SINAMICS G120C: Speed Control with S7-1200 via USS

SINAMICS G120C / V1.0 /

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Table of contents

1 Task

NOTICE	This reference only can be used in China and India.

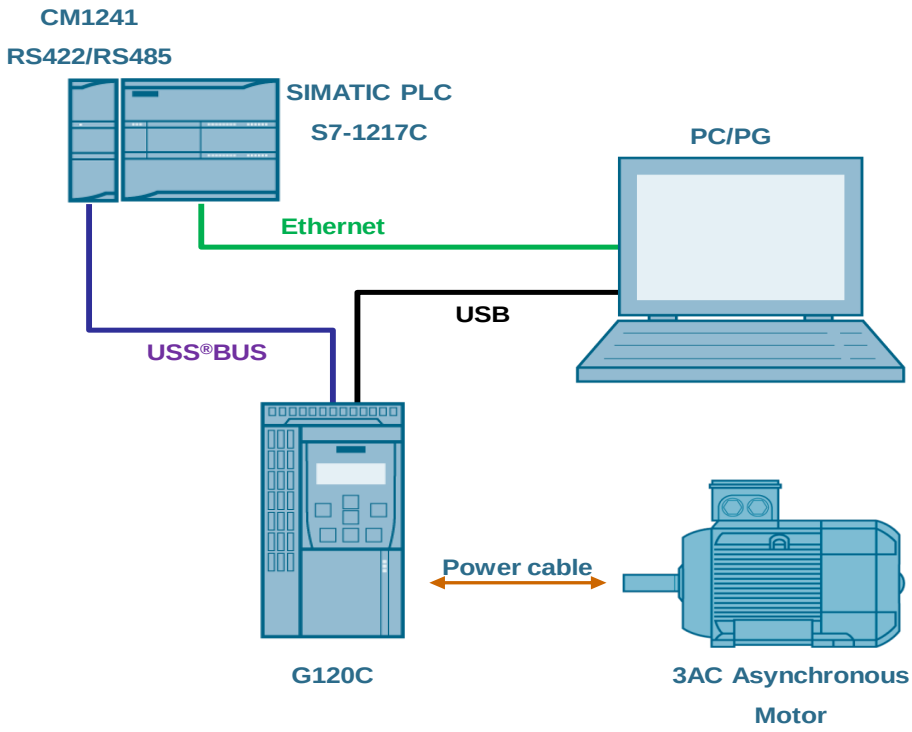
Introduction

SINAMICS G120C drives are able to exchange data via the RS485 interface and via USS with a SINAMICS S7-1200 controller.

Overview of the automation task

The figure below provides an overview of the automation task.

Figure 1-1: Overview of the automation task

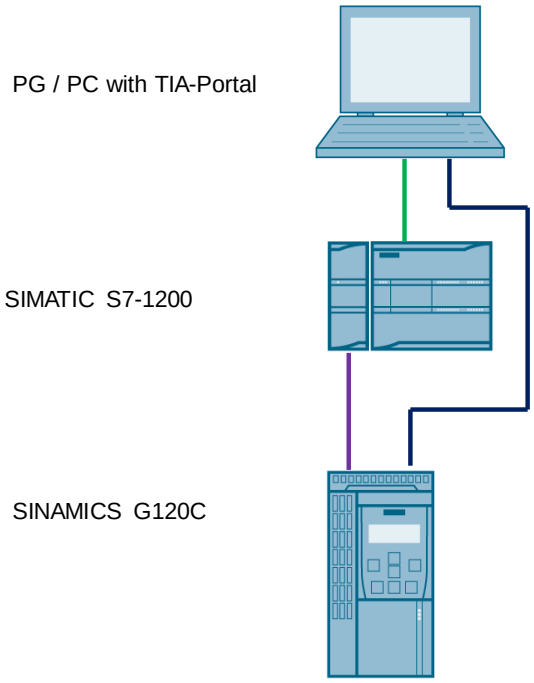


2 Solution

Schema Display

The following figure displays the most important components of the solution:

Figure 2-1: Overview of the most important components



Delimitation

This application does not include a description of

- SINAMICS G120C version
- BOP-2 operation of SINAMICS G120C

Basic knowledge of these topics is assumed.

Required knowledge

Basic knowledge on TIA Portal is assumed.

2.1 Hardware and Software Components

2.1.1 Validity

This application example is valid for

- TIA Portal V15 Professional
- S7-1200 CPU V4.1
- SINAMICS G120C USS V4.7.6

2.1.2 Used Components

The application was generated with the following components:

Hardware components

Table 2-1: Hardware components

Component	No.	Article number	Note
SIMATIC S7-1200 1217C DC/DC/DC	1	6ES7 217-1AG40-0XB0	V4.1
CM1241 RS422/RS485	1	6ES7 241-1CH32-0XB0	V2.1
SINAMICS G120C	1	6SL3210-1KE15-8UB1	V4.7.6

Standard software components

Table 2-2: Standard software components

Component	No.	Article number	Note
TIA Portal Professional	1	6AV2103-0AA05-0AA7	V15
Startdrive	1	6SL3072-4FA02-0XA0	V15

Sample files and projects

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

Table 2-3: Sample files and projects

Component	Note
109764624_G120C_USS-communication_PROJ_V10	Project file
109764624_G120C_USS-communication_DOC_V10_en.pdf	Reference document

3 Basics of USS introduction

The USS protocol uses a master/slave network for communication via a serial bus. The mater (SIMATIC controller) sends the message to the selected slave (SINAMICS G120C). A slave cannot send without having received a request for sending. Direct information transmission between the slaves is not possible. USS communication takes place in half duplex operation.

3.1 Implementation with SIMATIC S7-1200

Use the following system instructions:

- USS_PORT

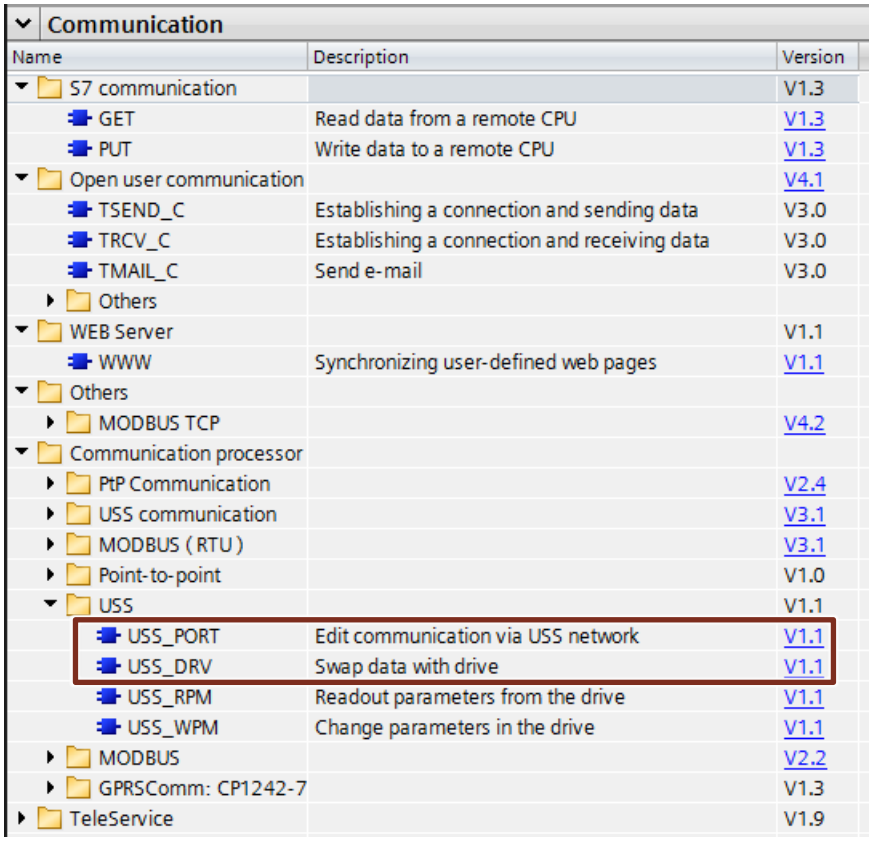
  To process communication via the USS network

- USS_DRV

  To prepare the send data and evaluate the response data

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

Figure 3-1: USS instructions for S7-1200



3.2 USS system instructions

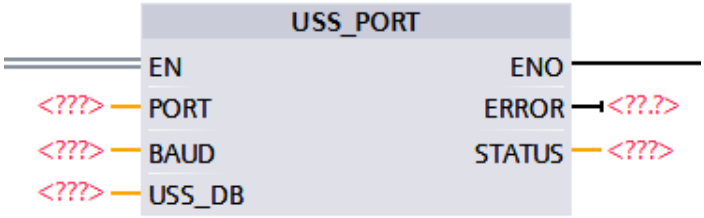
3.2.1 USS_PORT (S7-1200)

Description

The *USS_PORT* instruction handles communication over the USS network. In the program, use one *USS_PORT* instruction per PtP communications port to control the transmission.

All USS instructions that are assigned to the same USS network and same PtP communications port must use the same instance data block.

Figure 3-2: *USS_PORT* system instruction



Parameters

The following table shows the parameters of the *USS_PORT*

Table 3-1: Parameter list of *USS_PORT*

Parameter	Declaration	Data type	Memory area	Description
PORT	Input	PORT	D,L or constant	PtP communication port identifier. Constant that can be referenced within the *Constants* tab of the default tag table.
BAUD	Input	DINT	I,Q,M,D,L or constant	Baud rate for USS communication. For example: 300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 76800, 115200
USS_DB	InOut	USS_BASE	D	Reference to the instance DB of the *USS_DRIVE* instruction.
ERROR	Output	BOOL	I,Q,M,D,L	ERROR is set to TRUE if an error occurs.
STATUS	Output	WORD	I,Q,M,D,L	Status value of the request. Additional information is available in the *USS_Extended_Error* tag for some status codes.

NOTE The input value used in this application will described in chapter 3.4.

3.2.2 USS_DRV (S7-1200)

Description

The *USS_DRV* instruction exchanges data with the drive. A separate instruction must be used for each drive, but all USS instructions assigned to the same USS network and same PtP communications module must use the same instance data block. You must create the DB name when you call the first *USS_DRV* instruction.

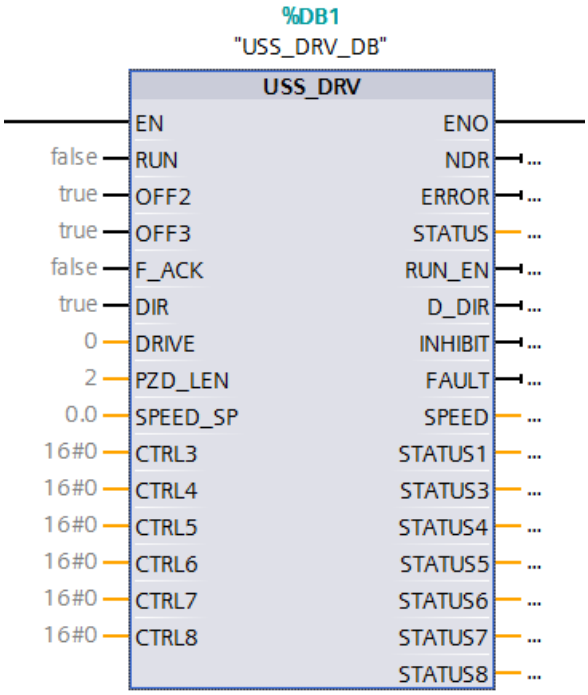
When the *USS_DRV* instruction is executed the first time, the drive indicated by the USS address (parameter DRIVE) is initialized in the instance DB. After this initialization, subsequent *USS_PORT* instructions can start communication with the drive at this drive number.

You can control the drive direction of rotation using either the DIR (BOOL) input or using the sign (positive or negative) at the SPEED_SP (REAL) input. The following table explains how these inputs work together to determine the drive direction, assuming the motor is wired for forward rotation.

Table 3-2: Drive direction

SPEED_SP	DIR	Direction of rotation of drive
Value > 0	0	Reverse
Value > 0	1	Forward
Value < 0	0	Forward
Value < 0	1	Reverse

Figure 3-3: *USS_DRV* system instruction



Parameters

The following table shows the parameters of the *USS_DRV* instruction:

Table 3-3: Parameter list of *USS_DRV*

Parameter	Declaration	Data type	Memory area	Description
RUN	Input	BOOL	I,Q,M,D,L or constant	Drive start, On/OFF1
OFF2	Input	BOOL	I,Q,M,D,L or constant	Coast stop
OFF3	Input	BOOL	I,Q,M,D,L or constant	Fast stop
F_ACK	Input	BOOL	I,Q,M,D,L or constant	Fault acknowledge
DIR	Input	BOOL	I,Q,M,D,L or constant	Drive direction
DRIVE	Input	USINT	I,Q,M,D,L or constant	Drive address
PZD_LEN	Input	USINT	I,Q,M,D,L or constant	Word length
SPEED_SP	Input	REAL	I,Q,M,D,L or constant	Speed setpoint
NDR	Output	BOOL	I,Q,M,D,L	New data ready
ERROR	Output	BOOL	I,Q,M,D,L	Error occurred
STATUS	Output	WORD	I,Q,M,D,L	Status value of the request
RUN_EN	Output	BOOL	I,Q,M,D,L	Run enabled
D_DIR	Output	BOOL	I,Q,M,D,L	Drive direction
INHIBIT	Output	BOOL	I,Q,M,D,L	Drive inhibited
FAULT	Output	BOOL	I,Q,M,D,L	Drive fault
SPEED	Output	REAL	I,Q,M,D,L	Drive actual speed

NOTE The input value used in this application will described in chapter 3.4.

