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Siemens Automation Cooperates with Education (SCE) | From Version V14 SP1

TIA Portal Module 062-101
Frequency converter G120 on PROFINET with SIMATIC S7-1500

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Frequency Converter G120 with Control Unit CU250S-2 PN Vector on PROFINET with SIMATIC S7-1500

1 Objective

In this chapter you learn how a frequency converter SINAMICS G120 with the Control Unit CU250S-2 PN Vector and together with a CPU1516F-3 PN/DP on PROFINET is put into operation.

The module explains the basic commissioning of the frequency converter SINAMICS G120 with the SINAMICS Startdrive software in the TIA Portal.

Subsequently we show step-by-step how the frequency converter SINAMICS G120 can be controlled and monitored from the program of the CPU1516F-3 PN/DP.

The SIMATIC S7 controllers listed in Chapter 3 can be used.

2 Requirement

This chapter is based on chapter "Global data blocks for SIMATIC S7 CPU1516F-3 PN/DP". In order to carry out this chapter you can for example, use the following project: "SCE_EN_032-600_Globale_Datenbausteine _R1508.zap13".

3 Required hardware and software

1 Engineering station: requirements include hardware and operating system (for additional information, see Readme on the TIA Portal Installation DVDs)

2 SIMATIC STEP 7 Professional software in TIA Portal – as of V13

3 SINAMICS Startdrive software in TIA Portal – as of V13

4 SIMATIC S7-1500/S7-1200/S7-300 controller, e.g. CPU 1516F-3 PN/DP – Firmware as of V1.6 with memory card and 16DI/16DO
Note: The digital inputs should be fed out to a control panel.

5 SINAMICS G120 frequency converter with:

- Control Unit CU250S-2 PN as of Firmware 4.6
- Power Module PM240-2
- IOP Intelligent Operator Panel
- Induction motor

6 Ethernet connection between engineering station and controller and between controller and frequency converter

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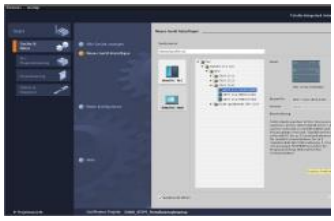
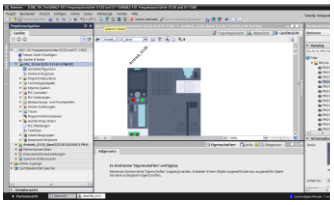


2 SIMATIC STEP 7 Professional (TIA Portal) as of V13

1 Engineering station



3 SINAMICS Startdrive (TIA Portal) as of V13

6 Ethernet connection

4 SIMATIC S7-1500 controller

Control panel

6 Ethernet connection

5 G120 frequency converter with:

- Control Unit CU250S-2 PN
- Power Module PM240-2
- IOP Intelligent Operator Panel
- Induction motor

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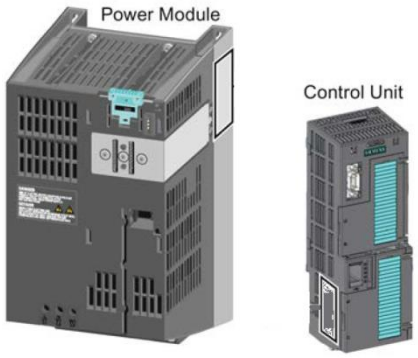
4 Theory

4.1 SINAMICS G120 frequency converter

Each SINAMICS G120 converter consists of a Control Unit (CU) and a Power Module (PM).

- The Control Unit controls and monitors the Power Module and the connected motor.
- The Power Modules contain rectifiers and converters for motors in a power range of 0.37 kW to 250 kW.



Note:

– *More detailed information about the frequency converter G120 with Control Unit CU250S-2 PN Vector is available in the manuals. In this module the frequency converter SINAMICS G120 is used as a PROFINET IO device.*

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4.2 Components for configuring a frequency converter SINAMICS G120

4.2.1 Control Units CU250S-2

The Control Units CU250S-2 differ with regard to their type of fieldbus connections. There are Control Units CU250S-2 with:

- RS485 interface for USS, Modbus RTU
- PROFIBUS interface
- RS485 interface for PROFINET, Ethernet/IP
- CANopen interface

All the Control Units have an **EEPROM** in order for power-failure-proof storage of the configuration data.

The used Control Unit CU250S-2 Vector has a **PROFINET interface** with two ports that supports the **PROFIdrive**, **PROFIsafe** and **PROFIenergy** profiles.

In addition, for example, **HTL or TTL encoders and temperature sensors** can be connected directly to a 15-pin encoder interface and **DRIVE-CLiQ-compatible encoders** as well as sensor modules to a DRIVE-CLiQ interface of the Control Unit.

The Control Unit supports the following functions of **Safety Integrated** (SIL 3, PL e, Cat. 3):

- Safe Torque Off (STO)
- Safe Stop 1 (SS1) with and without speed monitoring
- Safe Brake Control (SBC)
- Safely Limited Speed (SLS)
- Safe Direction (SDI)

Safe Speed Monitor (SSM)

- PROFIsafe communication to a higher-level control unit

Various **control methods** are available in order to meet the wide range of requirements in drive technology:

- U/f characteristic curves
- Flux current control
- Vector regulation with and without encoders

The following **special functions** can be used with this Control Unit:

- Basic positioning function with EPOS

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● Energy recovery capability through Efficient Infeed Technology (only PM250 Power Modules)

Terminals with **digital** and **analog** as well as **safe inputs and outputs** are available.

4.2.2 Operator Panels

The Operator Panels are used to commission, diagnose and control the converter as well as to back up and transfer the converter settings.

The **Intelligent Operator Panel (IOP)** is available for snapping onto the Control Unit or as a hand-held unit with a connecting line to the Control Unit. The IOP enables operator control and diagnostics of the converter.

The **BOP-2** is an Operator Panel for snapping onto the Control Unit. The BOP-2 has a two-line display for diagnostics and operator control of the converter.

Note:

– *For further information on the Operator Panels, please refer to the manuals:*

4.2.3 Memory cards for Control Unit (optional)

The SD or MMC memory cards can be optionally used to back up the converter settings.

It is possible to store up to 100 parameter sets. This can be done by using the SINAMICS Startdrive software.

A firmware update/downgrade is only possible by using a memory card.

If you use the "Basic positioner" function or the extended safety functions, a memory card with a valid license has to be inserted into the Control Unit.

Note:

– *A memory card is not required during operation.*

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4.2.4 Brake Relay

The Brake Relay provides a switch contact (NO contact) to control the motor brake solenoid.

4.2.5 Safe Brake Relay

The Safe Brake Relay controls a 24-V motor brake and monitors the brake control for short-circuits and wire breaks.

4.2.6 PM240-2 Power Modules

PM240-2 Power Modules have a brake chopper (four-quadrant applications) and are suitable for a wide range of applications in general mechanical engineering. The PM240-2 Power Modules are available without a filter or with integrated Class A line filter.

The PM240-2 Power Module is available for the following voltage and power range:

- 1-phase/3-phase 200 VAC ... 240 VAC 0.55 kW ... 4.0 kW
- 3-phase 200 VAC ... 240 VAC 5.5 kW ... 7.5 kW
- 3-phase 380 VAC ... 480 V 0.55 kW ... 250 kW
- 3-phase 500 VAC ... 690 VAC 11 kW ... 132 kW

Note:

– *If frequency converters are not put into operation for a longer period, the DC link capacitors have to be formed in accordance with the specifications in the operating instructions.*

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4.2.7 PM250 Power Modules

PM250 Power Modules are suitable for identical applications as the PM240 Power Modules. Any brake energy occurring can be fed back directly into the power network (four-quadrant applications – no brake chopper required). The PM250 Power Modules are available without a filter or with integrated Class A line filter.

The PM250 Power Module is available for the following voltage and power range:

- 3-phase 380 VAC - 480 VAC ±10% 7.5 kW to 90 kW

Note:

– *If frequency converters are not put into operation for a longer period, the DC link capacitors have to be formed in accordance with the specifications in the operating instructions.*

4.2.8 Line filter

A line filter allows the converter to reach a higher radio interference category. An external filter is not required for converters with built-in line filter.

4.2.9 Line reactor

The line reactor supports overvoltage protection, flattens the harmonics in the power network and bridges commutation notches.

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4.2.10 Output reactor

Output reactors reduce the voltage load of the motor windings as well as the load of the converter through capacitive charge/discharge currents in the lines. An output reactor is required for shielded motor lines greater than 50 m or unshielded motor lines greater than 100 m.

4.2.11 Sine-wave filter

The sine-wave filter at the output of the converter limits the voltage gradient and the peak voltages at the motor motor winding. The maximum permissible motor supply line length increases to 300 m. An output reactor becomes superfluous.

4.2.12 Braking resistor

The braking resistor allows rapid braking of loads with a high moment of inertia.

The Power Module controls the braking resistor through its integrated brake chopper.

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4.3 Safety measures and warnings

The following safety information and warnings are to be observed before the installation and commissioning of the SINAMICS G120.

4.3.1 General

⚠ WARNING

This equipment contains dangerous voltages and controls potentially dangerous rotating mechanical parts. Non-compliance with the warnings or failure to follow the instructions contained in this manual can result in loss of life, severe personal injury or serious damage to property.

Protection in case of direct contact by means of SELV / PELV is only permissible in areas with equipotential bonding and in dry indoor rooms. If these conditions are not fulfilled, other protective measures against electric shock must be applied e.g. protective insulation.

Only suitably qualified personnel should work on this equipment, and only after becoming familiar with all safety notices, installation, operation and maintenance procedures contained in this manual. The successful and safe operation of this equipment is dependent upon its proper handling, installation, operation and maintenance.

The power supply, DC and motor terminals, the brake and thermistor cables can carry dangerous voltages even if the inverter is inoperative. Wait at least five minutes to allow the unit to discharge after switching off the line supply before carrying out any installation work.

It is strictly prohibited for any mains disconnection to be performed on the motor-side of the system; any disconnection of the mains must be performed on the mains-side of the Inverter.

When connecting the line supply to the Inverter, make sure that the terminal case of the motor is closed.

When changing from the ON to OFF-state of an operation if an LED or other similar display is not lit or active; this does not indicate that the unit is switched-off or powered-down.

The inverter must always be grounded.

Isolate the line supply before making or changing connections to the unit.

Ensure that the inverter is configured for the correct supply voltage. The inverter must not be connected to a higher voltage supply.

Static discharges on surfaces or interfaces that are not generally accessible (e.g. terminal or connector pins) can cause malfunctions or defects. Therefore, when working with inverters or inverter components, ESD protective measures should be observed.

Take particular notice of the general and regional installation and safety regulations regarding work on dangerous voltage installations (e.g. EN 50178) as well as the relevant regulations regarding the correct use of tools and personal protective equipment (PPE).

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⚠ CAUTION

Children and the general public must be prevented from accessing or approaching the equipment!

This equipment may only be used for the purpose specified by the manufacturer. Unauthorized modifications and the use of spare parts and accessories that are not sold or recommended by the manufacturer of the equipment can cause fires, electric shocks and injuries.

NOTICE

Keep this manual within easy reach of the equipment and make it available to all users.

Whenever measuring or testing has to be performed on live equipment, the regulations of Safety Code BGV A2 must be observed, in particular § 8 "Permissible Deviations when Working on Live Parts". Suitable electronic tools should be used.

Before installing and commissioning, please read these safety instructions and warnings carefully and all the warning labels attached to the equipment. Make sure that the warning labels are kept in a legible condition and replace missing or damaged labels.

4.3.2 Transport and storage

⚠ WARNING

Correct transport, storage as well as careful operation and maintenance are essential for the proper and safe operation of the equipment.

⚠ CAUTION

Protect the equipment against physical shocks and vibration during transport and storage. It is important that the equipment is protected from water (rainfall) and excessive temperatures.

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4.3.3 Commissioning

⚠ WARNING

Working on the equipment by unqualified personnel or failure to comply with warnings can result in severe personal injury or serious damage to material. Only suitably qualified personnel trained in the setup, installation, commissioning and operation of the product should carry out work on the equipment.

⚠ CAUTION

Cable connection

The control cables must be laid separately from the power cables. Carry out the connections as shown in the installation section in this manual, to prevent inductive and capacitive interference from affecting the correct function of the system.

4.3.4 During operation

⚠ WARNING

The SINAMICS G120 inverters operate at high voltages.

When operating electrical devices, it is impossible to avoid applying hazardous voltages to certain parts of the equipment.

Emergency Stop facilities according to EN 60204, IEC 204 (VDE 0113) must remain operative in all operating modes of the control equipment. Any disengagement of the Emergency Stop facility must not lead to an uncontrolled or an undefined restart of the equipment.

Certain parameter settings may cause the SINAMICS G120 inverter to restart automatically after an input power failure, for example, the automatic restart function.

Wherever faults occurring in the control equipment can lead to substantial material damage or even grievous bodily injury (that is, potentially dangerous faults), additional external precautions must be taken or facilities provided to ensure or enforce safe operation, even when a fault occurs (e.g. independent limit switches, mechanical interlocks, etc.).

Motor parameters must be accurately configured for motor overload protection to operate correctly.

This equipment is capable of providing internal motor overload protection according to UL508C.

Only Control Units with fail-safe functions can be used as an "Emergency Stop Mechanism" (see EN 60204, section 9.2.5.4).

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4.3.5 Repair

⚠ WARNING
Repairs on equipment may only be carried out by Siemens Service, by repair centers authorized by Siemens or by authorized personnel who are thoroughly acquainted with all the warnings and operating procedures contained in this manual. Any defective parts or components must be replaced using parts contained in the relevant spare parts list. Disconnect the power supply before opening the equipment for access.

4.3.6 Disassembly and disposal

CAUTION
The packaging of the inverter is re-usable. Retain the packaging for future use. Easy-to-release screw and snap connectors allow you to break the unit down into its component parts. You can recycle these component parts, dispose of them in accordance with local requirements or return them to the manufacturer.

Note:

– *It is assumed that a ready pre-assembled converter unit with induction motor is being used for the following operating steps and tasks. Observe the safety regulations and warnings of the manufacturers when carrying out the electrical installation. Instructions and directives for mounting and electrical installation can be found in the manuals of the SINAMICS G120.*

4.4 Parameter assignment of the SINAMICS G120 frequency converter

There are two main types of parameters:

- Display parameters
- Adjustable parameters

4.4.1 Display parameters

Display parameters allow the reading of the internal measured quantities of the converter and motor. The Operator Panel and SINAMICS Startdrive represent the display parameters with a preceding "r". For example, r0027 is the parameter for the output current of the converter.

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4.4.2 Adjustable parameters

Adjustable parameters are the parameters that you use to adjust the converter to your application. When you change the value of an adjustable parameter, you also change the behavior of the converter. Adjustable parameters are represented with a preceding "p". For example, p1082 is the parameter for adjusting the maximum speed of the motor.

The following section displays some particularly important adjustable parameters.

Note:

– *Further information on the parameters is available in the list manual.*

4.4.3 P0010 Drive commissioning parameter filter

Parameter P0010 filters parameters so that only the parameters assigned to a specific function group can be selected. This means, for example, that the parameters required for quick commissioning are displayed in order. The following settings are available:

• P0010 = 0: Ready

In order to start up the converter, the P0010 has to be set to 0.

• P0010 = 1: Quick commissioning

• P0010 = 2: Power unit startup

• P0010 = 3: Motor startup

• P0010 = 4: Encoder startup

• P0010 = 5: Technological application/units

• P0010 = 11: Function modules

• P0010 = 15: Data records

• P0010 = 17: Basic positioning startup

• P0010 = 25: Position control startup

• P0010 = 29: Only Siemens-internal

• P0010 = 30: Parameter reset

• P0010 = 39: Only Siemens-internal

• P0010 = 49: Only Siemens-internal

• P0010 = 95: Safety Integrated startup

By setting p3900 unequal to 0, the quick commissioning is complete, and this parameter is set automatically to 0.

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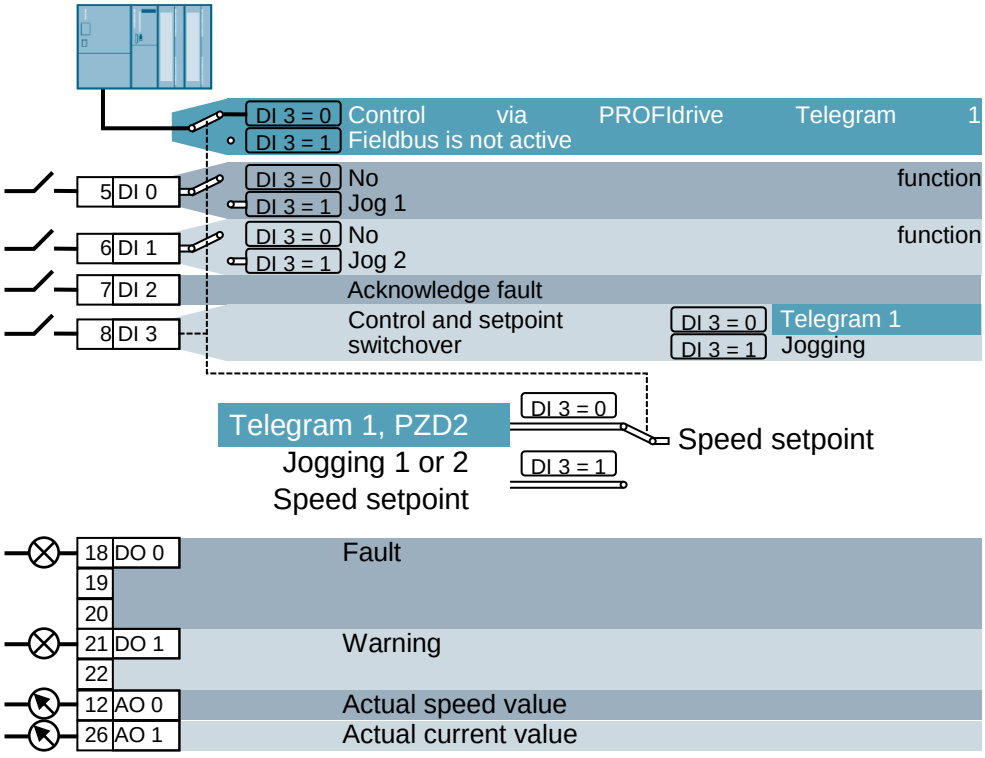
4.4.4 P0015 Macro drive unit

With the parameter P0015 you select command and setpoint sources of the converter by executing the corresponding macro files.

After the value has changed, the further changing of parameters is blocked as long as the macro is being executed. The status is displayed in r3996. Changing is not possible until r3996 = 0 again.

When a specific macro is executed, the correspondingly programmed settings are carried out and become effective.

For example, Macro 7: "Fieldbus with data record changeover"



Note:

– *Information about further macros is available in the operating instructions of the respective Control Unit.*

4.4.5 Changeability depending on the converter state

"P"-parameters can furthermore only be changed depending on the status of the converter.

For example, the parameter p1120 Ramp-function generator ramp-up time (with the attribute "C(1), U, T" in the parameter list) can only be changed in the quick commissioning "C", when P0010 = 1, in the ready state "T" or during operation "U" .

Status	Description
C(*)	Quick commissioning (P0010 = *)
U	Operation (drive running)
T	Drive ready-to-start

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4.4.6 BICO technology

A converter corresponding to the latest state-of-the-art has to offer the possibility to freely interconnect internal and external signals (setpoints or actual values as well as control and status signals).

This interconnection has to offer a high degree of flexibility so that the converter can be easily adapted to new applications.

The BICO technology and macros are used to meet these requirements.

By using the BICO technology the process data can be interconnected freely while using the "default" parameter assignment of the converter.

Here all the values that can be interconnected freely are defined as "connectors", for example, frequency setpoint, actual frequency value, actual current value, etc.

All the digital signals that can be interconnected freely are defined as "binectors", for example, status of a digital input, ON/OFF, message function at limit violations, etc.

A converter contains numerous input and output variables as well as variables within the control system that can be interconnected. Therefore, it is possible to adapt the converter to the various requirements by using the BICO technology.

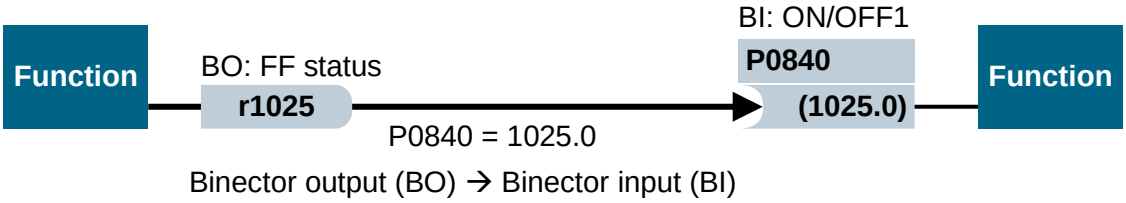
Binectors

A binector is a digital (binary) signal without any units that can have either the value 0 or 1. Binectors always reference functions. They are divided into binector inputs (BI) and binector outputs (BO).

The binector input is always identified with a "P"-parameter (for example, P0840 BI: ON/OFF1), whereas the binector output is always represented with an "r"-parameter (for example, r1025 BO: FF status).

Example

Combination of the command ON/OFF1 with selection of a fixed frequency.



When a fixed frequency is selected, the fixed frequency status bit (r1025) is changed internally from 0 to 1.

The source for the command ON/OFF1 is the parameter P0840 (default DI0). When the fixed frequency status bit is connected as the source for P0840 (P0840 = 1025), the converter starts by activating a fixed frequency and stops with OFF1 for deactivation of the fixed frequency.

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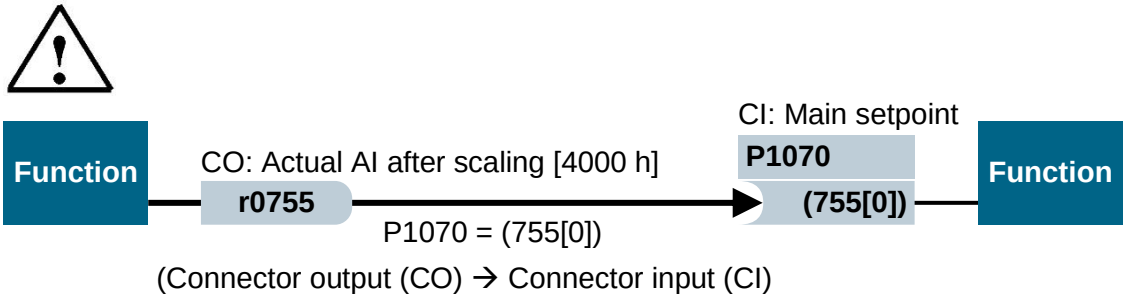
Connectors

A connector (16 or 32 bits) has a value that can contain a normalized variable (dimensionless) or also a variable with assigned units.

Connectors always reference functions. They are divided into connector inputs (CI) and connector outputs (CO). In essence the same applies as for binectors: The connector inputs are identified by a "P"-parameter (for example P0771 CI: AO (analog output)), whereas the connector outputs are always represented with an "r"-parameter (for example r0021 CO: Actual frequency).

Example

Interconnection of the parameter r0755 (display analog input) with an internal value (main frequency setpoint). To this purpose the CO parameter r0755 (scaled analog input) has to be interconnected with the CI parameter P1070 (main setpoint).



Note:

– *For further details please refer to the list manual.*

4.4.7 Control Data Set (CDS) and Drive Data Set (DDS)

Drive engineering has applications in which simutaneous changeover of multiple parameters with external signals is needed during operation.

To enable this, certain parameters have been organized into groups. These so-called data sets are:

- Control Data Set (CDS)
- Drive Data Set (DDS)

Note:

– *For more details, refer to the list manual and the operating instructions.*

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4.5 Commissioning of the SINAMICS G120 frequency converter

A converter of the type G120 always consists of the Power Module and the Control Unit. After the initial latching in of the Control Unit at the Power Module and switching on of the supply voltage, the Power Module is recognized by the Control Unit. If it is a compatible Power Module, the data are stored in the Control Unit.

Commissioning of the converter G120 is usually carried out in the following steps:

- Resetting to factory settings
- Basic commissioning
  - Quick commissioning
  - Calculation of the motor/control data
  - Optimization of the speed control
- Further settings for commissioning
  - Optional: Motor data identification
- Startup of the application
  - Commissioning of fail-safe functions (only with fail-safe applications)

4.5.1 Restoring factory settings through a parameter reset

The factory setting can be effected via the SINAMICS Startdrive software, via a menu function in the Intelligent Operator Panel (IOP) or via a direct parameter input.

Procedure for "Reset parameters":

p0010 = 30

p0970 = 1

P0970 = 0 is automatically set at the end of the calculations.

Through a factory setting via P0970, the original values of all the converter parameters can be restored. These values are designated with "Factory Setting" in the list manual.

The following parameters remain unchanged after a reset to factory settings:

- P0014 Storage mode
- Communication parameters (for example PROFIBUS and PROFINET settings)
- Power-Module-dependent data

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4.5.2 Basic commissioning

Basic commissioning should always be carried out by using the commissioning wizard via the SINAMICS Startdrive software or the Intelligent Operator Panel (IOP).

Alternatively, quick commissioning (P0010 = 1) can also be carried out by direct entry of the parameters. However, this procedure is not advisable.

Notes:

– *Commissioning by using the commissioning wizard via the SINAMICS Startdrive software is described in Chapter 6 of this document.*

– *For information about carrying out commissioning by using the commissioning wizard via the Intelligent Operator Panel (IOP) please refer to the operating instructions of the IOP.*

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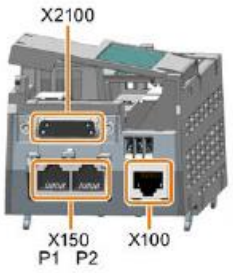
4.6 PROFINET interface of the SINAMICS G120, CU250S-2 PN Vector



The frequency converter can be integrated into an Ethernet network at the PROFINET interface X150 with the two ports P1 and P2. Now:

- The parameter assignment and diagnostics of the frequency converter via Ethernet can be carried out by using the SINAMICS Startdrive software in the TIA Portal.
- The converter can be integrated into a PROFINET network.

In PROFINET IO operation, the converter supports the following functions:

- IO-RT: Real-time communication (as used in this document.)
- IO-IRT: Isochronous real-time communication
- MRP: Media redundancy when used in a network with ring topology
- MRPD: Media redundancy requirement: IRT when used in a network with ring topology
- Diagnostic interrupts in accordance with the error classes specified in the PROFIdrive profile

4.6.1 Telegrams

Various telegrams, whose process data lengths and contents differ, are available for selection for IO-RT communication with the frequency converter.

The simplest telegram, set as the standard, is the Standard Telegram 1.

4.6.2 Assignment of the process data (PZD) for the SINAMICS G120 with Standard Telegram 1

Control words and setpoints (PLC -> SINAMICS) and status words and actual values (SINAMICS -> PLC) can be transferred with the process data. The structure of the PZD area is as follows for Telegram 1, for a coupling via PROFINET:

	PZD1	PZD2
Request telegram (PLC -> SINAMICS)	Control word (STW1)	Main setpoint (NSOLL_A)
Response telegram (SINAMICS -> PLC)	Status word (ZSW1)	Main actual value (NIST_A)

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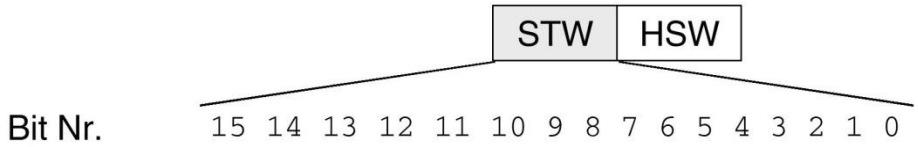
4.6.3 Control word 1 (STW1)



Bit	Significance		Comments	Signal inter-connection in the inverter
	Telegram 20	All other telegrams		
0	0 = OFF1		The motor brakes with the ramp-down time p1121 of the ramp-function generator. The inverter switches off the motor at standstill.	P0840[0] = r2090.0
	0 → 1 = ON		The inverter goes into the “ready” state. If, in addition bit 3 = 1, then the inverter switches on the motor.	
1	0 = OFF2		Switch off the motor immediately, the motor then coasts down to a standstill.	P0844[0] = r2090.1
	1 = No OFF2		The motor can be switched od (ON command).	
2	0 = Quick stop (OFF3)		Quick Stopp: The motor brakes with the OFF3 rampdown time p1135 don to standstill.	P0848[0] = r2090.2
	1 = No Quick Stopp (OFF3)		The motor can be switched on (ON command).	
3	0 = Inhibit operation		Immediately switch-off motor (cancel Pulses).	P0852[0] =r2090.3
	1 = Enable operation		Switch-on motor (pulses can be enabled).	
4	0 = Disable RFG sperren		The inverter immediately sets ist ramp-function generator output to 0.	p1140[0] = r2090.4
	1 = Do not disable RFG		The ramp-function generator can be enabled.	
5	0 = Stop RFG		The output of the ramp-function generator Stopps at the actual value.	P1141[0]= r2090.5
	1 = Enable RFG		The output of the ramp-function generator follows the setpoint.	
6	0 = Inhibit setpoint		The inverter brakes the motor with the ramp-down time p1121 of the ramp-function generator.	P1142[0]= r02090.6
	1 = Enable setpoint		Motor accelerates with the ramp-up time p1120 to the setpoint.	
7	0 → 1 = Acknowledge faults		Acknowledge fault. If the ON command is still active, the inverter switches to „closing lockout“ state.	p2103[0] = r2139.7
8, 9	Reserved			
10	0 = No control via PLC		Inverter ignores the process data from the fieldbus.	P0854[0]= r2090.10
	1 = Control via PLC		Control via fieldbus, inverter accepts the process data from the fieldbus.	
11	1 = Direction reversal		Invert setpoint in the inverter.	p1113[0] = r2090.11
12	Not used			
13	---1)	1 = MOP up	Increase the setpoint saved in the motorized potentiometer.	P1035[0] = r2090.13
14	---1)	1 = MOP down	Reduce the setpoint saved in the motorized potentiometer.	P1036[0]= r2090.14
15	CDS bit 0	Reserved	Changes over between settings for different operation interfaces (command data sets).	P0810 = r2090.15

1) If you change over from another telegram to telegram 20, then the assignment of the previous telegram is kept.

