

CPX-AP-.-PN with Siemens PLC through PROFINET

This Application Note gives a step by step description of how to integrate CPX-AP-I-PN and CPX-AP-A-PN with Siemens PLC in TIA Portal programming environment.

This library is intended for common use of CPX-AP-I-PN and CPX-AP-A-PN.

CPX-AP-I-PN
CPX-AP-A-PN

Title CPX-AP-.PN with Siemens PLC through PROFINET
Version 1.60
Document no. 100332
Originalen
AuthorFesto

Last saved 29.10.2025

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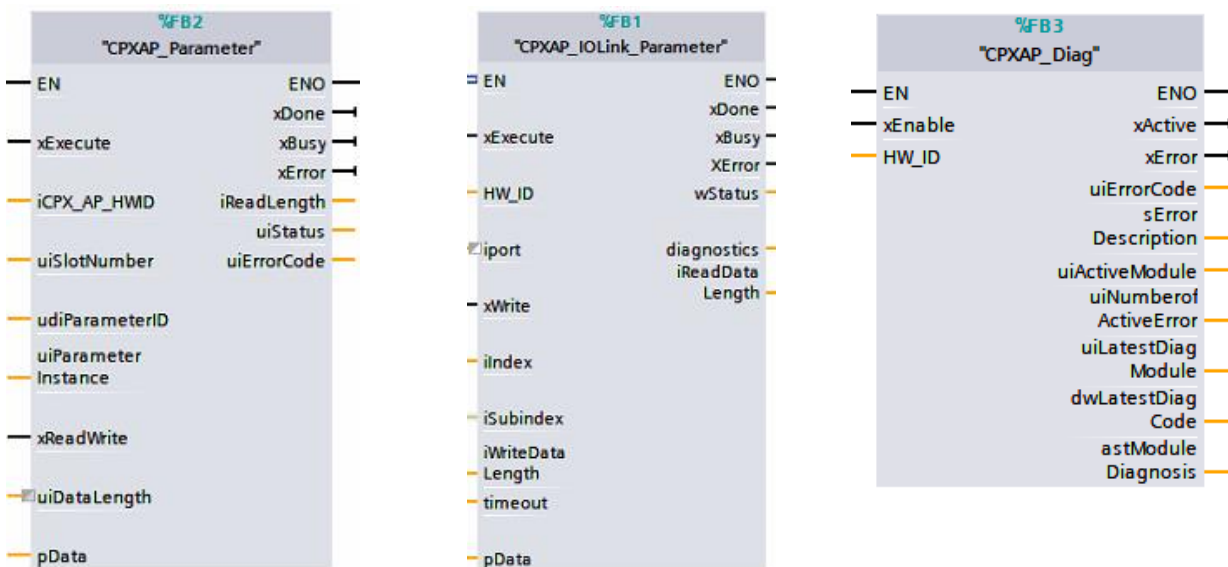
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1 Introduction

This application note demonstrate the communication between **CPX-AP-.PN** interface module and a Siemens PLC through **PROFINET** predefined protocol.

The **CPX-AP_Festo_Lib** library contains three function blocks, each designed for specific functions:

- The **CPXAP_Parameter** block is used to read and write parameters in CPX-AP expansion modules.
- The **CPXAP_IOLink_Parameter** block is used to read and write parameters in IO-Link devices connected to the CPX-AP IO-Link Master module.
- The **CPXAP_Diag** block continuously reads status and error information from connected modules and detects fault diagnostics.



1.1 Software Used

Software Name	Software Version
TIA Portal	V14 (Above)
CPX-AP-I-PN / CPX-AP-A-PN GSDML File	GSDML V2.35 / V2.44
CPX-AP_Festo_Lib_V1.6	V1.6

Table 1.1: Software used

1.2 Hardware Used

Device Name	Device Type	Version / Firmware
Siemens S7 PLC	S7-1200/S7-1500	V2.0
CPX-AP Head Module	CPX-AP-I-PN-M12/CPX-AP-A-PN-M12	V1.5.8 and Above
Ethernet Cables	-	Version Free

Table 1.2: Hardware used

**Note****AP system communication cable**

When connecting the NEBC-D8G4 cable for the AP system communication, it is recommended to use the tool. Unreliable connections can affect communication.

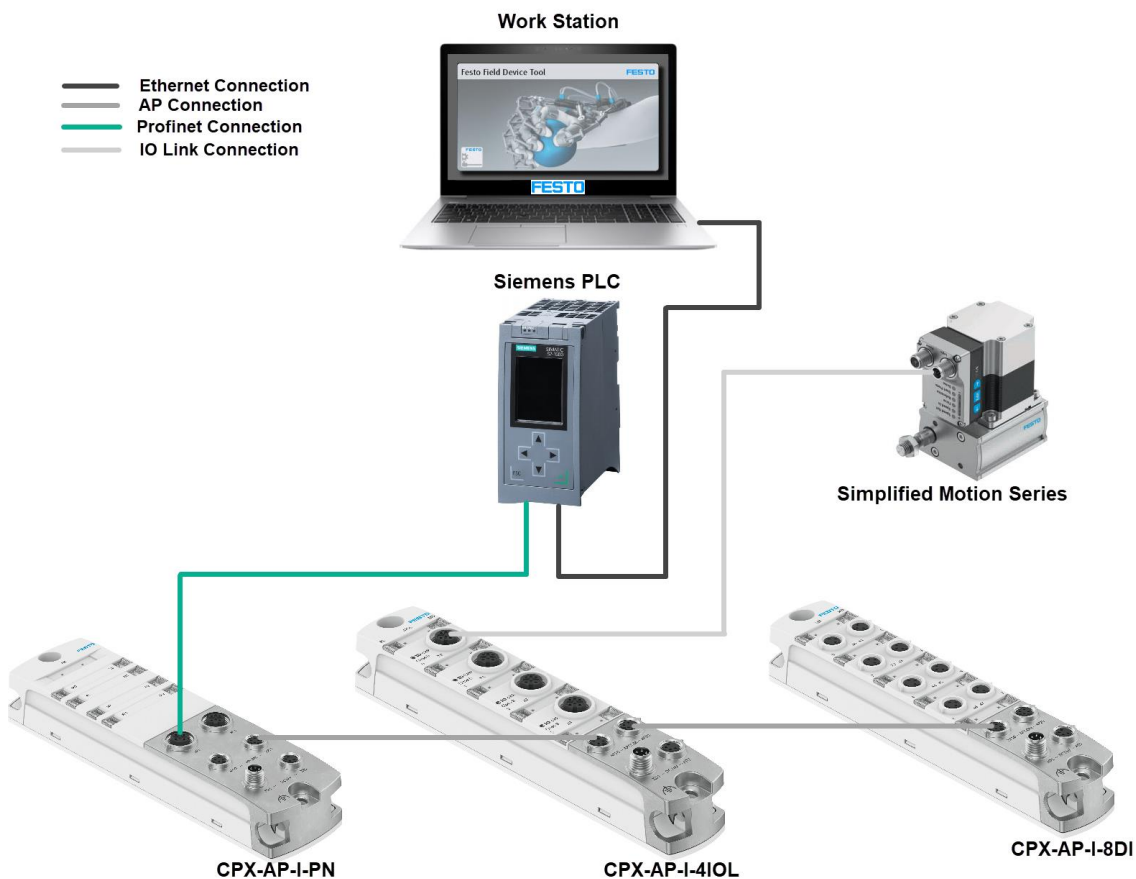
- SAC BIT M8-D10



- The tool can be bought at Phoenix Contact (Article No. 1208461)

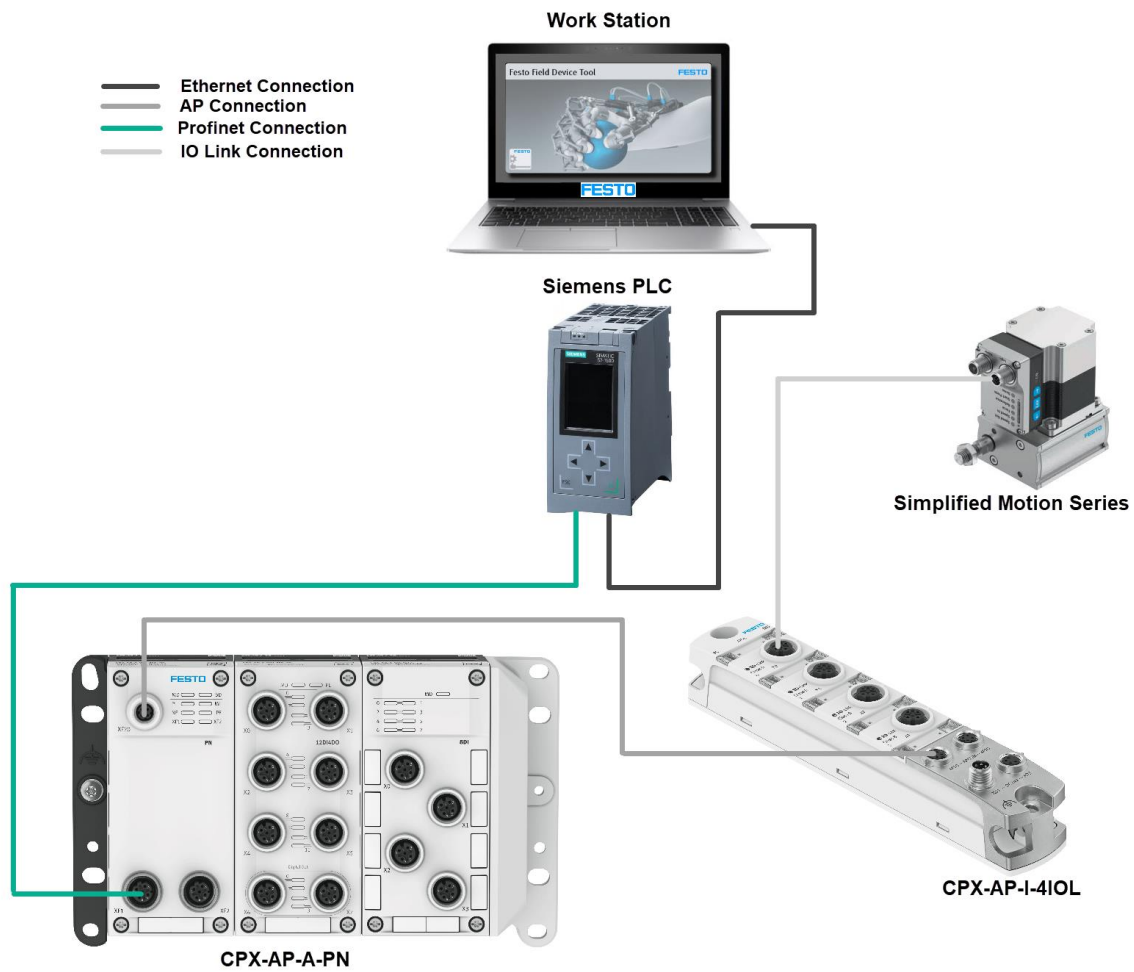
1.3 Topology Overview

1.3.1 Topology Overview of CPX-AP-I-PN

**Note**

- Above network configuration is an example network for this application note but depends on users network configuration above architecture may change.

1.3.2 Topology Overview of CPX-AP-A-PN

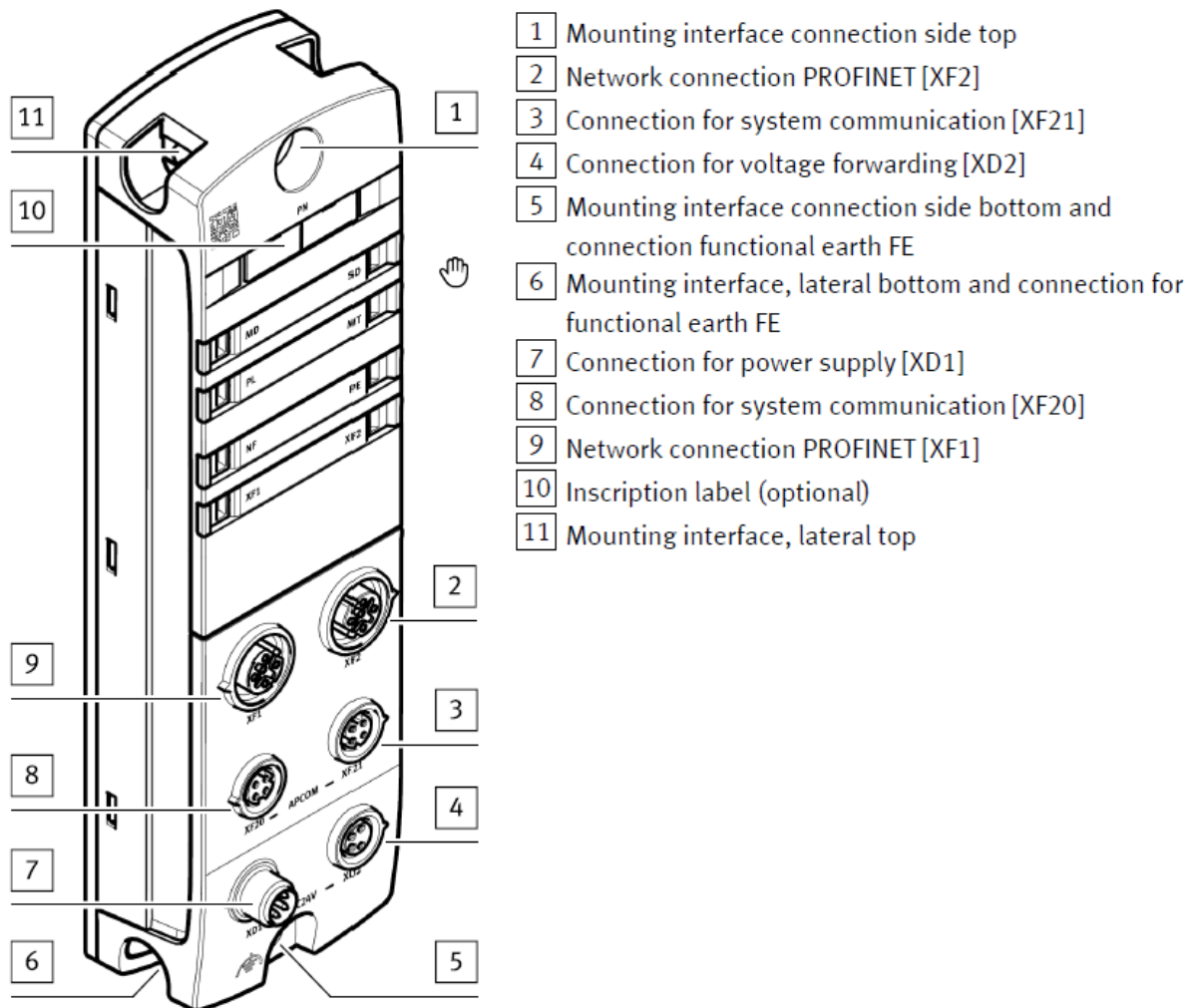


Note

- Above network configuration is an example network for this application note but depends on users network configuration above architecture may change.

2 Hardware Overview

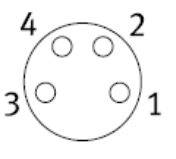
2.1 Hardware Overview of CPX-AP-I-PN

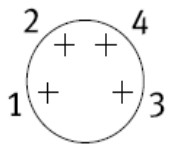


1. The Power Supply connection for XD1 is as shown below.
2. If the NEBU-M8G4 cable is used to supply power to XD1, the connection details will be as shown below.

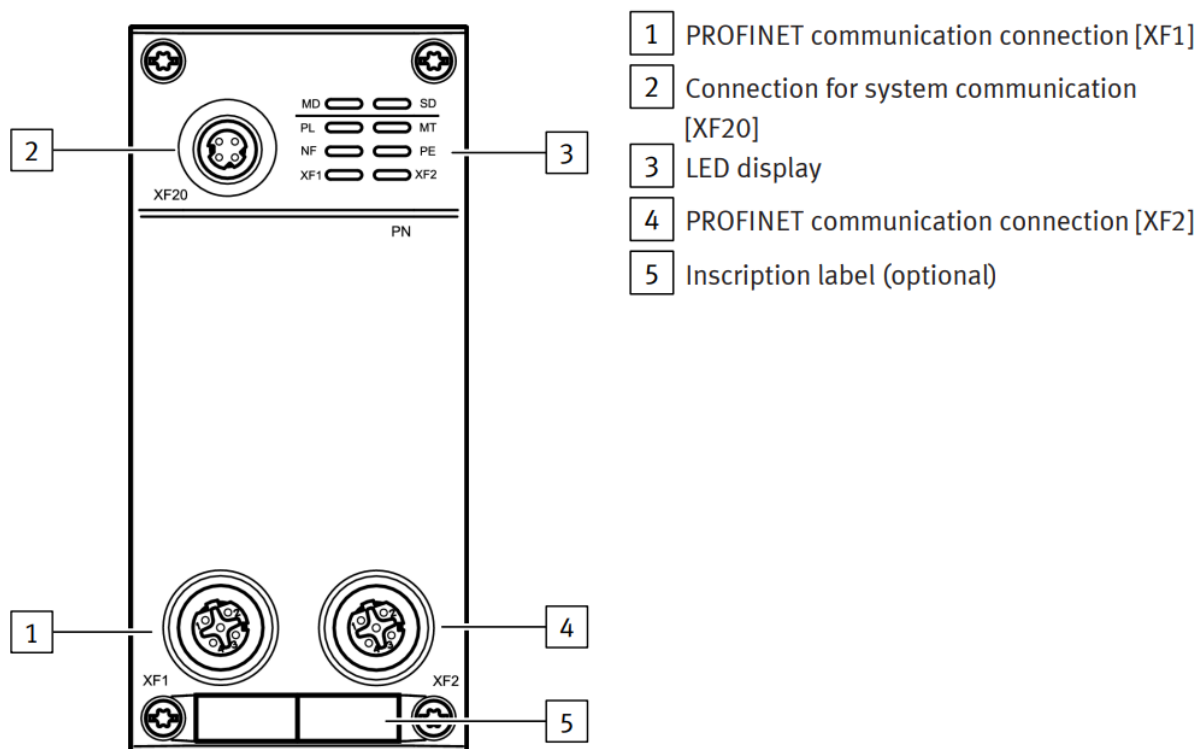
Electrical connection, open cable end, 4-wire – plug, 4-pin				
	1	BN	1	Plug M8
	2	WH	2	
	3	BU	3	
	4	BK	4	

Connection XD2 is used for voltage forwarding to supply power between CPX-AP-I devices.
 The connection details are shown below.

