Simple Speed Control of a SINAMICS V20 with S7-1200/1500 using the USS® Protocol

SINAMICS V20 (Firmware ≥ V3.51)
SIMATIC S7-1200 (Firmware ≥ V4.1), SIMATIC S7-1500 (Firmware ≥ V1.7)

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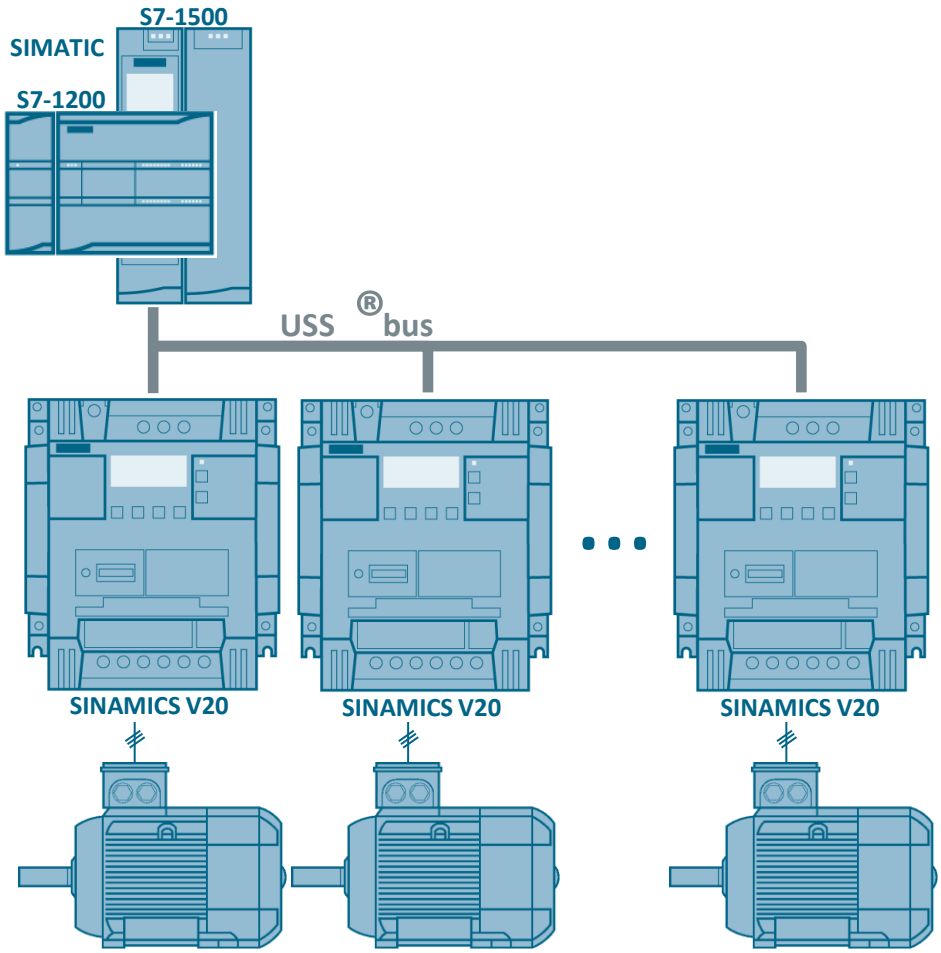
Table of Contents

1 Task

1.1 Overview

The SINAMICS V20 drives are to be controlled by a SIMATIC S7-1200 or S7-1500 via the RS485 interface and using USS® (Universal Serial Interface protocol). The supplied sample projects show the configuration and programming of the controller for a USS® bus with a SINAMICS V20 drive.

Figure 1-1: Schematic representation



1.2 Operation of the drive

In the example, the drive is operated in the following ways:

- Watch table in TIA Portal
- KTP600 operator panel in TIA Portal

Control

The SINAMICS V20 drive is to be controlled via the following bit signals of the control word (STW):

- *ON/OFF1* – start bit of the SINAMICS V20 (STW1, bit 0)
  If this parameter has the value TRUE, this input enables operation of the V20 at the preset speed.
- *OFF2* – coast down to a standstill (STW1, bit 1)
  If this parameter has the value FALSE, this bit causes the SINAMICS V20 to coast down to a standstill, without braking.
- *OFF3* – fast stop bit (STW1, bit 2)
  If this parameter has the value FALSE, this bit causes a fast stop by braking the SINAMICS V20.
- *Fault ack.* – error acknowledgment bit (STW1, bit 7)
  With this bit, you reset the error bit of the SINAMICS V20 once you have eliminated the drive fault. This informs the drive that it is no longer necessary to signal the fault.
- *Reverse* – direction control of the SINAMICS V20 (STW1, bit 11)
  This bit has to be set for clockwise rotation (provided that the speed setpoint is positive).

Entering the speed

Speed setpoint (HSW)
This is the speed setpoint of the SINAMICS V20 as a percentage of the configured frequency. When entering a positive value, the motor rotates clockwise if *Reverse* has the value TRUE.

Status evaluation

The SINAMICS V20 drive is to continuously transfer the following bit signals of the status word (STW) to the controller:

- *Inverter running* – operation enabled (ZSW1, bit 2)
  This bit signals whether the SINAMICS V20 is running.
- *Motor runs right* – drive direction (ZSW1, bit 14)
  This bit signals clockwise rotation of the motor.
- *ON inhibit active* – SINAMICS V20 inhibit (ZSW1, bit 6)
  This bit signals the status of the inhibit bit for the SINAMICS V20.
- *Inverter fault active* – drive fault (ZSW1, bit 3)
  This bit signals that a fault has occurred in the SINAMICS V20. The user has to eliminate the fault and set the acknowledgment bit (STW1, bit 7) to delete this bit.

Transferring the actual speed

Actual speed (HIW)
This is the actual speed of the SINAMICS V20 as a percentage of the configured frequency. When the value is positive, the motor rotates clockwise if *Motor runs right* has the value TRUE.

Display of communication errors

In the event of a communication error, the error status of the USS® system instructions of the STEP 7 program is to be displayed.

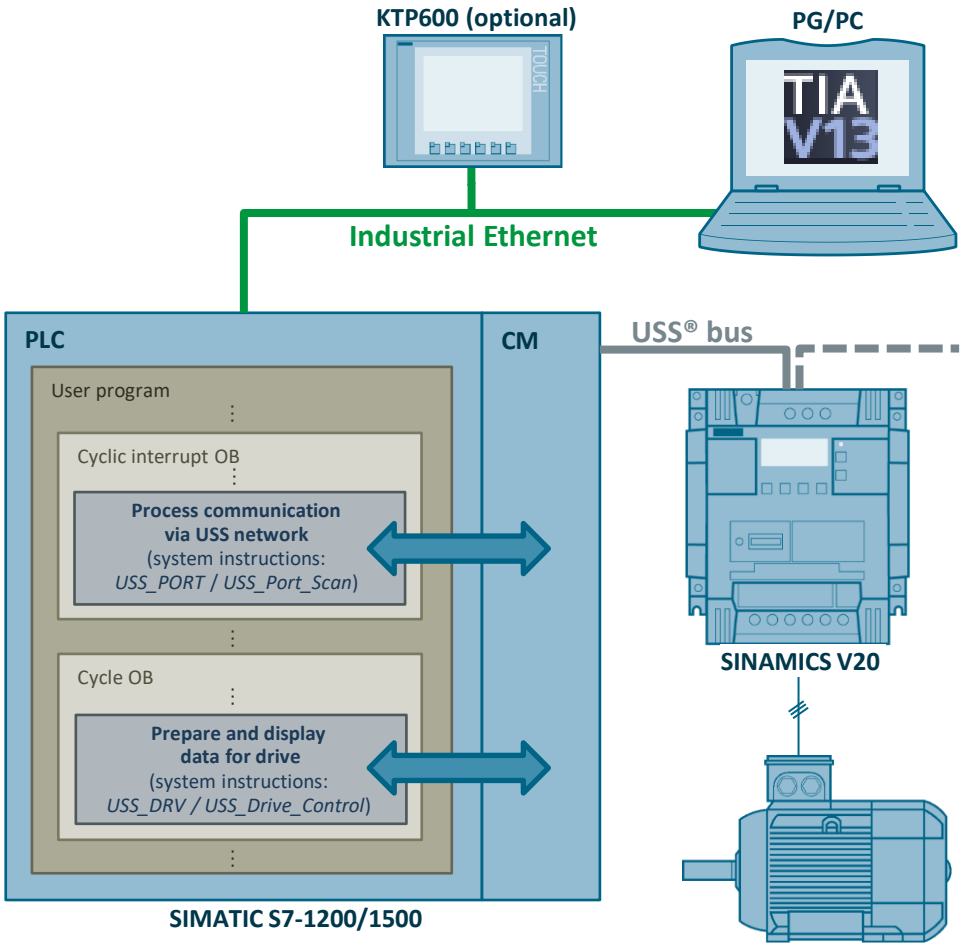
2 Solution

2.1 Overview

Diagrammatic representation

To connect the bus, you need a RS485 communication module for both the SIMATIC S7-1200 and the S7-1500. This module is operated in the control program by USS system statements. The figure below shows the basic configuration.

Figure 2-1: Function chart



Scope

To the extent not necessary for understanding this application example, this document does not contain a general description of

- the hardware components used.
- TIA Portal.
- the STEP 7 and WinCC configuration software.
- the USS® protocol.

Basic knowledge of these topics is required.

Required knowledge

Knowledge of automation and drive technology is helpful to understand the application example. You need basic knowledge of SINAMICS drives and configuring SIMATIC controllers in TIA Portal.

2.2 Hardware and software components

2.2.1 Validity

This application is valid for

- SINAMICS V20 with the following firmware version data or higher:

  Table 2-1: SINAMICS V20 firmware version data

Parameter	Index	Meaning	Value
r0018	-	Firmware version	3.51
r0964	[0]	Company (Siemens = 42)	42
	[1]	Product type (V20 = 8001)	8001
	[2]	Firmware version	351
	[3]	Firmware date (year)	2012
	[4]	Firmware date (day/month)	1012
	[5]	Number of inverters	1
	[6]	Firmware version	500

- S7-1200 PLC with firmware V4.1 or higher[1]
- S7-1200 CM1241 communication module with firmware V2.1 or higher
- S7-1200 CB1241 communication board with firmware V1.0 or higher
- S7-1500 controller with firmware V1.7 or higher
- S7-1500 CM PtP communication module with firmware V1.0 or higher
- STEP 7 software V13 SP1 or higher

2.2.2 Components used

The application was created with the following components.

Hardware components

The following table contains only the main components necessary from a functional perspective. It does not list

- line-side components such as circuit-breakers, fuses or line filters.
- load-dependent components such as braking resistors.
- fixing accessories such as mounting rails.
- standard wiring material and terminal blocks.
- other small accessories.

[1] Please note: An update to ≥V4.1 is only possible for S7-1200 controllers with article numbers …….-1xx40-….

Table 2-2: Hardware components

Component	No.		Article number	Note
Drive components				
SINAMICS V20 (3AC400V, 0.75KW, FILTER C3)	1		6SL3210-5BE17-5CV0	… or any other SINAMICS V20 with a firmware version listed in 2.2.1.
SIMOTICS GP low-voltage motor, 3 AC 50Hz 400V, 0.75 KW	1		1LA7083-4AA60	… or any other asynchronous motor that complies with the specification of the SINAMICS V20 used.
S7-1200 controller components				
SIMATIC S7-1200 CPU 1215	1		6ES7511-1AK01-0AB0	For the required firmware version, see section 2.2.1.
SIMATIC S7-1200 CM1241 communication module	1	alternatively	6ES7241-1CH32-0XB0	
SIMATIC S7-1200 CB1241 communication board			6ES7241-1CH30-1XB0	
SUB-D connector, 9-pin	1		-	For bus connection on the CM 1241
S7-1500 controller components				
SIMATIC S7-1500 CPU 1511-1 PN	1		6ES7511-1AK01-0AB0	... or any other S7-1500 CPU with firmware V1.7 or higher.
SIMATIC S7-1500 CM PTP RS422/485 HF communication module	1	alternatively	6ES7541-1AB00-0AB0	
SIMATIC S7-1500 CM PTP RS422/485 BA communication module			6ES7540-1AB00-0AA0	When using this communication module, reduce the baud rate in the control software of the application example to ≤ 19.2 kbit/s and replace the hardware ID of the CM PtP.
SUB-D connector, 15-pin	1		-	For bus connection on the CM PtP
HMI				
SIMATIC HMI KTP600 Basic color PN	(1)		6AV6647-0AD11-3AX0	… can be simulated in TIA Portal for test and demonstration purposes
Other				
SITOP PSU100L stabilized 24V power supply	1		6EP1333-1LB00	24V power supply for SIMATIC CPU and KTP600. You can also use a different power supply that meets the requirements of the loads.
USS bus cable	Sold by the meter		-	Shielded three-wire cable
RS485 bus termination network	1		6SL3255-0VC00-0HA0	Package content: 50 pcs.

