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# Configuring a SINAMICS S120 with Startdrive >= V15

SINAMICS S120

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# Table of Contents

# 1 Introduction

## 1.1 Overview

SIMATIC S7-1500 CPUs support the connection of drives as a speed, positioning or synchronous axis via PROFINET, PROFIBUS or an analog drive connection. TIA Portal V15 (or higher) additionally provides the option to insert a SINAMICS S120 drive into a TIA Portal project using the "SINAMICS Startdrive" software.

Figure 1-1: Components overview
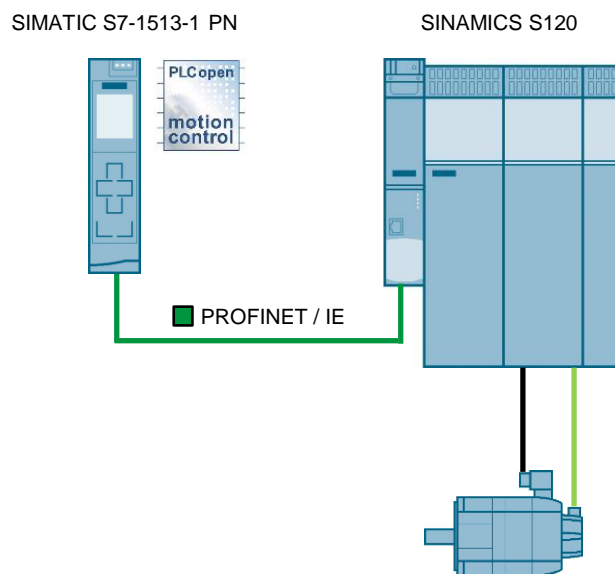


In this application example, a SINAMICS S120 is operated as a position-controlled drive. This drive is to act as the master axis for a second drive configured with gearing. The configuration of the drives is created with "SINAMICS Startdrive".

## 1.2　Components used

This application example was created with the following hardware and software components:

Table 1-1: Hardware and software components

| Component | No. | Article no. | Note |
|---|---|---|---|
| SIMATIC S7-1513-1 PN | 1 | 6ES7513-1AL01-0AB0 | Alternatively, a different S7-1500 controller can be used. |
| SINAMICS Control Unit CU320-2 PN | 1 | 6SL3040-1MA01-0AA0 | - |
| SINAMICS S120 smart line module | 1 | 6SL3130-6AE15-0AA0-Z | - |
| SINAMICS S120 double motor module | 1 | 6SL3120-2TE13-0AA0-Z | - |
| Sensor module SMC20 | 1 | 6SL3055-0AA00-5BA1 | - |
| Synchronous motor with incremental encoder without DRIVE-CLIQ interface | 1 | 1FK7022-5AK71-1AG3 | - |
| Synchronous motor with absolute encoder with DRIVE-CLIQ interface | 1 | 1FK7022-5AK71-1LG0 | - |
| STEP 7 Professional V15.1 | 1 | 6ES7822-1..05-.. | - |
| SINAMICS Startdrive V15.1 | 1 | 6SL3072-4FA02-0X.. | - |

This application example consists of the following components:

Table 1-2: Components of the application example

| Component | Note |
|---|---|
| 109743270_SINAMICS_S120_TIA_PROJ_v120.zip | This zip file contains the STEP 7 TIA Portal V15.1 project. |
| 109743270_SINAMICS_S120_TIA_DOCU_V120.pdf | This document. |

# 2 Engineering

## 2.1 How the user program works

**S7-1500 Motion Control**

S7-1500 Motion Control supports controlled positioning and moving of axes and is an integral part of each S7-1500 CPU. The S7-1500T technology CPU provides additional motion control functions.

The motion control functionality supports the following technology objects:

- Speed Axis
- Positioning Axis
- Synchronous Axis
- External Encoder
- Output Cam and Cam Track (version 3.0 or higher)
- Cam (S7-1500T: version 3.0 or higher)
- Kinematics (S7-1500T: FW 2.5 or higher)

Drives with PROFIdrive support and analog setpoint interface are controlled using standardized motion control instructions according to PLCopen.

The axis control panel and comprehensive online and diagnostics functions support the commissioning and optimization of drives.

This application example implements position-controlled operation of a SINAMICS S120 drive with the "Positioning Axis" technology object. In addition, it includes the configuration of a "synchronous axis".

Figure 2-1: Configuration as a positioning axis
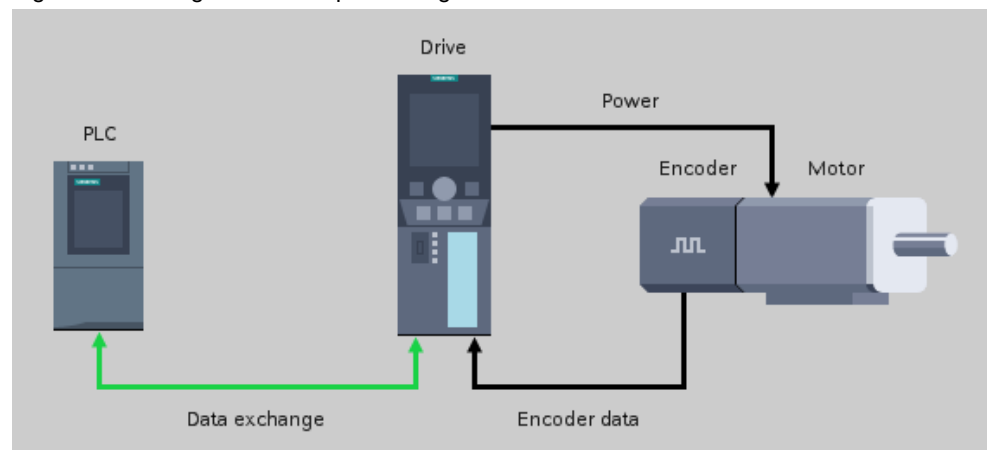


| Note | Chapter 2.3.2 describes the configuration of the "Positioning Axis" and "Synchronous Axis" technology objects. |

**Structure of the user program for the master axis**

In this application example, the SINAMICS S120 servo drive acting as the master axis is configured as a "positioning axis". A user program provides you with the option to operate this position-controlled drive with the aid of motion control instructions. To this end, the following instructions were inserted into the program:

- MC_HALT (FB 1200)
- MC_HOME (FB 1201)
- MC_MOVEABSOLUTE (FB 1202)
- MC_MOVEJOG (FB 1203)
- MC_POWER (FB 1206)
- MC_RESET (FB 1207)

The motion control instructions for the master axis are called in the "MotionControlPos" function block (FB 1). This function block uses the "InstMotionControlPos" instance (DB 3).

Figure 2-2: Program structure for the master axis
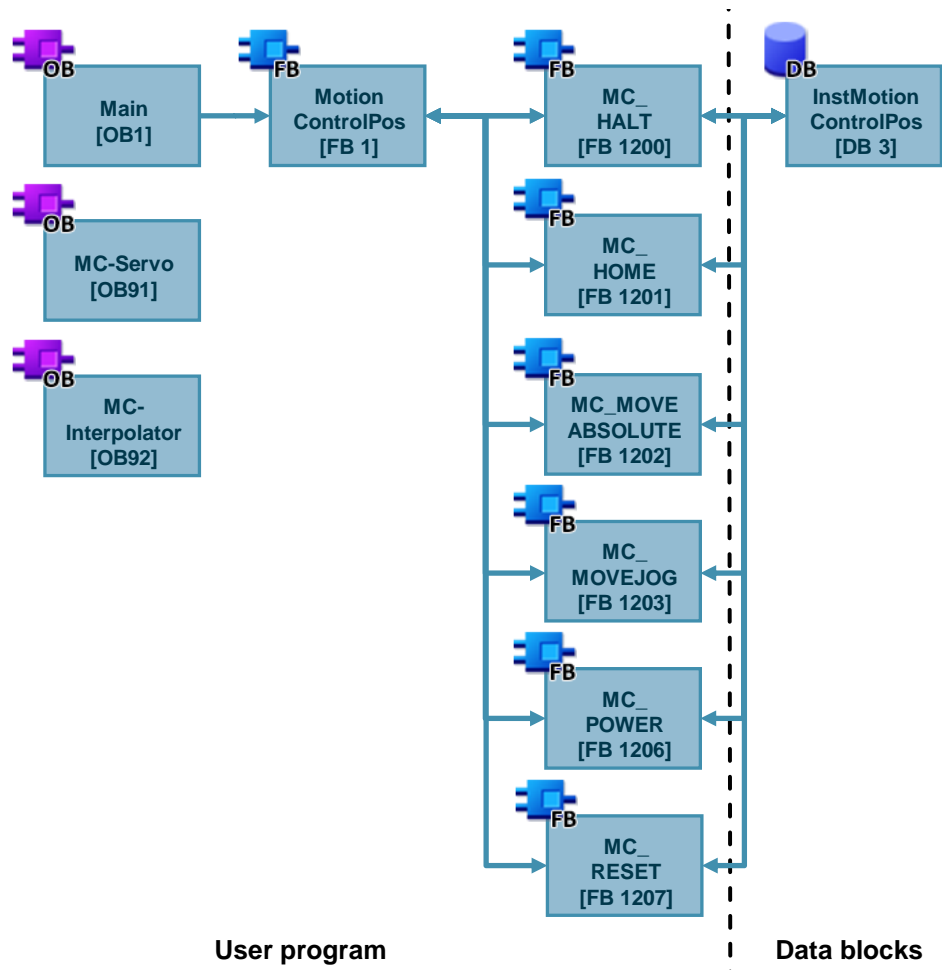
**Structure of the user program for the slave axis**