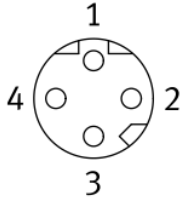
Connection for voltage forwarding [XD2]		
Socket M8, 4-pin, A-coded	Signal	
	1	+24 V DC logic supply PS
	2	0 V DC load supply PL
	3	0 V DC logic supply PS
	4	+24 V DC load supply PL

Connection for power supply [XD1]		
Plug M8, 4-pin, A-coded	Signal	
	1	+24 V DC logic supply PS
	2	0 V DC load supply PL
	3	0 V DC logic supply PS
	4	+24 V DC load supply PL

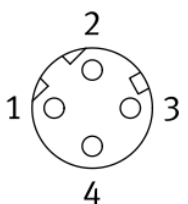
2.2 Hardware Overview of CPX-AP-A-PN



Connection for system communication [XF20]

Socket M8, 4-pin, D-coded		Signal	
	1	RX–	Received data –
	2	TX+	Transmitted data +
	3	RX+	Received data +
	4	TX–	Transmitted data –
	Thread	Shield	Functional earth FE

Connection PROFINET network [XF1], [XF2]

Socket M12, 4-pin, D-coded		Signal	
	1	TD+	Transmitted data +
	2	RD+	Received data +
	3	TD–	Transmitted data –
	4	RD–	Received data –
	Thread	Shield	Functional earth FE

3 Software Configuration

3.1 Creating a New Project and Adding Controller in TIA Portal

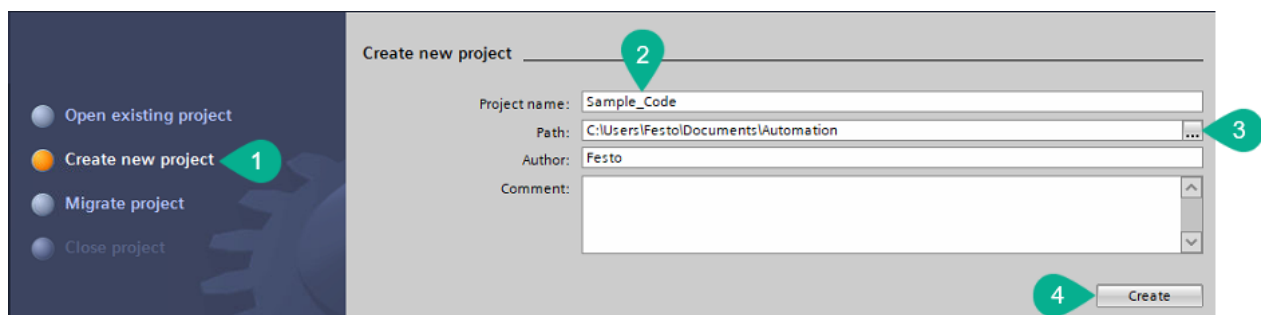
This chapter provides a comprehensive overview of creating a project and the PROFINET configuration process for Siemens.

Step 1



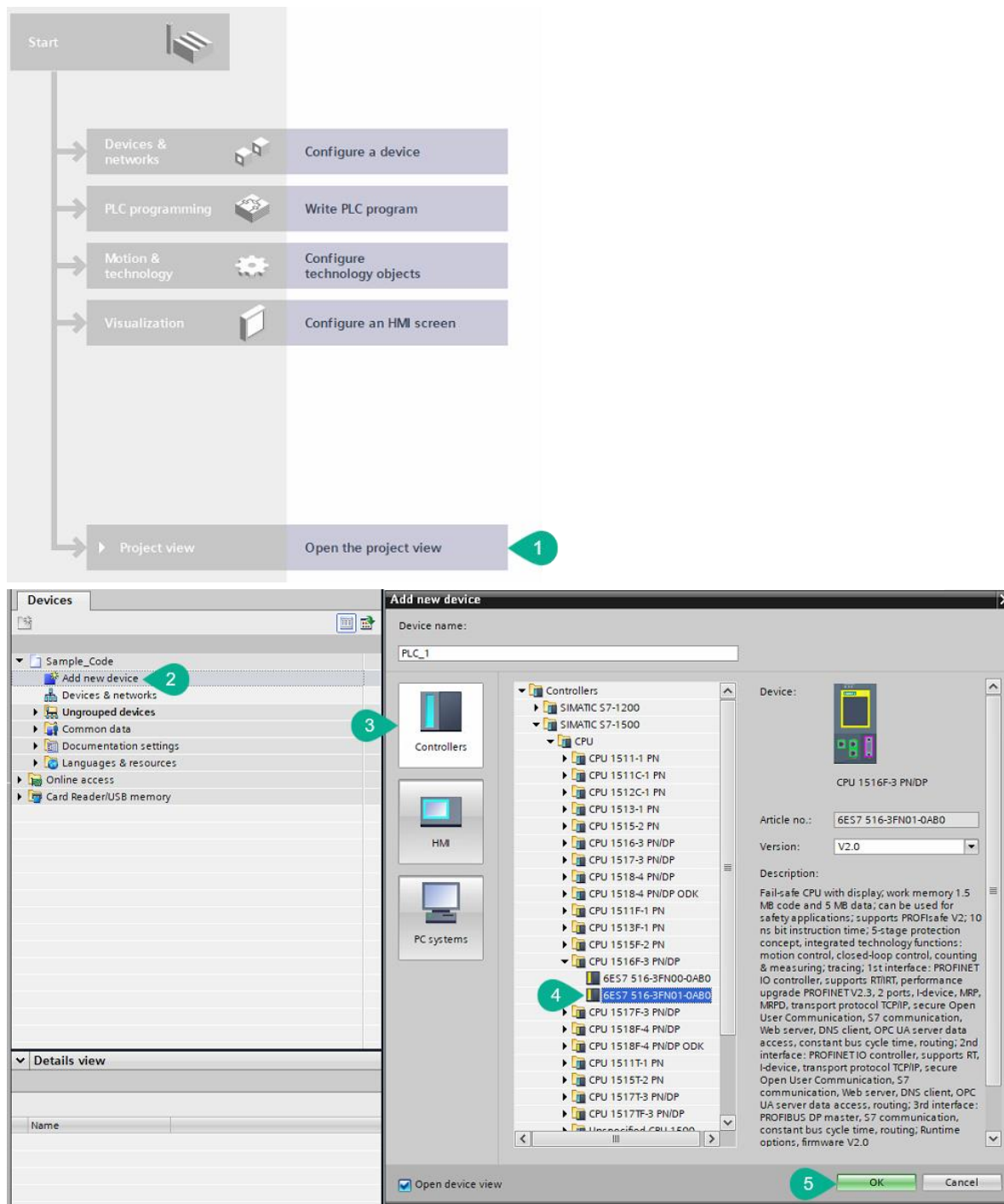
Open the **TIA Portal V14** software (**Windows Start >> Siemens >> TIA Portal V14**).

Step 2



1. Click on **Create new project** option to create a new project.
2. Enter the Project name on the **Project name** field.
3. Select the **Path** where the project has to be saved.
4. Click on **Create** button to create project.

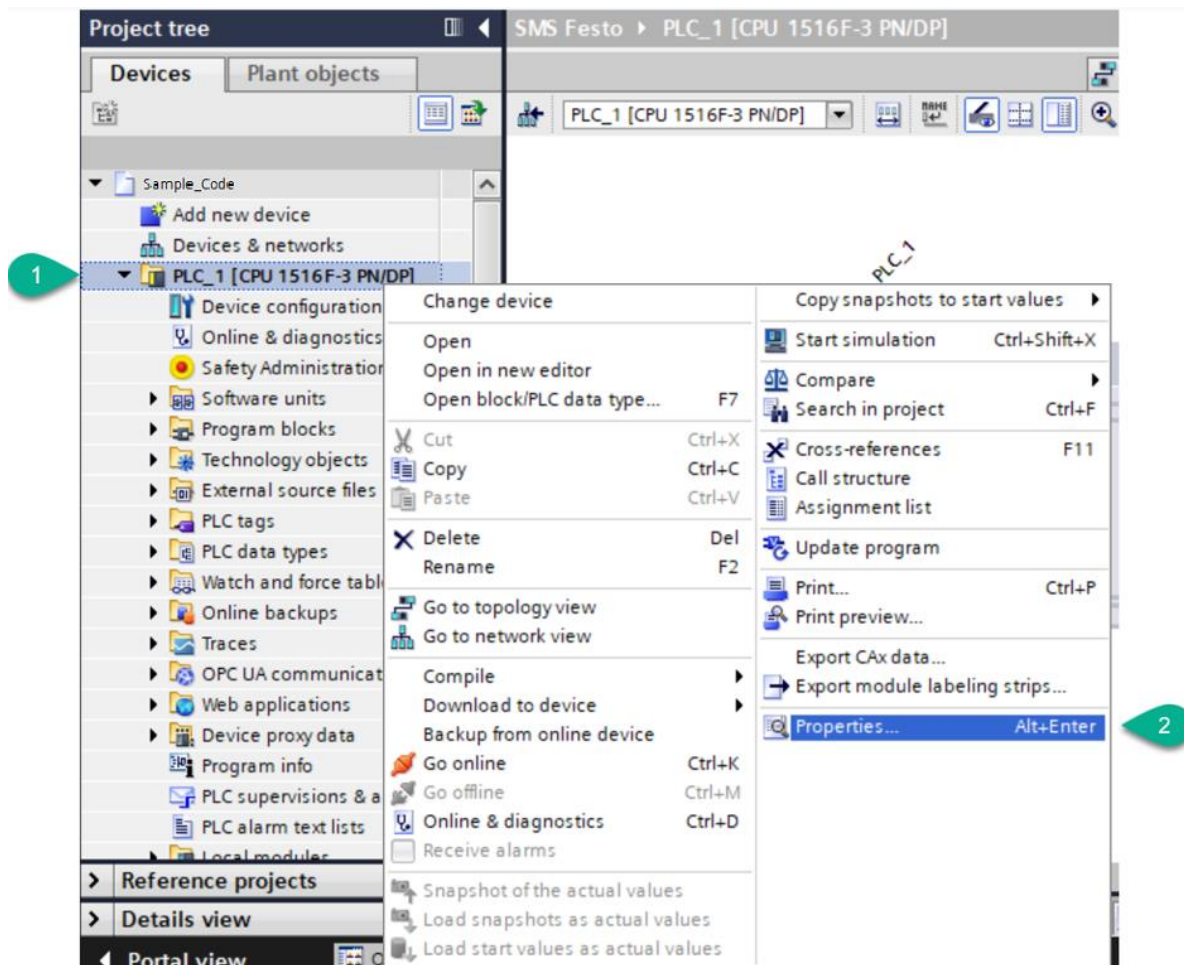
Step 3



1. Click on **Project view** to Open the project view.
2. Double click on **Add New Device** to add a new PLC to the project.
3. Click on **Controllers**, the list of available Controllers will be displayed.
4. Select the required PLC in the list. For this application note, the **CPU 1516F-3 PN/DP** has been selected.
5. Click on **OK** to add the selected PLC to the Project.

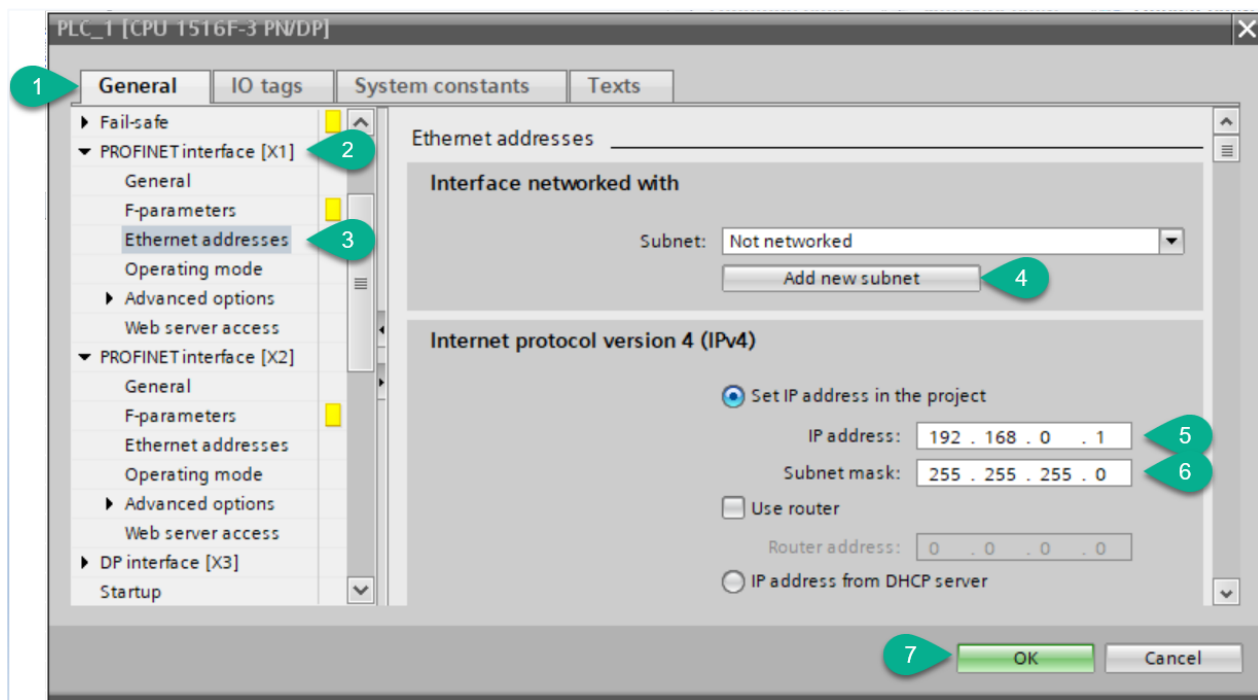
3.2 Configuring the IP Address for PLC

Step 1



1. Right click on **PLC_1** from the Project tree.
2. Click on **Properties** from the right click menu.

The properties tab will be displayed as shown below **Step 2**.

Step 2

1. Select **General** from Properties tab.
2. Click on **PROFINET interface [X1]** to open the drop down.
3. Click on **Ethernet addresses** from PROFINET interface dropdown to change the IP address.
4. Click on **Add new subnet** to add new interface network.
5. Enter the required IP address on the **IP address** field
6. Enter the Subnet mask on the **Subnet mask** field
7. Click on **OK** to confirm the configuration and close the Properties tab.

**Note**

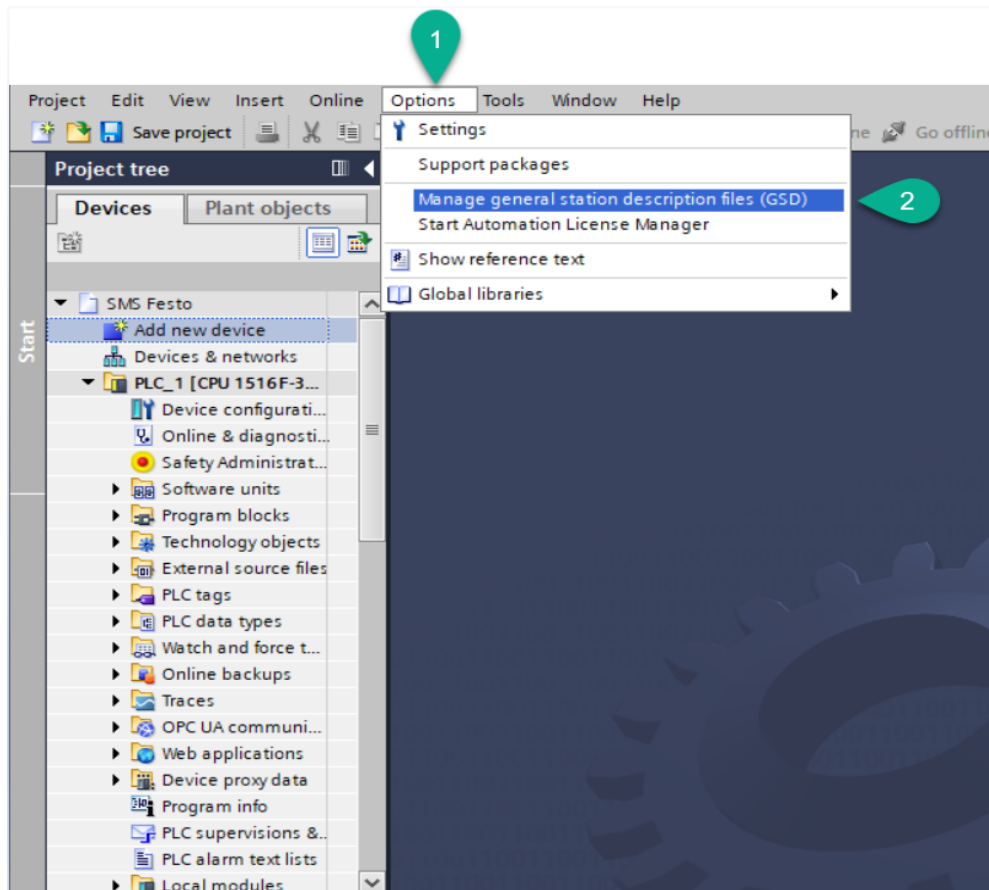
- For this application example, the CPX-AP-.PN is connected to the PROFINET interface [X1].
- If the CPX-AP-.PN is connected to PROFINET interface[X2] , then that port IP address must be in the same range of IP address of CPX-AP-.PN.

3.3 Adding the GSDML File of CPX-AP-.PN to TIA Portal

Step 1

Download the GSDML File for **CPX-AP-.PN** module from the Festo Support Portal. And save the GSDML file in an appropriate folder in your PC.

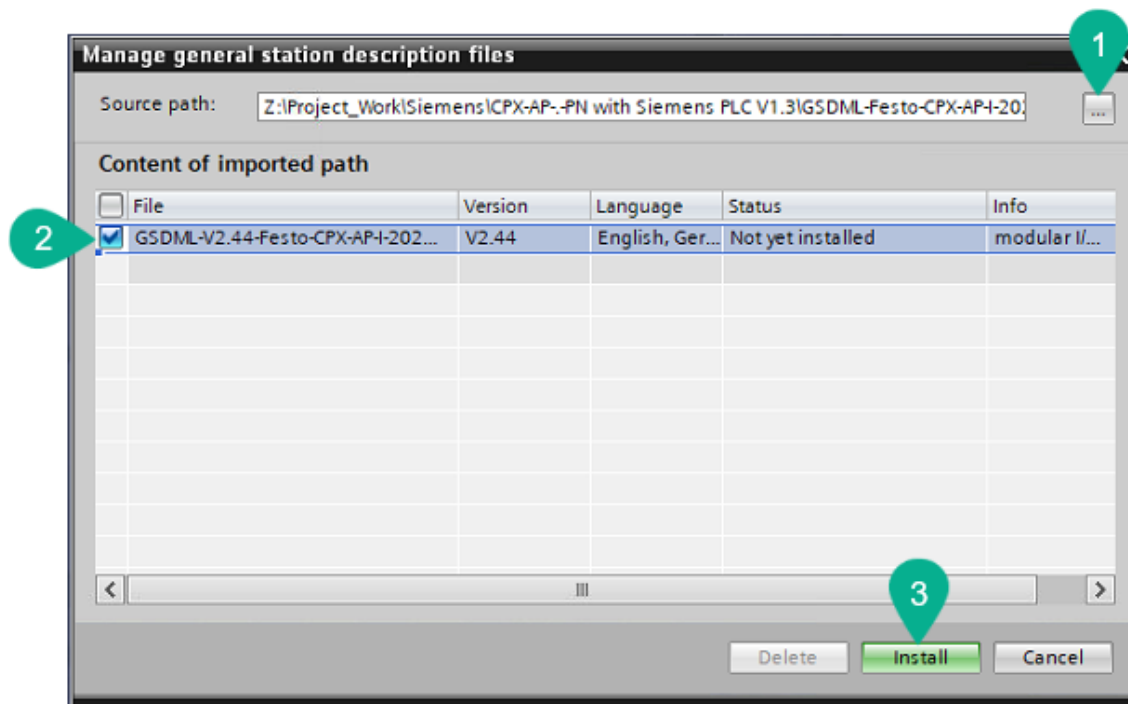
Step 2



1. Click on **Options** menu from the top menu bar.
2. Click on **Manage general station description files(GSD)** from Options menu.