Component	No.	Article number	Note
IE TP cord preassembled with two RJ45 connectors	1(2)	6XV1850-2Gxxx xxx=E50 ⇨ 0.5m H10 ⇨ 1m H20 ⇨ 2m H60 ⇨ 6m N10 ⇨ 10m	For … PLC ⇔ PG/PC PLC ⇔ KTP700 (optional) Other Ethernet cables are also possible.

Software components

Table 2-3: Software components

Component	Article number	Note
SIMATIC STEP 7 Basic V13 SP1 Floating License	6ES7822-0A.03-…	… when using a SIMATIC S7-1200
SIMATIC STEP 7 Prof. V13 SP1 Floating License	6ES7822-1..03-…	… when using a SIMATIC S7-1200 or SIMATIC S7-1500

Sample files and projects

The following list contains all files and projects that are used in this example.

Table 2-4: Sample files and projects

Documents	Note
109480894_V20USSatS7-12001500_DOC_V1d0_TIAV13SP1_en.pdf	... this document
109480894_V20USSatS7-1200_PROJ_V1d0_TIAV13SP1.zip	TIA project with S7-1200
109480894_V20USSatS7-1500_PROJ_V1d0_TIAV13SP1.zip	TIA project with S7-1500

3 Principle of Operation

3.1 Complete overview

3.1.1 Basic software structure

The USS protocol uses a master/slave network for communication via a serial bus. The master (SIMATIC controller) uses an address parameter to send a message to a selected slave (SINAMICS V20). A slave cannot send without having received a request for sending. Direct information transmission between the individual slaves is not possible. USS communication takes place in half duplex operation.

In STEP 7, different libraries have to be used for the S7-1200 and S7-1500 controllers. However, their system blocks are handled similarly.

The STEP 7 program is divided into an **interrupt-driven** part and a program part to be **cyclically** processed.

Interrupt-driven part
This part calls a *USS_PORT* (S7-1200) or *USS-Port_Scan* (S7-1500) system instruction from a cyclic interrupt OB for each communication port. This system instruction processes communication via the USS network.

Cyclic part
This part calls a *USS_DRV* (S7-1200) or *USS_Drive_Control* (S7-1500) system instruction on the respective port from a cycle OB for each existing slave. This system instruction prepares send data for the drive and evaluates the drive's response data.

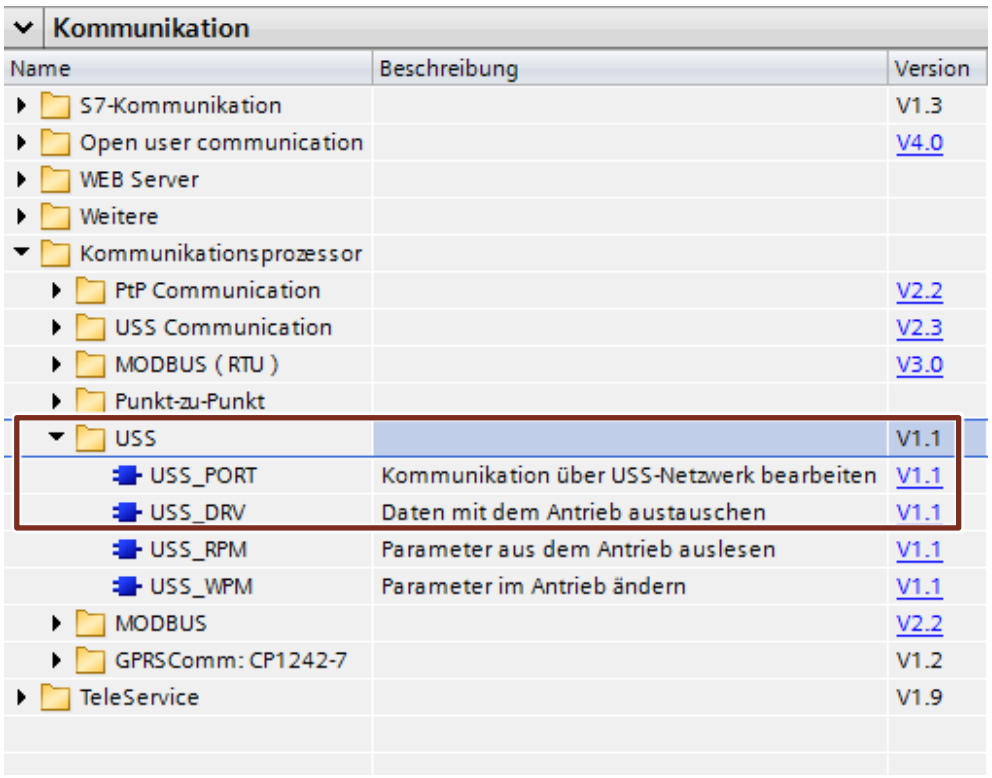
3.1.2 Implementation with SIMATIC S7-1200

Use the following system instructions:

- *USS_PORT*
  to process communication via the USS® network
- *USS_DRV*
  to prepare the send data and evaluate the response data

These system instructions can be found in the *Instructions* task card, *Communication*.

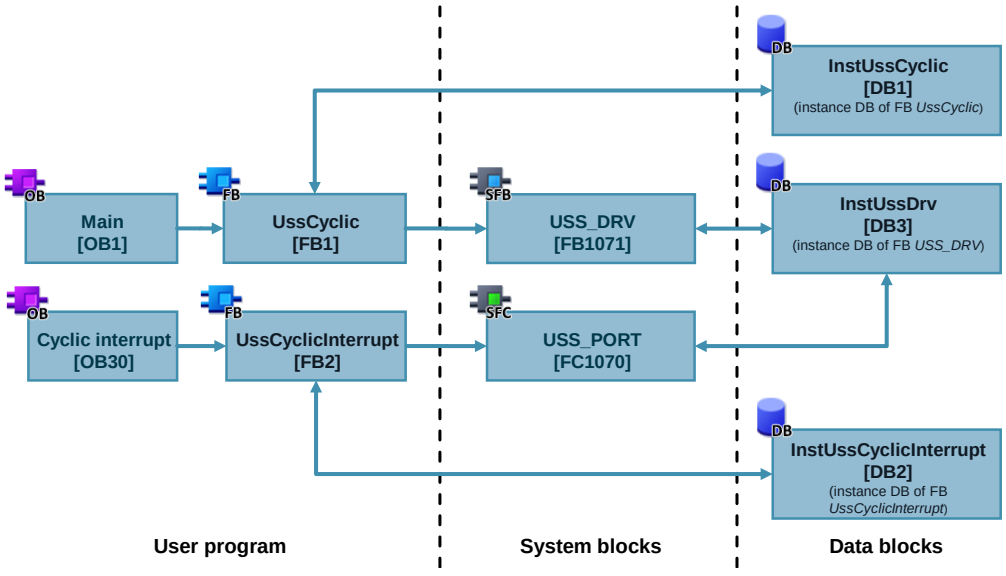
Figure 3-1: USS instructions for S7-1200



Note The instructions in the *USS Communication* folder are currently not suitable for the S7-1200 in this application example.

The following figure shows the call structure of the program example.

Figure 3-2: Block call diagram for SIMATIC S7-1200



The *UssCyclic* and *UssCyclicInterrupt* user blocks use optimized block access.

Note Know-how protected use of the *UssCyclic* user block in a library is not possible.

Reason:
The *USS_DRV* system FB cannot put its data into the *InstUssCyclic* instance DB of the calling *UssCyclic* block as a multi-instance; it uses the *InstUssDrv* single instance. This is necessary as the *USS_PORT* system FB can only access the entire instance DB of *USS_DRV* via its *USS_DB* formal parameter of the *USS_BASE* data type; it cannot access an instance data block within *InstUssCyclic*.

3.1.3 Implementation with SIMATIC S7-1500

Use the following system instructions:

- *USS_Port_Scan*
  to process communication via the USS® network
- *USS_Drive_Control*
  to prepare the send data and evaluate the response data

These system instructions can be found in the *Instructions* task card, *Communication*.

Figure 3-3: USS instructions for S7-1500

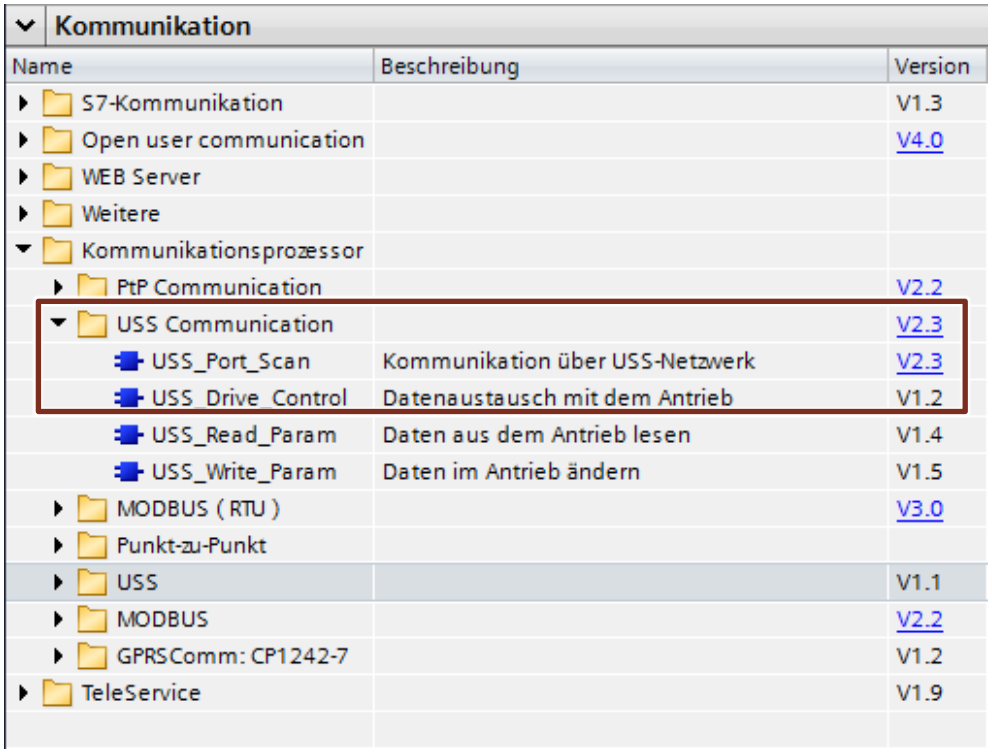
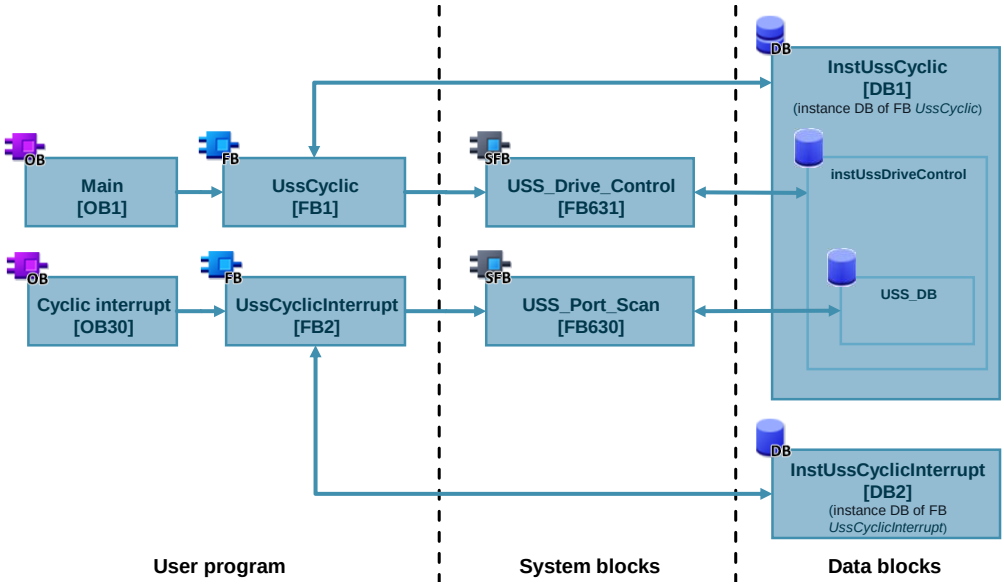


Figure 3-4: Block call diagram for SIMATIC S7-1500



The *UssCyclic* and *UssCyclicInterrupt* user blocks use optimized block access.

