SINAMICS G120XA: Speed Control with S7-1200 via USS

SINAMICS G120XA / V1.0

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1 Task

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

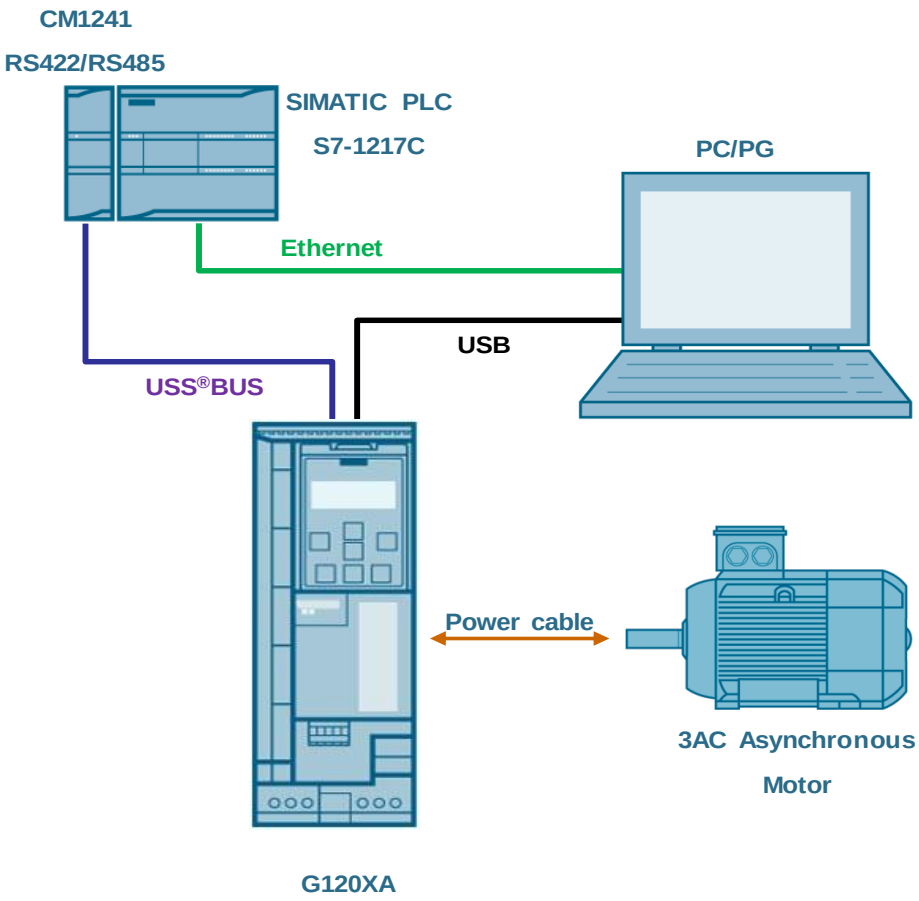
Introduction

SINAMICS G120XA 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



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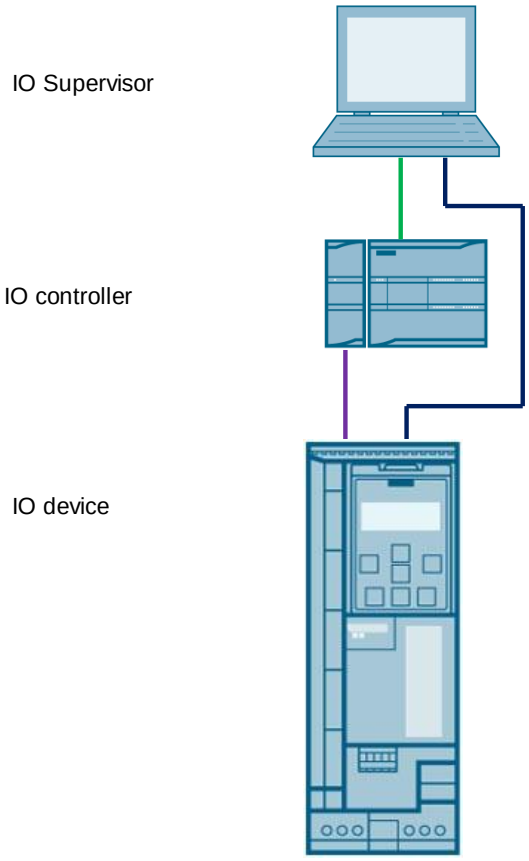
2 Solution

2.1 Solution overview

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 G120XA version
- BOP-2, IOP-2 and Smart Access Module operation of SINAMICS G120XA

Basic knowledge of these topics is assumed.

Required knowledge

Basic knowledge on TIA Portal is assumed.

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2.2 Hardware and Software Components

2.2.1 Validity

This application example is valid for

- TIA Portal V15 SP1
- S7-1200 CPU V4.1
- SINAMICS G120XA V4.7.11

2.2.2 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	6ES7217-1AG40-0XB0	V4.1
CM1241 RS422/RS485	1	6ES7 241-1CH32-0XB0	V2.1
SINAMICS G120XA	1	6SL3220-1YD16-0CB0	V4.7.11
Smart Access Module	1	6SL3255-0AA00-5AA0	V01.02.06.01

Standard software components

Table 2-2: Standard software components

Component	No.	Article number	Note
TIA Portal	1	6AV2103-0AA05-0AA7	V15 SP1

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
109770390_Sinamics_G120XA_with_S7-1200_via_USS.pdf	Project file
109770390_Sinamics_G120XA_with_S7-1200_via_USS.zip	Reference document

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3 Basics

3.1 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 G120XA). 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.

Implementation with SIMATIC S7-1200

Use the following system instructions:

- USS_PORT

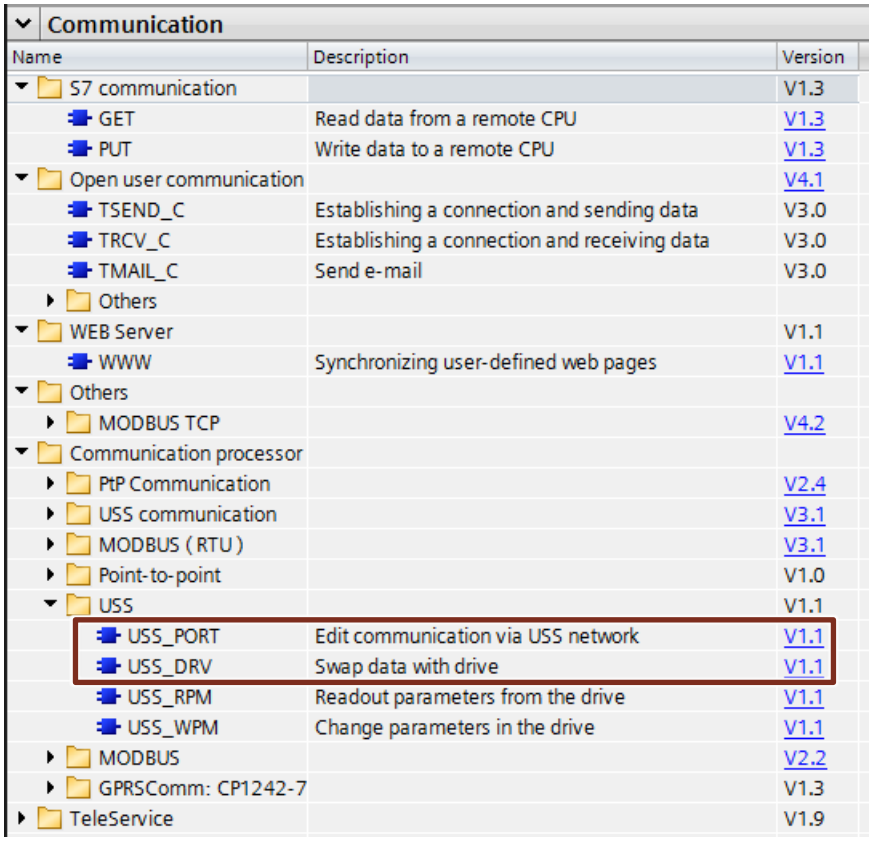
  To process communication via the USS network

- 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



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3.2 USS system instructions

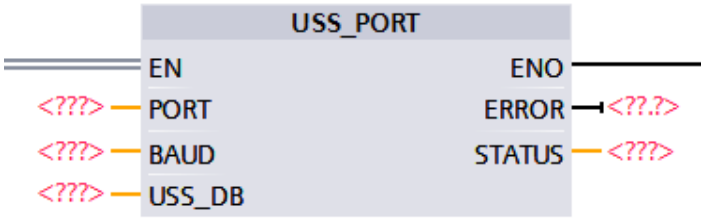
USS_PORT (S7-1200)

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.

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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.

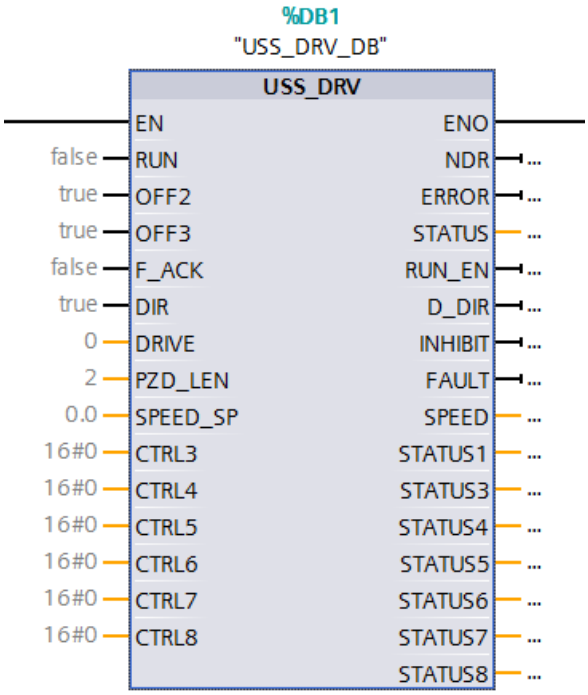
When the *USS_DRV* instruction is executed the first time, the drive indicated by the USS address (parameter DRIVE) is initialized in the instance DB. After this initialization, subsequent *USS_PORT* instructions can start communication with the drive at this drive number.