In this application example, the SINAMICS S120 drive acting as a slave axis is configured as a "synchronous axis". In the user program, with the aid of the "MC_GEARIN" motion control block, the slave axis can be synchronized with the master axis configured as a "positioning axis".

To this end, the following motion control instructions were inserted into the program:

- MC_POWER (FB 1206)
- MC_RESET (FB 1207)
- MC_GEARIN (FB 1208)

The motion control instructions for the slave axis are called in the "MotionControlSyn" function block (FB 2). This function block uses the "InstMotionControlSyn" instance (DB 4).

Figure 2-3: Program structure of the slave axis
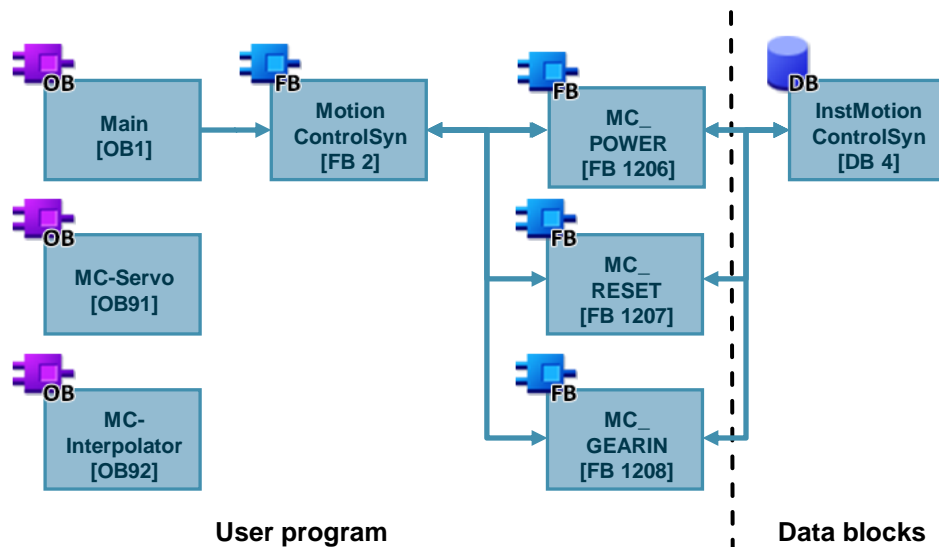


**Note** For information about the motion control blocks, refer to the TIA Portal Online Help or the "SIMATIC S7-1500 Motion Control in TIA Portal" Function Manual \3\.

https://support.industry.siemens.com/cs/ww/en/view/109749262

A watch table is available for operating the two drives using the motion control instructions. This table is shown in Chapter 2.5.3.

## 2.2 Configuring the SINAMICS S120

TIA Portal V15 (and higher) provides the option to configure the SINAMICS S120 drive with the "SINAMICS Startdrive" option package and control it using motion control instructions.

### 2.2.1 Configuring the SINAMICS S120 (offline)

| Note | Chapter 2.3.1 provides a detailed description of the offline configuration of the SINAMICS S120. |
|------|--------------------------------------------------------------------------------------------------|

The offline configuration of the SINAMICS S120 is created in the "Device view" of your TIA Portal program. This is where you have to insert and connect the individual components of the SINAMICS S120 drive.
The following figure shows the configuration of the SINAMICS S120 demonstration unit (article number: 6ZB2480-0BA00).

Figure 2-4: Configuration of the SINAMICS S120
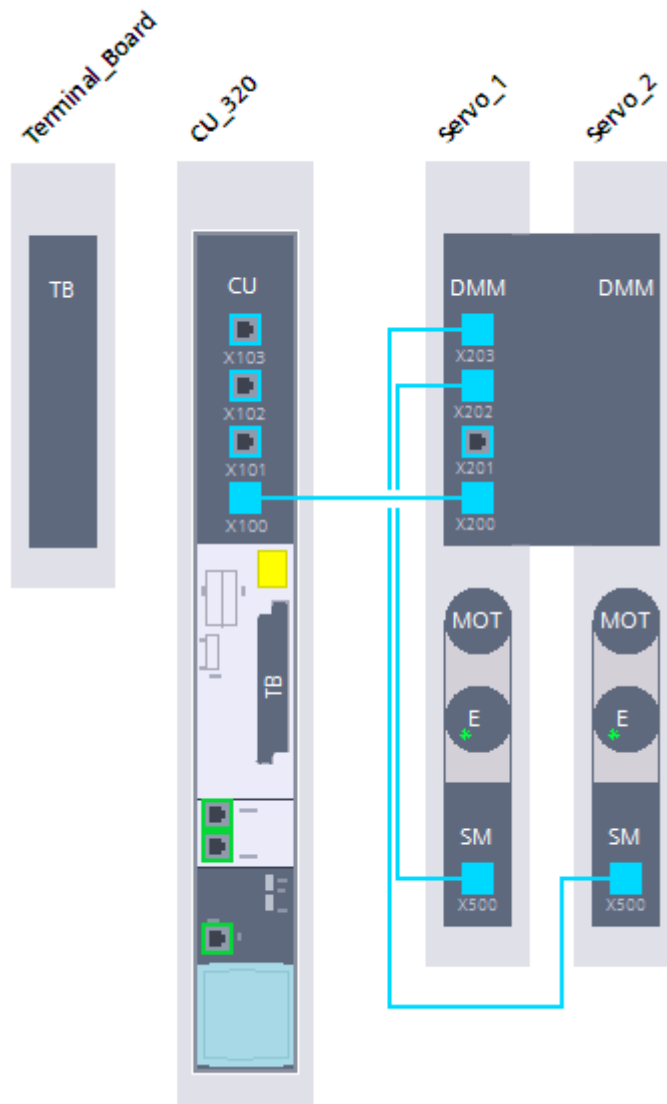
The "Device overview" lists the used components of the SINAMICS S120 drive.

Figure 2-5: Device overview



| | ⚙ | ... | Module | Slot | Type | Article no | Drive ... |
|---|---|---|---|---|---|---|---|
| | | | ▼ Drive control | | | | 1 |
| | | | ▶ CU_320 | | CU320-2 PN | 6SL3040-1MA01-0Axx | 1 |
| | | | ▼ Drive axis_1 | | | | 2 |
| | | | ▶ Motor Module_1 | | Double Motor Module Booksize | 6SL3120-2TE13-0Axx | 2 |
| | | | ▶ Encoder evaluation_1 | | SMI20 | 1FK7022-xAK7x-xLGx | 6 |
| | | | Measuring system_1 | | EnDat 2.1 encoder | 1FK7022-xAK7x-xLGx | 5 |
| | | | Motor_1 | | 1FK7 synchronous motor | 1FK7022-xAK7x-xLGx | 4 |
| | | | ▼ Drive axis_2 | | | | 3 |
| | | | ▶ Motor Module_1 | | Double Motor Module Booksize | 6SL3120-2TE13-0Axx | 3 |
| | | | ▶ Encoder evaluation_1 | | Sensor Module Cabinet SMC20 | 6SL3055-0AA00-5Bxx | 9 |
| | | | Measuring system_1 | | SIN/COS encoder | 1FK7022-xAK71-xAGx | 8 |
| | | | Motor_1 | | 1FK7 synchronous motor | 1FK7022-xAK71-xAGx | 7 |
| | | | ▼ Input/output object_1 | | | | 4 |
| | | | Terminal Board_1 | | Terminal Board TB30 | 6SL3055-0AA00-2Txx | 10 |