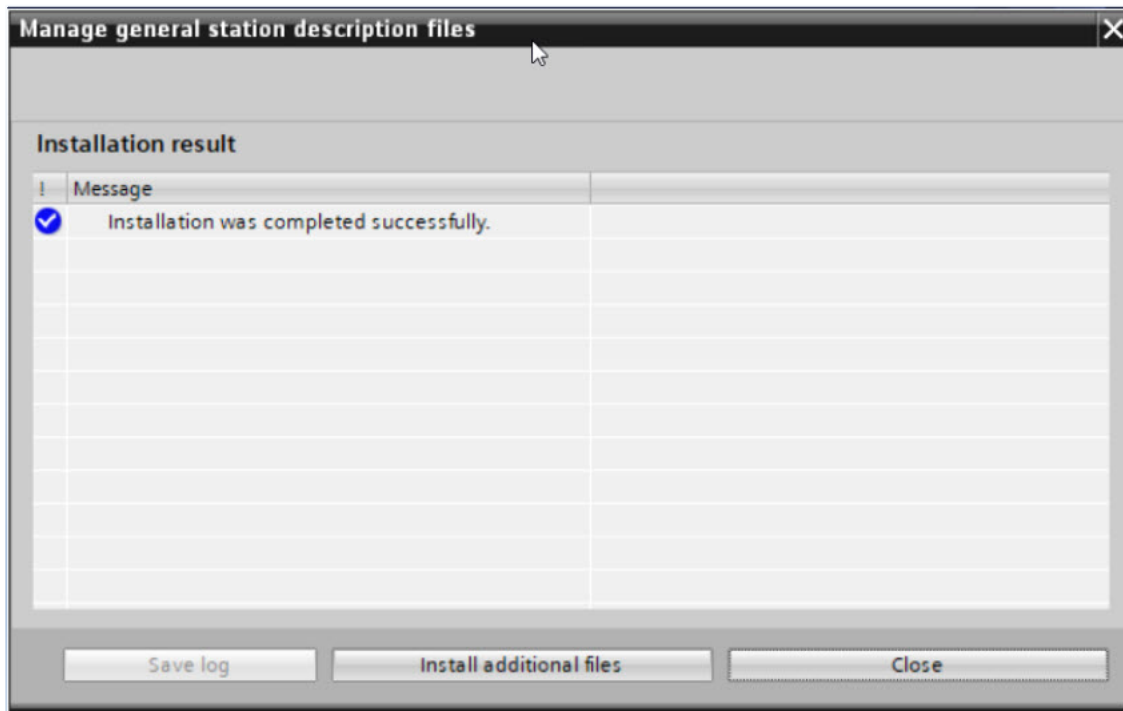
The Manage general station description files tab will be displayed as shown below **Step 3**.

Step 3



1. Select the Path from the **Source path** field, where the GSDML file is saved.
2. Select the GSDML file from the file list.
3. Click on **Install** to add GSD to the project.

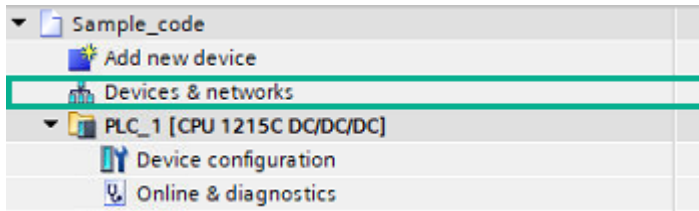
Once the installation is completed, the installation wizard will be shown as below.



3.4 Configuring the CPX-AP-I- PN Module

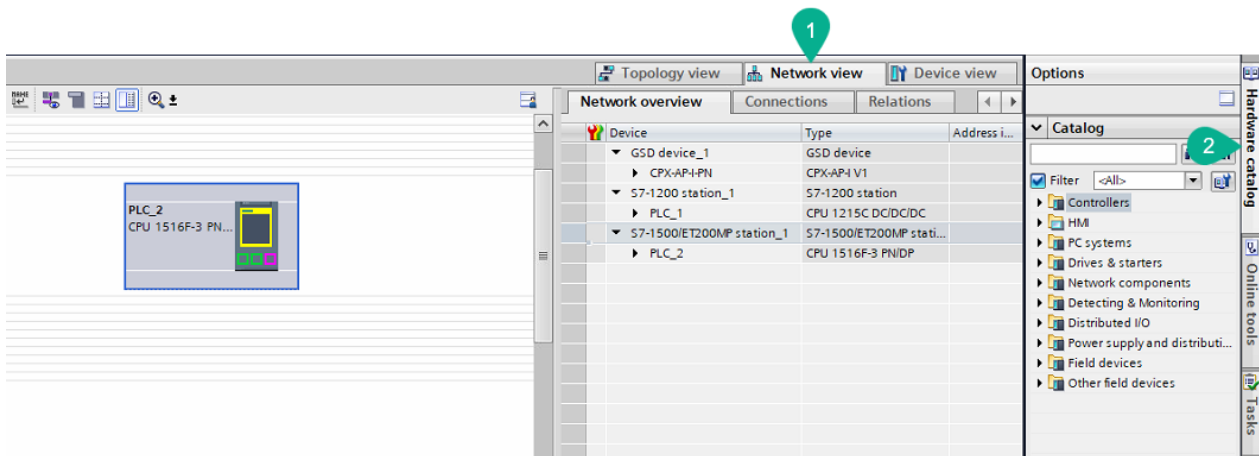
3.4.1 Adding CPX-AP-I-PN module to Network View

Step 1



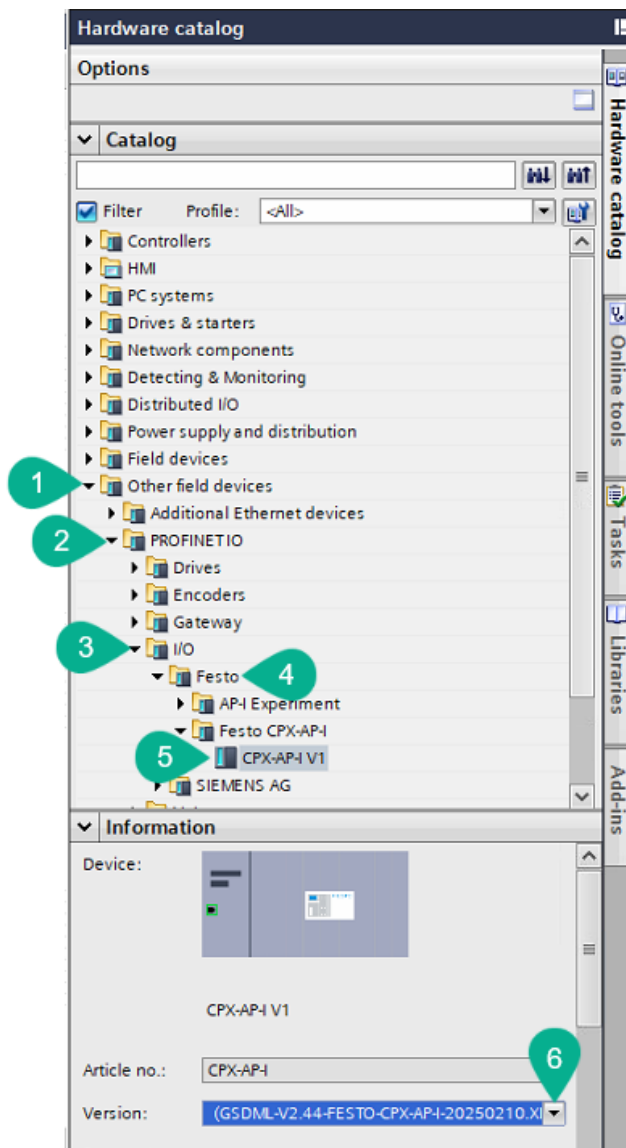
Double click on **Devices and Networks** to go to network view .

Step 2

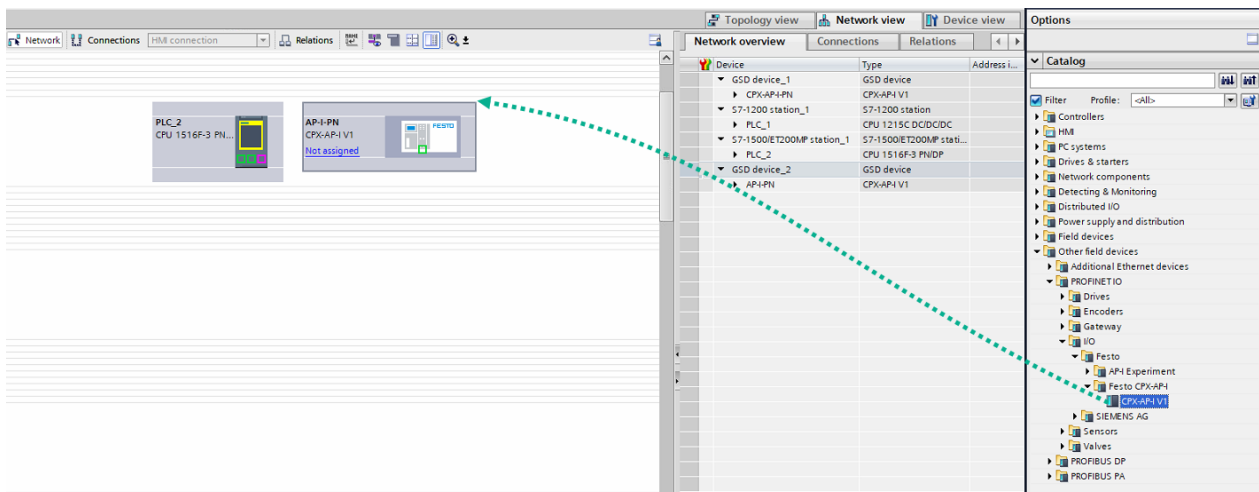


1. Click on the **Network View**.
2. Click on the **Hardware Catalog**.

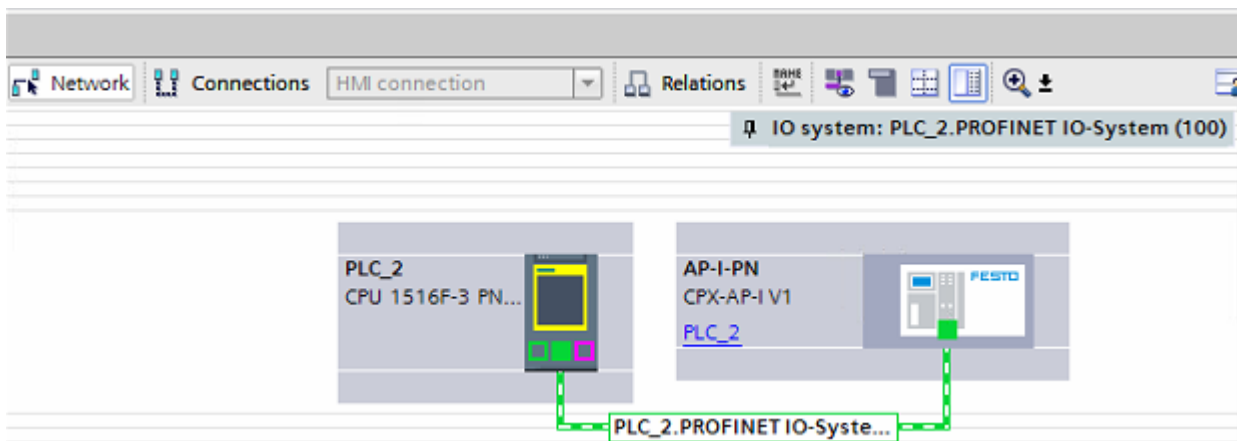
Step 3



1. Select **Other field devices** from Hardware catalog menu.
2. Select **PROFINET IO** from the other field devices drop down menu.
3. Select **IO** from the PROFINET IO drop down menu.
4. Select **Festo** from the **I/O** drop-down menu
5. **CPX-AP-I V1** module can be viewed under the Festo **CPX-AP-I** folder.
6. Click on the dropdown arrow, then select the updated version of GSDML (V2.35 or above).

Step 4

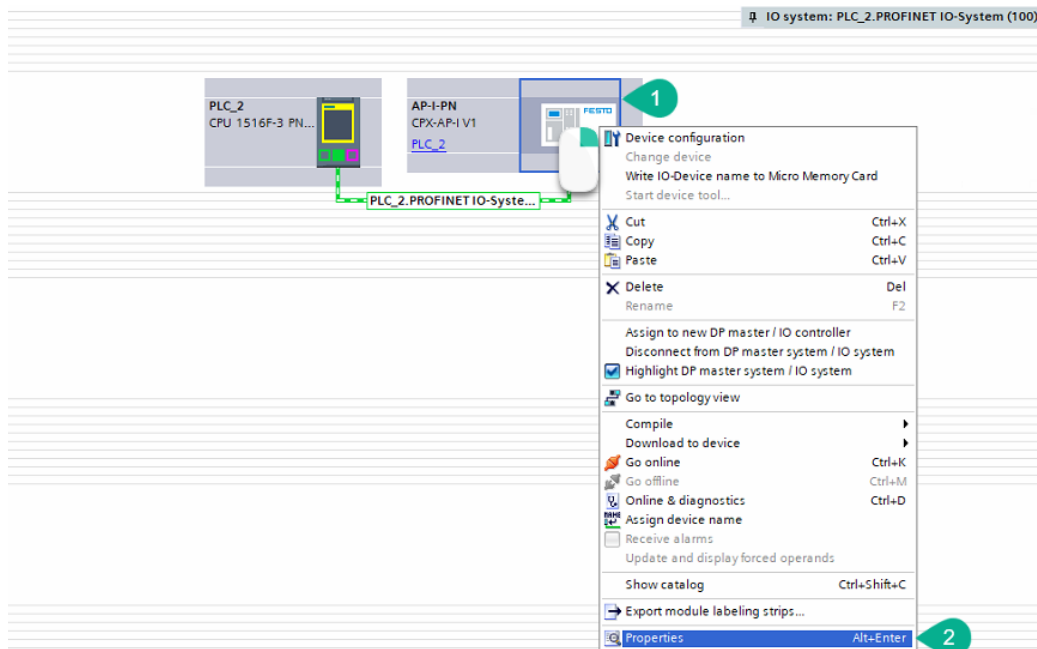
Drag and drop **CPX-AP-I V1** module to network view.

Step 5

Connect the S7-1500 PLC to CPX-AP-I-PN module. In the example the CPX-AP-I-PN module is connected to **PROFINET interface[X1]** of S7-1500 PLC.

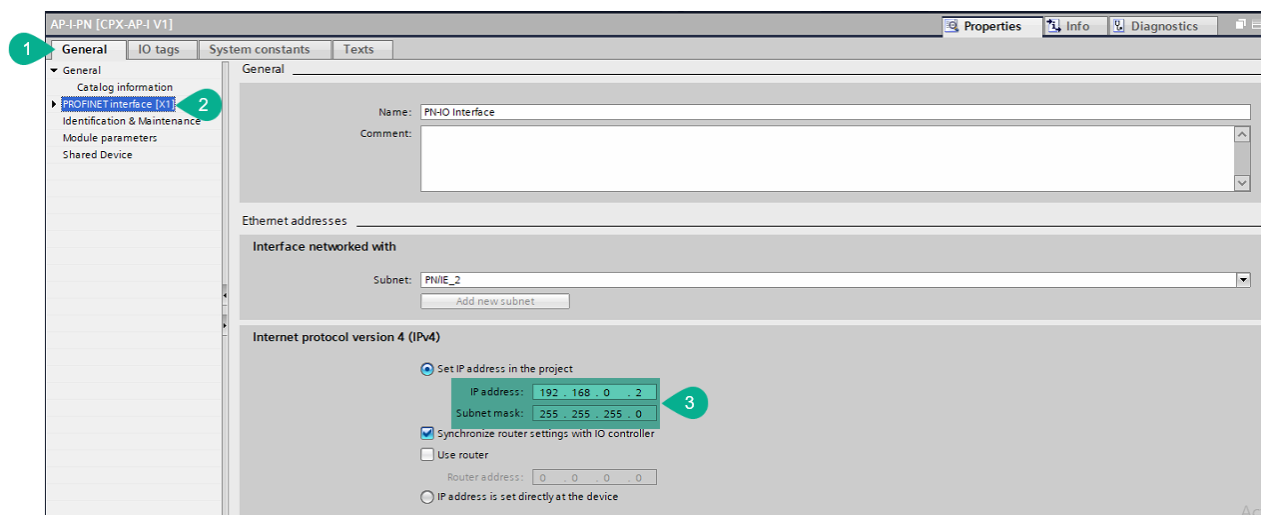
3.4.2 CPX-AP-I-PN IP Address Configuration

Step 1



1. Right Click on **AP-I-PN** from the Network view
2. Click on **Properties** from the right click menu.

Step 2



1. Select **General** from Properties tab.
2. Click on **PROFINET interface [X1]** to open the interface Manu.
3. Enter the required IP address on the **IP address** and **Subnet mask** field.

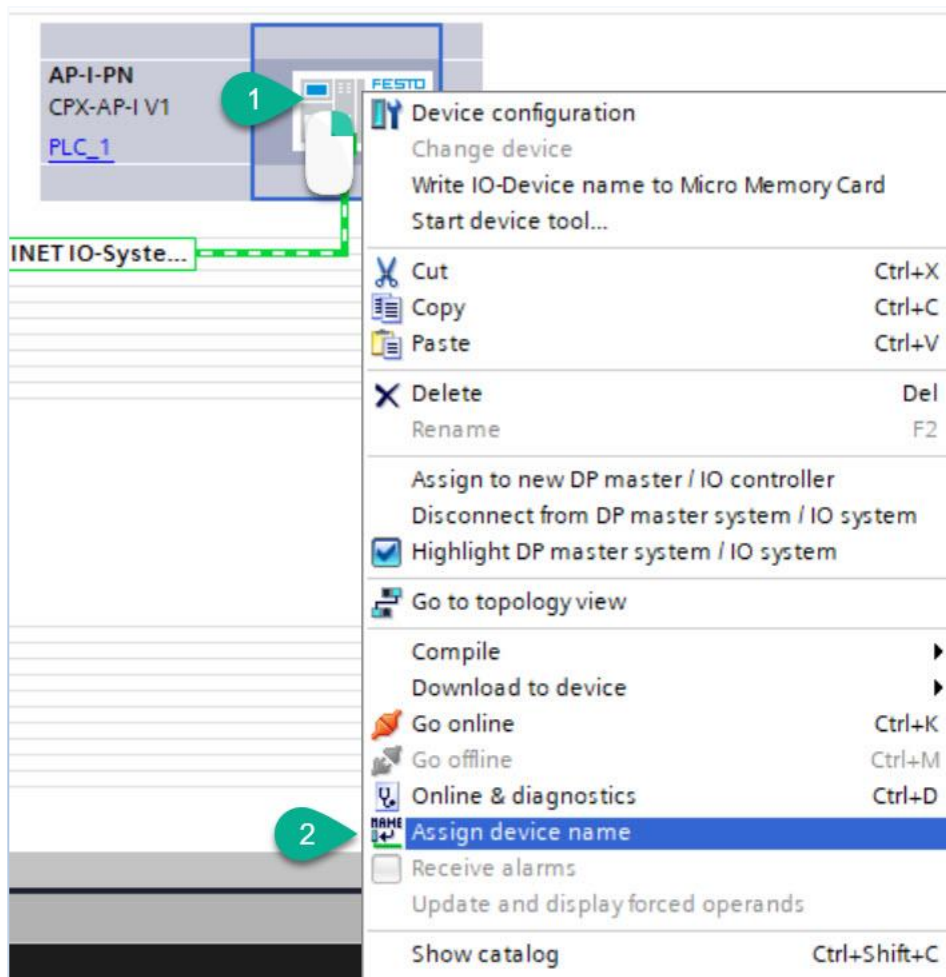


Note

- IP address of the PROFINET interface of CPX-AP-I-PN module , S7-1500 PLC must be in same range.