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



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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
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

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3.3 Details of G120XA USS function

3.3.1 Control word 1 (STW1)

Table 3-4: Control word 1 (STW1)

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

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3.3.2 Status word 1 (ZSW1)

Table 3-5: Status word 1 (ZSW1)

Bit	Significance	Remarks	Signal interconnection 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

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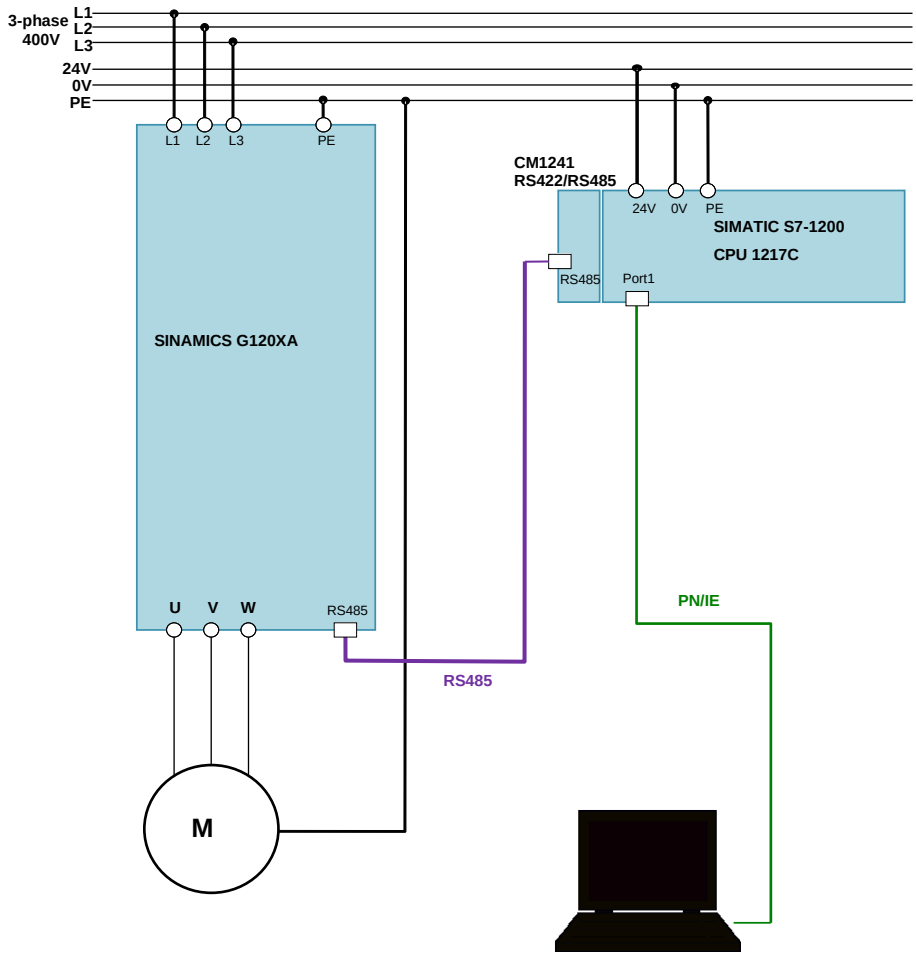
3.4 Installation

3.4.1 Hardware configuration

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 must for you to check the supply voltage; otherwise, the drive can be damaged!

Figure 3-4:



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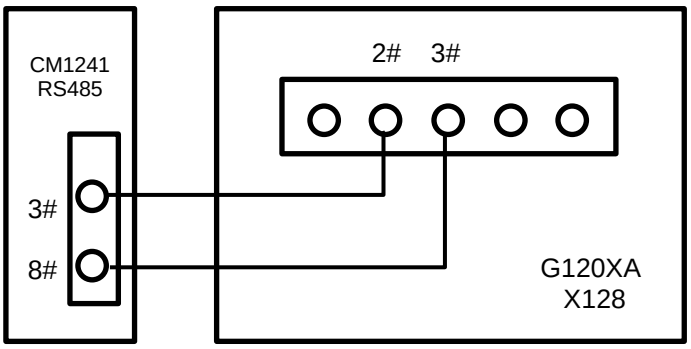
3.4.2 USS configuration

The figure below is the wiring configuration for the USS communication.

Figure 3-5:



3.4.3 I/O configuration

The figure below is the I/O wiring for the USS communication macro.

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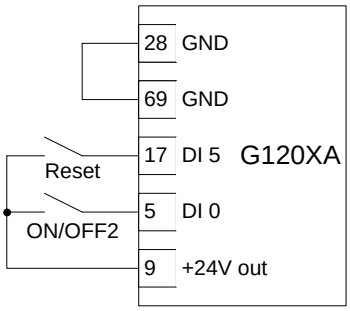
Figure 3-6



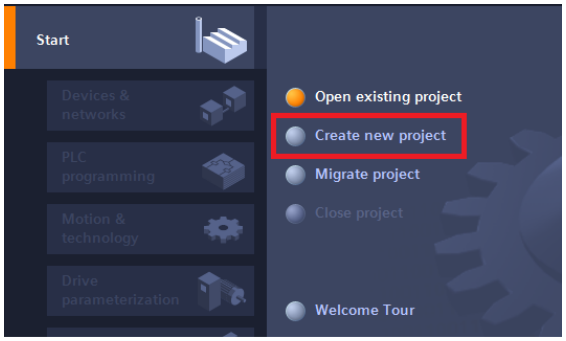
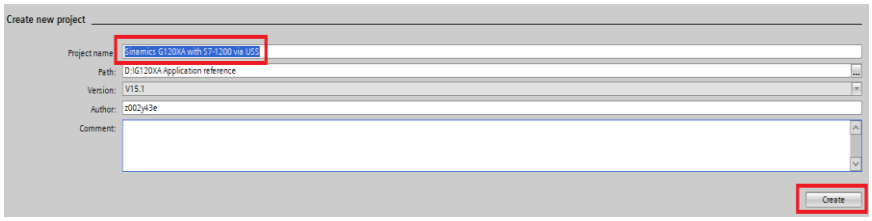
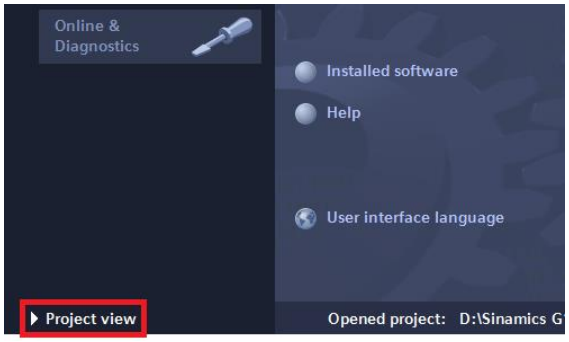
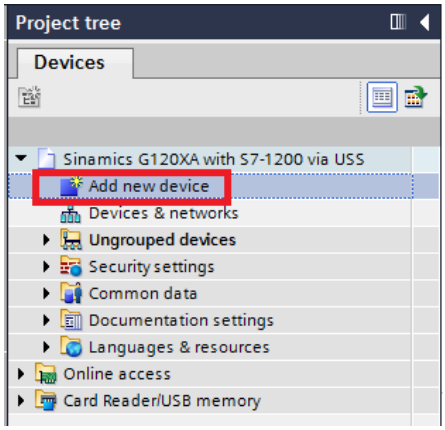
NOTE Due to the default USS communication macro control, the ON/OFF2 and Reset command is from digital input, not from the USS communication. And other control command and setpoint is from the USS communication.

4 Configuration

4.1 Configure PLC project

Create the PLC project and configure the PLC as table 4-1.

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

No.	Picture	Remarks
1.		Open TIA Portal V15 SP1 in your PC and then click “Create new project”.
2.	 Input the project name and then press "Create" to create project.	
3.		Press the "Project view" to open the project.
4.		Double click "Add new device" to add the target CPU to this project.

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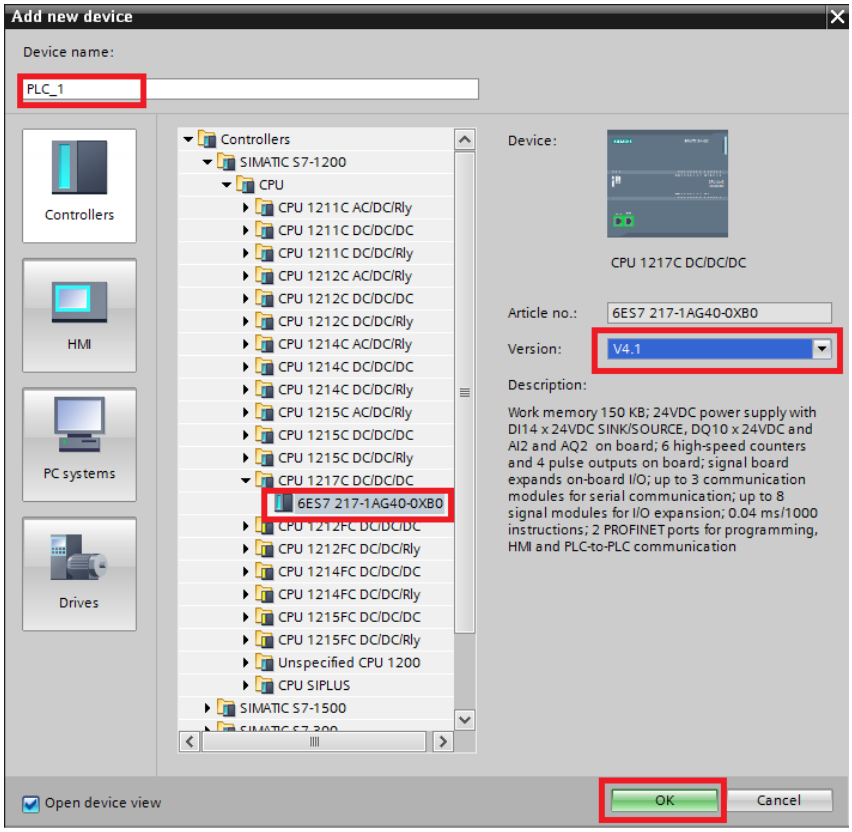
No.	Picture	Remarks
5.	 1. Find the target CPU. 2. Modify the device name. 3. Select the correct version. 4. Press "OK" to add this CPU to the project.	

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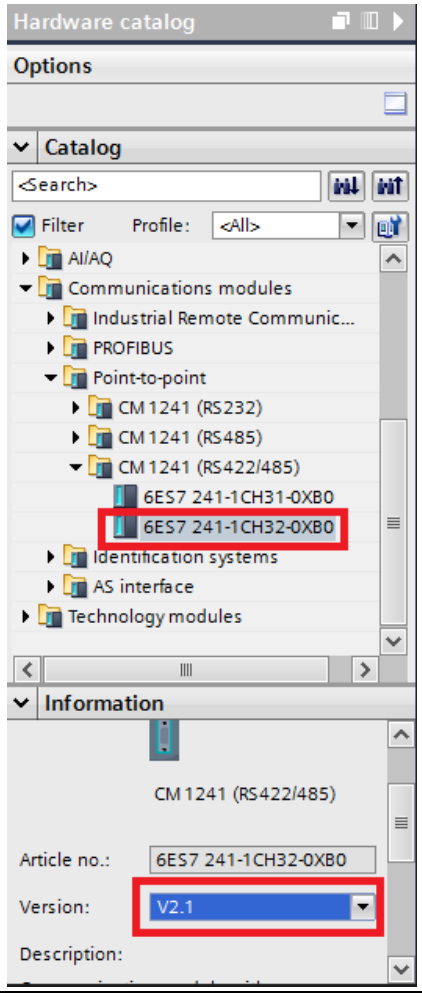
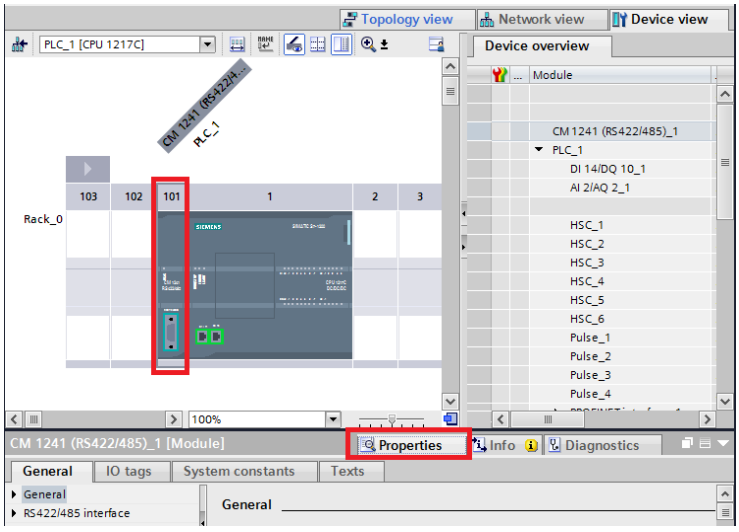
No.	Picture	Remarks
6.		1. In the hardware catalog, find the target communication module. 2. Select the correct version. 3. Then double click to add this module to the project.
7.	 Click the communication module and then select the "Properties".	