3.3 Details of G120C USS function

3.3.1 Control word 1 (STW1)

Table 3-4: Control word 1 (STW1)

Bit	Significance	Explanation	Signal intercom-nection in the inverter
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 on (ON command).	
2	0 = Quick stop (OFF3)	Quick stop: The motor brakes with the OFF3 ramp-down time p1135 down to standstill.	p0848[0]=r2090.2
	1 = No quick stop (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	The inverter immediately sets its 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 stops at the actual value.	p1141[0]=r2090.3
	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]=r2090.6
	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 the “switching on inhibited” state.	p2103[0]=r2090.7
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	Reserved		
13	1 = MOP up	Increase the setpoint saved in the motorized potentiometer.	p1035[0]=r2090.13

Bit	Significance	Explanation	Signal intercom-nection in the inverter
14	1 = MOP down	Reduce the setpoint saved in the motorized potentiometer	p1036[0]=r2090.14
15	Reserved		

3.3.2 Status word 1 (ZSW1)

Table 3-5: Status word 1 (ZSW1)

Bit	Significance	Remarks	Signal intercom nection in the inverter
0	1 = Ready for switching on	Power supply switched on; electronics initialized; pulses locked.	p2080[0]=r0899.0
1	1 = Ready	Motor is switched on (ON/OFF = 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 stop is not active.	p2080[5]=r0899.5
6	1 = Switching on inhibited 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]=r0899.0
10	1 = Comparison speed reached or exceeded	Speed is greater than or equal to the corresponding maximum speed.	p2080[0]=r2199.1
11	1 = Torque limit not reached	Comparison value for current or torque has been fallen below.	p2080[11]=r0056.13 /r1407.7
12	Reserved		p2080[12]=r0899.12
13	0 = Alarm, motor over temperature	--	p2080[13]=r2135.14
14	1 = Motor rotates clockwise	Internal inverter actual value > 0	p2080[14]=r2197.3
	0 = Motor rotates counterclockwise	Internal inverter actual value < 0	
15	0 = Alarm, inverter thermal overload		p2080[15]=r2135.15

3.4 Installation

The figure below shows the hardware configuration of the application:

CAUTION	**Wrong wiring can damage the drive!** In this application, the three phase 400V power supply is used. It is a must for you to check the supply voltage; otherwise, the drive can be damaged!

Figure 3-4

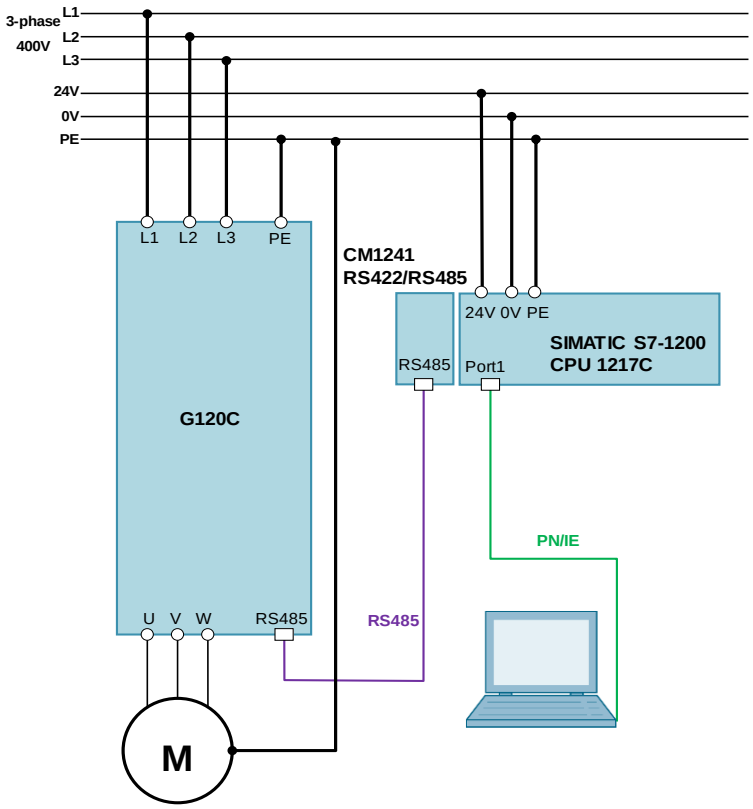


Figure 3-2: USS communication between CM1241 and G120C

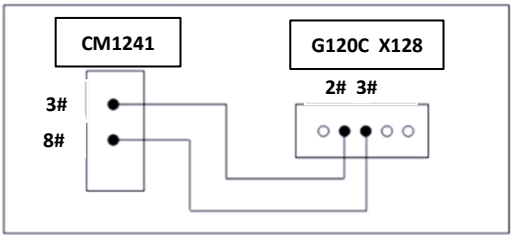
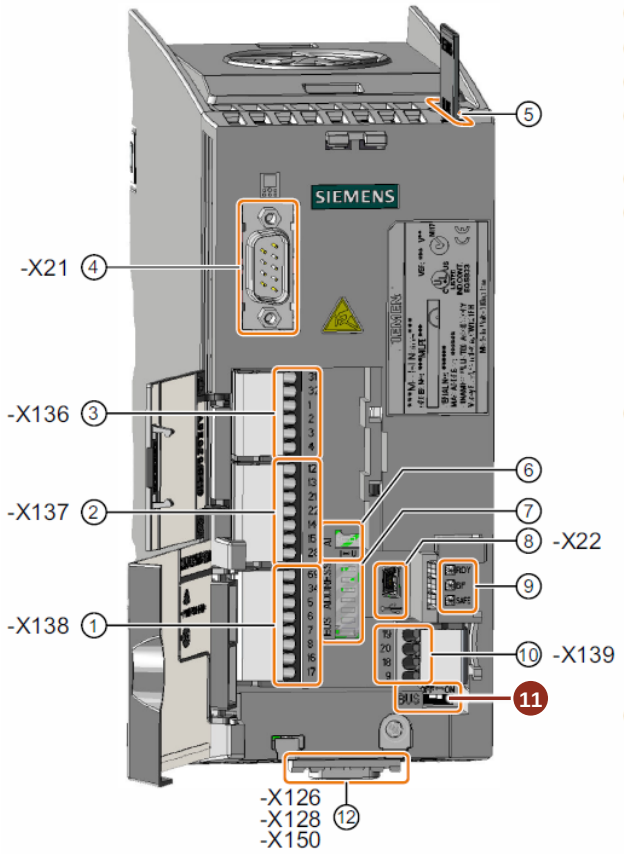


Figure 3-4: Position of the terminal bus switch (Frame sizes FSAA … FSC)

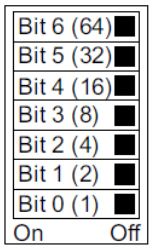
To access the interfaces at the front of the Control Unit, you must lift the Operator Panel (if one is being used) and open the front doors.



① Terminal strip -X138
② Terminal strip -X137
③ Terminal strip -X136
④ Interface -X21 to the Operator Panel
⑤ Memory card slot
⑥ Switch for AI 0

- I 0/4 mA … 20 mA
- U -10/0 V … 10 V

⑦ Switch for the bus address



⑧ USB interface -X22 for connection to a PC

⑨ RDY BF SAFE Status LED

⑩ Terminal strip -X139

11 OFF ON Switch for bus termination, only on G120C USS/MB

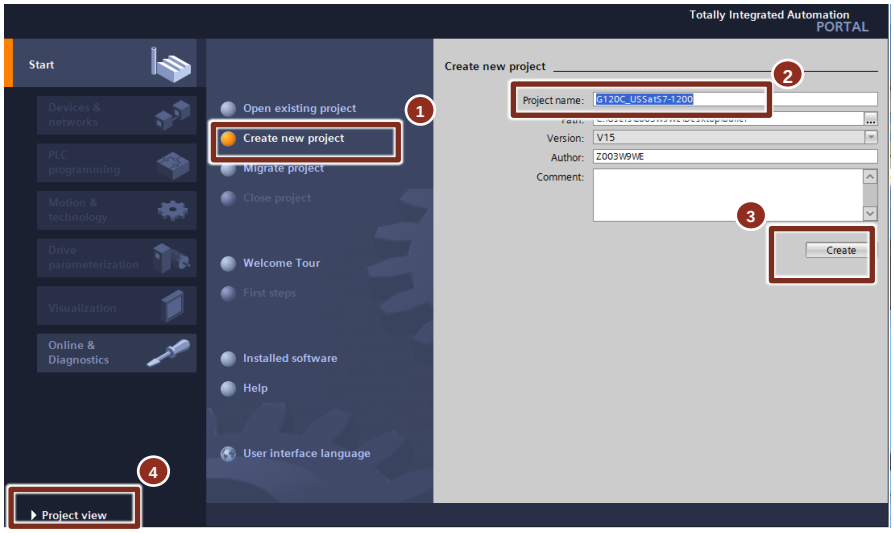
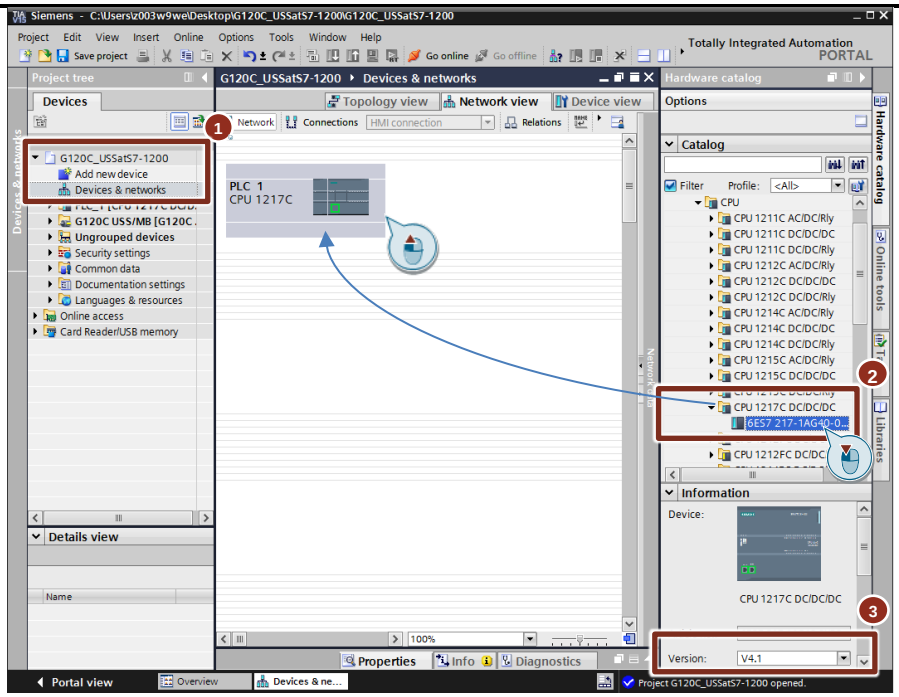
⑫ Fieldbus interface at the bottom

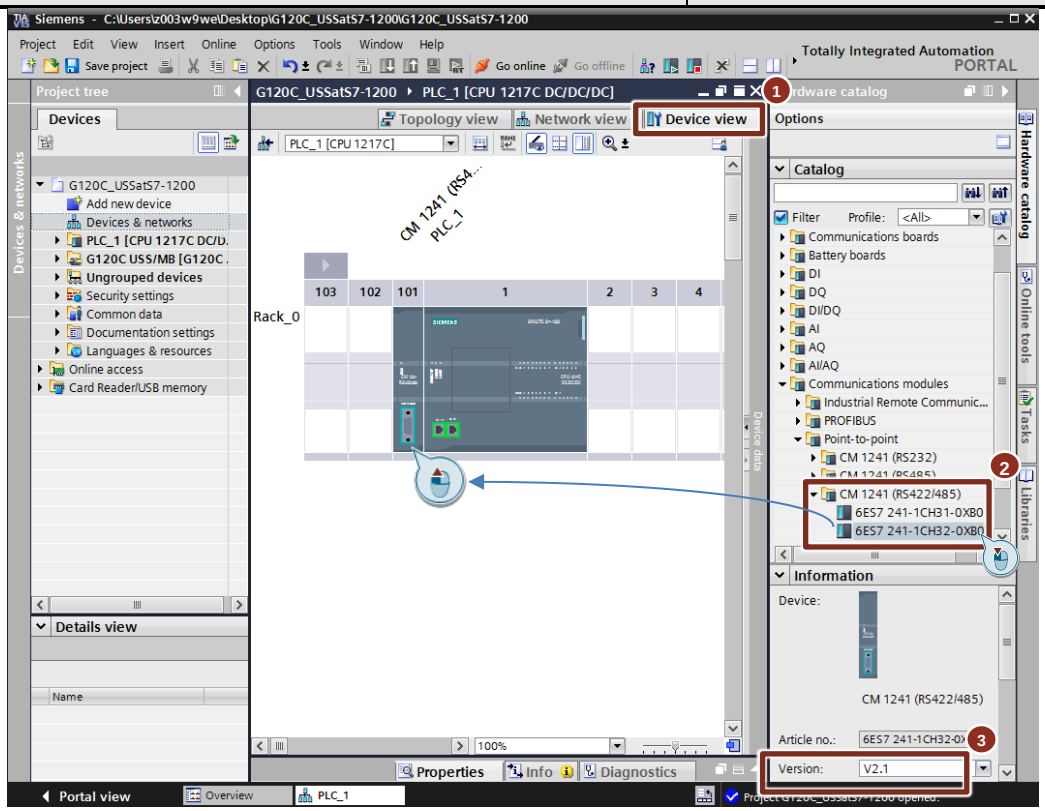
NOTE The position of the bus termination switch for the frame sizes FSD – FSF can be found in the G120C manual \3\.