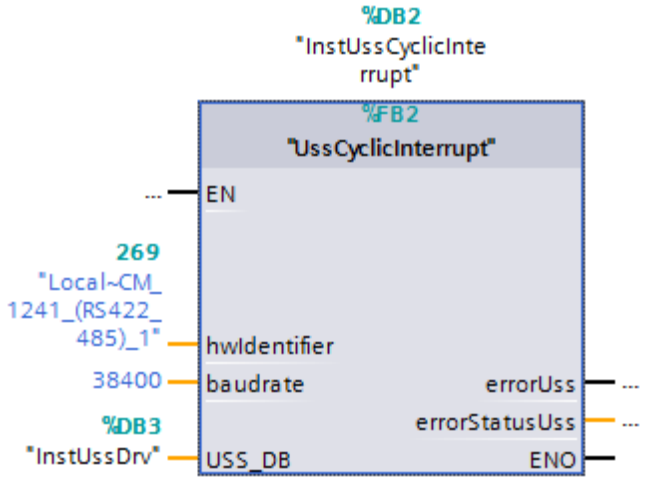
3.2 Blocks

3.2.1 UssCyclicInterrupt [FB2]

Call

All activities relating to processing USS communication for the communication module with the parameterized hardware ID should be combined in this block.

Figure 3-5: *UssCyclicInterrupt* user FB



The block name is intended to indicate that the block is called by the cyclic interrupt OB.

Note Call other instances of a *UssCyclicInterrupt* not in the same but in other cyclic interrupt OBs. This provides you (even if the cyclic interrupts have the same call interval) with the option to equalize communication of multiple ports in terms of time by changing the phase shift.

List of formal parameters

Table 3-1: Block parameters of the *UssCyclicInterrupt* FB

Name	Data type	Meaning
IN parameter		
hwIdentifier	PORT	Hardware identifier of the communication module Preferably use the appropriate symbolic system constant as the actual parameter (in the project tree, *PLC tags*). When replacing the communication module, the hardware identifier value may change. However, the symbolic name is retained. The parameter is only passed on to the *USS_PORT* or *USS_Port_Scan* system instruction.
baudrate	UDInt	Baud rate in bit/s Allowed for SINAMICS V20: 9600 19200 38400 57600 76800 93750 115200 (default value: 38400 baud) The parameter is only passed on to the *USS_PORT* or *USS_Port_Scan* system instruction.
USS_DB	USS_BASE (for S7-1200) P2P_USS_BASE (for S7-1500)	Data reference S7-1200: Reference to the instance DB of the *USS_DRV*[2] instruction. S7-1500: Reference to the *USS_DB* structure tag in the instance data of the *USS_Drive_Control* instruction.

[2] In TIA Portal, the instance DB for the *USS_DRV* instruction is stored in the project tree, *System blocks>Program resources*.

Name	Data type	Meaning
OUT parameter		
errorUss	Bool	Communication error Saved *ERROR* error bit of the *USS_PORT or USS_Port_Scan*[3] system instruction. In the example, this error bit is reset using the HMI or the watch table.
errorStatusUss	Word	Error code Saved *STATUS* error code of the *USS_PORT or USS_Port_Scan*[3] system instruction. In the example, this error code is reset to 0000_{hex} using the HMI or the watch table.

Function

In this application example, the block has only the following tasks:

- Calls and supplies the *USS_PORT* system instruction
- Saves the *USS_PORT* output parameter *STATUS* when *ERROR* = true

Call interval

On the one hand, the call interval of the cyclic interrupt OB in which the *UssCyclicInterrupt* user FB and finally the *UDD_PORT* or *USS_Port_Scan* system instruction are called

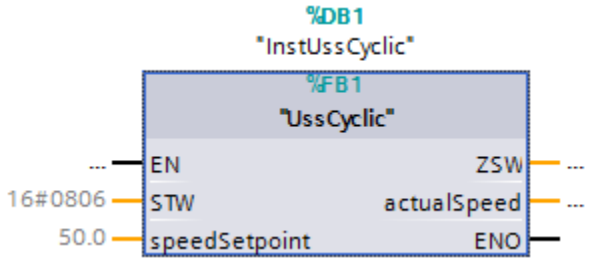
- should be as short as possible to minimize the communication time;
- on the other hand, it must be long enough to process each communication request reliably without errors.

3.2.2 UssCyclic [FB1]

Call

All activities to be cyclically performed while processing USS communication should be combined in this block.

Figure 3-6: *UssCyclic* user FB



The block name is intended to indicate that the FB is called by a cycle OB.

[3] Communication errors are only signaled at the *ERROR* and *STATUS* outputs of the *USS_PORT* instruction. Therefore, it is sufficient to read out the error code of this system instruction.

Table 3-2: Block parameters of the *UssCyclic* FB

Name	Data type	Meaning
IN parameter		
STW	Word	Control word of the SINAMICS V20 With the *UssCyclic* FB, the following STW bits can be transferred to the SINAMICS V20: ON/OFF1 (bit 00) OFF2 (bit 01) OFF3 (bit 02) Fault ack. (bit 07) Reverse (bit 11)
speedSetpoint	Real	Speed setpoint Specified as a percentage of the frequency of the inverter output and therefore independent of the pole pair number and motor slip.
OUT parameter		
ZSW	Word	Status word of the SINAMICS V20 With the *UssCyclic* FB, the following ZSW bits can be received from the SINAMICS V20: Inverter running (bit 02) Motor runs right (bit 14) ON inhibit active (bit 06) Inverter fault active (bit 03)
actual Speed	Real	Actual speed Specified as a percentage of the frequency of the inverter output and therefore independent of the pole pair number and motor slip.

Function

In this application example, the block only has the task to ensure the supply of the called *USS_DRV* or *USS_Drive_Control* system instruction.

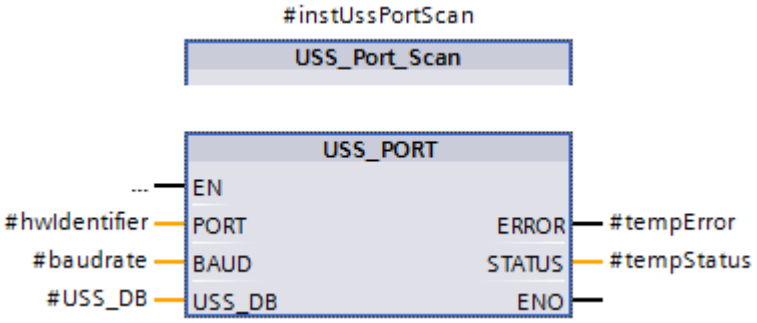
The following default settings were made in the associated *InstUssCyclic* instance DB:

- STW = 0806_{hex}
  This means that bits 01 (OFF2), 02 (OFF3) and 11 (Reverse) have already been set when the controller is restarted.
- speedSetpoint = 50.0
  Ensures that the drive immediately ramps up with the parameterized ramp-up time to 50% of its rated speed when the ON/OFF1 button is pressed.

3.2.3 USS® system instructions

***USS_PORT* (S7-1200) / *USS_Port_Scan* (S7-1500)**

Figure 3-7: *USS_PORT* or *USS_Port_Scan* system instruction

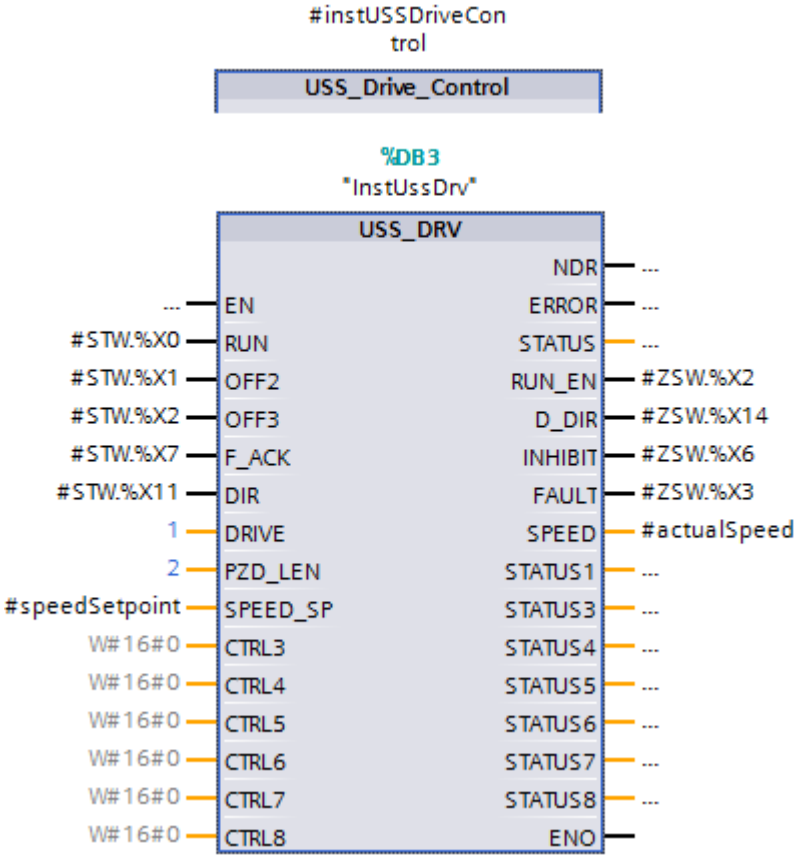


The *USS_PORT* system FB is described in the STEP 7 Basic System Manual in \6\ or in the appropriate section of the online help in TIA Portal.

The *USS_Port_Scan* system FB is described in the STEP 7 Professional System Manual in \5\ or in the appropriate section of the online help in TIA Portal.

USS_DRV (S7-1200) / *USS_Drive_Control* (S7-1500)

Figure 3-8: *USS_DRV* or *USS_Drive_Control* system instruction



The *USS_DRV* system FB is described in the STEP 7 Basic System Manual in \6\ or in the appropriate section of the online help in TIA Portal.[4]

The *USS_Drive_Control* system FB is described in the STEP 7 Professional System Manual in \5\ or in the appropriate section of the online help in TIA Portal.

[4] The symbolic name of the instruction is USS_DRV. In the manual and online help, it is called USS_DRIVE.

4 Configuration and Project Engineering

This chapter describes the configuration steps necessary for you to create the sample project. You will find helpful project engineering support, in particular if your required configuration differs from the supplied application example in terms of hardware and component parameterization.

Requirement

- **Configuration software**
  The software components are installed on your development system according to Table 2-3.
- **SINAMICS V20**
  The parameterization is performed using the built-in BOP (**B**asic **O**perator **P**anel). Therefore, on the line side, the drive has already been supplied with 230 or 400V – depending on the version.
- **SIMATIC S7-1200/1500**
  In TIA Portal, you have opened a new software project or a project to be expanded/modified.

Default values

The below parameterization of the SINAMICS V20 assumes that the device is in the as-supplied state or has been reset to factory default. In this state, there is a default parameterization that forms the basis for Table 4-1. Parameters that do not have to be changed for this application example regarding the default values will not be mentioned in the following sections.