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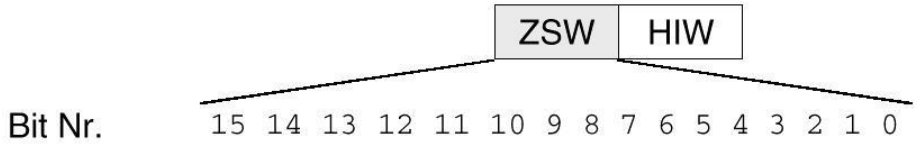
4.6.4 Status word 1 (ZSW1)



Bit	Significance		Comments	Signal inter-connection in the inverter
	Telegram 20	All other telegrams		
0	1 = Ready to start		Power supply switched on; electronics initialized; pulses locked.	P2080[0] = r0899.0
1	1 = Ready		Motor is switched on (ON/OFF1 = 1), no fault is active. With the command “Enable operation” (STW1.3), the inverter switches on the motor	p2080[1] = r0899.1
2	1 = Operation enabled		Motor follows setpoint. See control word 1, bit 3	p2080[2] = r0899.2
3	1 = Fault active		The inverter has a fault. Acknowledge fault using STW1.7.	p2080[3] = r2139.3
4	1 = OFF2 inactive		Coast down to standstill is not active.	p2080[4] = r0899.4
5	1 = OFF3 inactive		Quick Stopp is not active	p2080[5] = r0899.5
6	1 = Closing lockout active		It is only possible to switch on the motor after an OFF1 followed by ON.	p2080[6] = r0899.6
7	1 = alarm active		Motor remains switched on; no acknowledgement is necessary.	p2080[7] = r2139.7
8	1 = Speed deviation within the tolerance range		Setpoint/actual value deviation within the tolerance range.	p2080[8] = r2197.7
9	1 = Master control requested		The automation system is requested to accept the inverter control.	p2080[9] = r0899.9
10	1 = Comparison speed reached or exceeded		Speed is greater than or equal to the corresponding maximum speed.	p2080[10] = r2199.1
11	1 = current or torque limit reached	1 = torque limit reached	Comparison value for current or torque has been reached or exceeded.	p2080[11] = r0056.13/ r1407.7
12	---1)	1 = Holding brake open	Signal to open and close a motor holding brake.	p2080[12] = r0899.12
13	0 = Alarm, motor overtemperature		—	p2080[13] = r2135.14
14	1 = Motor rotates clockwise	0 = Motor rotates counterclockwise	Internal inverter actual value > 0 Internal inverter actual value < 0	p2080[14] = r2197.3
15	1 = CDS display	0 = Alarm, inverter thermal overload		p2080[15] = r0836.0/ r2135.15

2) If you change over from another telegram to telegram 20, then the assignment of the previous telegram is kept.

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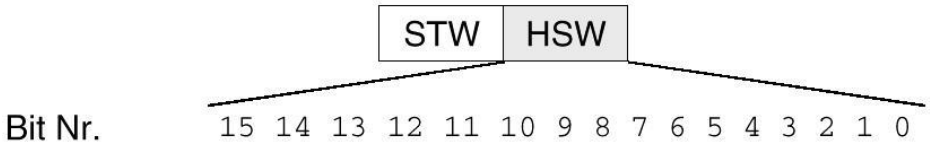
4.6.5 Main setpoint (HSW/NSOLL_A; 16-bit)



The main setpoint is a 16-bit word in which the required speed is transferred to the converter.

The setpoint is transferred as an integer with preceding sign (-32768 to 32767). The value 16384 (4000 Hex) corresponds to +100%.

The value 100% is defined at a particular rotary speed by means of the parameter P2000 (reference speed). The speed that is to correspond to a setpoint of 100% via the interface is entered in this parameter.

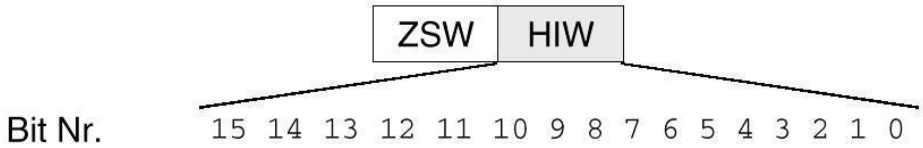
The speed of the converter is calculated as follows:

n= (HSW x P2000)/16384

***Note**:*

– *The parameter P2000 (reference speed) is automatically calculated for Drive Data Set 0 during motor startup and set to the value of parameter P1082 (maximum speed).*

4.6.6 The main actual value (HIW/NIST_A; 16-bit)



The main actual value is a 16-bit word through which the actual speed of the converter is transferred. The normalization of this value corresponds to that of the setpoint.

n= (HIW x P2000)/16384

***Note**:*

– *The parameter P2000 (reference speed) is automatically calculated for Drive Data Set 0 during motor startup and set to the value of parameter P1082 (maximum speed).*

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4.6.7 Layout of the request telegram in double-word format

The request telegram is sent to the SINAMICS G120 in double-word format.

The layout of the bits is shown in the table.

Control word																Main setpoint															
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
QB 256								QB 257								QB 258								QB 259							
7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0

4.6.8 Layout of the response telegram in double-word format

The response telegram is returned by the SINAMICS G120 in double-word format.

The layout of the bits is shown in the table.

Status word																Main actual value															
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
IB 256								IB 257								IB 258								IB 259							
7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0

Note:

– *A data block in which the data are stored temporarily is used for the request telegram and for the response telegram in the control program. The telegrams are mapped there respectively in a structure that is created by means of the PLC data types.*

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4.7 SINAMICS Startdrive commissioning tool for SINAMICS G120

The most recent version of the SINAMICS Startdrive commissioning software can be downloaded from the Website:

support.industry.siemens.com .

SINAMICS Startdrive is a tool integrated in TIA Portal and corresponds to the familiar TIA Portal in its structure and handling.

The SINAMICS Startdrive extension contains the data and views for the SINAMICS G120 frequency converters already supported there.

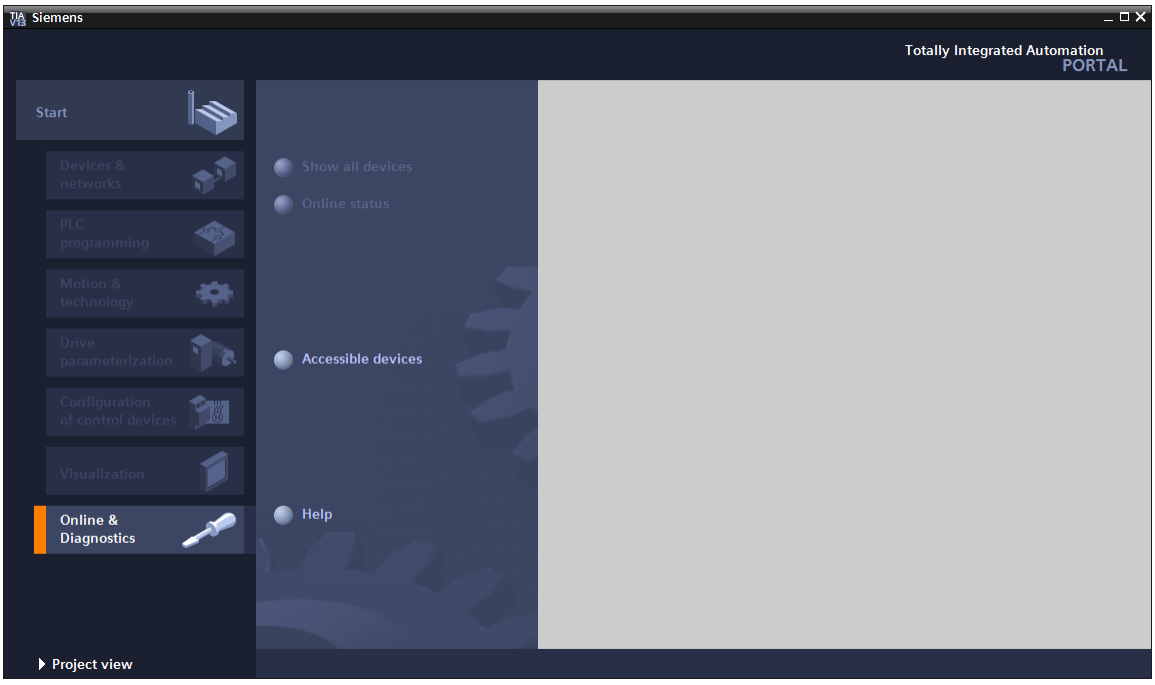
This enables easy parameter assignment and commissioning of the frequency converters. A wide range of functions and aids are available for diagnostics and troubleshooting.

4.7.1 Resetting frequency converters and setting the IP address

A new IP address can be directly assigned to the Control Unit of the frequency converter with SINAMICS Startdrive in TIA Portal. The Control Unit can now be reset.

→ To do so select the Totally Integrated Automation Portal, which is opened with a double-click. (→ TIA Portal V13)

→ Then select the item → "Online & Diagnostics" and open the → "Project view".



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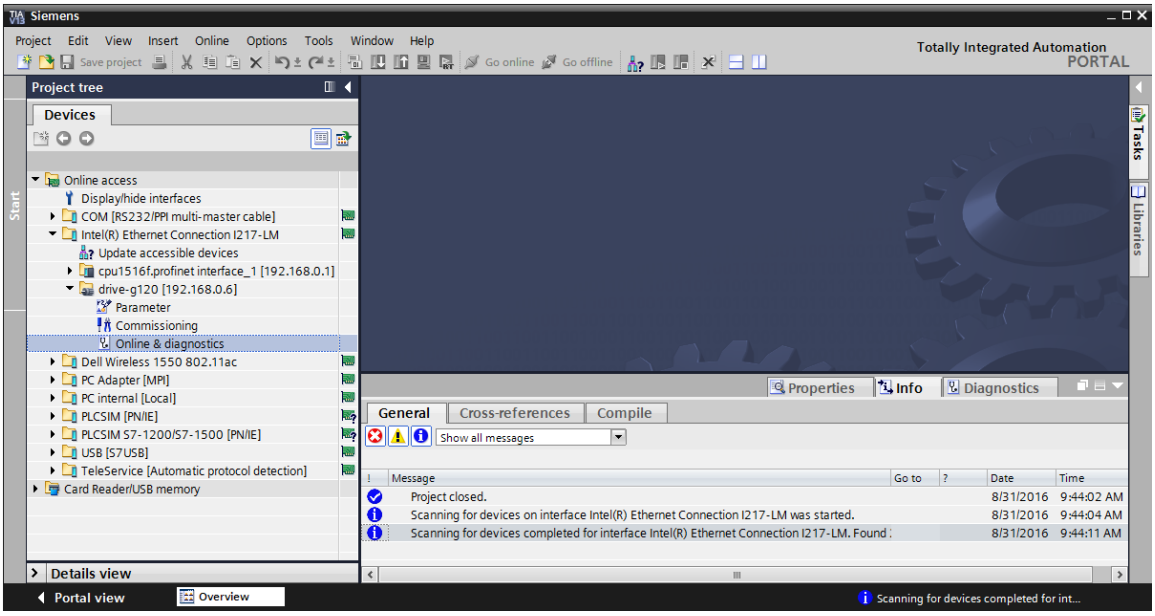
→ In the project tree select the network card of your computer under → "Online access". When you click → "Update accessible devices", you see the IP address (if already set) or the MAC address (if the IP address has not yet been assigned) of the Control Unit of the connected SINAMICS G120 frequency converter→. Select → "Online & diagnostics".



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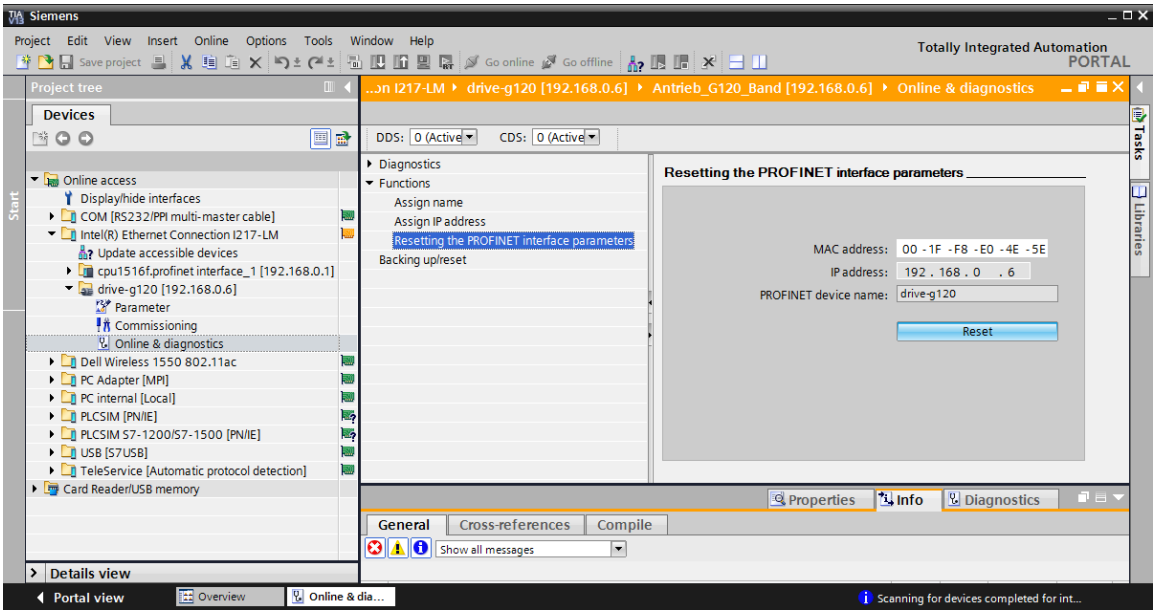
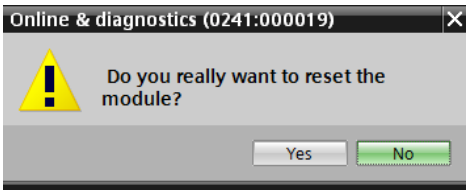
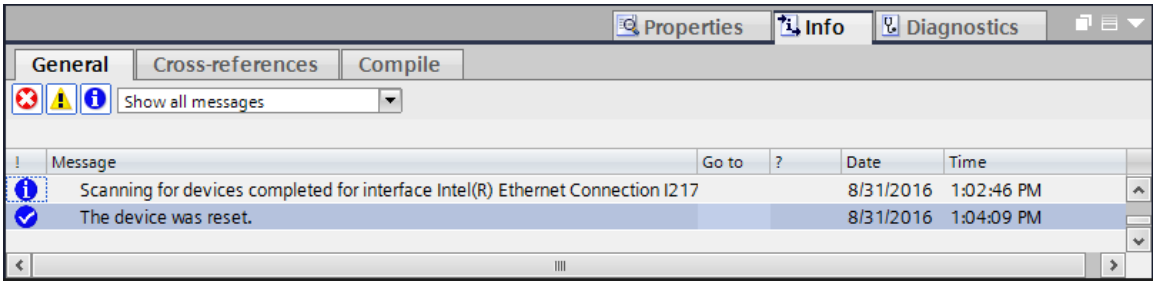
→ Before you reassign the IP address, we recommend that you first reset the PROFINET interface parameters. To do so select the function → "Resetting the PROFINET interface parameters" and click → "Reset".



→ Answer the prompt whether you really want to reset with → "Yes".



→ Successful resetting can be checked in the messages in the → "Info" window → "General".



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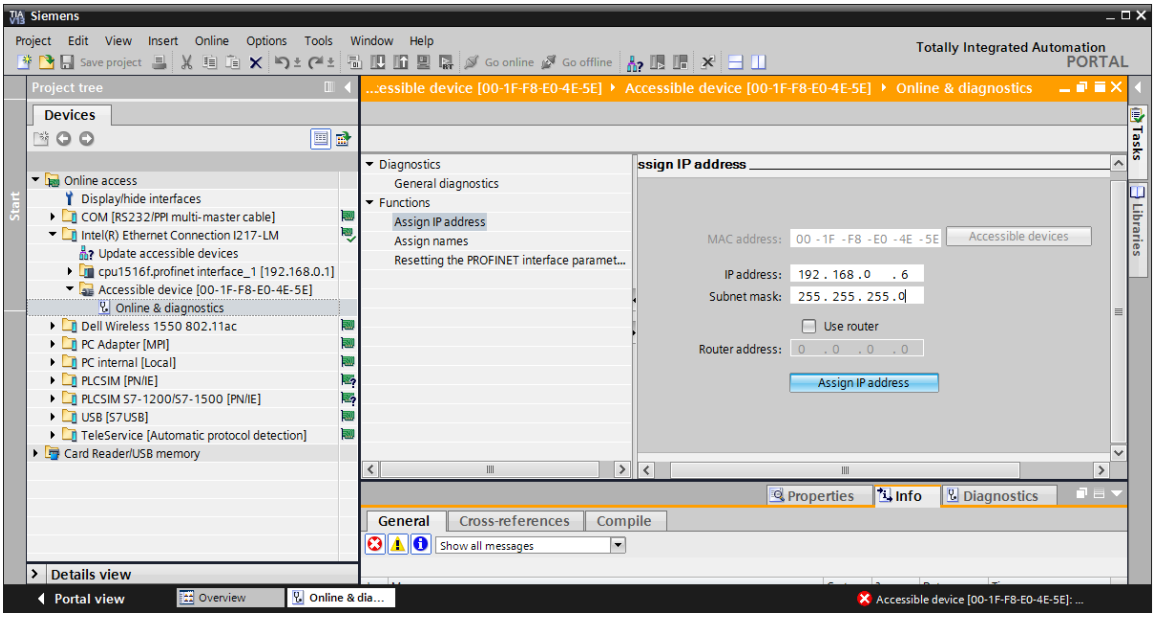
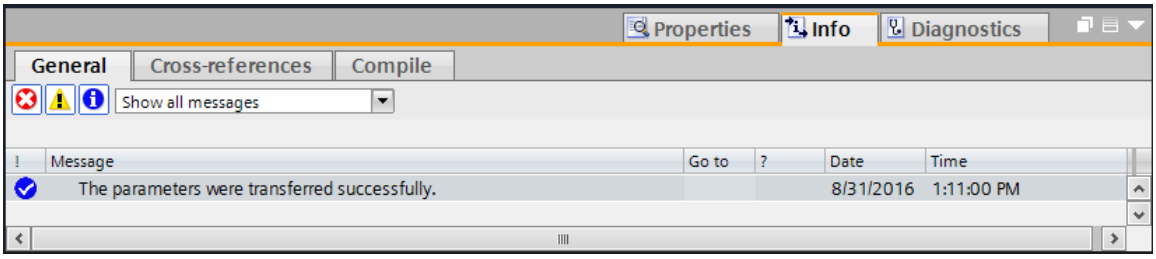
→ Then once again select → "Update accessible devices" and then → "Online & diagnostics" of your frequency converter. To assign the IP address, select the function → "Assign IP address". Enter the following IP address at this point: → IP address: 192.168.0.6 → Subnet mask: 255.255.255.0. Click → "Assign IP address" and this new address is assigned to the Control Unit of your frequency converter.



→ The successful assignment of the IP address is shown again as a message in the window → "Info" → "General".



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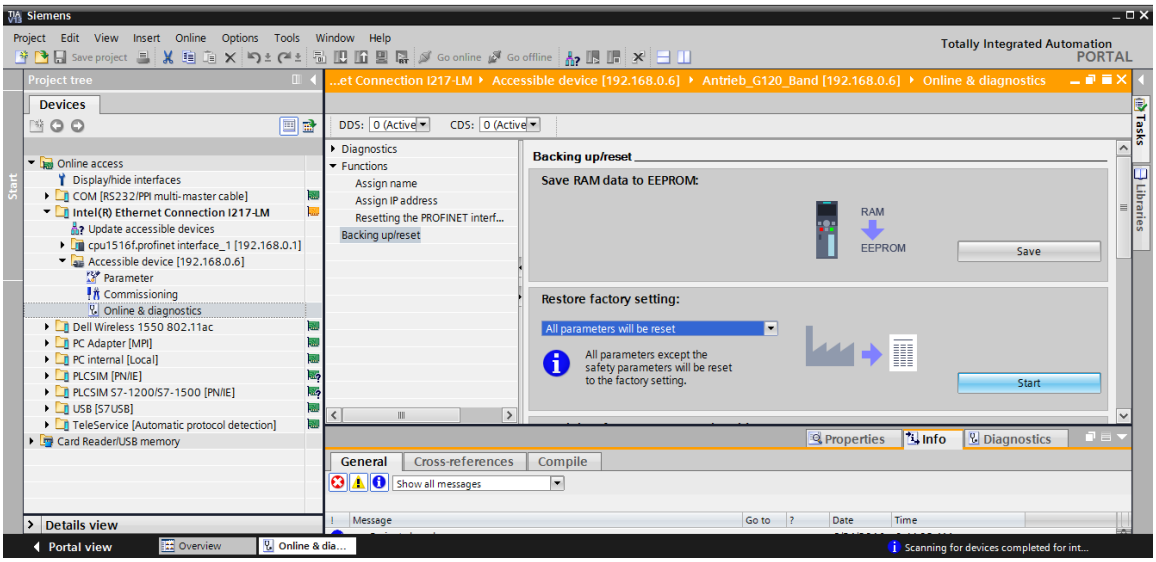
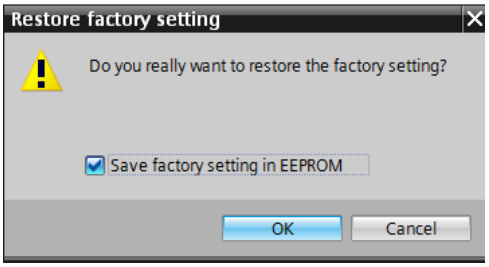
→ Before you can now carry out resetting of the frequency converter to the factory setting you have to once again select → "Update accessible devices" and the → "Online & Diagnostics" of your frequency converter. In order to reset the frequency converter to factory settings, select → "Restore factory resetting" under → "Backing up/reset" and click → "Start".



→ Select the option ☑ "Save factory setting in EEPROM" so that the parameters of the factory setting are loaded from the EEPROM into the RAM of the device after switching off and on - and not the data of an old project. Confirm the prompt whether you really want to reset with → "OK".



Note:

– *The communication settings such as the IP address and the subnet mask are retained when the frequency converter is set to the factory setting.*

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5 Task

In the following section the project from the chapter "SCE_EN_032-600_Global_Data_Blocks" is to be supplemented by a frequency converter G120 with Control Unit CU250S-2 PN.

Controlling of the belt motor via analog values is now replaced by the controlling of the frequency converter via PROFINET. Monitoring of the actual speed value is also effected via PROFINET.

6 Planning

The conveyor belt driven by an induction motor will now be controlled via a frequency converter with a variable speed.

This frequency converter has to be created, configured and commissioned in the project.

The parameter assignment of the frequency converter is done offline with the SINAMICS Startdrive software, whereby the commissioning wizard is used.

Here the motor data of the induction motor are taken from the rating plate of the motor and entered manually.

In this project the following induction motor is wired in Delta mode and operated single-phase with 230V.

Figure 1: Rating plate of induction motor

A diagram of the two connection types can be found on the inside of the terminal box cover of most motors:

• Star connection (Y)

• Delta connection (Δ)

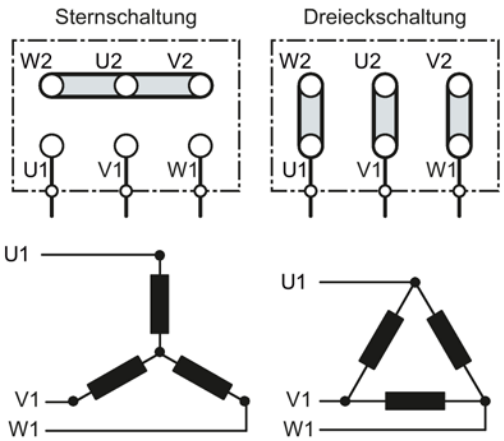

Figure 2: Star connection/delta connection

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The frequency converter SINAMICS G120 receives the start command and speed specification in the following via PROFINET from the SIMATIC S7-1500. The actual speed value is also read out of the SINAMICS G120 frequency converter via PROFINET and is monitored for the high and low limits in the SIMATIC S7-1500.

A "Frequency converter" data block [DB4] is created in the control program in which the data are stored temporarily for the request telegram and the response telegram. The telegrams are created there by means of the PLC data types and are mapped respectively in a structure.

In the "Main" organization block [OB1] you copy the actual values from the converter into the "Frequency converter" data block [DB4] and the setpoints from the data into the converter.

Finally, the data created in the "Frequency converter" data block [DB4] can be accessed when calling up the functions and function blocks.

6.1 Technology schematic diagram

At this point you see the technology schematic diagram for the task.

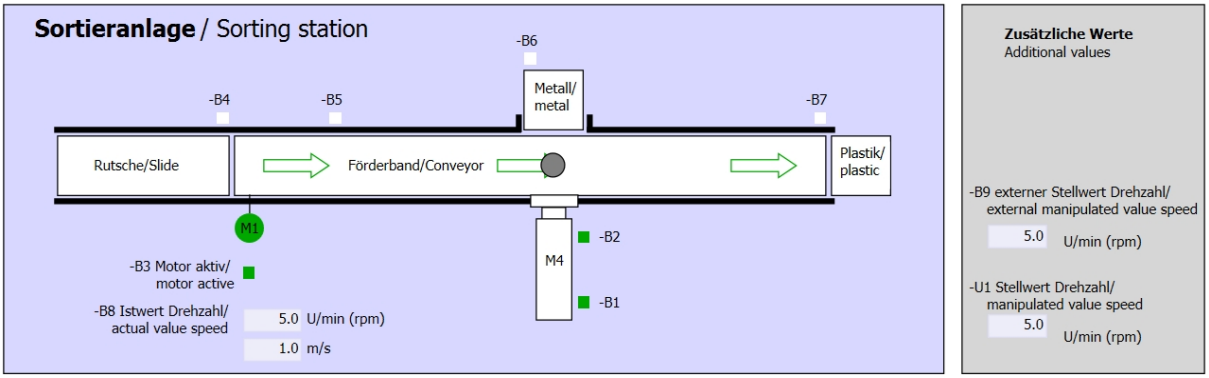

Figure 3: Technology schematic diagram

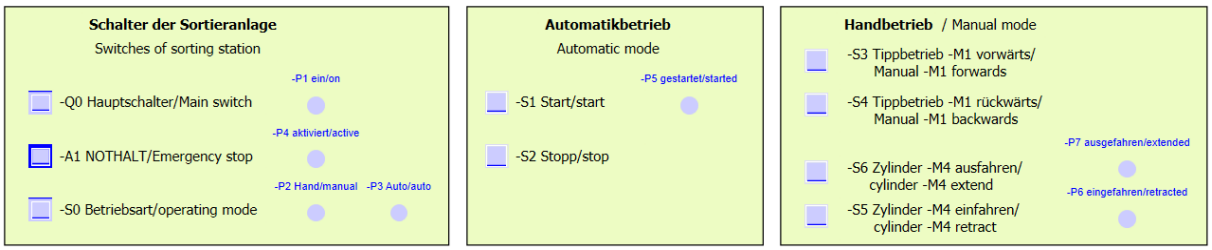

Figure 4: Operator panel

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6.2 Reference table

The following signals are required as global operands for this task.

DI	Type	ID	Function	NC/NO
I 0.0	BOOL	-A1	Return signal emergency stop ok	NC
I 0.1	BOOL	-K0	Main switch "ON"	NO
I 0.2	BOOL	-S0	Mode selector manual (0)/automatic (1)	Manual = 0
I 0.3	BOOL	-S1	Pushbutton automatic start	NO
I 0.4	BOOL	-S2	Pushbutton automatic stop	NC
I 0.5	BOOL	-B1	Sensor cylinder -M4 retracted	NO
I 1.0	BOOL	-B4	Sensor part at slide	NO
I 1.3	BOOL	-B7	Sensor part at end of conveyor	NO
ID256	STRUCT	PZD_IN_G120_01	Telegram 1 receive process data from G120 conveyor1	

DO	Type	ID	Function	
OD256	STRUCT	PZD_OUT_G120_01	Telegram 1 send process data to G120 conveyor1	

Legend for reference list

DI	Digital input	DO	Digital output
AI	Analog input	AO	Analog output
I	Input	O	Output
NC	Normally Closed		
NO	Normally Open		

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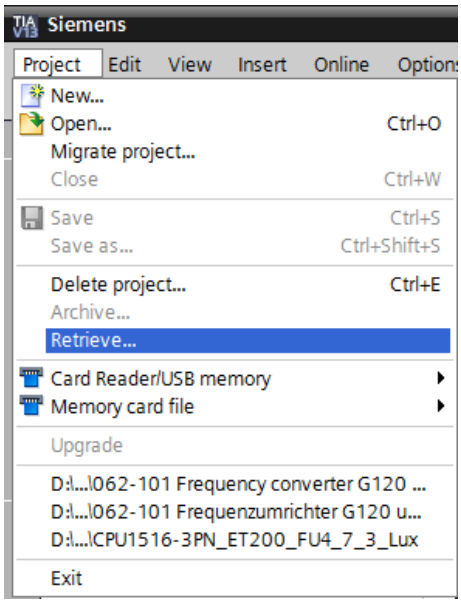
7 Structured step-by-step instructions

You can find instructions on how to perform planning below. If you already have a good understanding of everything, it is sufficient to focus on the numbered steps. Otherwise, simply follow the steps of the instructions illustrated below.