4 Configuration

4.1 Configure PLC project

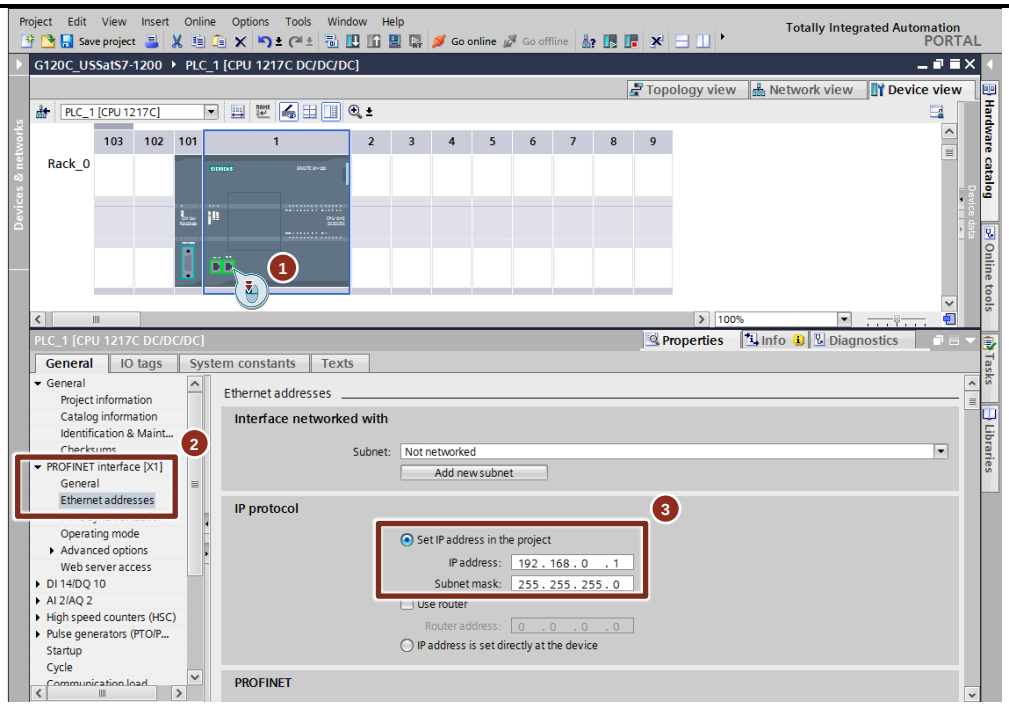
Table 4-1 Creation of new project and configuration of the PLC

No.	Picture	Remarks
1		
	1. Open TIA Portal V15 in your PC and then click “Create new project”. 2. Assign the new project a name “G120C_USSatS7-1200”. 3. Click “Create” to finish the creation of a new project. 4. Click “Project view” to change to project view.	
2		
	1. In the project tree, go to Devices & Network view. 2. In the Hardware catalog task card, locate the SIMATIC S7-1217 DC/DC/DC 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. 3. Select the CPU with a version = 4.1 (S7-1200).	

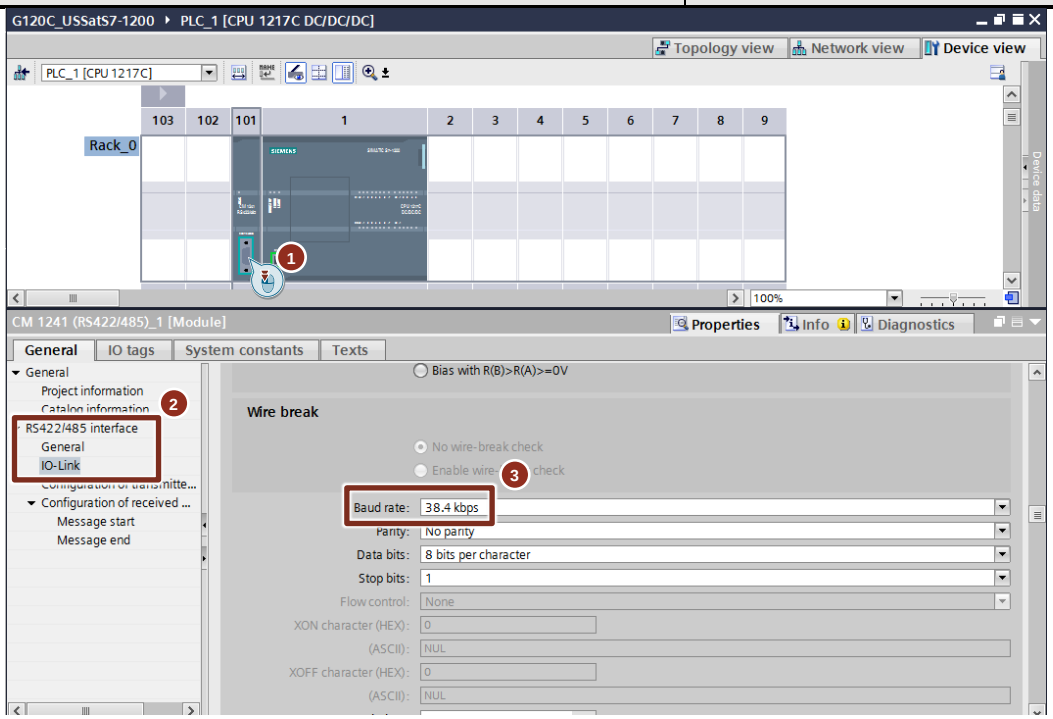
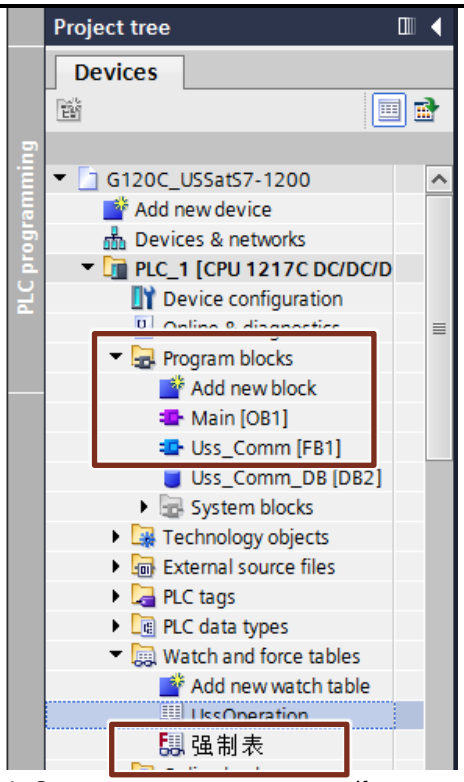
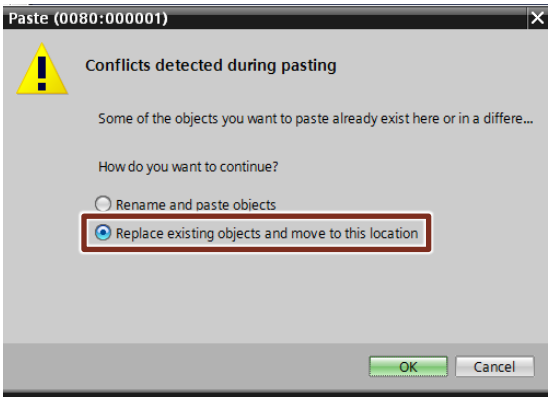
No.	Picture	Remarks
3		

1. In the graphic area, select the SIMATIC controller and go to the Device view.
2. In the Hardware catalog task card, locate the
   - CM1241 (RS422/RS485) communication module, version = 2.1, for the CPU 1217C

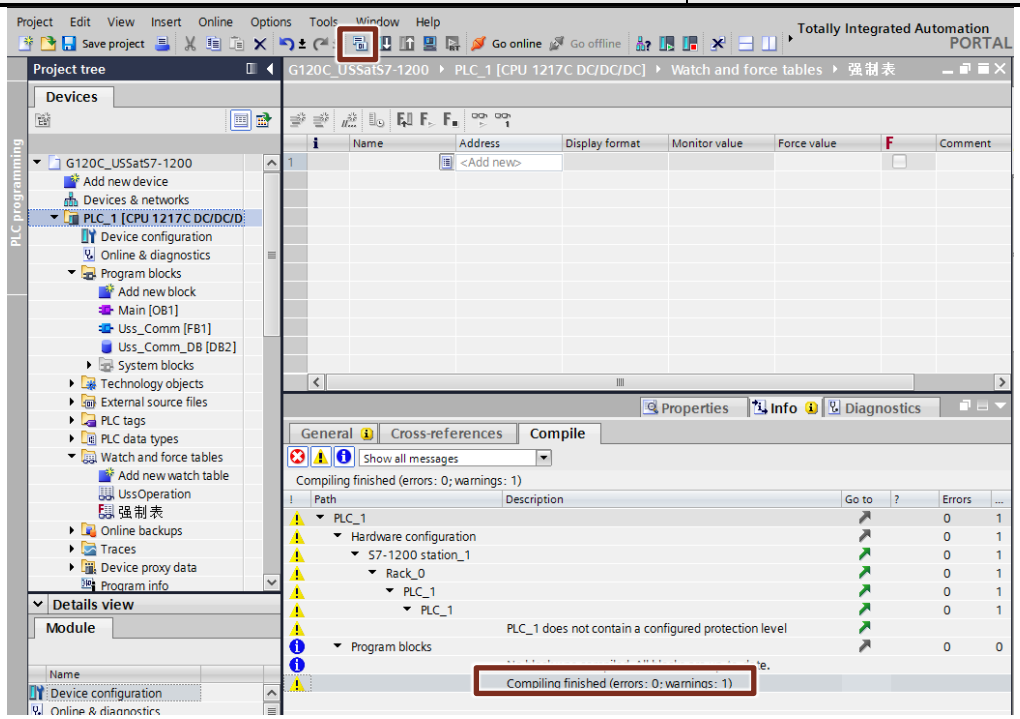
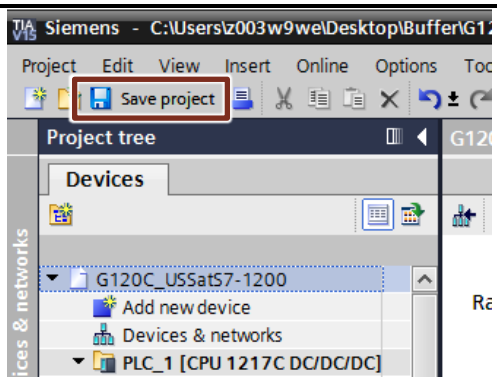
And use drag and drop to move it to an allowed slot next to the CUP in the graphic area of the Network view.

4		

If necessary, change the Ethernet address. To do this, double-click the CPU to open its properties.

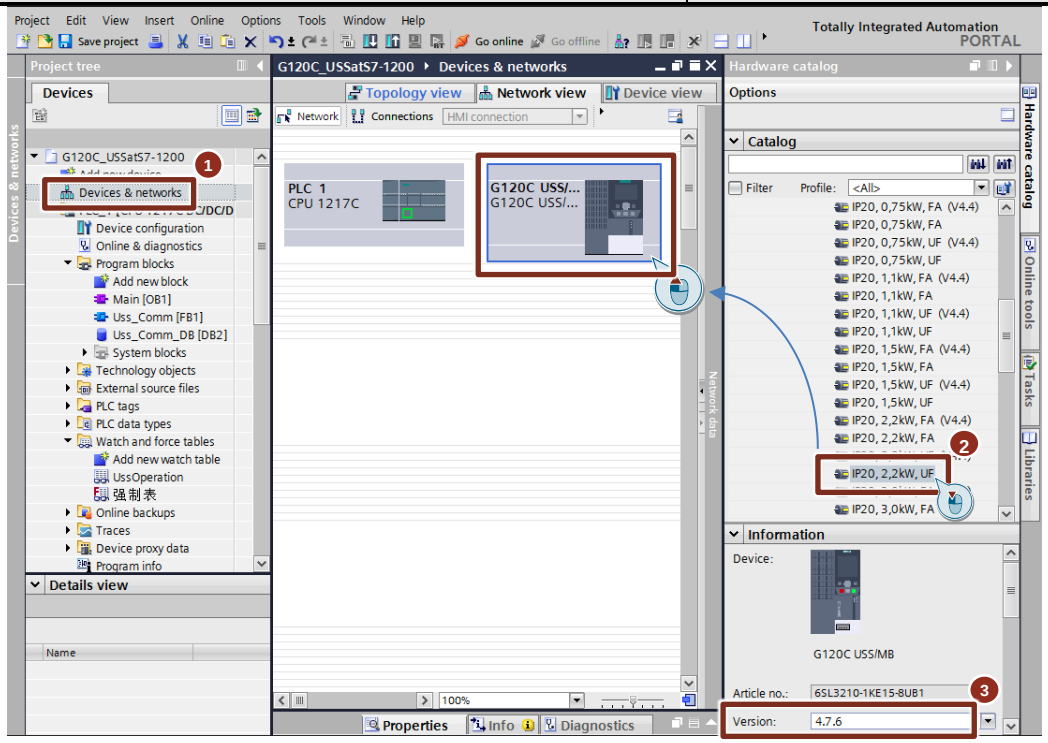
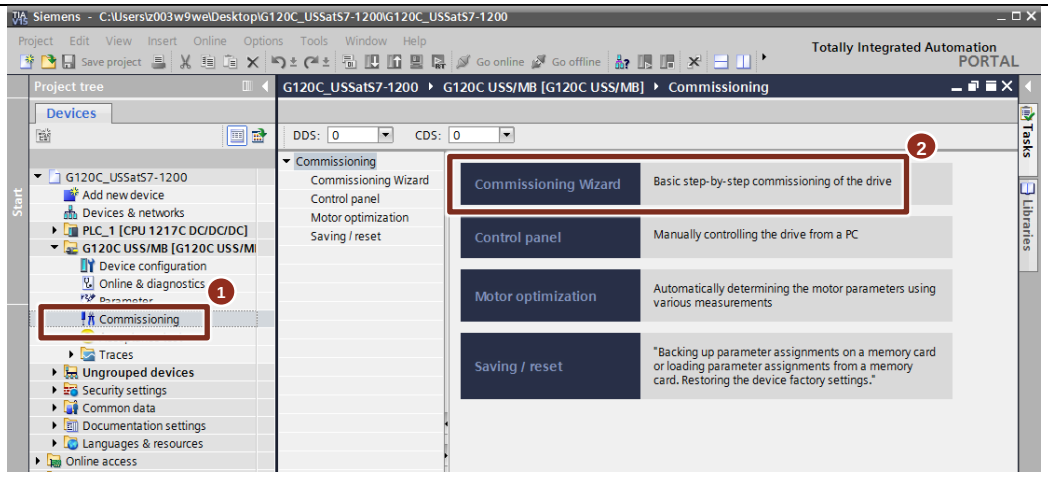
No.	Picture	Remarks
5		
6	 	

