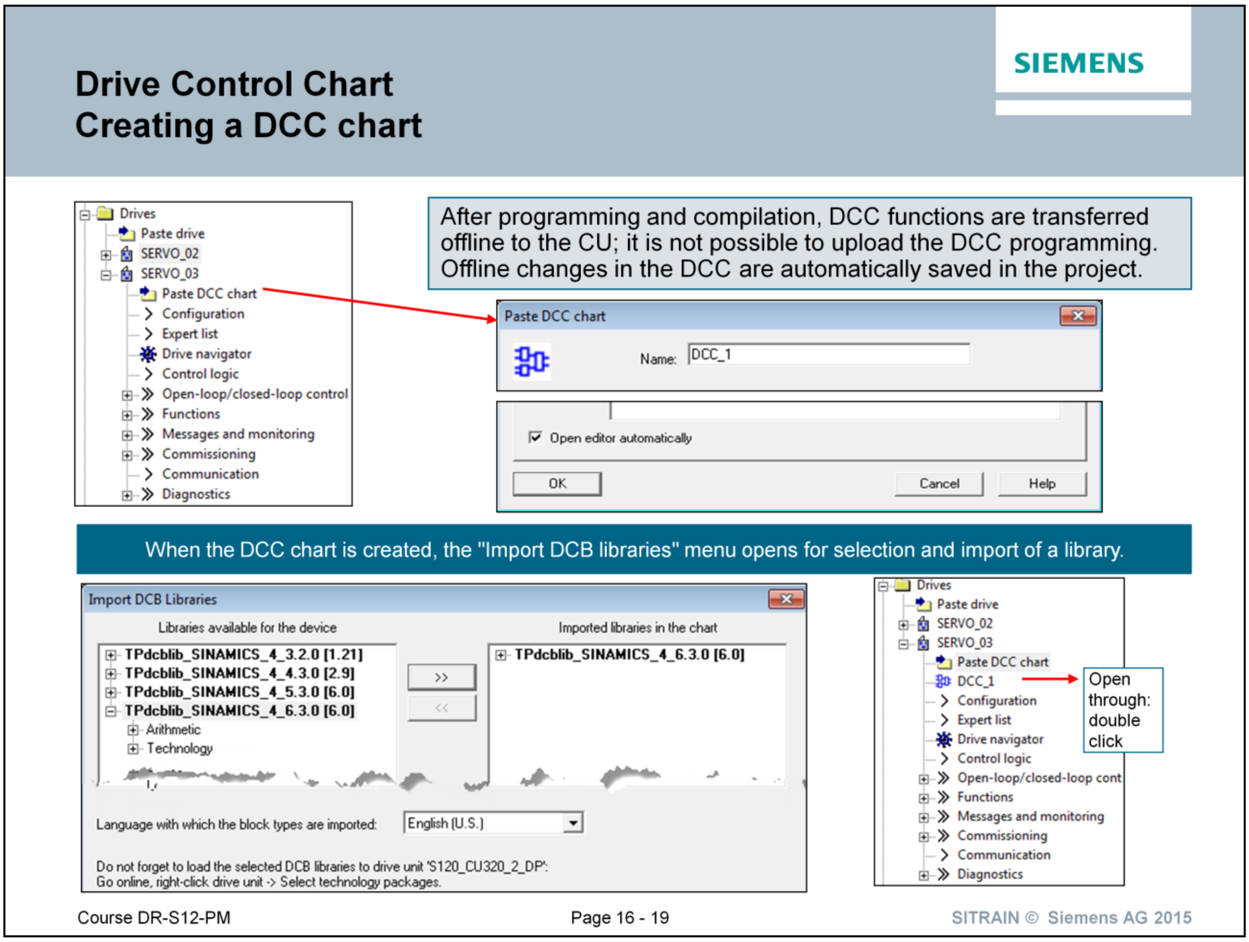
- SINAMICS S120, S150, SM150, G130, G150, GM150 and GL150 from firmware version V2.5 + SP1
- SINAMICS DCM from firmware version 1.1
- SIMOTION P, C, and D, Version 4.1 and higher
- SINAMICS integrated in SIMOTION D firmware version V2.5 + SP1 and higher



DCC chart

DCC charts are assigned to the respective drive object.
DCC charts can be created both directly under the SINAMICS CU320 or under the respective motor object.

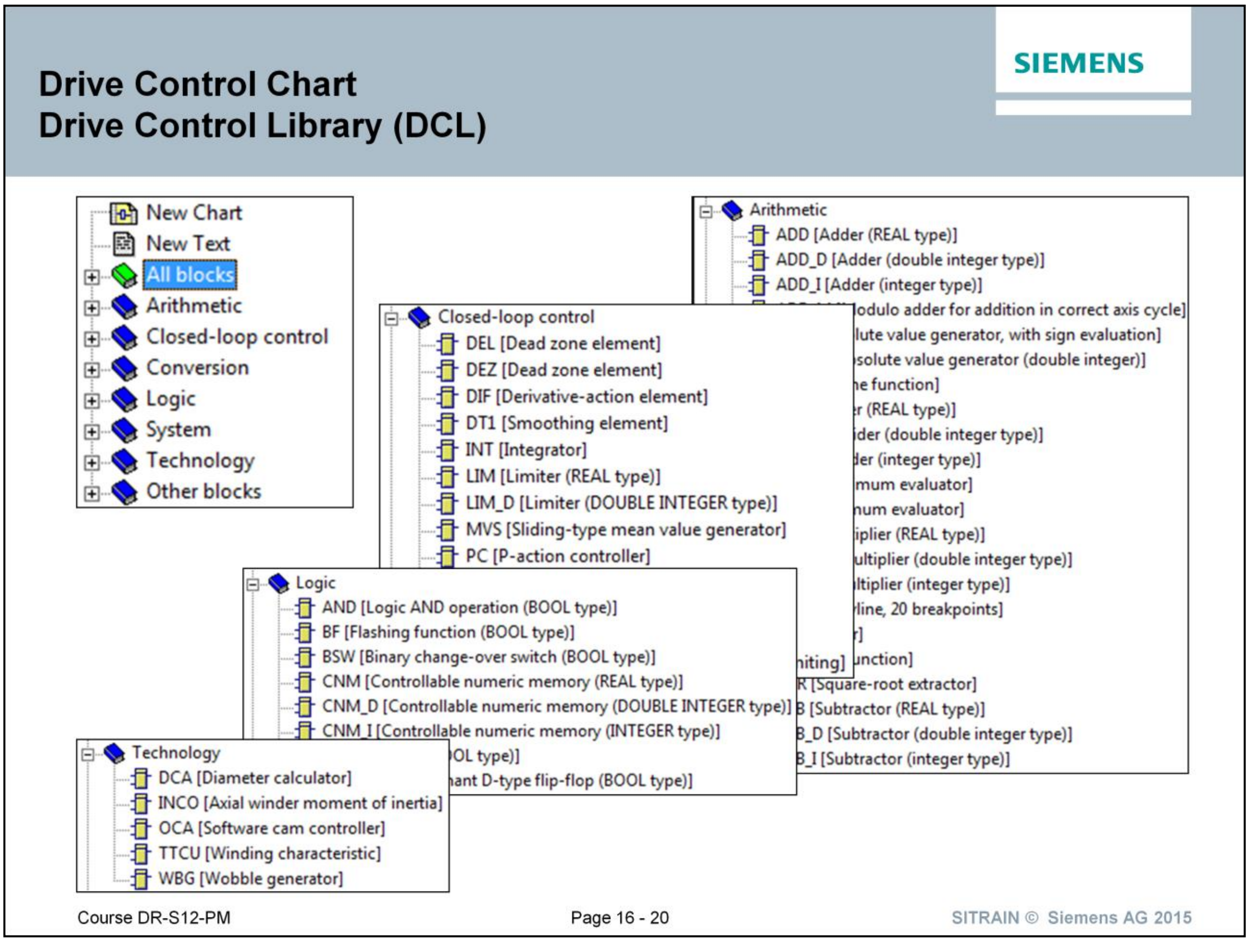
DCB library

Drive **C**ontrol **B**lock library
For working with the pre-prepared blocks, the respective library must be imported. When so doing, select the language for the help texts.