7.1 Retrieving an existing project

→ Before we can extend the project "SCE_EN_032-600_Global_Data_Blocks_R1508.zap13" from the chapter „SCE_EN_032-600_Global_Data_Blocks", we have to retrieve it. To retrieve an existing project, you have to select the respective archive in the project view under → Project → Retrieve. Confirm your selection with Open. (→ Project → Retrieve → Selection of a .zap archive → Open)



→ Next, the target directory in which the retrieved project is to be stored can be selected. Confirm your selection with "OK". (→ Target directory → OK)

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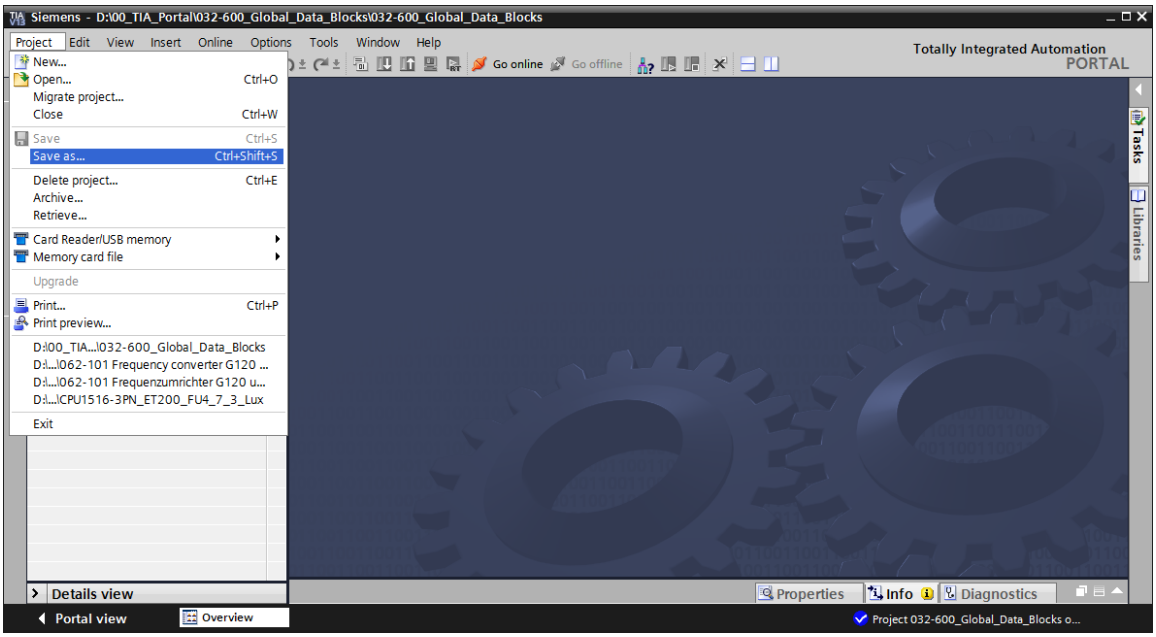
→ Save the opened project under the name 062-101 Frequency converter G120 and S7-1500.
(→ Project → Save as … → 062-101 Frequency converter G120 and S7-1500 → Save)



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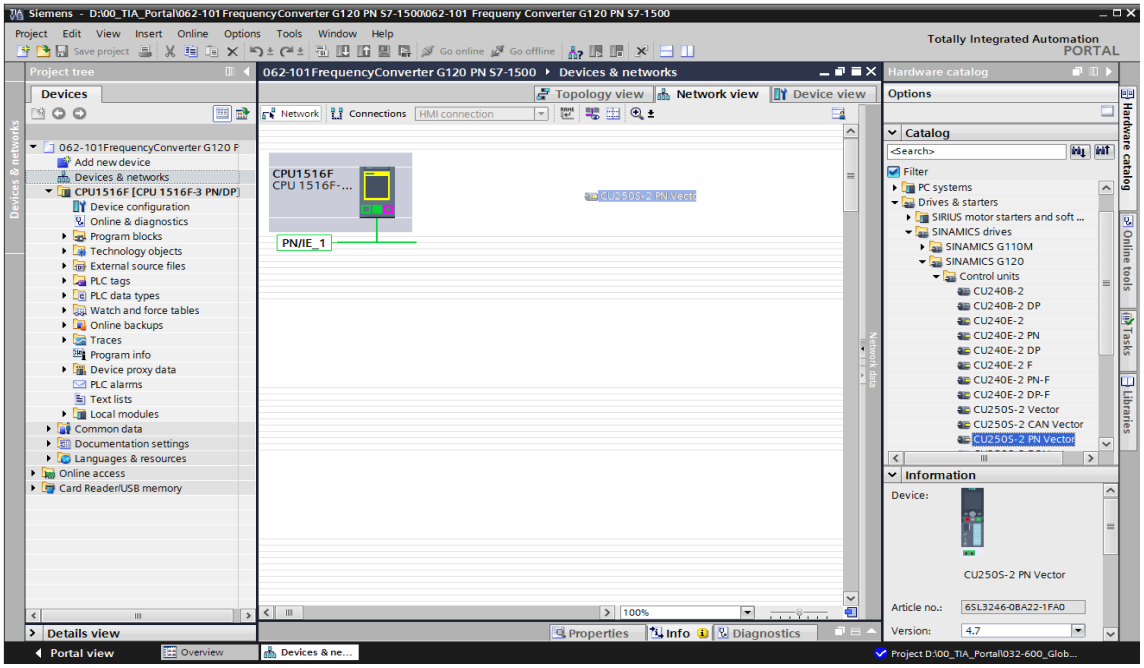
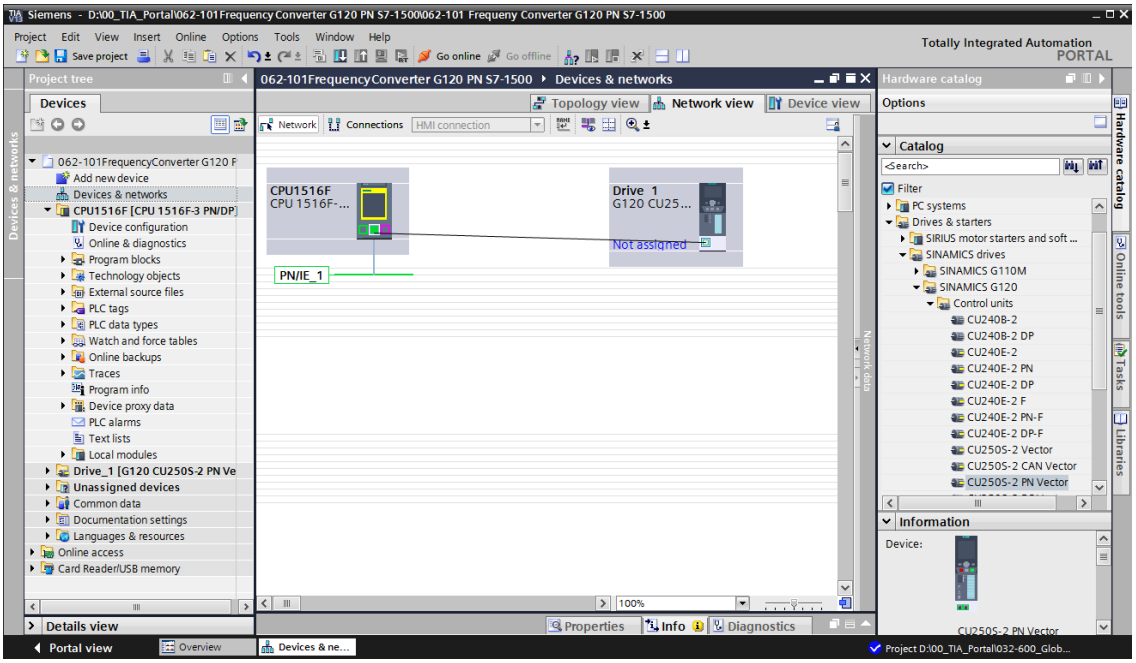
7.2 Creating a frequency converter in the TIA Portal

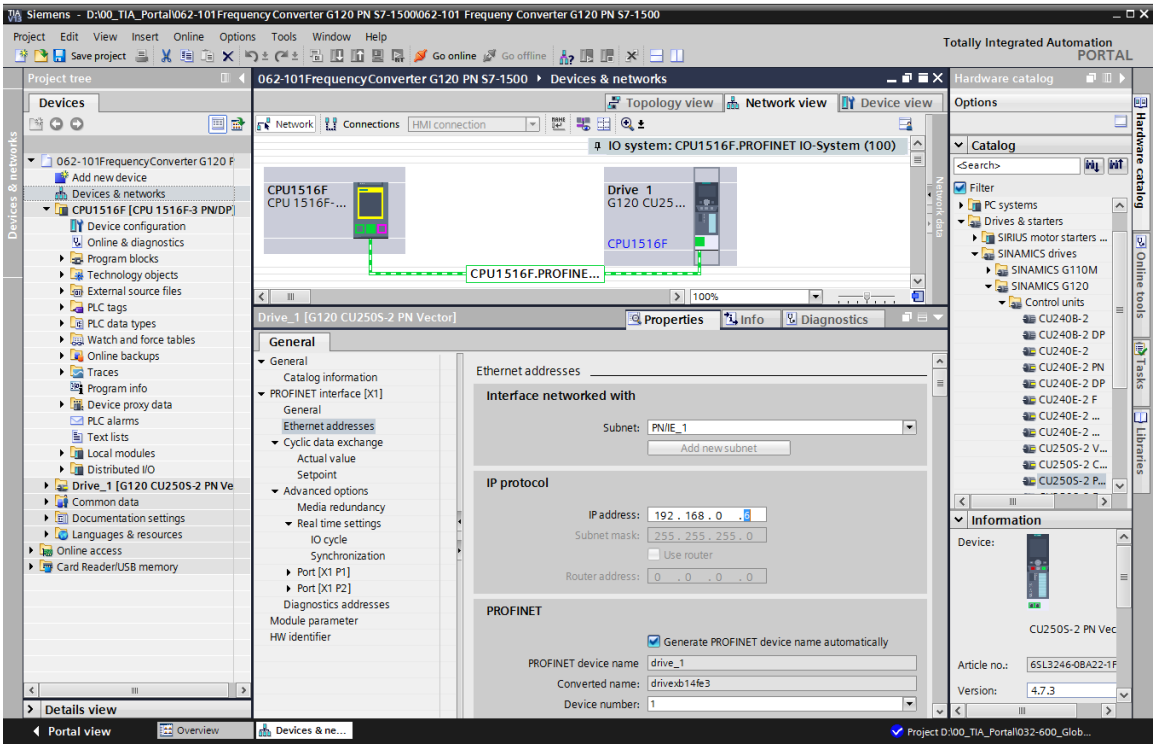
→ In order to network the Control Unit of the SINAMICS G120 with the CPU1516F-3 PN/DP you have to change to the 'Network view'. At this point the desired 'CU250S-2 PN Vector' can be dragged-and-dropped into the network view. (→ Devices & networks → Network view → Drives & starters → SINAMICS drives → SINAMICS G120 → Control units→ CU250S-2 PN Vector → Article No.: 6SL3246-0BA22-1FA0 → Version 4.7).



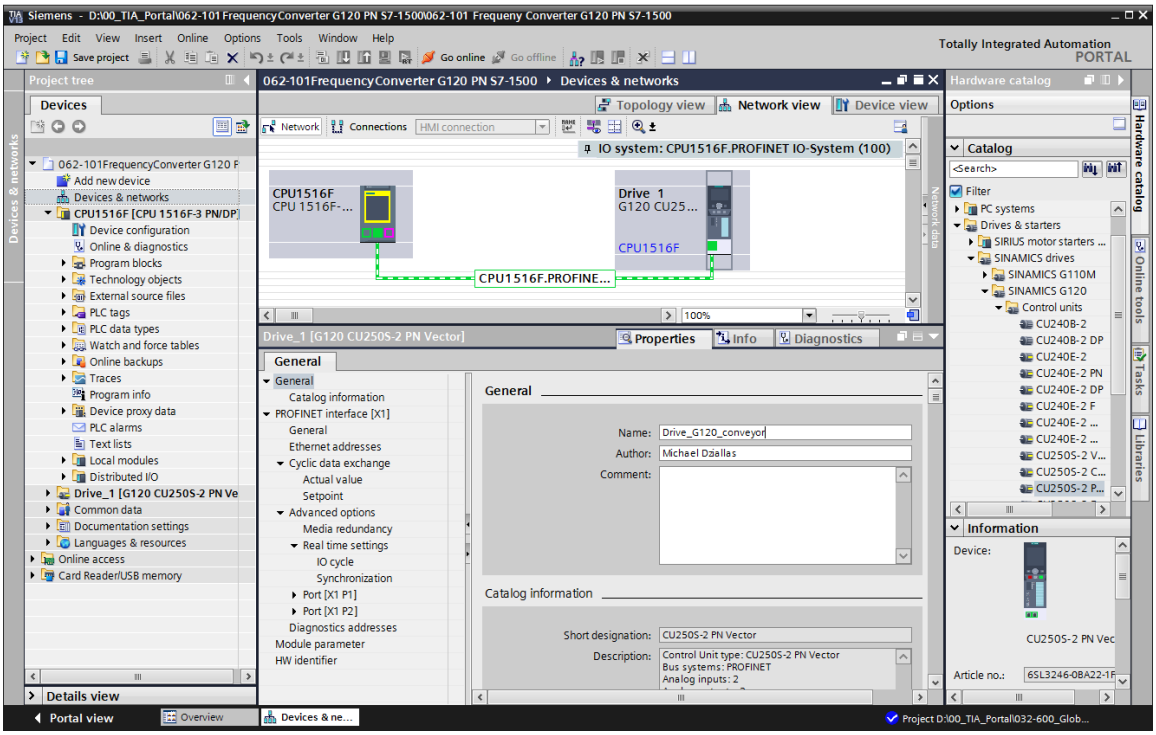
→ Connect the Ethernet interfaces of the Control Unit of the G120 and the CPU1516F-3 PN with the mouse. (→ Ethernet → Ethernet)



→ an IP address suitable for the CPU in the properties of the 'PROFINET interface [X1]' of the 'G120'. (→ G120 CU250S-2 PN Vector → PROFINET interface [X1] → Properties → Ethernet addresses → IP protocol → IP address: 192.168.0.6)



→ The device name is entered under 'General'. (→ General → Name: Drive_G120_conveyor)



Note:

– *This name is applied automatically as the PROFINET device name under the 'PROFINET' point for the 'PROFINET interface' of the 'G120 CU250S-2 PN-Vector'.*

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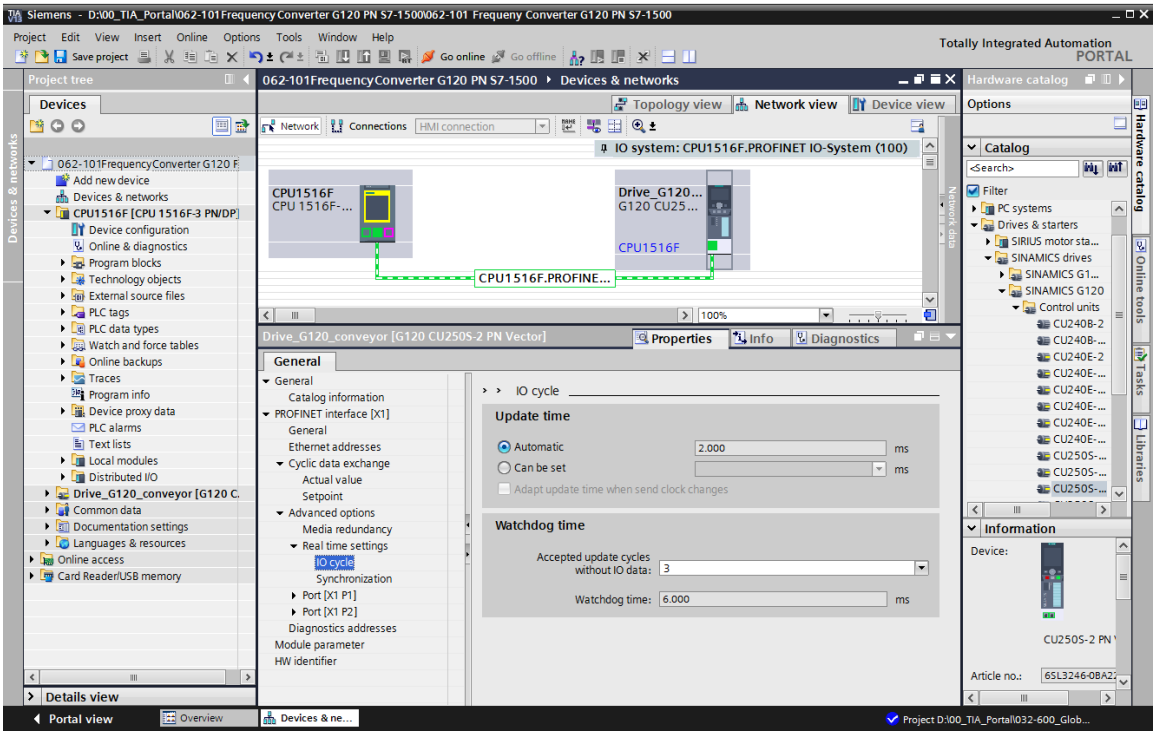
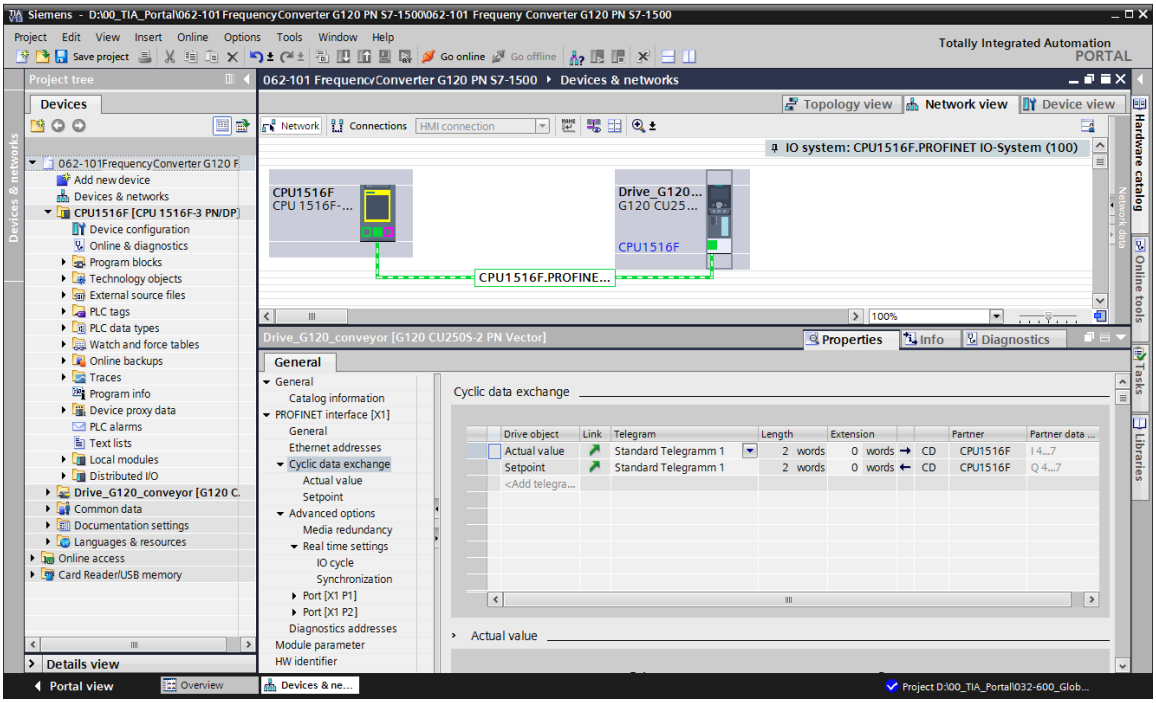
→ Settings for the 'IO cycle' such as the 'Update time' and 'Watchdog time' can also be set for this device. (→ Advanced options → Real time settings → IO cycle → Update time → Watchdog time)



→ The 'Standard Telegram 1' is specified for the 'Cyclic data exchange' between the PLC and the frequency converter. (→ PROFINET interface [X1] → Cyclic data exchange → Actual value: Standard Telegram 1→ Setpoint: Standard Telegram 1)



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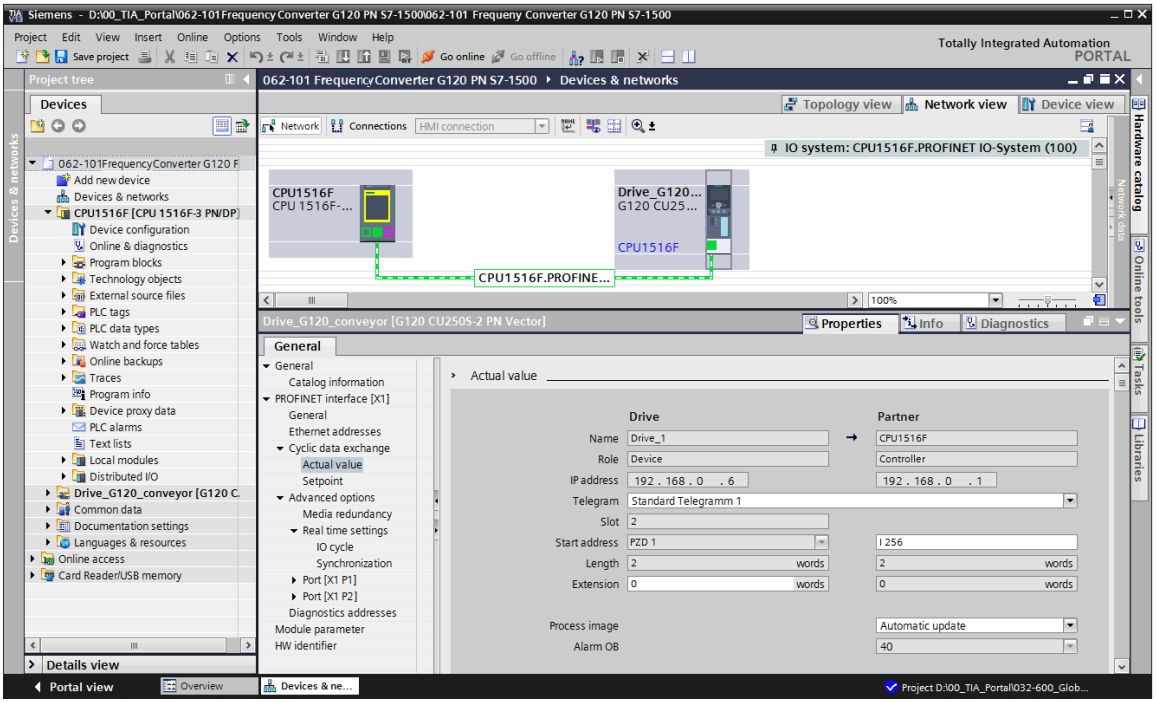
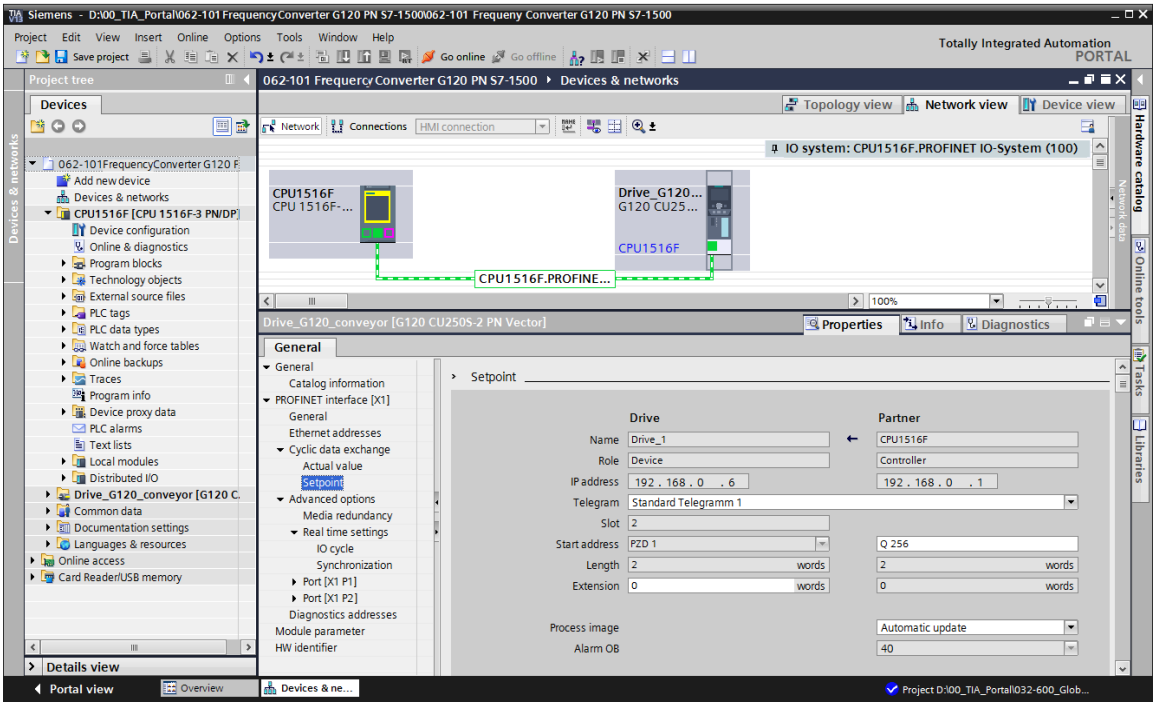
→ For the address ranges, select 'I 256…259' and 'O 256 … 259'. (→ PROFINET interface [X1] → Cyclic data exchange → Actual value → Start address I 256 → Setpoint → Start address O 256)





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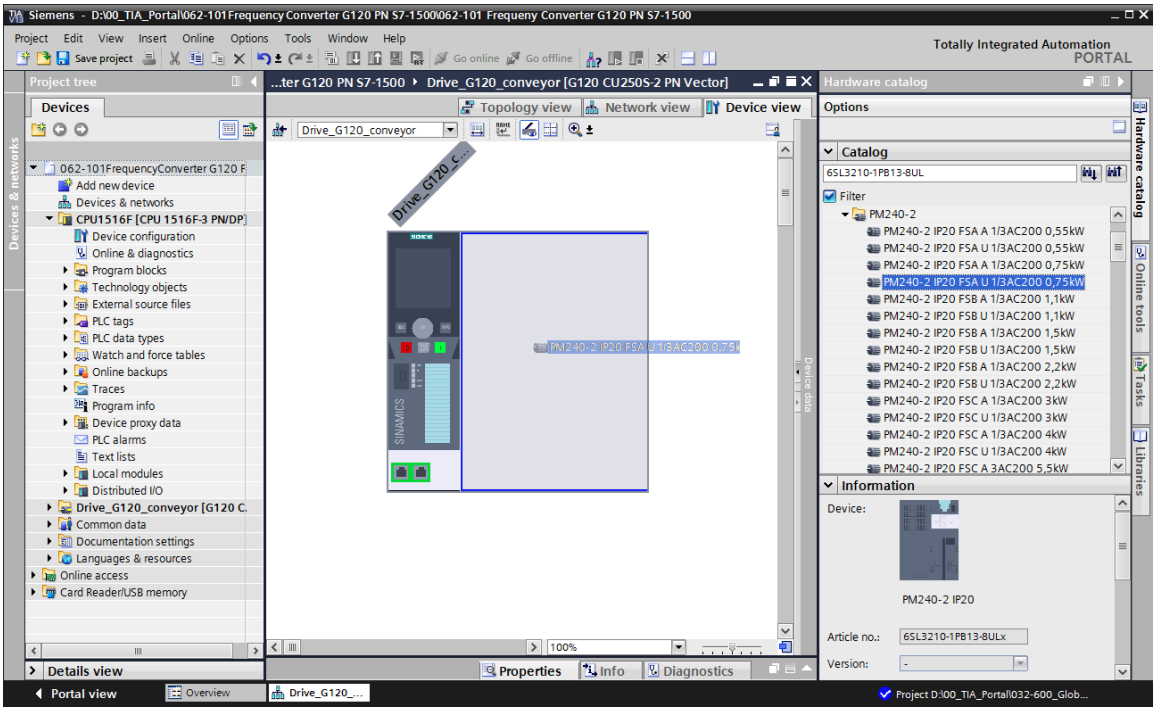
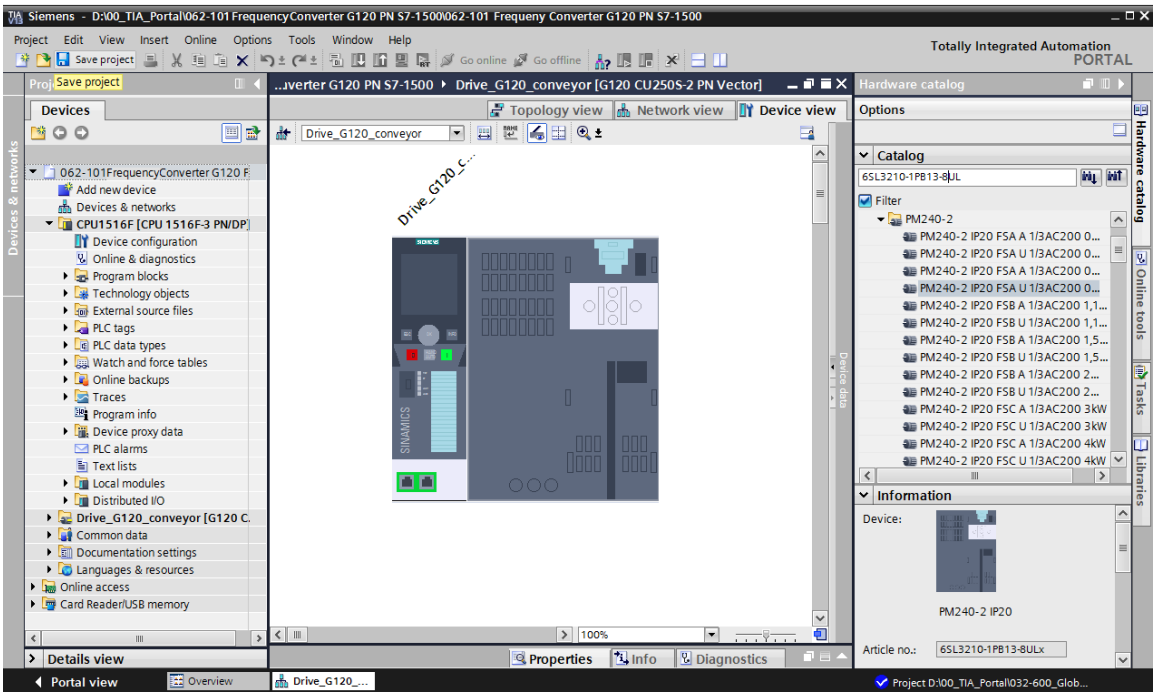
→ Change to the 'Device view' from 'Drive_G120_conveyor'. There the used Power Module, for example 'PM240-2 IP20 FSA U 1/3 AC200 0.75kW', is selected and assigned to the 'Drive_G120_conveyor'.