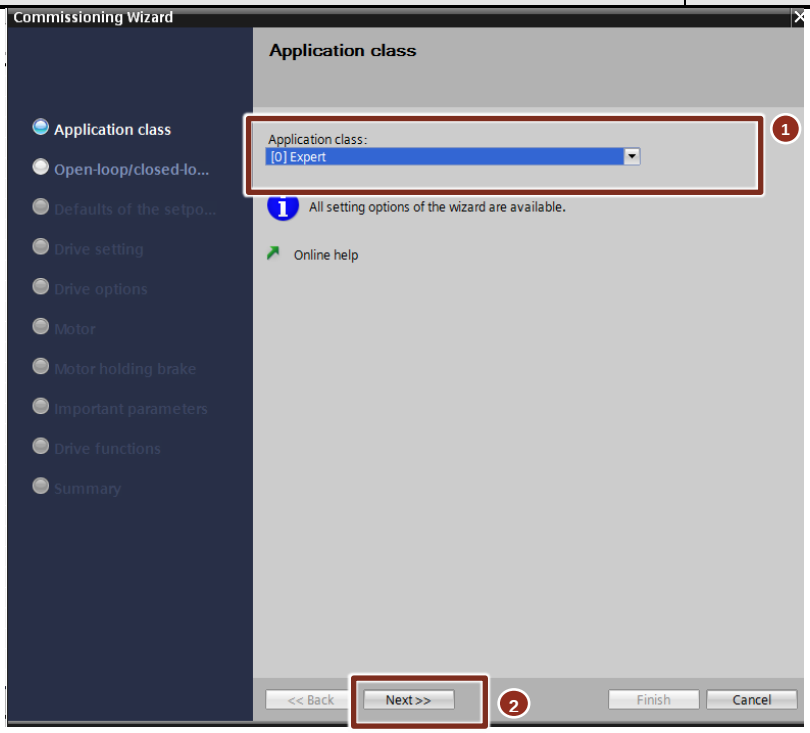
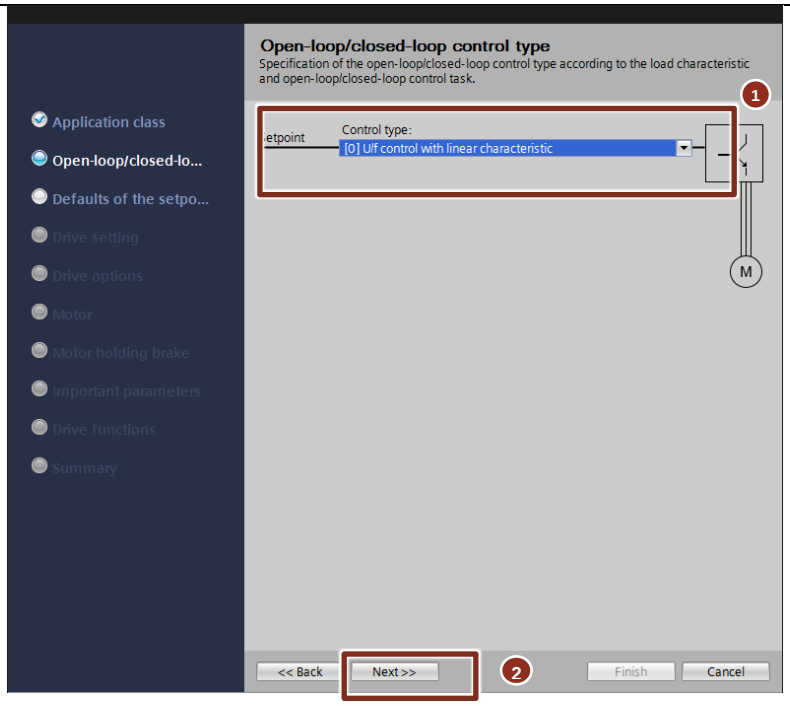
1. Create your user program or –if you want to use the supplied sample program – copy the following objects from the sample program to your new project.
2. For the copy operation, you can open both TIA projects at the same time. In the dialog regarding conflicts when copying, select ***Replace existing objects and move to this location***.

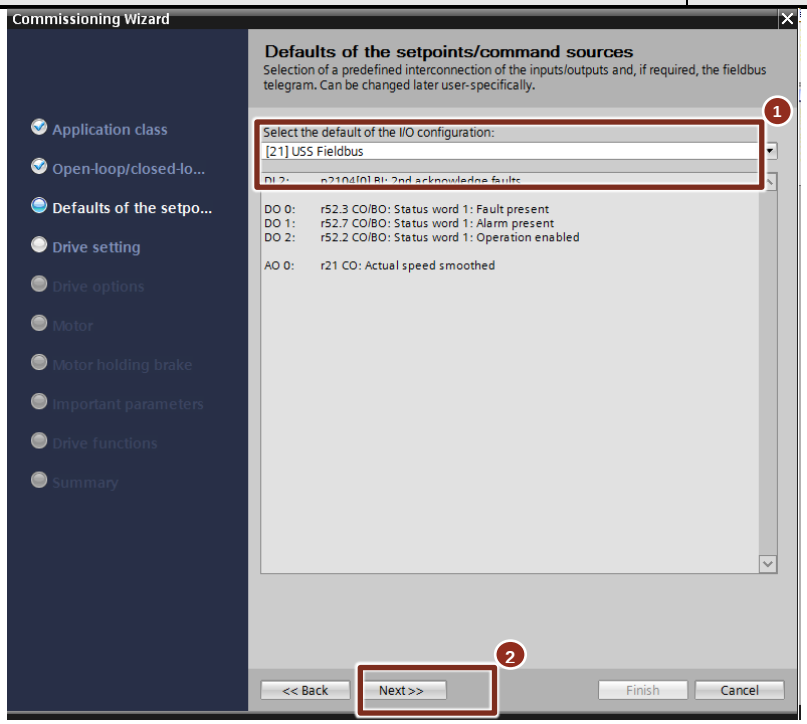
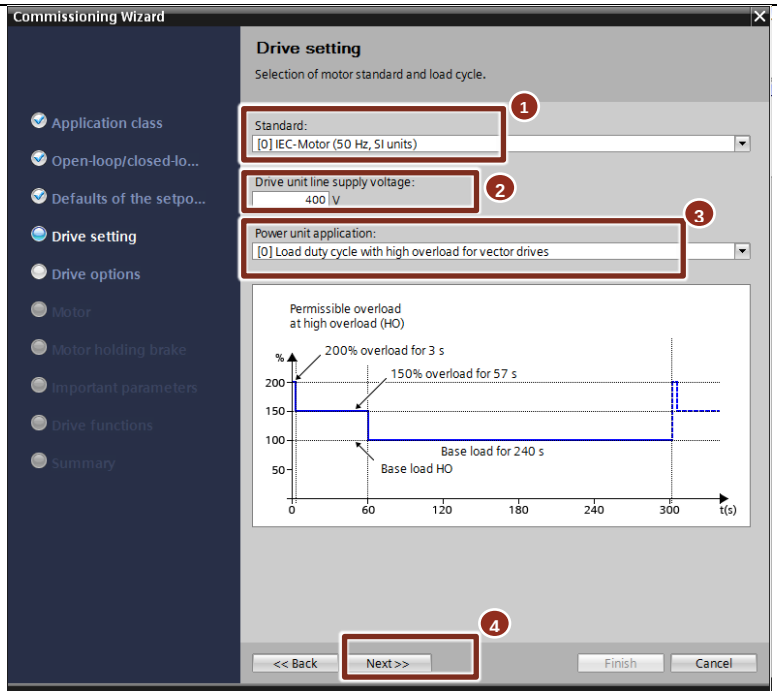
No.	Picture	Remarks
7	 Compile the PLC_1 device in order to detect possible errors.	
8	 Save the project.	

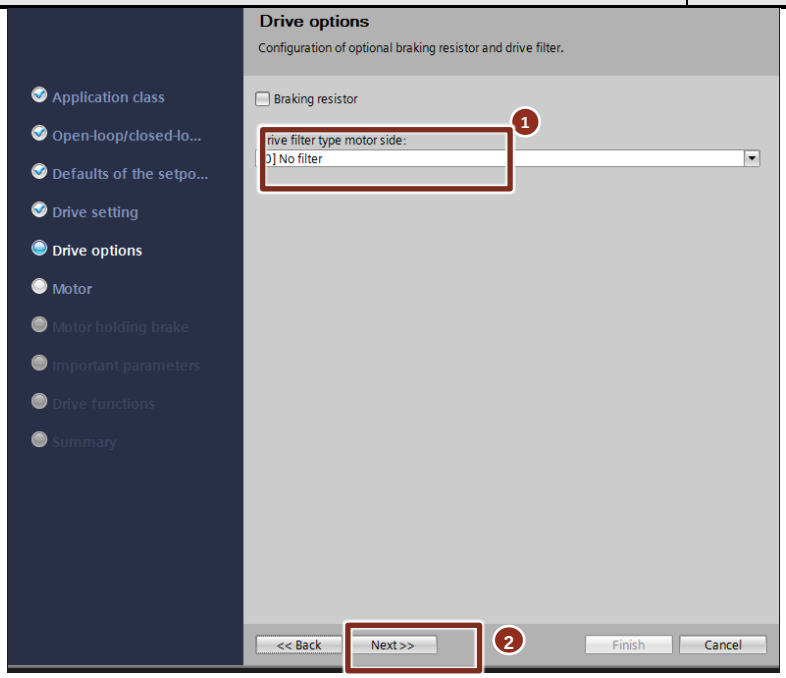
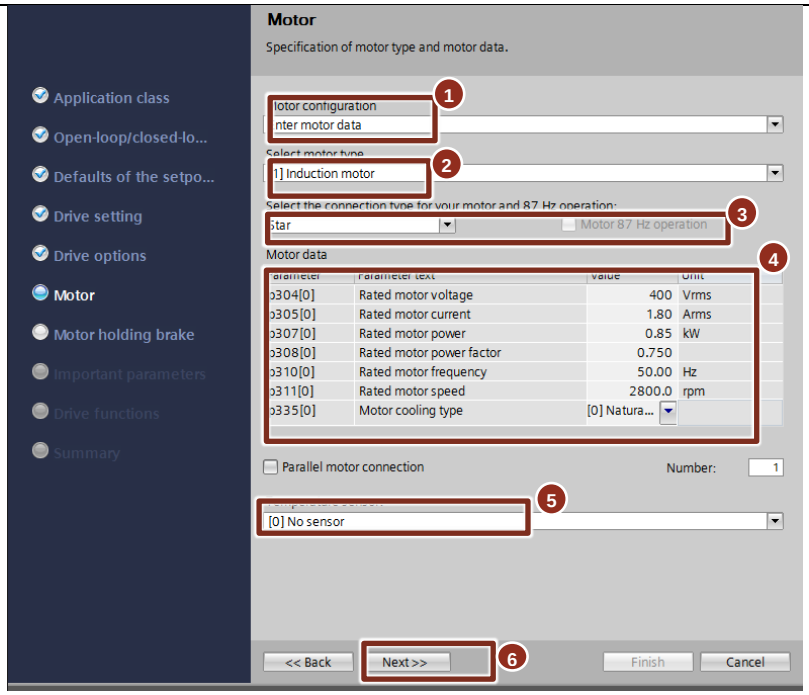
4.2 G120C configuration