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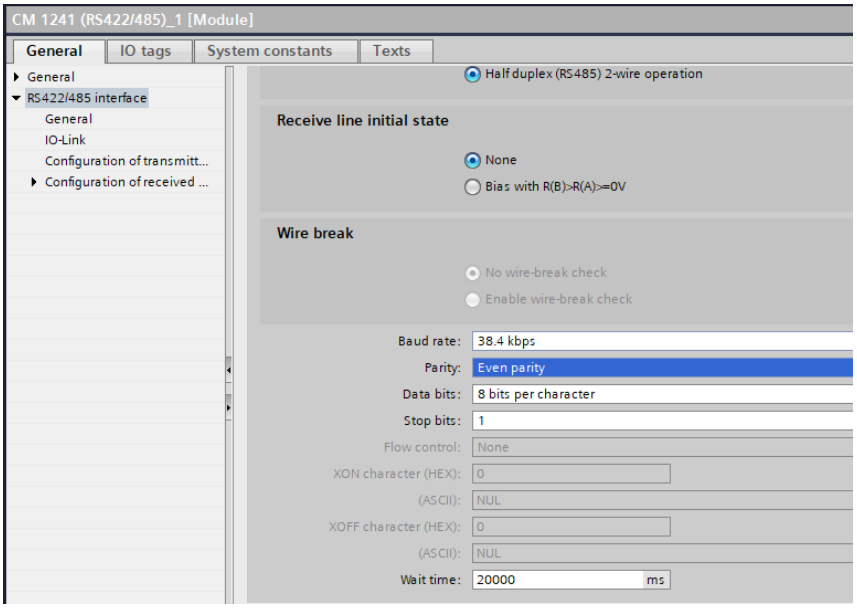
No.	Picture	Remarks
8.	 Set the communication properties and make it the same as the PLC logic in the following.	

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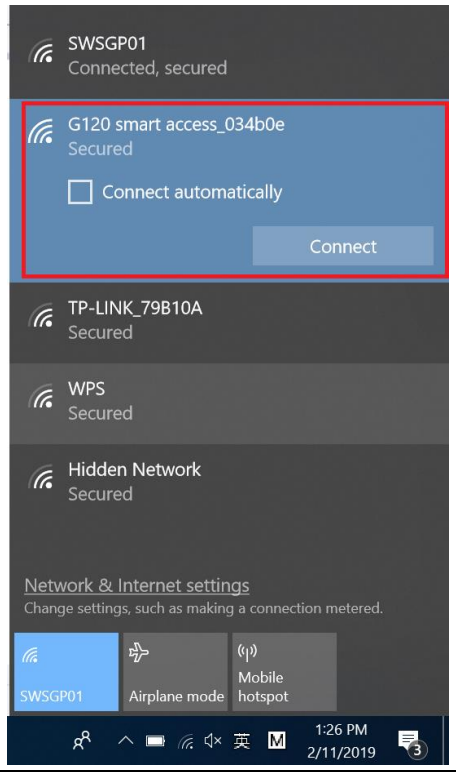
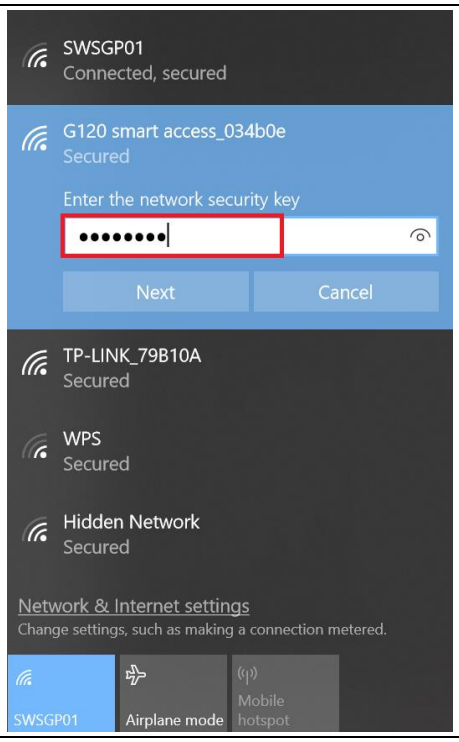
4.2 G120XA configuration

Table 4-2 Quick Commissioning via Smart Access Module

No.	Description	Remarks
1.		Select the G120 smart access module and then click “Connect” to connect the wifi. *Note: If the default password is already changed, then skip to step 6.*
2.		Input the original password “12345678” and then click the “Next” button.

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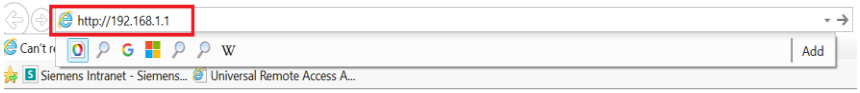
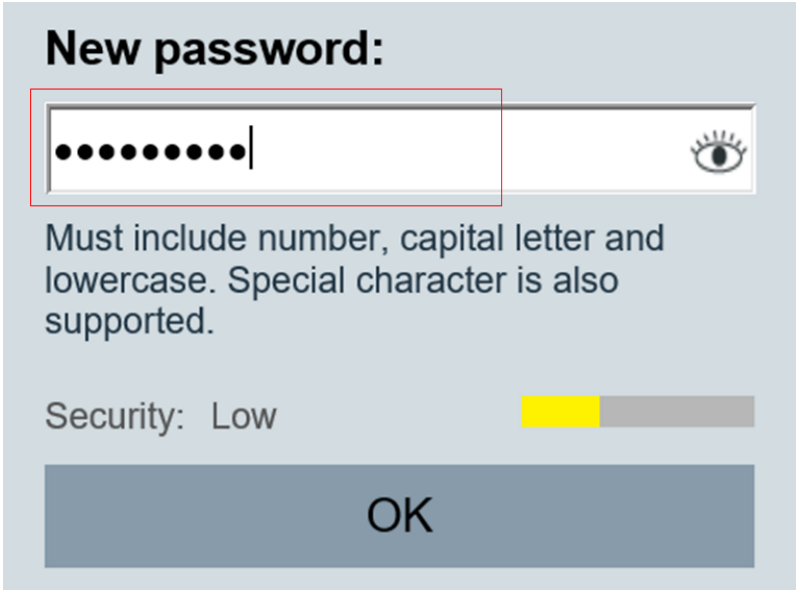
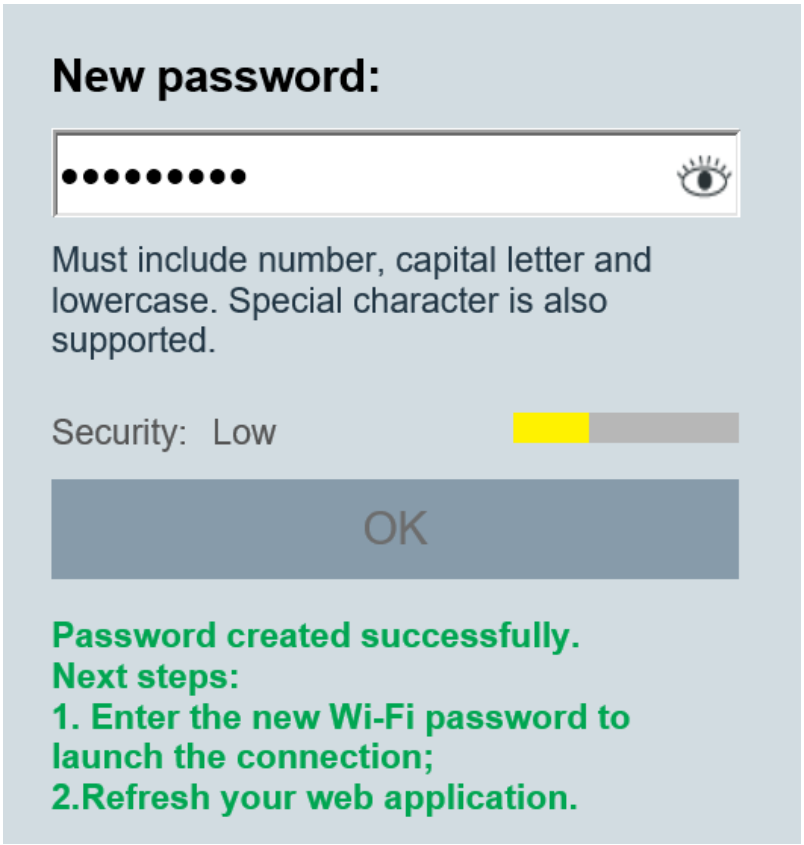
No.	Description	Remarks
3.	 Open the browser and input the address http://192.168.1.1 or https://192.168.1.1 to visit the website.	
4.	 Input the new password and then press “OK”.	
5.	 After the password changed successfully, press “OK”.	

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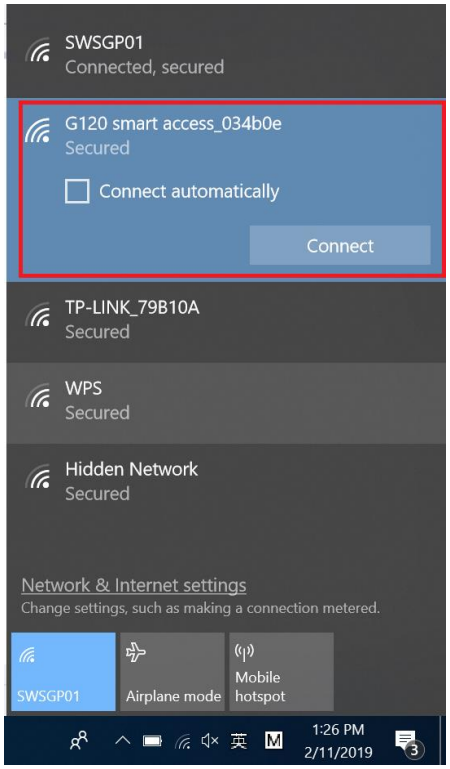
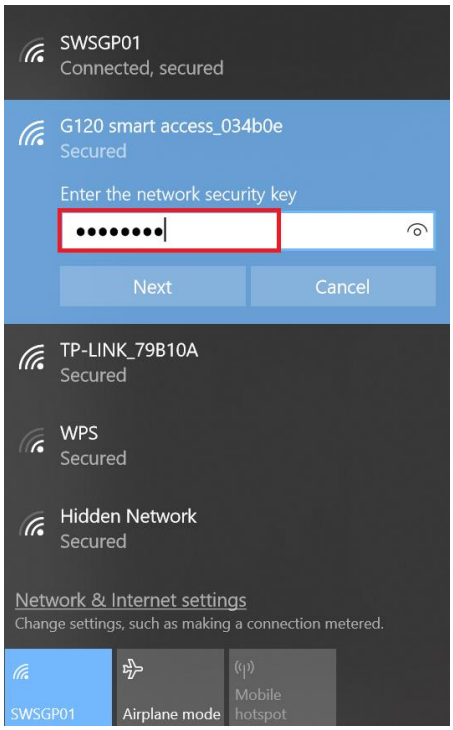
No.	Description	Remarks
6.		Select the G120 smart access module and then click “Connect” to connect the wifi.
7.		Input the new password created before and then press “Next”.
8.	 Open the browser and input the address http://192.168.1.1 or https://192.168.1.1 to visit the website.	