(→ Device view → Drive_G120_conveyor → PM 240-2 IP20 FSA U 1/3 AC200 0.75kW)



→ Save the project with the existing settings. (→ Save project)



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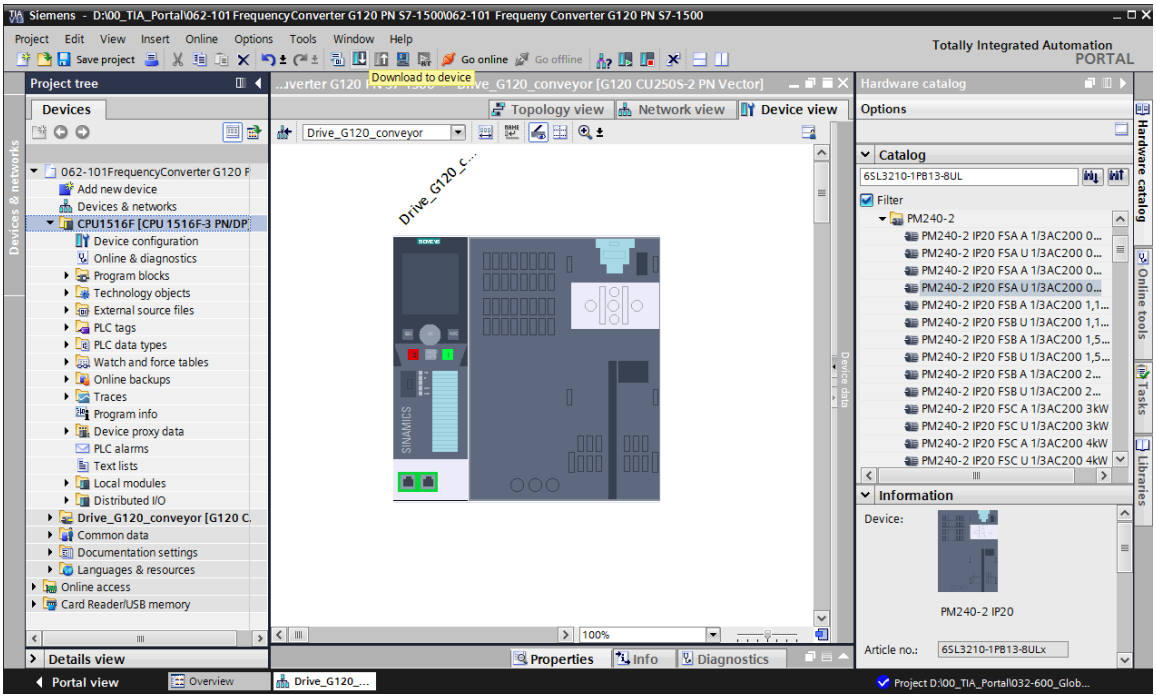
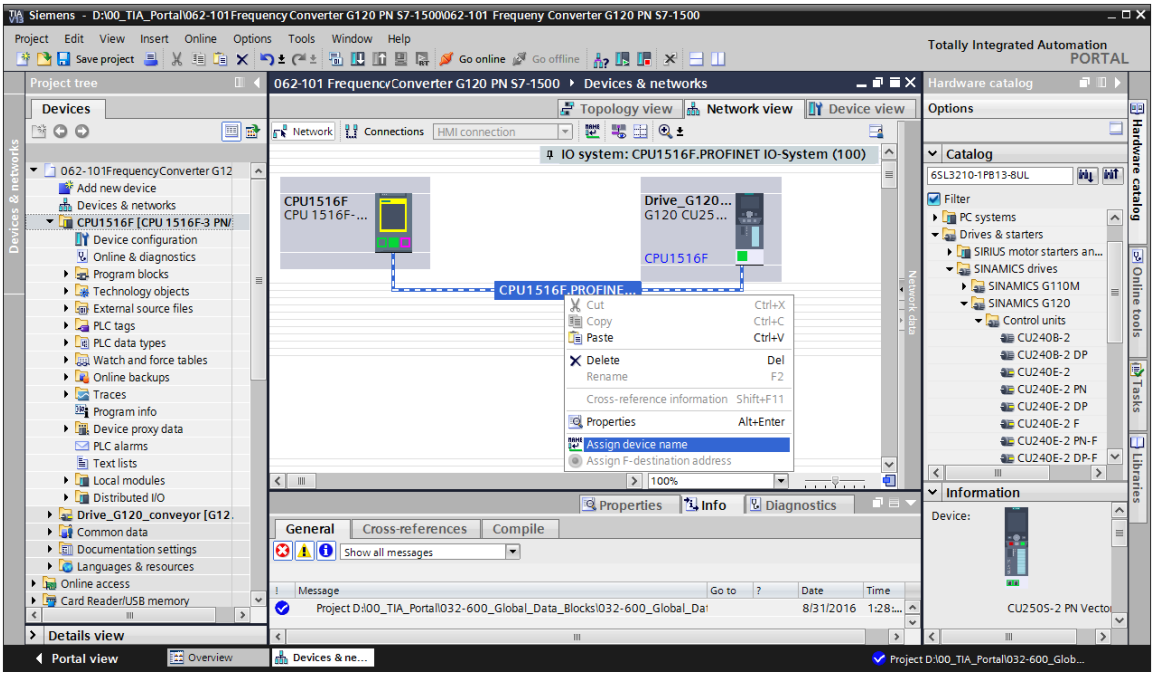
→ Download the device configuration with the frequency converter G120 as the device to the 'CPU_1516F [CPU1516F-3 PN/DP]' by clicking the ' Download to device' icon. (→CPU_1516F [CPU1516F-3 PN/DP] →)



→ The device name still has to be assigned to the frequency converter G120 as an IO device of the CPU_1516F. To do so, select the 'PN/IE_1' network and select 'Assign device name'. (→ PN/IE_1 → Assign device name)



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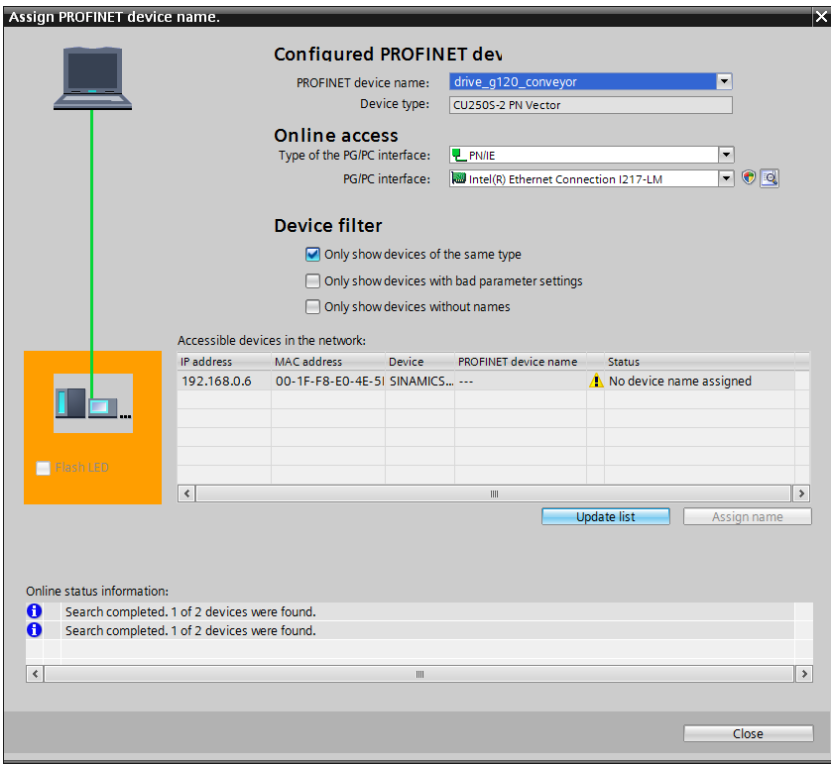
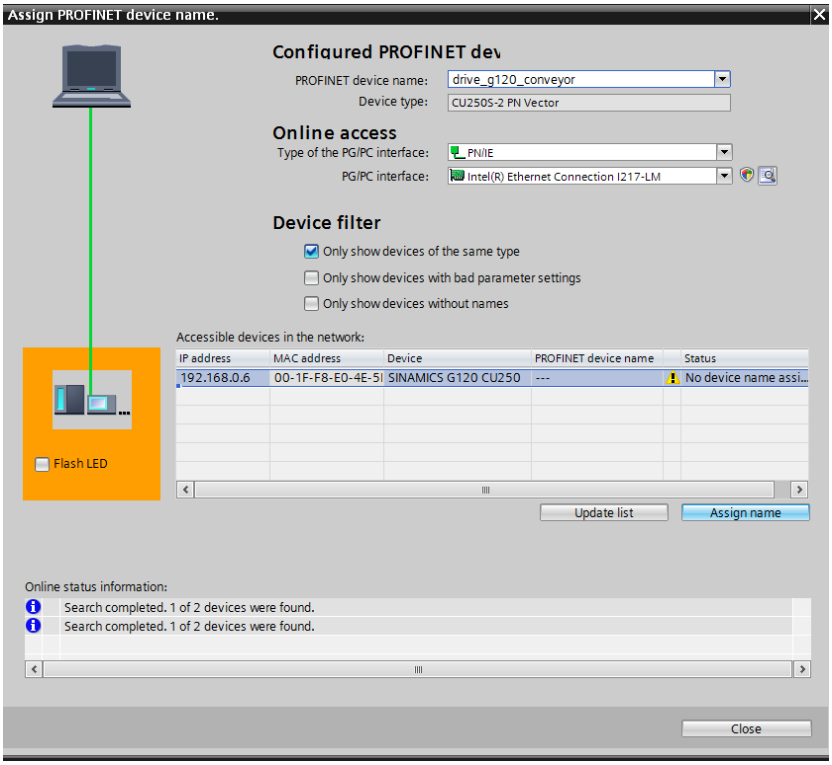
→ In the subsequent dialog, the "PG/PC interface' can be selected, before we select the 'Drive_G120_conveyor' and 'Assign name'. (→ PROFINET device name: Drive_G120_conveyor → SINAMICS G120 CU250S → Assign device name)





Note:

– *If several IO devices exist in the network, the device can be identified on the basis of the imprinted MAC address.*

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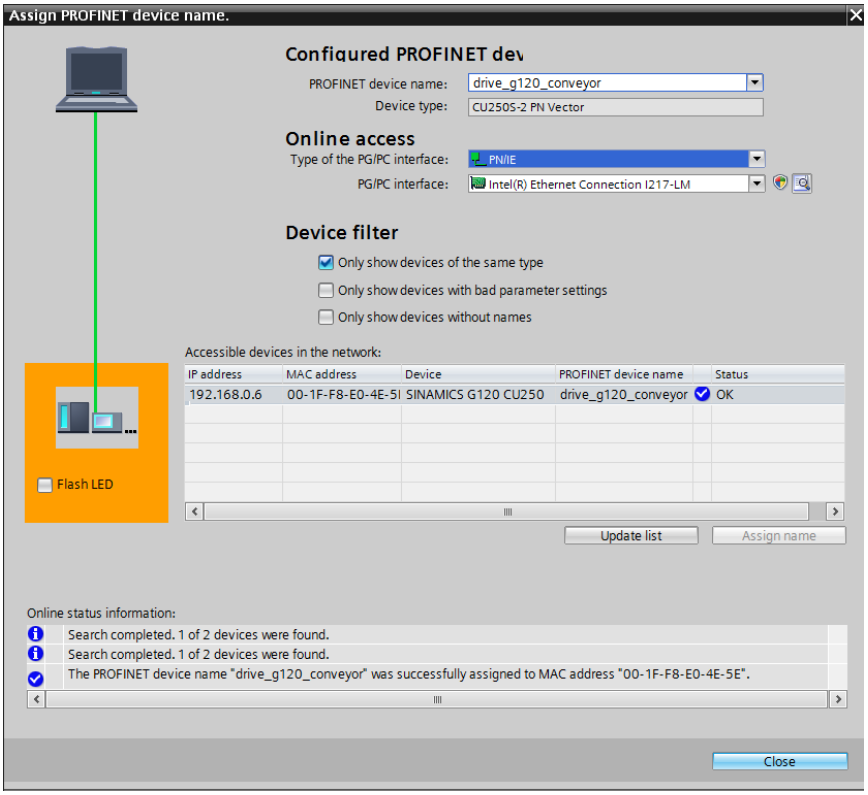
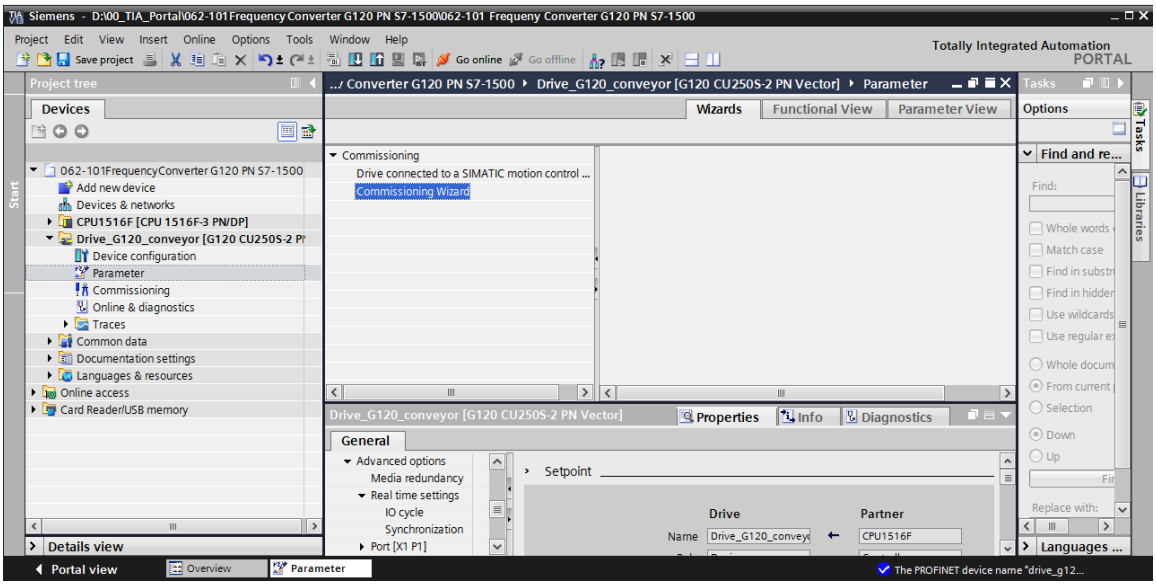
→ If too many components are displayed, the view can be filtered by clicking on 'Only show devices of the same type'. If the device name was assigned successfully, this is indicated by 'OK' in the status. (→ Close)



7.3 Assigning parameters of the frequency converter with the commissioning wizard

→ To assign the parameters of the frequency converter, double-click 'Parameter' of 'Drive_G120_conveyor' to open the parameters and start the 'Commissioning Wizard'. (→ Drive_G120_conveyor → Parameter → Commissioning Wizard)



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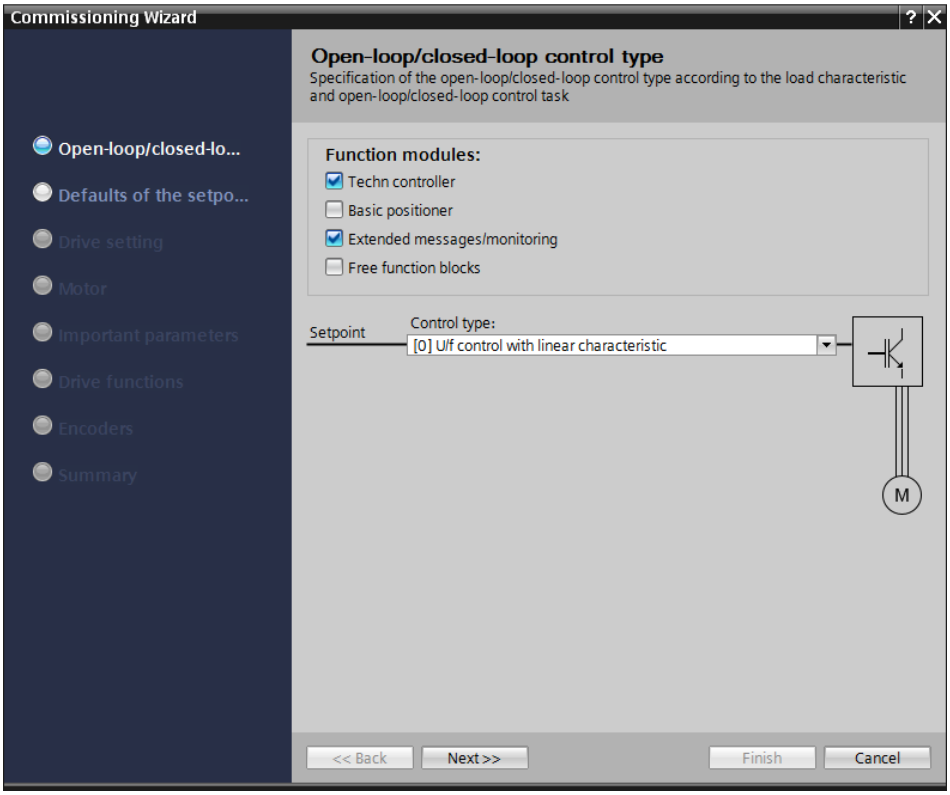
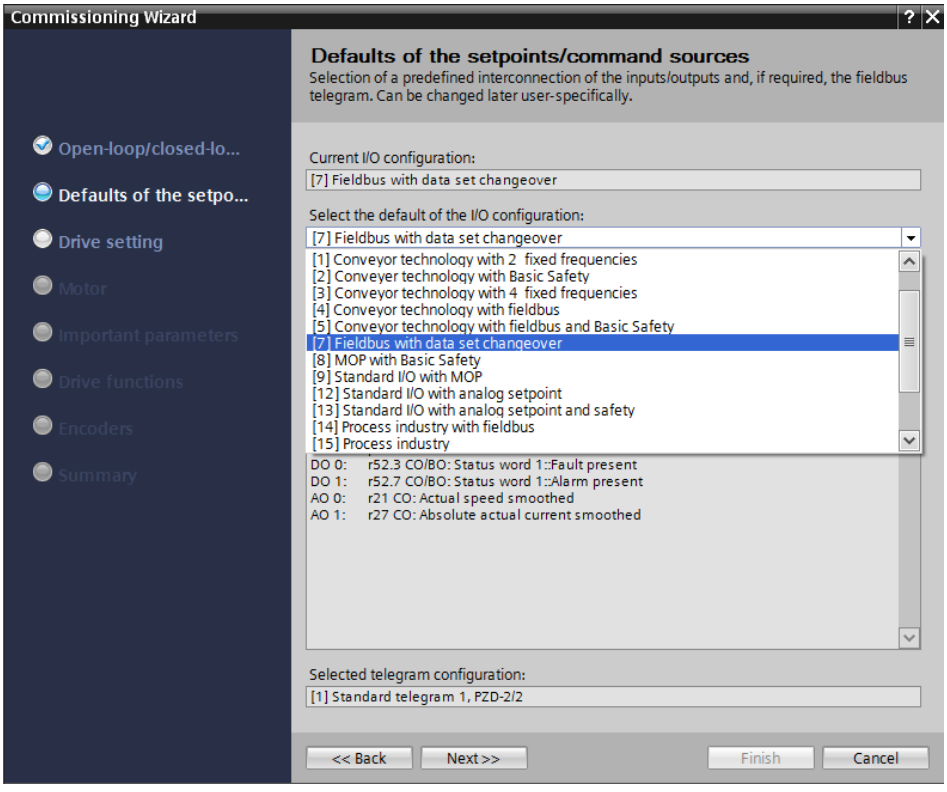
→ In the subsequent dialog, select 'U/f control with linear characteristic' as the control type. Keep the default selection for the function modules. (→ U/f control with linear characteristic → Next)



→ For selection of the setpoint and command source, select the macro 7 'Fieldbus with data set changeover'. (→[7] Fieldbus with data set changeover)



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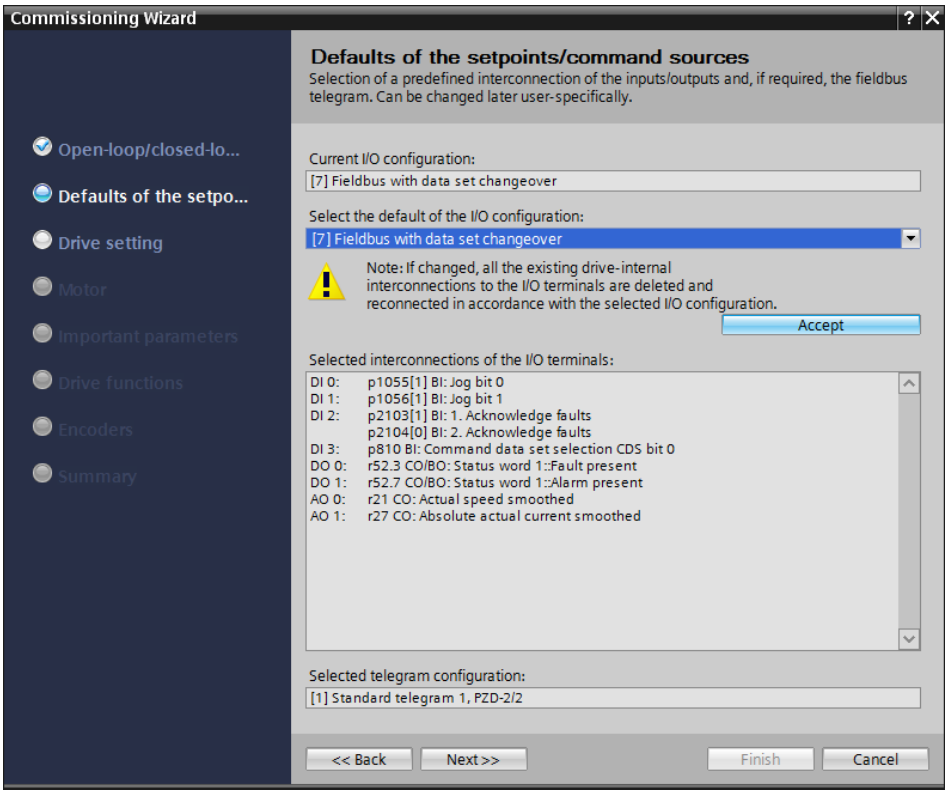
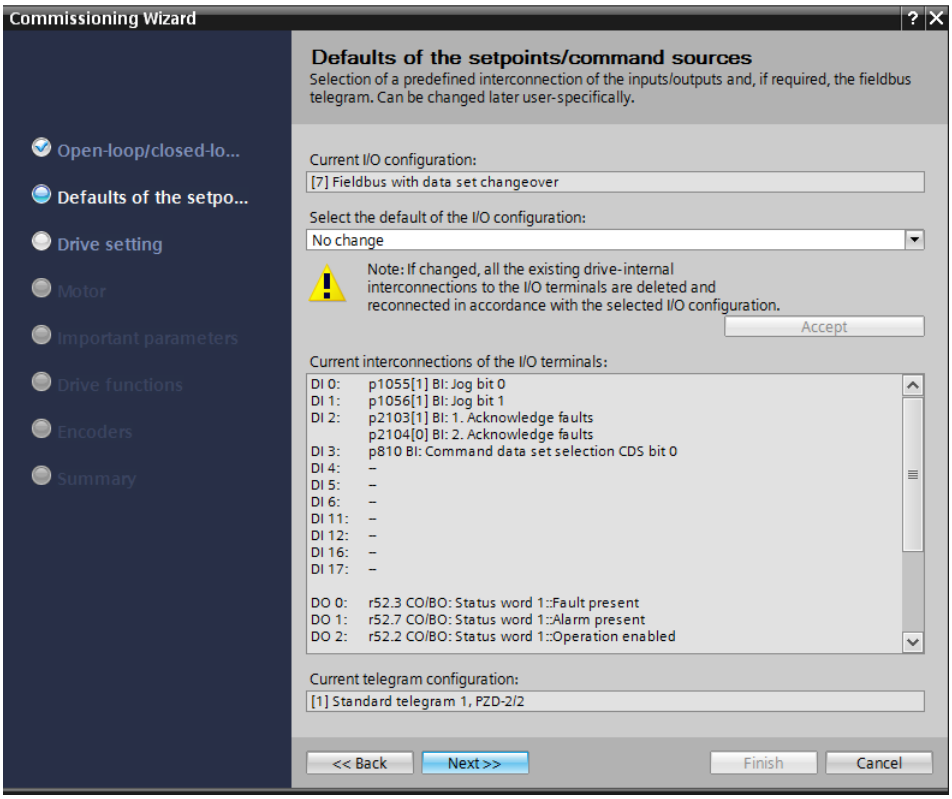
→ The selection of the macro '[7] Fieldbus with data set changeover' still has to be confirmed with 'Accept'. (→ Accept)



→ The current interconnections of the IO terminals for the Macro 7 are now displayed. (→ Next)



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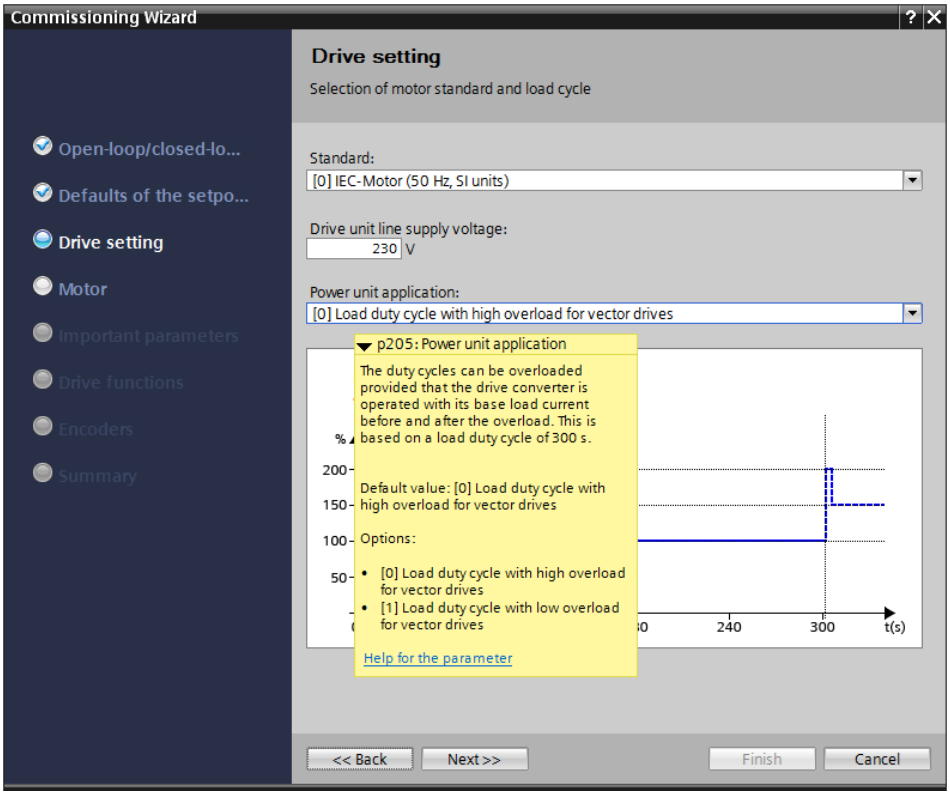
→ For the drive settings, select the 'IEC-Motor (50 Hz, SI units)' and 'Load duty cycle with high overload for vector drives'. (→ IEC-Motor (50 Hz, SI units) → Load duty cycle with high overload for vector drives → Next)



Note:

– *Further information about the settings is available in the tool tip text, the online help or in the list manual.*