Once this library has been imported for a chart for this drive unit, it is available for all other DCC charts within that drive unit.

User-specific libraries

For Starter V4.2 and DCC/CFC V7.1 and higher, it is possible to create and import user-specific block libraries.



Libraries

After the import, prepared blocks with the following functions are available in the block catalog:

- Arithmetic blocks
- Closed-loop control blocks
- Conversion blocks
- Logic blocks
- System blocks
- Technology blocks

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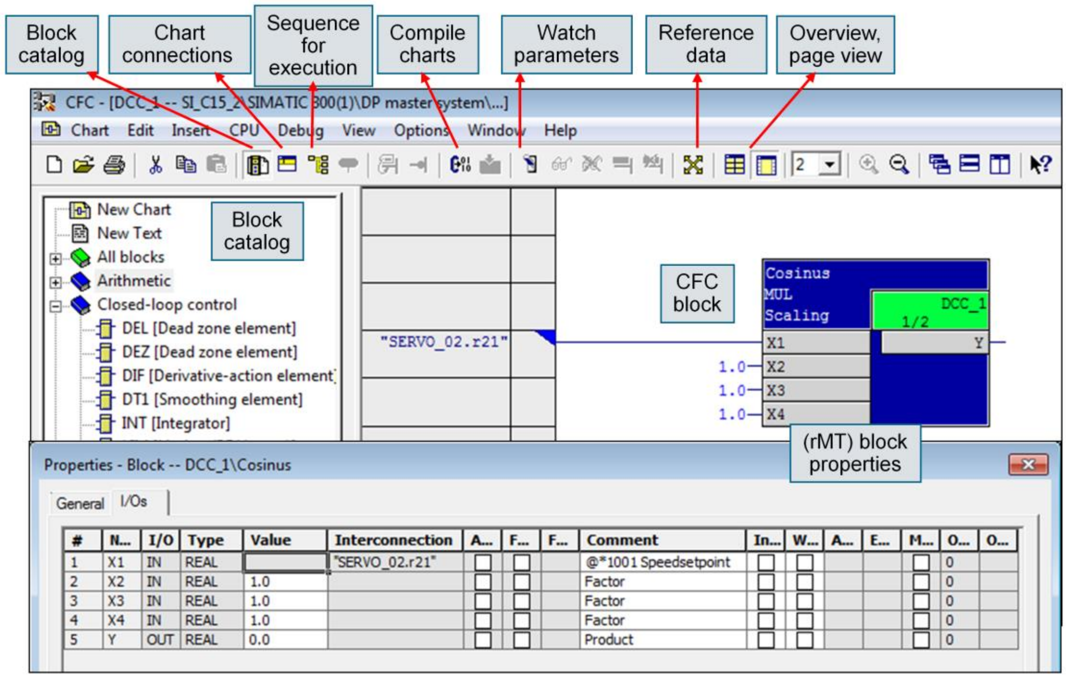
Drive Control Chart
DCC workbench



#	N...	I/O	Type	Value	Interconnection	A...	F...	F...	Comment	In...	W...	A...	E...	M...	O...	O...
1	X1	IN	REAL		"SERVO_02.r21"	☐	☐		@*1001 Speedsetpoint	☐	☐			☐	0	
2	X2	IN	REAL	1.0		☐	☐		Factor	☐	☐			☐	0	
3	X3	IN	REAL	1.0		☐	☐		Factor	☐	☐			☐	0	
4	X4	IN	REAL	1.0		☐	☐		Factor	☐	☐			☐	0	
5	Y	OUT	REAL	0.0		☐	☐		Product	☐	☐			☐	0	

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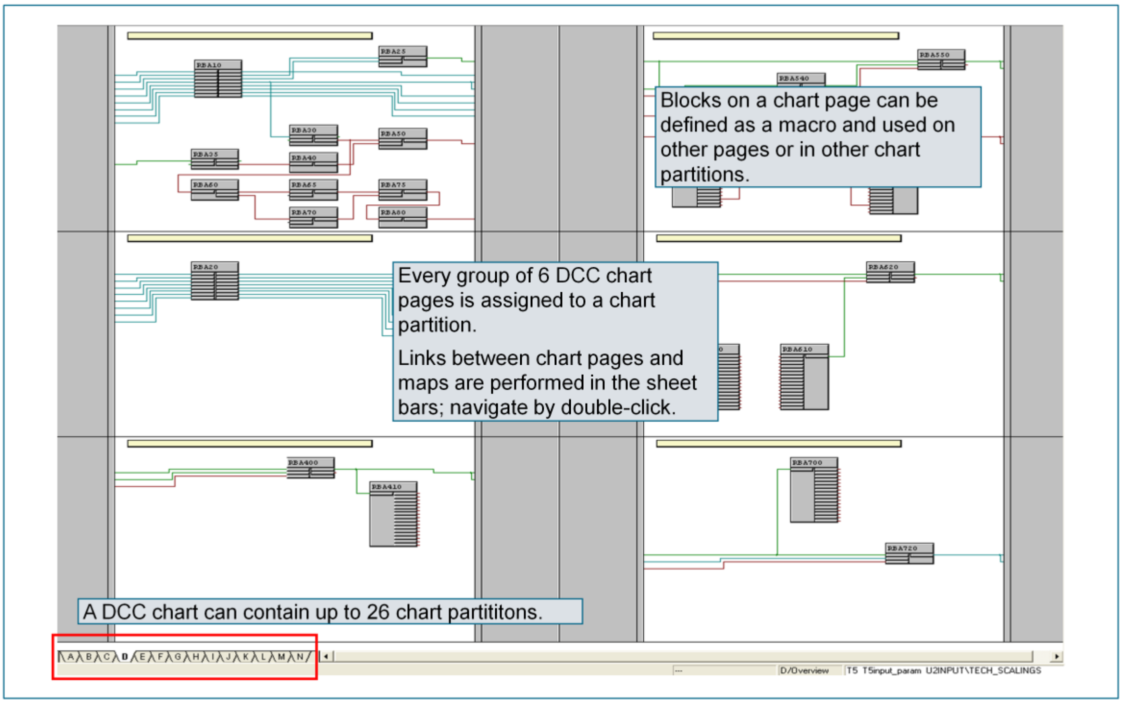
Drive Control Chart
DCC chart organization



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DCC chart

A DCC chart can be created in STARTER for each drive object.
A DCC chart consists of max. 26 chart partitions (A, B, …, Z), which in turn can each contain 6 chart pages (1, 2, …, 6).

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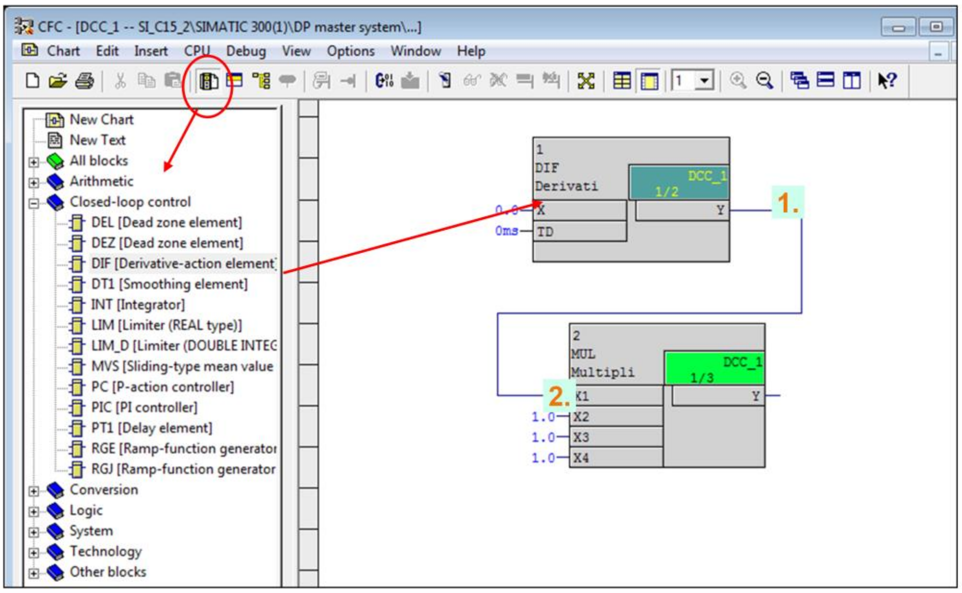
Drive Control Chart
Adding and interconnect function blocks