When you add a device, for example a controller, from the hardware catalog to the project in TIA Portal, an associated default parameterization will be created. This default parameterization will be used as a basis in Table 4-2. Parameters and settings that do not have to be changed for this application example regarding the default values will not be mentioned in the following sections.

Note Both the procedure for parameterizing the SINAMICS V20 and the one for configuring the SIMATIC controllers in TIA Portal offer various options. The following configuration steps represent one possible solution. Steps or procedures deviating from this approach can also lead to the same goal.

4.1 Parameterizing the SINAMICS V20

Table 4-1: Table for parameterizing the SINAMICS V20 drive

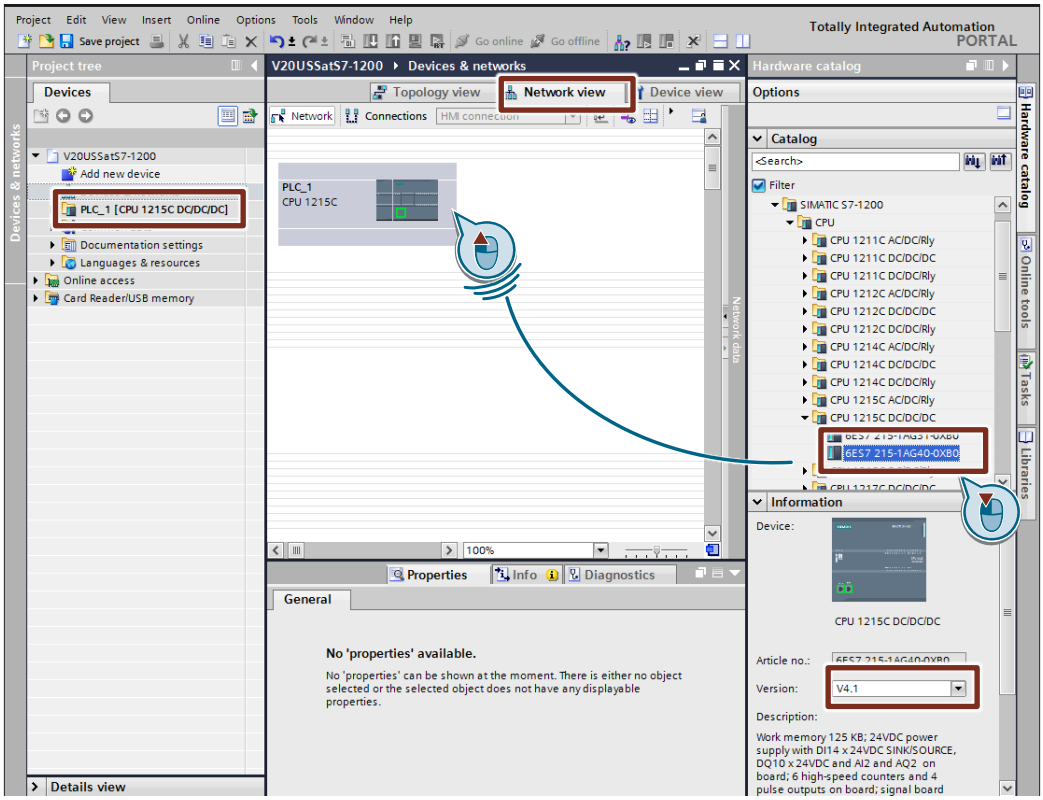
No.	Action
General: • The SINAMICS V20 is parameterized using the built-in BOP. For information on how to use the BOP, please refer to the SINAMICS V20 Operating Instructions in \10\. • Unless expressly noted, press the M and OK buttons <2s.	
1.	Provided that the SINAMICS V20 is in the as-supplied state and the display displays 50.7, continue with no. 2. If the inverter has already been running, the display menu with the output frequency is visible on the BOP. In this case, reset the device to factory default. To do this, use M to go from the display menu to the parameter menu and change the following parameters: • Commissioning parameter P0010 ⇨ 30 (LED on the BOP flashes green.) • Reset to factory setting[5] P0970 ⇨ 21
2.	The display displays 50.7 and the LED on the BOP has a steady green light. Use the arrow keys ▲ ▼ to select the 50/60 or Hz/hp setting that matches your region and use OK to exit the screen.
3.	The LED on the BOP flashes green. You are now in the setup menu in the "Motor data" step and, provided that you are running the example with a connected motor, you can start entering the motor parameters. When you have finished entering the motor parameters or if you do not want to enter any motor parameters, press M. You are now in the "Connection macro" step.
4.	Use the arrow keys ▲ ▼ to choose the connection macro -Cn010 (Cn010) and use OK to select it.
5.	Use M (>2s) to return to the display menu. The LED on the BOP returns to a steady green light.
6.	Use M to go to the parameter menu and set the user access level to "Expert": • Access level P0003 ⇨ 3
7.	Set the USS PKW length to 4: • PKW length P2013 ⇨ 4
8.	Transfer the changed parameter values from RAM to EEPROM: • RAM to EEPROM P0971 ⇨ 21
9.	Set the access level back to "Standard". • Access level P0003 ⇨ 1
10.	Use M (>2s) to return to the display menu.

[5] When resetting to factory default, connection parameters P2010, P2011, P2023 used for the USS protocol are not automatically reset in the process. However, they are supplied in step 4 of the table.

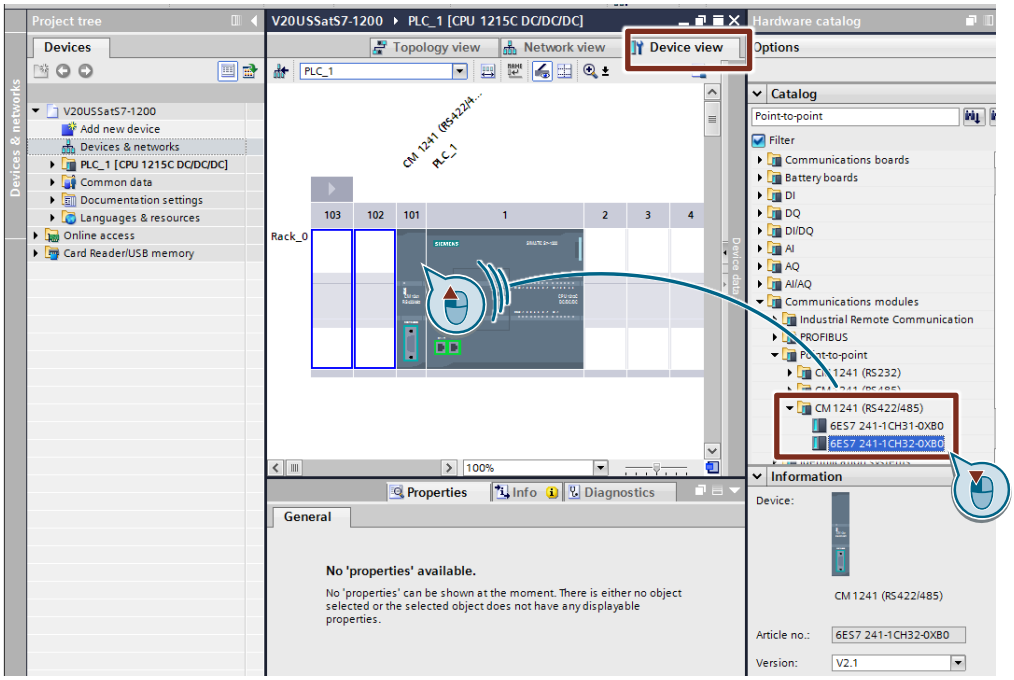
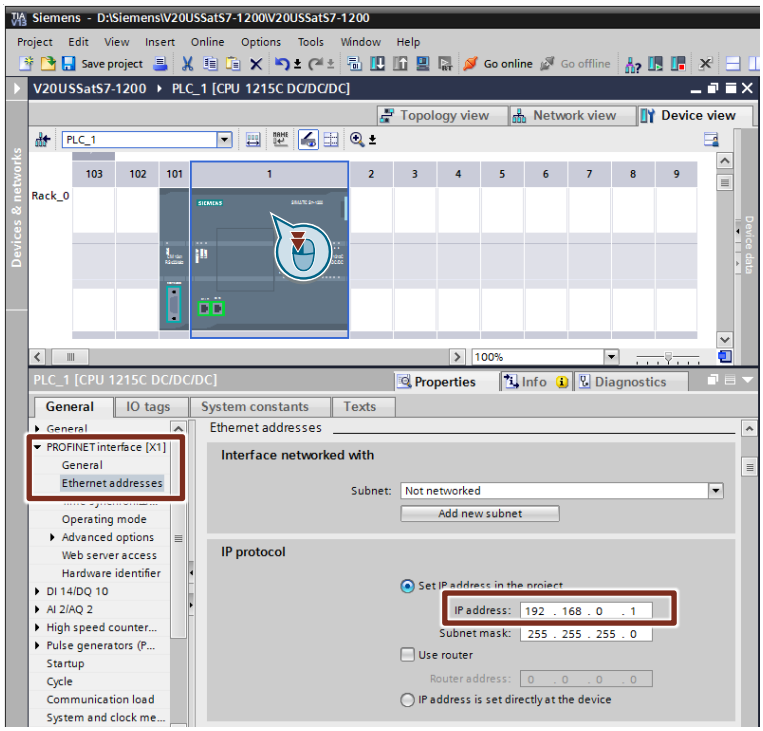
4.2 Configuring the SIMATIC controller

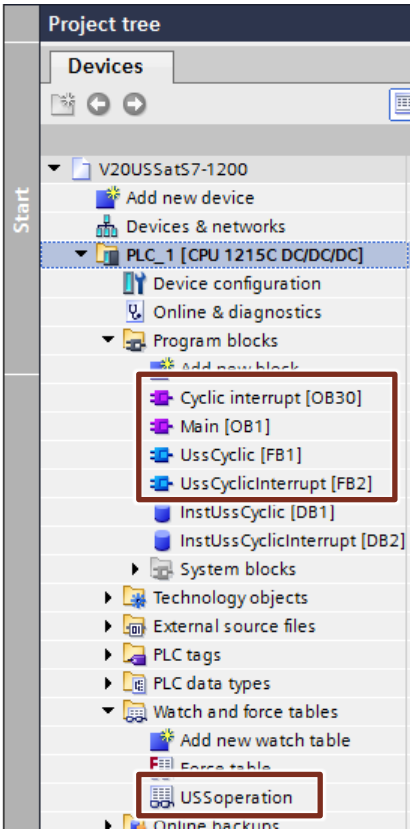
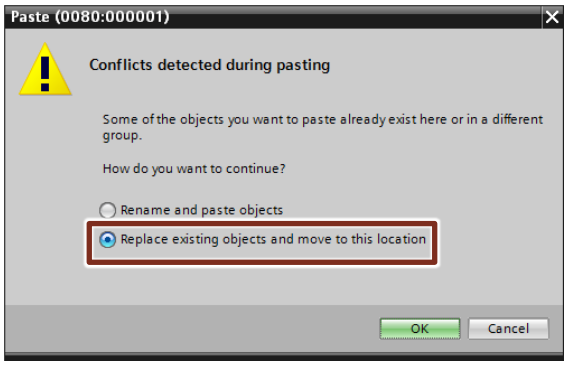
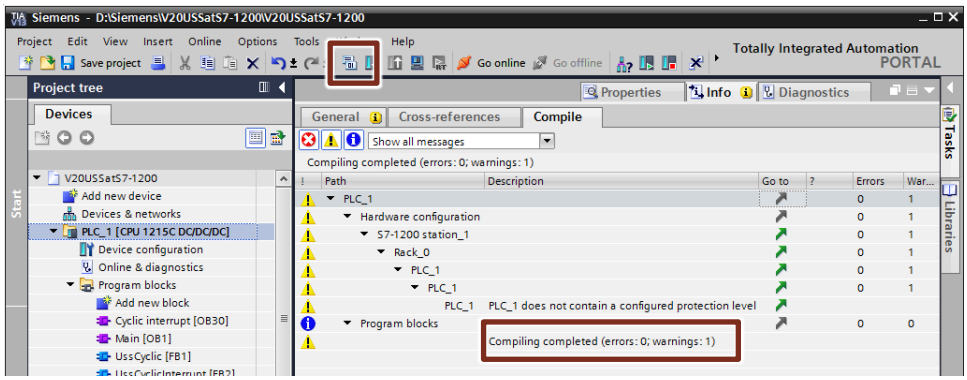
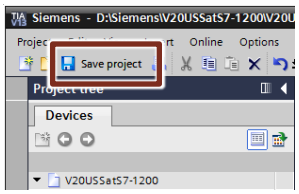
The screenshots in the following table are from the *V20USSatS7-1200* STEP 7 project. Deviations due to the use of the *V20USSatS7-1500* project are indicated in the text.