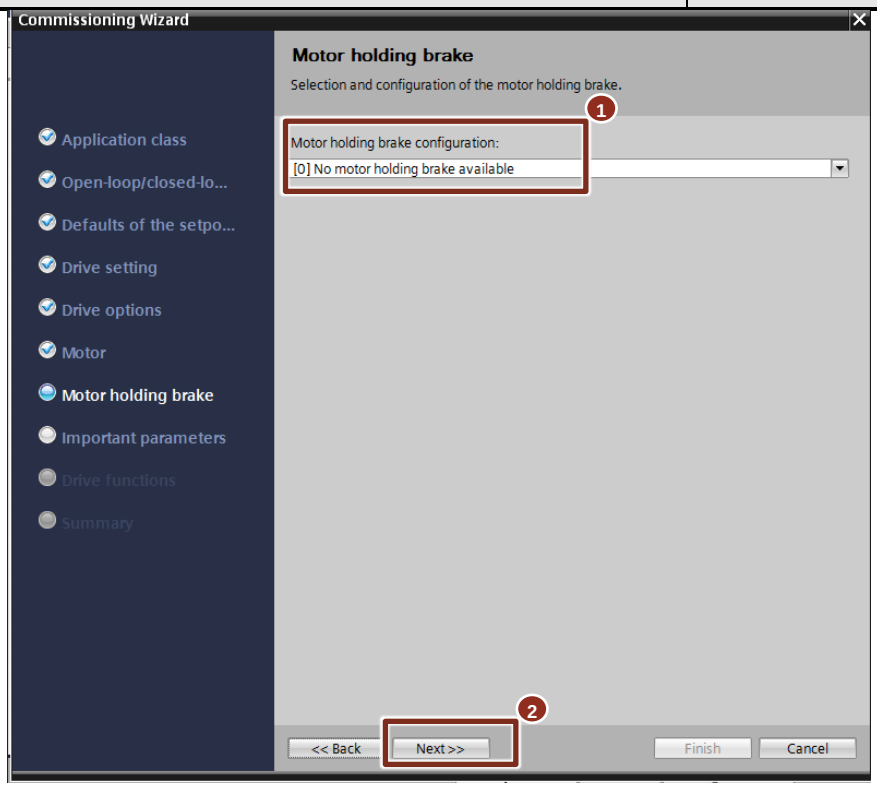
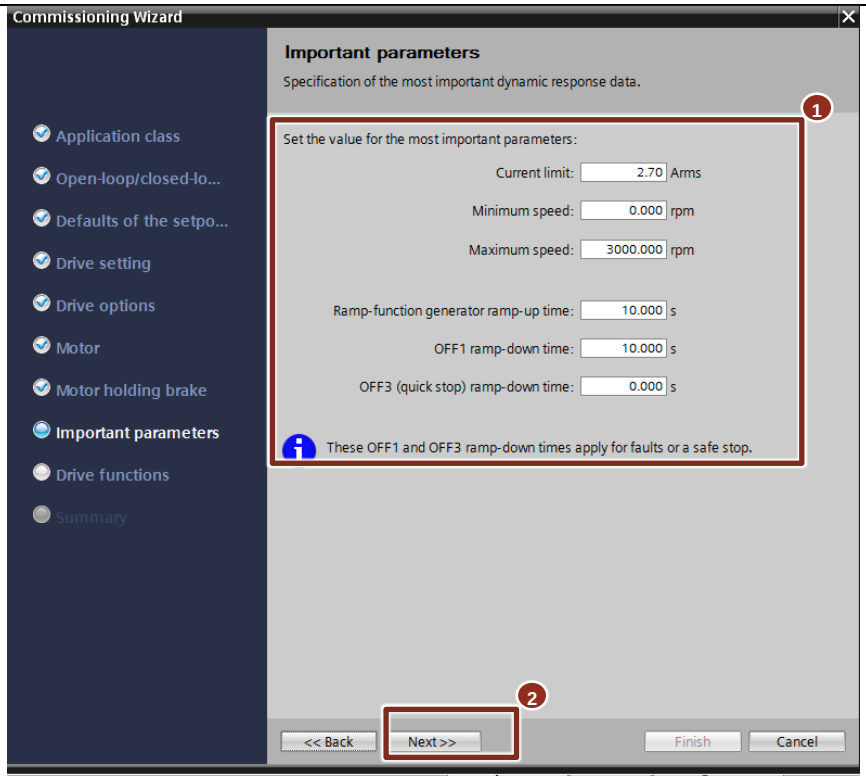
Table 4-2 Quick Commissioning via Startdrive in TIA Portal V15

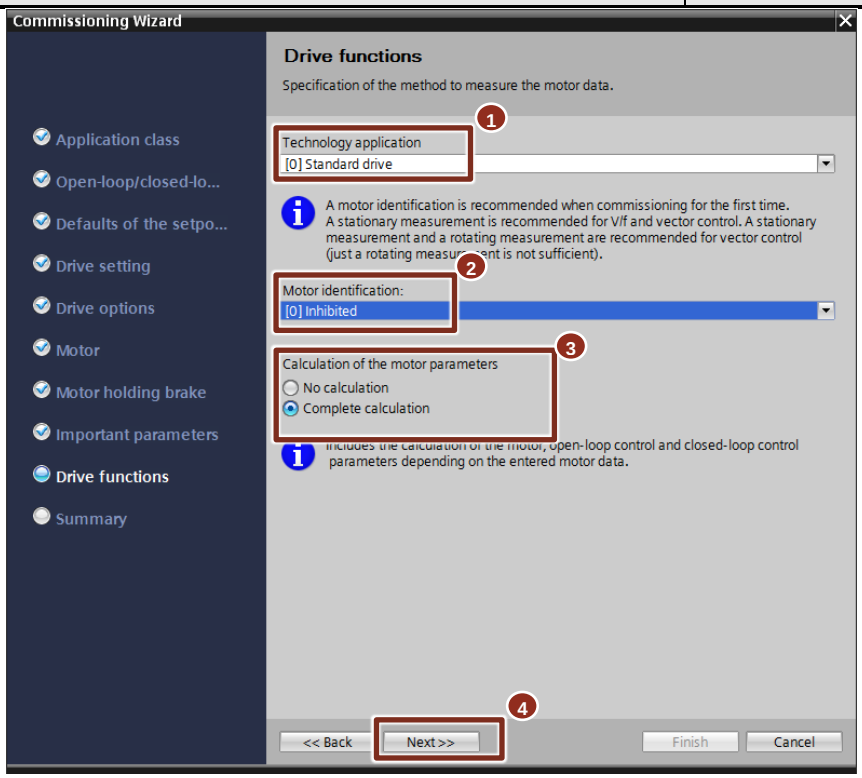
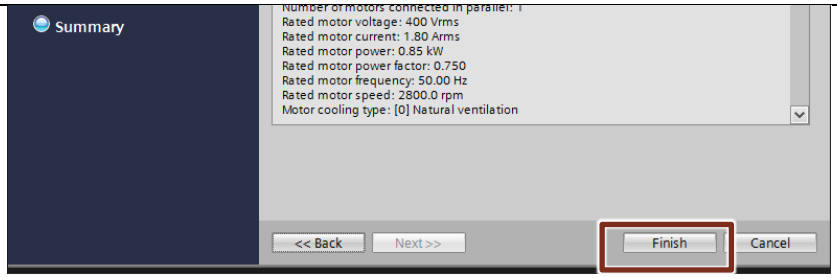
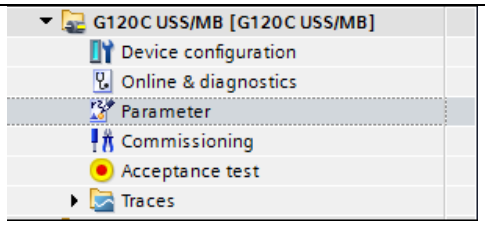
No.	Description	Remarks
1	 1. In the project tree, go to Devices & networks and select the Network view. 2. In the Hardware catalog task card, locate the *G120C USS IP20, 2.2kW UF* and use drag and drop to move it to the graphic area of the Network view. In this area, it will be created as G120C USS/MB. 3. Select the drive with a version = 4.7.6.	
2	 1. In the project tree, go to the ***Commissioning*** under *G120C USS/MB*. 2. Click the ***Commissioning Wizard*** function to open Commissioning Wizard dialog.	

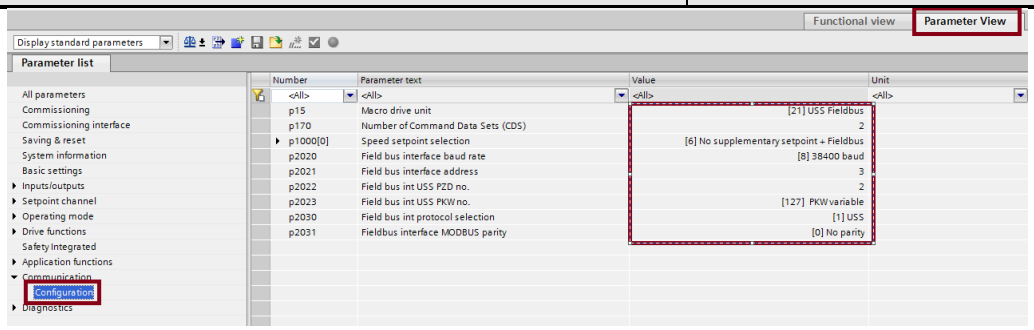
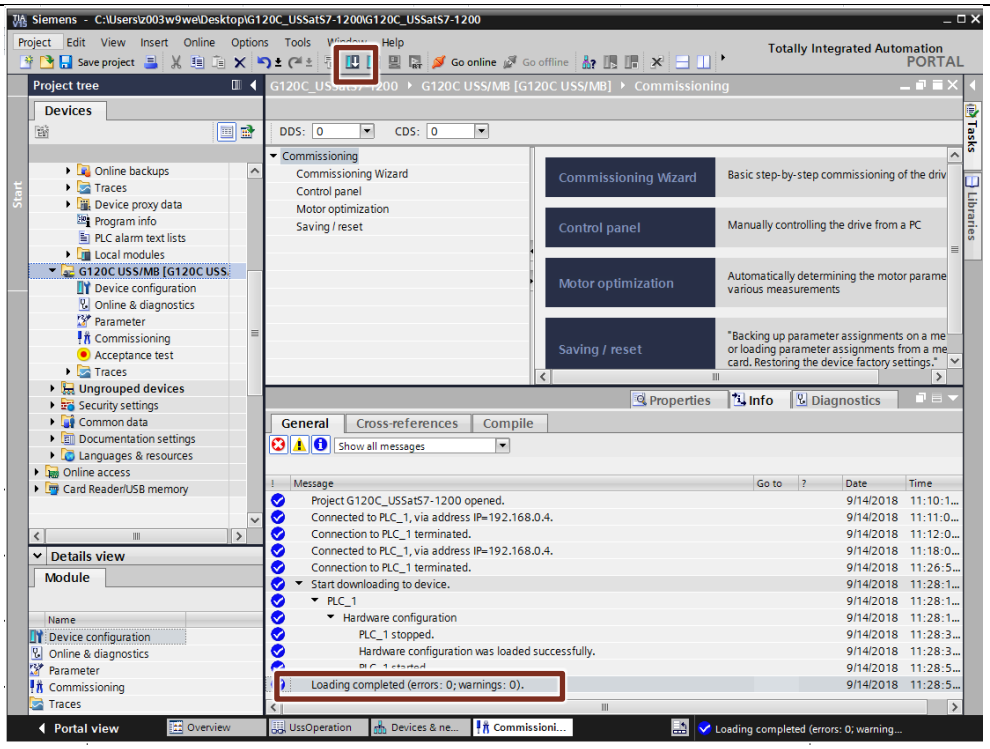
No.	Description	Remarks
3	 1. Choose ***Expert*** at the ***Application class*** card. 2. Click ***Next***. *NOTICE:* *This application also can be finished in "Standard Drive Control" or "Dynamic Drive Control" application class*	
4	 1. Choose ***U/f control with linear characteristic*** at the ***Open-loop/close-loop control type*** card. 2. Click ***Next***.	

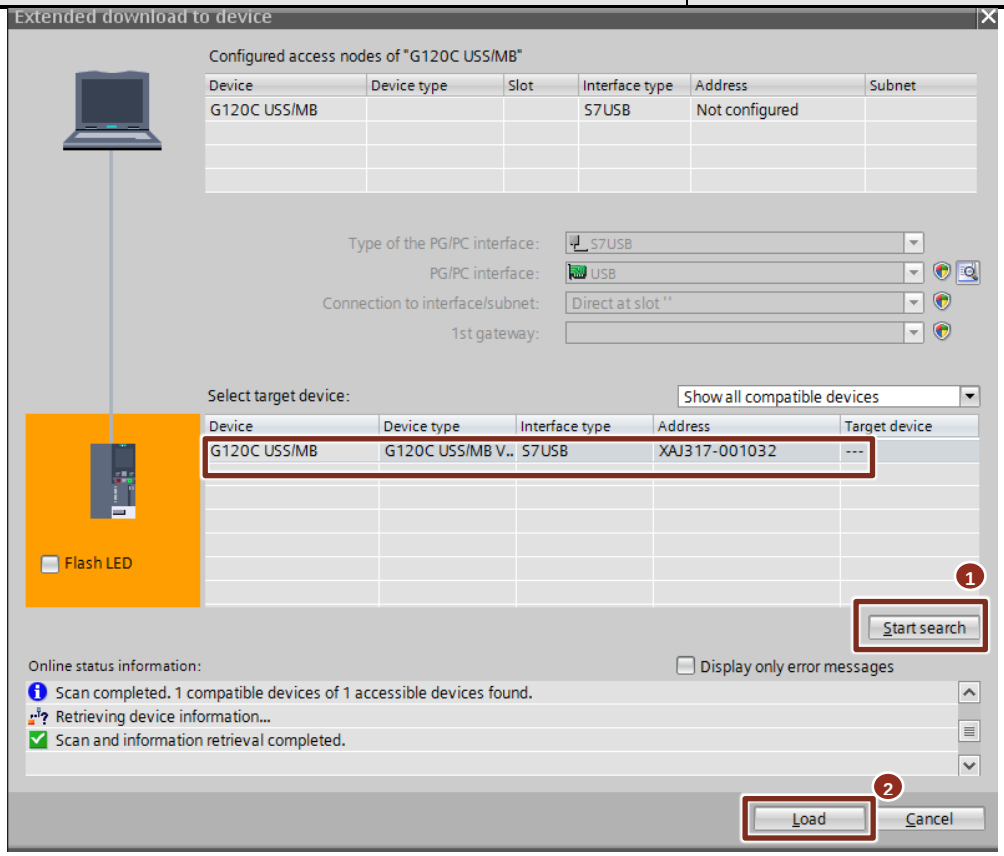
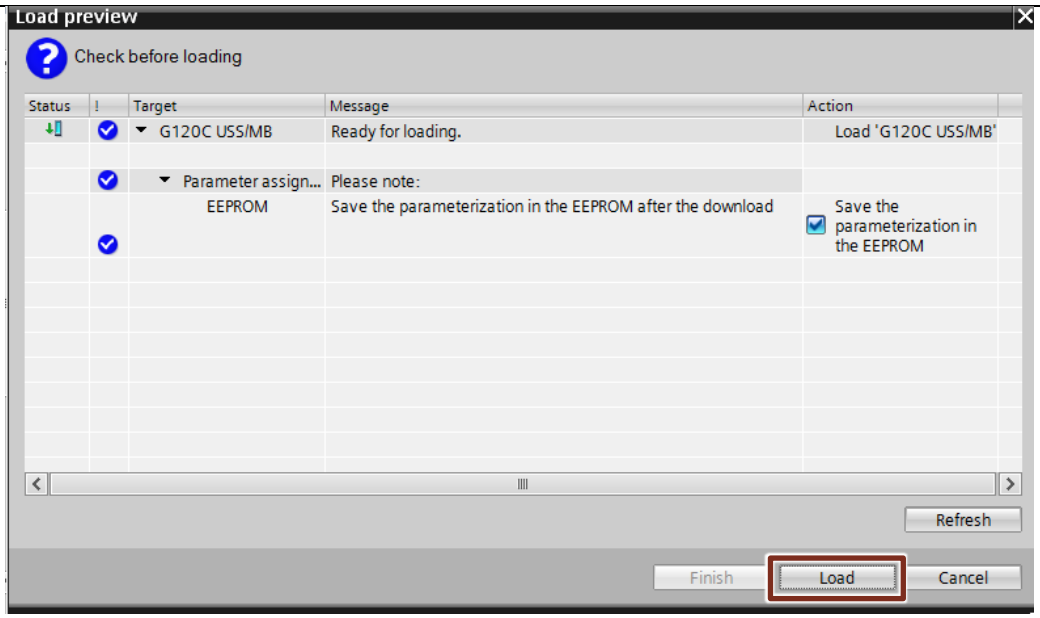
No.	Description	Remarks
5	 1. Choose ***USS Fieldbus*** at the ***Defaults of the setpoints/command sources*** card. 2. Click ***Next***.	
6	 1. Choose ***IEC-Motor (50 Hz, SI units)*** for Standard. 2. Input ***400 V*** for the drive unit line supply voltage. 3. Choose ***Load duty cycle with high overload for vector drives*** for the power unit application. 4. Click ***Next***.	