Open catalog > Select block > Insert using drag-and-drop >
Click on the source of the interconnection > Click on the target

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Interconnections Creating a link between 2 blocks:

1. Select source of the interconnection

2. Select target of the interconnection

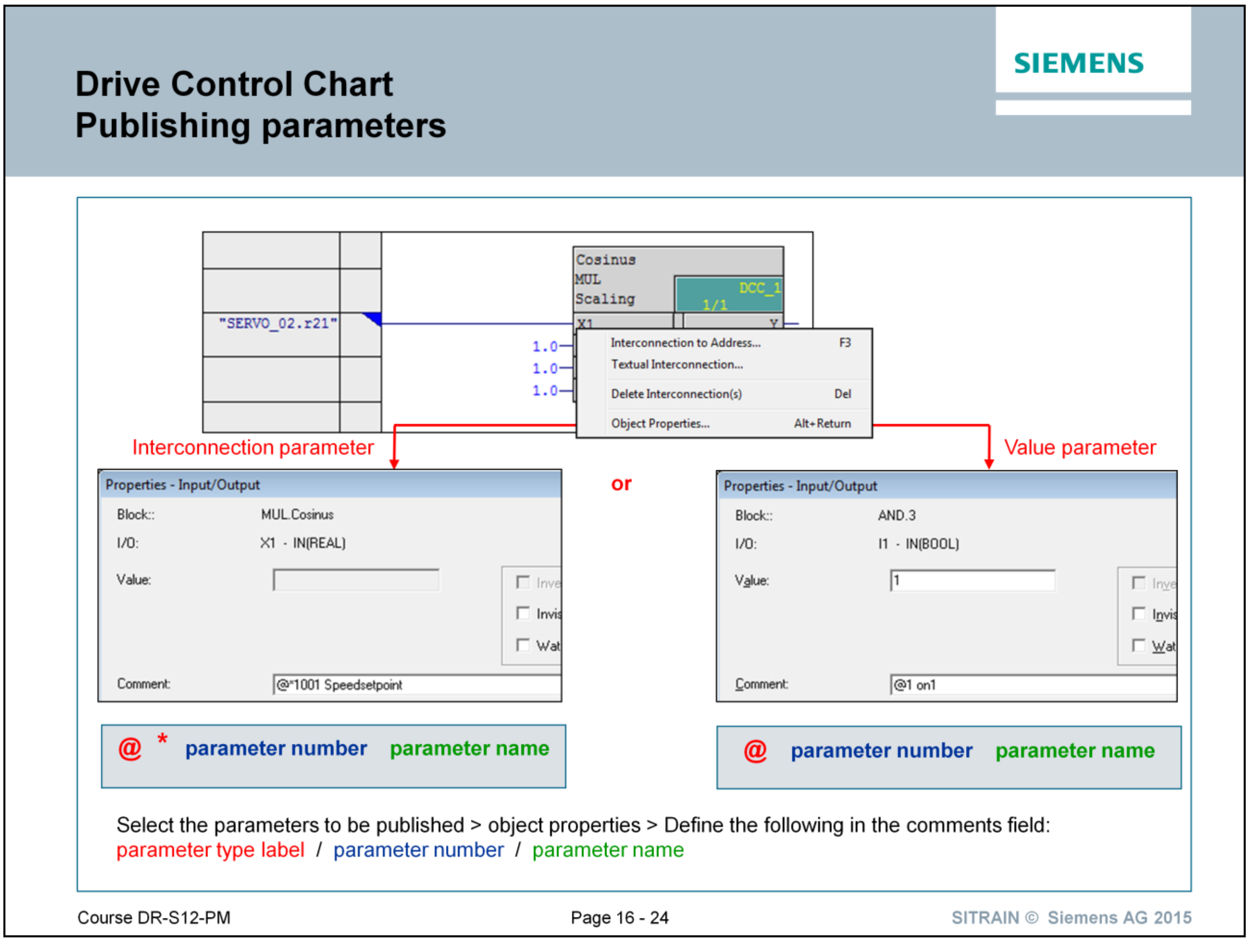
The interconnection is implemented.

Interconnections that span pages are implemented in the same manner.

A corresponding entry is made automatically in the sheet bar.

Double-click this entry to open the flashing interconnection to another sheet. In this way, it is possible to jump quickly from the source to the target of an interconnection as well as from the target to the source.

Note When an interconnection is made, DCC checks to what extent the data types of the source and the target correspond. If they match, the interconnection is created automatically. If the data types differ, no interconnection is created. Instead, the following message is displayed:
Conversion blocks can then be used to match up the data types.



Publishing Each drive parameter interconnected to a block must be published before it is compiled. The following syntax must be adhered to in this context:

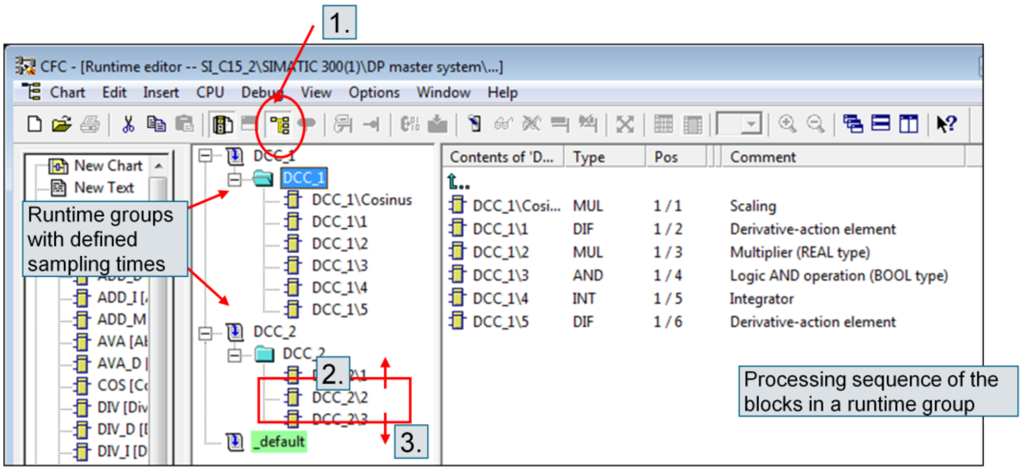
- Connection parameter: @*Parameter no. Parameter name
- Value parameter: @Parameter no. parameter name

Parameter no. Each parameter published must be assigned its own parameter no.

Parameter name Each parameter published should be assigned its own parameter name.

Note After successful compilation, these parameters are incorporated in the expert list of the assigned drive object.

Drive Control Chart
runtime editor and execution sequence



A marked block can be moved between runtime groups per "Drag & Drop". In the same way, it is possible to adapt its position within a runtime group to achieve the desired processing order.

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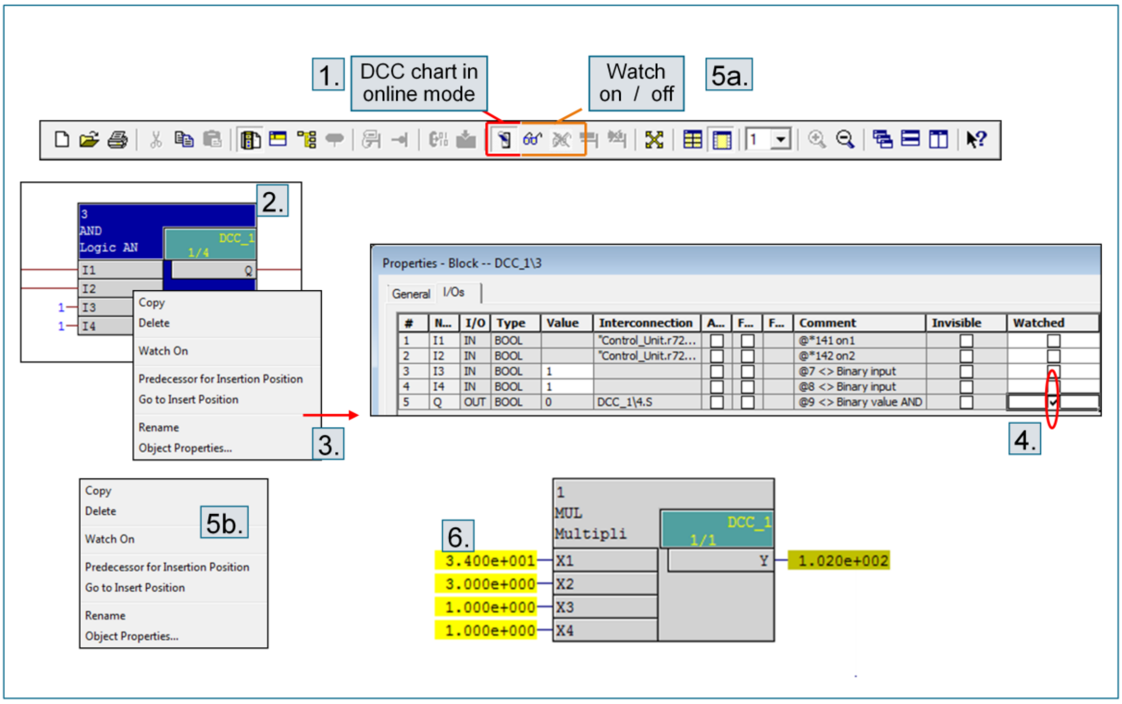
You could change the execution sequence as follow:

1. Open runtime editor
2. Select block
3. Move the block to the desired execution group and position using drag-and-drop

Drive Control Chart
Test mode



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1. Select online mode.

2. Mark the blocks.

3. Select object properties and register I/Os for testing.

4. Register I/O for testing and select „watched“.

5. Set "Watch On" (using either 5a or 5b).

6. The registered block connections are shown with the current online data.

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Chapter 17

Support and training

Course DR-S12-PM

Learning Targets	2
Course DVD	3
SITRAIN	8
Service & Support	13
Technical documentation	18

Learning Targets

- You will be familiar with the course DVD and be able to navigate through it
- You will know SITRAIN courses offered for SINAMICS drives
- You will be familiar with the further Service and Support available

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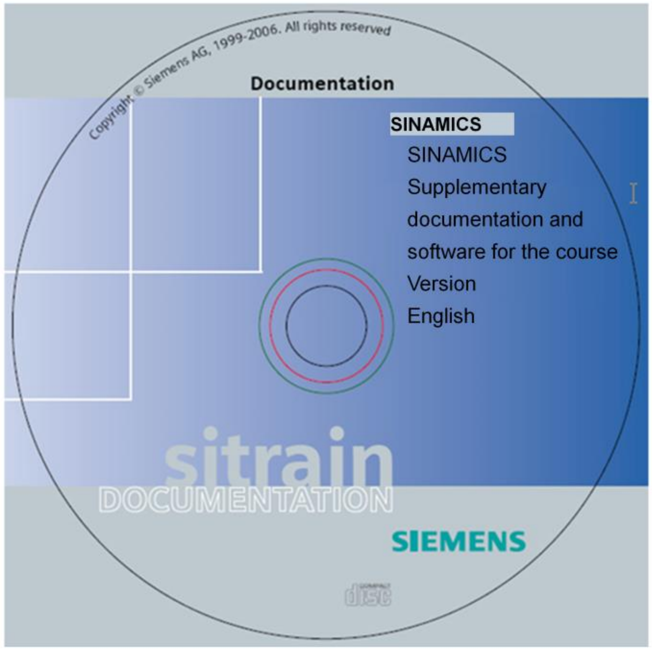
Course DVD



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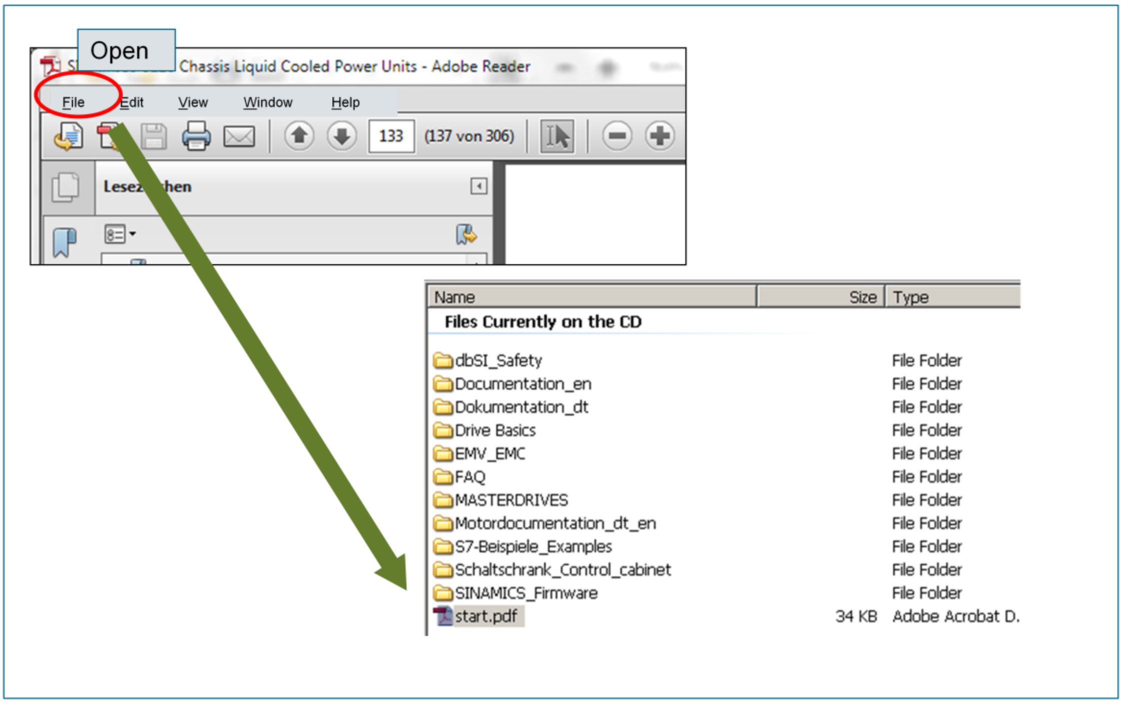
The course DVD provides you with standard documentation for the courses on SINAMICS low-voltage drives

The DVD contains the documentation for:

- Operation
- Programming
- Configuring
- Commissioning
- Functions

Note Acrobat® Reader must be installed before you can use the DVD.

Course DVD
Starting the DVD



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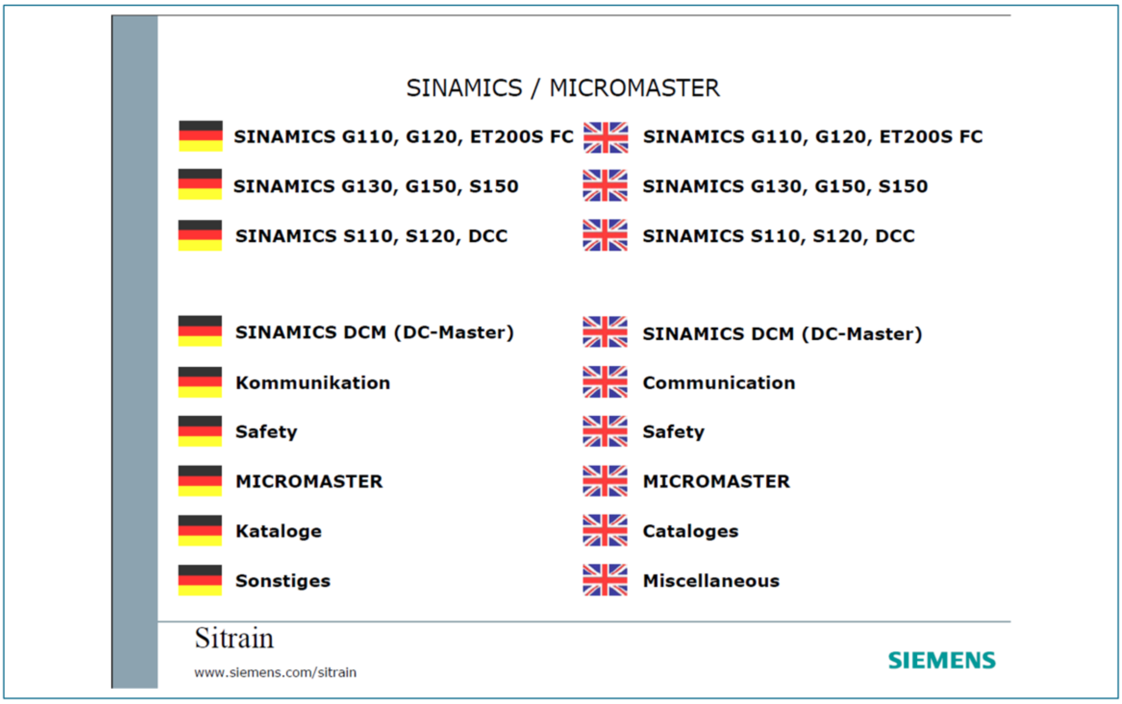
Starting the DVD To start the DVD, double-click in the Explorer on the "start.pdf" file or use the *File → Open* menu in Acrobat® Reader to select the " start.pdf" file.