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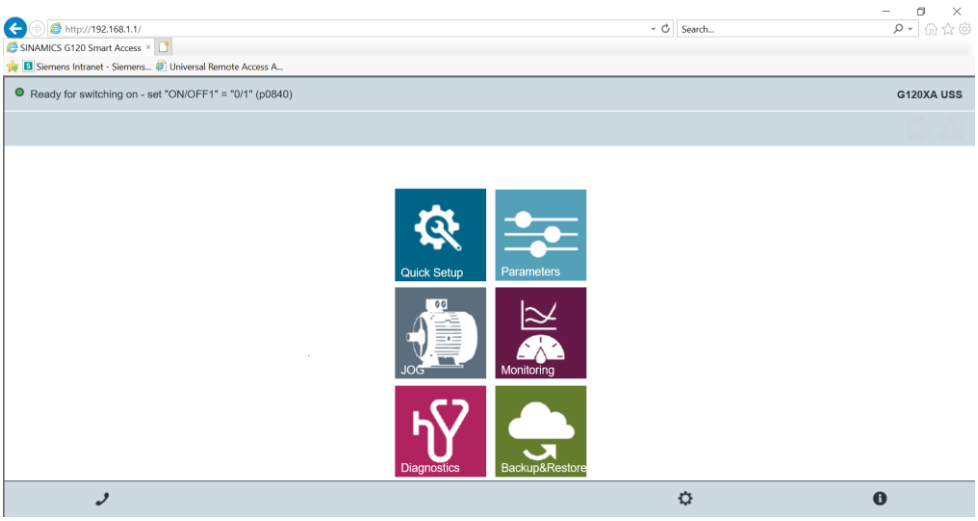
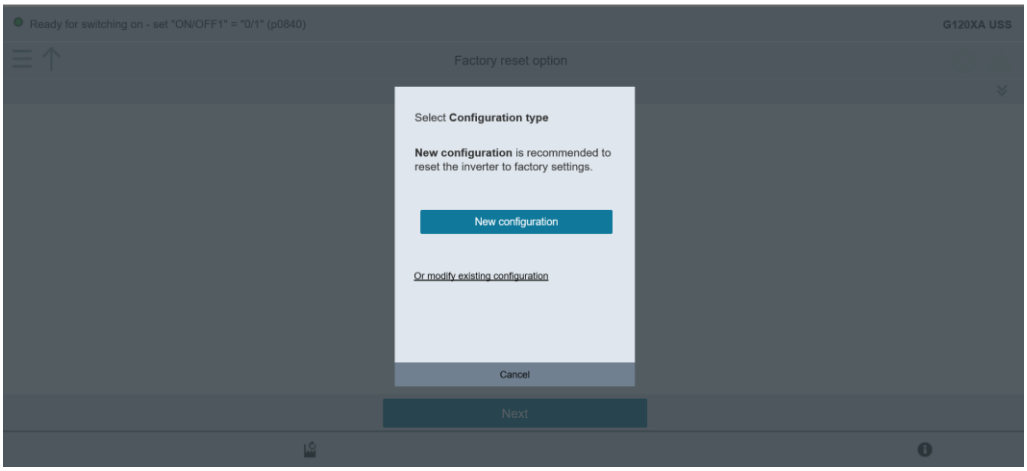
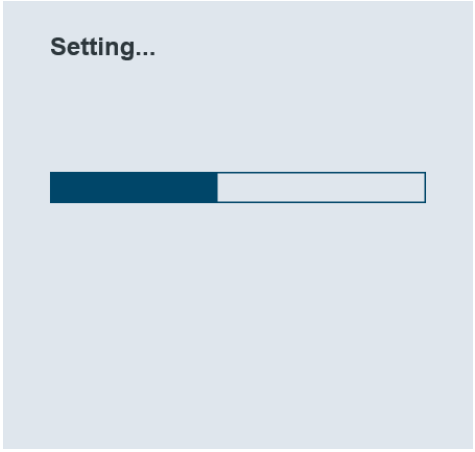
No.	Description	Remarks
9.	 Press the “Quick Setup” to start the quick commissioning.	
10.	 Click the “New configuration”. This step will do the factory reset first.	
11.	 Waiting for the factory setting.	

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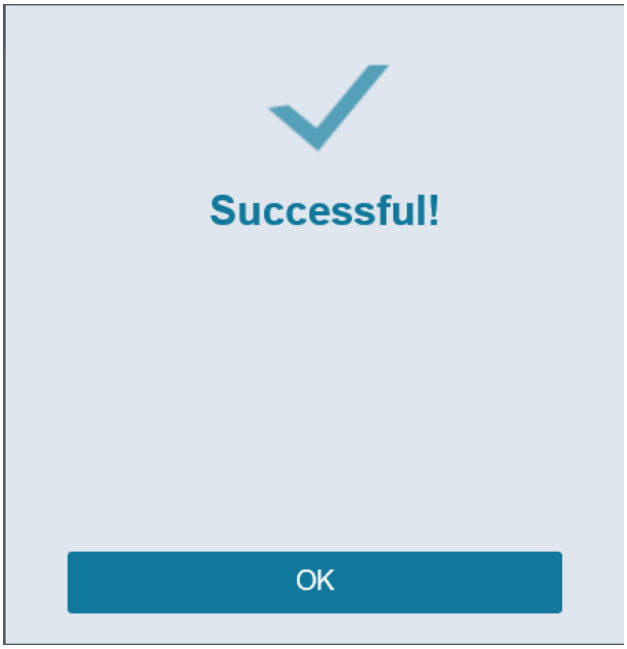
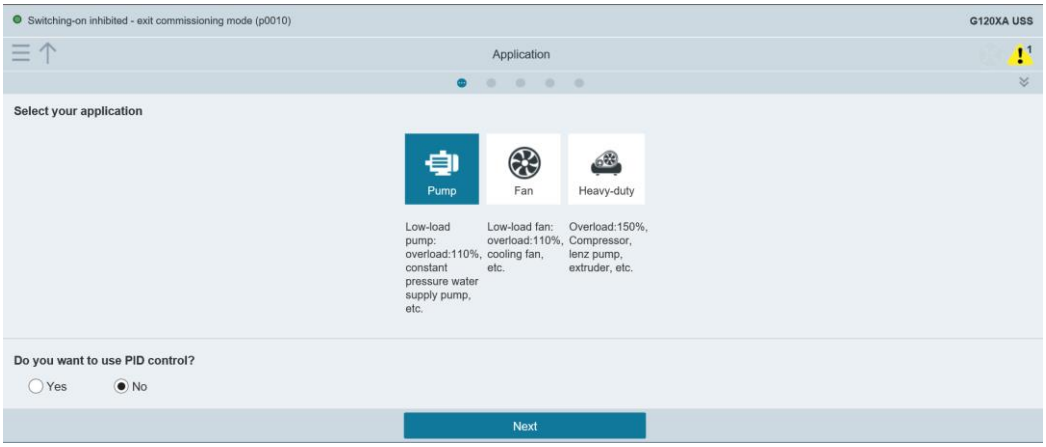
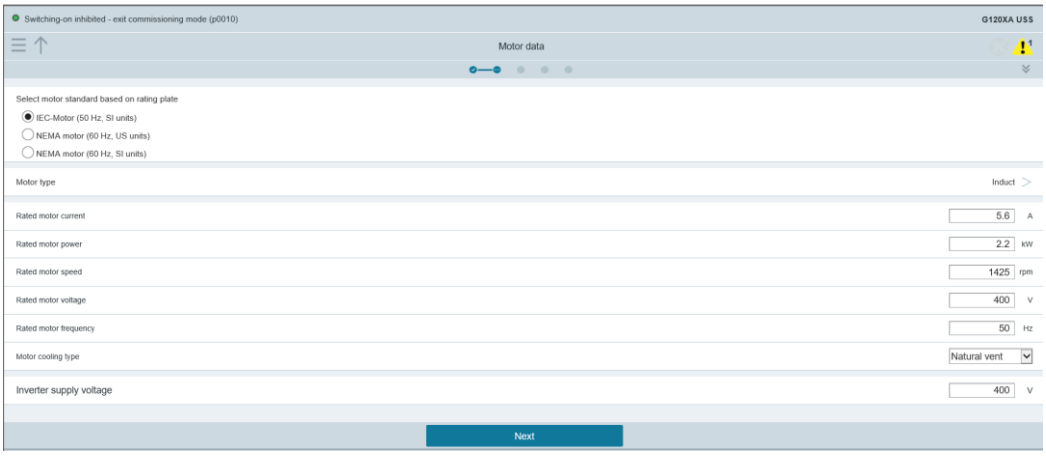
No.	Description	Remarks
12.	 When factory setting finished, press “OK”.	
13.	 1. Select the “Pump” application and do not use the PID control. 2. Then press “Next”.	
14.	 Input the motor data and then press “Next”.	

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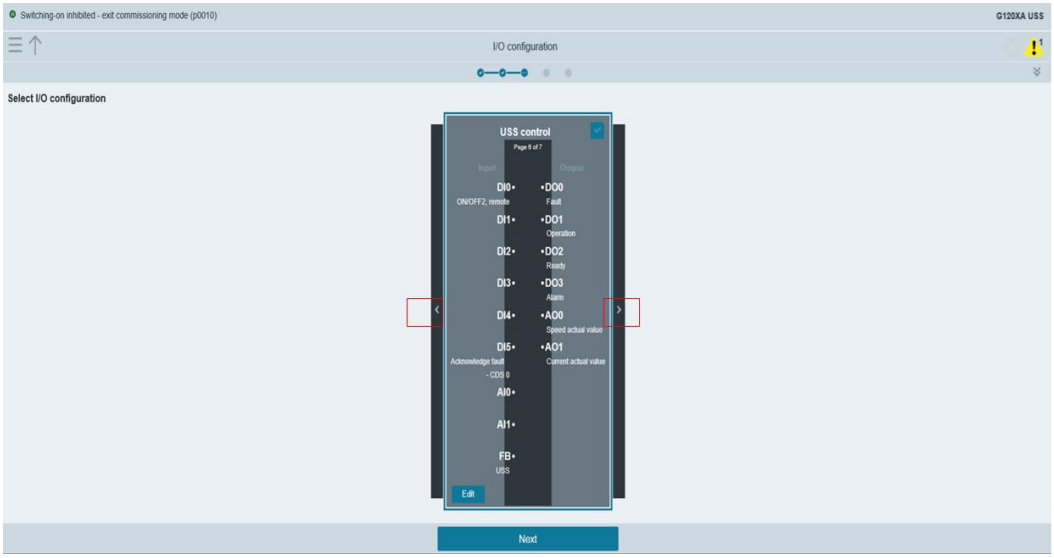
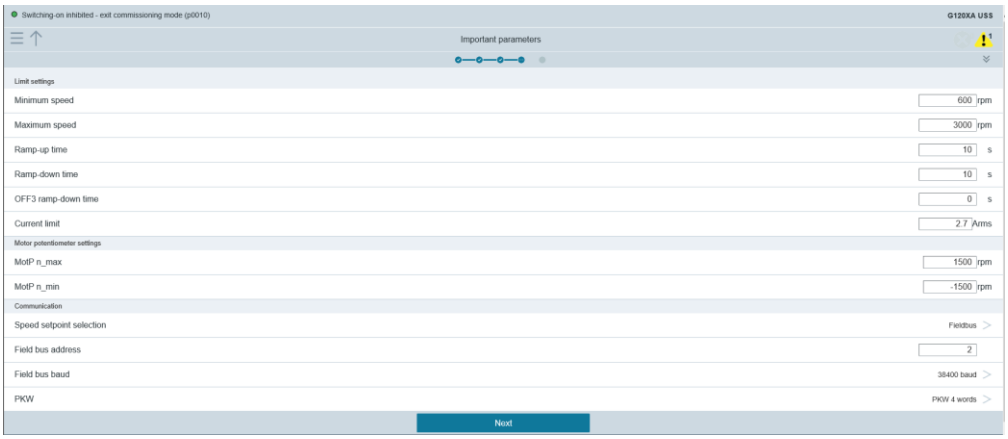
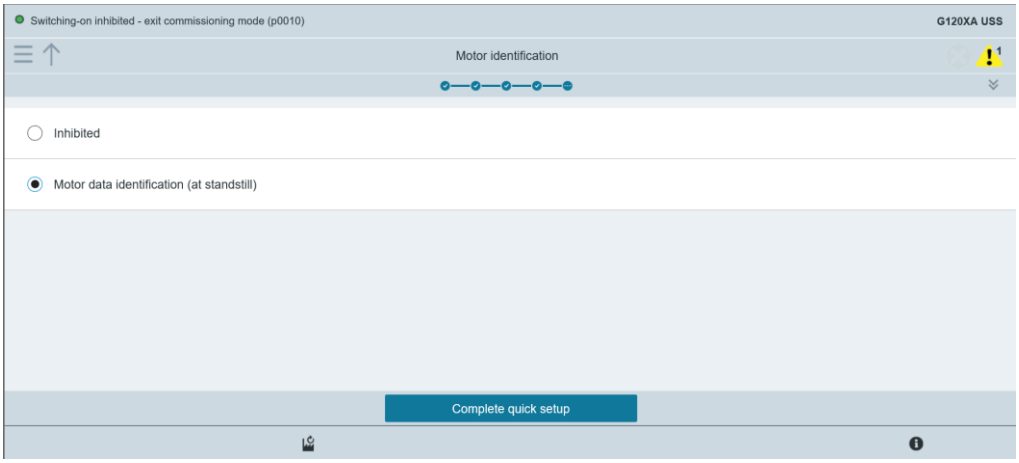
No.	Description	Remarks
15.	 1. Click the left arrow or the right arrow to find the target I/O configuration to “USS control”. 2. Then Press “Next”.	
16.	 1. Input the important parameters, especially for the communication parameters. 2. Then press “Next”.	
17.	 Select the “Motor data identification” for the motor identification and press “Complete quick setup”. *Note:* *The default control mode is vector control. Need motor ID identification.*	