| **Note** | For more information about the configuration, refer to the "SINAMICS S120 Commissioning Manual with Startdrive", \5\. |
|---|---|
| | https://support.industry.siemens.com/cs/ww/en/view/109743147 |
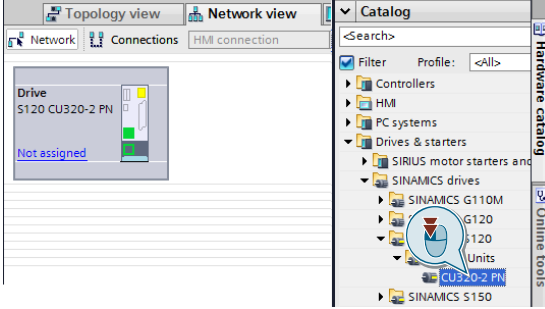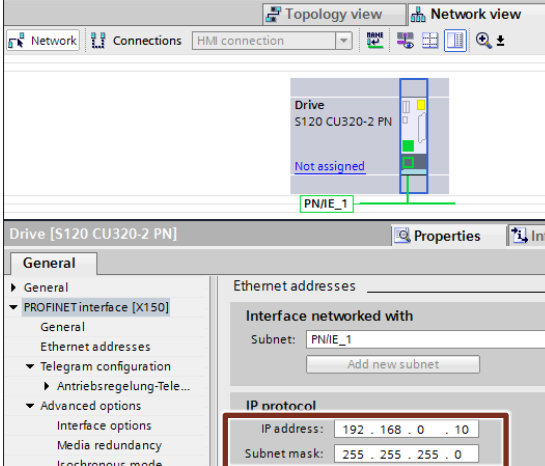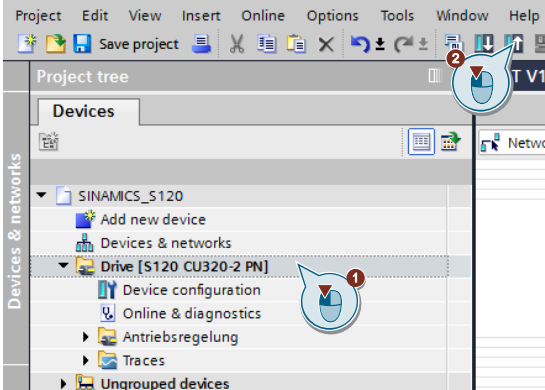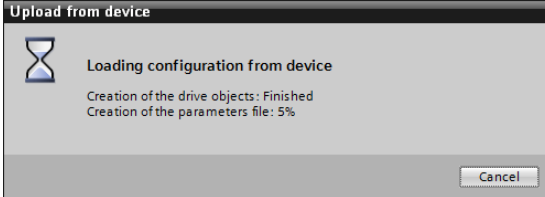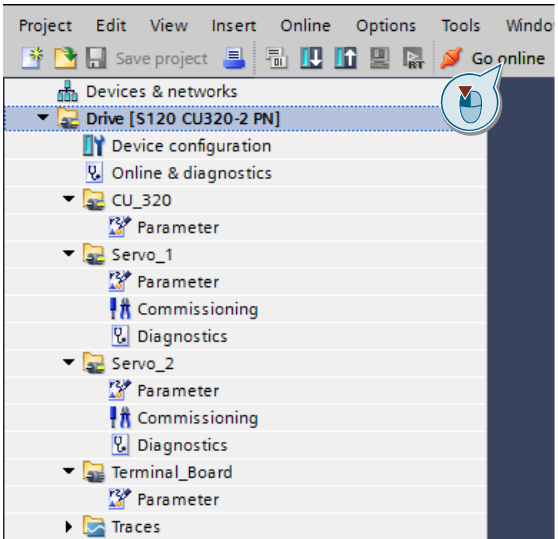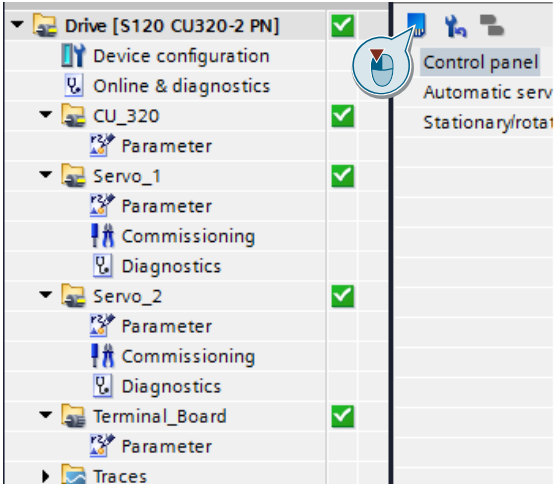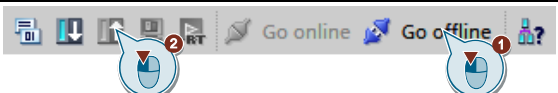
## 2.2.2 Downloading the SINAMICS S120 configuration (online)

SINAMICS Startdrive also provides the option to download the configuration of the used SINAMICS S120 station to a TIA Portal project. The following table describes the steps necessary to do this.

Table 2-1: Downloading the drive configuration

| No. | Action | Comment |
|---|---|---|
| 1. | In the "Network view" of your TIA Portal project, insert a SINAMICS CU320-2 PN. |  |
| 2. | Assign a PROFINET subnet to the CU320-2 PN and assign the device name and the IP address according to the drive you are using. |  |
| 3. | 1. In the product window, select the drive.<br>2. Download the configuration of the SINAMICS S120 drive to your TIA Portal project. |  |
| 4. | The drive configuration is downloaded to the TIA Portal project. |  |

| No. | Action | Comment |
|---|---|---|
| 5. | When the configuration has been successfully downloaded, establish an online connection to the drive. |  |
| 6. | Commission the drive online and finally save this data to the drive's non-volatile memory. |  |
| 7. | Close the online connection and then re-download the drive configuration to your TIA Portal project. |  |
| 8. | Save the TIA Portal project. | - |