Course DVD
Home page



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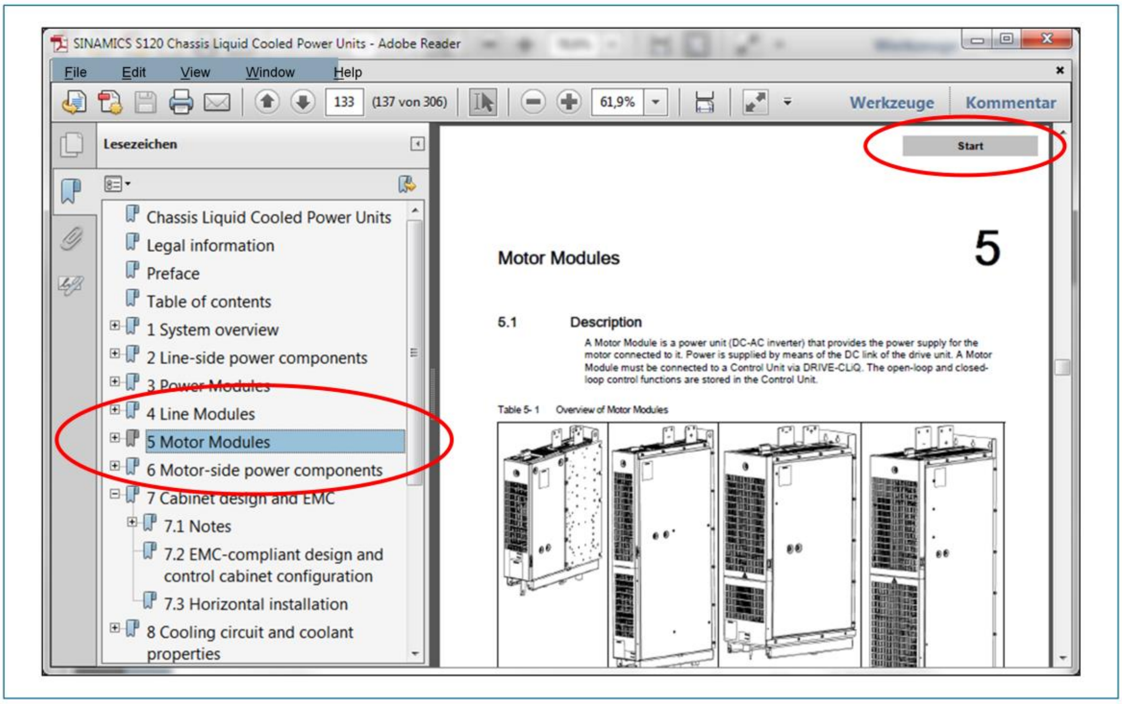
DVD home page When you open the file "Start.PDF", the DVD's home page will be displayed first.
You can click to select the documents of your choice in German or English on this page.

Course DVD
Navigating through the document



The bookmark function of Acrobat® Reader is available for navigation through the documentation.

Contents You can return to the first page of the document from any page in the document by clicking the "Contents" button.

Return You can use the "Return to home page" button to return directly to the home page of the DVD to select a different document.

Course DVD
Search function

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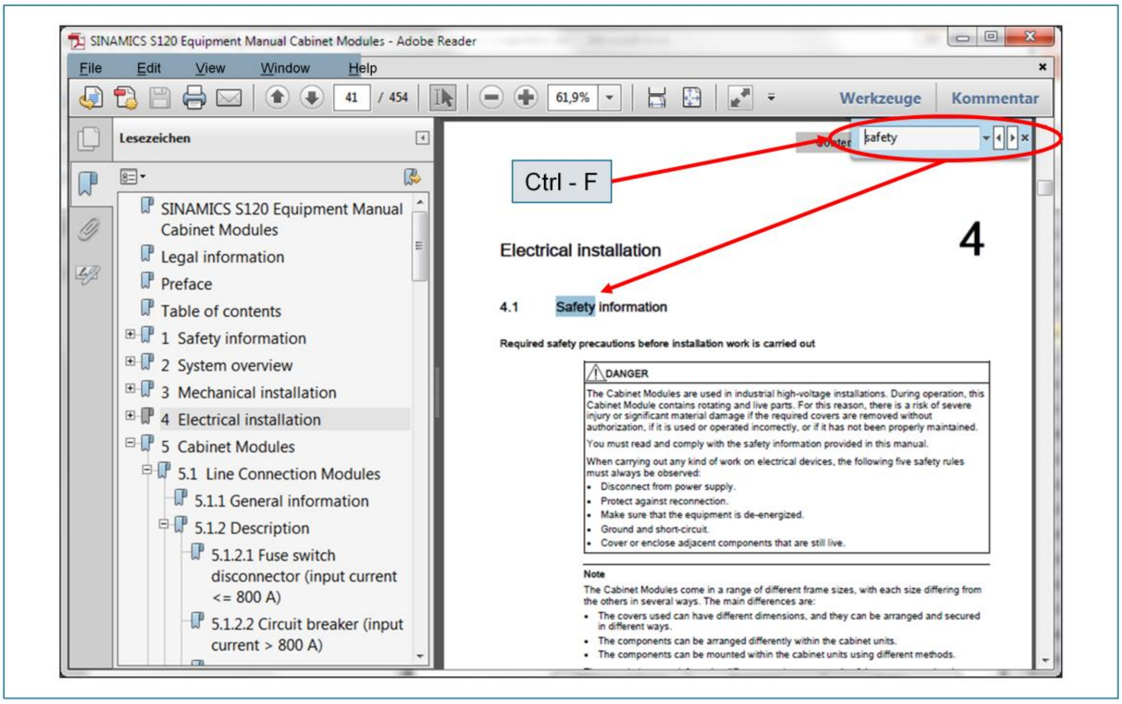

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Find

The files on the DVD are automatically linked to a search index when opened.

This facilitates a search over all files on the DVD using a search term entered.

All documents where the search term has been found are listed in the results list. Click on the corresponding document to open it.

The full range of courses offered can be accessed using the following link:

www.siemens.com/sitrain or

www.siemens.com/sitrain

Course search The search function allows you to set various search filters such as keyword, target group, etc. to find the desired course. The filters can also be combined.

Top links Top links provide direct access to a variety of courses, for example SIMATIC S7, SINUMERIK solution line, etc.

Training news Here you will find the latest courses offered and SITRAIN activities at a glance.

Course catalog The course catalog enables you to find the desired course using training methods or via the organizational structure of the Siemens Mall.