Table 4-2: Table for configuring the SIMATIC S7-1200 controller

No.	Action
1.	In the project tree, go to *Devices & networks* and select the *Network view*. In the *Hardware catalog* task card, locate the *SIMATIC S7-1200 CPU 1215C DC/DC/DC* or *SIMATIC S7-1500 CPU 1511-1 PN* and use drag and drop to move it to the graphic area of the Network view. In this area and in the project tree, it will be created as *PLC_1*[6]. Select the CPU with a version ≥V4.1 (S7-1200) or ≥V1.7 (S7-1500). 

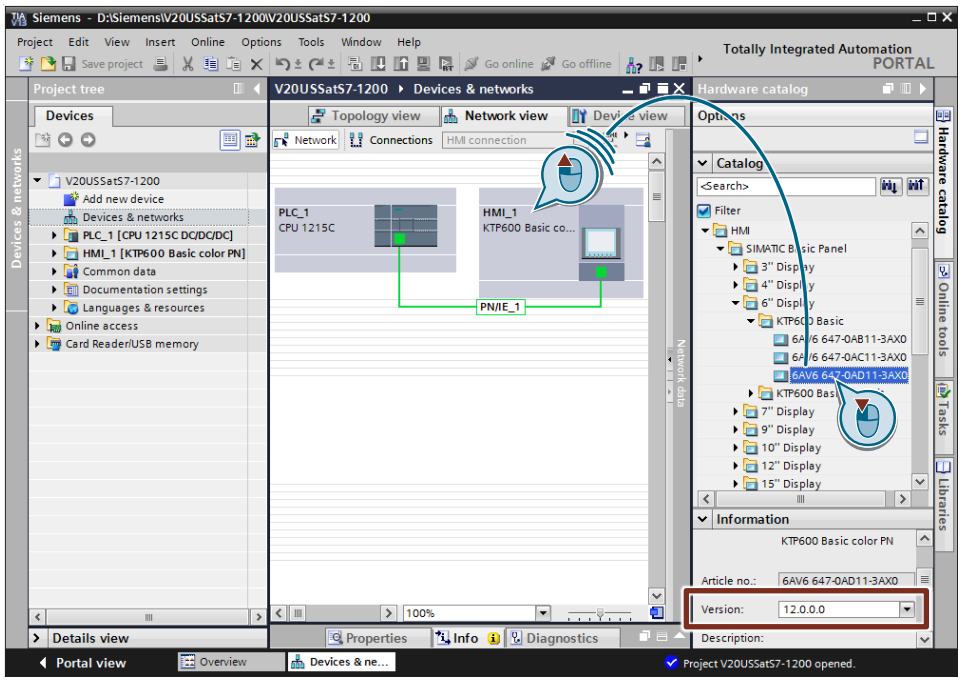
[6] Name can be changed.

No.	Action
2.	In the graphic area, select the SIMATIC controller and go to the *Device view*. In the *Hardware catalog* task card, locate the • *CM1241 (RS422/485)* communication module, version ≥V2.1, for the CPU 1215C • *CM PtP RS422/485 HF* communication module, version ≥V1.0 for the CPU 1511-1 PN and use drag and drop to move it to an allowed slot next to the CPU in the graphic area of the Network view. 
3.	If necessary, change the Ethernet address. To do this, double-click the CPU to open its properties. 

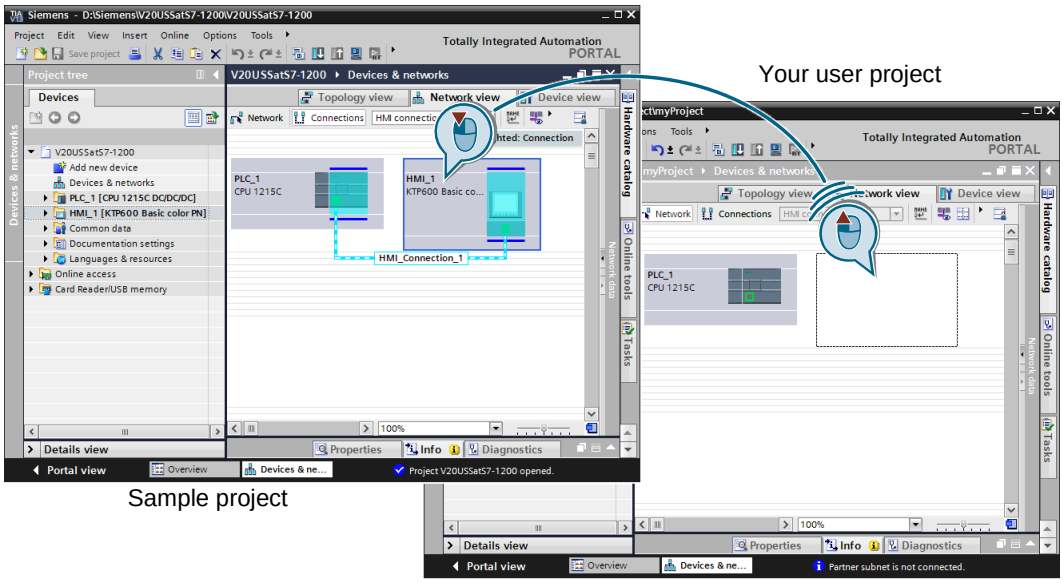
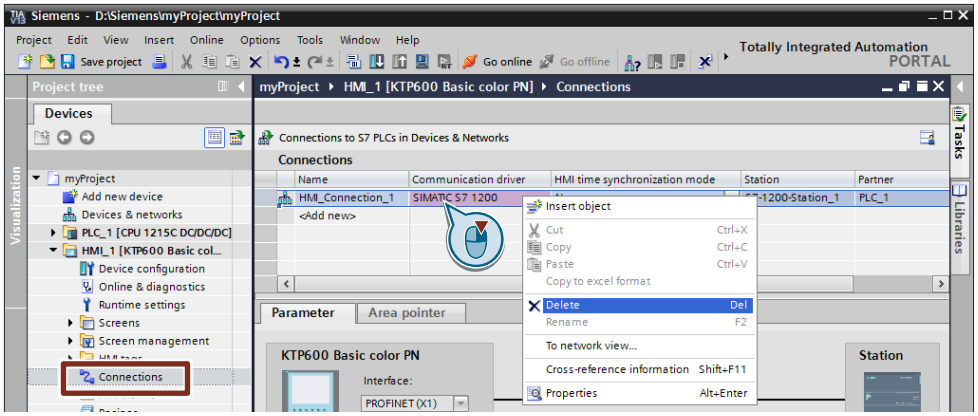
No.	Action
4.	Create your user program or – if you want to use the supplied sample program – copy the following objects from the sample program to your new project:   For the copy operation, you can open both TIA projects at the same time. In the dialog regarding conflicts when copying, select *Replace existing objects and move to this location*.
5.	Compile the *PLC_1* device in order to detect possible errors.  You can ignore the warning displayed when compiling the device.
6.	Save the project. 

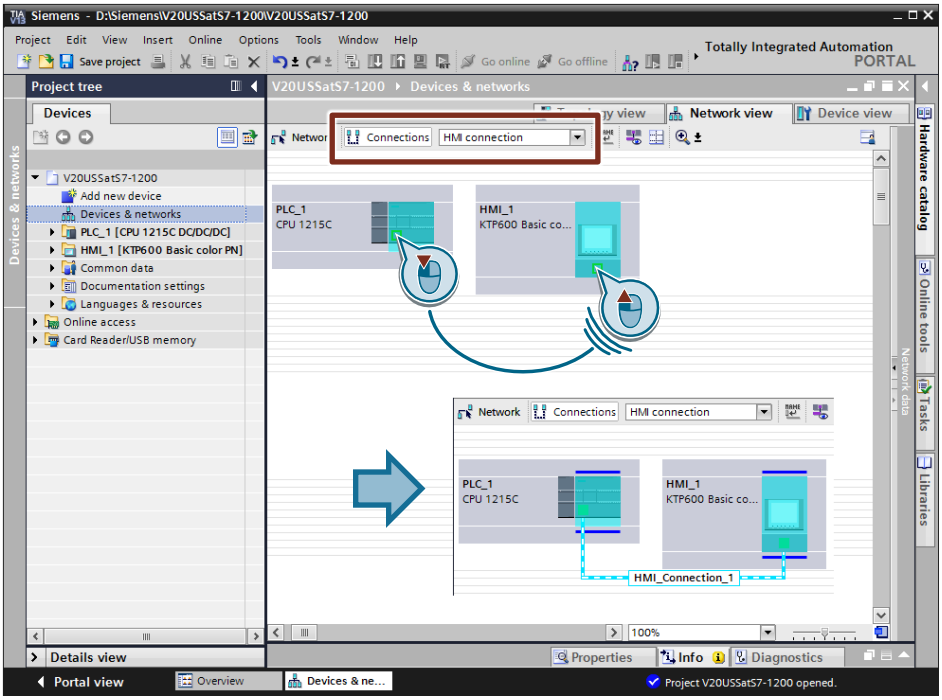
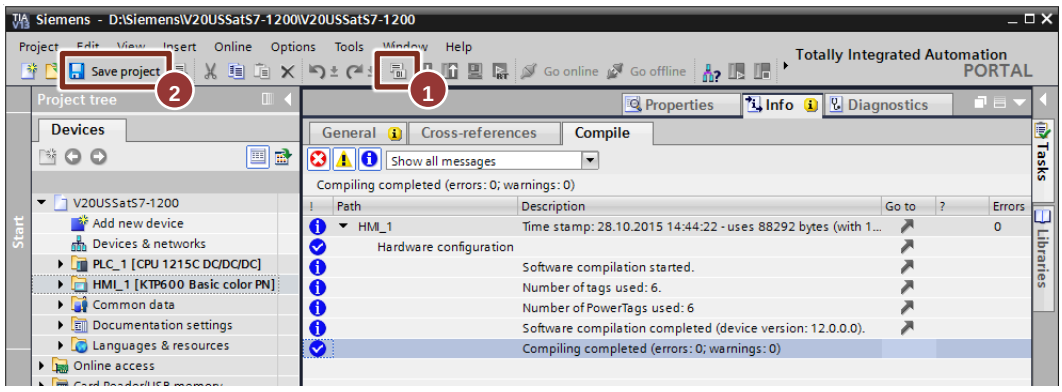
4.3 Configuring the SIMATIC HMI KTP600 operator panel

Table 4-3: Table for configuring the SIMATIC HMI KTP600 operator panel

No.	Action
1.	In the project tree, go to *Devices & networks* and select the *Network view*. In the *Hardware catalog* task card, locate the *SIMATIC Basic Panel KTP600 Basic* and use drag and drop to move it to the graphic area of the Network view. In this area, it will be created as *HMI_1*[7]. Select the panel with a version ≥V12.0.0.0. 

[7] Name can be changed.

No.	Action
	Alternatively, you can also copy the fully configured operator panel from the supplied sample project to your new project. For the copy operation, you can open both TIA projects at the same time and use drag and drop to move the HMI device via from the graphic area of the Network view of the source project to the one of the target project. 
2.	Continue with step 3, provided that you have newly added the HMI device from the catalog. If you have added the HMI device by copying it, you have to delete the old connection. 

No.	Action
3.	Configure a new HMI connection in the Network view. To do this, use drag and drop to connect the Ethernet interfaces of *PLC_1* and *HMI_1*. As a consequence, *HMI_Connection_1*[8] will be created. 
4.	Compile the *HMI_1* device in order to detect possible errors and save its configuration. 