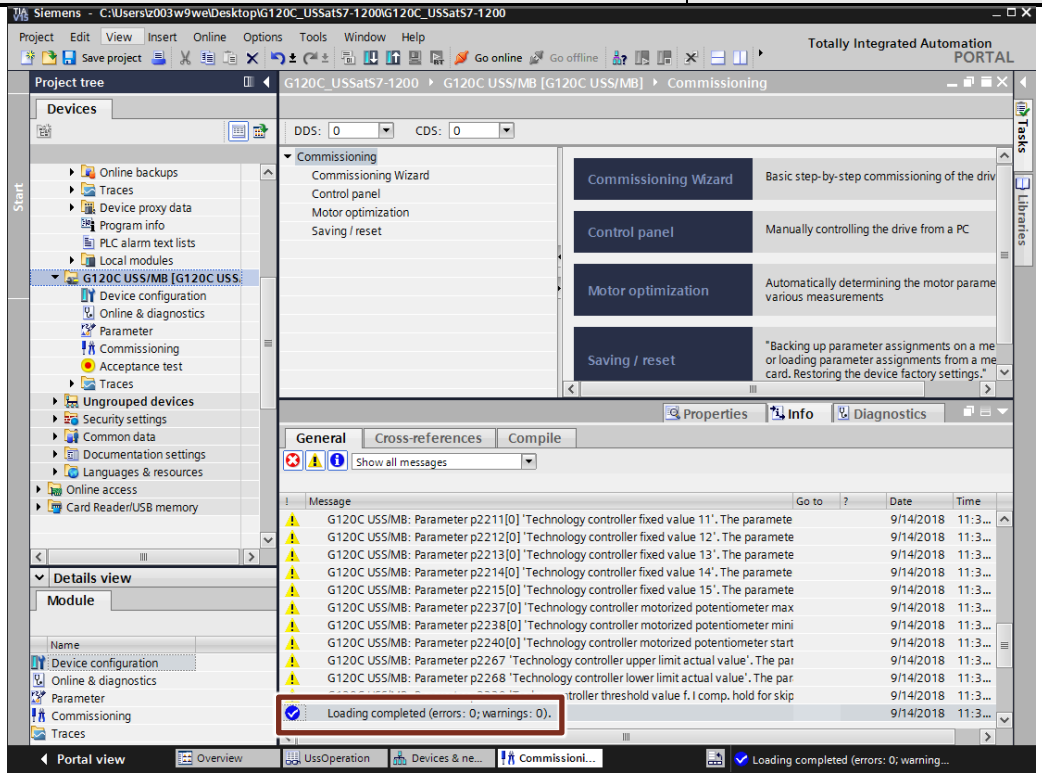
No.	Description	Remarks
7	 1. Choose ***No filter*** at the Drive options card. 2. Click ***Next***.	
8	 1. Choose ***Enter motor data*** for the Motor configuration. 2. Choose ***Induction motor*** for the motor type. 3. Choose ***Star*** for the connection type. 4. Input the required motor data accordingly. 5. Choose ***No sensor*** for the temperature sensor. 6. Click ***Next***.	

No.	Description	Remarks
9	 1. Choose ***No motor holding brake available*** at the ***motor holding brake*** card. 2. Click ***Next***.	
10	 1. Input important parameters accordingly at the important parameters card. 2. Click ***Next***.	

No.	Description	Remarks
11	 1. Choose ***Standard drive*** for the Technology application. 2. Choose ***Inhibited*** for the motor identification. 3. Choose ***Complete calculation*** for the Calculation of the motor parameters. 4. Click ***Next***.	
12	 Click ***Finish***.	
13	 Double click the ***Parameter.***	

No.	Description	Remarks
14	 Switch to parameter view. Click the configuration option of the communication command. Modify the related communication parameters.	
15	 ***Download*** the configuration to the drive.	

No.	Description	Remarks
16	 1. Connect the G120C with the USB cable to the PG. 2. Click ***Start search*** and the connected G120C is showed in the table. 3. Click ***Load***..	
17	 Click ***Load*** to load the configuration to the drive.	

No.	Description	Remarks
18	 Loading finish.	

4.3 Program PLC logic

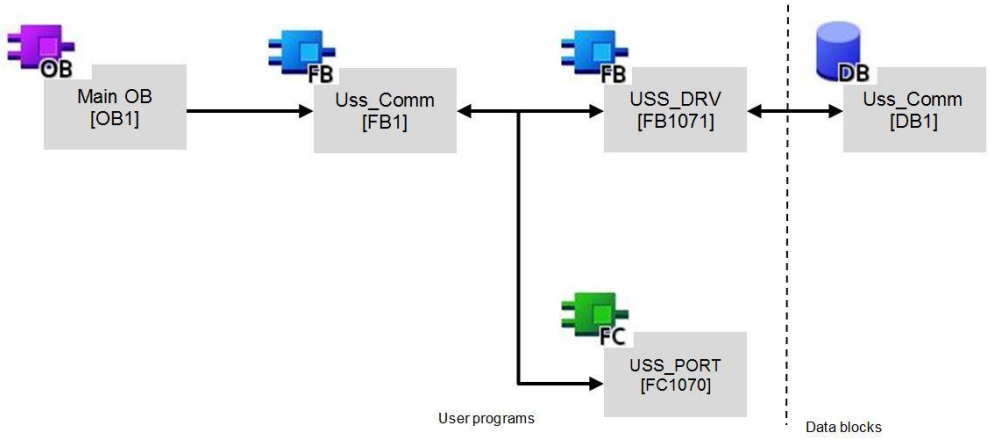
In this application example, the SINAMICS G120C drive is controlled by S7-1217 CPU via USS communication. To achieve this control, the following instructions have been added to the program:

- USS_DRV(FB1071)
- USS_PORT(FC1070)

This FB and FC are called in the "Uss_Comm"(FB1) function block.

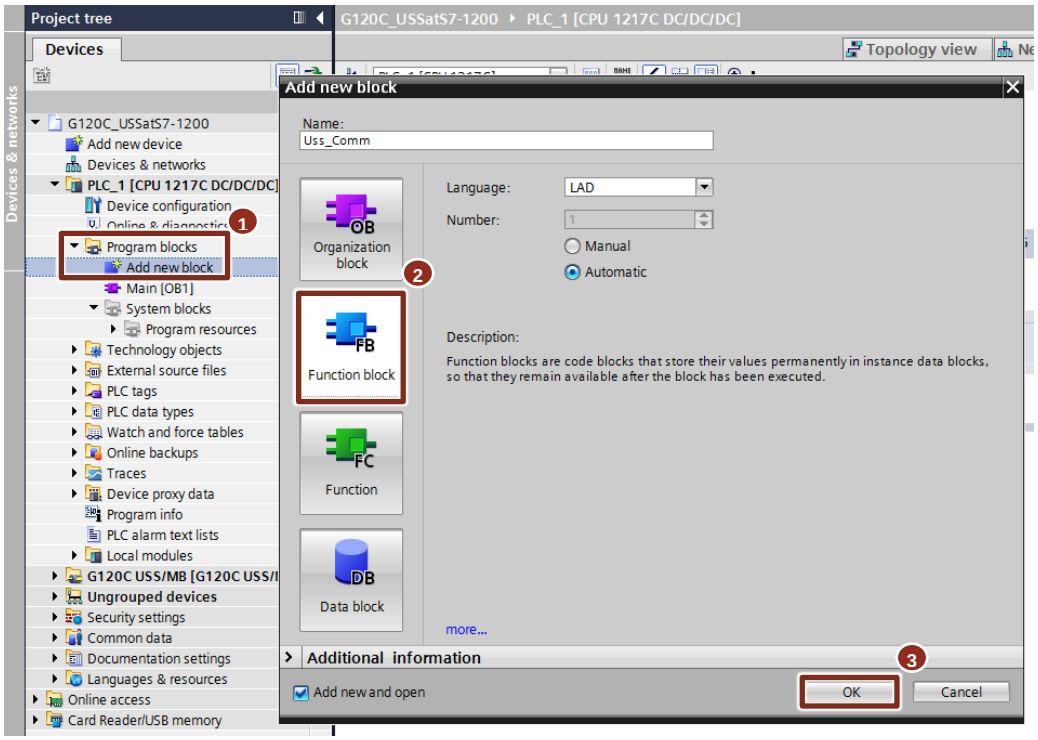
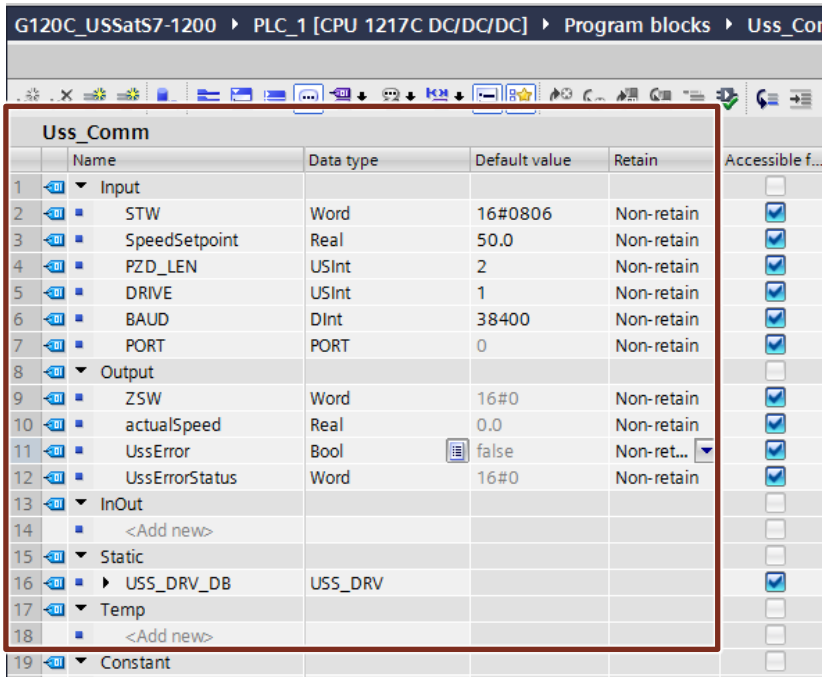
The figure 4-1 shows the program structure.