| Note | The configuration of the SINAMICS S120 drive can only be downloaded to a TIA Portal project if the drive is not assigned to a controller. |
|---|---|
| |  |
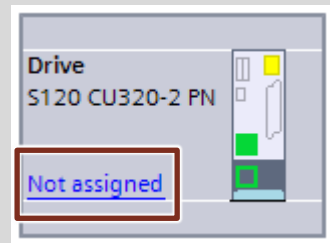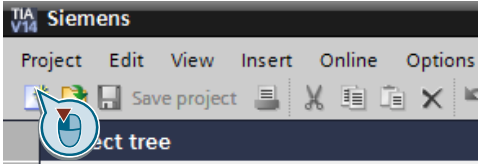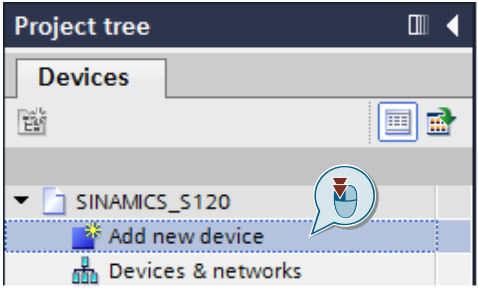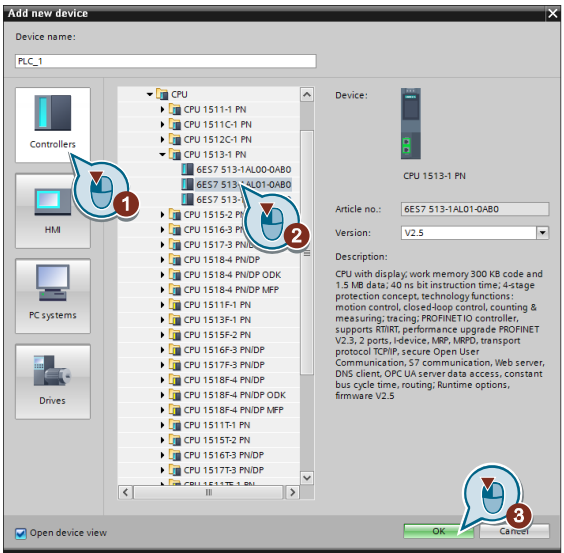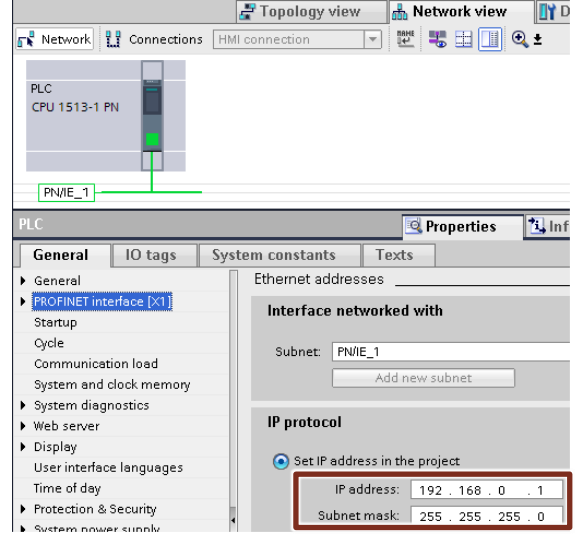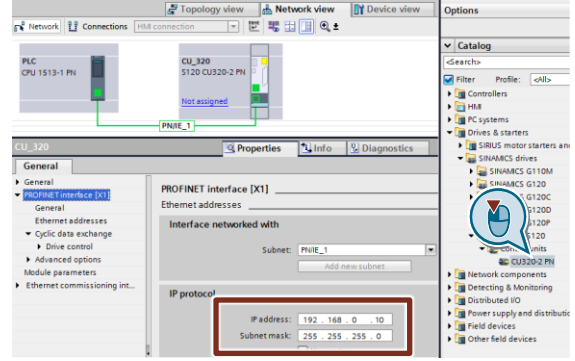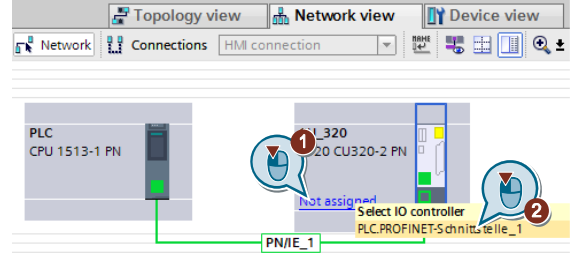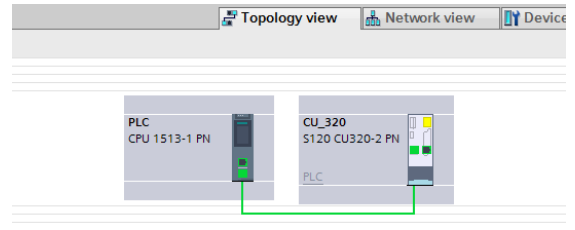
## 2.3 Configuring the hardware
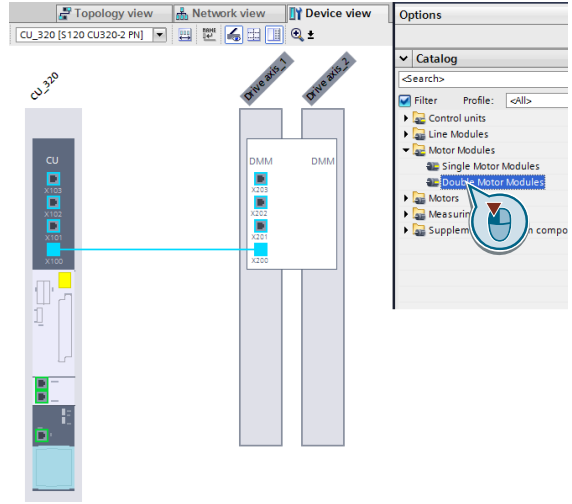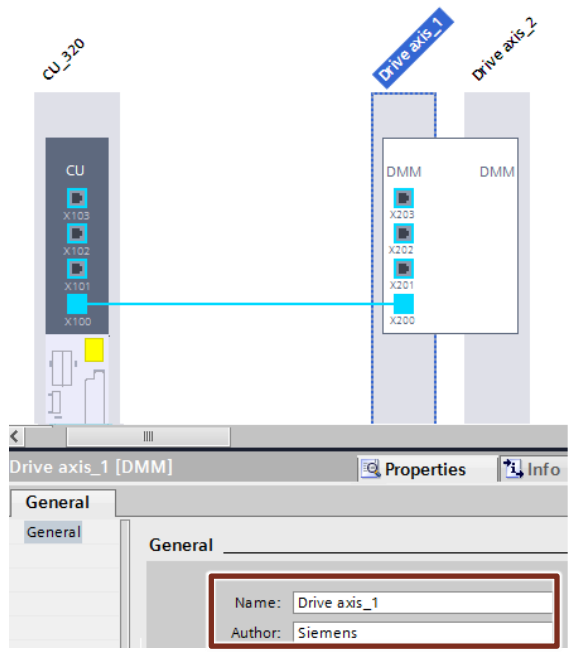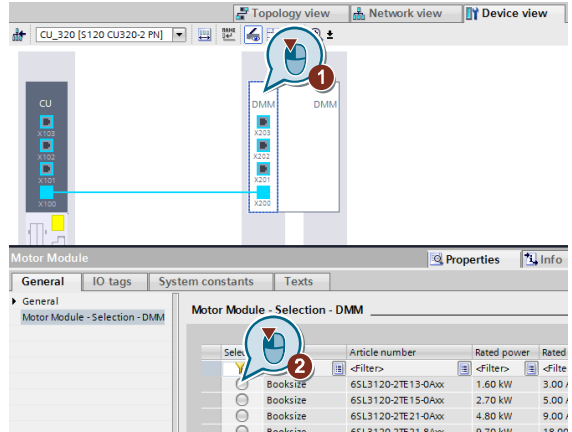
The following tables describe the steps for configuring the SIMATIC S7 CPU and the SINAMICS S120 drive. This requires that you have installed the software on your PG/PC as described in Table 1-1.
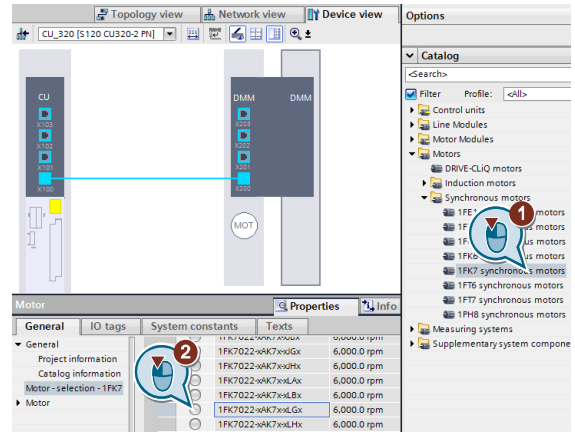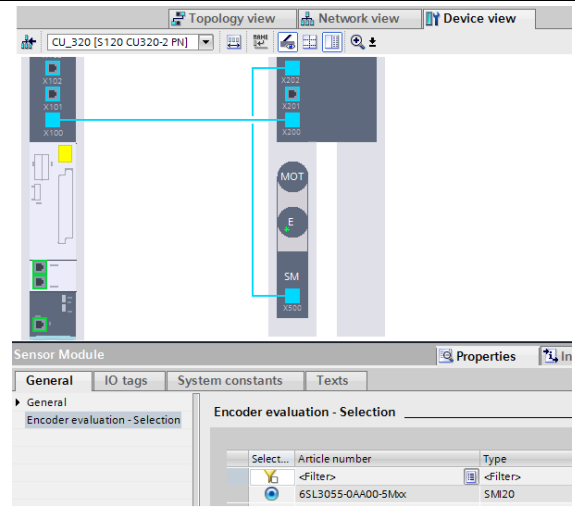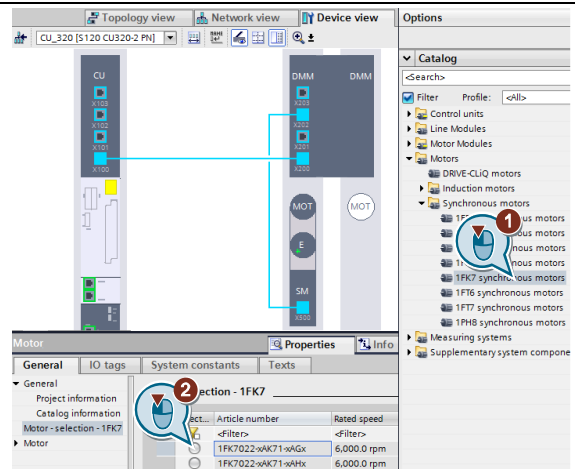
### 2.3.1 Configuring controller and drive
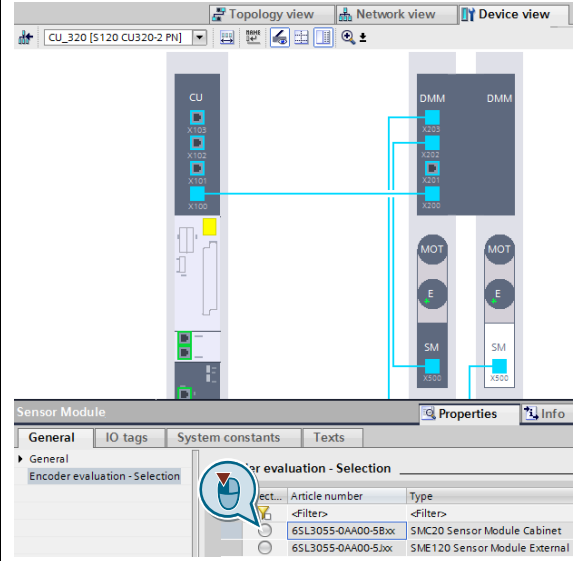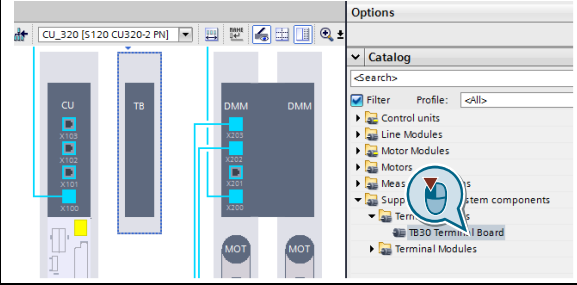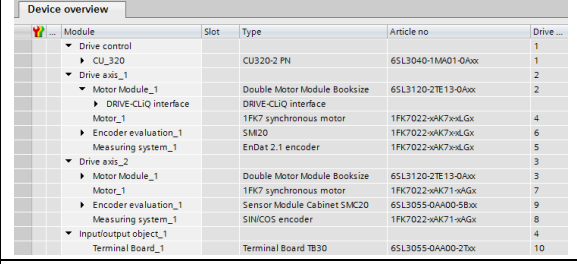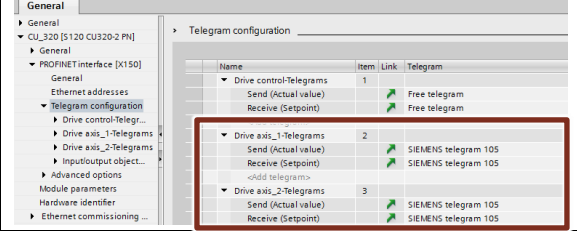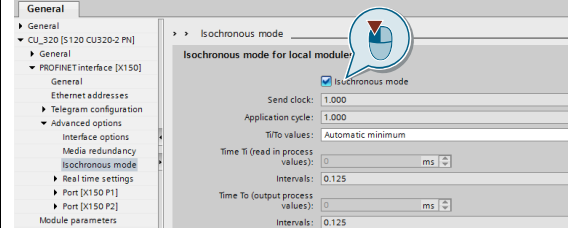
Table 2-2: Configuring controller and drive