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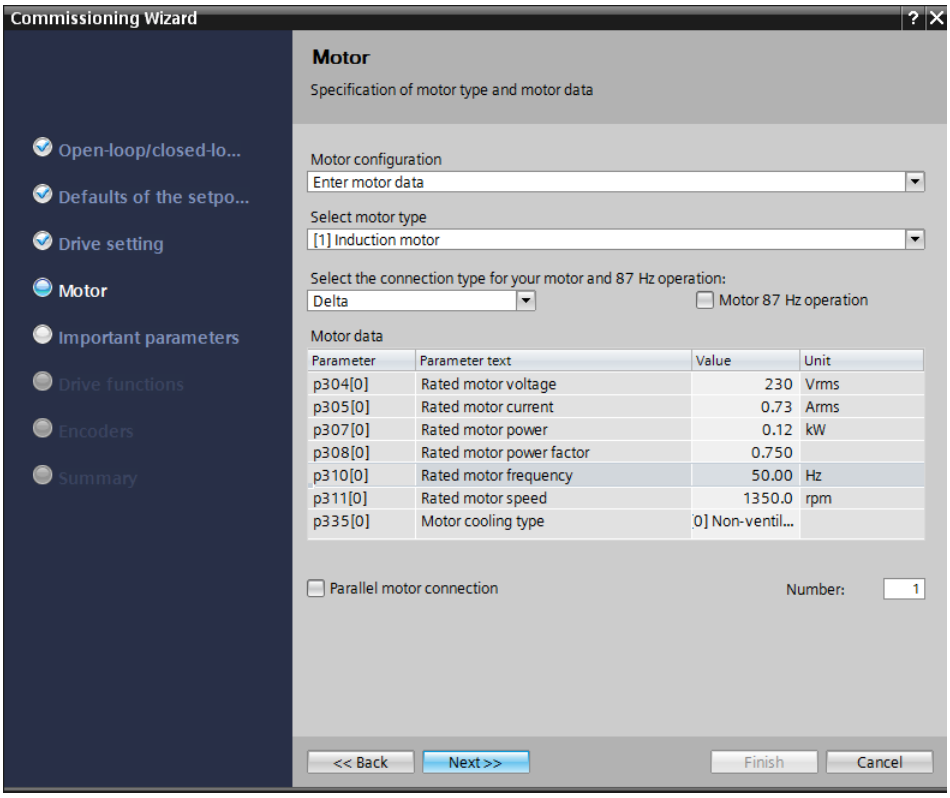
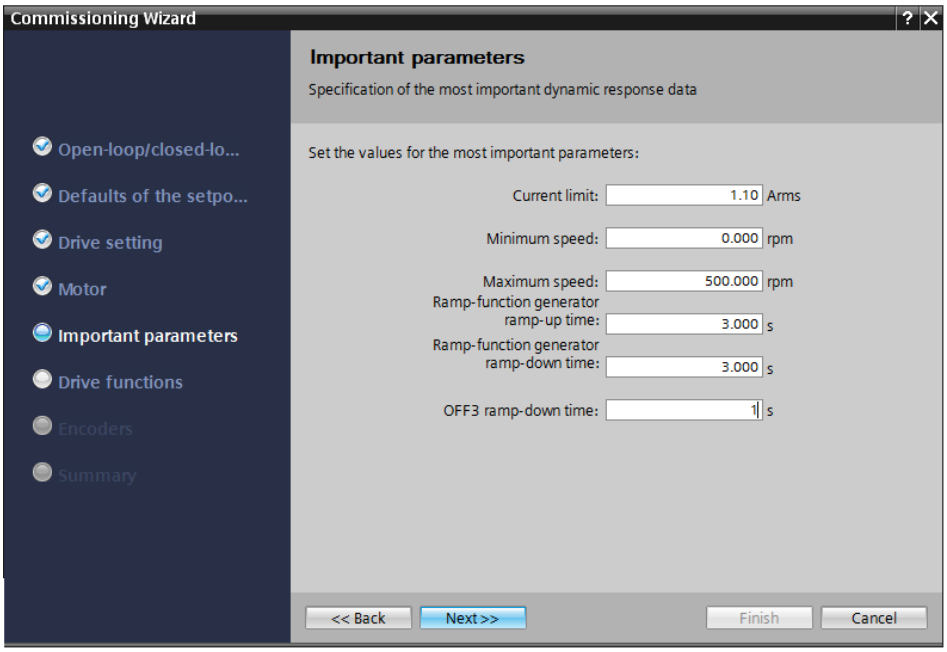
→ In the subsequent dialog, select 'Induction motor' as the motor type and enter the motor data in accordance with the specifications of the rating plate of the motor (→ Enter motor data → Induction motor → Connection type: Delta → … → Next)



Note:

– *Alternatively, SIEMENS motors can also be selected directly via the order numbers.*

→ The following screenshot shows an example for the parameters for the current/speed limiting and for the ramp-function generator.(→ Next)



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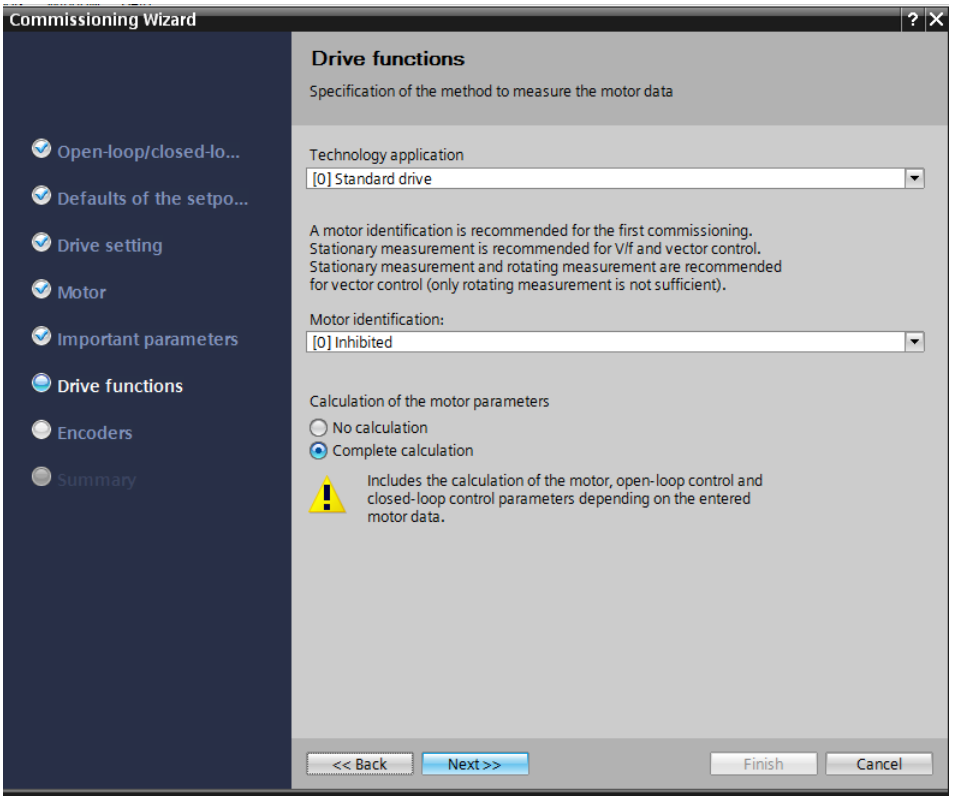
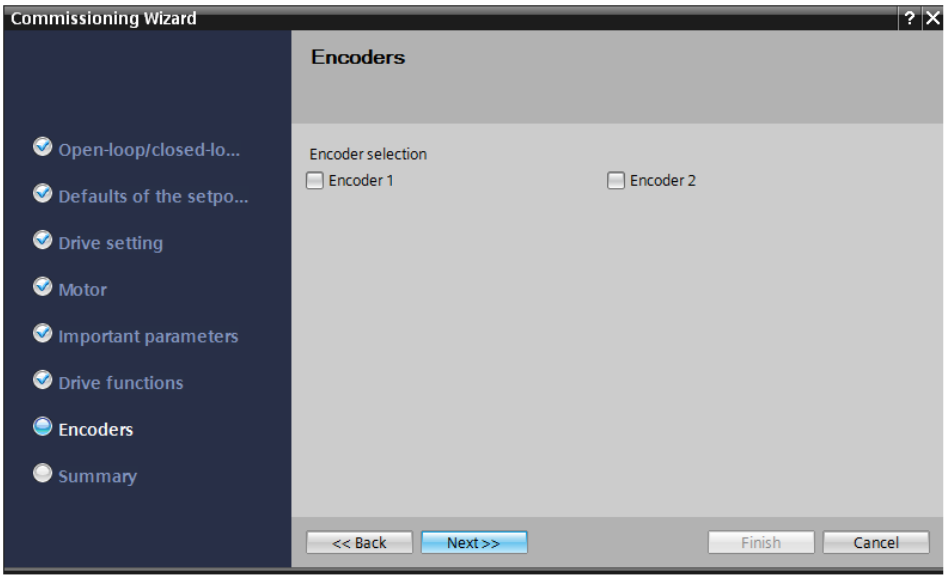
→ Select 'Standard drive' for the Technology application. Set the motor identification to 'Inhibited', and select 'Complete calculation' for calculating the motor parameters based on parameter values from before. (→ Standard drive → Motor identification: Inhibited → Complete calculation → Next)



→ Do not select an encoder at this point. (→ Next)



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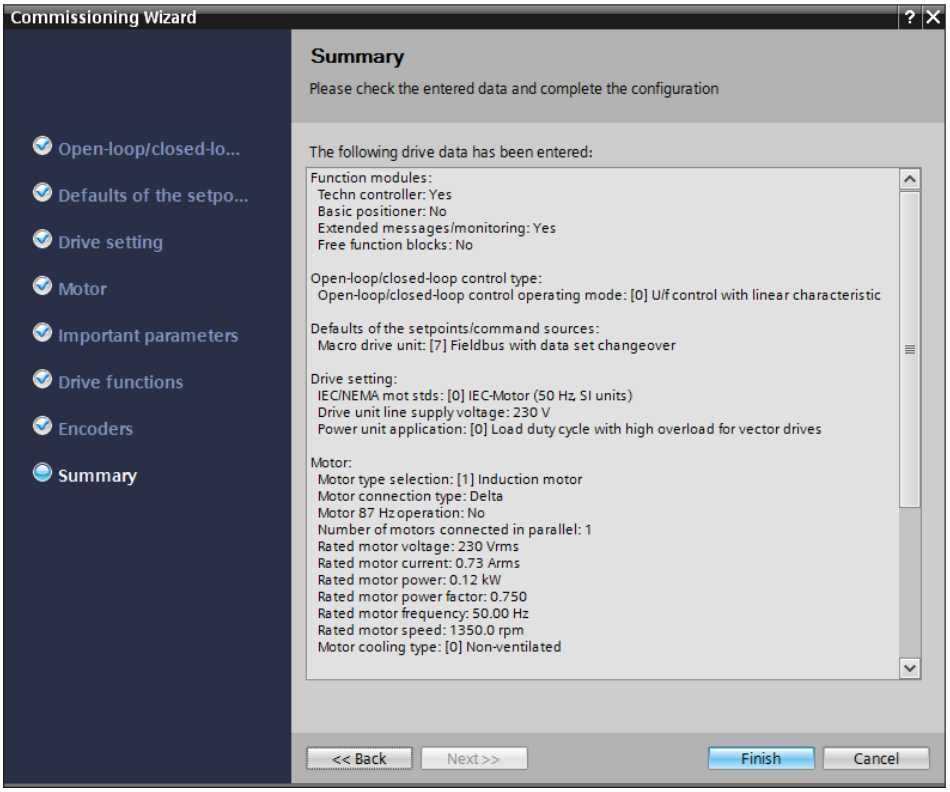
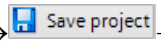
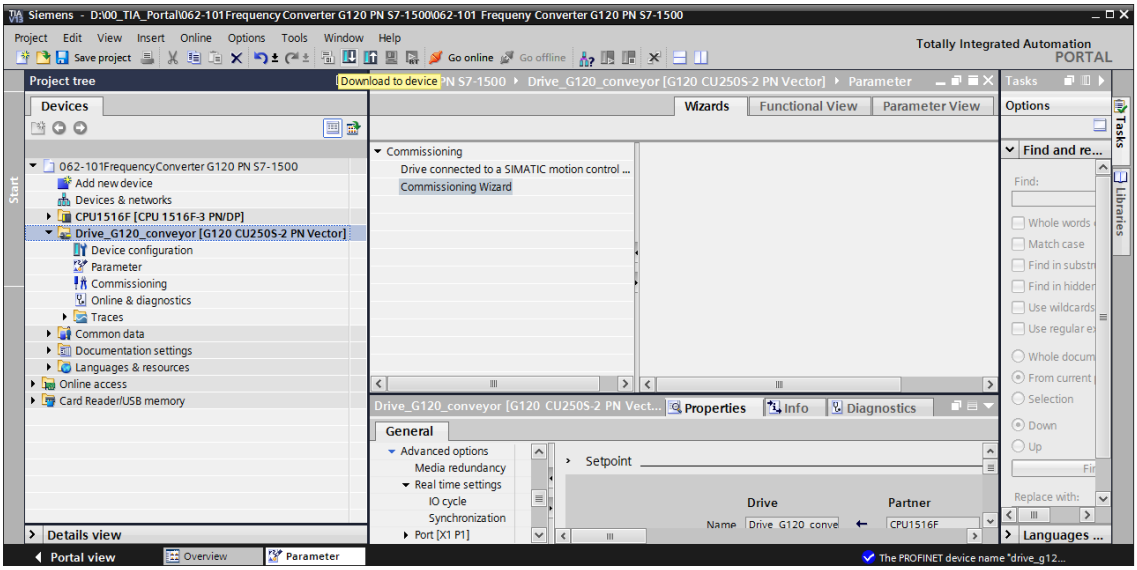
→ In the subsequent summary, all the settings are shown once more for checking. These are applied by using the 'Finish' button. (→ Finish)



→ Save the project once more before downloading the parameters into the 'Drive_G120_conveyor',  '. (→ 

→ Drive_G120_conveyor → )



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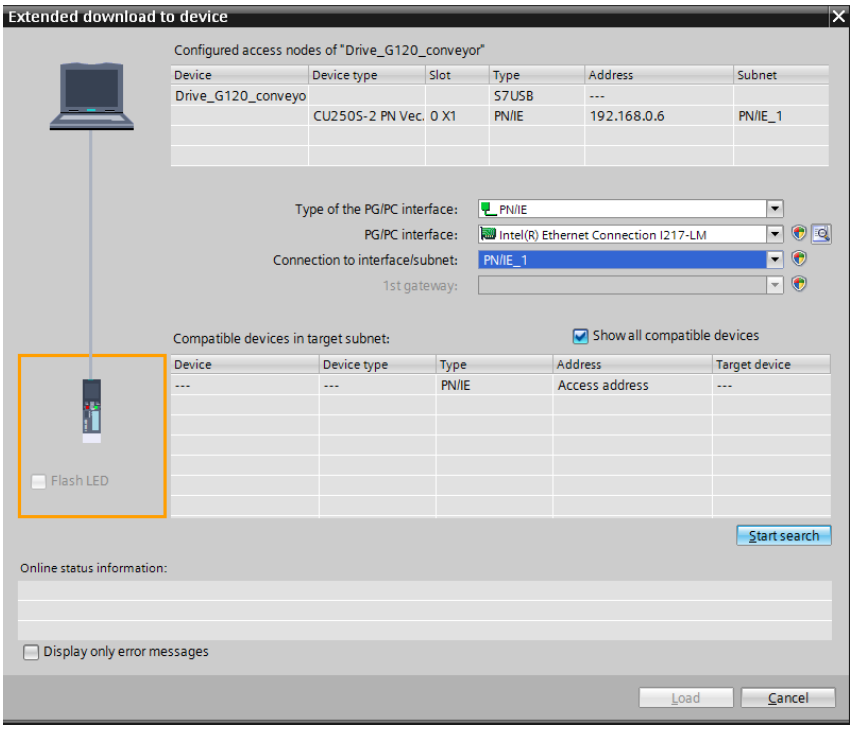
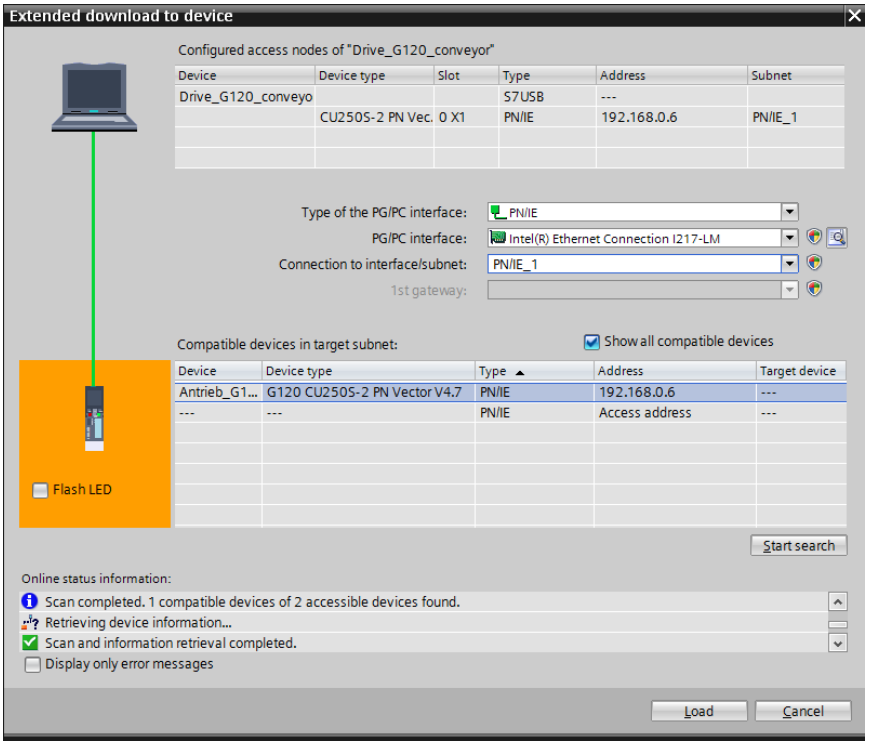
→ In the subsequent dialog, select 'PN/IE' as the PG/PC interface type, select the previously set network adapters as the PG/PC interface and select 'PN/IE_1' as the connection of the CPU to the subnet. Click 'Start search'. (→ Type of the PG/PC interface: PN/IE → PG/PC interface: …… → Connection to interface/subnet: PN/IE_1 → Start search)



→ You should now see your 'SINAMICS drive' and be able to select it as the target device. Click 'Load''. (→ SINAMICS drive → Load)



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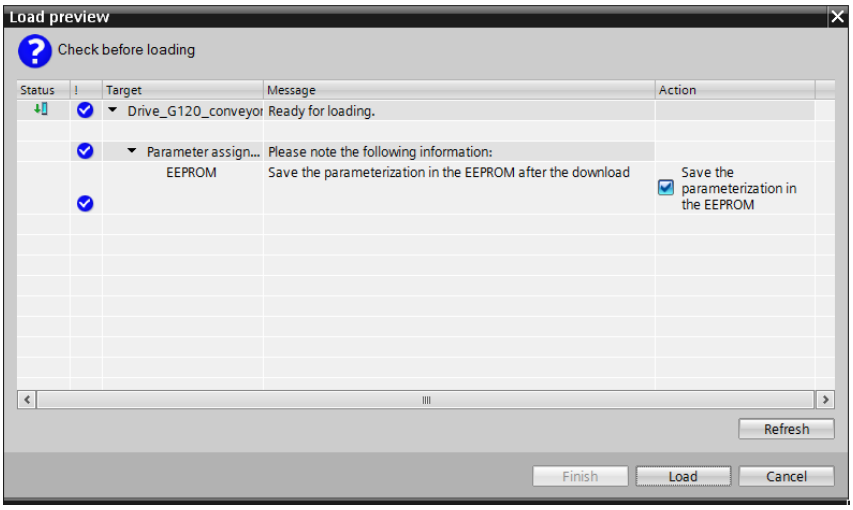
→ The configuration is compiled automatically and is displayed once more in an overview so that you can check the steps to be carried out before loading. Now select '☑ Save the parameterization in the EEPROM' and click 'Load'. (→ ☑ Save the parameterization in the EEPROM → Load)

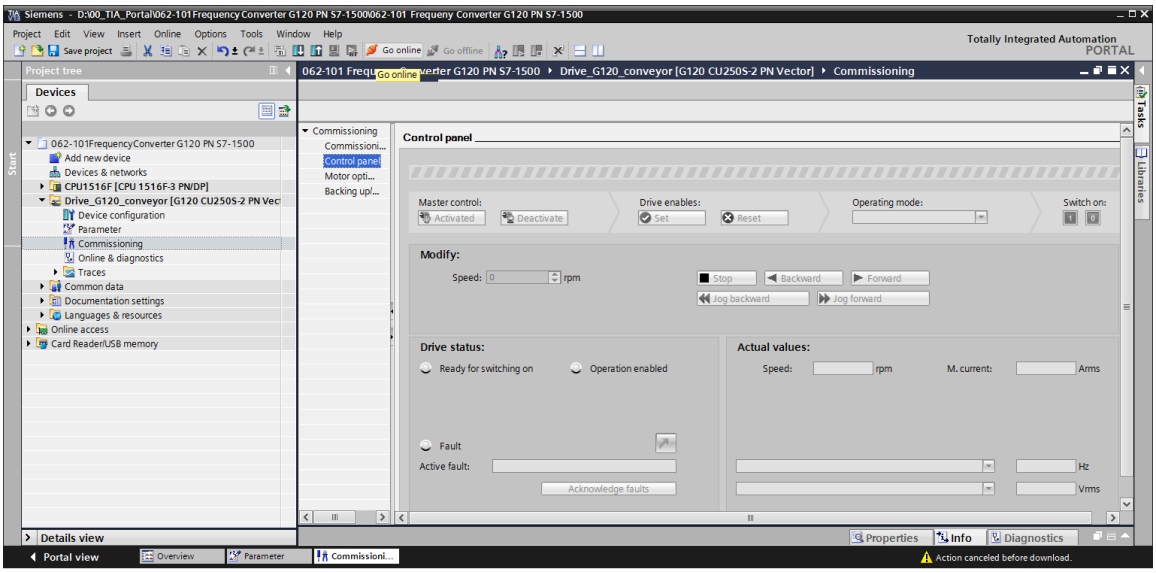


Note:

– *It is advisable to back up the parameters in the EEPROM as well, so that these are retained in the case of a voltage drop*

7.4 Testing and commissioning of frequency converters with control panel

→ In order to test the current parameter assignment without PLC program, open the 'Control panel' from the 'Commissioning' menu of the 'Drive_G120_conveyor'. Finally, click ' Go online'. (→ Drive_G120_conveyor → Commissioning → Control panel) (→ Go online)



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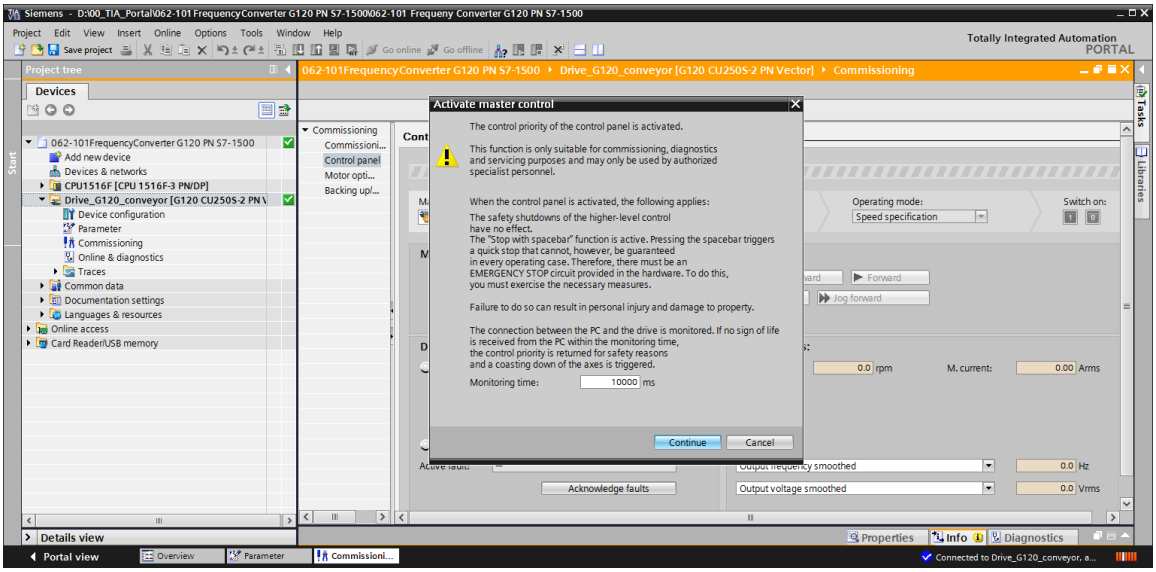
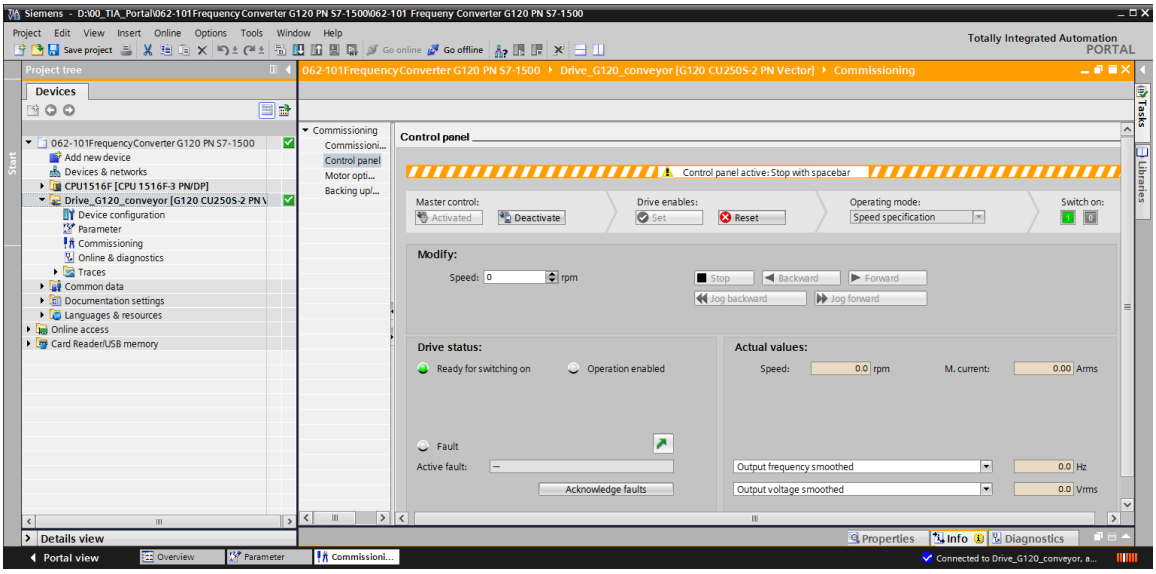
→ The first step is to 'Activate master control' in the control panel. The communication between the PC and the converter will then be monitored It is necessary that successful communication takes place at least every 10000 ms. Otherwise the motor stops and the enables are reset. (→Master control: Activated → 10000 ms → Continue)



→ The drive enables first have to be set in order to start the motor Set. As a rule, this happens automatically. The drive can then be switched on 1. (→ Switch on 1)



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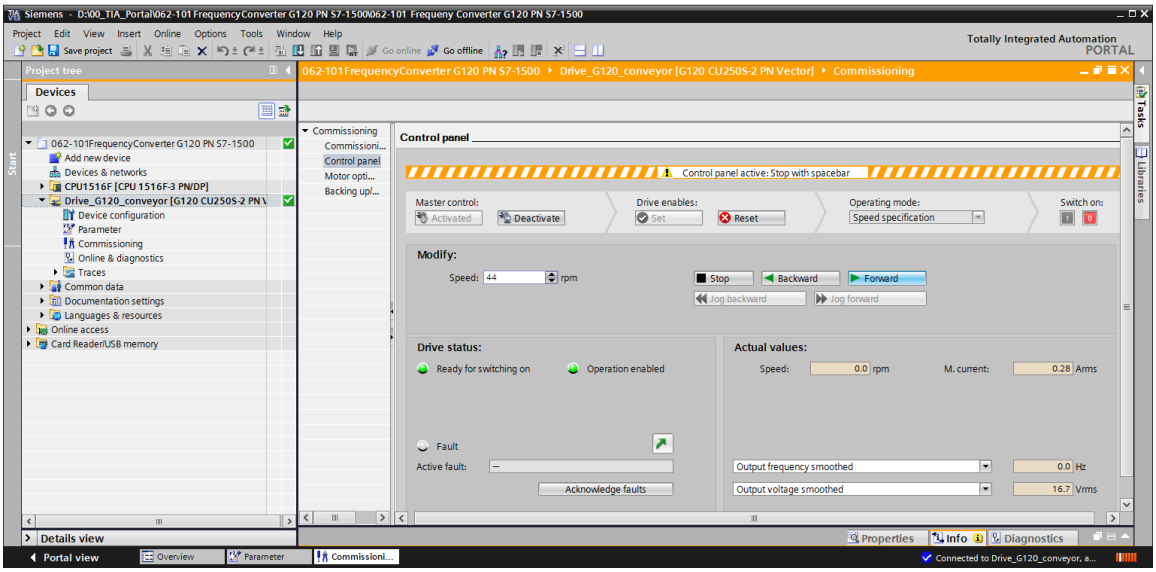
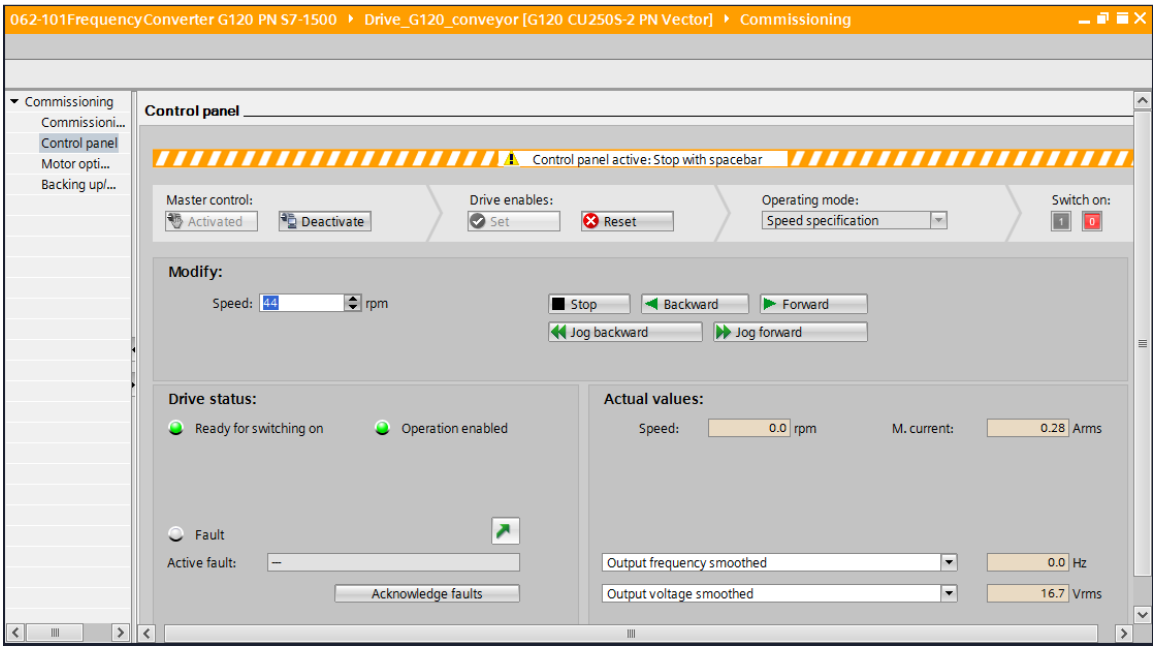
→ Now the motor can be run at the selected speed Forward or Backward.
(→ Speed: 44 → Forward)