SITRAIN
SINAMICS S120 training program

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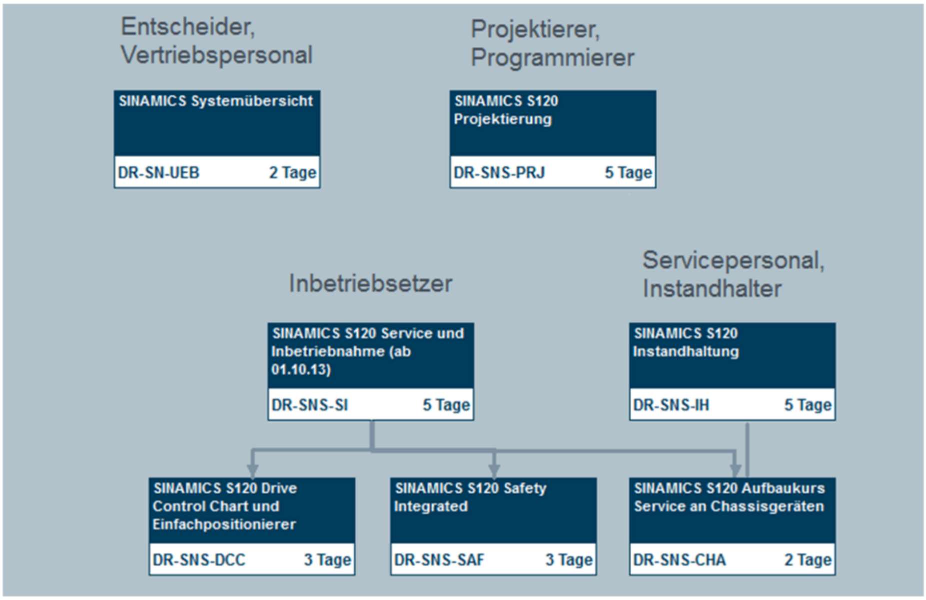

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Example: SINAMICS S120 Safety Integrated

Description

This course teaches you how to handle drive-integrated safety functions. You will know how to apply the different functions and how you can parameterize them. You will therefore be able to utilize the benefits of Safety Integrated compared to conventional safety technology (e.g. reduced cabling or faster standard commissioning).

Requirements

Knowledge of SINAMICS S120 corresponding to course DR-SNS-SI.
Knowledge of SIMATIC S7 is advantageous for the topic PROFIsafe.

Target group

Project managers, project employees,
Programmers
Commissioning personnel, configuring engineers

Contents

Fundamentals, standards and regulations of machine safety

Procedure of risk assessment

Performance Level (PL) and Safety Integrity Level (SIL)

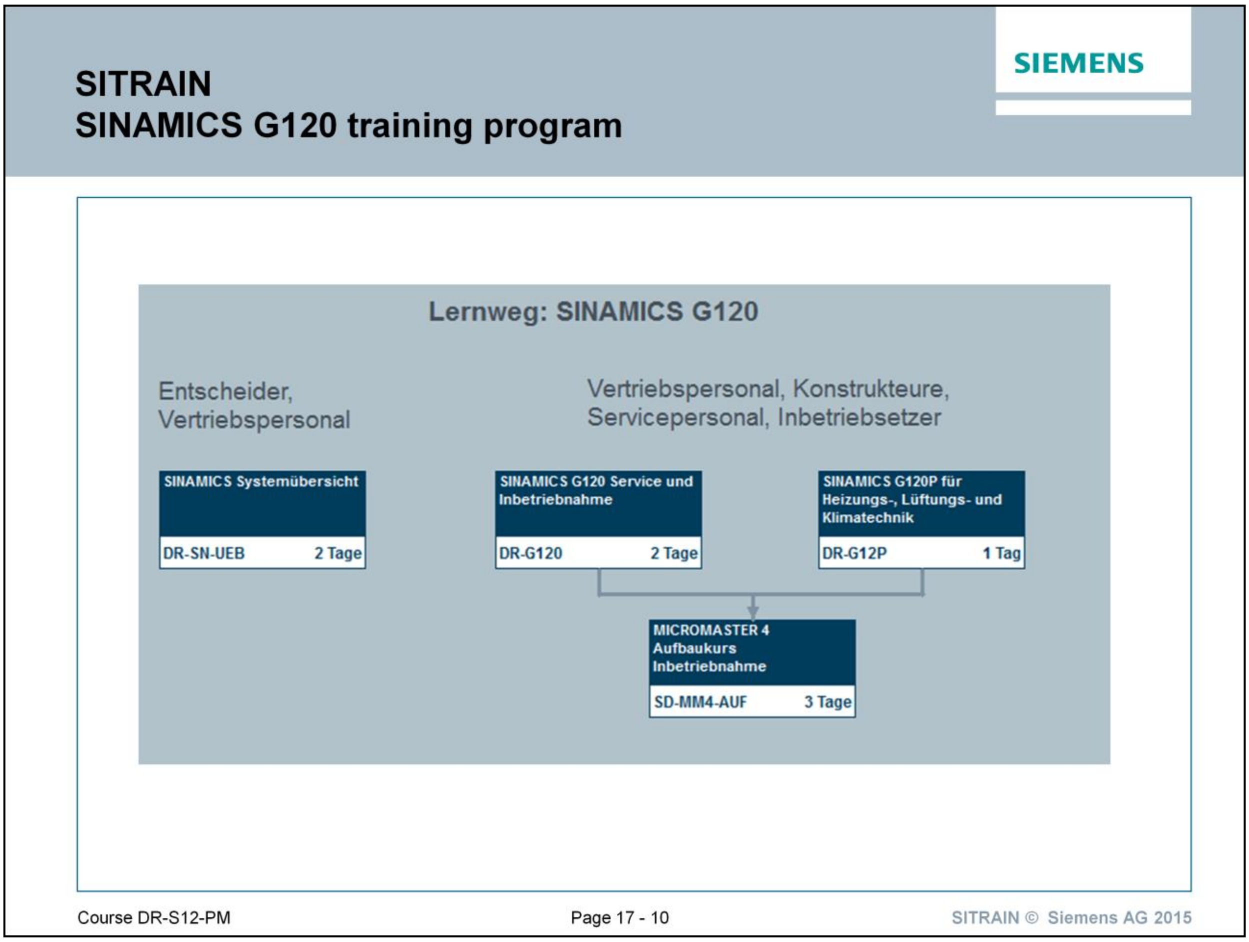
Safety Evaluation Tool (SET) for the determination of PL and SIL

SINAMICS S120 Safety Integrated Basic and Extended Functions

Control of the drive-integrated safety functions via
- Terminal Module TM54F and DRIVE-CLiQ
- SIMATIC F-CPU and PROFIsafe

Influence of the settings of the closed-loop controller and the kinetic energy of an axis on the safety functions

Practical exercises on training equipment with SINAMICS S120, TM45F and SIMATIC F-CPU



Example: SINAMICS G120 Service and Commissioning

Description

Information required for engineering/configuring and the first commissioning of the SINAMICS G120 drive system is provided in this course.

An important component of this course are practical exercises carried out on a SINAMICS G120 training case.

At the end of this course, you are able to reliably handle the STARTER commissioning tool. This means you are able to effectively use various inverter functions, optimize closed-loop controls and achieve the best possible success when using the SINAMICS G120 system.

Requirements

Basic knowledge of electrical engineering

Target group

Commissioning personnel, configuring engineers
Service personnel
Maintenance personnel

Contents

Design of the SINAMICS G120 drive system

Commissioning and parameterization with the STARTER commissioning tool

Inverter functions (flying restart, braking, closed-loop control)