| No. | Action | Comment |
|---|---|---|
| 1. | Open TIA Portal and create a new project. |  |
| 2. | Double-click "Add new device". |  |
| 3. | Insert your desired controller:<br>1. Select "Controller".<br>2. Select the desired CPU.<br>3. Then click "OK". |  |

| No. | Action | Comment |
|---|---|---|
| 4. | Open the "Network view" and insert a new subnet. In the controller "Properties", set the desired network address. |  |
| 5. | Add the SINAMICS S120 CU320-2 PN and connect it to the SIMATIC controller. |  |
| 6. | 1. Select the assignment option of the SINAMICS S120.<br>2. Assign the drive to the controller you are using. |  |
| 7. | Open the topology view and connect Port_2 [X1.P2] of the SIMATIC controller to Port_1 [X1.P1] of the SINAMICS S120. |  |

| No. | Action | Comment |
|---|---|---|
| 8. | In the "Device view", configure the SINAMICS S120. Insert a "double motor module" into the device view.<br><br>(The infeed of the SINAMICS S120 used in this application example does not have a DRIVE-CLIQ interface. Consequently, the infeed is not configured at this point. |  |
| 9. | In the motor module properties, you can change the motor module name. |  |
| 10. | 1. In the Device view, select the motor module.<br>2. In the double motor module properties, select the module you are using. |  |

| No. | Action | Comment |
|---|---|---|
| 11. | 1. From the catalog, insert a 1FK7 synchronous motor into the first motor module.<br>2. In the motor properties, select the module you are using. |  |
| 12. | Leave the SMI20 signal module unchanged. |  |
| 13. | 1. From the catalog, insert another 1FK7 synchronous motor into the second motor module.<br>2. In the motor properties, select the module you are using. |  |

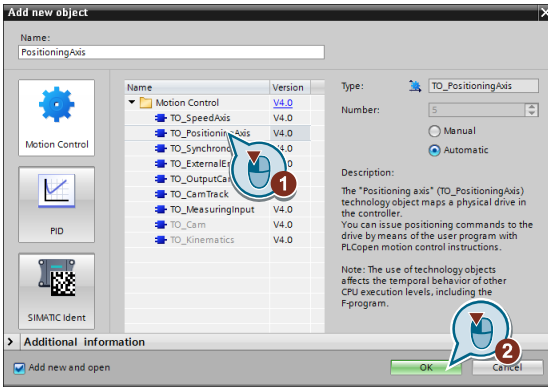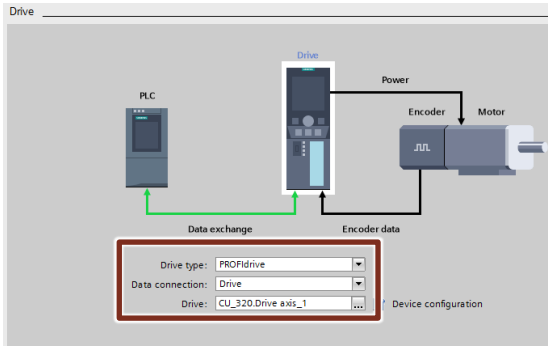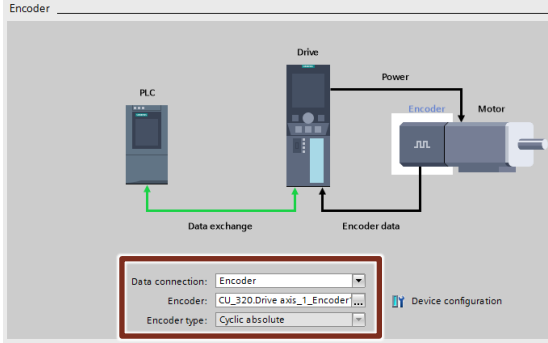| No. | Action | Comment |
|---|---|---|
| 14. | As the signal module in the second motor module, select the SMC20. |  |
| 15. | Insert the TB30 Terminal Module into the Device view and finally check the DRIVE-CLiQ connections. |  |
| 16. | The "Device overview" lists the components used. |  |
| 17. | In the "Device view", select the CU_320-2 PN. In "Telegram configuration", set SIEMENS telegram 105 for the motor modules. |  |
| 18. | Enable "Isochronous mode" in "Advanced options" - "Isochronous mode". |  |

| No. | Action | Comment |
|---|---|---|
| 19. | In the "Parameter view", you can access parameters of the drive. |  |
| 20. | Save the configuration. | - |

### 2.3.2 Configuring the technology objects
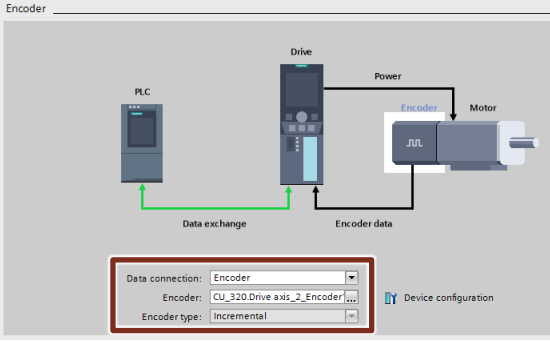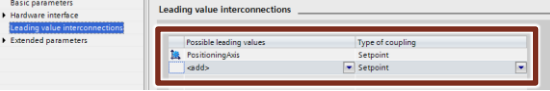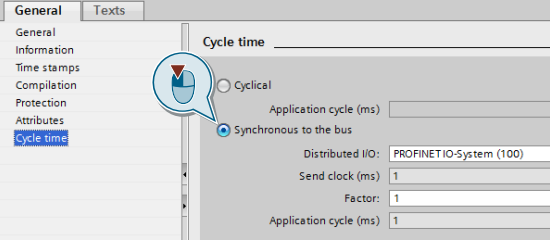
Two technology objects are configured for this application example.