→ The drive can be switched off by clicking '0'. After completion of the test, it is necessary to Deactivate the master control. (→ 0 → Deactivate)



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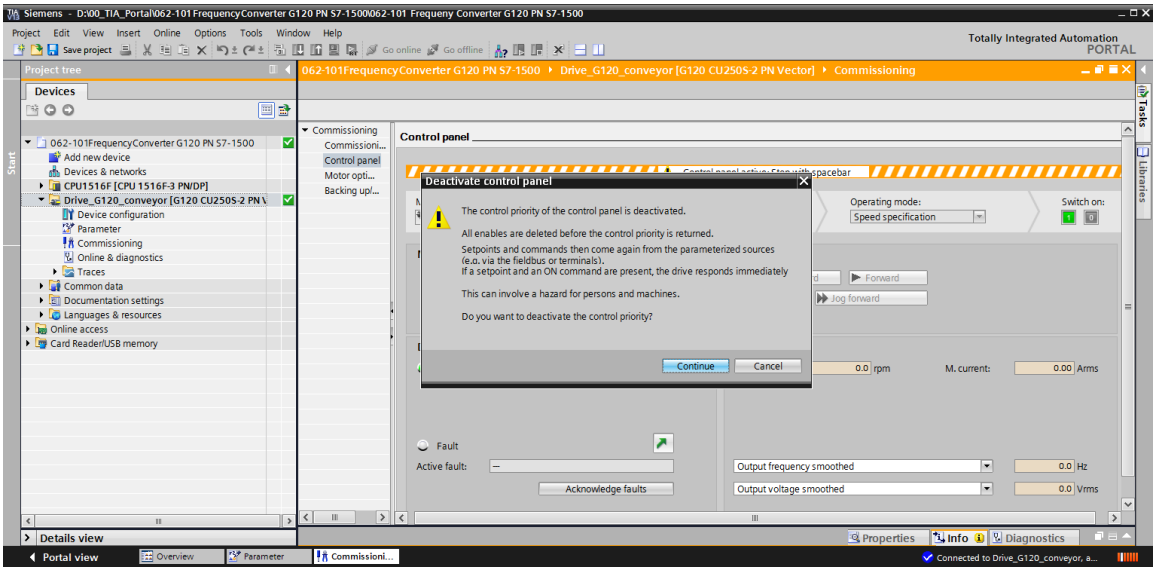
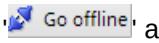
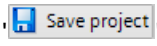
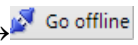
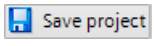
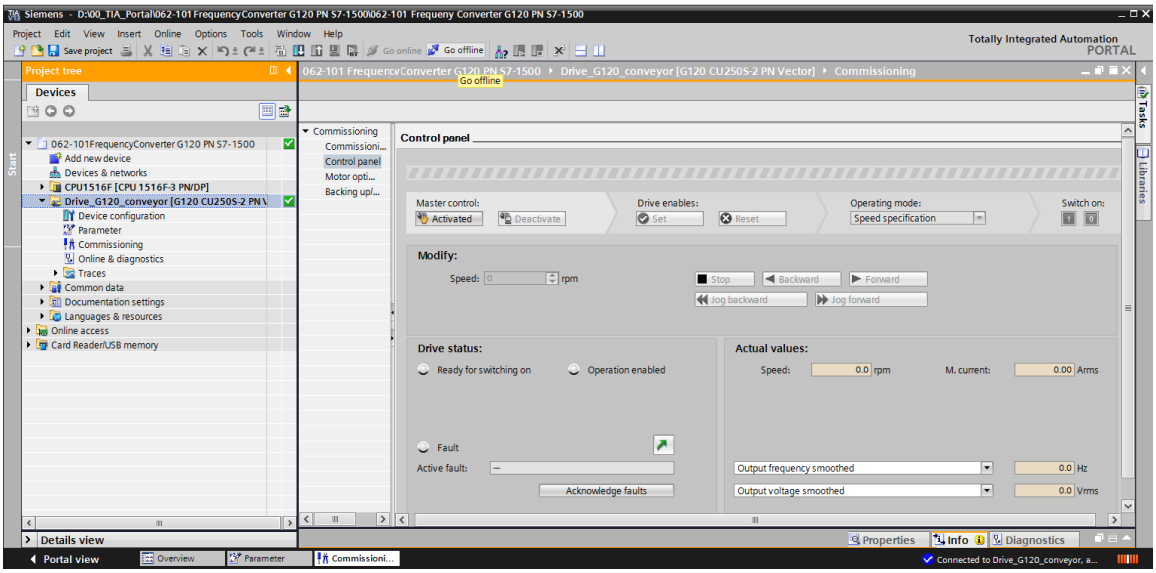
→ Confirm the prompt for deactivation with '  '. (→ )



→ Finally, '  ' and save the project again '  '. (→  → )



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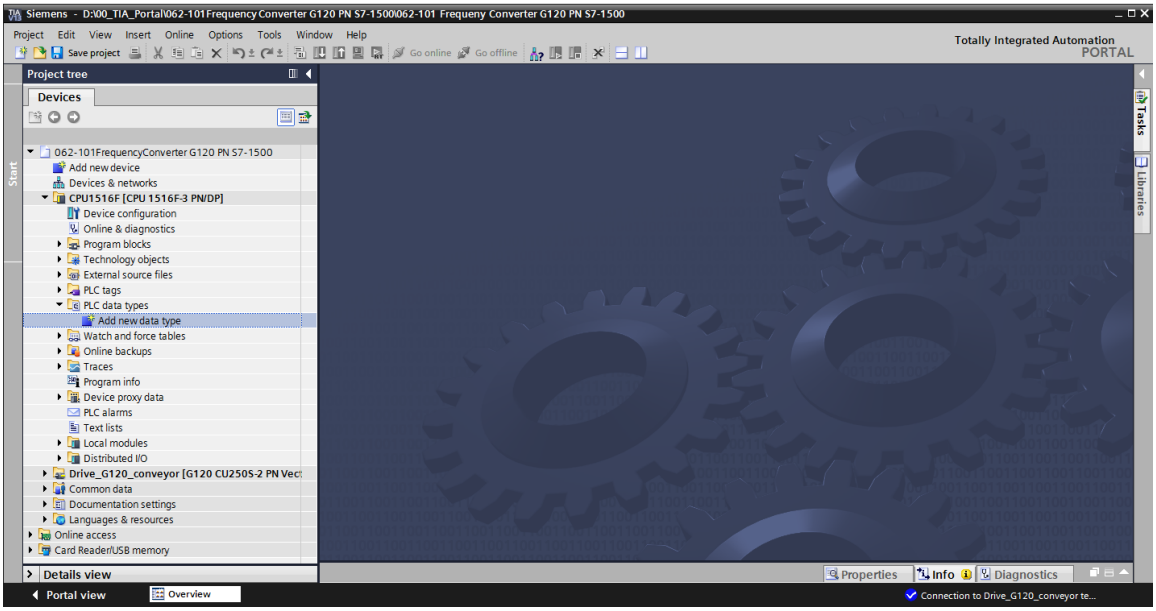
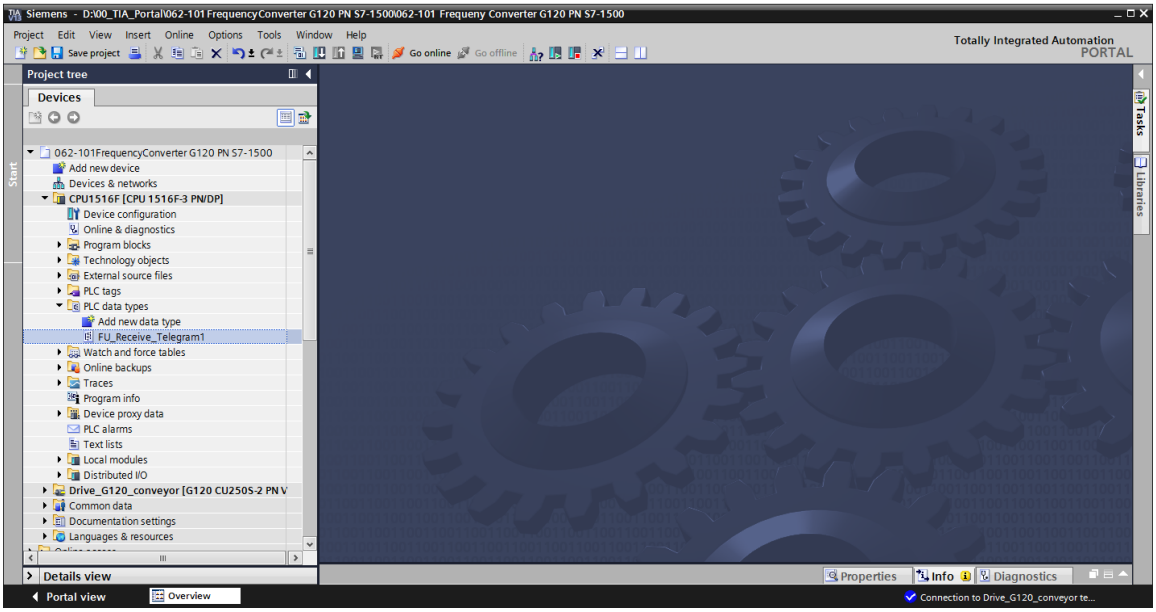
7.5 Creating a program for controlling the frequency converter

→ Before you adapt the program so that it can control the frequency converter, two 'PLC data types' have to be created that correspond to the structure of the send and receive Telegram 1. (→ PLC data types→ Add new data type)



→ Change the name of the PLC data type to 'FU_Receive_Telegram1' and open it by double-clicking it. (→ FU_Receive_Telegram1)



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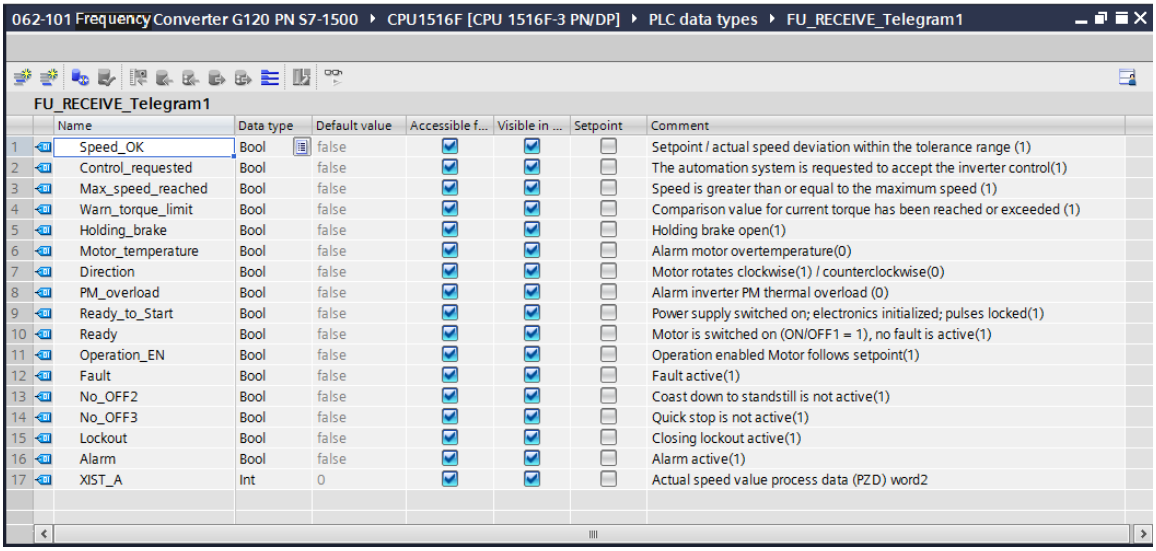
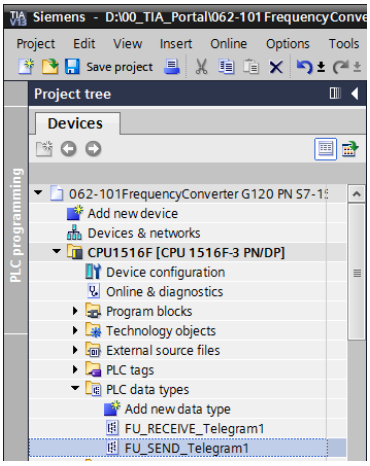
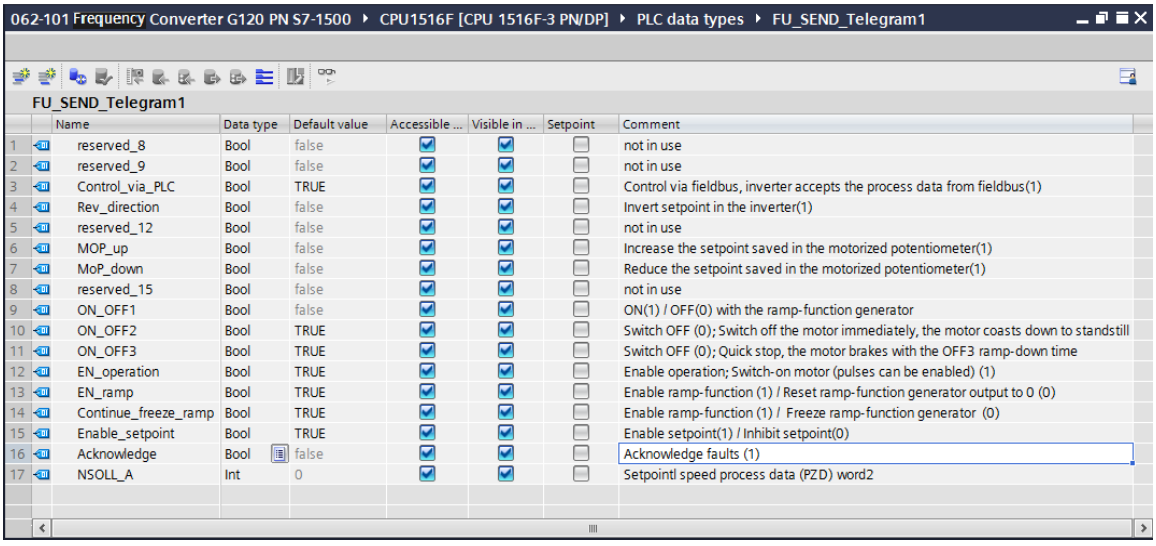
→ Create the tags shown below the same as in a data block. (→ FU_Receive_Telegram1)



	Name	Data type	Default value	Accessible f...	Visible in ...	Setpoint	Comment
1	Speed_OK	Bool	false	☑	☑	☐	Setpoint / actual speed deviation within the tolerance range (1)
2	Control_requested	Bool	false	☑	☑	☐	The automation system is requested to accept the inverter control(1)
3	Max_speed_reached	Bool	false	☑	☑	☐	Speed is greater than or equal to the maximum speed (1)
4	Warn_torque_limit	Bool	false	☑	☑	☐	Comparison value for current torque has been reached or exceeded (1)
5	Holding_brake	Bool	false	☑	☑	☐	Holding brake open(1)
6	Motor_temperature	Bool	false	☑	☑	☐	Alarm motor overtemperature(0)
7	Direction	Bool	false	☑	☑	☐	Motor rotates clockwise(1) / counterclockwise(0)
8	PM_overload	Bool	false	☑	☑	☐	Alarm inverter PM thermal overload (0)
9	Ready_to_Start	Bool	false	☑	☑	☐	Power supply switched on; electronics initialized; pulses locked(1)
10	Ready	Bool	false	☑	☑	☐	Motor is switched on (ON/OFF1 = 1), no fault is active(1)
11	Operation_EN	Bool	false	☑	☑	☐	Operation enabled Motor follows setpoint(1)
12	Fault	Bool	false	☑	☑	☐	Fault active(1)
13	No_OFF2	Bool	false	☑	☑	☐	Coast down to standstill is not active(1)
14	No_OFF3	Bool	false	☑	☑	☐	Quick stop is not active(1)
15	Lockout	Bool	false	☑	☑	☐	Closing lockout active(1)
16	Alarm	Bool	false	☑	☑	☐	Alarm active(1)
17	XIST_A	Int	0	☑	☑	☐	Actual speed value process data (PZD) word2

→ Create an additional PLC data type called 'FU_Send_Telegram1' and the tags shown below. (→ FU_Send_Telegram1)





	Name	Data type	Default value	Accessible ...	Visible in ...	Setpoint	Comment
1	reserved_8	Bool	false	☑	☑	☐	not in use
2	reserved_9	Bool	false	☑	☑	☐	not in use
3	Control_via_PLC	Bool	TRUE	☑	☑	☐	Control via fieldbus, inverter accepts the process data from fieldbus(1)
4	Rev_direction	Bool	false	☑	☑	☐	Invert setpoint in the inverter(1)
5	reserved_12	Bool	false	☑	☑	☐	not in use
6	MOP_up	Bool	false	☑	☑	☐	Increase the setpoint saved in the motorized potentiometer(1)
7	MoP_down	Bool	false	☑	☑	☐	Reduce the setpoint saved in the motorized potentiometer(1)
8	reserved_15	Bool	false	☑	☑	☐	not in use
9	ON_OFF1	Bool	false	☑	☑	☐	ON(1) / OFF(0) with the ramp-function generator
10	ON_OFF2	Bool	TRUE	☑	☑	☐	Switch OFF (0); Switch off the motor immediately, the motor coasts down to standstill
11	ON_OFF3	Bool	TRUE	☑	☑	☐	Switch OFF (0); Quick stop, the motor brakes with the OFF3 ramp-down time
12	EN_operation	Bool	TRUE	☑	☑	☐	Enable operation; Switch-on motor (pulses can be enabled) (1)
13	EN_ramp	Bool	TRUE	☑	☑	☐	Enable ramp-function (1) / Reset ramp-function generator output to 0 (0)
14	Continue_freeze_ramp	Bool	TRUE	☑	☑	☐	Enable ramp-function (1) / Freeze ramp-function generator (0)
15	Enable_setpoint	Bool	TRUE	☑	☑	☐	Enable setpoint(1) / Inhibit setpoint(0)
16	Acknowledge	Bool	false	☑	☑	☐	Acknowledge faults (1)
17	NSOLL_A	Int	0	☑	☑	☐	Setpointl speed process data (PZD) word2

Note:

– *For some enable bits, the start value is already set to TRUE so that these do not have to be set additionally in the program.*

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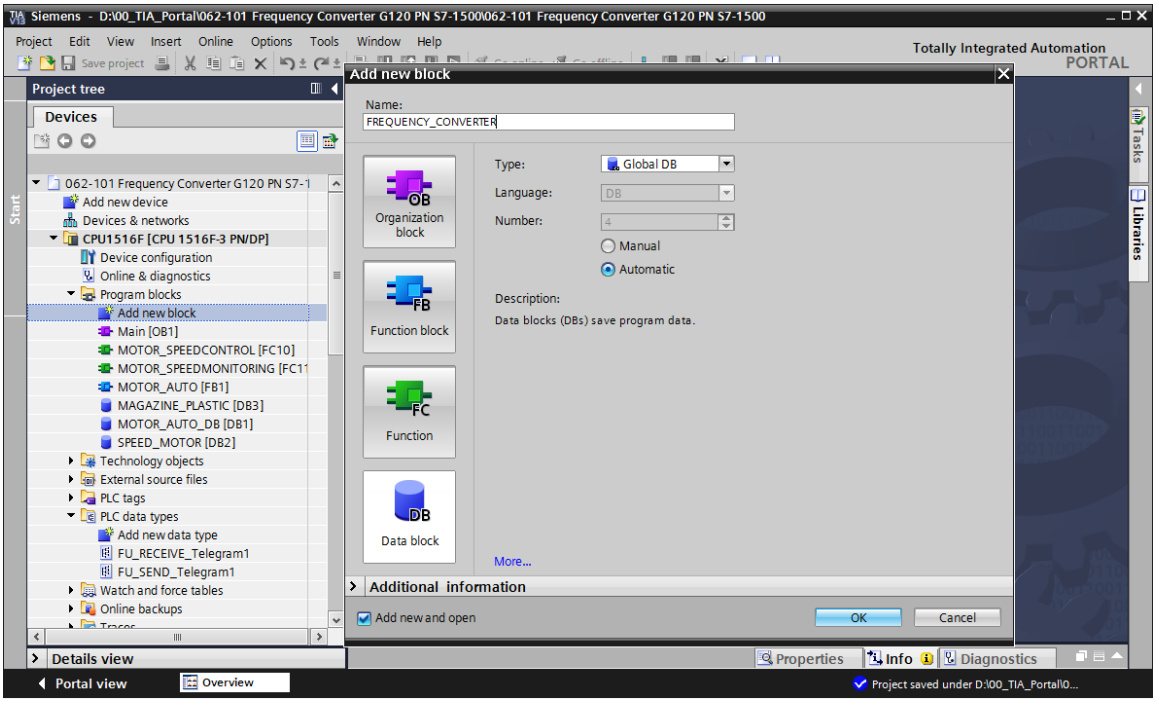
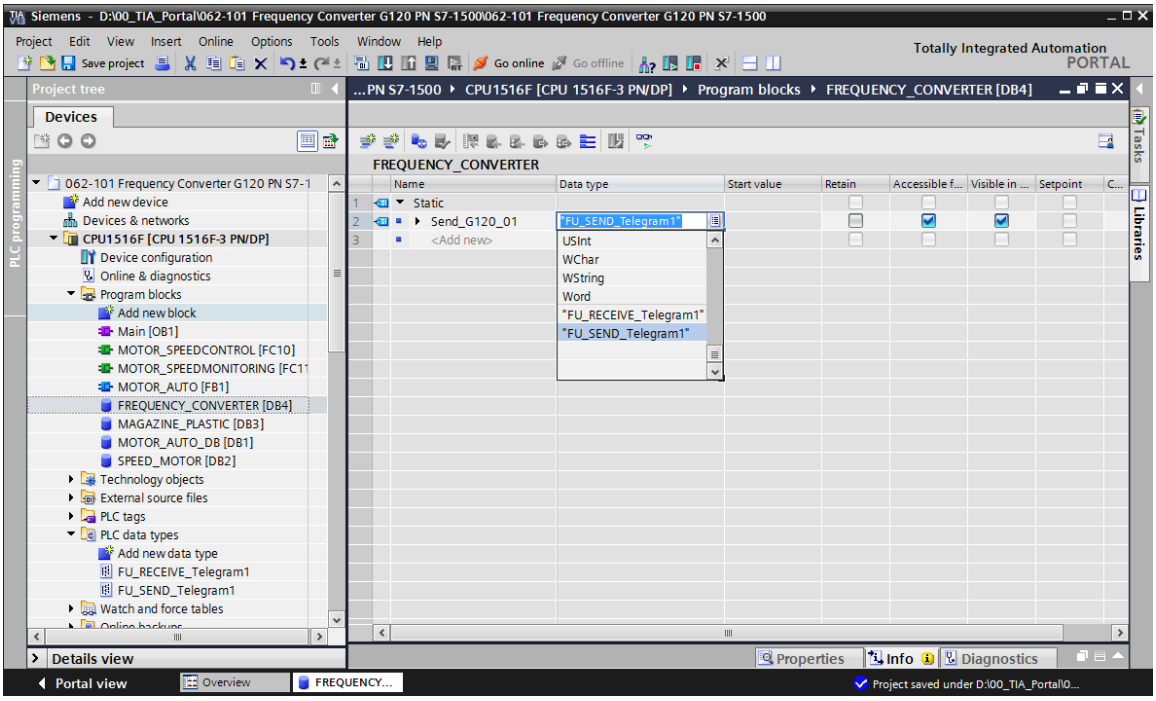
→ Create the global data block 'FREQUENCY_CONVERTER' for the request and response telegram. (→ Add new block → DB → Global DB → FREQUENCY_CONVERTER → OK)



→ Create the tag 'Send_G120_01' and select 'FU_SEND_Telegram1' as the data type. (→ Send_G120_01 → "FU_SEND_Telegram1")



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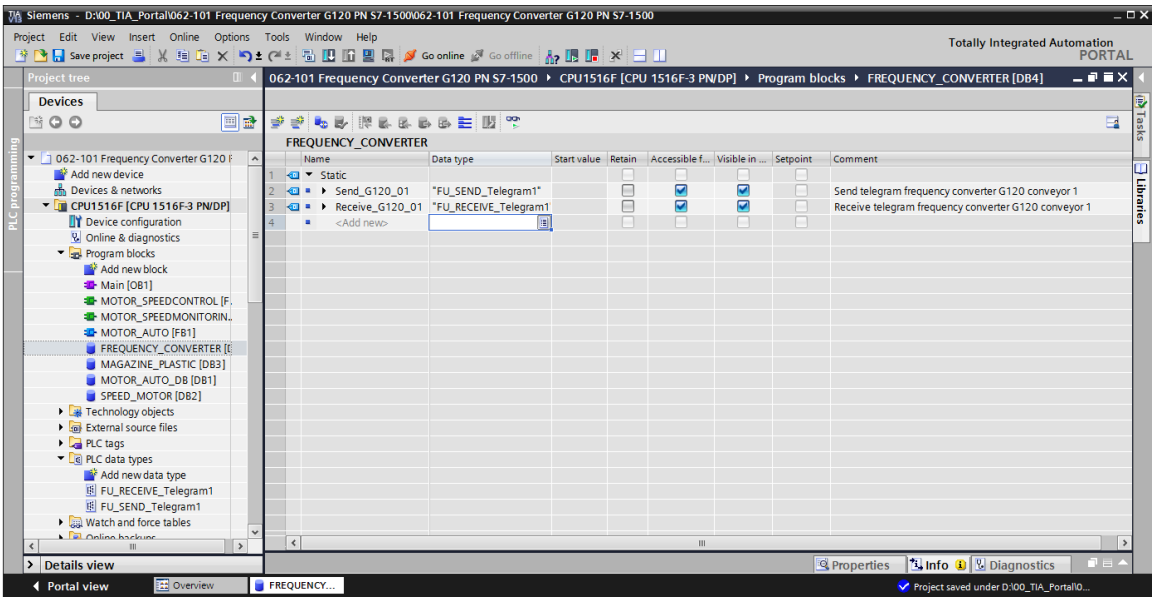
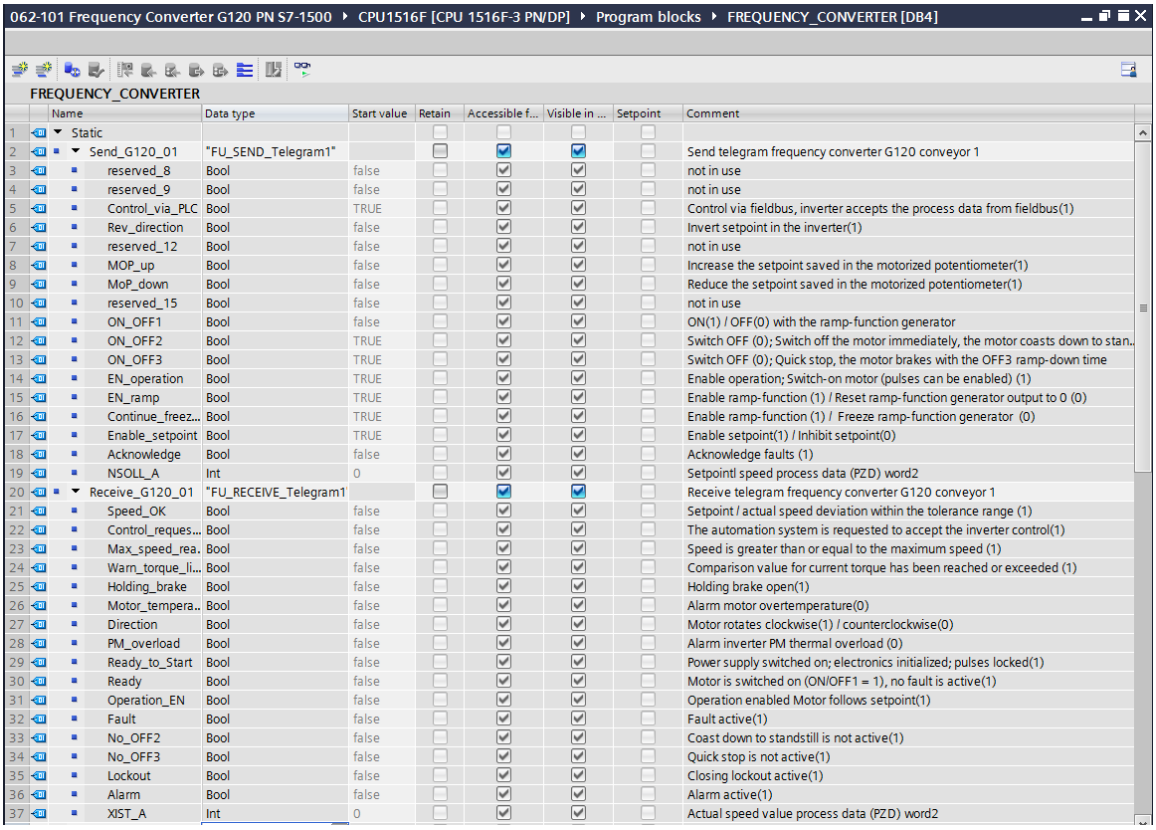
→ Create an additional tag 'Receive_G120_01' and select 'FU_RECEIVE_Telegram1' as the data type. Provide comments for the two tags. (→ Receive_G120_01 → 'FU_RECEIVE_Telegram1')



→ The data block can be created quickly and efficiently by using the PLC data types 'FU_SEND_Telegram1' and 'FU_RECEIVE_Telegram1', see representation.