[8] Name can be changed.

5 Installation and Commissioning

5.1 Installing the hardware

Note Always follow the installation, mounting and wiring guidelines for the individual components provided in the appropriate manuals and accompanying notes.

Table 5-1: Table for installing and wiring the hardware

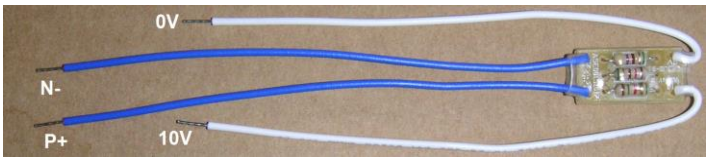
No.	Action
1.	Mechanically install the hardware. (SINAMICS V20, motor if applicable, SIMATIC controller, operator panel, 24V power supply unit)
2.	On the secondary side, connect the asynchronous motor (if applicable) to the SINAMICS V20. On the primary side, connect the SINAMICS V20 to the main circuit.
3.	Wire the 24 V DC connector of the SIMATIC S7 controller to the output of the 24V power supply unit. If you are connecting an operator panel, wire also the OP's 24 V DC connector to the output of the 24V power supply unit.
4.	Establish the USS® bus connection between the communications processor of the CPU and the SINAMICS V20. Provide bus termination and line polarization. For the bus design and wiring, always comply with the appropriate RS-485 interface standard specifications. For suggestions on wiring the networks with S7-1200 and S7-1500, please refer to the figures following this table. For bus termination where no RS485 bus connector can be used, Siemens offers a bus termination network (for the article number, see Table 2-2). Figure 5-1: Bus termination network 
5.	Use an Industrial Ethernet cable to connect the SIMATIC CPU (e.g., port 1) to the KTP600 operator panel, provided that you do not only want to simulate the HMI in TIA Portal.
6.	Use an Industrial Ethernet cable to connect the SIMATIC CPU (e.g., port 2) to your development system.

Figure 5-2: USS® bus wiring when using a SIMATIC S7-1200 controller

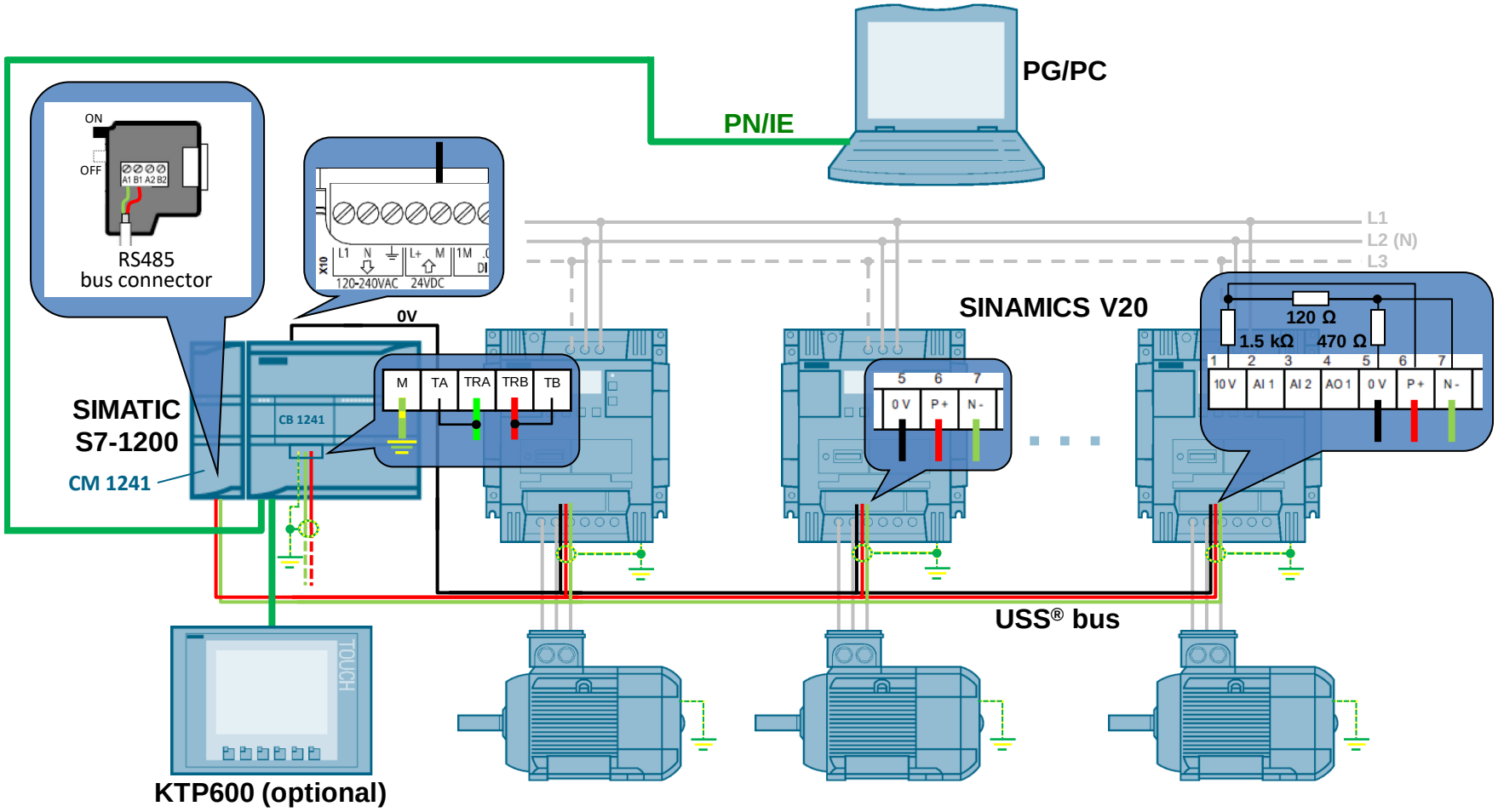
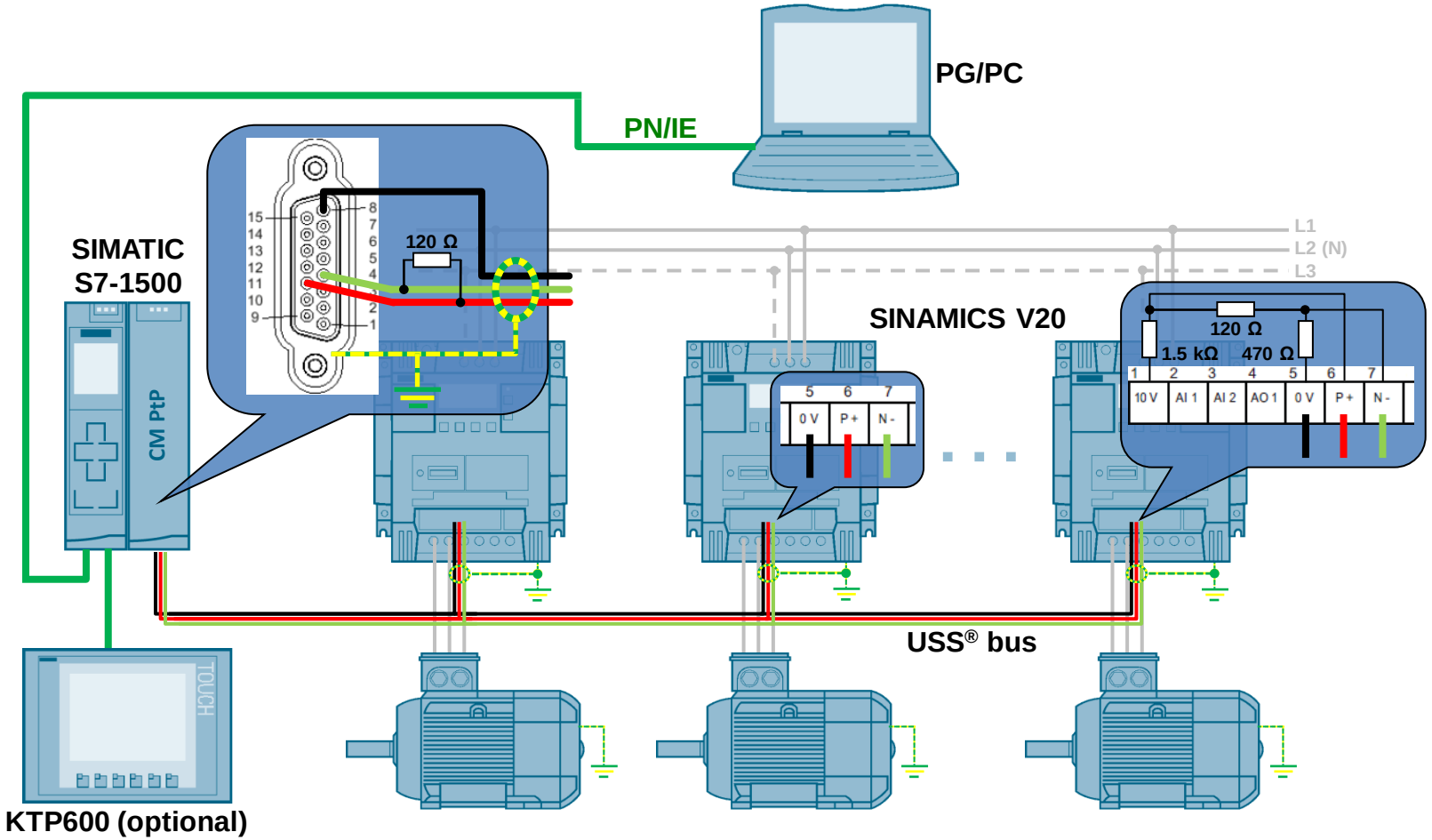
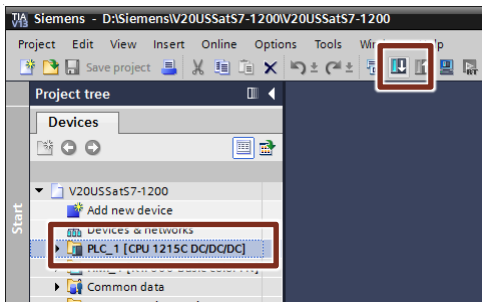