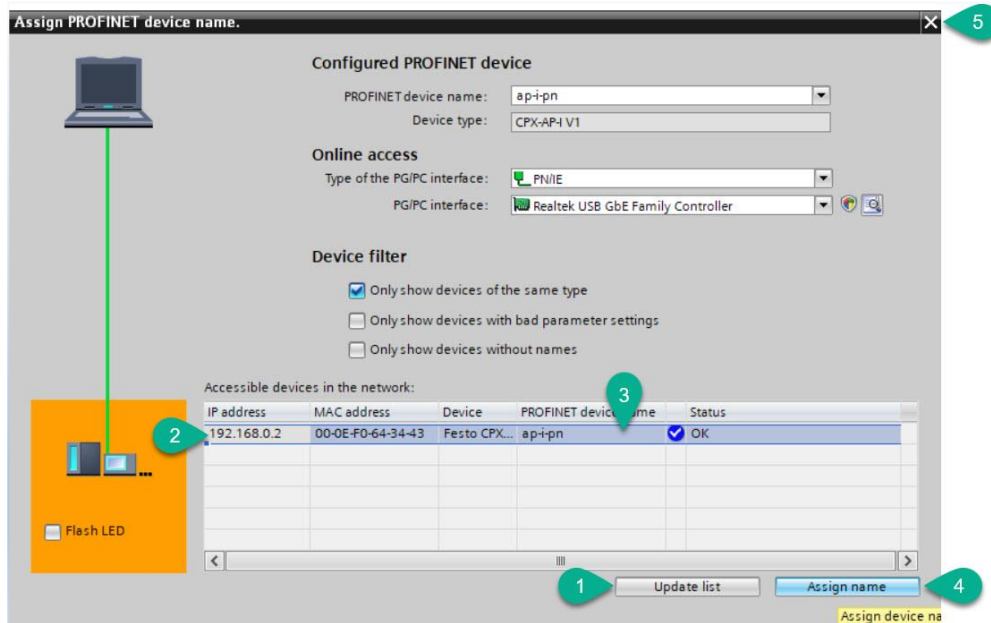
3.4.3 Assigning PROFINET Name to CPX-AP-I-PN Module

Step 1



1. Right Click on **AP-I-PN** from the Network view
2. Click on **Assign device name** from the right click menu.

The Assign device name tab will be displayed as shown below **Step 2**.

Step 2

1. Click on **Update List** to scan the accessible devices in the network.
2. Once the scan is completed the **CPX-AP-I-PN** module will be appear on the field.
3. Select the **CPX-AP-I-PN** device from accessible device column.
4. Click on **Assign name** to assign the device name.
5. Click on **Close** to finish the assigning device name.

3.4.4 Finding the Order of CPX-AP-I Devices in Web Server

CPX-AP web server ap-i-pn / 192.168.0.2

Home
Diagnosis
PROFINET / I&M
Ethernet
Report

Device information

Device 1 - I-PN-M12
 CPX-AP-I-PN-M12
 MC: 8321 Product Key: 3S7PNC4J0RV OrderNumber: 8086607
 SW: 1.2.24 HW: 1
 PS: 24.1 V
 PL: 24.1 V

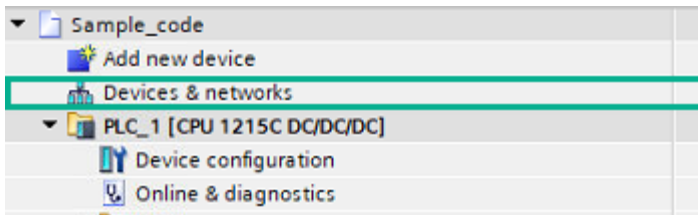
Device 2 - I-4IOL
 CPX-AP-I-4IOL-M12
 MC: 8213 Product Key: 3S7PP8J63GW OrderNumber: 8086604
 SW: 1.5.6 HW: 1
 IO bytes per port: 4
 IOL-D 1: 014Dh Festo AG & Co. KG
 00025Fh EPCE-TB-45-10-FL-ST-M-H1-PLK-AA
 8101539
 Input 16 bits / Output 16 bits
 ProductKey 3S7PPD4K9L8
 IOL-D 2: Deactivated
 IOL-D 3: Deactivated
 IOL-D 4: Deactivated

Device 3 - I-8DI-M8
 CPX-AP-I-8DI-M8-3P
 MC: 8199 Product Key: 3S7PNT0GFDG OrderNumber: 8086600
 SW: 1.43.10 HW: 1
 Inputchannels: 8 Inputbytes: 1

1. Open **CPX-AP Web server** using Festo Automation Suite.
2. The webserver is displayed as shown Above.
3. In our example the CPX-AP-I devices are connected in the above order.

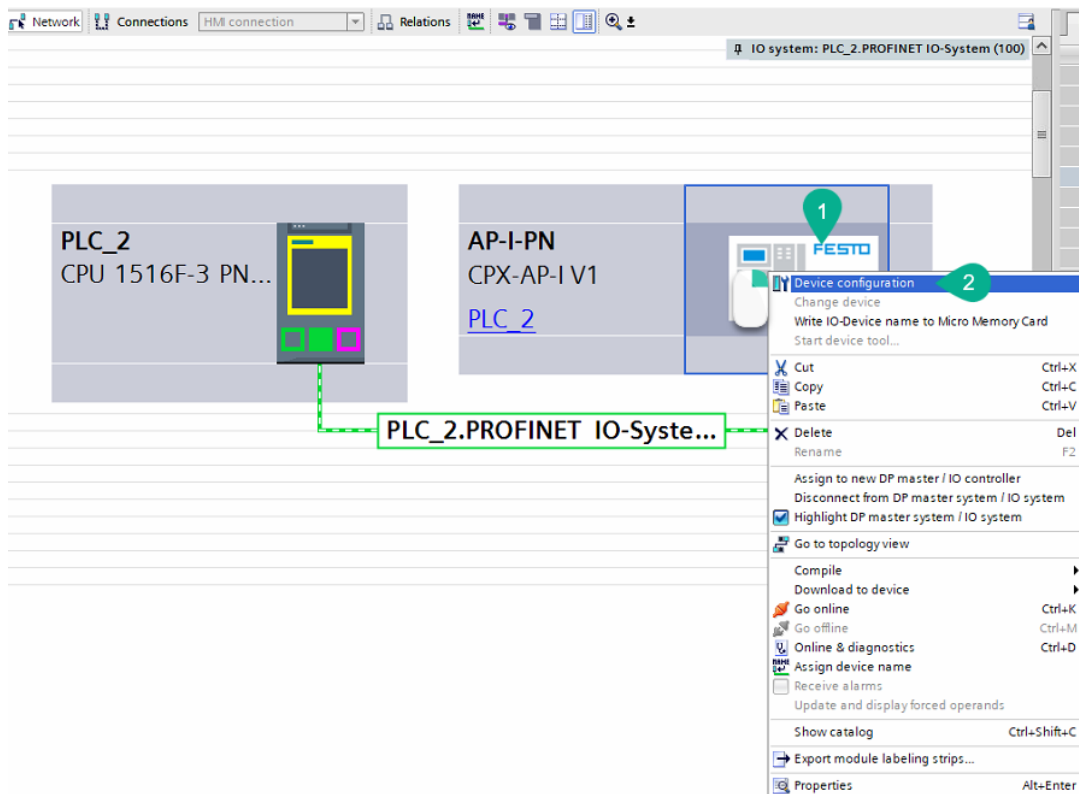
3.4.5 Configuring CPX-AP-I Devices in TIA Portal

Step 1



Double click on **Devices and Networks** to go to network view.

Step 2



1. Right click on **AP-I-PN** from the Network view
2. Click on **Device Configuration** from the right click menu.

Device Configuration tab will be displayed as shown below **Step 3**.

Step 3

The screenshot displays the Siemens SIMATIC Manager interface for configuring a CPX-AP-I PN module. The top bar shows the project path: Sample_code > Ungrouped devices > AP-I-PN [CPX-AP-I V1]. The main window is divided into several panes:

- Topology view:** Shows a rack diagram with the CPX-AP-I PN module installed in slot 0.
- Device overview:** A table listing the modules and their properties.

Module	Rack	Slot	I address	Q address	Type
CPX-AP-I-PN_1	0	0			CPX-AP-I V1
PN-HO Interface	0	0 X1			CPX-AP-I-PN
CPX-AP-I-PN-M12_1	0	1			CPX-AP-I-PN-M12
CPX-AP-I-PN-M12	0	1 1			CPX-AP-I-PN-M12
Diagnosis structure	0	1 2	4...16		Diagnosis structure
Status bits	0	1 3	17		Status bits
	0	1 4			
	0	1 5			
CPX-AP-I-4IOL-M12_1	0	2			CPX-AP-I-4IOL-M12
CPX-AP-I-4IOL-M12	0	2 1			CPX-AP-I-4IOL-M12
IO-Link In/Out 2/2 Byte	0	2 Port 1	1...3	0...1	IO-Link In/Out 2/2 ...
Port deactivated	0	2 Port 2			Port deactivated
Port deactivated_1	0	2 Port 3			Port deactivated
Port deactivated_2	0	2 Port 4			Port deactivated
CPX-AP-I-8DI-M8-3P_1	0	3	0		CPX-AP-I-8DI-M8-3P
- Options:** A pane on the right showing the hardware catalog. It includes a search bar and a filter dropdown set to 'All'.

Numbered callouts indicate the following steps:

1. Select the CPX-AP-I-PN module in the device overview table.
2. Select the CPX-AP-I-PN-M12_1 module in the device overview table.
3. Select the CPX-AP-I-4IOL-M12 module in the device overview table.
4. Select the IO-Link In/Out 2/2 Byte module in the device overview table.
5. Select the IO-Link digital IO module in the hardware catalog.

1. Click on **Hardware Catalog** from the Device configuration tab.
2. Expand **Module** to find all the available CPX-AP-I devices.
3. Expand the **IO-Link Master Modules** to locate the CPX-API-I-4IOL-M12 Master module. Then, drag and drop the **CPX-API-I-4IOL-M12** Master module under the CPX-API-I-PN in **slot 2**.
4. Expand the **submodules** to locate the diagnosis structure and status bits. Then, drag and drop the **diagnosis structure** and **status bits** submodule.
5. Expand the **IO-Link generic devices** to locate the IO-Link telegram. Then, drag and drop the required IO-Link telegram under the **CPX-AP-I-4IOL-M12** in the ports to activate it. Next, drag and drop the **Port Deactivate** telegram under the **CPX-AP-I-4IOL-M12** from **port 2** to **port 4** to deactivate the port position.

**Note**

- The I/O modules **highlighted** in the image can be configured using the same steps shown above. Configurations may vary depending on the network setup. For example, refer to the steps in the image above to add more modules to the network or under the main module.

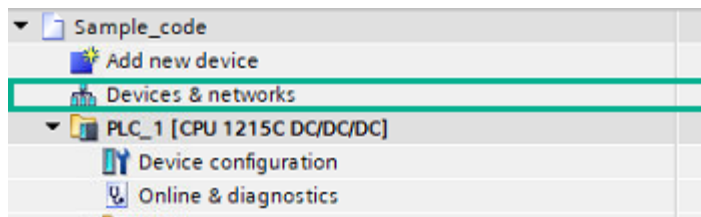
3.4.6 Finding the Slot and Sub Slot Number of CPX-AP-I Devices

Consider the following CPX-AP-I devices connected in the network. An SMS device is connected to the first port of the **CPX-AP-I-4IOL-M12** IO Link Master Module. The slot and sub-slot numbering will be as shown below.

Device overview								
	Module	...	Rack	Slot	I address	Q address	Type	Article number
	▼ CPX-API-PN_1		0	0			CPX-API V1	CPX-API
	▶ PN-IO Interface		0	0 X1			CPX-API-PN	
	▼ CPX-API-PN-M12_1		0	1			CPX-API-PN-M12	8086607
	CPX-API-PN-M12		0	1 1			CPX-API-PN-M12	8086607
	Diagnosis structure		0	1 2	4...16		Diagnosis structure	
	Status bits		0	1 3	17		Status bits	
			0	1 4				
			0	1 5				
	▼ CPX-API-4IOL-M12_1		0	2			CPX-API-4IOL-M12	8086604
	CPX-API-4IOL-M12		0	2 1			CPX-API-4IOL-M12	8086604
	IO-Link In/Out 2/ 2 Byte ...		0	2 Port 1	1...3	0...1	IO-Link In/Out 2/ 2 ...	
	Port deactivated		0	2 Port 2			Port deactivated	Port deactivated
	Port deactivated_1		0	2 Port 3			Port deactivated	Port deactivated
	Port deactivated_2		0	2 Port 4			Port deactivated	Port deactivated
	CPX-API-8DI-M8-3P_1		0	3	0		CPX-API-8DI-M8-3P	8086600
			0	4				
			0	5				
			0	6				

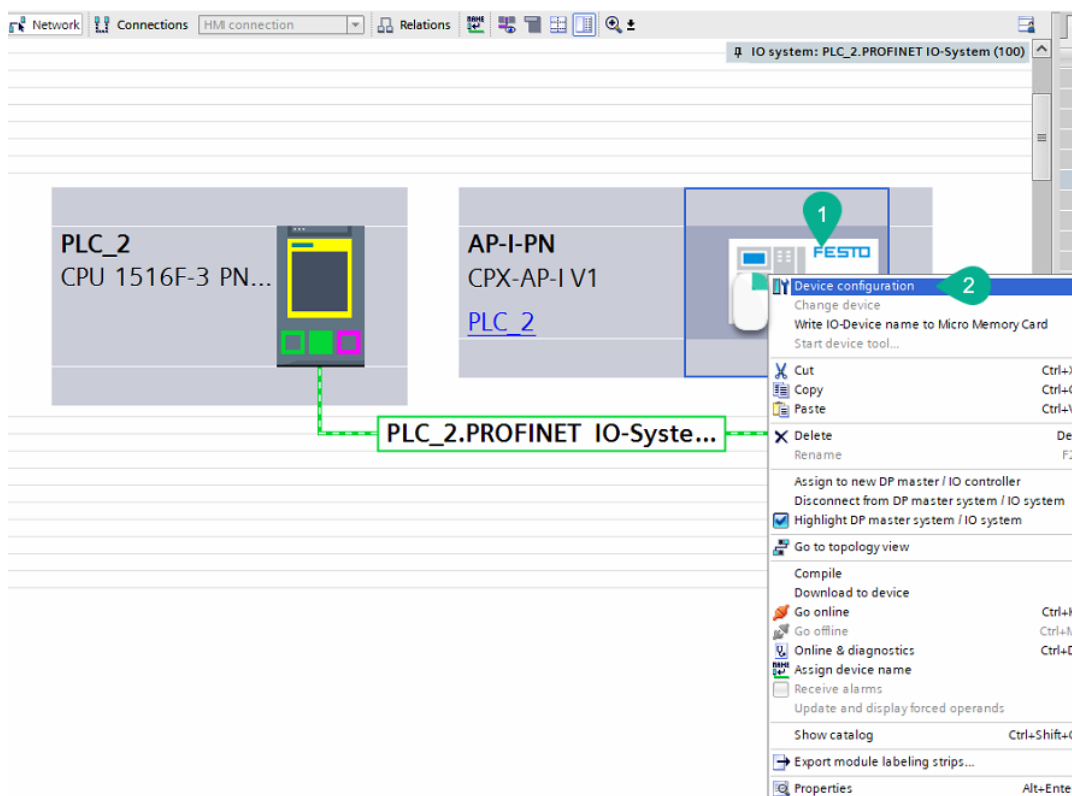
3.4.7 Determining Hardware ID of CPX-AP-I-PN-M12 Module

Step 1



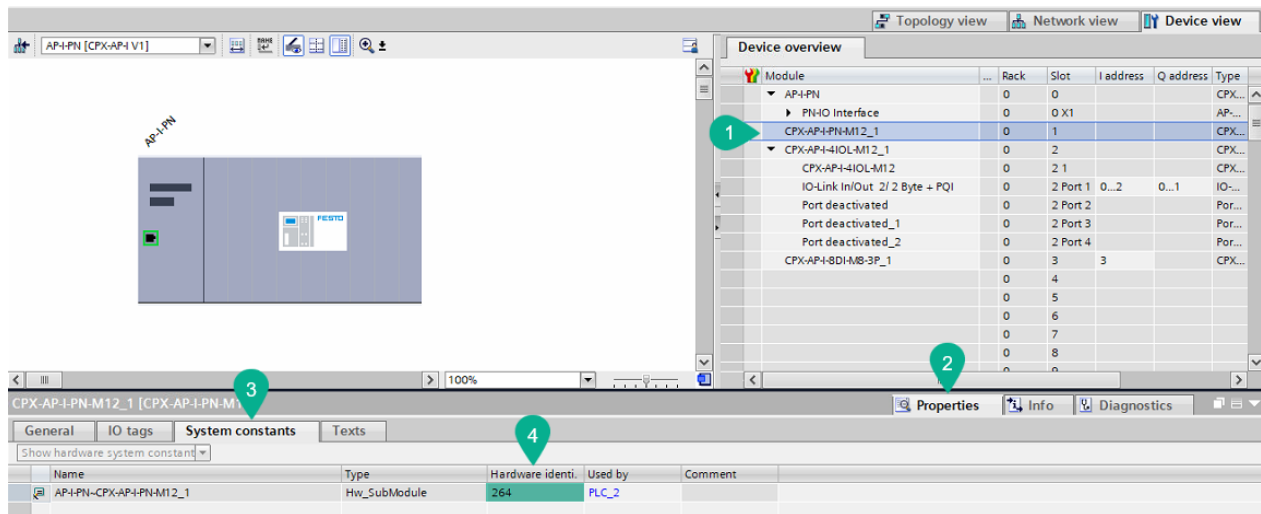
Double click on **Devices and Networks** to go to network view.

Step 2

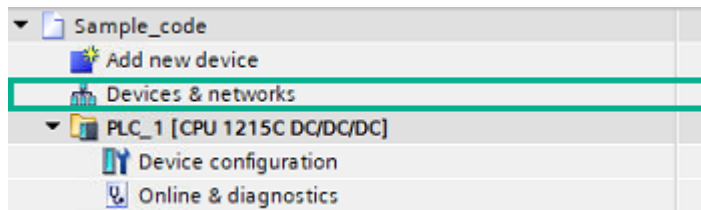


1. Right click on **AP-I-PN** from the Network view
2. Click on **Device Configuration** from the right click menu.

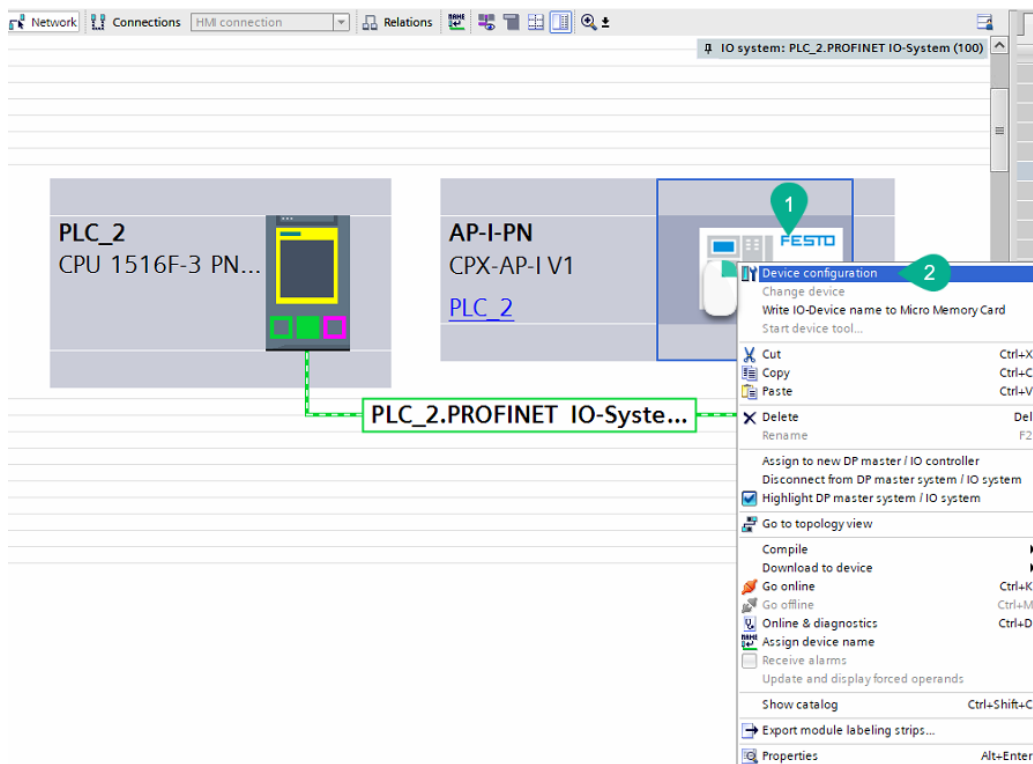
The Device Configuration tab will be displayed as shown below **Step 3**.