	Name	Data type	Start value	Retain	Accessible f...	Visible in ...	Setpoint	Comment
1	Static							
2	Send_G120_01	"FU_SEND_Telegram1"						Send telegram frequency converter G120 conveyor 1
3	reserved_8	Bool	false					not in use
4	reserved_9	Bool	false					not in use
5	Control_via_PLC	Bool	TRUE					Control via fieldbus, inverter accepts the process data from fieldbus(1)
6	Rev_direction	Bool	false					Invert setpoint in the inverter(1)
7	reserved_12	Bool	false					not in use
8	MOP_up	Bool	false					Increase the setpoint saved in the motorized potentiometer(1)
9	MoP_down	Bool	false					Reduce the setpoint saved in the motorized potentiometer(1)
10	reserved_15	Bool	false					not in use
11	ON_OFF1	Bool	false					ON(1) / OFF(0) with the ramp-function generator
12	ON_OFF2	Bool	TRUE					Switch OFF (0); Switch off the motor immediately, the motor coasts down to stan..
13	ON_OFF3	Bool	TRUE					Switch OFF (0); Quick stop, the motor brakes with the OFF3 ramp-down time
14	EN_operation	Bool	TRUE					Enable operation; Switch-on motor (pulses can be enabled) (1)
15	EN_ramp	Bool	TRUE					Enable ramp-function (1) / Reset ramp-function generator output to 0 (0)
16	Continue_freez...	Bool	TRUE					Enable ramp-function (1) / Freeze ramp-function generator (0)
17	Enable_setpoint	Bool	TRUE					Enable setpoint(1) / Inhibit setpoint(0)
18	Acknowledge	Bool	false					Acknowledge faults (1)
19	NSOLL_A	Int	0					Setpointl speed process data (PZD) word2
20	Receive_G120_01	"FU_RECEIVE_Telegram1"						Receive telegram frequency converter G120 conveyor 1
21	Speed_OK	Bool	false					Setpoint / actual speed deviation within the tolerance range (1)
22	Control_reques...	Bool	false					The automation system is requested to accept the inverter control(1)
23	Max_speed_rea...	Bool	false					Speed is greater than or equal to the maximum speed (1)
24	Warn_torque_li...	Bool	false					Comparison value for current torque has been reached or exceeded (1)
25	Holding_brake	Bool	false					Holding brake open(1)
26	Motor_tempera...	Bool	false					Alarm motor overtemperature(0)
27	Direction	Bool	false					Motor rotates clockwise(1) / counterclockwise(0)
28	PM_overload	Bool	false					Alarm inverter PM thermal overload (0)
29	Ready_to_Start	Bool	false					Power supply switched on; electronics initialized; pulses locked(1)
30	Ready	Bool	false					Motor is switched on (ON/OFF1 = 1), no fault is active(1)
31	Operation_EN	Bool	false					Operation enabled Motor follows setpoint(1)
32	Fault	Bool	false					Fault active(1)
33	No_OFF2	Bool	false					Coast down to standstill is not active(1)
34	No_OFF3	Bool	false					Quick stop is not active(1)
35	Lockout	Bool	false					Closing lockout active(1)
36	Alarm	Bool	false					Alarm active(1)
37	XIST_A	Int	0					Actual speed value process data (PZD) word2

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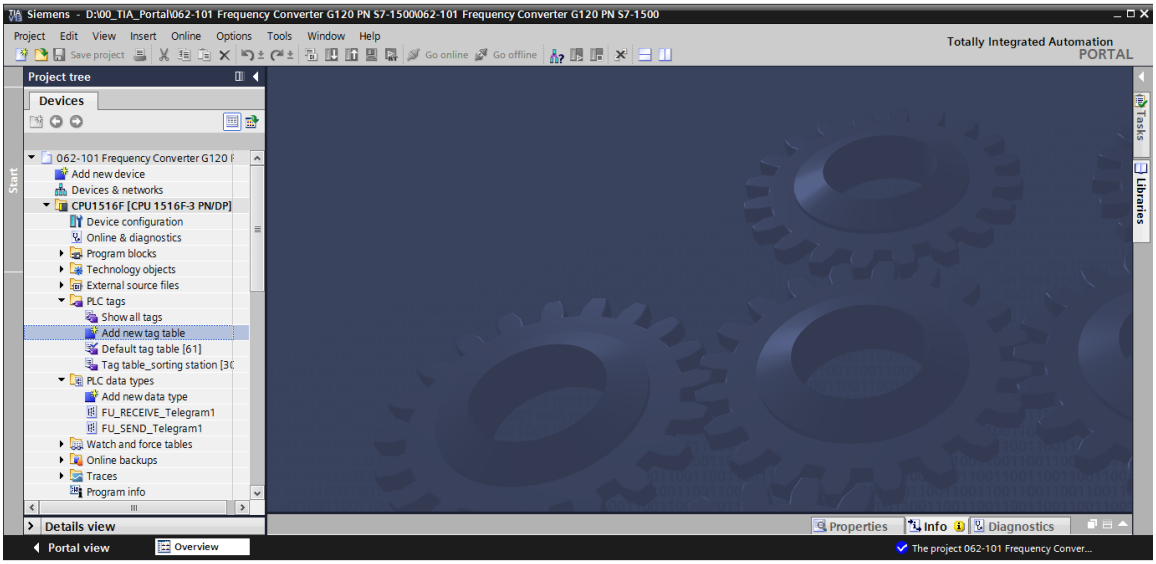
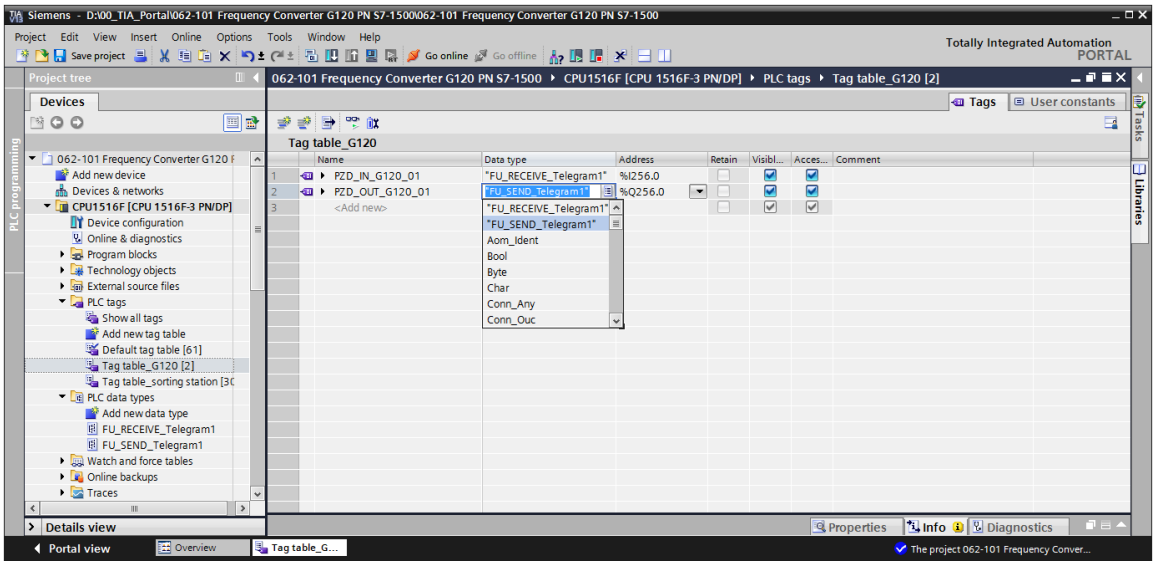
→ The global PLC tags are created in a new tag table for the communication with the frequency converter. (→ Add new tag table)



→ Change the name of the tag table to 'Tag_table_G120‘ and specify, as shown, two structure tags 'PZD_IN_G120_01' and 'PZD_OUT_G120_01' using the PLC data types 'FU_RECEIVE_Telegram1' and 'FU_SEND_Telegram1'. (→ PZD_IN_G120_01 → 'FU_RECEIVE_Telegram1' → PZD_OUT_G120_01→ 'FU_SEND_Telegram1')



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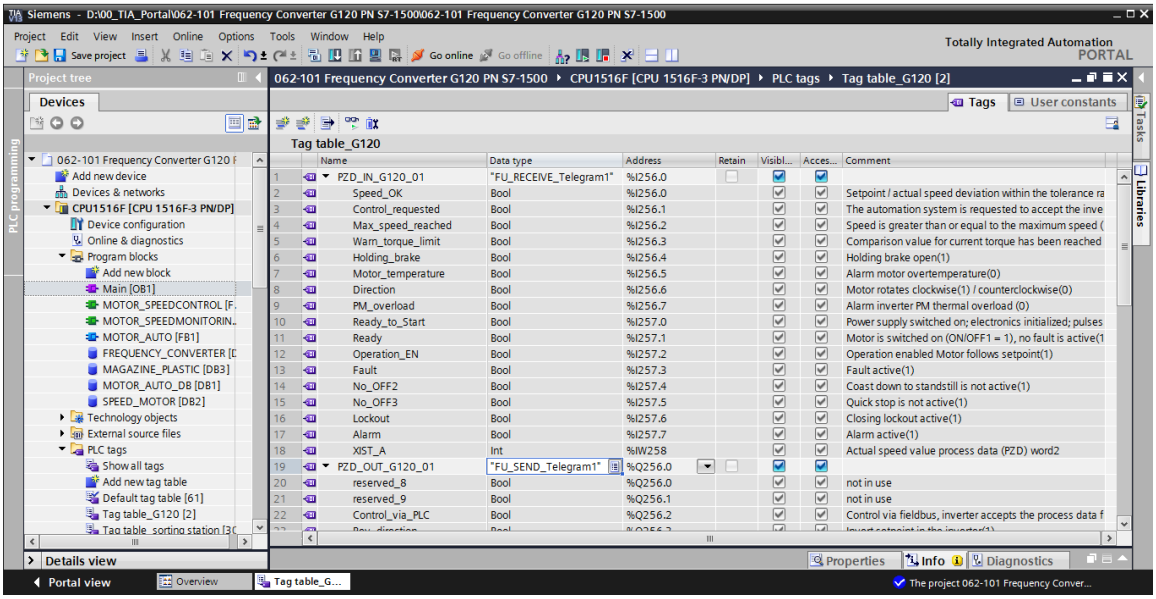
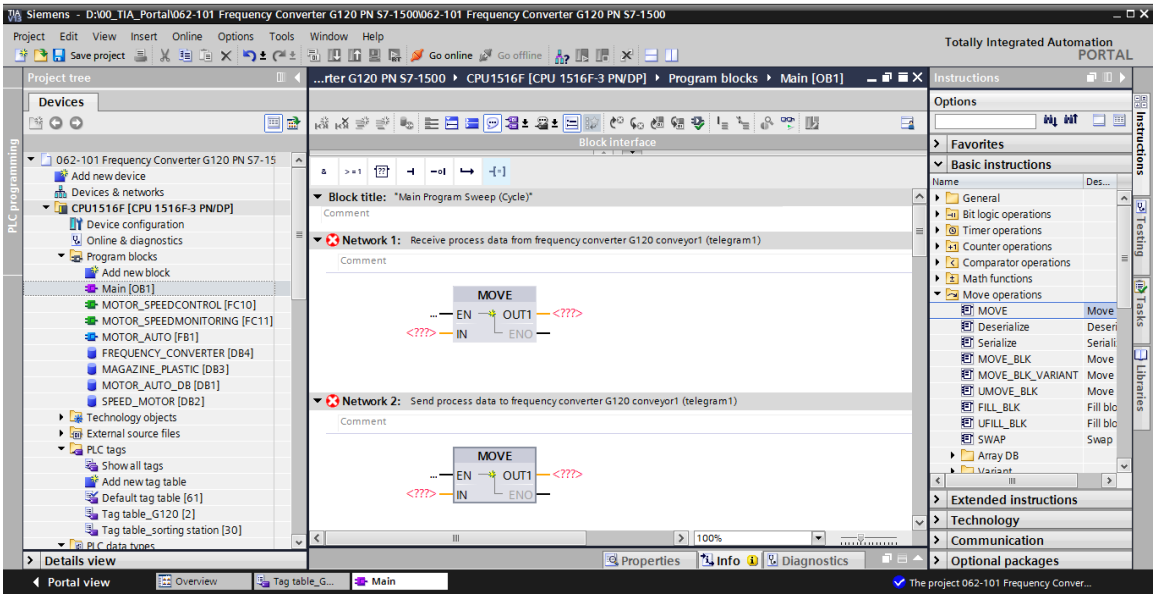
→ The tags have been created in accordance with their structures by the use of the PLC data types 'FU_SEND_Telegram1' and 'FU_RECEIVE_Telegram1'. Open the 'Main' block [OB1]. (→ Main [OB1])



→ Insert two new networks at the beginning of the Main [OB1]. Drag-&-drop the 'Move' command from the "Instructions' under the 'Move operations' item into these networks. (→ → → Instructions → Move operations → Move → Move)



→ Select the 'Tag_table_G120' in the project navigation. Now you can drag-&-drop the two tags 'PZD_IN_G120_01' and 'PZD_OUT_G120_01' directly from the details view onto the connections of the Move instructions. (→ Tag_table_G120 → PZD_IN_G120_01 → PZD_OUT_G120_01)

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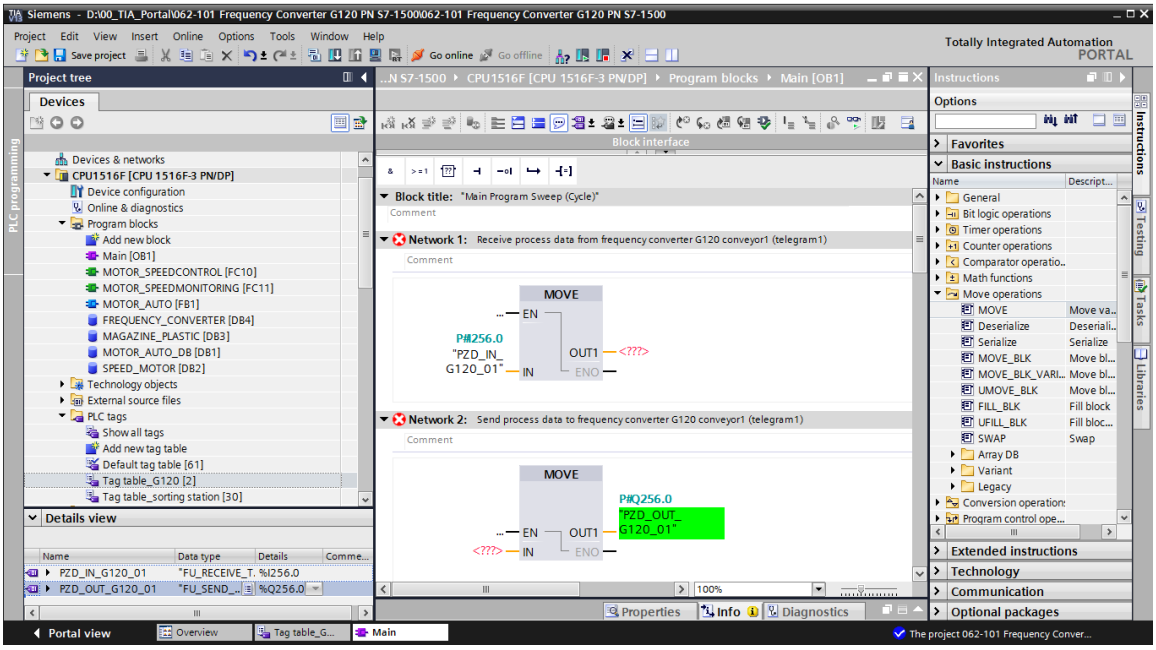
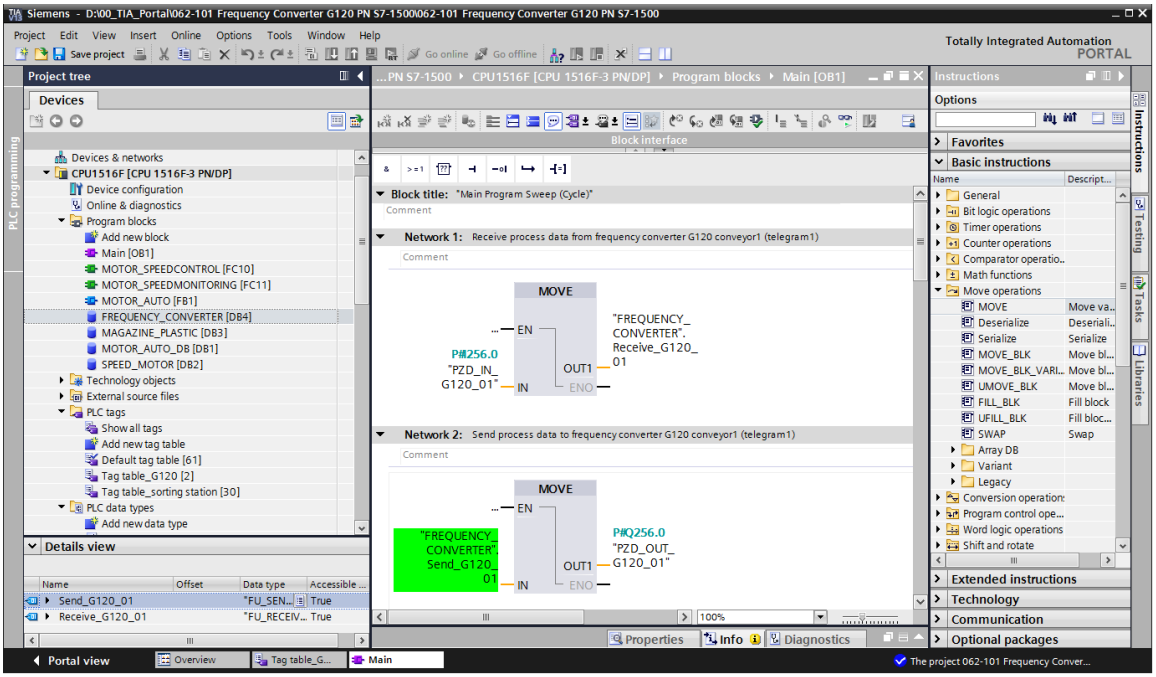


→ Select the "FREQUENCY_CONVERTER [DB4]' data block in the project tree. You can again drag-&-drop the two structure tags 'Send_G120_01' and 'Receive_G120_01' directly from the details view onto the connections of the Move instructions. (→ Send_IN_G120_01 → Receive_OUT_G120_01)



→ Open the structure of the tag 'Receive_G120_01' in the details view and from there drag-&-drop the tag 'Receive_G120_01.XIST_A' to the connection 'Actual_speed_AI' of the block 'MOTOR_SPEED_MONITORING'. (→ Receive_G120_01.XIST_A)

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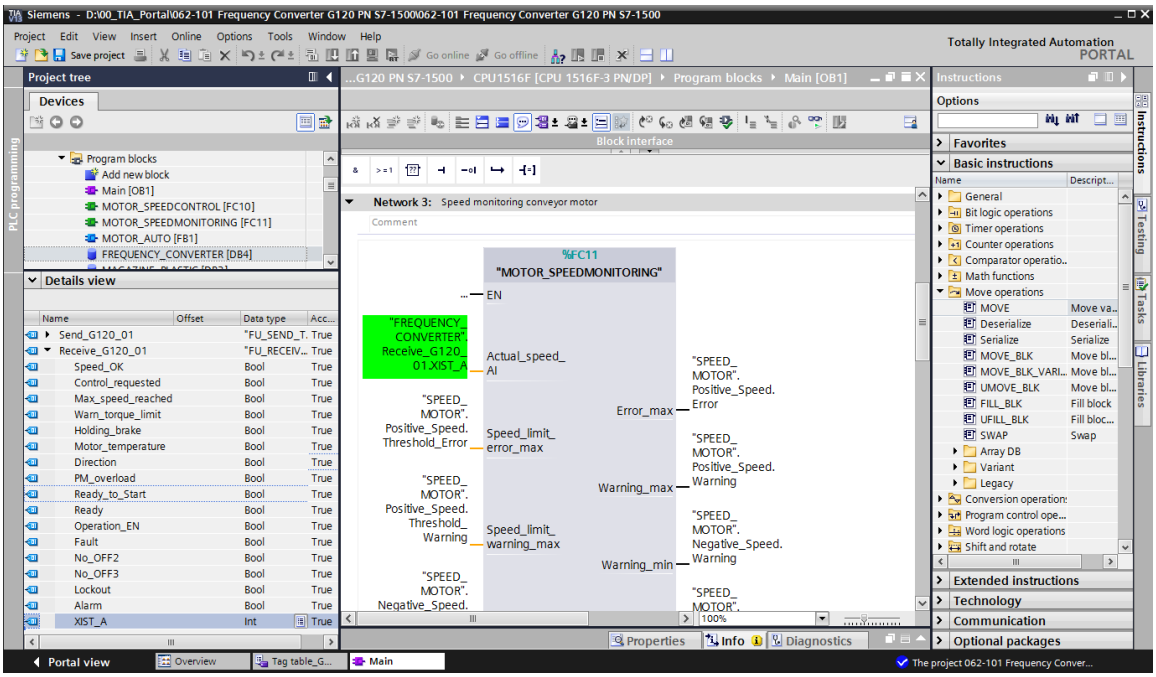
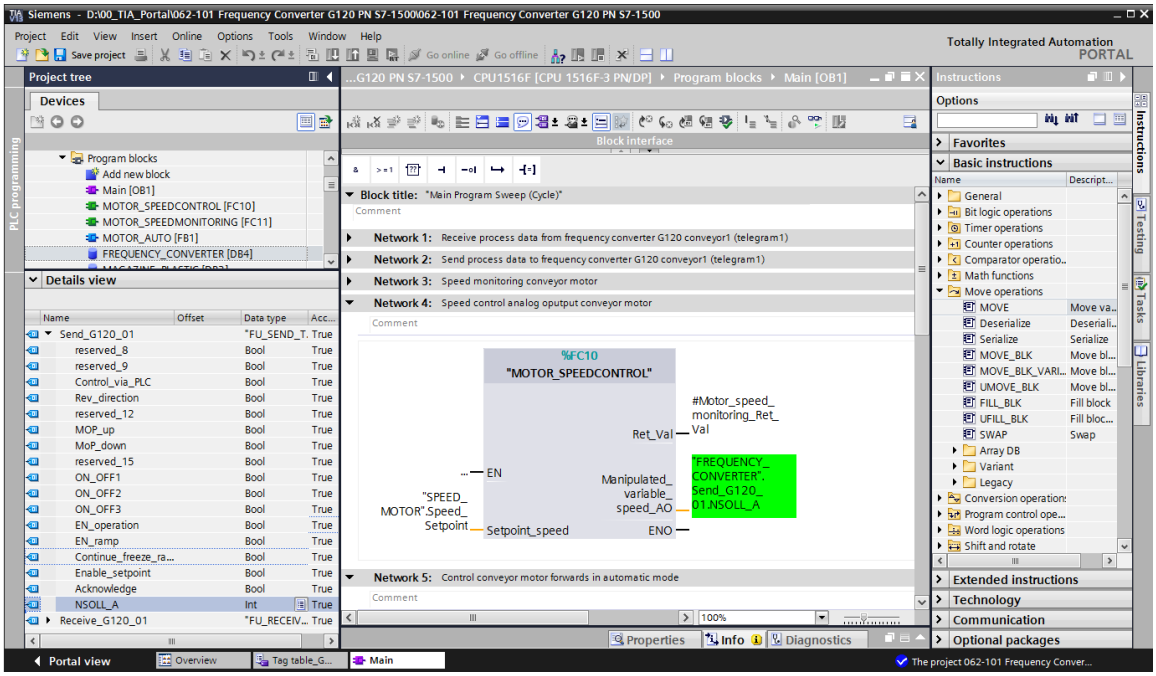


→ Drag the tag 'Send_G120_01.NSOLL_A' to the connection 'Setpoint_speed‘ of the block 'MOTOR_SPEEDCONTROL'. (→ Send_G120_01.NSOLL_A)



→ As the activation command, drag the tag 'Send_G120_01.ON_OFF1' to the connection 'Conveyor_motor_automatic_mode' of the block 'MOTOR_AUTO'. (→ Send_G120_01. ON_OFF1)

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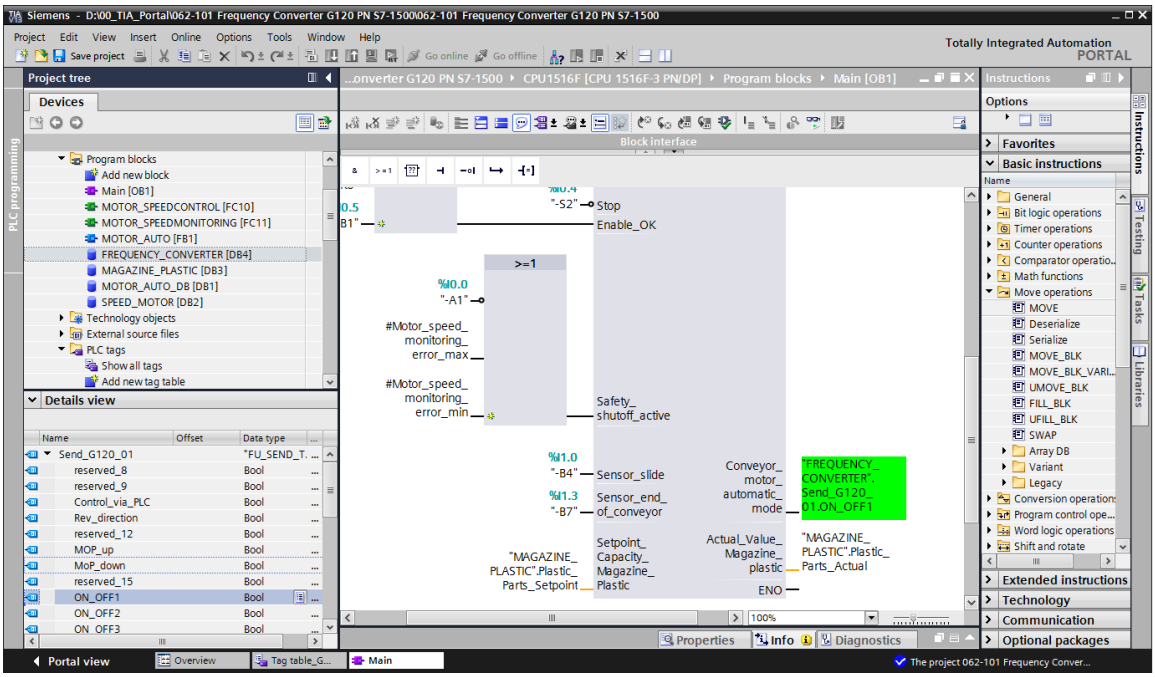
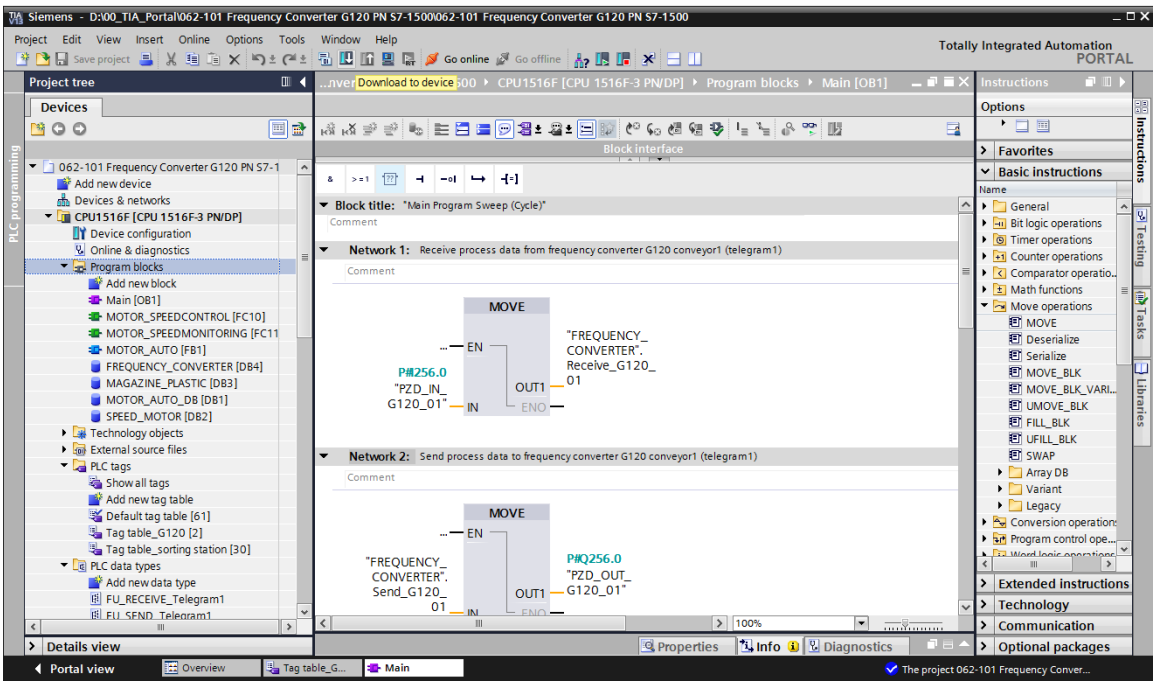