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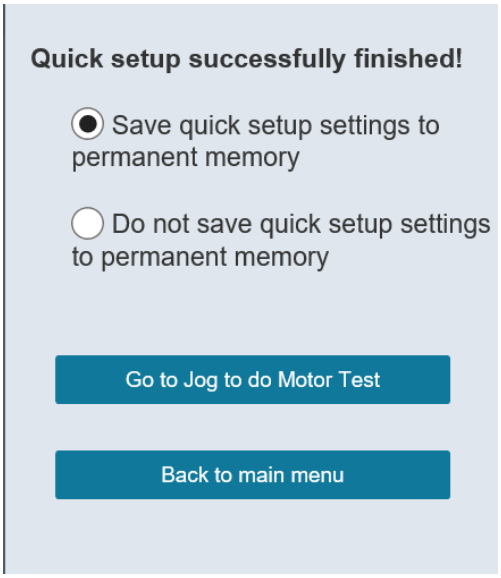
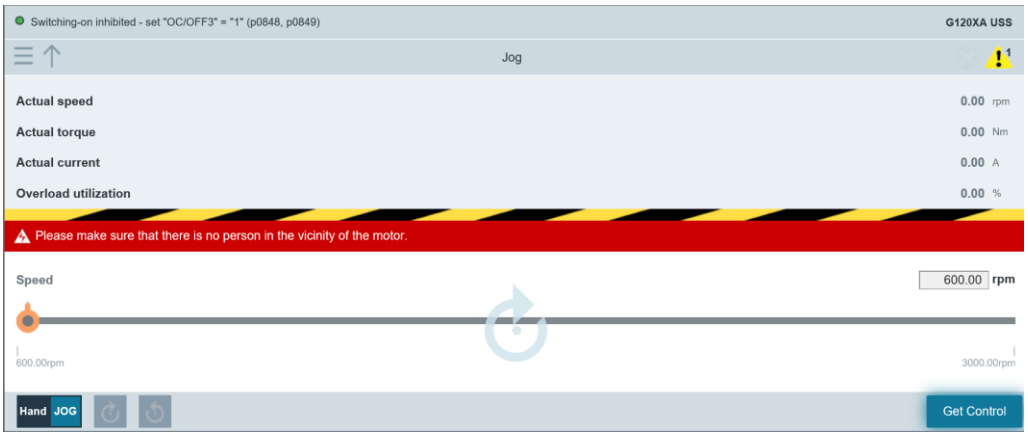
No.	Description	Remarks
18.	 Select the “Save quick setup settings to permanent memory” and then click “Go to Jog to do Motor Test”.	
19.	 Press “Get Control”	

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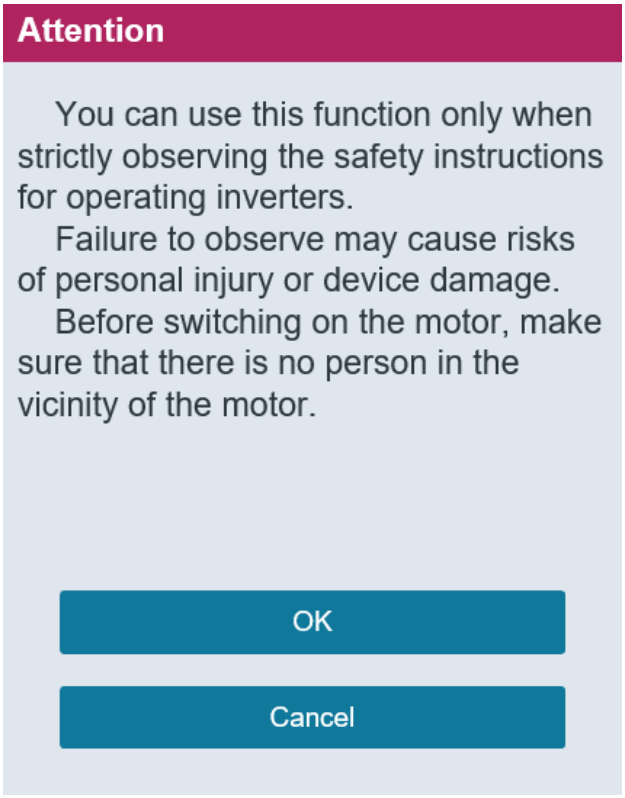
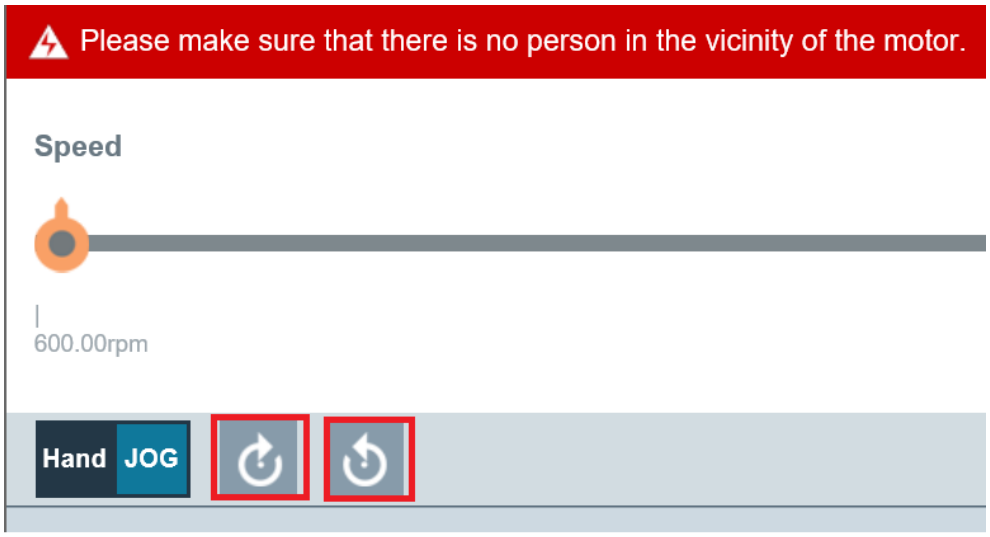
No.	Description	Remarks
20.	 Press “OK”.	
21.	 Press the CW command or CCW command until the motor ID identification finished.	

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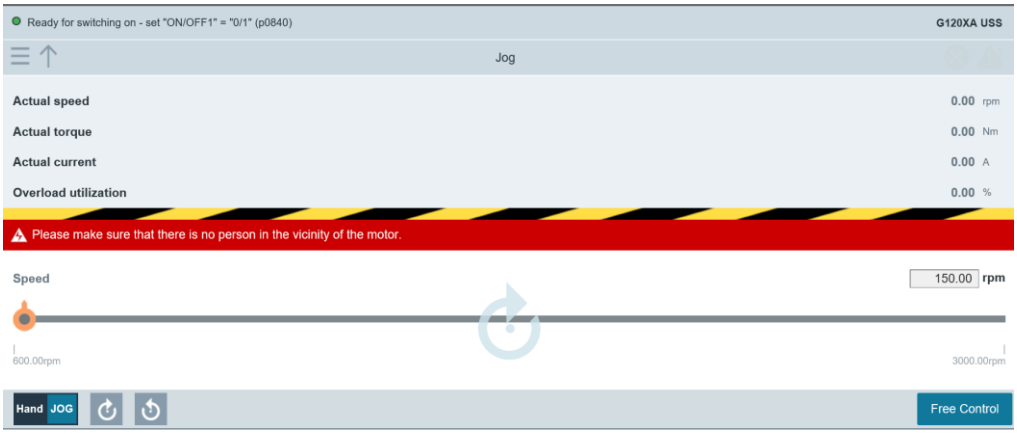
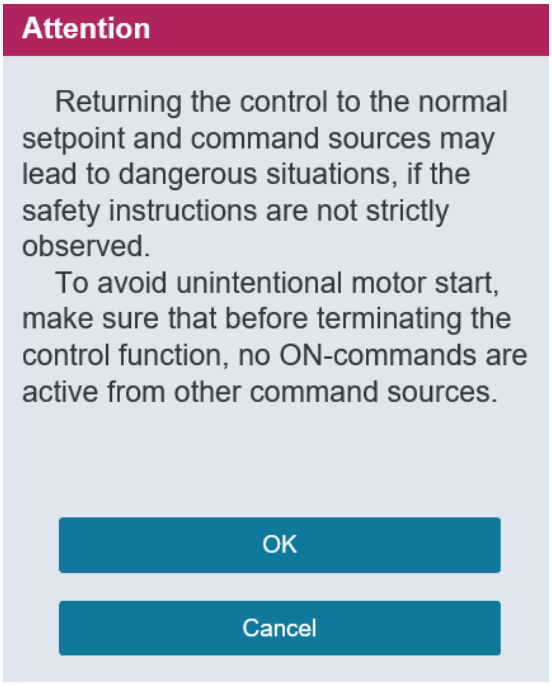
No.	Description	Remarks
22.	 Press the “Free Control“.	
23.	 Press “OK”.	

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4.3 Program PLC logic

In this application example, the SINAMICS G120XA 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_Communication"(FB1) function block.

The figure 4-1 shows the program structure.

Figure 4-1 Program structure

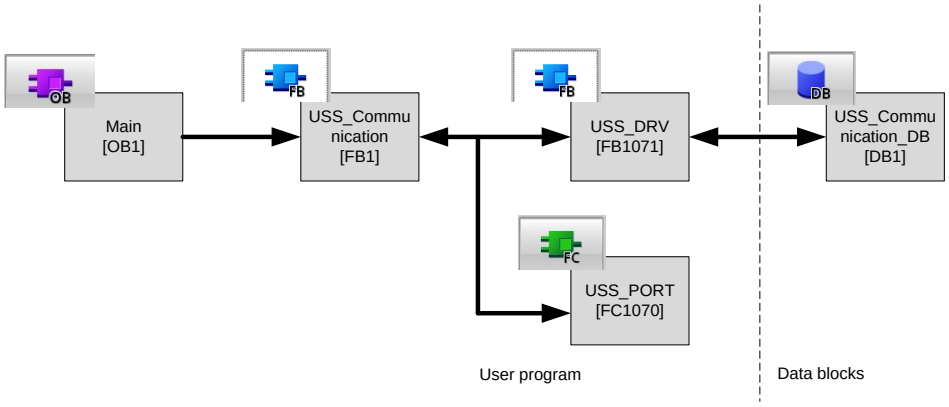

Table 4-3 is the details about the PLC logic programming.