Step 3

1. Click on **CPX-AP-I-PN-M12_1** device from Device overview tab.
2. Click on **Properties** tab to view the CPX-AP-I-4IOL-M12 properties.
3. Click on **System constants** tab to find the Hardware id.
4. Find the HW_ID of CPX-AP-I-PN-M12 module from Hardware identifier column.

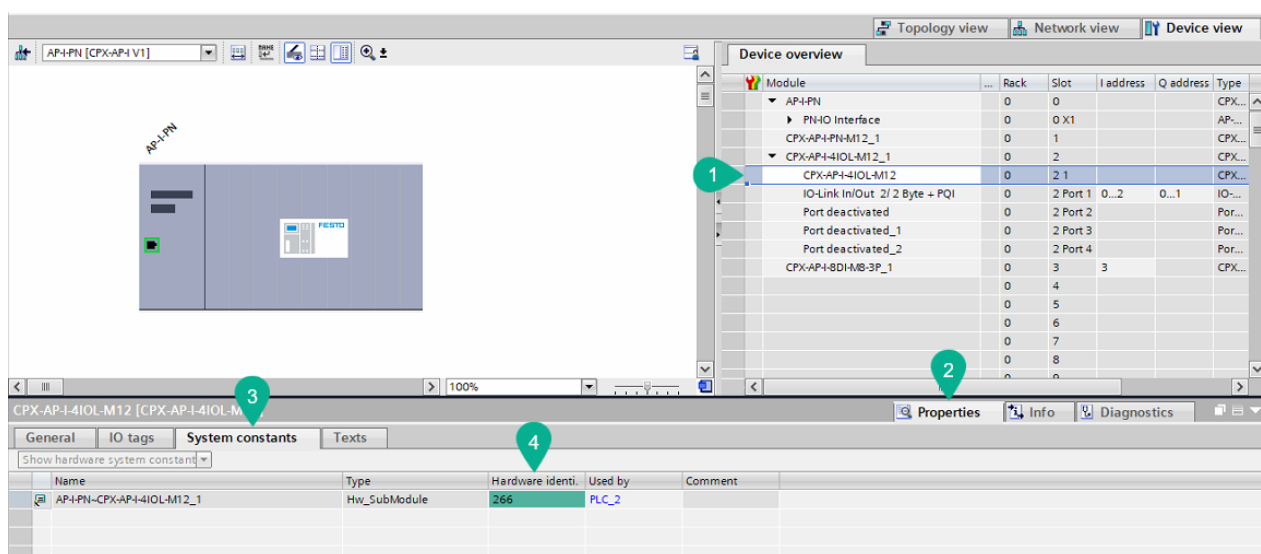
3.4.8 Determining Hardware ID of CPX-AP-I-4IOL-M12 IO Link Module.**Step 1**

Double click on **Devices and Networks** to go to network view.

Step 2

1. Right click on **AP-I-PN** from the Network view
2. Click on **Device Configuration** from the right click menu.

The Device Configuration tab will be displayed as shown below **Step 3**.

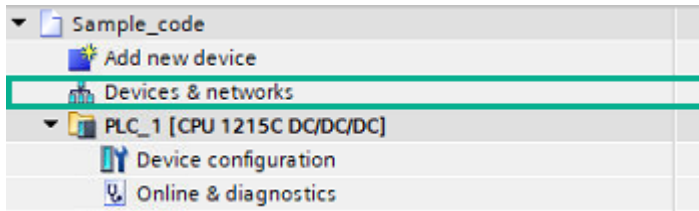
Step 3

1. Click on **CPX-AP-I-4IOL-M12** device from Device overview tab.
2. Click on **Properties** tab to view the CPX-AP-I-4IOL-M12 properties.
3. Click on **System constants** tab to find the Hardware id.
4. Find the HW_ID of CPX-AP-I-4IOL-M12 IO-Link master module from Hardware identifier column.

3.5 Configuring the CPX-AP-A-PN Module

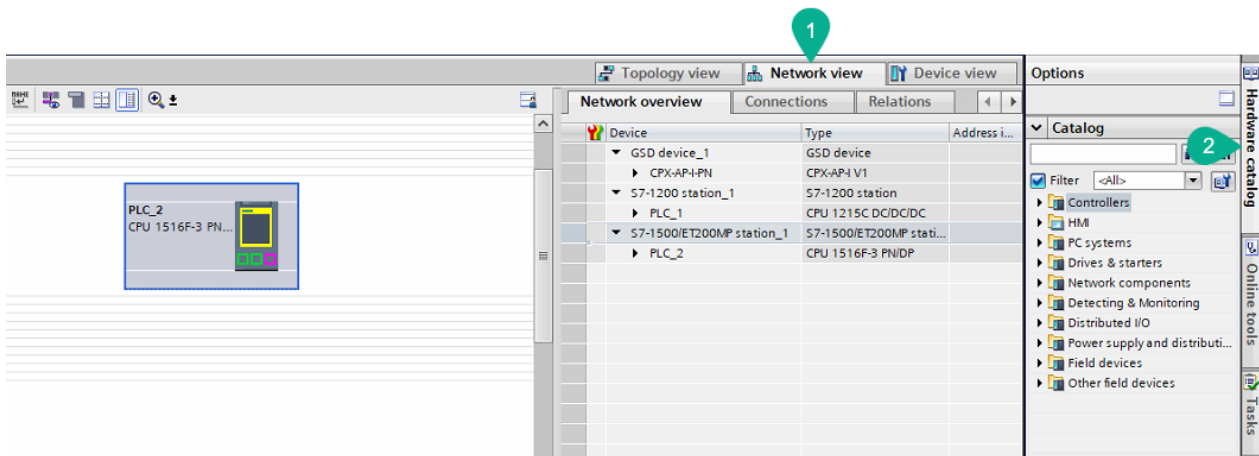
3.5.1 Adding CPX-AP-A-PN module to Network View

Step 1



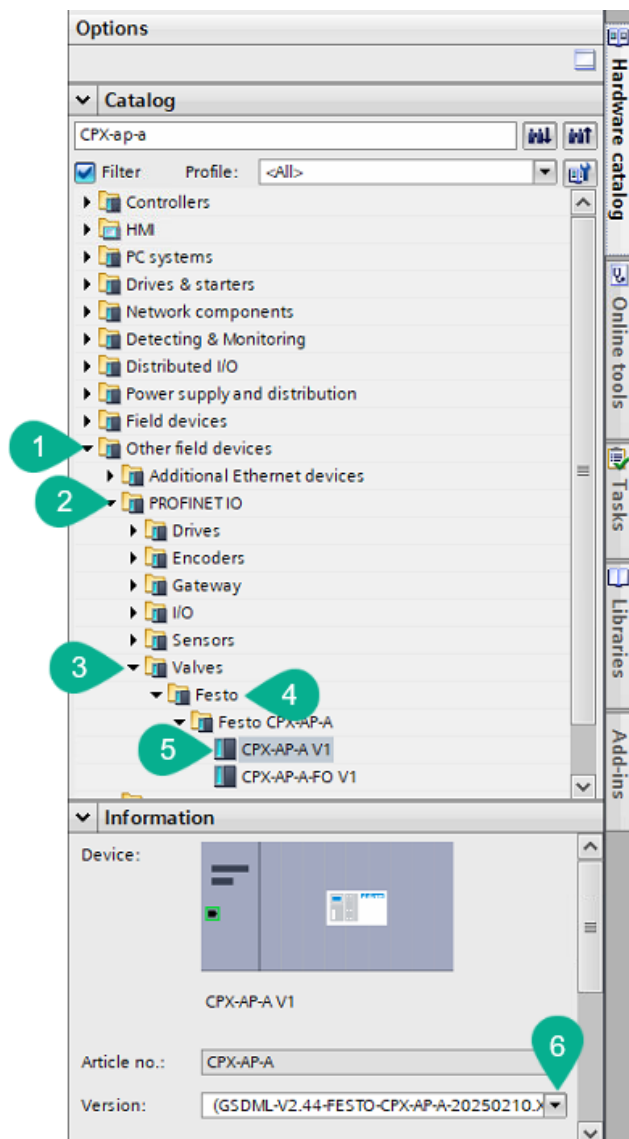
Double click on **Devices and Networks** to go to network view .

Step 2

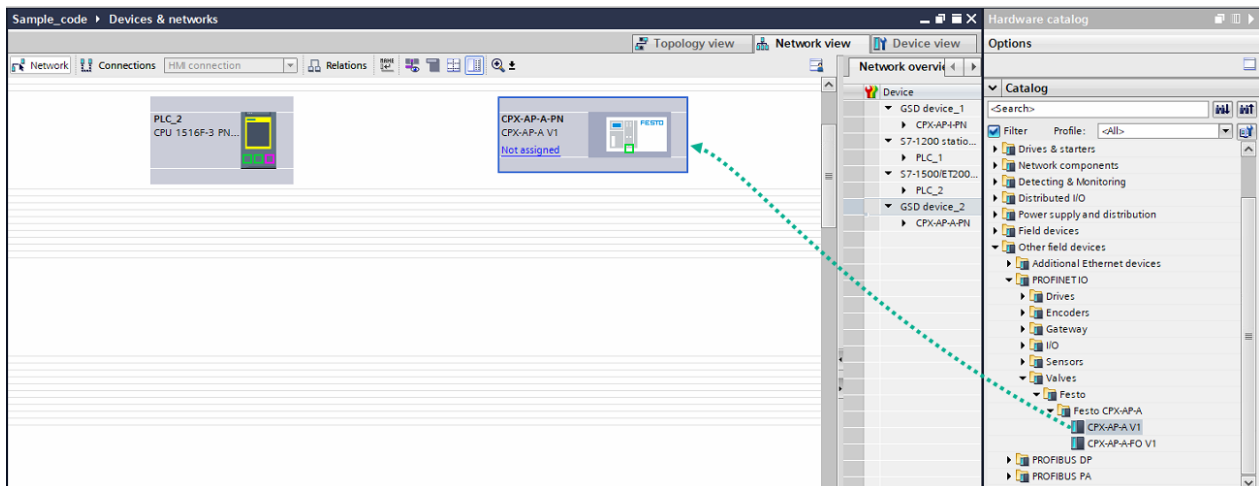


1. Click on the **Network View**.
2. Click on the **Hardware Catalog**.

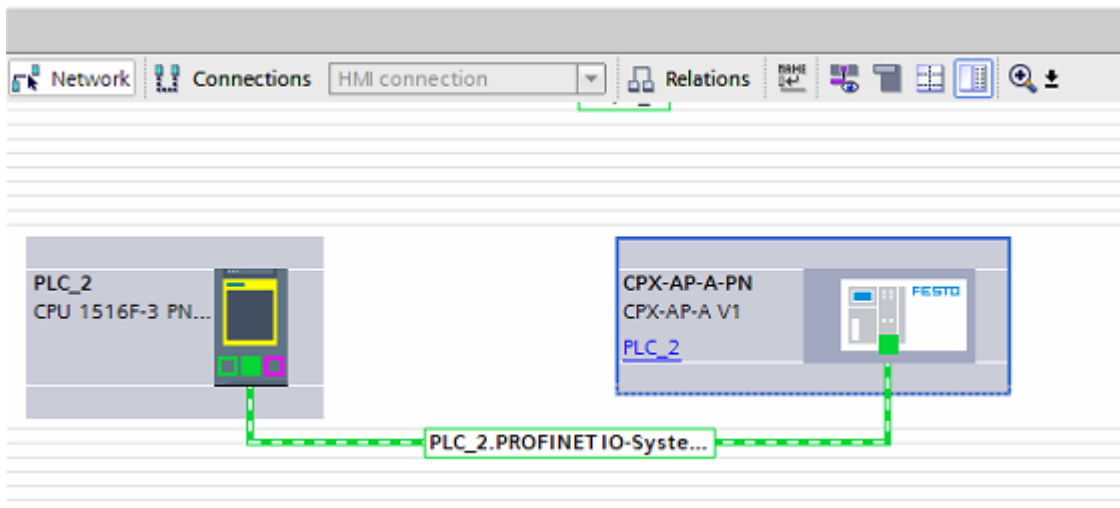
Step 3



1. Select **Other field devices** from Hardware catalog menu.
2. Select **PROFINET IO** from the other field devices drop down menu.
3. Select **Valves** from the PROFINET IO drop down menu.
4. Select **Festo** from the IO drop down menu.
5. **CPX-AP-A V1** module can be viewed under the Festo CPX-AP-A folder.
6. Click on the dropdown arrow, then select the updated version of GSDML (V2.35 or above).

Step 4

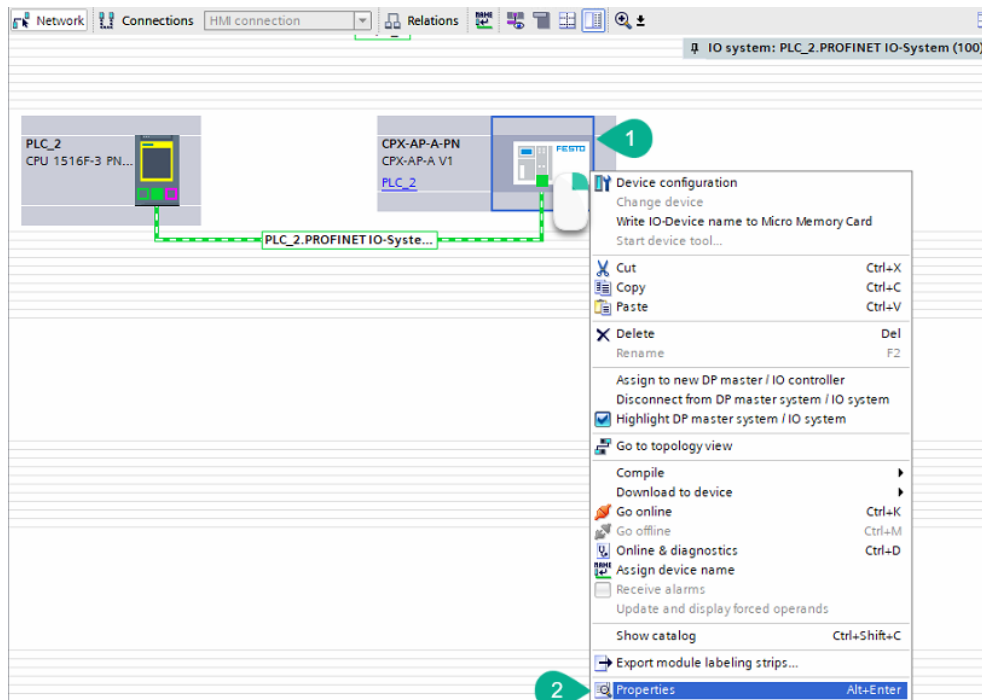
Drag and drop **CPX-AP-A V1** module to network view.

Step 5

Connect the S7-1500 PLC to CPX-AP-A-PN module. In the example the CPX-AP-A-PN module is connected to **PROFINET interface[X1]** of S7-1500 PLC.

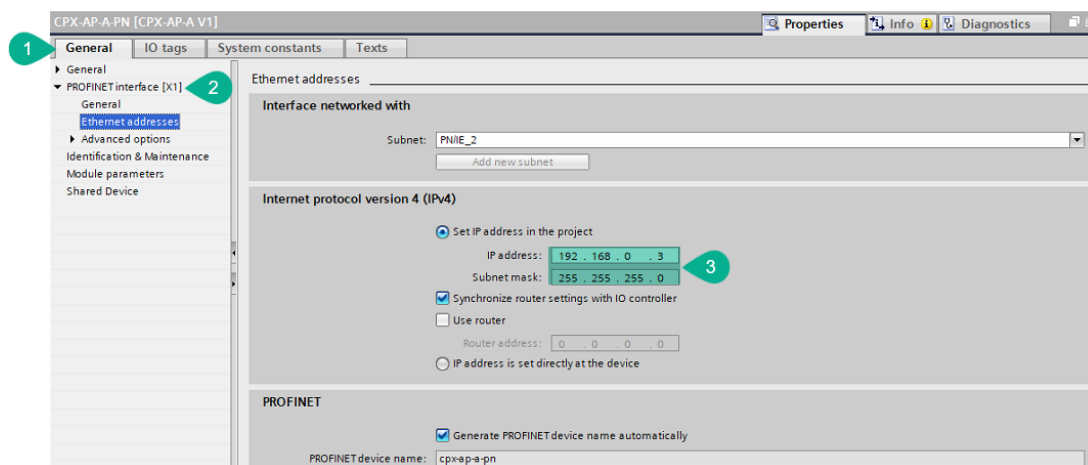
3.5.2 CPX-AP-A-PN IP Address Configuration

Step 1



1. Right on **AP-A-PN** from the Network view
2. Click on **Properties** from the right click menu.

Step 2



1. Select **General** from Properties tab.
2. Click on **PROFINET interface [X1]** to open the interface Manu.
3. Enter the required IP address on the **IP address** and **Subnet mask** field.

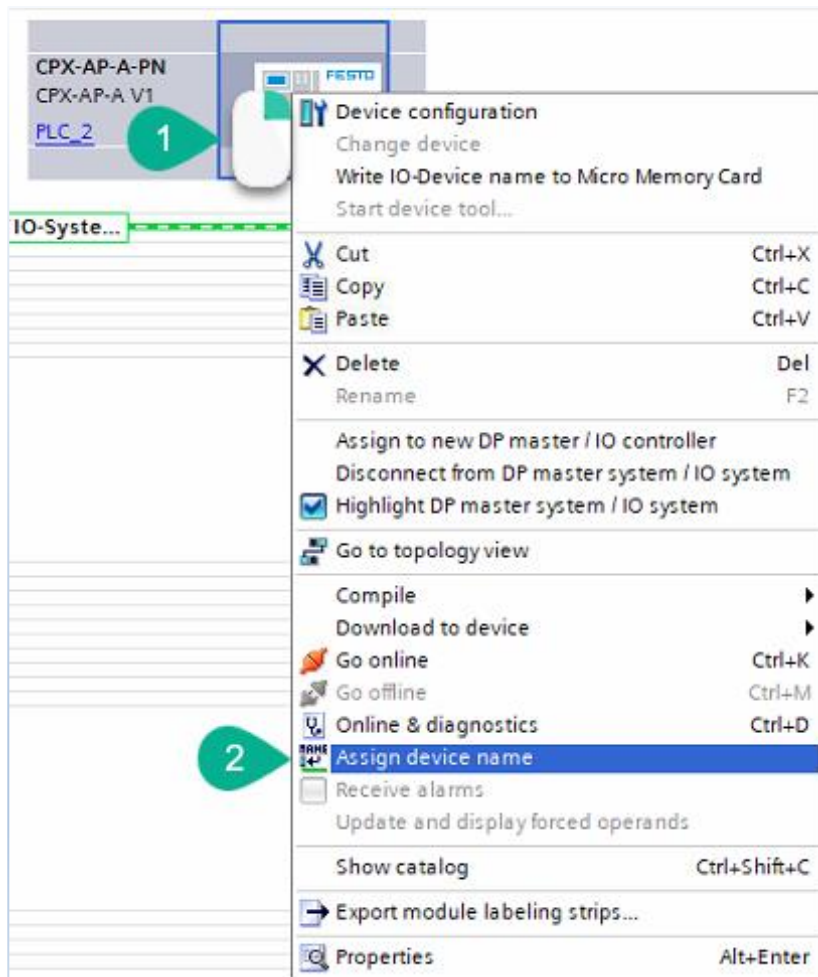


Note

- IP address of the PROFINET interface of CPX-AP-A-PN module , S7-1500 PLC must be in same range.