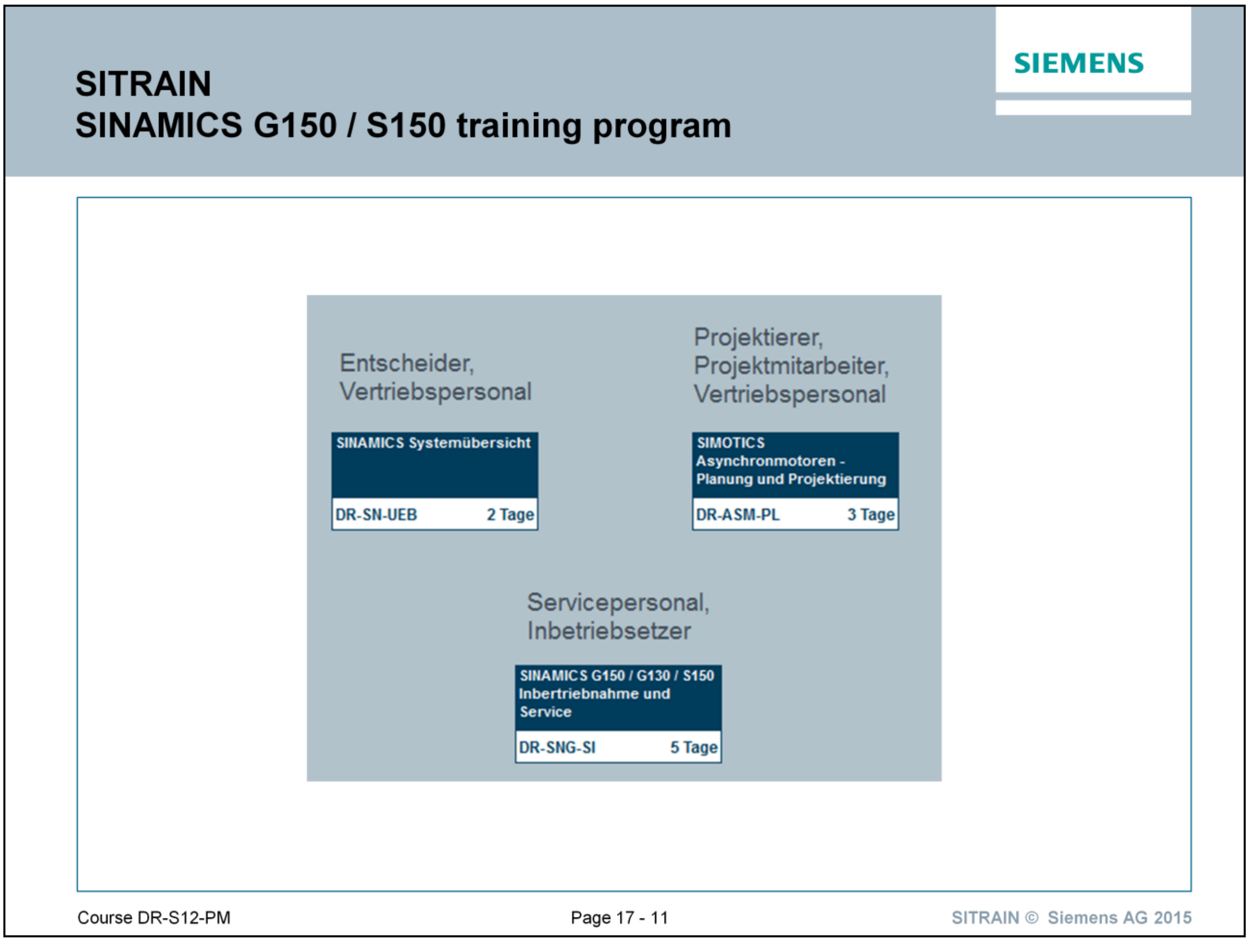
Data management

Flexible signal interconnection with BICO technology

Safety Integrated functions

Diagnostics and troubleshooting

Practical exercises using the training case



Example: SINAMICS G150 Service and Commissioning

Description	This training course covers the technical knowledge for commissioning and servicing SINAMICS chassis and cabinet units G130, G150 and S150. Practical exercises for replacing spare parts and rectifying faults is a major part of this course. Once the course has been completed, you will be able to commission and optimize drives, replace spare parts and carry out drive diagnosis using the AOP30 or the STARTER tool.
Requirements	Basic knowledge of electrical engineering
Target group	Commissioning personnel, configuring engineers Service personnel Maintenance personnel
Content	Design of the drive system and overview of documentation and service Commissioning, servicing and diagnostics using the AOP30 operator panel and the STARTER tool Hardware functions, circuit diagrams and function diagrams Software functions and controller optimization Installation, electrical connection, EMC Replacement of components in SINAMICS G150/G130/S150 chassis and cabinet units Practical fault diagnostics exercises

SITRAIN
Do you have any questions?

SIEMENS

We can help you!

... on the Internet:
www.siemens.com/sitrain

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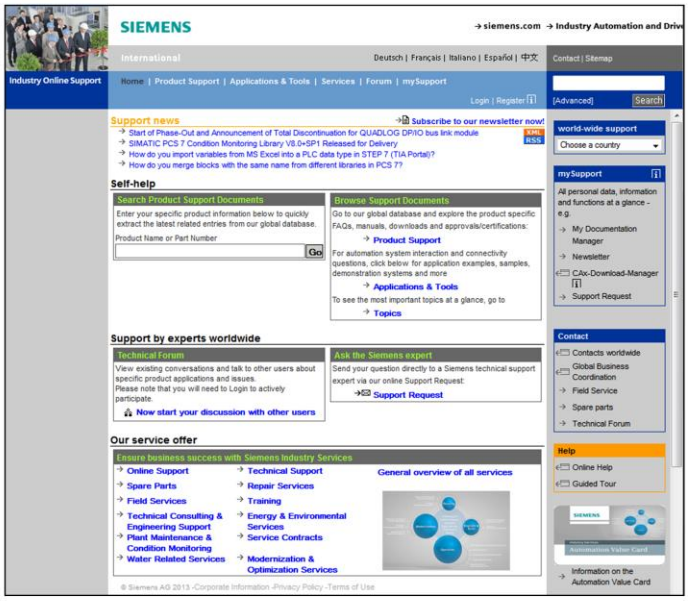
Service & Support
Do you require Service & Support?

www.siemens.com/automation/service&support



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The Service & Support Portal provides online access at www.siemens.com/automation/service&support at any time to comprehensive information and services covering the full product range of Industry Automation and Drive Technology.

Online support is divided into two main topics:

Know-how

- Product Support:
  Technical information and downloads on products (manuals, FAQ, software updates, etc.)
- Applications & Tools:
  Automation solutions (example solutions, system descriptions, demonstrations, calculators, tools, etc.)
- Services:
  Information on the comprehensive services offered by Service & Support (contacts, repair, etc.)

Communication

- Forum:
  Direct customer-customer communication for technical queries
- Support Request:
  Send technical request directly to an expert

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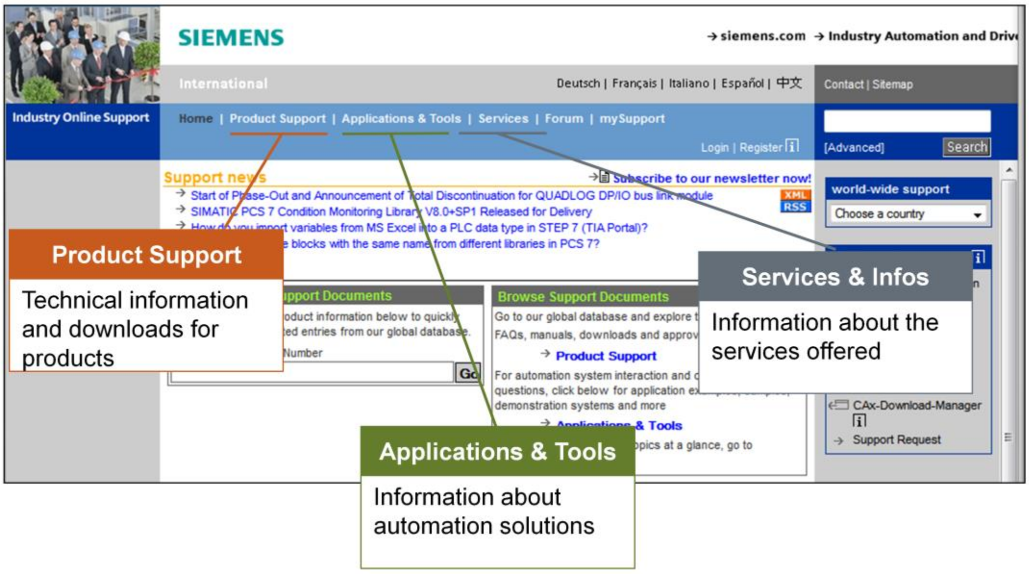
Service & Support
Know-how offered in the Service & Support Portal



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General The Online Support is always available with a comprehensive information system with a wide offer. Online Support is always the first step to obtain help fast, from product support though service information to interactive services.

Product Support In-depth expert knowledge with up-to-date information about our products and systems provide the basis for the Product Support's expertise in the form of frequently asked questions, downloads of updates/upgrades for example, up-to-date product information from marketing/sales, manuals in electronic form as PDF files, test certificates and characteristic curves.

Application & Tools Applications & Tools is the new platform for solutions and system descriptions in the Service & Support Portal. Applications & Tools help you to solve your automation tasks. This support can be obtained in the form of programming examples and tools, background knowledge, function descriptions, handling instructions, performance data, etc. The focus here is not on the individual product; rather, on the interaction between individual products.