Table 4-3 PLC Program

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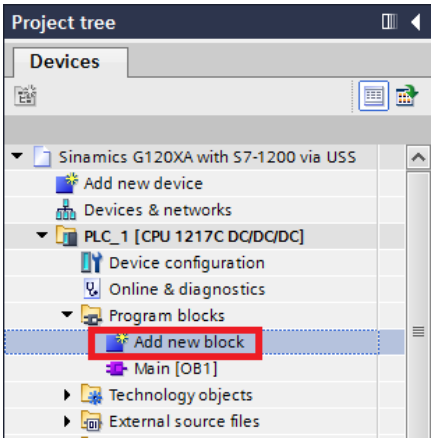
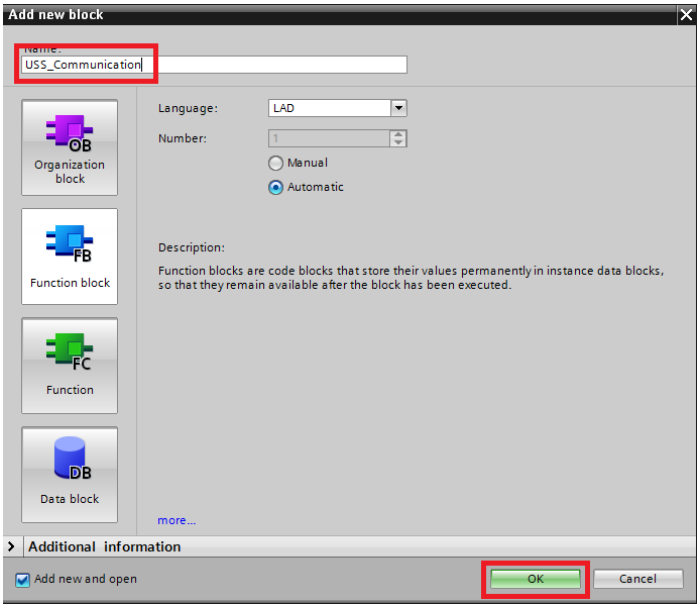
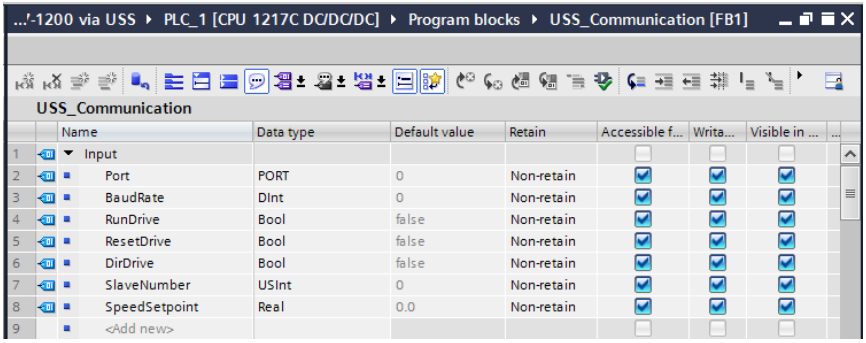
No.	Picture	Remarks
1.		Double click the "Add new block" to add one new FB.
2.	 Input the function block name and then press "OK" to create it.	
3.	 Edit the input variables of this function block.	

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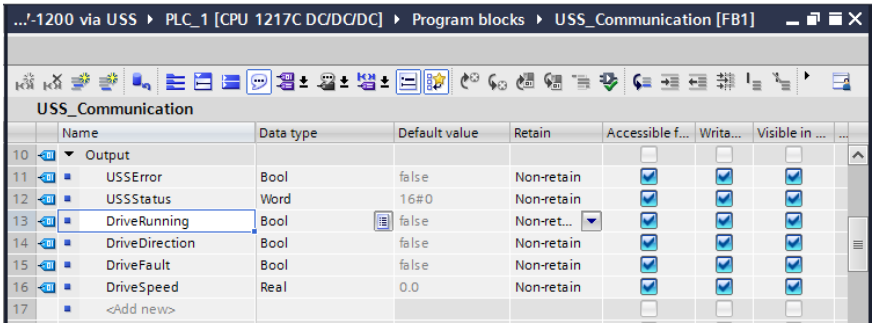
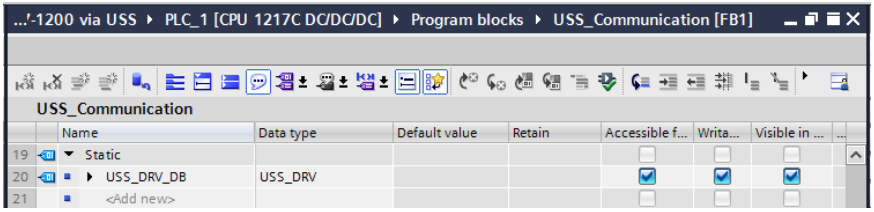
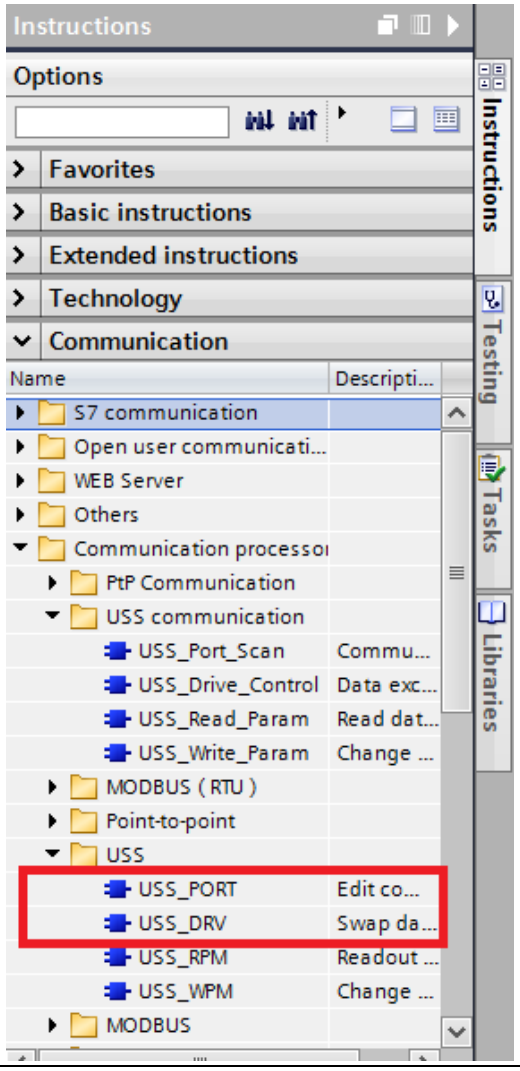
No.	Picture	Remarks
4.	 Edit the output variables of this function block.	
5.	 Edit the static variables of this function block.	
6.		Insert the "USS_PORT" and "USS_DRV" into the function block.

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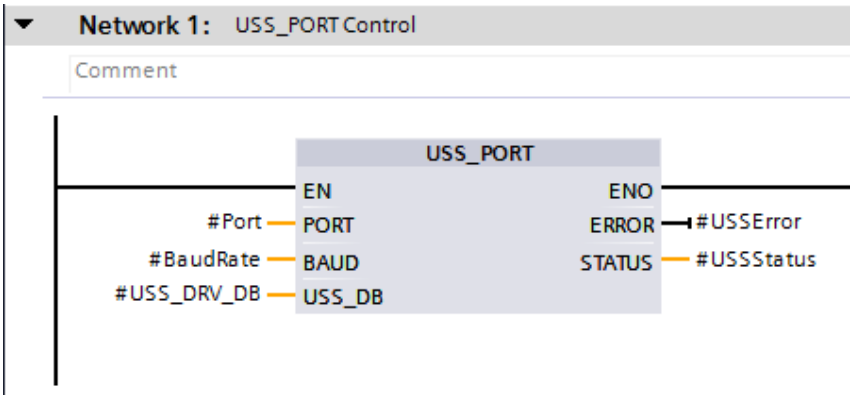
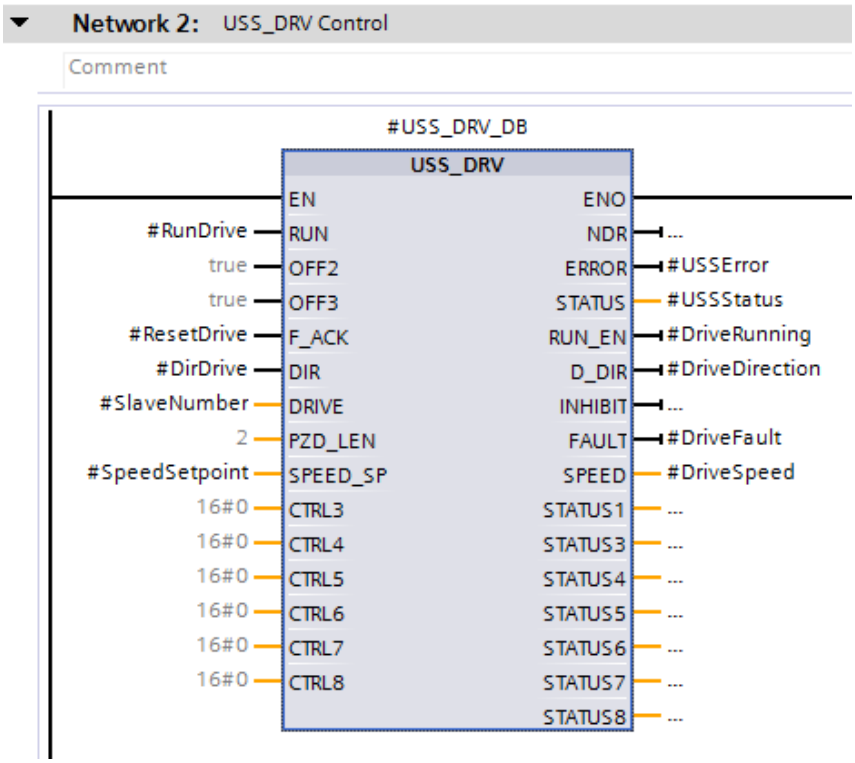
No.	Picture	Remarks
7.	 Edit the instruction "USS_PORT" as it.	
8.	 Edit the "USS_DRV" as it.	