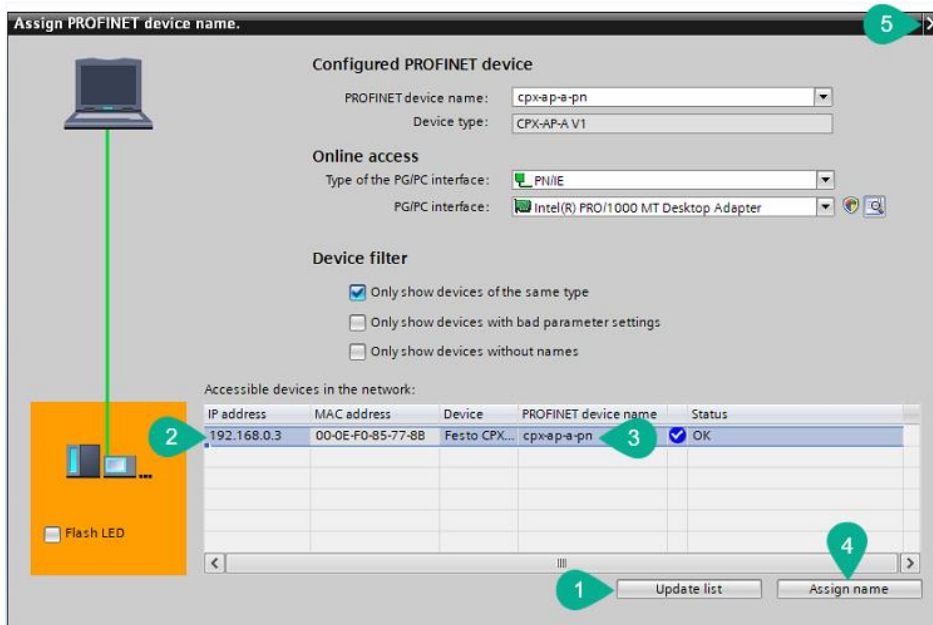
3.5.3 Assigning PROFINET Name to CPX-AP-A-PN Module

Step 1



1. Right click on **AP-A-PN** from the Network view
2. Click on **Assign device name** from the right click menu.

The Assign device name tab will be displayed as shown below **Step 2**.

Step 2

1. Click on **Update List** to scan the accessible devices in the network.
2. Once the scan is completed the CPX-AP-A-PN module will be appear on the field.
3. Select the **CPX-AP-A-PN** device from accessible device column.
4. Click on **Assign name** to assign the device name.
5. Click on **Close** to Finish the Assigning device name.

3.5.4 Finding the order of CPX-AP-A devices in Web Server

CPX-AP web server cpxx-ap-a-pnxb12075 / 192.168.0.3

Home
AP topology
AP module
Diagnosis
PROFINET / I&M
Ethernet
Report

Device information

Device 1 - A-PN-M12

CPX-AP-A-PN-M12 →
MC: 12417 Product Key: [NPLXM768MTT](#) OrderNumber: 8129241
SW: 1.5.9 HW: 1
PS: 24,0 V PL: 24,1 V

Device 2 - A-12DI4DO-M12

CPX-AP-A-12DI4DO-M12-5P →
MC: 12290 Product Key: [JXLZLSLK53N](#) OrderNumber: 8129111
SW: 1.117.6 HW: 2
PS: 24,1 V PL: 24,0 V
Inputchannels: 12 Inputbytes: 2
Outputchannels: 4 Outputbytes: 1

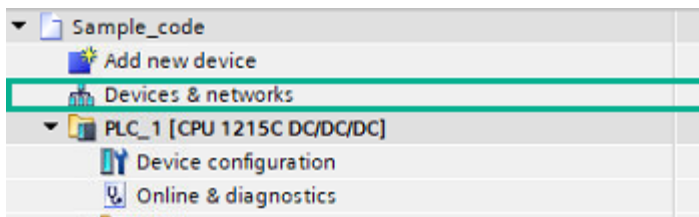
Device 3 - A-4IOL

CPX-AP-A-4IOL-M12 →
MC: 12309 Product Key: [HNBDRBVJM42](#) OrderNumber: 8129114
SW: 1.6.6 HW: 1
PS: 24,1 V PL: 24,0 V
IO bytes per port: 4
IOL-D 1: Deactivated
IOL-D 2: Deactivated
IOL-D 3: Deactivated
IOL-D 4: Deactivated

1. Open **CPX-AP Web server** using Festo Automation Suite.
2. The webserver is displayed as shown above and In our example the CPX-AP-A devices are connected in the following order.

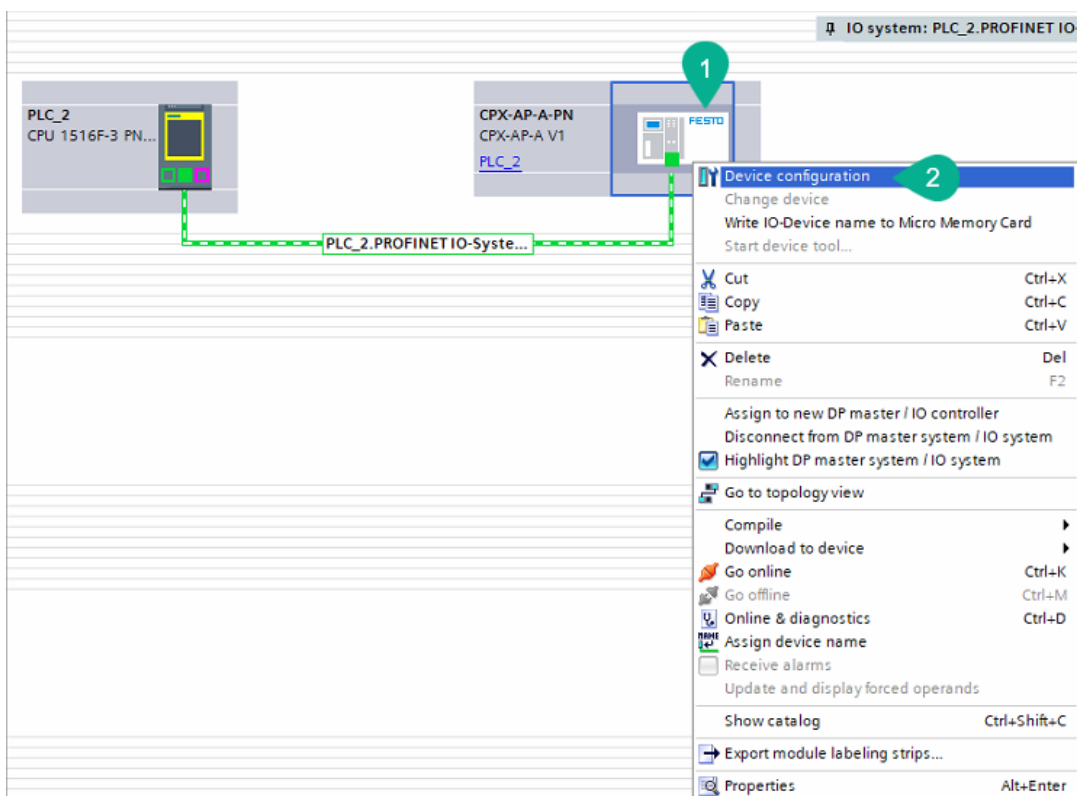
3.5.5 Configuring CPX-AP-A Devices in TIA Portal.

Step 1



Double click on **Devices and Networks** to go to network view.

Step 2



1. Right click on **AP-A-PN** from the Network view
2. Click on **Device Configuration** from the right click menu.

Device Configuration tab will be displayed as shown below **Step 3**.

Step 3

The screenshot displays the Siemens SIMATIC Manager interface for configuring a CPX-AP-A-PN module. The main window shows a 3D rack view with the module installed. The 'Device overview' table lists the modules and their properties. The 'Catalog' tree on the right shows the available modules and their submodules.

Device overview table:

Module	Rack	Slot	I address	Q address	Type	Article number	Firm...
CPX-AP-A-PN	0	0			CPX-AP-A V1	CPX-AP-A	
PN-IO Interface	0	0 X1			CPX-AP-A-PN		
CPX-AP-A-PN-M12_1	0	1			CPX-AP-A-PN-M12	8129241	
CPX-AP-A-PN-M12	0	1 1			CPX-AP-A-PN-M12	8129241	
Diagnosis structure	0	1 2	2...14		Diagnosis structure		
Status bits	0	1 3	15		Status bits		
	0	1 4					
	0	1 5					
CPX-AP-A-12DI4DO-M12-5P...	0	2	0...1	0	CPX-AP-A-12DI4DO...	8129111	
CPX-AP-A-4IOL-M12_1	0	3			CPX-AP-A-4IOL-M12	8129114	
CPX-AP-A-4IOL-M12	0	3 1			CPX-AP-A-4IOL-M12	8129114	
IO-Link In/Out 2/2 Byte	0	3 Port 1	16...18	1...2	IO-Link In/Out 2/2 ...		
Port deactivated	0	3 Port 2			Port deactivated	Port deactivated	
Port deactivated_1	0	3 Port 3			Port deactivated	Port deactivated	
Port deactivated_2	0	3 Port 4			Port deactivated	Port deactivated	
	0	4					
	0	5					
	0	6					
	0	7					
	0	8					
	0	9					
	0	10					
	0	11					
	0	12					
	0	13					
	0	14					
	0	15					
	0	16					
	0	17					
	0	18					
	0	19					
	0	20					
	0	21					
	0	22					
	0	23					

Catalog tree:

- Head module
 - Analog Modules
 - Digital Modules
 - CPX-AP-A-12DI4DO-M12-5P
 - CPX-AP-A-12DI4DO-M8-4P
 - CPX-AP-A-12DI4DO-PI
 - CPX-AP-A-16DI4DO-M12-5P
 - CPX-AP-A-8DI-M12-5P
 - CPX-AP-A-8DI-M8-3P
 - CPX-AP-A-8DI-PI
 - CPX-AP-A-8DO-M12-5P
 - CPX-AP-A-8DO-M8-3P
 - CPX-AP-A-8DO-PI
 - CPX-AP-A-8HDO-M12-5P
 - CPX-AP-A-4DI4DO-M12-5P
 - CPX-AP-A-4DI4DO-M8-3P
 - CPX-AP-A-4DI-M8-3P
 - CPX-AP-A-8DI-M12-5P
 - CPX-AP-A-8DI-M8-3P
 - CPX-AP-A-8DO-M12-5P
 - CPX-AP-A-8DO-M8-3P
 - Interface Modules
 - CPX-AP-A-PN-CU
 - CPX-AP-A-PN-M12
 - IO-Link Master Modules
 - CPX-AP-A-4IOL-M12
 - CPX-AP-A-4IOL-M12
 - Pneumatics MPA-L
 - Pneumatics MPA-S
 - Pneumatics VTSA
 - Pneumatics VTUG
 - Pneumatics VTUX
 - Universal In/Out 2/2 bytes
 - Universal In/Out 4/4 bytes
 - Universal In/Out 6/6 bytes
- Submodules
 - Diagnosis structure
 - Festo IO-Link Devices
 - IO-Link digital IO
 - IO-Link generic Devices
 - IO-Link In/Out 0/16 Byte + PQI
 - IO-Link In/Out 0/2 Byte + PQI
 - IO-Link In/Out 0/4 Byte + PQI
 - IO-Link In/Out 0/8 Byte + PQI
 - IO-Link In/Out 16/0 Byte + PQI
 - IO-Link In/Out 2/0 Byte + PQI
 - IO-Link In/Out 2/2 Byte + PQI
 - IO-Link In/Out 4/0 Byte + PQI
 - IO-Link In/Out 4/4 Byte + PQI
 - IO-Link In/Out 8/0 Byte + PQI
 - IO-Link In/Out 8/8 Byte + PQI
 - IO-Link In/Out 16/16 Byte + PQI
 - IO-Link In/Out 32/32 Byte + PQI
 - Port deactivated
 - Power Load
 - Power Supply
 - Status bits
 - Status bits with qualifier
 - Valve Counters

Numbered callouts (1-6) indicate the following:

- CPX-AP-A-PN module in the rack.
- CPX-AP-A-PN-M12 module in the rack.
- CPX-AP-A-12DI4DO-M12-5P module in the rack.
- CPX-AP-A-4IOL-M12 module in the rack.
- IO-Link In/Out 2/2 Byte module in the rack.
- Port deactivated module in the rack.

1. Click on **Hardware Catalog** from the Device configuration tab.
2. Expand **Module** to find all the available CPX-AP-A devices.
3. Expand the **Interface Modules** to locate the CPX-AP-A-PN-M12 module. Then, drag and drop the **CPX-AP-A-PN-M12** module under the **CPX-AP-A-PN** in **slot 1**.
4. Expand the **IO-Link Master Modules** to locate the CPX-AP-A-4IOL-M12 Master module. Then, drag and drop the **CPX-AP-A-4IOL-M12** Master module under the **CPX-AP-A-PN** in **slot 3**.
5. Expand the **Submodules** to locate the diagnosis structure and status bits. Then, drag and drop the **Diagnosis structure** and **Status bits** submodule.
6. Expand the **IO-Link generic devices** to locate the IO-Link telegram; then, drag and drop the required IO-Link telegram under the CPX-AP-A-4IOL-M12 in the ports to activate them. If any ports are not in use, deactivate the remaining ports.



Note

- The I/O modules **highlighted** in the image can be configured using the same steps shown above. Configurations may vary depending on the network setup. For example, refer to the steps in the image above to add more modules to the network or under the main module.

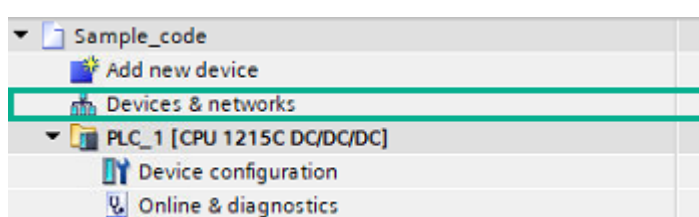
3.5.6 Finding the Slot and Sub Slot Number of CPX-AP-A Devices

Consider the following CPX-AP-A devices connected in the network. An SMS device is connected to the first port of the **CPX-AP-A-4IOL-M12** IO Link Master Module. The slot and sub-slot numbering will be as shown below.

Device overview								
Module	...	Rack	Slot	I address	Q address	Type	Article number	
▼ CPX-AP-A-PN		0	0			CPX-AP-A V1	CPX-AP-A	
▶ PN-IO Interface		0	0 X1			CPX-AP-A-PN		
▼ CPX-AP-A-PN-M12_1		0	1			CPX-AP-A-PN-M12	8129241	
CPX-AP-A-PN-M12		0	1 1			CPX-AP-A-PN-M12	8129241	
Diagnosis structure		0	1 2	2...14		Diagnosis structure		
Status bits		0	1 3	15		Status bits		
		0	1 4					
		0	1 5					
CPX-AP-A-12DI4DO-M12-5P_1		0	2	0...1	0	CPX-AP-A-12DI4DO...	8129111	
▼ CPX-AP-A-4IOL-M12_1		0	3			CPX-AP-A-4IOL-M12	8129114	
CPX-AP-A-4IOL-M12		0	3 1			CPX-AP-A-4IOL-M12	8129114	
IO-Link In/Out 2/ 2 Byte + PQI		0	3 Port 1	16...18	1...2	IO-Link In/Out 2/ 2 ...		
Port deactivated		0	3 Port 2			Port deactivated	Port deactivated	
Port deactivated_1		0	3 Port 3			Port deactivated	Port deactivated	
Port deactivated_2		0	3 Port 4			Port deactivated	Port deactivated	
		0	4					

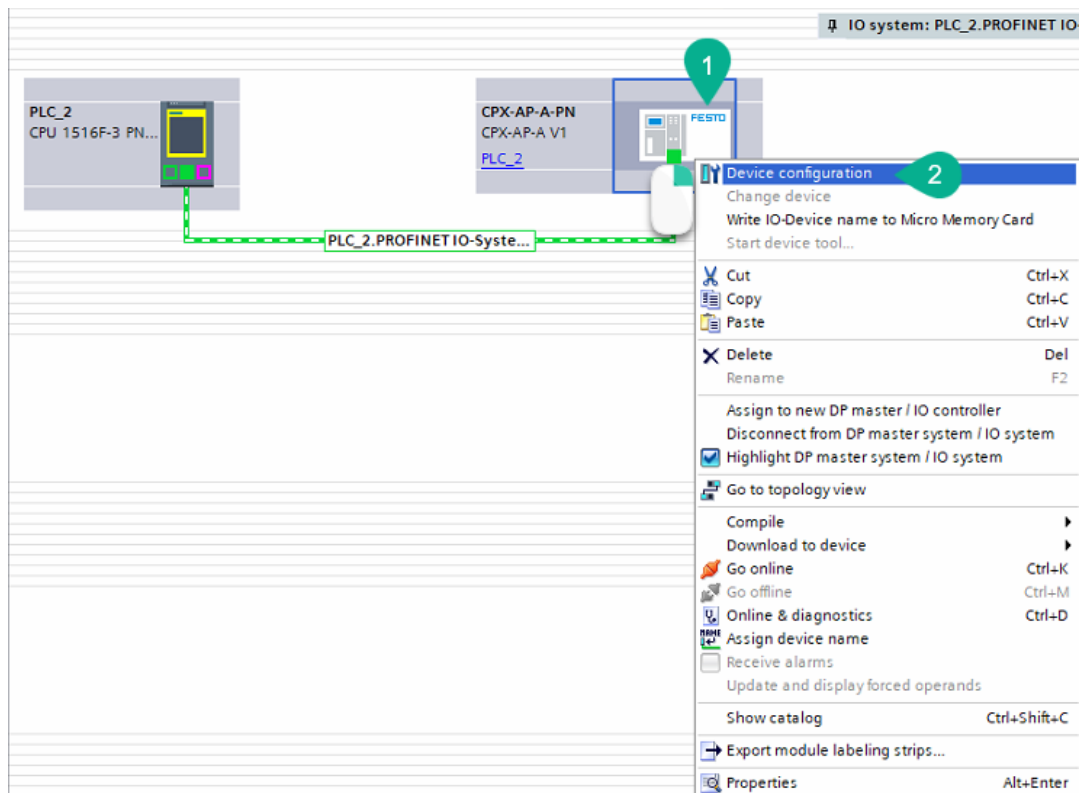
3.5.7 Determining Hardware ID of CPX-AP-A-PN-M12 Module

Step 1



Double click on **Devices and Networks** to go to network view.

Step 2



1. Right click on **AP-A-PN** from the Network view
2. Click on **Device Configuration** from the right click menu.

The Device Configuration tab will be displayed as shown below **Step 3**.

Step 3

The screenshot shows the HW Config interface. The 'Device overview' table lists modules in a rack. The 'Properties' tab is active, showing the 'System constants' sub-tab. A table of hardware identifiers is displayed below.