Services Shows you the full range of services offered, including detailed information on our Service & Support processes and a database with details of contact persons.

Infos Search for the latest brochures on Service & Support – or find out at which trade show you can meet us in person? All this and more is provided under the keyword "Infos".

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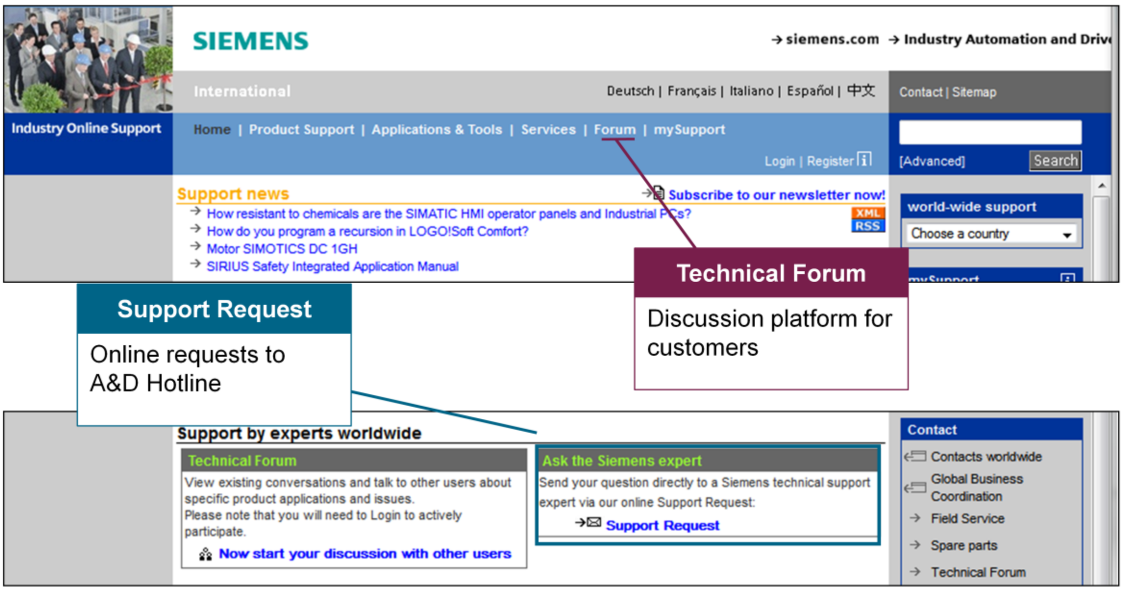
Service & Support
Communication in the Service & Support Portal



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Technical forum To augment this comprehensive service offer, we maintain a direct dialog with specialists using state-of-the art, web-based technology. The new technical forum is an attractive discussion platform in German and English where users and experts can exchange information.

Support Request The internet-based *Support Request* will always provide you with a direct response to your queries. Outline your situation in online screens. The Knowledge Base will provide you with appropriate solutions straight away. If the proposed solution does not match your problem, send the web form directly to our expert team at *Technical Support* (hotline).

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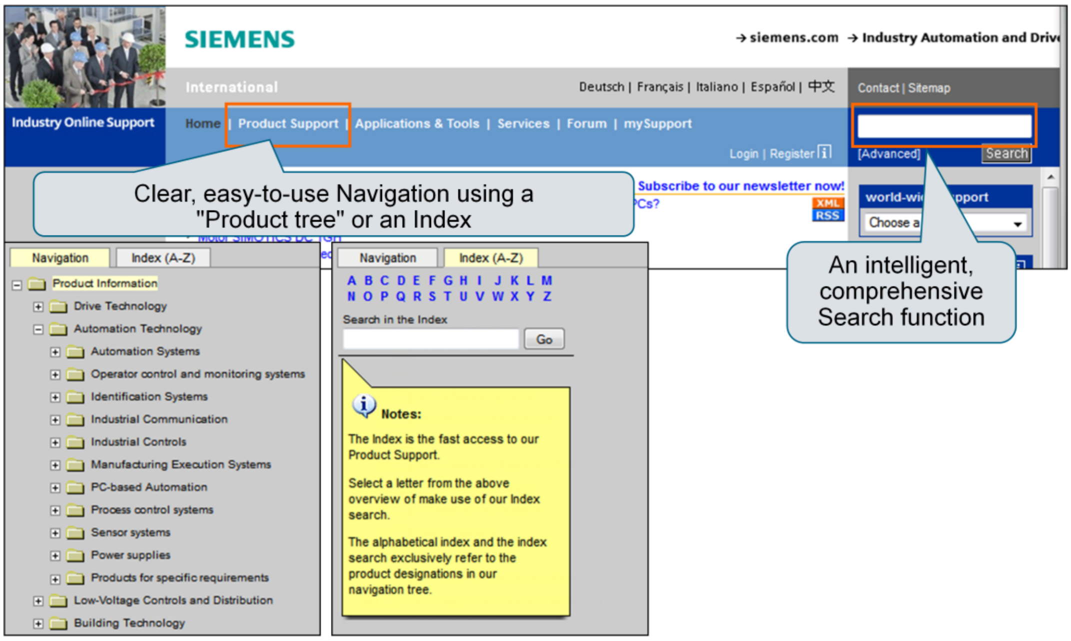
Service & Support
Only a few clicks away from the information your require



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An intelligent Search function and easy-to-use Navigation system are available to help you find the desired information:

Search An intelligent and comprehensive search function supplies you with the relevant results.

- Automatic detection of keywords
- Automatic spell checking
- Automatic sorting of hit list according to relevance

Navigation You can also use the navigation functionality in the product tree to access the desired information. An index makes for easy product selection.

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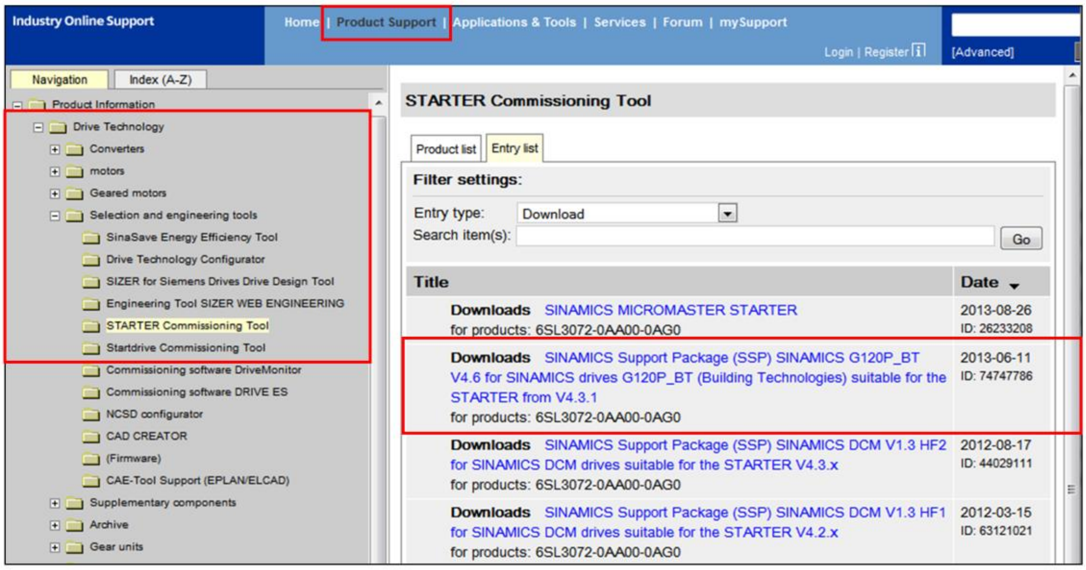
Service & Support
Download STARTER



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Technical documentation
Target groups

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User documentation

- ☑ Operation
- ☑ Programming
- ☑ Diagnostics manual

End users
Operating
Programming

Manufactor documentation

- ☑ Hardwaredescription
  - ☒ Hardware components
- ☑ Software
  - ☒ Sotwarefunctions
- ☑ Service
  - ☒ Commissioning, service

Planning
Technical design
Commissioning
Service

Presales-Dokumentation

- ☑ Catalogs
- ☑ Brochures. flyers
- ☑ Product briefs

OEM

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Technical documentation on the Internet

www.siemens.com/motioncontrol/docu

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