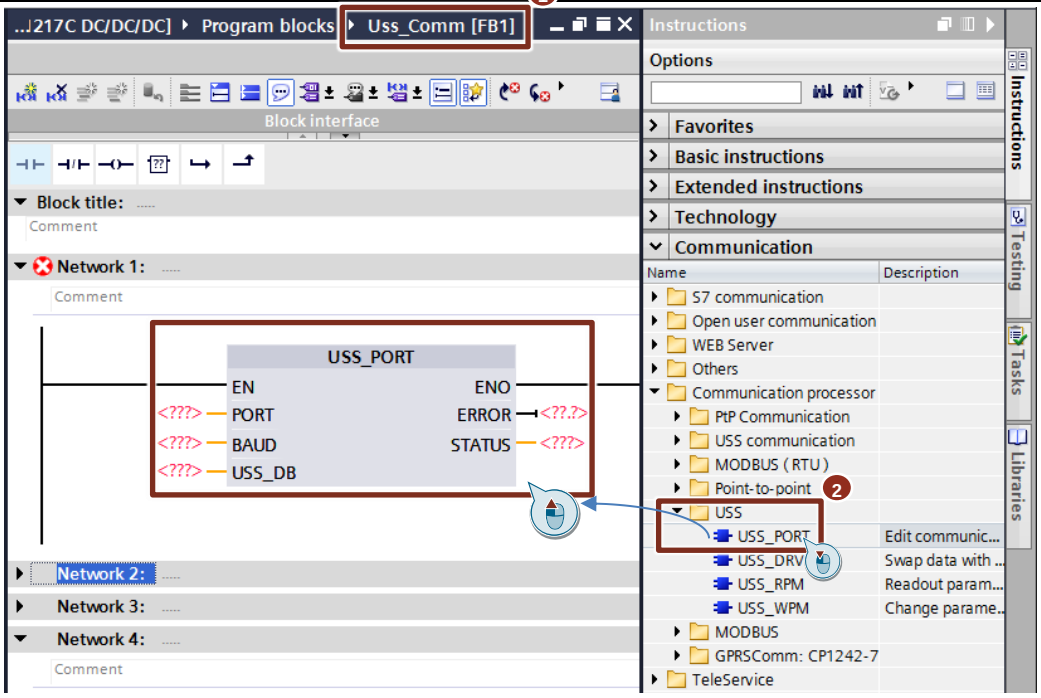
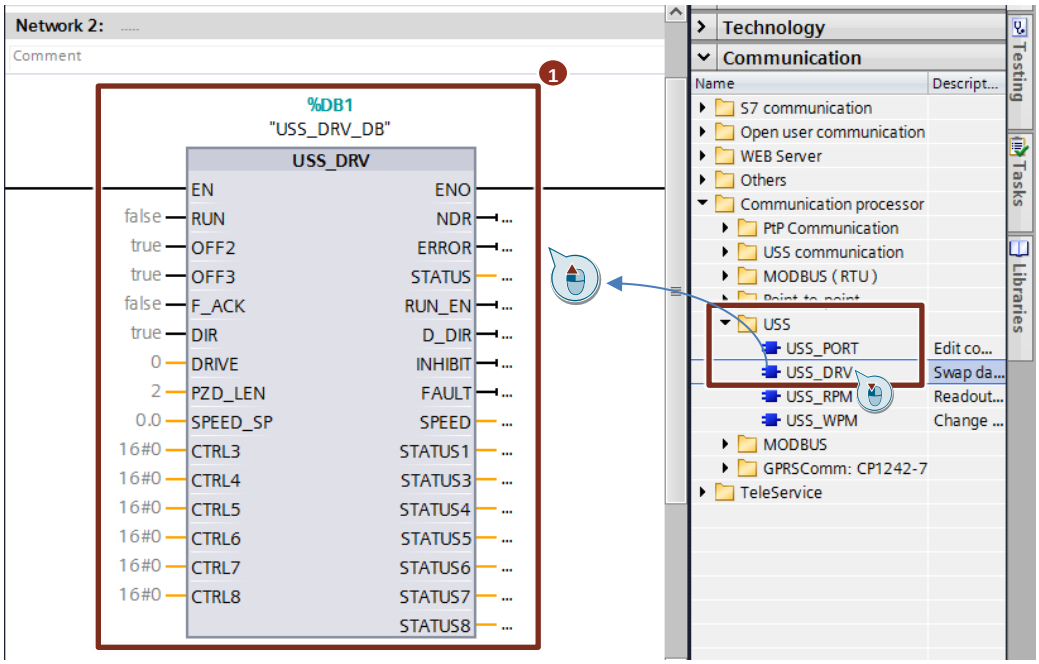
Figure 4-1 program structure

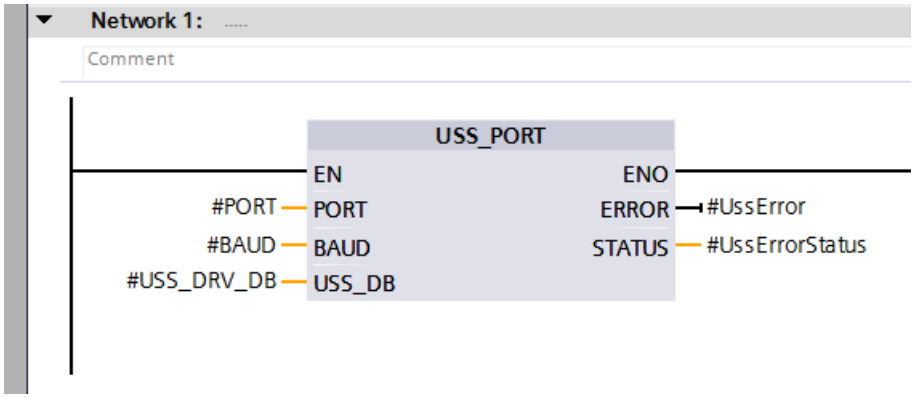
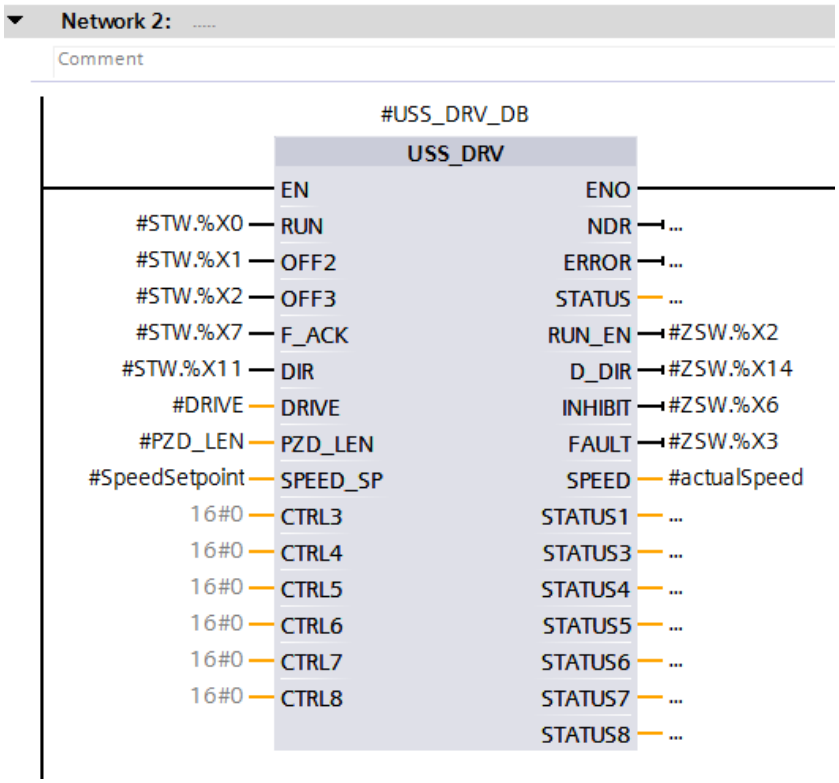


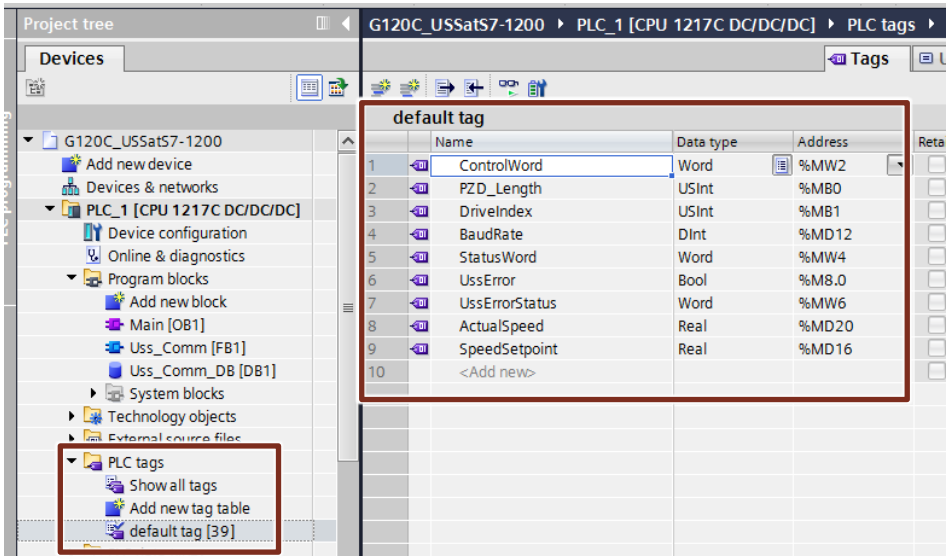
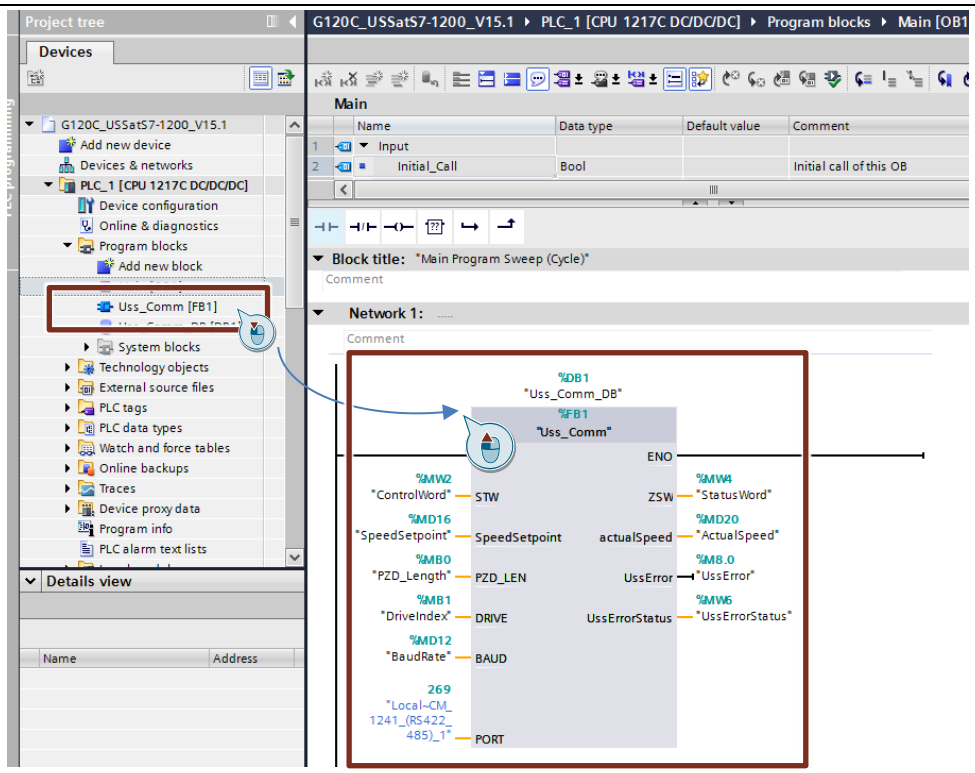
And in the Table 4-3 is about the PLC programming.

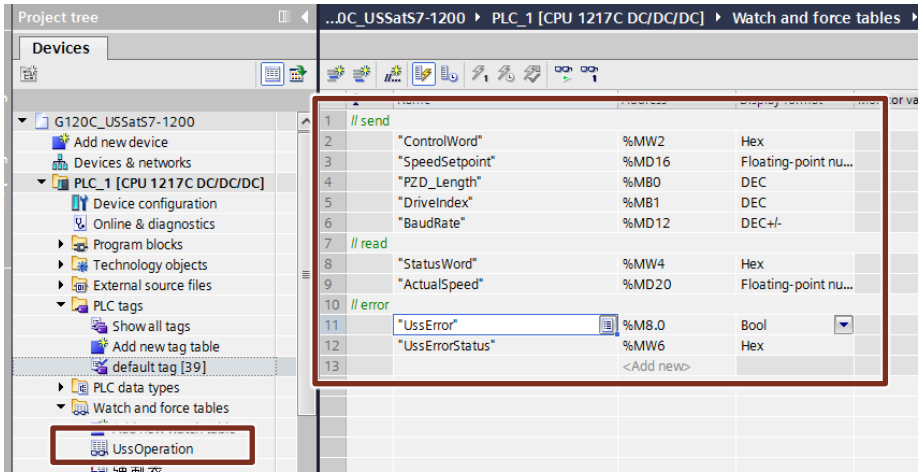
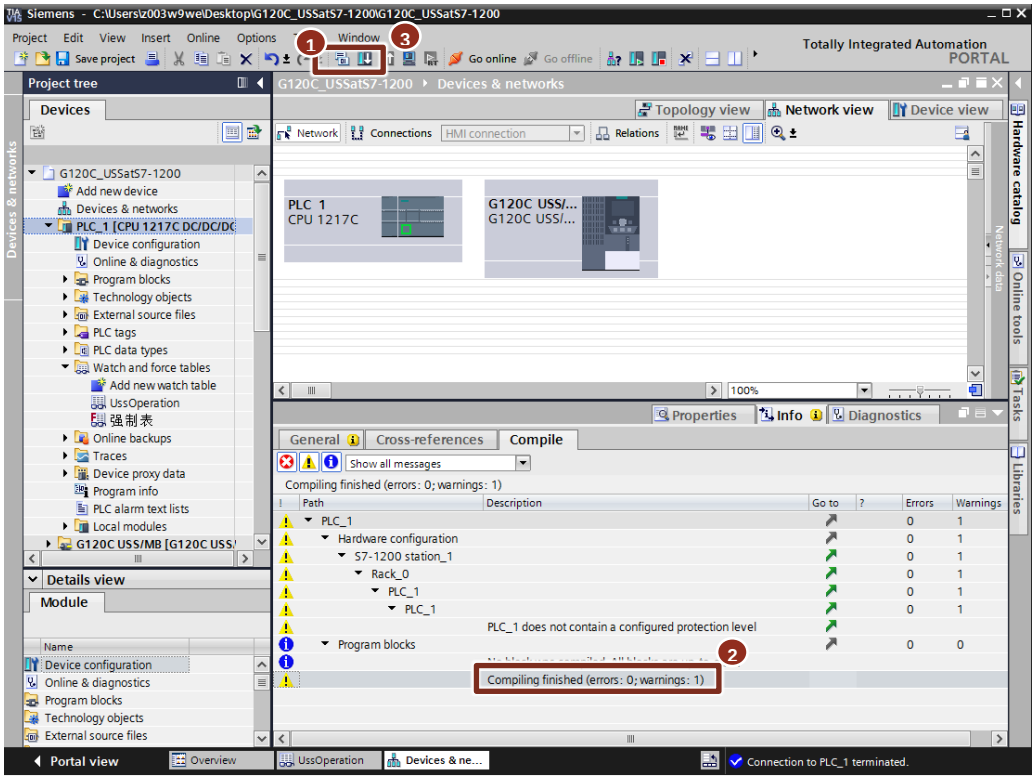
Table 4-3 PLC Program