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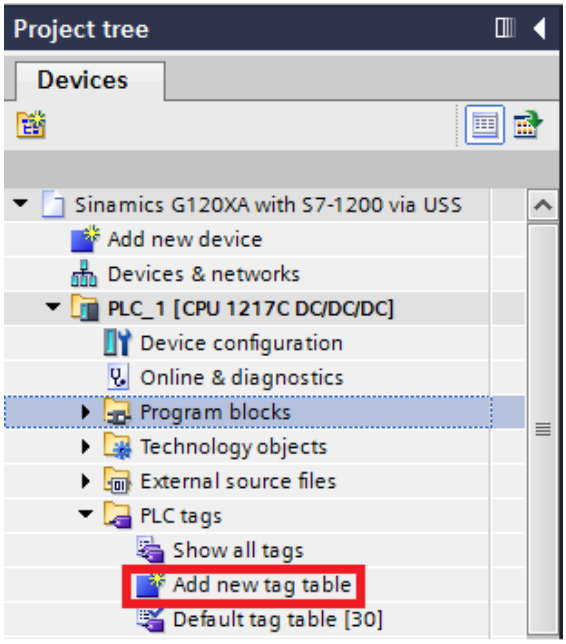
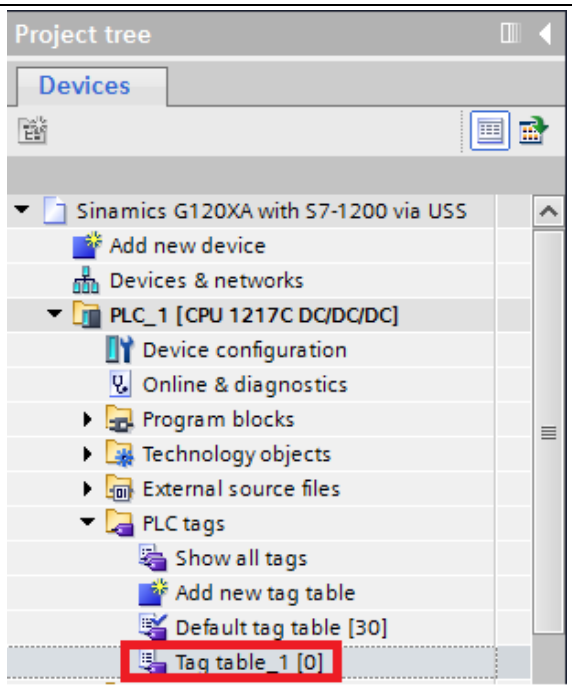
No.	Picture	Remarks
9.		Double click the "Add new tag table" to add a new PLC tag table.
10.		Double click the created PLC tag table to open it.

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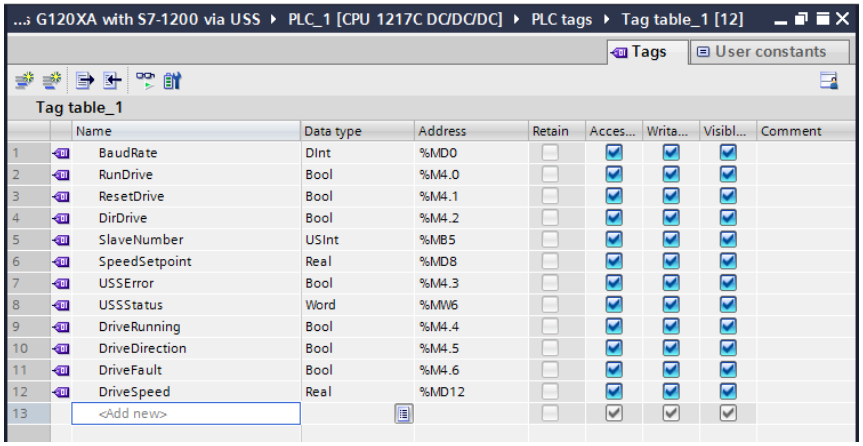
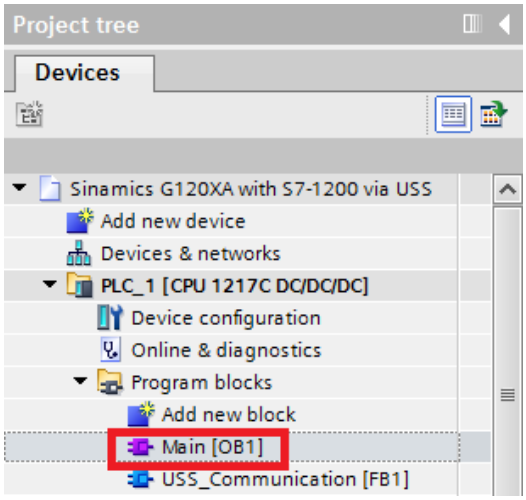
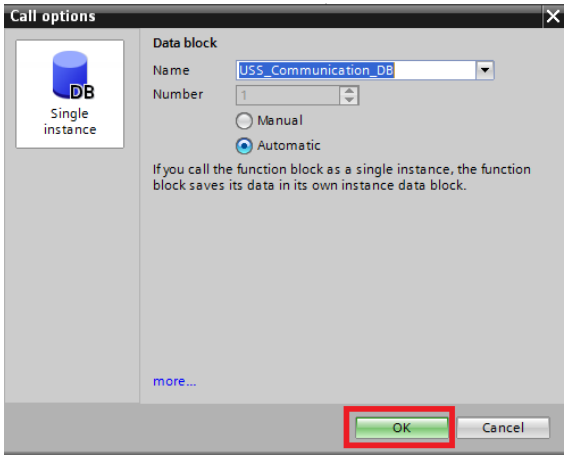
No.	Picture	Remarks
11.	 Create the tags as it.	
12.		Double click "OB1" to open it.
13.		Call the function block "USS_Communication" and press "OK" to create the data block automatically.

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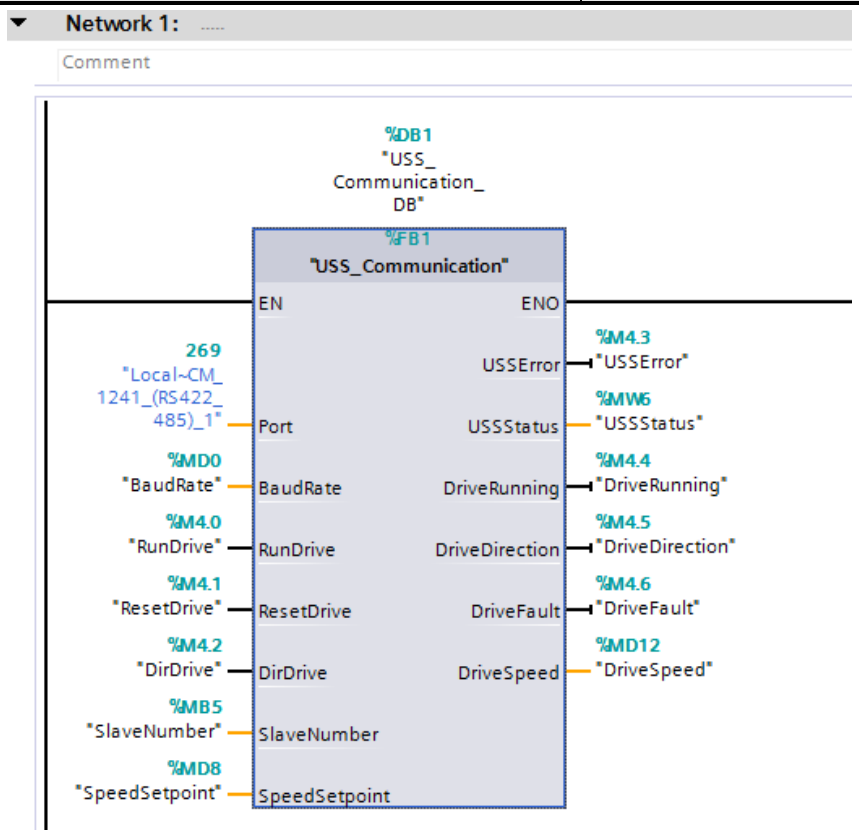
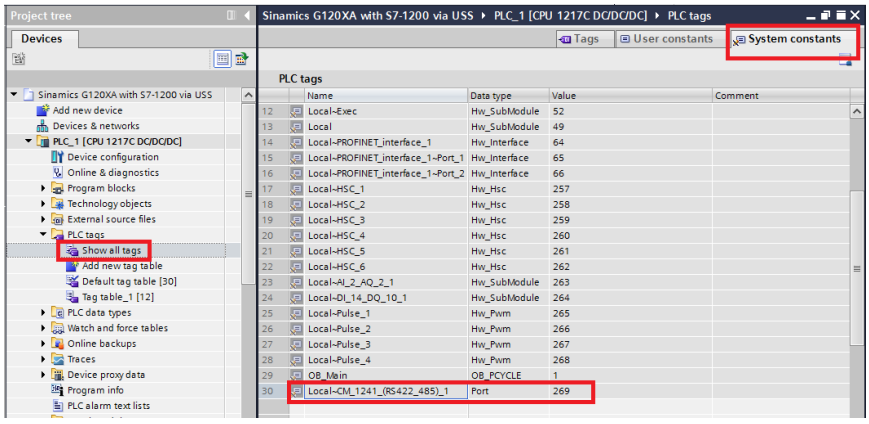
No.	Picture	Remarks
14.	 Create the logic as it. *Note:*  *Click "Show all tags", select "System constants", and then find the port number of the communication module.*	

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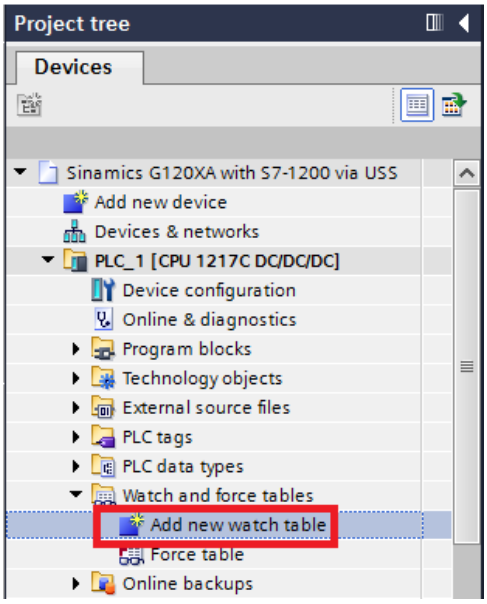
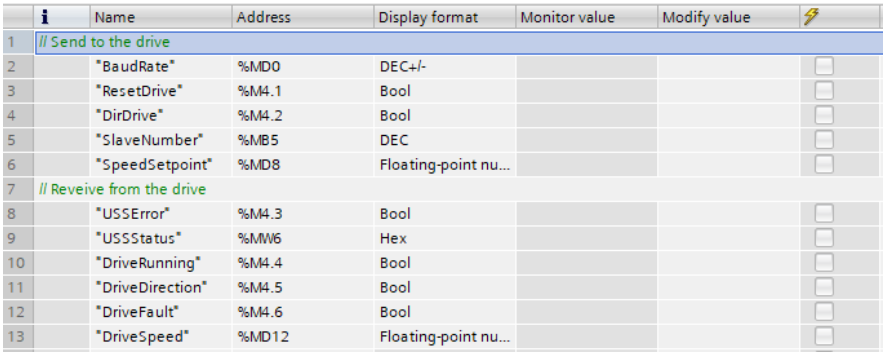
No.	Picture	Remarks
15.		Double click "Add new watch table" to add a new watch table.
16.	 Edit the watch table as it.	
17.	Compile the project and download to the CPU.	