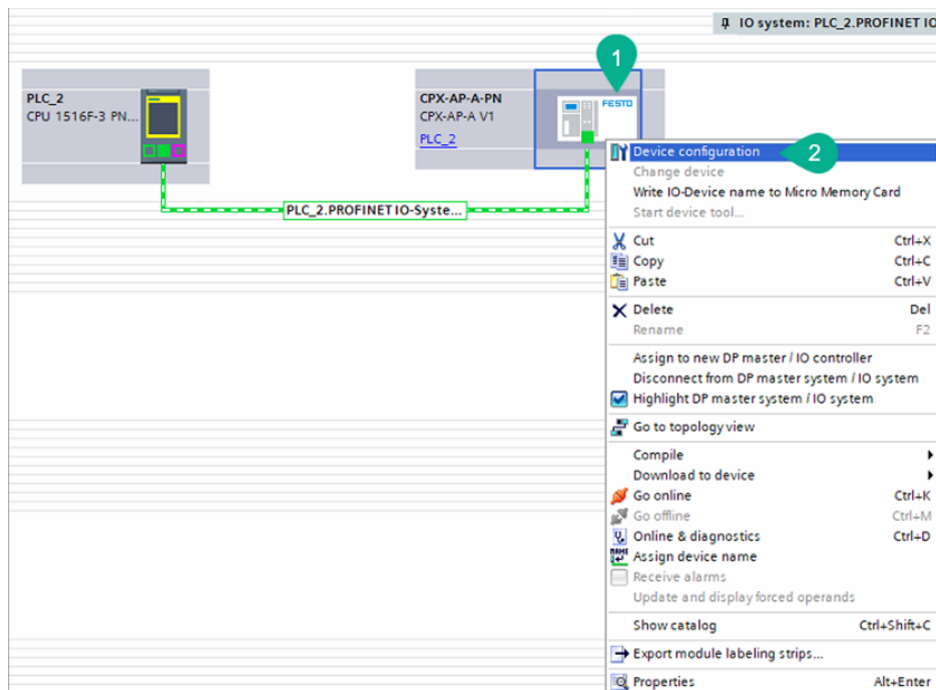
Name	Type	Hardware identi.	Used by	Comment
CPX-AP-A-PN-CPX-AP-A-PN-M12_1	Hw_SubModule	268	PLC_2	
CPX-AP-A-PN-CPX-AP-A-PN-M12_1	Hw_SubModule	265	PLC_2	
CPX-AP-A-PN-CPX-AP-A-PN-M12_1-Diagnosis_struct...	Hw_SubModule	269	PLC_2	
CPX-AP-A-PN-CPX-AP-A-PN-M12_1-Status_bits	Hw_SubModule	270	PLC_2	

1. Click on **CPX-AP-A-PN-M12_1** device from Device overview tab.
2. Click on **Properties** tab to view the **CPX-AP-A-4IOL-M12** properties.
3. Click on **System constants** tab to find the Hardware id.
4. Find the HW_ID of CPX-AP-A-PN-M12 module from Hardware identifier column.

3.5.8 Determining Hardware ID of CPX-AP-A-4IOL-M12 IO Link Module.**Step 1**

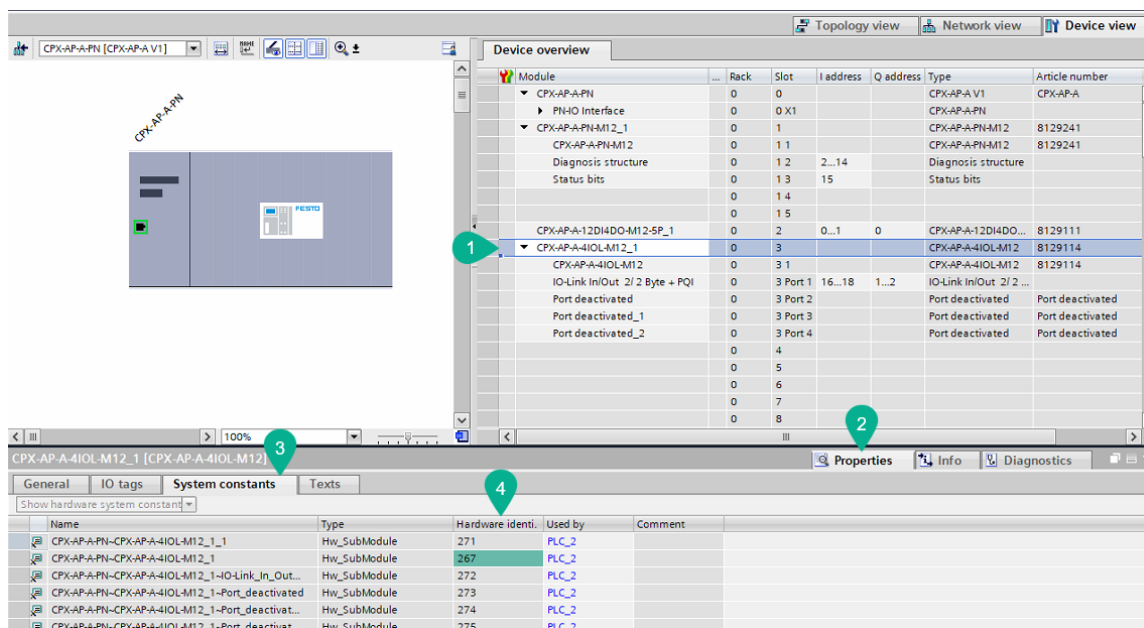
The screenshot shows the 'Sample_code' tree in the HW Config software. The 'Devices & networks' folder is highlighted with a red box.

Double click on **Devices and Networks** to go to network view.

Step 2

1. Right click on **CPX-AP-A-PN** from the Network view
2. Click on **Device Configuration** from the right click menu.

The Device Configuration tab will be displayed as shown below **Step 3**.

Step 3

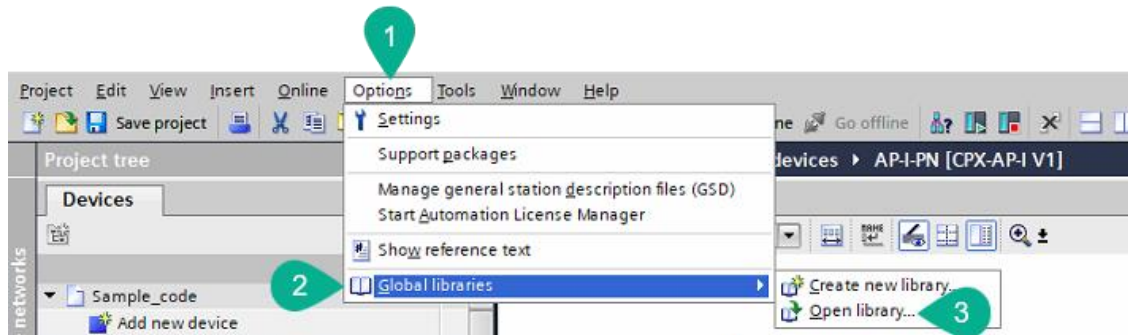
1. Click on **CPX-AP-A-4IOL-M12** device from Device overview tab.
2. Click on **Properties** tab to view the CPX-AP-A-4IOL-M12 properties.
3. Click on **System constants** tab to find the Hardware id.
4. Find the HW_ID of CPX-AP-A-4IOL-M12 IO-Link master module from Hardware identifier column.

3.6 Adding CPX-AP_Festo_Lib Library into TIA Portal

Step 1

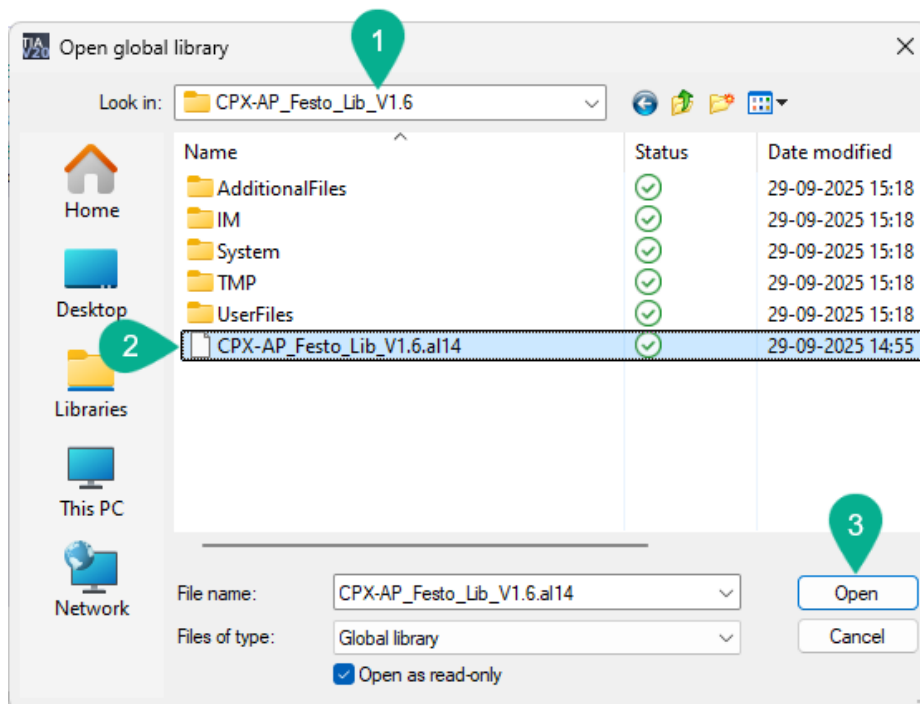
Download the CPX-AP_Festo_Lib_V1.6 library file from the Festo Support Portal and save it in an appropriate folder on your PC.

Step 2



1. Click on **Options** menu from top menu bar.
2. Expand the **Global libraries** options.
3. Click on **Open library** to open the library file.

Step 3



1. Choose the **path** where the library is saved in the system.
2. Select the **Library file** from Open global library window.
3. Click on **Open** to import the library to Global libraries.

Step 4

The screenshot shows the 'Global libraries' pane in TIA Portal. The tree structure is as follows:

- Global libraries
 - Buttons-and-Switches
 - Long Functions
 - Monitoring-and-control-objects
 - Documentation templates
 - CPX-AP_Festo_Lib_V1.6_V20** (Callout 2)
 - Types
 - S7-1200
 - FunctionBlocks
 - CPXAP_Diag
 - CPXAP_IOLink_Parameter
 - CPXAP_Parameter
 - IOLink_typeDiagnostics
 - stDiagnostics
 - S7-1500 (Callout 3)
 - FunctionBlocks
 - CPXAP_Diag
 - CPXAP_IOLink_Parameter
 - CPXAP_Parameter
 - IOLink_typeDiagnostics
 - stDiagnostics

Callout 1 points to the 'IOLink_typeDiagnostics' block in the S7-1500 library. Callout 2 points to the 'CPX-AP_Festo_Lib_V1.6_V20' library. Callout 3 points to the 'S7-1500' library.

1. Click on **Libraries** to view the opened library.
2. Expand **CPX-AP_Festo_Lib_V1.6** to find the all Library folders.
3. Expand **Types** folder to find the Library sub folders.

The Library sub folder S7-1200/1500 has following Blocks and Supporting files.

For S7-1200 and S7-1500 integration with CPX-AP devices, Library has 3 Function Blocks and 2 User data type file namely.

Function Blocks

1. CPXAP_Parameter
2. CPXAP_IOLink_Parameter
- 3.
4. CPXAP_Diag

User Data Type

1. IOLink_typeDiagnostics
2. stDiagnostics

3.7 Adding Function blocks and Supporting files to Program



Drag and drop the Folder **S7-1500** from the Library to the folder **Program Blocks** in the project.



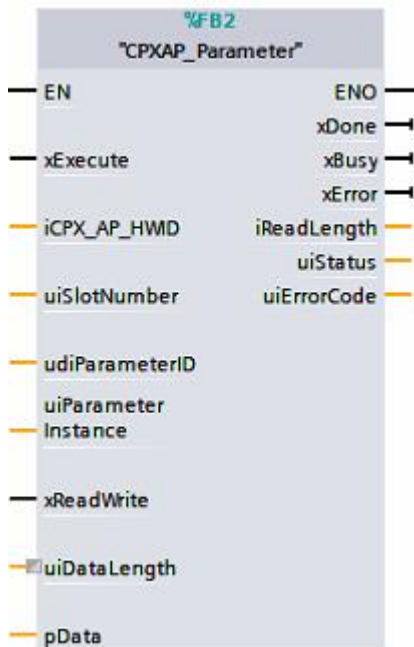
Note

- Depending on the type of PLC CPU configuration used, the user can drag and drop the library file into the program block. Two types of function blocks are available: S7-1200 and S7-1500.

4 CPX-AP_Festo_Lib Library Function Blocks

4.1 CPXAP_Parameter

CPXAP_Parameter function block used to read and write a Parameter in CPX-AP modules. Parameters can access through ISDU (Index Service Data Units) values. The function block looks like below.



4.1.1 CPXAP_Parameter Block In-Out Variables

In-Out Variables	Data Type	Description
pData	VARIANT	Variable to be Read/Written with the corresponding Parameter Data Type. Example : If the User wants to read or write a Parameter which is of the Data Type Integer , then a variable of the Data Type Integer must be linked to pData.

Table 4.1: CPXAP_Parameter Block In-Out Variables description

4.1.2 CPXAP_Parameter Block Input Variables

Input Variables	Data Type	Description
xExecute	BOOL	TRUE – Parameter Read/Write
iCPX_AP_HWID	HW_ANY	Hardware ID of CPX-AP-.PN-M12 module. Refer Chapter 3.4.7 or Refer Chapter 3.5.7 to determine the Hardware ID of CPX-AP-.PN-M12 module.
uiSlotNumber	UINT	Slot Number of the device whose Parameter is Read or Write. Refer Chapter 3.4.6 or Refer Chapter 3.5.6 to determine the Slot number of the CPX-AP devices connected in the Network.
udiParameterID	UDINT	ID of the Parameter that needs to be read or written to. Refer the CPX-AP-. device Manuals to get to know the Parameter ID.
uiParameterInstance	UINT	Instance of the Parameter. Refer the CPX-AP-. device Manuals to get to know the Parameter Instance.
xReadWrite	BOOL	FALSE – Read Parameter. TRUE – Write Parameter.
uiDataLength	UINT	Number of Bytes of data to be Read or Written using the Function Block.

Table 4.2: CPXAP_Parameter Block Input Variables descriptions

4.1.3 CPXAP_Parameter Block Output Variables

Output Variables	Data Type	Description
xDone	BOOL	TRUE – Parameter Read or Write Finished.. FALSE - Parameter Read or Write not yet finished.
xBusy	BOOL	TRUE – Parameter Read or Write started. FALSE – Parameter Read or Write not yet started or it's completed.
xError	BOOL	TRUE – Parameter Read or Write has an error. FALSE – No error during Parameter Read or Write
iReadLength	INT	Number of bytes of Parameter Data read.
uiStatus	UINT	Status of Read or Write operation. The below status values are in Decimal . 1 – Parameter Read or Write successful. 67 – Status Error. Parameter Read or Write Failed.
uiErrorCode	UINT	Gives the error code of the error occurred during Parameter Read or write . The below error code values are in Decimal . 1 – Invalid Parameter ID given. 8 – Invalid Data Length given .

Table 4.3: CPXAP_Parameter Block Output Variables descriptions

4.2 CPXAP_IOLink_Parameter

This Function block is used to read & write Parameter in sub-modules of CPX-AP-.4IOL-M12. User can either read or write one IO-Link Parameter in single execution. IO-Link Parameters are access through ISDU (Index Service Data Units). The **CPXAP_IOLink_Parameter** function block looks like below.



4.2.1 CPXAP_IOLink_Parameter Block In-Out Variables

In-Out Variables	Data Type	Description
pData	VARIANT	Variable to be Read/Written with the corresponding Parameter Data Type. Example : If the User wants to read or write a Parameter which is of the Data Type Integer , then a variable of the Data Type Integer must be linked to pData.

Table 4.4: CPXAP_IOLink_Parameter Block In-Out Variables description

4.2.2 CPXAP_IOLink_Parameter Block Input Variables

Input Variables	Data Type	Description
xExecute	BOOL	TRUE – Parameter Read/Write
HW_ID	HW_ANY	Hardware ID of CPX-AP-.-4IOL IO Link Master module . Refer Chapter 3.4.8 or Refer Chapter 3.5.8 to determine the Hardware ID of CPX-AP-.-4IOL IO Link Master module .
iPort	INT	The port of the CPX-AP-.-4IOL IO Link Master module to which the IO Link device is connected.
iIndex	INT	Index of the Parameter of IO Link device. Refer IO Link device manual.
iSubIndex	INT	Sub Index of the Parameter of IO Link device. Refer IO Link device manual.
xWrite	BOOL	FALSE – Read Parameter. TRUE – Write Parameter.
iWriteDataLength	INT	Number of Bytes of data to be Read or Written using the Function Block.
timeout	Time	Time after which a command is cancelled

Table 4.5: CPXAP_IOLink_Parameter Block Input Variables descriptions

4.2.3 CPXAP_IOLink_Parameter Block Output Variables

Output Variables	Data Type	Description
xDone	BOOL	TRUE – Parameter Read or Write Finished.. FALSE - Parameter Read or Write not yet finished.
xBusy	BOOL	TRUE – Parameter Read or Write started. FALSE – Parameter Read or Write not yet started or it's completed.
xError	BOOL	TRUE – Parameter Read or Write has an error. FALSE – No error during Parameter Read or Write
iReadLength	INT	Number of bytes of Parameter Data Read.
wStatus	WORD	Status of Read or Write operation. Refer Chapter 4.2.4 for detailed information.
diagnostics	IOLink_typeDiagnostics	Detailed diagnostic information of the FB. Refer Chapter 4.2.5

Table 4.6: CPXAP_IOLink_Parameter Block Output Variables descriptions

4.2.4 wStatus

The wstatus output the current status and any errors, while the diagnostics output provides a diagnostic structure with detailed information in the event of an error.

Status Value	Status Description
16#0000	Operation completed, no warning and no further details
16#7000	No operation in progress (initial value)
16#7001	First call after input of a new command (rising edge on "execute")
16#7002	Subsequent call
16#8201	Unsupported port
16#8202	Unsupported index
16#8203	Unsupported subindex
16#8205	The length at the "writeLen" Parameter does not match the data record that will be written
16#8401	The IO-Link master has reported an error code, see "diagnostics"
16#8402	Received data record does not match operation
16#8403	Operation could not be completed in the specified time
16#8600	Internal state machine has reached an undefined state

Status Value	Status Description
16#8601	System function WRREC reports an error, see "diagnostics"
16#8602	System function RDREC reports an error, see "diagnostics"
16#0000	Operation completed, no warning and no further details

Table 4.7: wStatus descriptions

4.2.5 Diagnostics

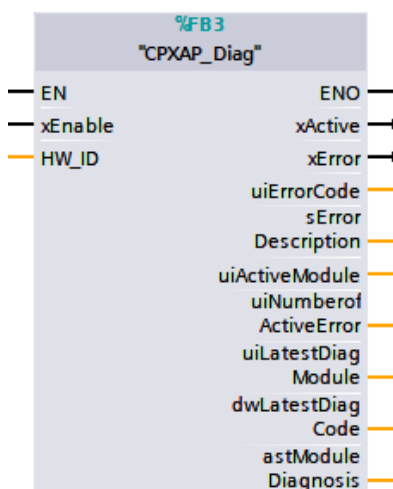
In the event of an error, the diagnostics output gives detailed information about the pending error.