Figure 5-3: USS® bus wiring when using a SIMATIC S7-1500 controller

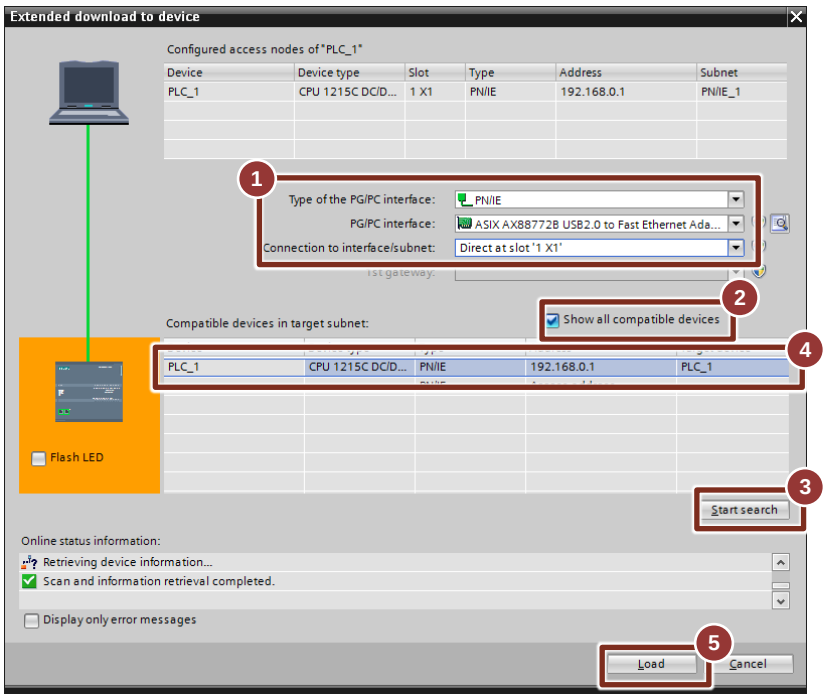


5.2 Installing the software (download)

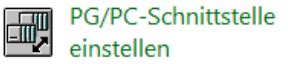
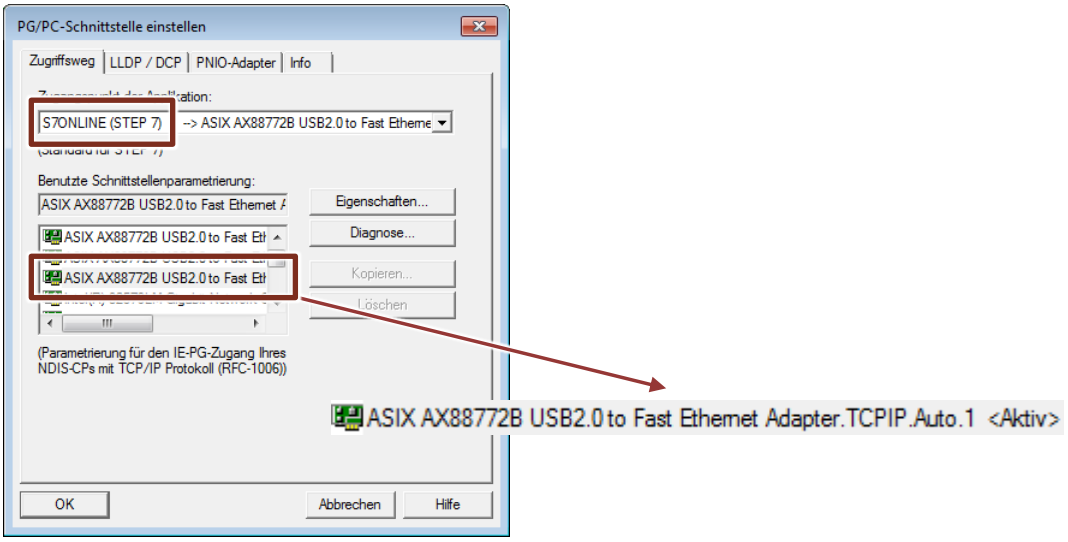
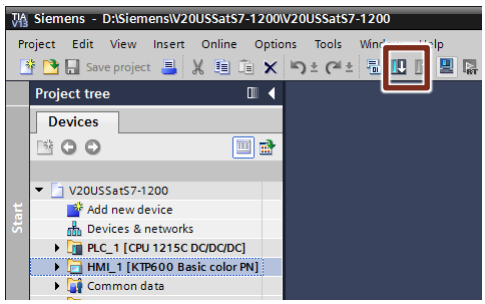
Table 5-2: Installing the software (download)

No.	Action
	General
1.	Make sure that • the hardware has been completely installed and wired (see chapter 5.1). • the 24 V DC power supply for the SIMATIC controller is switched on.
	SIMATIC S7-1200/1500
2.	Connect the SIMATIC S7 controller to your PG/PC via Industrial Ethernet.
3.	If you are using one of the supplied archives from Table 2-4, unzip it to a local directory of your development system and open the respective TIA project: • V20USSatS7-1200 • V20USSatS7-1500 If you are using your own project that has already been modified, open this project.
4.	Download *PLC_1* to the CPU. 

No.	Action
5.	When downloading for the first time, the "Extended download to device" window opens.



1. Select the *PN/IE* interface type, the network card used and the interface connection type.
2. Leave "Show all compatible devices" checked (default setting).
3. Select "Start search".
4. The found PLC is entered.
5. Start downloading. While downloading, follow the instructions/information displayed on the screen.

No.	Action
	KTP600
6.	If you want to use the simulation in TIA Portal, you have to set the PG/PC interface in the control panel of your development system (this step is not necessary if you are using a real operator panel instead of the simulation). Go to *Control Panel* > *All Control Panel Items* >   Select the access point of the application (*S7ONLINE (STEP 7)*) and the interface parameter assignment (network card) you are using. Select the one with the *…TCPIP.Auto.1* extension. Select *OK* to close the window.
7.	If you are using a real operator panel, download *HMI_1* to the KTP600.  When the "Extended download" window appears, proceed in the same way as when downloading the PLC (see step 5 of this table). After successful downloading, the configured start screen appears on the operator panel.

5.3 Commissioning

A specific commissioning routine is not required. Provided that you have performed the hardware and software installation described above, you only have to energize the power circuit for the SINAMICS V20 if this has not already been done. The next steps are described in the following chapter, 6 "Operation of the Application".

6 Operation of the Application

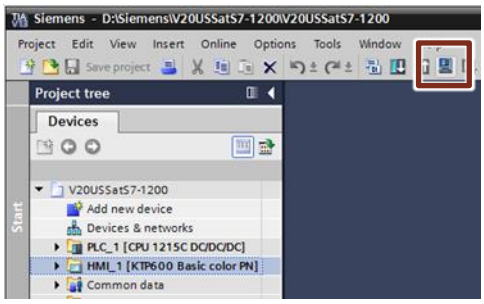
The application example is preferably operator controlled and monitored using the HMI (KTP600 or KTP600 simulation in TIA Portal). However, operator control is also possible online in TIA Portal using watch tables.

6.1 Operator control using the HMI

6.1.1 Switching on the operator panel

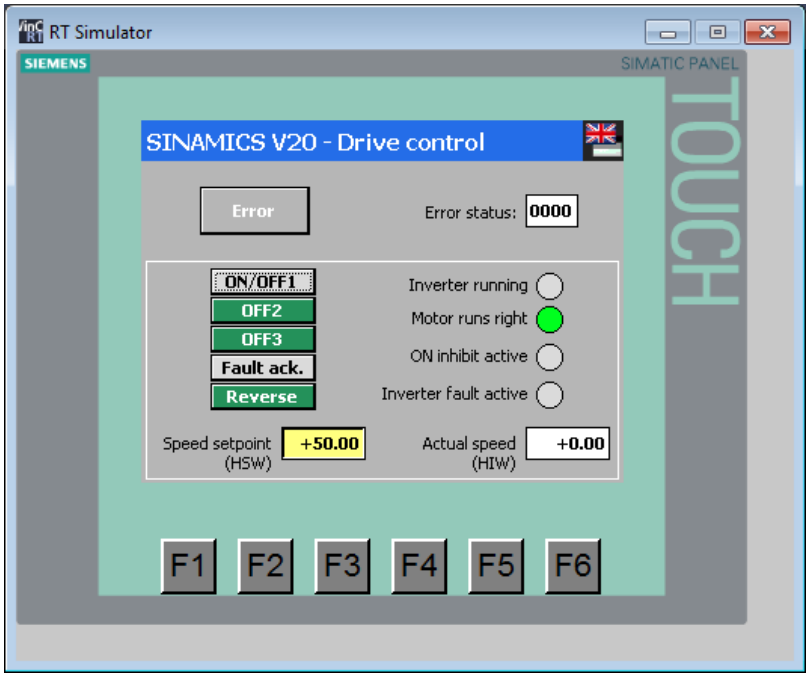
If you are using a real KTP600, it starts up automatically when you apply voltage to it. To simulate the KTP600, go online with your TIA project and start the simulation. In both cases, the start screen – the only user screen in this example – is displayed (see Figure 6-2).

Figure 6-1: Starting the KTP600 simulation



6.1.2 Operating screen

Figure 6-2: User screen on the KTP600 operator panel



Language

on the right edge of the header allows you to switch between English and German.

Control elements

The buttons displayed in the white frame on the operator panel, indicators and input/output fields correspond to the signals listed in chapter 1.2 "Operation of the drive". An unpressed button is displayed in gray and represents the logical state *false*. A pressed button is displayed in green and represents the logical state *true*.

In the yellow input field, enter the speed setpoint as a percentage of the output frequency of the SINAMICS V20. The white output field displays the actual speed, also as a percentage of the output frequency.

Functions are not assigned to the six function keys below the screen; these keys have no function.

Default

Due to entered start values in the *InstUssCyclic* instance DB, the drive starts at 50% of its rated speed in forward direction only when pressing *ON/OFF1*.

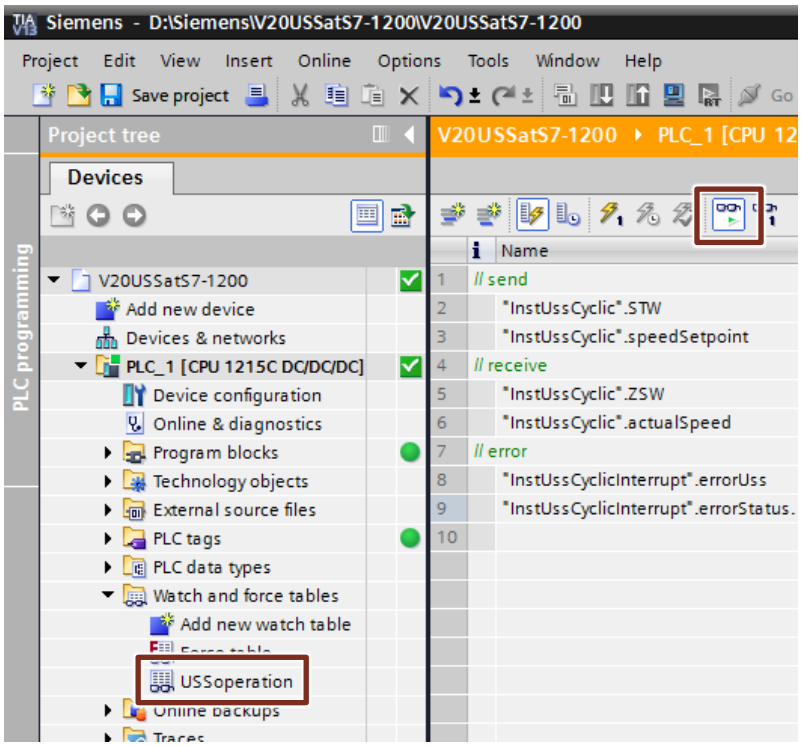
Error display

If a communication error occurs, the top part of the screen displays the saved error status of the *USS_PORT* or *USS_Port_Scan* system FB. In this case, the *Error* button flashes, which allows you to reset the error display.

6.2 Operator control using the watch table

Open the *USSoperation* watch table and go online.

Figure 6-3: Opening the *USSoperation* watch table



The tags in the watch table are identical to the ones on the operator panel. The only thing that differs is the representation of *STW* and *ZSW*; in contrast to the operator panel, they are not represented bit by bit but word by word.