1. One "positioning axis" for operation as the master axis.
2. One "synchronous axis" for operation as a slave axis.

Table 2-3: Configuring the technology object

| No. | Action | Comment |
|---|---|---|
| 1. | Insert the "Positioning Axis" technology object ("TO_PositioningAxis") for the master axis into the control project.<br>1. Select the "Positioning Axis" technology object.<br>2. Then click "OK". |  |
| 2. | In "Hardware interface", "Drive", "Drive type", select PROFIdrive. In "Drive", select the desired motor module of the SINAMICS S120. |  |
| 3. | In "Hardware interface", "Encoder", "Encoder", select the desired encoder module of the SINAMICS S120. In addition, enter the encoder type you are using. |  |

| No. | Action | Comment |
|---|---|---|
| 4. | In "Data exchange with the drive", "Drive telegram", enter telegram 105. Check "Automatically apply drive values at runtime (online)". |  |
| 5. | In "Data exchange with encoder", "Encoder telegram", enter telegram 105. Check "Automatic data exchange for encoder values (online)". |  |
| 6. | Insert the "Synchronous Axis" technology object ("TO_SynchronousAxis") for the slave axis into the control project.<br>1. Select the "Synchronous Axis" technology object.<br>2. Then click "OK". |  |
| 7. | In "Hardware interface", "Drive", "Drive type", select PROFIdrive. In "Drive", select the desired motor module of the SINAMICS S120. |  |

| No. | Action | Comment |
|---|---|---|
| 8. | In "Hardware interface", "Encoder", "Encoder", select the desired encoder module of the SINAMICS S120. In addition, enter the encoder type you are using. |  |
| 9. | In "Data exchange with the drive/encoder", select telegram 105 (see steps 4 and 5). | - |
| 10. | In "Leading value interconnections" add "PositioningAxis" to the list of possible leading values |  |
| 11. | Open the settings of the organization block "MC-Servo" and set the application cycle in "Cycle time" to "Synchronous to the bus". |  |
| 12. | Save the configuration. | - |
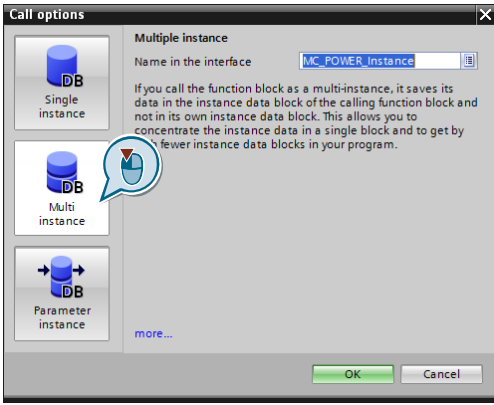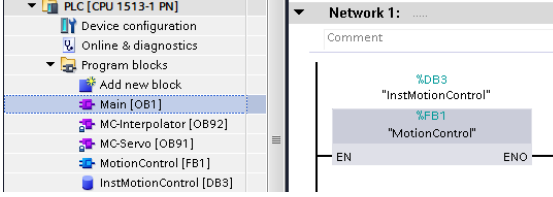
### 2.3.3 Creating the S7 program

Chapter 2.1 shows the structure of the user program and the motion control instructions used. The following table shows how to create these programs.

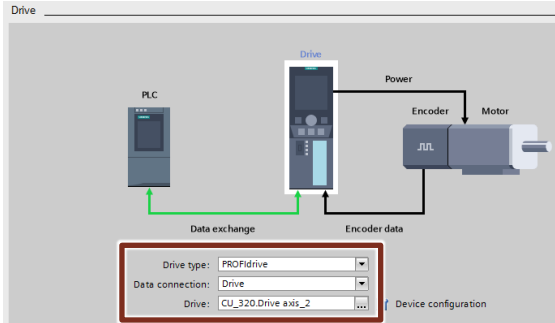| Note | Perform the steps in the following table for each drive object (master and slave axis). |
|------|------------------------------------------------------------------------------------------|

Table 2-4: Creating the S7 program

| No. | Action | Comment |
|-----|--------|---------|
| 1. | Insert a function block into the program.<br>1. Select the "function block".<br>2. Set the desired address and programming language of the block.<br>3. Select "OK" to confirm. |  |
| 2. | In "Instructions", open the "Motion Control" folder. |  |
| 3. | From the "Motion Control" folder, insert the desired instructions into the function block created in step 1 of this table. |  |

| No. | Action | Comment |
|---|---|---|
| 4. | When inserting the motion control instructions, use the multi-instance option.<br><br>Advantages of the multi-instance option:<br>• Lower number of instance DBs<br>• Easy programming of local subprograms<br>• Good structuring option for complex blocks |  |
| 5. | Call the function block with the motion control instructions in the OB1 organization block. |  |
| 6. | Save the configuration. | - |

## 2.4     Installation and startup

### 2.4.1     IP addresses and device names

Table 2-5: IP addresses and device names

| Components | Device name | IP addresses |
|---|---|---|
| SIMATIC S7 1513-1 PN | PLC | 192.168.0.1 |
| SINAMICS S120 CU320-2 PN | Drive | 192.168.0.10 |
| PG/PC | - | 192.168.0.200 |

The network mask is always 255.255.255.0 and no router is used.

### 2.4.2     Settings on the PG/PC

To connect the components of the application example to your development system (PG/PC), assign a static IP address to the PG/PC's network card.
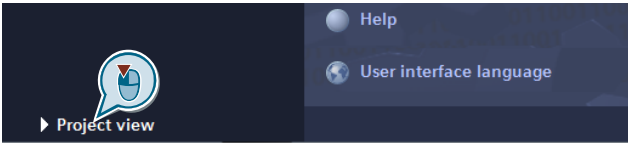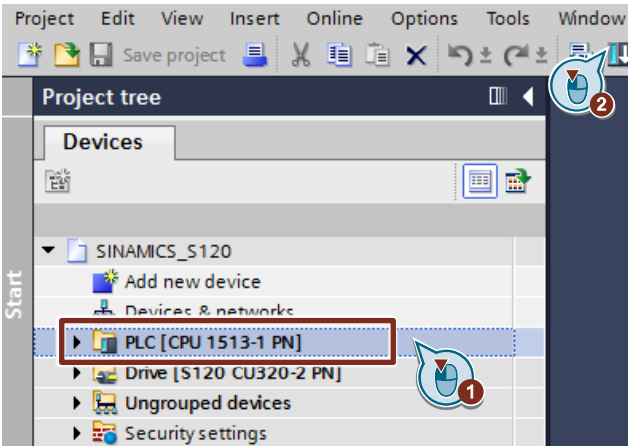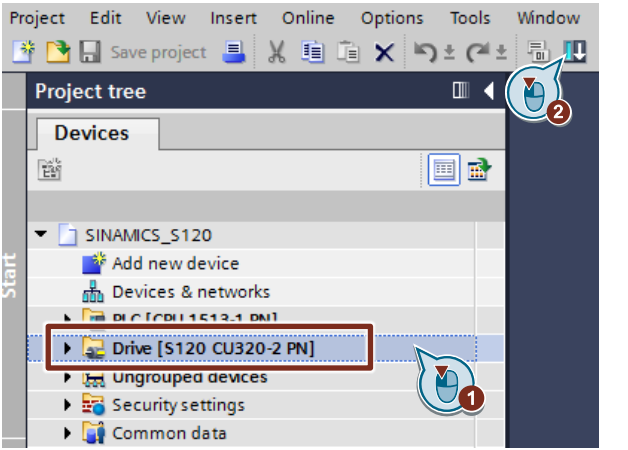
Figure 2-6: Network card settings
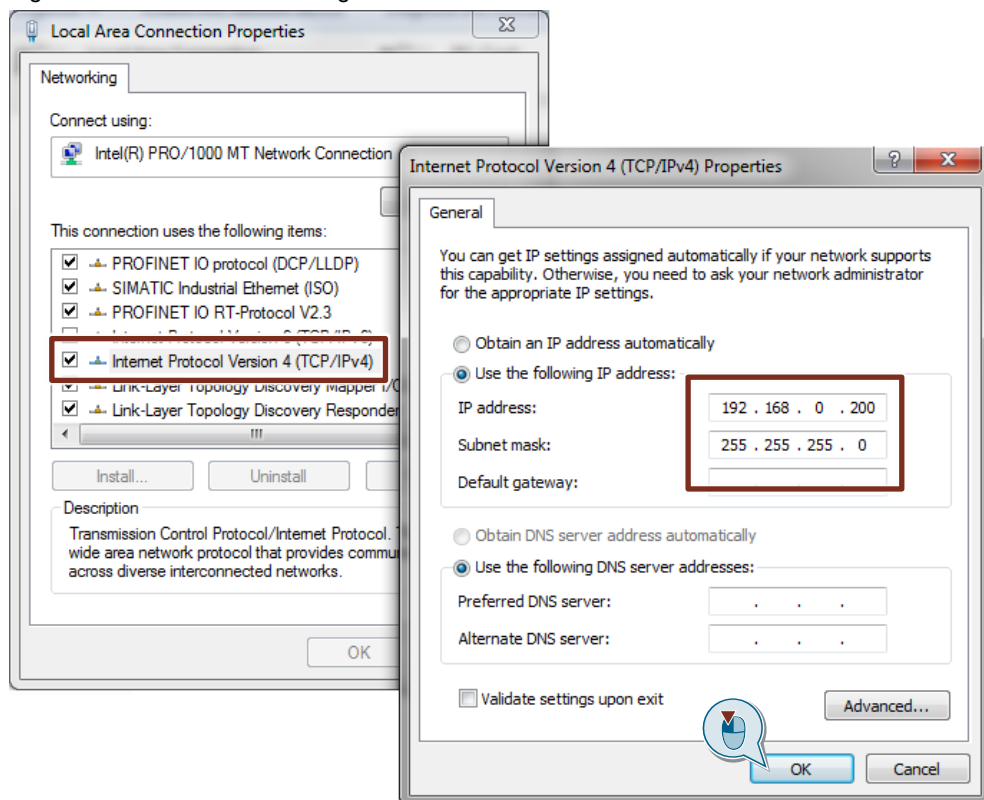