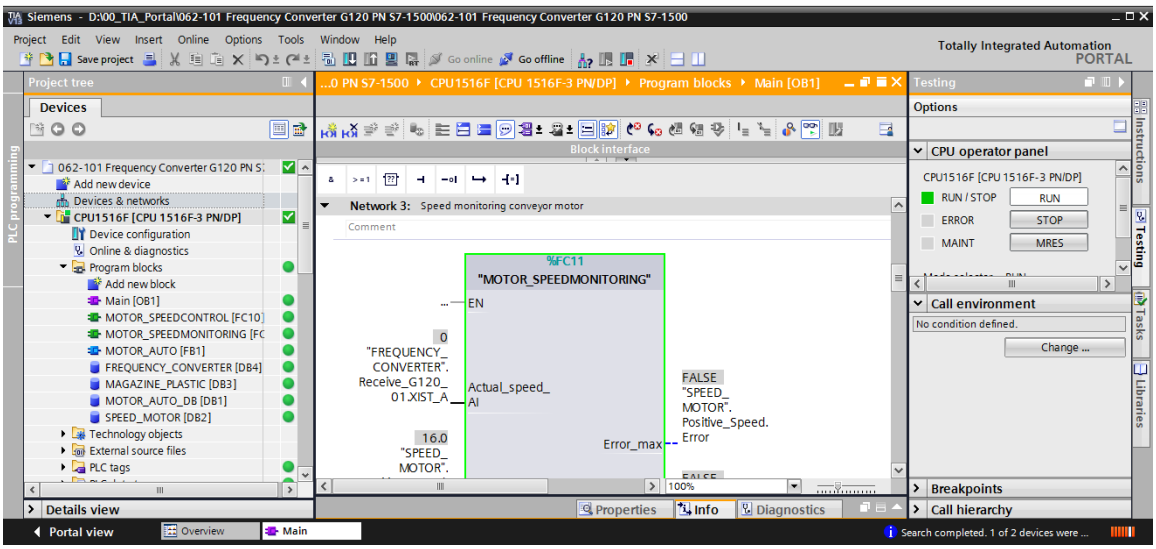
7.6 Loading the program in SIMATIC S7 CPU 1516F-3 PN/DP

→ Save the project once more before downloading the modified and created 'Program blocks' to the CPU 1516F '  '. (→ Save project → Program blocks → )

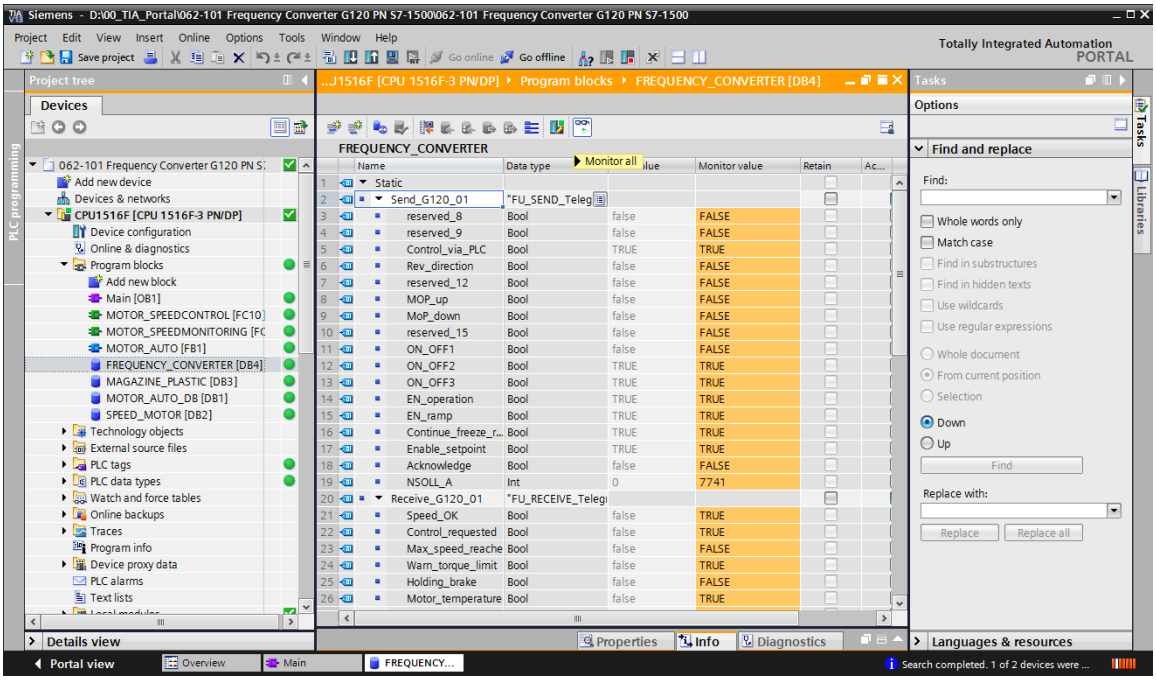


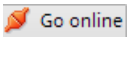
7.7 Diagnostics of SIMATIC S7 CPU 1516F-3 PN/DP

→ The block Main [OB1] can be monitored to diagnose the control of the converter from the program. Monitoring is activated and deactivated by clicking the  icon. (→ Main [OB1] → )



→ The complete send and receive data of the communication with the converter (control words/status words/setpoint/actual value) are visible in the 'FREQUENCY_CONVERTER [DB4]' data block. Monitoring can be activated and deactivated at this point as well by clicking the  icon. (→ FREQUENCY_CONVERTER [DB4] → )



→ The online network view lends itself to diagnostics of the PROFINET connection between the CPU 1516F controller and the frequency converter. (→ Devices & networks → Network view → 

)

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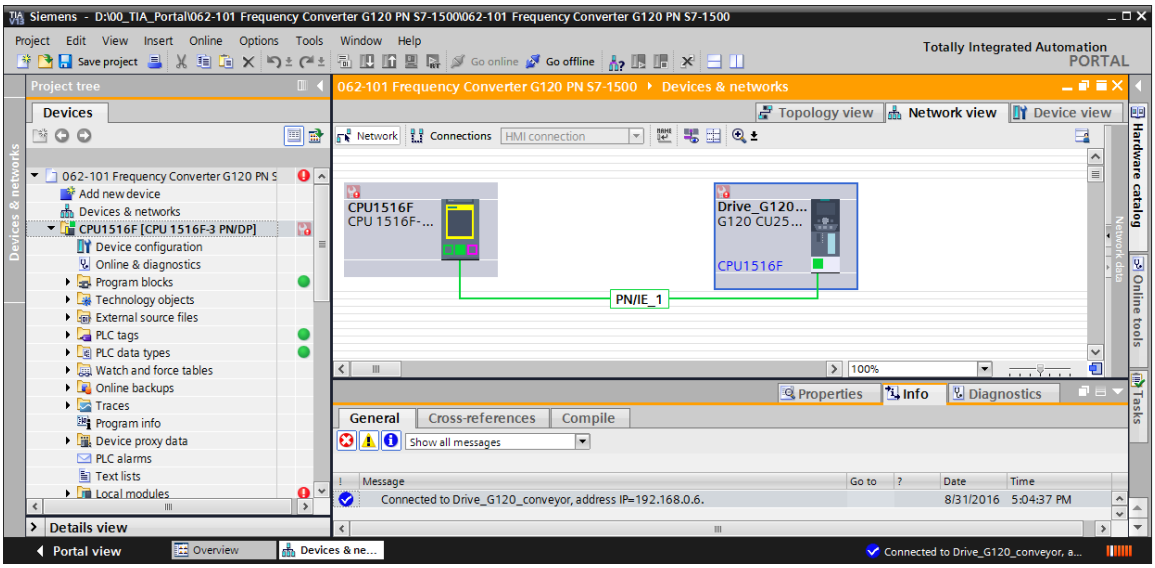
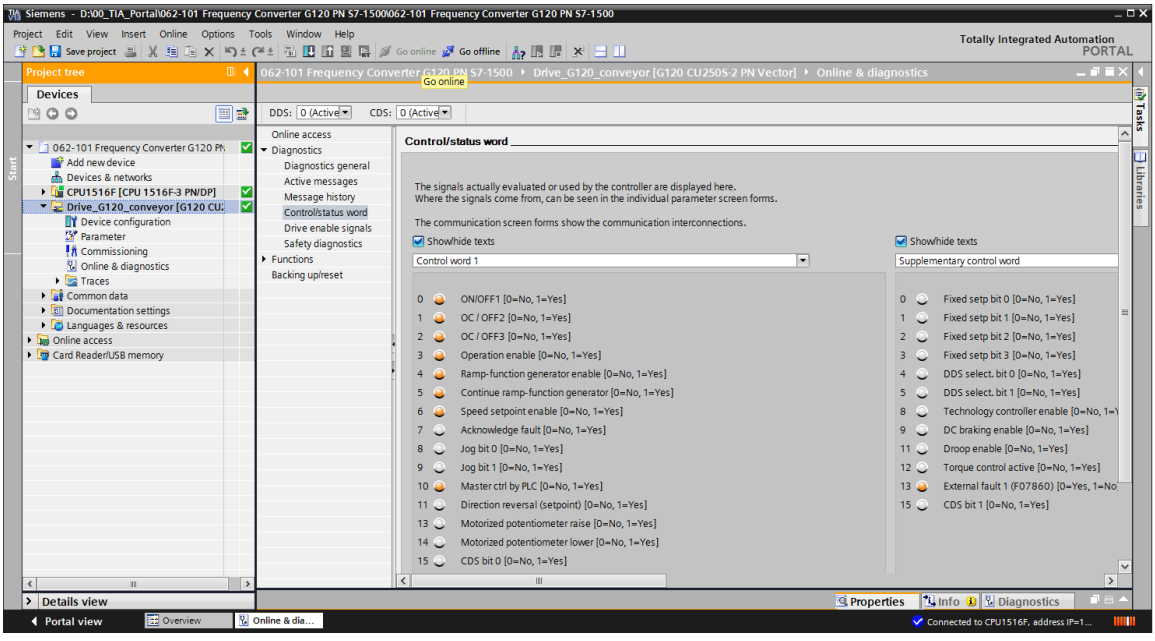


7.8 Diagnostics with SINAMICS Startdrive for frequency converter G120

→ The "Control/status words' can also be monitored in the frequency converter. This is available under 'Online & Diagnostics' (→ Drive_G120_conveyor → Online & diagnostics → Diagnostics → Control/status word → Go online)



→ Under 'Drive enable signals' you also see the missing enables in order to be able to start the motor. (→ Drive enable signals)

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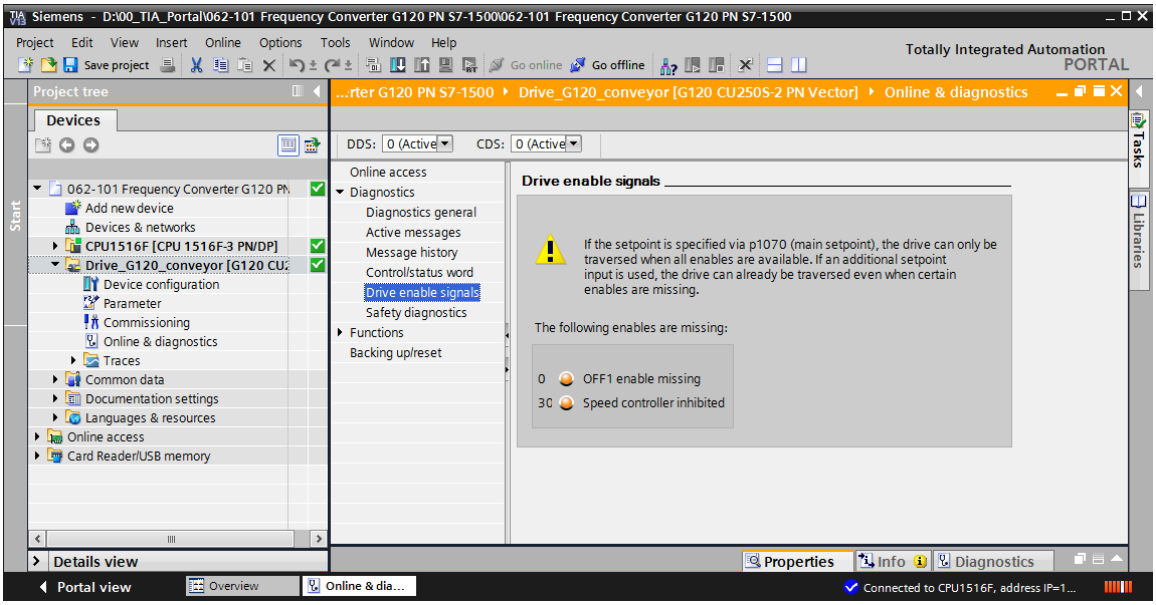
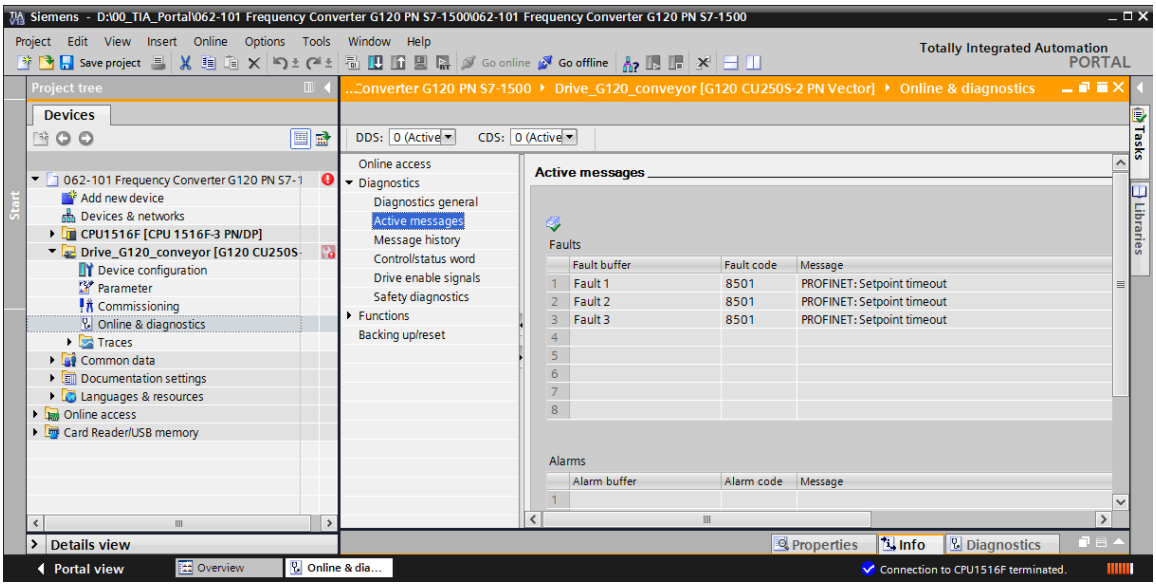


→ Under 'Active messages' you see pending faults and warnings. You can click the '  ' icon to acknowledge these. (→ Active messages → )



→ The values can also be monitored online in the 'Functional View' of 'Parameter'. (→ Parameter → Functional View)

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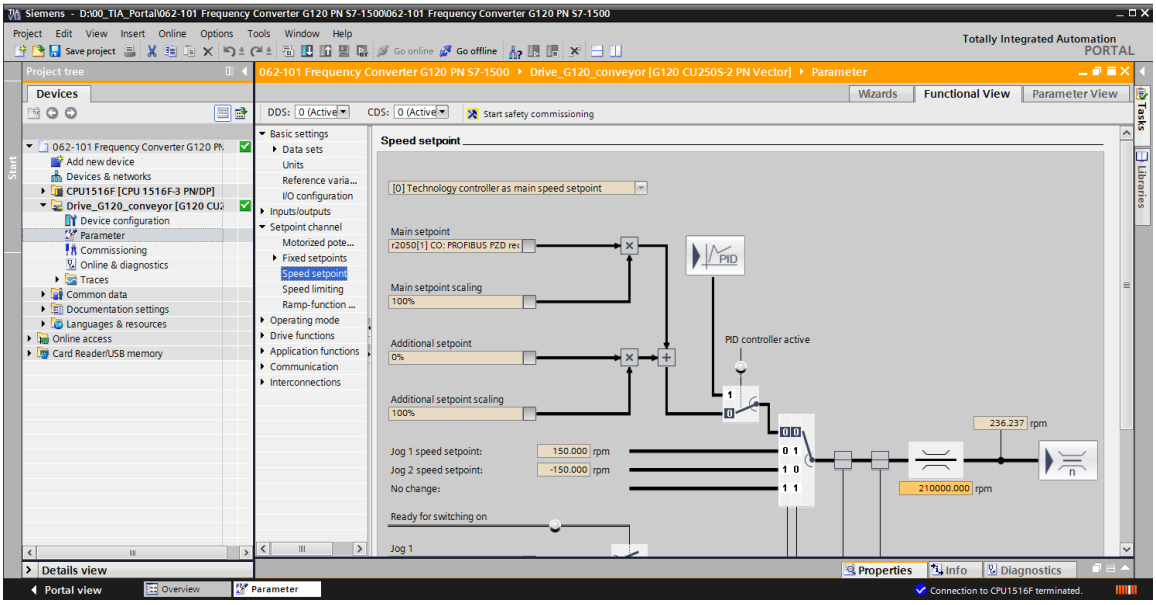
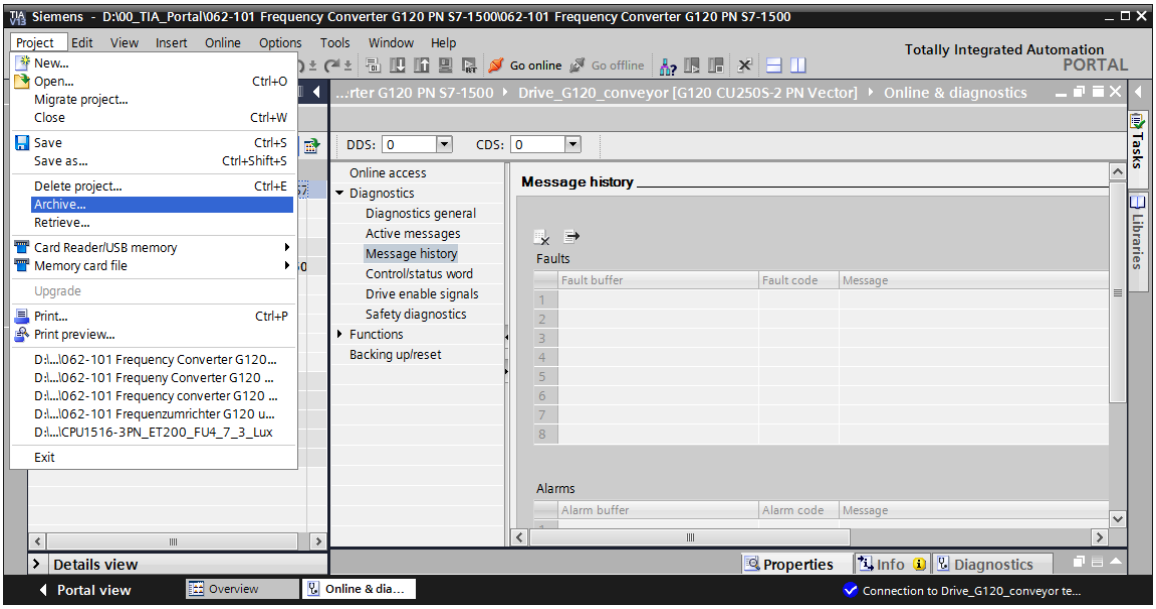


7.9 Archiving the project

→ Finally, the complete project will be archived. In the menu item → 'Project', select → 'Archive…'. Open a folder in which you want to archive your project and save your project as the file type 'TIA Portal project archive'. (→ Project → Archive → TIA Portal project archives → SCE_EN_062-101 Frequency Converter G120 and S7-1500…. → Save)



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7.10 Checklist – step-by-step instructions

The following checklist helps trainees/students to independently check whether all steps of the step-by-step instruction have been carefully completed and enables them to successfully complete the module on their own.

No.	Description	Checked
1	Frequency converter SINAMICS G120 with Control Unit CU250S-PN Vector created as distributed IO of the CPU1516F- 3 PN/DP.	
2	Device configuration with the frequency converter G120 as device loaded successfully into the CPU1516F-3 PN/DP.	
3	Device name of the Control Unit CU250S-PN Vector assigned.	
4	SINAMICS G120 frequency converter with induction motor parameterized in SINAMICS Startdrive.	
5	Parameter assignment successfully loaded from SINAMICS Startdrive into the SINAMICS G120 frequency converter.	
6	Induction motor tested successfully in operation with SINAMICS G120 frequency converter via control panel.	
7	Data block 'FREQUENCY_CONVERTER' [DB4] created.	
8	Program changes carried out in Main [OB1].	
9	Compiling and downloading of the program blocks is successful and without error message.	
10	Switch on system (-K0 = 1) Cylinder retracted/feedback activated (-B1 = 1) EMERGENCY STOP (-A1 = 1) not activated AUTOMATIC mode (-S0 = 1) Automatic stop pushbutton not actuated (-S2 = 1) Briefly actuate automatic start pushbutton (-S1 = 1) Sensor part at slide activated (-B4 = 1) Then the induction motor is switched on via the frequency converter and remains active → Motor ON	
11	Sensor at conveyor end activated (-B7 = 1) → Motor OFF (after 2 seconds)	
12	Briefly actuate automatic stop pushbutton (-S2 = 0)→ Motor OFF	
13	Activate EMERGENCY STOP (-A1 = 0)→ Motor OFF	
14	Operating mode manual (-S0 = 0)→ Motor OFF	
15	Switch off system (-K0 = 0)→ Motor OFF	
16	Cylinder not retracted (-B1 = 0)→ Motor OFF	
17	Project archived successfully.	

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8 Exercise

8.1 Task - exercise

The maximum speed of the motor was limited to 500.00 1/min by the parameter assignment Adjust the normalization in both blocks "MOTOR_ SPEEDCONTROL" [FC10] and "MOTOR_SPEEDMONITORING" [FC11] correspondingly so that calculation can be carried out with the suitable physical values.

8.2 Technology schematic diagram

At this point you see the technology schematic diagram for the task.

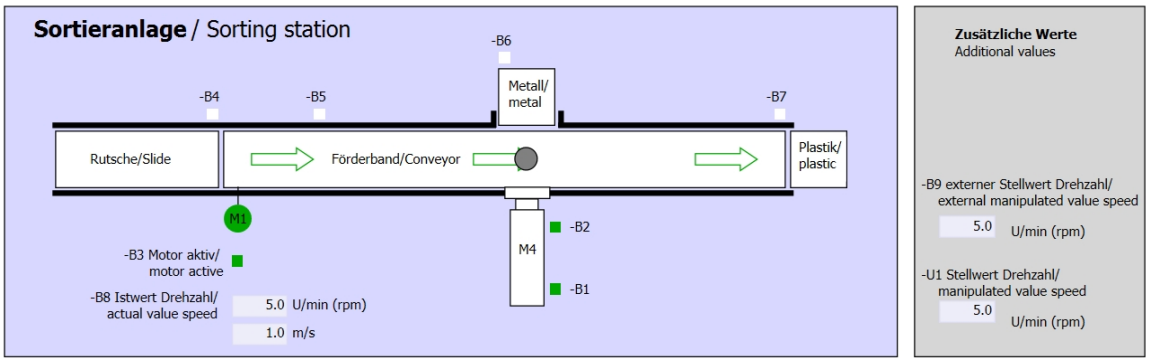

Figure 5: Technology schematic diagram

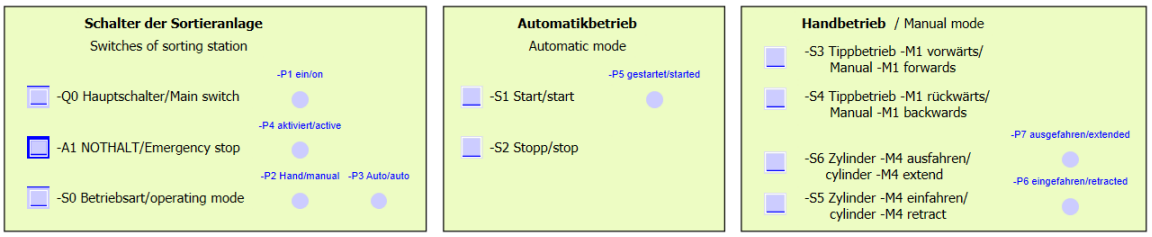

Figure 6: Operator panel

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8.3 Reference table

The following signals are required as global operands for this task.

DI	Type	ID	Function	NC/NO
I 0.0	BOOL	-A1	Return signal emergency stop ok	NC
I 0.1	BOOL	-K0	Main switch "ON"	NO
I 0.2	BOOL	-S0	Mode selector manual (0)/automatic (1)	Manual = 0
I 0.3	BOOL	-S1	Pushbutton automatic start	NO
I 0.4	BOOL	-S2	Pushbutton automatic stop	NC
I 0.5	BOOL	-B1	Sensor cylinder -M4 retracted	NO
I 1.0	BOOL	-B4	Sensor part at slide	NO
I 1.3	BOOL	-B7	Sensor part at end of conveyor	NO
ID256	STRUCT	PZD_IN_G120_01	Telegram 1 receive process data from G120 conveyor1	

DO	Type	ID	Function	
OD256	STRUCT	PZD_OUT_G120_01	Telegram 1 send process data to G120 conveyor1	

Legend for reference list

DI	Digital input	DO	Digital output
AI	Analog input	AO	Analog output
I	Input	O	Output
NC	Normally Closed		
NO	Normally Open		

8.4 Planning

Plan the implementation of the task by yourself

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8.5 Checklist – exercise

The following checklist helps trainees/students to independently check whether all steps of the exercise have been carefully completed and enables them to successfully complete the module on their own.

No.	Description	Checked
1	Program changes carried out in MOTOR_ SPEEDCONTROL“ [FC10].	
2	Program changes carried out in MOTOR_ SPEED_MONITORING" [FC11].	
3	Compiling and downloading of the program blocks is successful and without error message.	
4	Switch on system (-K0 = 1) Cylinder retracted/feedback activated (-B1 = 1) EMERGENCY STOP (-A1 = 1) not activated AUTOMATIC mode (-S0 = 1) Automatic stop pushbutton not actuated (-S2 = 1) Briefly actuate automatic start pushbutton (-S1 = 1) Sensor part at slide activated (-B4 = 1) Then the induction motor is switched on via the frequency converter and remains active. →Motor ON The speed corresponds to the speed setpoint in the range of +/- 50 1/min	
5	Sensor at conveyor end activated (-B7 = 1) → Motor OFF (after 2 seconds).	
6	Briefly actuate automatic stop pushbutton (-S2 = 0) → Motor OFF	
7	Activate EMERGENCY STOP (-A1 = 0) → Motor OFF	
8	Operating mode manual (-S0 = 0) → Motor OFF	
9	Switch off system (-K0 = 0)→ Motor OFF	
10	Cylinder not retracted (-B1 = 0) → Motor OFF	
11	Speed > Speed limit fault max. → Motor OFF	
12	Speed < Speed limit fault min. → Motor OFF	
13	Project archived successfully.	

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9 Additional information

More information for further practice and consolidation is available as orientation, for example: Getting Started, videos, tutorials, apps, manuals, programming guidelines and trial software / firmware, under the following link:

siemens.com/sce/drives

Preview "Additional information" – In preparation

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Further information

Siemens Automation Cooperates with Education
siemens.com/sce

SCE Learn-/Training Documents
siemens.com/sce/documents

SCE Trainer Packages
siemens.com/sce/tp

SCE Contact Partners
siemens.com/sce/contact

Digital Enterprise
siemens.com/digital-enterprise

Industrie 4.0
siemens.com/future-of-manufacturing

Totally Integrated Automation (TIA)
siemens.com/tia

TIA Portal
siemens.com/tia-portal

SIMATIC Controller
siemens.com/controller

SIMATIC Technical Documentation
siemens.com/simatic-docu

Industry Online Support
support.industry.siemens.com

Product catalogue and online ordering system Industry Mall
mall.industry.siemens.com

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