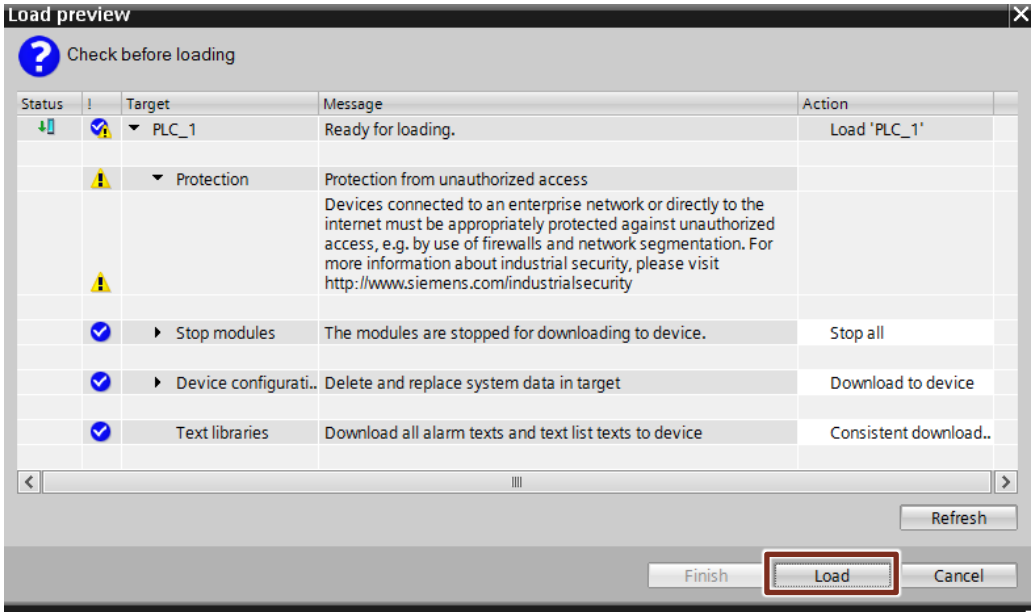
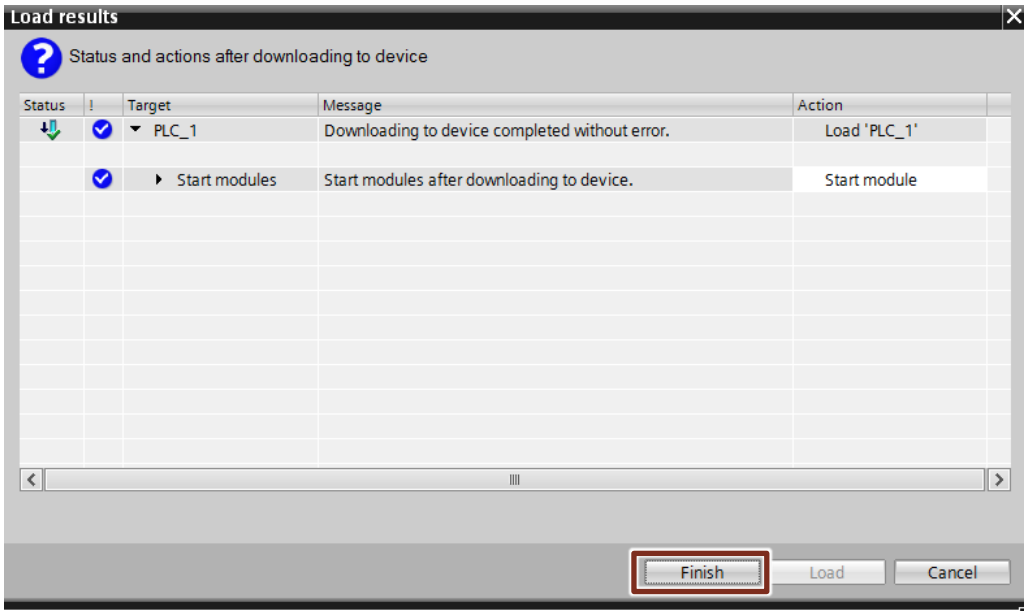
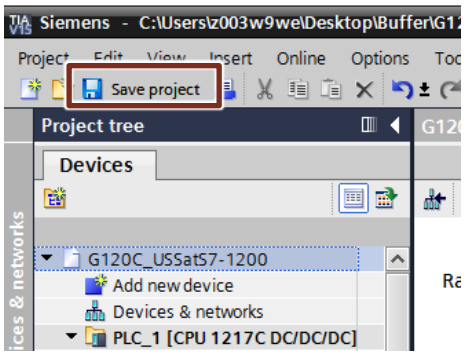
No.	Picture	Description
1		
	1. Double-click ***Add new block*** in the program blocks. 2. Select to create a new FB and give a name as ***Uss_Comm***. 3. Click ***OK***.	
2		
	Define the variants in the ***Uss_Comm[FB1]*** as picture.	

No.	Picture	Description
3		1. Open ***Uss_Comm[FB1]***. 2. Select a ***USS_PORT*** in the ***Communication*** catalog and drag it into the ***Network 1***.
4		1. Select ***USS_DRV*** in the ***Communication*** catalog and drag it into ***Network 2***.

No.	Picture	Description
5	 Configure the ***USS_PORT*** block as picture.	
6	 Configure the ***USS_DRV*** block as picture.	

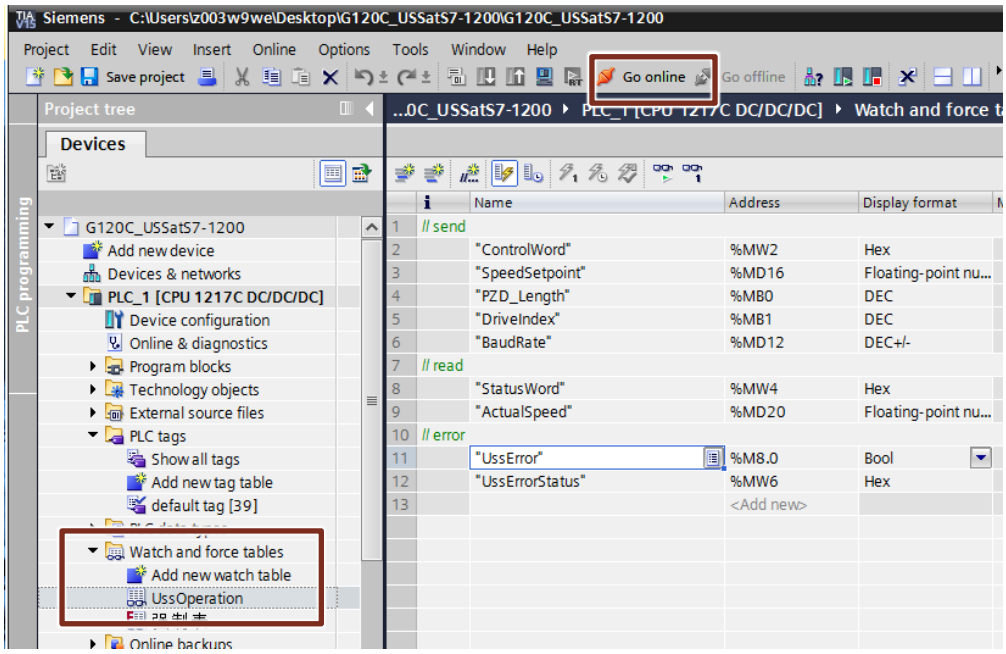
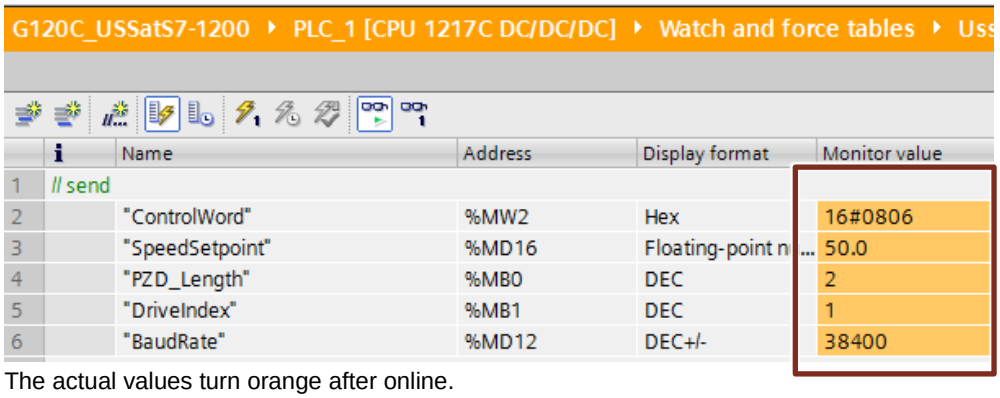
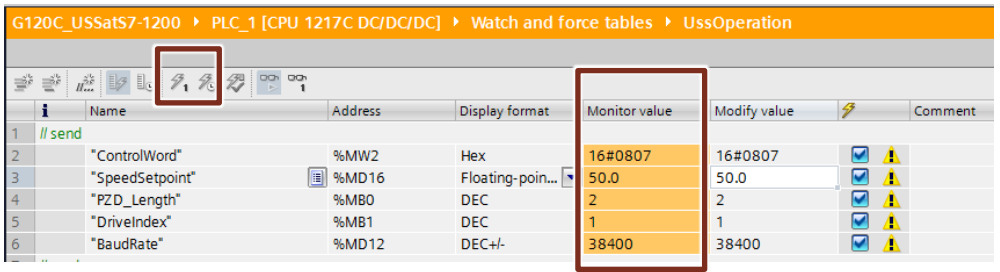
No.	Picture	Description
7	 1. Open the ***default tag*** of the PLC tags in the Project tree. 2. Define default tags as picture.	
8	 Drag the ***Uss_Comm[FB1]*** from program block into ***Main[OB1]*** and configure the block as picture.	

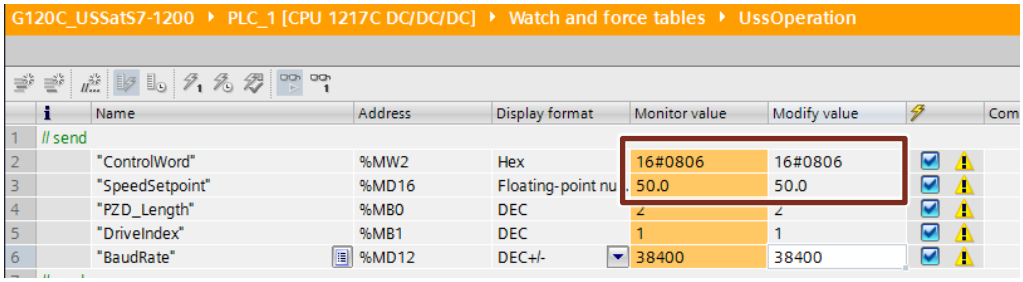
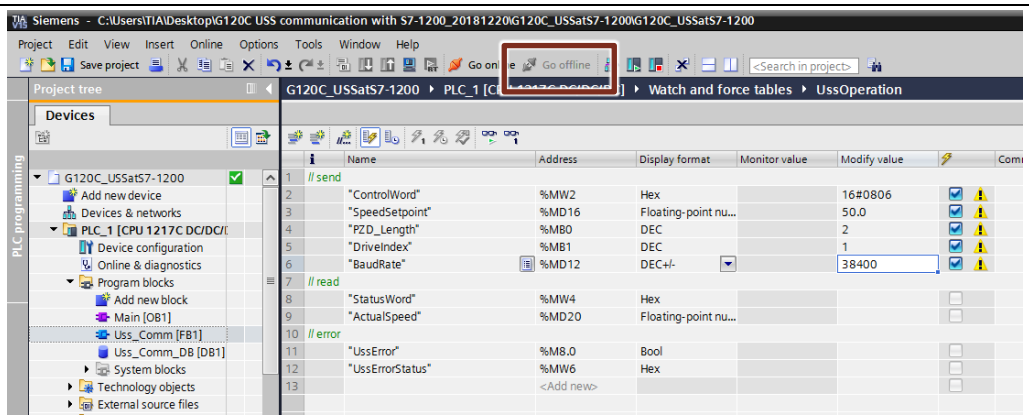
No.	Picture	Description
9	 Create watch table and configure it.	
10	 1. ***Compile*** the program. 2. Compiling finished. 3. Click ***download***.	

No.	Picture	Description
11		Click ***Load*** to load the program into PLC.
12		Click ***Finish***.
13		Save the project.

4.4 Operation

Table 4-4 Operation

No.	Picture	Description
1	 1. Go to the UssOperation. 2. Click Go online.	
2	 The actual values turn orange after online.	
3	 1. Configure the ***PZD_Length*** to 2 and the ***DriveIndex*** to 1. 2. Configure the ***ControlWord*** as 16#0807 to set the off1 on. 3. Configure the ***speedSetpoint*** to 50.0 then the motor start to run. 4. Click ***Modify all selected values once and now*** for activate the values.	

No.	Picture	Description
4		
	Configure the ***ControlWord*** back to 16#0806 to disable off1 and the motor stop running.	
5		
	Click ***Go offline***.	

5 Related literature

Table 5-1 Reference documents

	Topic
\1\	Siemens Industry Online Support http://support.industry.siemens.com
\2\	Download page of this entry https://support.industry.siemens.com/cs/ww/en/view/109764624
\3\	Simple speed control of a V20 with S7-1200/1500 using the USS protocol https://support.industry.siemens.com/cs/ww/en/view/109480894
\4\	G120C manual FW 4.7.10 https://support.industry.siemens.com/cs/ww/en/view/109757226

6 Contact

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7 History

Table 7-1

Version	Date	Modifications
V1.0	02/2019	First version