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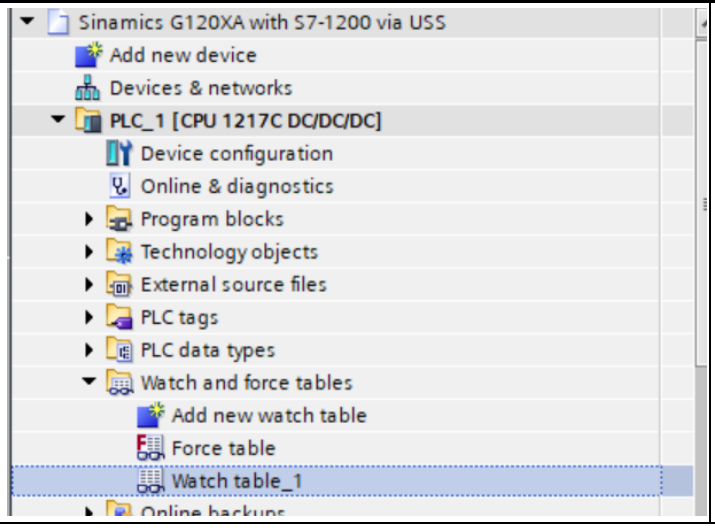
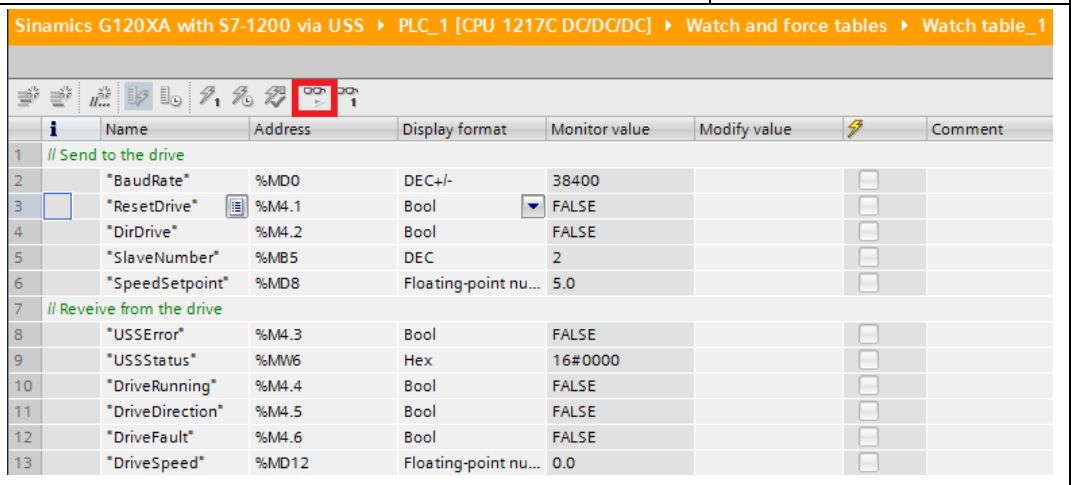
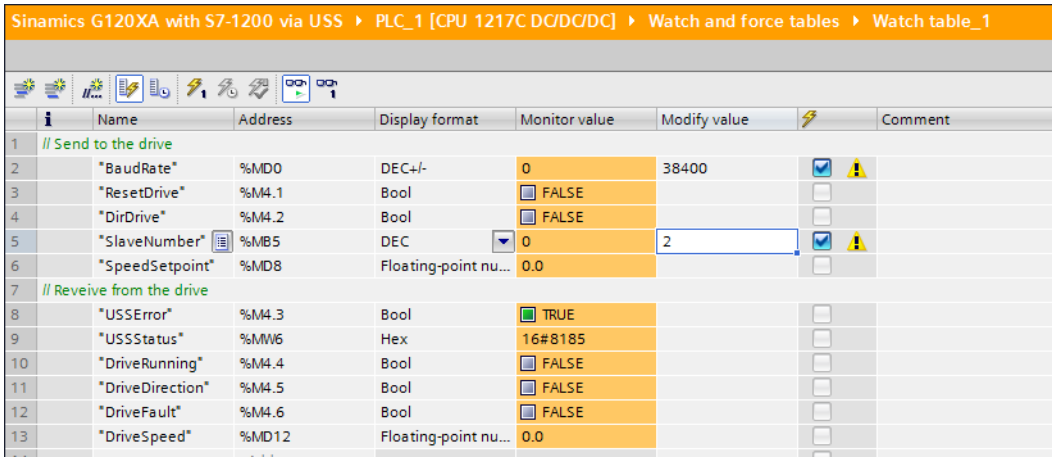
4.4 Operation

Table 4-4 describes how to use the project to run the motor.

Table 4-4

No.	Description	Remark
1.		Double click the “Watch table_1” to open the watch table.
2.	 Monitor the watch table.	
3.	 Modify the value of “BaudRate” and “SlaveNumber” to active the USS communication.	

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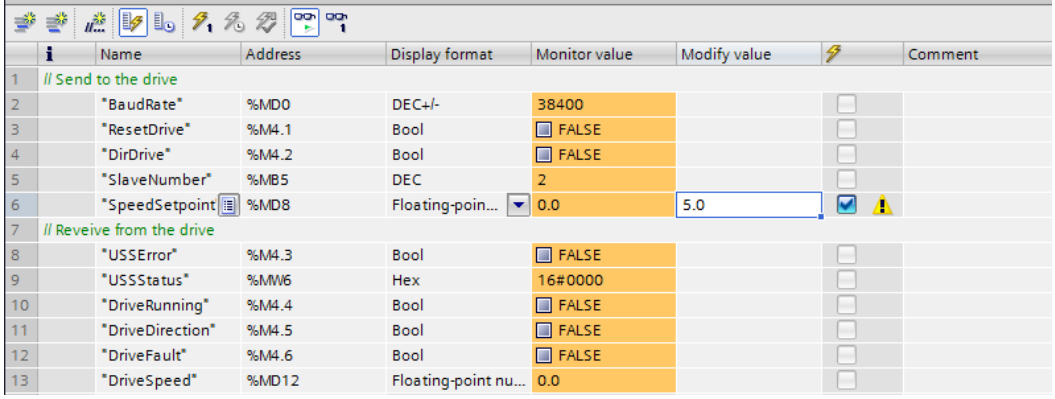
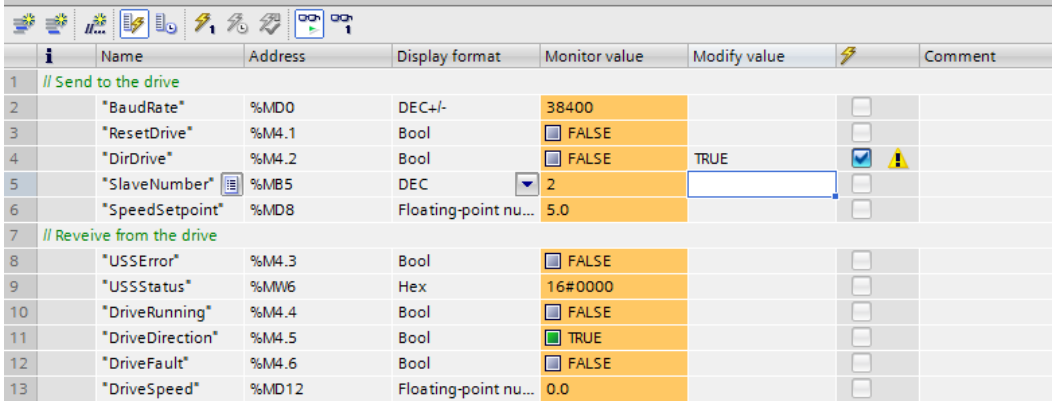
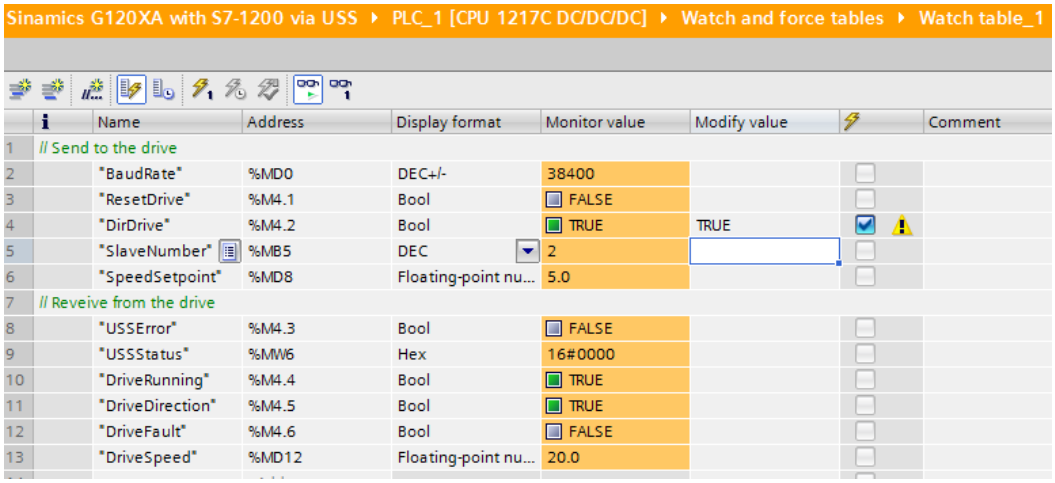
No.	Description	Remark
4.	Sinamics G120XA with S7-1200 via USS ▸ PLC_1 [CPU 1217C DC/DC/DC] ▸ Watch and force tables ▸ Watch table_1  Modify the value of “SpeedSetpoint”.	
5.	Enable the ON/OFF2 command from the digital input. *Note:* *Due to it is the pump application, the output only can be one direction. If the drive is already enabled, and the motor is not running, then change the output direction via the following.* Sinamics G120XA with S7-1200 via USS ▸ PLC_1 [CPU 1217C DC/DC/DC] ▸ Watch and force tables ▸ Watch table_1  *Set the “DirDirve” to 1.*	
6.	Sinamics G120XA with S7-1200 via USS ▸ PLC_1 [CPU 1217C DC/DC/DC] ▸ Watch and force tables ▸ Watch table_1  Monitor the output of the drive.	

	Name	Address	Display format	Monitor value	Modify value	Comment
1	// Send to the drive					
2	"BaudRate"	%MD0	DEC+/-	38400		
3	"ResetDrive"	%M4.1	Bool	FALSE		
4	"DirDrive"	%M4.2	Bool	FALSE		
5	"SlaveNumber"	%MB5	DEC	2		
6	"SpeedSetpoint"	%MD8	Floating-poin...	0.0	5.0	
7	// Reveive from the drive					
8	"USSError"	%M4.3	Bool	FALSE		
9	"USSStatus"	%MW6	Hex	16#0000		
10	"DriveRunning"	%M4.4	Bool	FALSE		
11	"DriveDirection"	%M4.5	Bool	FALSE		
12	"DriveFault"	%M4.6	Bool	FALSE		
13	"DriveSpeed"	%MD12	Floating-point nu...	0.0		

	Name	Address	Display format	Monitor value	Modify value	Comment
1	// Send to the drive					
2	"BaudRate"	%MD0	DEC+/-	38400		
3	"ResetDrive"	%M4.1	Bool	FALSE		
4	"DirDrive"	%M4.2	Bool	FALSE	TRUE	
5	"SlaveNumber"	%MB5	DEC	2		
6	"SpeedSetpoint"	%MD8	Floating-point nu...	5.0		
7	// Reveive from the drive					
8	"USSError"	%M4.3	Bool	FALSE		
9	"USSStatus"	%MW6	Hex	16#0000		
10	"DriveRunning"	%M4.4	Bool	FALSE		
11	"DriveDirection"	%M4.5	Bool	TRUE		
12	"DriveFault"	%M4.6	Bool	FALSE		
13	"DriveSpeed"	%MD12	Floating-point nu...	0.0		

	Name	Address	Display format	Monitor value	Modify value	Comment
1	// Send to the drive					
2	"BaudRate"	%MD0	DEC+/-	38400		
3	"ResetDrive"	%M4.1	Bool	FALSE		
4	"DirDrive"	%M4.2	Bool	TRUE	TRUE	
5	"SlaveNumber"	%MB5	DEC	2		
6	"SpeedSetpoint"	%MD8	Floating-point nu...	5.0		
7	// Reveive from the drive					
8	"USSError"	%M4.3	Bool	FALSE		
9	"USSStatus"	%MW6	Hex	16#0000		
10	"DriveRunning"	%M4.4	Bool	TRUE		
11	"DriveDirection"	%M4.5	Bool	TRUE		
12	"DriveFault"	%M4.6	Bool	FALSE		
13	"DriveSpeed"	%MD12	Floating-point nu...	20.0		

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5 Related literature

Table 5-1Reference documents

	Topic	Title / Link
\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/109770390

6 Contact

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7 History

Table 7-1

Version	Date	Modifications
V1.0	03/2019	First version

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