7 Expansion to multiple Slaves

7.1 Expansion to multiple slaves with S7-1200

Expansion to multiple drives

The application example operates one SINAMICS V20. However, up to 16 drives can be operated via one port. To increase the number of drives, proceed as follows:

Table 7-1: Expansion to up to 16 drives for S7-1200

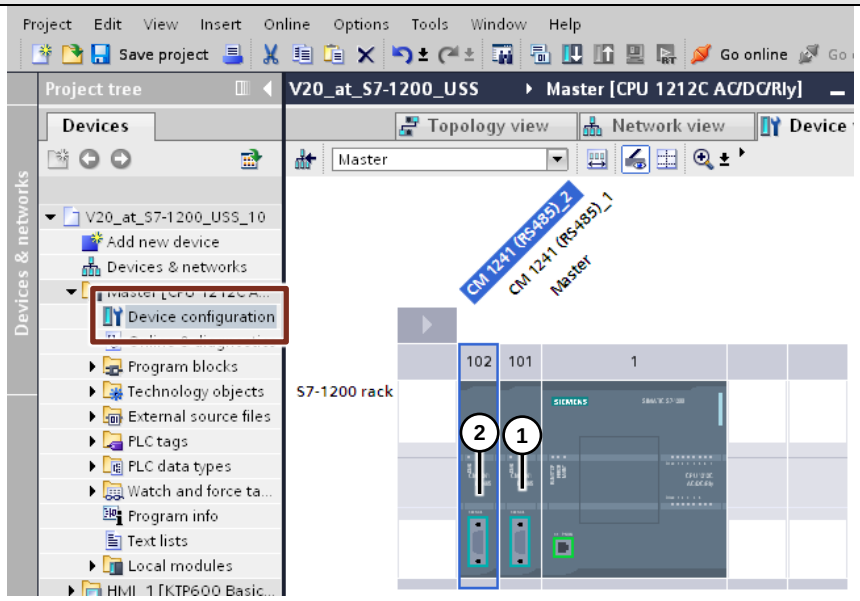
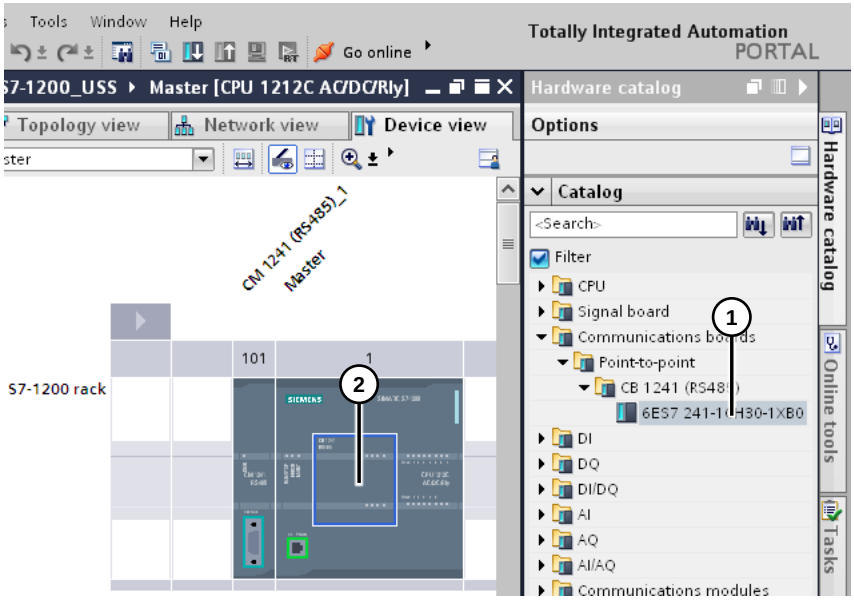
No.	Instruction
1.	Add the number of desired drives to your configuration as shown in Figure 5-2.
2.	Follow no. 1 to 10 of Table 4-1 to parameterize the added inverters using the built-in BOP. From "2" onward, the drive addresses have to be assigned continuously.
3.	Change the program so that the *USS_DRV* block is called for each drive. In this process, the appropriate address of the drive must be entered in the *DRIVE* input variable.

Expansion to multiple ports

You can provide the CPU with a maximum of three communication modules and one communication board. Up to 16 drives are possible on each module/board. In the section below, you will learn how to expand the application by a port.

Table 7-2: Port expansion for S7-1200

No.	Instruction
Installing and wiring new hardware	
1.	As shown in Figure 5-2, add the drives to your configuration that are to communicate with the controller via the new, additional port.
2.	Add a new CM1241 (RS485) communication module to the SIMATIC S7-1200 station or insert a CB1241 (RS485) communication board into the CPU.
3.	Physically establish the USS bus connection between the new drives and the new port.
Parameterizing new drives using the BOP	
4.	Follow no. 1 to 10 of Table 4-1 to parameterize the added inverters using the built-in BOP. From "1" onward, the drive addresses have to be assigned continuously.
Device configuration in TIA Portal	
5.	In the device configuration, copy the existing communication module (1) and paste it directly to the left of it into slot 102 (2).

No.	Instruction
	 When using a different module type or the communication board (1), use drag and drop to move it from the catalog to the intended location in the workspace (2).  Configure the module/board pasted from the catalog. Change the transmission speed (38.4 kbit) and parity (even). All other default values do not need to be changed.

No.	Instruction
Program extension in TIA Portal	
6.	In the project tree, copy the code blocks ... • *Cyclic_interrupt* • *UssCyclic* and the data block (in System blocks > Program resources) … • *InstUssDrv* The copies are automatically created with index _1: • *Cyclic_interrupt_1* • *UssCyclic_1* • *InstUssDrv_1* The name of the copied blocks can be changed in the block properties.
7.	Open the Main OB (OB1). Now drag the copied block, *UssCyclic_1,* to a network and supply it with a new instance data block.
8.	Open the newly created block *UssCyclic_1*. Now adjust the number of calls of *USS_DRV* in the block to the number of drives in the new communication module. For the remaining calls of *USS_DRV*, replace the instance data block and insert the *InstUssDrv_1* data block.
9.	Open the cyclic interrupt OB *Cyclic_interrupt_1*. Here the call of the *UssCyclicInterrupt* block can be retained. However, supply it with a new instance data block. The *hwIdentifier* input must contain a reference to the new communication module. In the *USS_DB* input, refer to the new data block, *InstUssDrv_1*.
10.	Compile the entire STEP7 program.

7.2 Expansion to multiple slaves with S7-1500

Expansion to multiple drives

The application example operates one SINAMICS V20. However, up to 16 drives can be operated via one port. To increase the number of drives, proceed as follows:

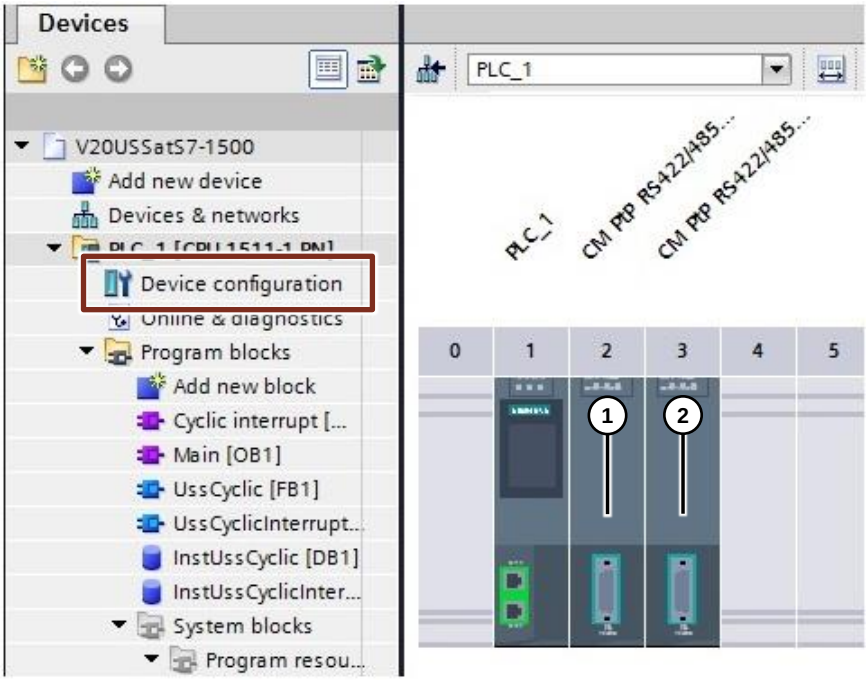
Table 7-3: Expansion to up to 16 drives for S7-1500

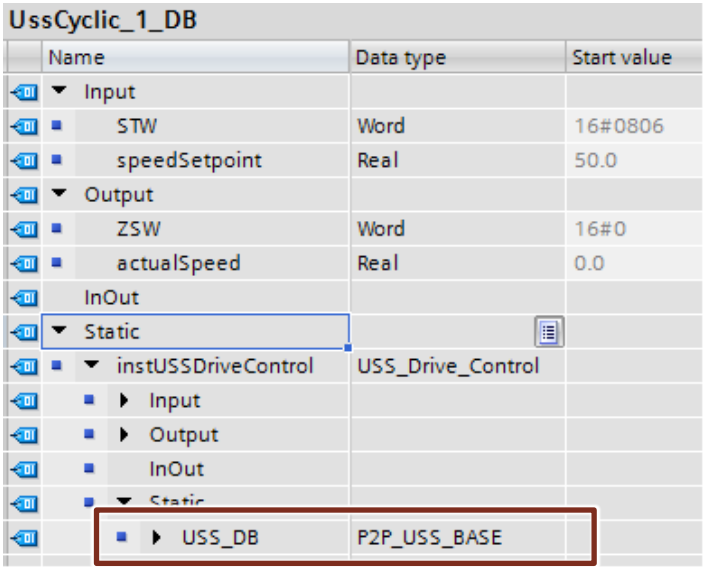
No.	Instruction
1.	Add the number of desired drives to your configuration as shown in Figure 5-2.
2.	Follow no. 1 to 10 of Table 4-1 to parameterize the added inverters using the built-in BOP. From "2" onward, the drive addresses have to be assigned continuously.
3.	Change the program so that the *USS_Drive_Control* block is called for each drive. In this process, the appropriate address of the drive must be entered in the *DRIVE* input variable.

Expansion to multiple ports

You can provide the CPU with more communication modules. Up to 16 drives are possible on each module. In the section below, you will learn how to expand the application by a port.

Table 7-4: Port expansion for S7-1500

No.	Instruction
	Installing and wiring new hardware
1.	As shown in Figure 5-2, add the drives to your configuration that are to communicate with the controller via the new, additional port.
2.	Add a new CM PtP RS422/485 communication module to the SIMATIC S7-1500 station.
3.	Physically establish the USS bus connection between the drives and the new port.
	Parameterizing new drives using the BOP
4.	Follow no. 1 to 10 of Table 4-1 to parameterize the added inverters using the built-in BOP. From "1" onward, the drive addresses have to be assigned continuously.
	Device configuration in TIA Portal
5.	In the device configuration, copy the existing communication module (1) and paste it directly to the right of it (2). 
	Program extension in TIA Portal
6.	In the project tree, copy the code blocks ... • *Cyclic_interrupt* • *UssCyclic* The copies are automatically created with index _1: • *Cyclic_interrupt_1* • *UssCyclic_1* The name of the copied blocks can be changed in the block properties.
7.	Open the Main OB (OB1). Now drag the copied block, *UssCyclic_1,* to a network and supply it with a new instance data block.

No.	Instruction
8.	Open the newly created block *UssCyclic_1*. Now adjust the number of calls of *USS_Drive_Control* in the block to the number of drives in the new communication module. For the remaining calls of *USS_Drive_Control*, replace the instance.
9.	Open the cyclic interrupt OB *Cyclic_interrupt_1*. Here the call of the *UssCyclicInterrupt* block can be retained. However, supply it with a new instance data block. The *hwIdentifier* input must contain a reference to the new communication module. The *USS_DB* input must contain a reference to the USS_DB tag. This tag is located in the new instance data block of *UssCyclic_1*. 
10.	Compile the entire STEP7 program.

8 Links & Literature

Table 8-1

	Topic	Title
\1\	Siemens Industry Online Support	http://support.industry.siemens.com
\2\	Download page of the entry	https://support.industry.siemens.com/cs/ww/en/view/109480894
\3\	SIMATIC S7-1200	S7-1200 Programmable Controller – System Manual http://support.automation.siemens.com/WW/view/en/91696622
		Update to the S7-1200 System Manual https://support.industry.siemens.com/cs/ww/en/view/89851659
\4\	SIMATIC S7-1500	S7-1500 Automation System – System Manual https://support.industry.siemens.com/cs/ww/en/view/59191792
		S7-1500 Automation System – Getting Started https://support.industry.siemens.com/cs/ww/en/view/71704272
\5\	STEP 7 Professional V13 SP1	STEP 7 Professional V13 SP1 – System Manual https://support.industry.siemens.com/cs/ww/en/view/109011420
\6\	STEP 7 Basic V13 SP1	STEP 7 Basic V13 SP1 – System Manual https://support.industry.siemens.com/cs/ww/en/view/109054417
\7\	WinCC Professional V13 SP1	WinCC Professional V13 SP1 – System Manual https://support.industry.siemens.com/cs/ww/en/view/109096785
\8\	V13 SP1 Updates	Updates for STEP 7 V13 SP1 and WinCC V13 SP1 https://support.industry.siemens.com/cs/ww/en/view/109311724
\9\	USS®	Specification: Universal Serial Interface Protocol USS Protocol https://support.industry.siemens.com/cs/ww/en/view/24178253
\10\	SINAMICS V20	SINAMICS V20 Operating Instructions https://support.industry.siemens.com/cs/ww/en/view/104426056

9 History

Table 9-1

Version	Date	Modifications
V1.0.0	12/2015	First version
V1.0.1	09/2018	Change text in table 2-2