These settings ensure that the components of the application example are reachable.

### 2.4.3 Downloading the project to the components

Table 2-6: Downloading to the components

| No. | Action | Comment |
|---|---|---|
| 1. | Unzip the "109743270_SINAMICS_S120_TIA_PROJ_v10.zip" file to a local directory. | - |
| 2. | Double-click the ap15 file in the project folder you have just unzipped to open the project in TIA Portal. | - |
| 3. | If TIA Portal opens in the Portal view, go to the bottom left to select the "Project view". |  |
| 4. | Download the SIMATIC controller program: <br> 1. In the project tree, select the S7 controller. <br> 2. Download the project to the controller. |  |
| 5. | Download the configuration of the SINAMICS drive: <br> 1. In the project tree, select the drive. <br> 2. Download the project to the drive. |  |

## 2.5 Operation

There are three options to operate the drive:

- The drive's control panel in Startdrive.
- The axis control panel in the technology object.
- A watch table in the control program.

### 2.5.1 Drive control panel

If you do not transfer the control program, you can operate the drive using a control panel in the Startdrive configuration.

Figure 2-7: Opening the drive control panel
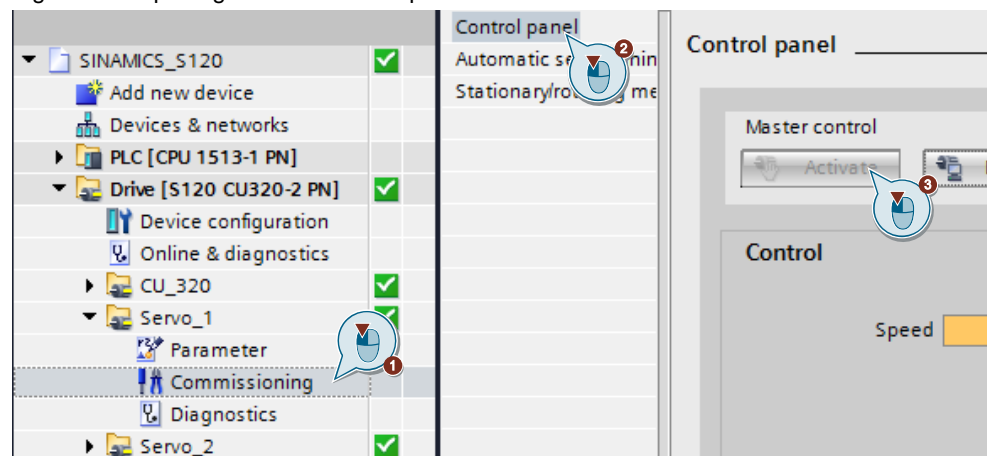


The control panel in Startdrive provides you with the option to operate the drive at a specified speed. It displays status messages and actual values of the drive. In addition, the control panel is where you acknowledge active fault messages.

Figure 2-8: Drive control panel
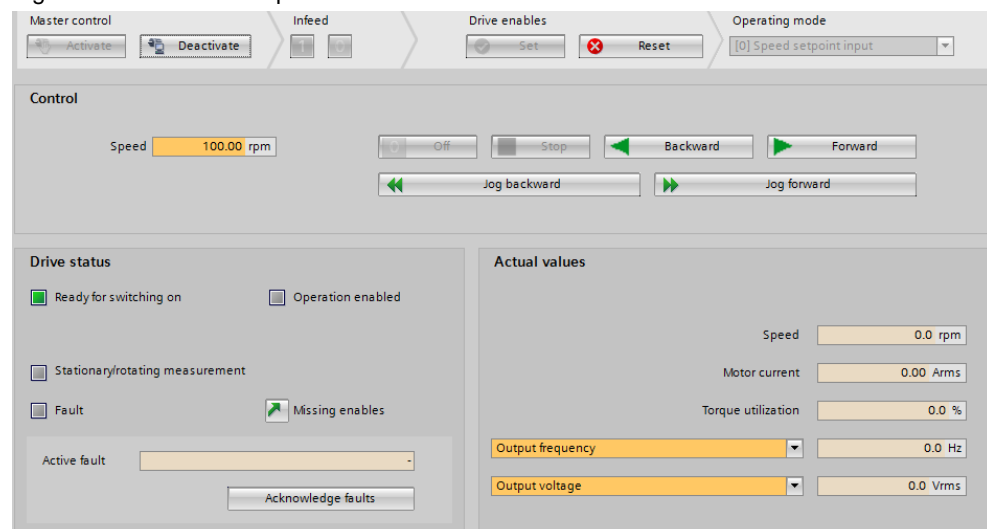
## 2.5.2 Axis control panel

When you have transferred the control program, the technology object's axis control panel is available to you. It is located in the "Commissioning" folder of the technology object.

Figure 2-9: Opening the axis control panel
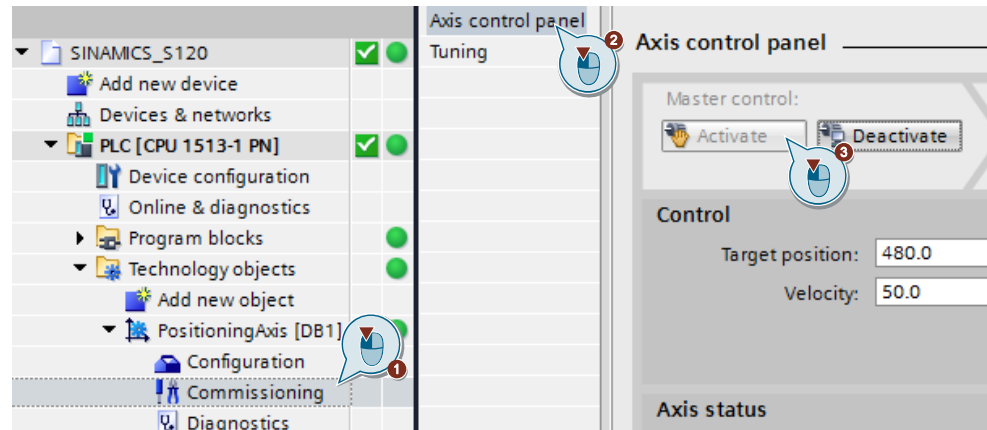


The axis control panel offers the following "operating modes":

- Homing
- Set home position
- Jog
- Velocity specification/speed setpoint
- Positioning relative and positioning absolute

Figure 2-10: Axis control panel of the technology object
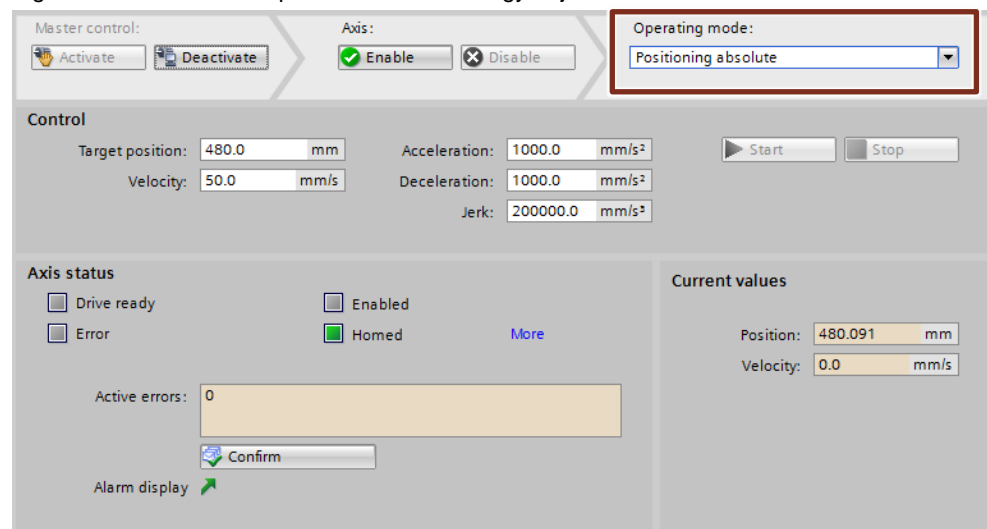


| Note | For information on how to use the axis control panel, refer to the "SIMATIC S7-1500 Motion Control in TIA Portal" Function Manual, \3\. |
| --- | --- |
| | https://support.industry.siemens.com/cs/ww/en/view/109749262 |

### 2.5.3 Watch tables

You use the watch tables to operate the motion control blocks. These blocks allow you to position the master axis. In addition, you can synchronize the slave axis with the master axis.

Establish an online connection to the SIMATIC controller and open a watch table.

Figure 2-11: Watch tables for using the technology objects
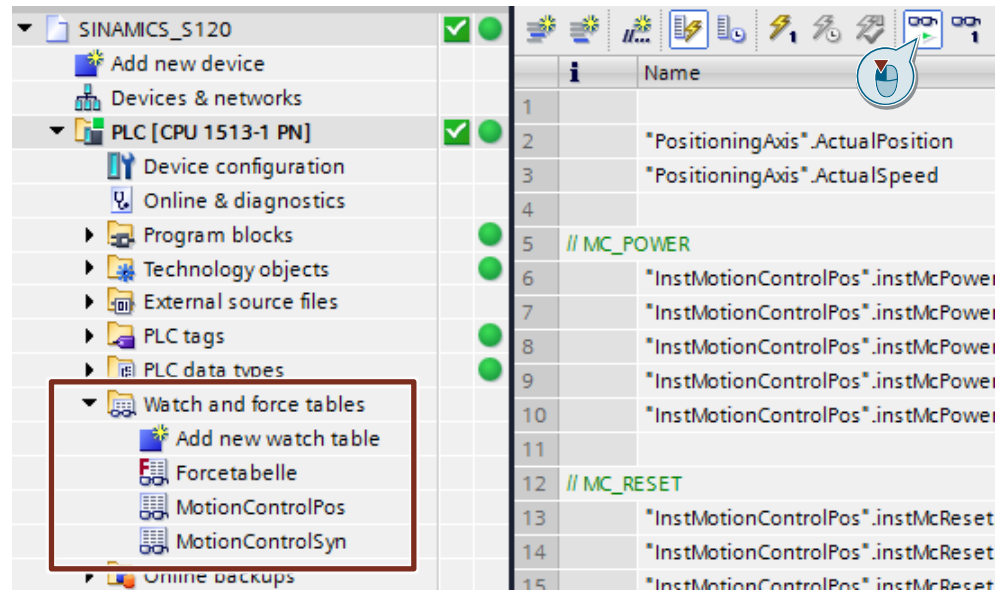


The "MotionControlSyn" watch table is used to control the slave axis. Using the "MC_GEARIN" motion control instruction, it can be synchronized with the master axis.

Figure 2-12: "MotionControlSyn" watch table

The "MotionControlPos" watch table is used to control the master axis configured as a "positioning axis". Move this axis using the "MC_MOVEABSOLUTE" absolute positioning command or the "MC_MOVEJOG" JOG function.

Figure 2-13: "MotionControlPos" watch table

| | i | Name | Display format | Monitor value | Modify value |
|---|---|---|---|---|---|
| 1 | | | | | |
| 2 | | "PositioningAxis".ActualPosition | Floating-point number | 96.103 | |
| 3 | | "PositioningAxis".ActualSpeed | Floating-point number | 119.433391839266 | |
| 4 | | | | | |
| 5 | | // MC_POWER | | | |
| 6 | | "InstMotionControlPos".instMcPower.Enable | Bool | ☑ TRUE | TRUE |
| 7 | | "InstMotionControlPos".instMcPower.Status | Bool | ☑ TRUE | |
| 8 | | "InstMotionControlPos".instMcPower.Busy | Bool | ☑ TRUE | |
| 9 | | "InstMotionControlPos".instMcPower.Error | Bool | ☐ FALSE | |
| 10 | | "InstMotionControlPos".instMcPower.ErrorId | Hex | 16#0000 | |
| 11 | | | | | |
| 12 | | // MC_RESET | | | |
| 13 | | "InstMotionControlPos".instMcReset.Execute | Bool | ☐ FALSE | FALSE |
| 14 | | "InstMotionControlPos".instMcReset.Done | Bool | ☐ FALSE | |
| 15 | | "InstMotionControlPos".instMcReset.Busy | Bool | ☐ FALSE | |
| 16 | | "InstMotionControlPos".instMcReset.Error | Bool | ☐ FALSE | |
| 17 | | "InstMotionControlPos".instMcReset.ErrorId | Hex | 16#0000 | |
| 18 | | | | | |
| 19 | | // MC_HOME | | | |
| 20 | | "InstMotionControlPos".instMcHome.Execute | Bool | ☐ FALSE | FALSE |
| 21 | | "InstMotionControlPos".instMcHome.Position | Floating-point number | 0.0 | |
| 22 | | "InstMotionControlPos".instMcHome.Done | Bool | ☐ FALSE | |
| 23 | | "InstMotionControlPos".instMcHome.Busy | Bool | ☐ FALSE | |
| 24 | | "InstMotionControlPos".instMcHome.Error | Bool | ☐ FALSE | |
| 25 | | "InstMotionControlPos".instMcHome.ErrorId | Hex | 16#0000 | |
| 26 | | | | | |
| 27 | | // MC_MOVEABSOLUTE | | | |
| 28 | | "InstMotionControlPos".instMcMoveAbsolute.Execute | Bool | ☑ TRUE | TRUE |
| 29 | | "InstMotionControlPos".instMcMoveAbsolute.Position | Floating-point number | 400.0 | 400.0 |
| 30 | | "InstMotionControlPos".instMcMoveAbsolute.Velocity | Floating-point number | 20.0 | 20.0 |
| 31 | | "InstMotionControlPos".instMcMoveAbsolute.Done | Bool | ☐ FALSE | |
| 32 | | "InstMotionControlPos".instMcMoveAbsolute.Busy | Bool | ☑ TRUE | |
| 33 | | "InstMotionControlPos".instMcMoveAbsolute.Error | Bool | ☐ FALSE | |
| 34 | | "InstMotionControlPos".instMcMoveAbsolute.ErrorId | Hex | 16#0000 | |
| 35 | | | | | |
| 36 | | // MC_MOVEJOG | | | |
| 37 | | "InstMotionControlPos".instMcJog.JogBackward | Bool | ☐ FALSE | FALSE |
| 38 | | "InstMotionControlPos".instMcJog.JogForward | Bool | ☐ FALSE | FALSE |
| 39 | | "InstMotionControlPos".instMcJog.Velocity | Floating-point number | 30.0 | 30.0 |
| 40 | | "InstMotionControlPos".instMcJog.Error | Bool | ☐ FALSE | |
| 41 | | "InstMotionControlPos".instMcJog.ErrorId | Hex | 16#0000 | |

The watch tables also show the current position and velocity of the axis.

| Note | For information about the motion control blocks, refer to the TIA Portal Online Help and the "S7-1500 Motion Control in TIA Portal" Function Manual \3\. <br><br> https://support.industry.siemens.com/cs/ww/en/view/109749262 |
|---|---|

# 3 Appendix

## 3.1 Service and support

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