Status Value	Status Description
status	Last status code of the interface Parameter "status" of the FB.
subfunctionStatus	Status of system functions RDREC/WRREC or error code from IO-Link master (%W1: Error code from IO-Link master, %W0: ISDU error code). For detailed information, refer to the Online Help for the system function in question, or the device manual of the IO-Link master/device.
stateNumber	State of the FB's state machine in which the error occurred.

Table 4.8: Diagnostics descriptions

4.3 CPXAP_Diag

The **CPXAP_Diag** function block performs automated diagnostic monitoring of Festo CPX/AP modules. It continuously reads status and error information from connected modules and detects faults.



4.3.1 CPXAP_Diag Block Input Variables

Input Variables	Data Type	Description
xEnable	BOOL	TRUE = Enable Function Block. Enable signal to start the diagnosis process.
HW_ID	HW_ANY	Hardware ID of CPX-AP-.PN-M12 module . Refer Chapter 3.4.7 or Refer Chapter 3.5.7 to determine the Hardware ID of CPX-AP-.PN-M12 module .

Table 4.9: CPXAP_Diag Block Input Variables descriptions

4.3.2 CPXAP_Diag Block Output Variables

Output Variables	Data Type	Description
xActive	BOOL	TRUE = Function Block is enabled. Status flag indicating that diagnosis is active.
xError	BOOL	TRUE = An error occurred while reading diagnosis parameters. Error flag indicating a diagnosis error.
uiErrorCode	UINT	Numeric code of the last error detected during diagnosis.
sErrorDescription	STRING	Detailed description of the last error related to the function block operation refer chapter 4.5.1 .
uiActiveModule	UINT	Number of active modules detected in the system. Used to limit the scan range and validate module count (max 80).
uiNumberOfActiveError	UINT	Count of modules currently in an error state matching defined criteria.
uiLatestDiagModule	UINT	Index of the module with the latest detected error.
dwLatestDiagCode	DWORD	Detailed error code from the latest diagnostic event.
astModuleDiagnosis	STRUCT of the type Array [1..80] of "stDiagnostics"	Array holding diagnostic information for each module, including error status (xModuleError) and detailed error codes (dErrorCode).

Table 4.10: CPXAP_Diag Block Output Variables descriptions

4.4 Structure Data Type

4.4.1 stDiagnostics

Structure Variables	Type	Description
xModuleError	BOOL	Indicates whether the module has an error (TRUE = error present, FALSE = no error).
dErrorCode	DWORD	detailed 32-bit error code constructed from multiple bytes of error data, representing the full diagnostic code for the module. For additional errors, refer chapter 4.5.2 .

Table 4.11: stDiagnostics descriptions

4.5 String Description

4.5.1 sErrorDescription

Status Value	Status Description
16#0000	No Error
16#1000	Communication Error/Invalid Hardware ID
16#2000	Invalid Module Count Input

Table 4.12: sErrorDescription descriptions

4.5.2 dErrorCode

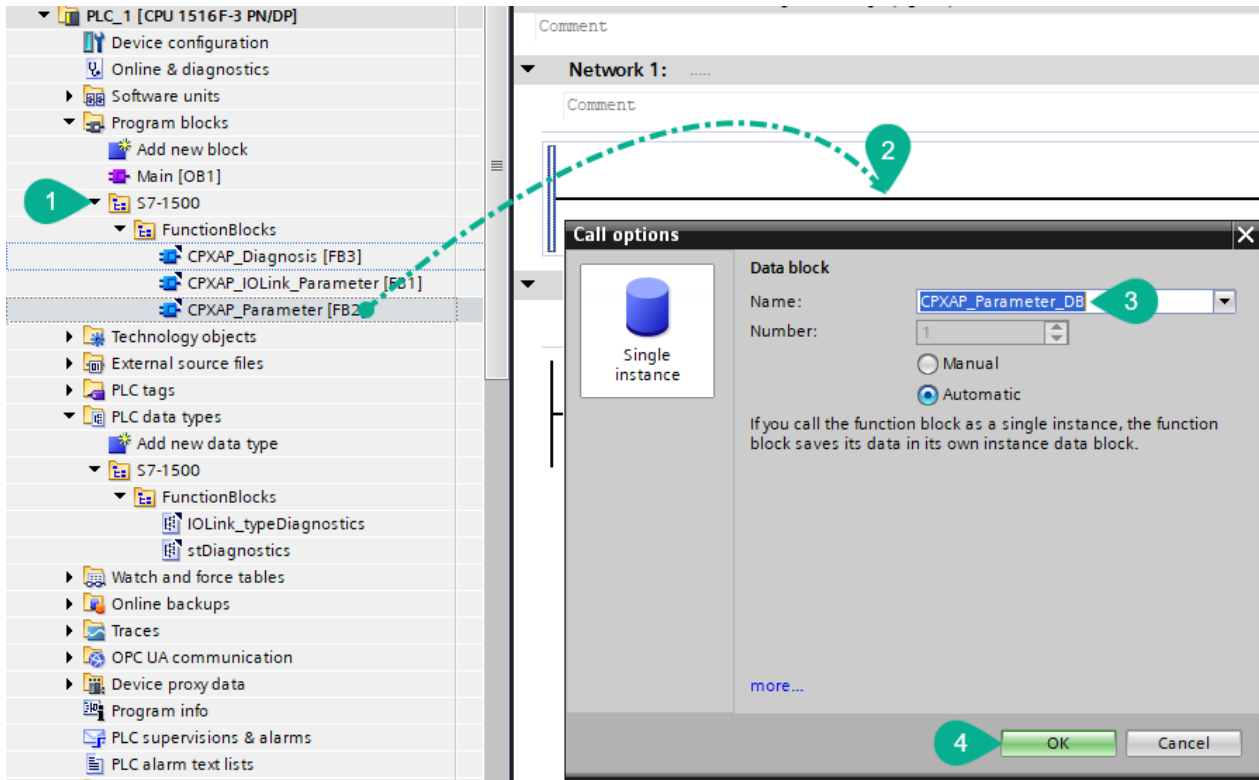
Status Value	Status Description
16#0000	No Error
16#0801	Device remove or added

Table 4.13: dErrorCode descriptions

5 Configuration of CPX-AP Festo Function blocks in TIA Portal

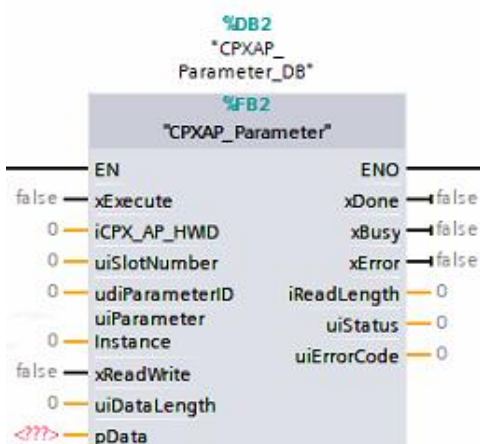
5.1 Configuring the CPX-AP Library Function Blocks

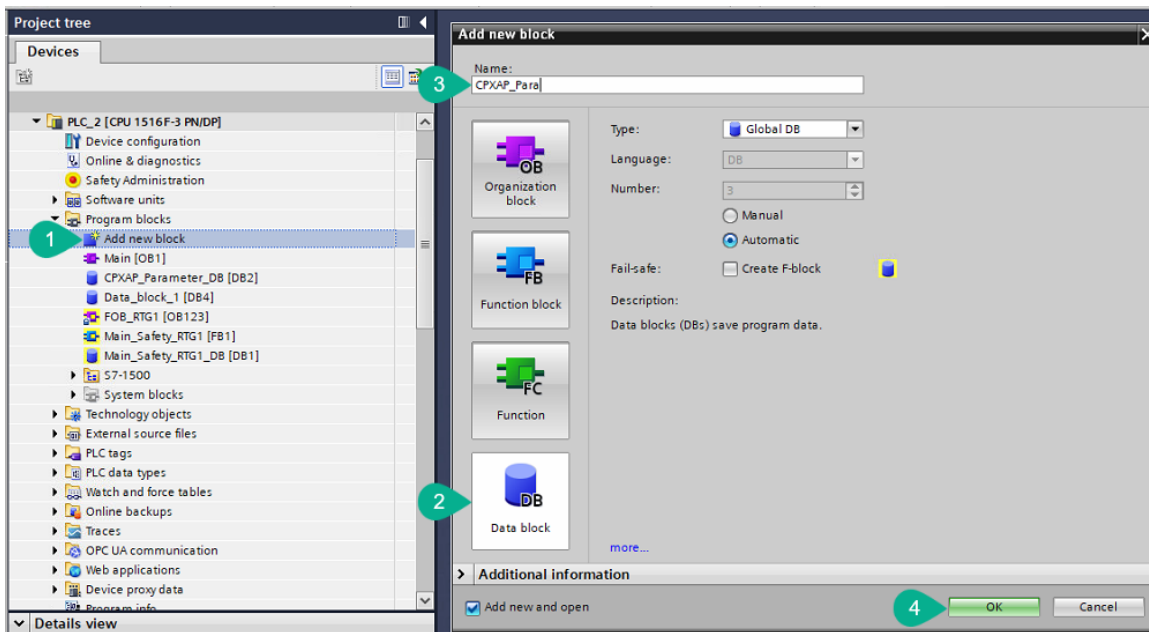
Step 1



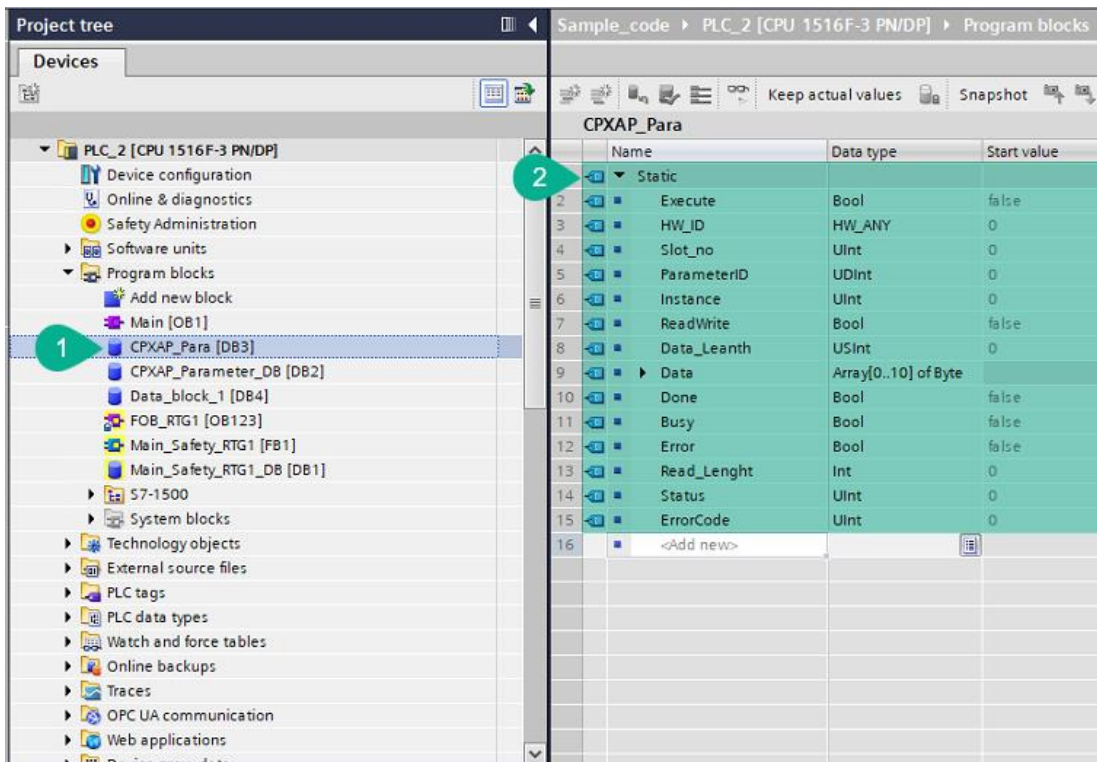
1. Expand the **S7-1500** and Function Blocks folders to find all the available function blocks.
2. Drag and drop the **CPXAP_Parameter** block into the Main Program OB; the Call Options window will appear.
3. Enter the **name** of the DB instance in the Name field.
4. Click **OK** to confirm the name and close the Call Options tab.

The called function block is shown below.



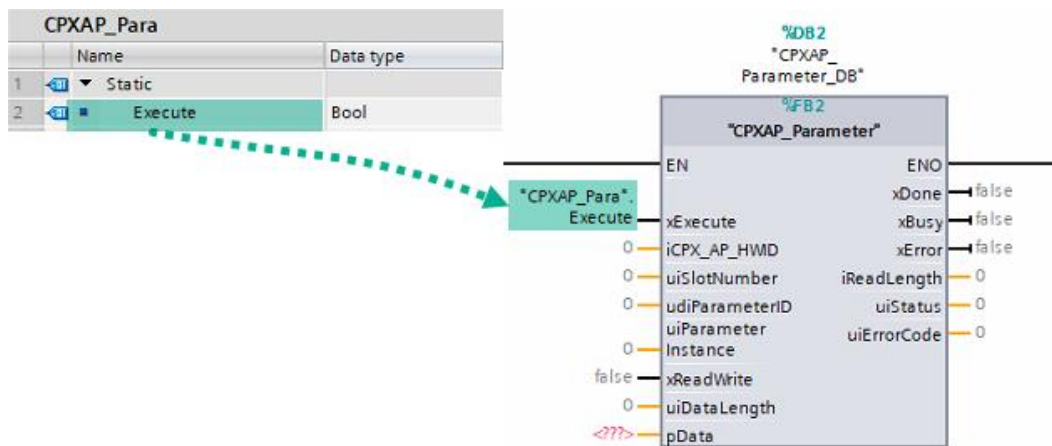
Step 2

1. Double-click on **Add new block** to initiate the creation of a data block for **CPXAP_Parameter** FB.
2. Select **Data Block** Type: Choose the option to create a Global Data (DB).
3. Enter the required name for the data block in Name field.
4. Click **OK** to confirm the DB name and close the Add new block window.

Step 3

1. Double-click on the **CPXAP_Para** DB to create the required tags.
2. Create all required tags inside the Data Block and assign the necessary data types for each tag.

Step 4



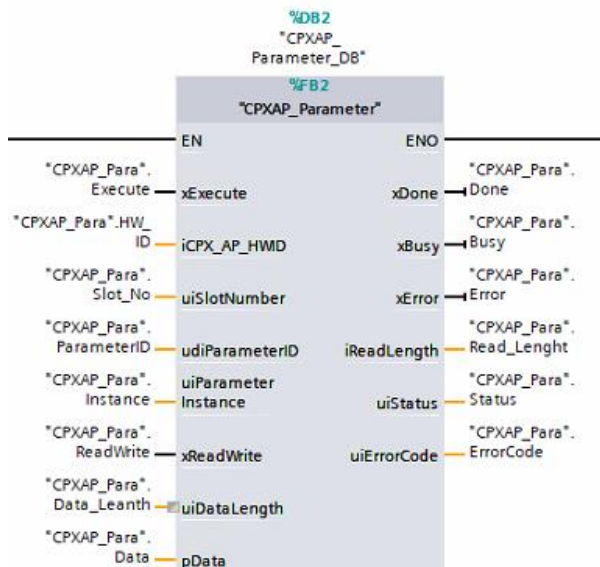
Drag and Drop the **Execute** tag from **CPXAP_Para** Data block to **xExecute** input tag in **CPXAP_Parameter** function block.



Note

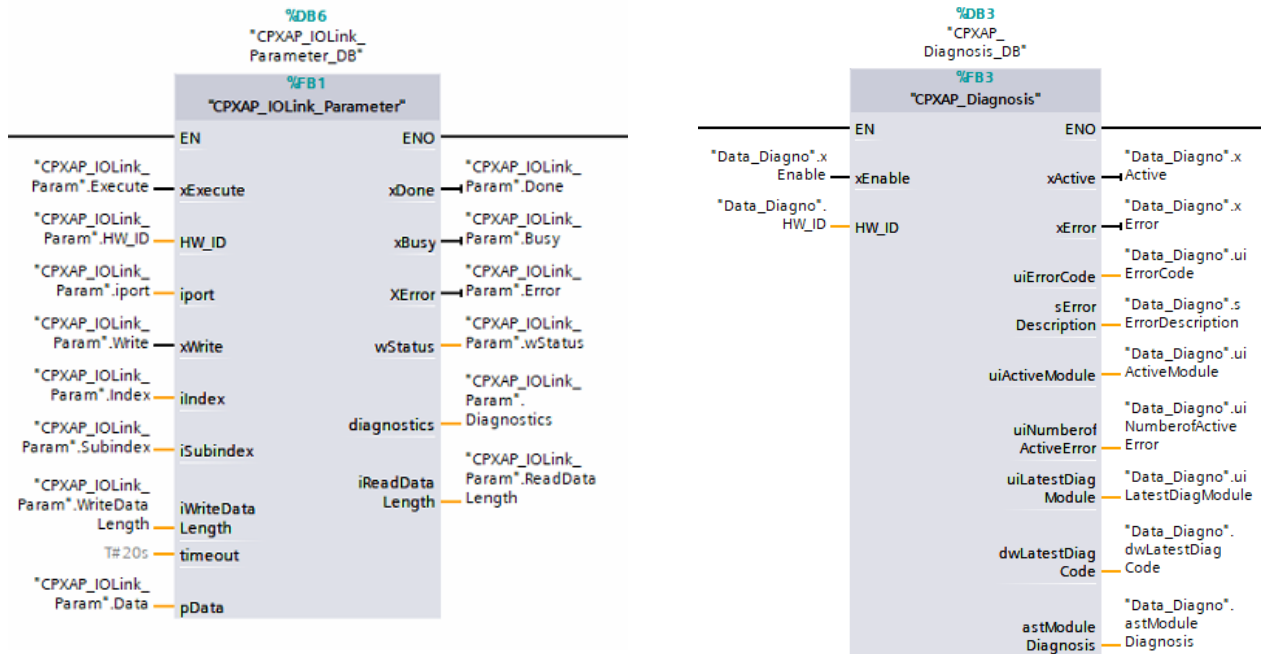
- Repeat Step 4 for create and assign the different input & output tags in function block.

Once all tags have been assigned successfully, the **CPXAP_Parameter** Function Block will look like the one below.



Follow the same steps mentioned above to assign all relevant tags for the **CPXAP_IOLink_Parameter** and **CPXAP_Diagnosis** function blocks.

Once all tags have been assigned successfully, the **CPXAP_IOLink_Parameter** and **CPXAP_Diagnosis** function blocks will appear as shown below.



6 Sample Code for CPX-AP -.- PN Function Blocks

This sample code is used to control, read or write Parameters and diagnostic data of CPX-AP-.-PN module and it's sub-modules connected to Siemens PLC through PROFINET **CPX-AP_Festo_Lib_V1.3** library FBs.

6.1 Sample Code for Read and Write the Parameter Using CPXAP_Parameter FB

To read the Parameter **Configuration of voltage monitoring load supply PL**, refer to the CPX-AP-.-PN-M12 device manual for detailed information.

ID	Parameter	Instance- s	Data type	Access ¹⁾	Arraysi ze
20022	Configuration of voltage monitoring load supply PL – 0: load voltage monitoring inactive – 1: load voltage monitoring active, with suppression of diagnostics at switch-off (factory setting) – 2: load voltage monitoring active	1	UINT8	rw	–

From the **CPX-AP-.-PN-M12** device manual, we learn that the Parameter **Configuration of voltage monitoring load supply PL** has a data type of **UINT8**. Since the data type of the Parameter is **UINT8**, we need to use a variable of the data type **USINT** to **read/write** the Parameter data.

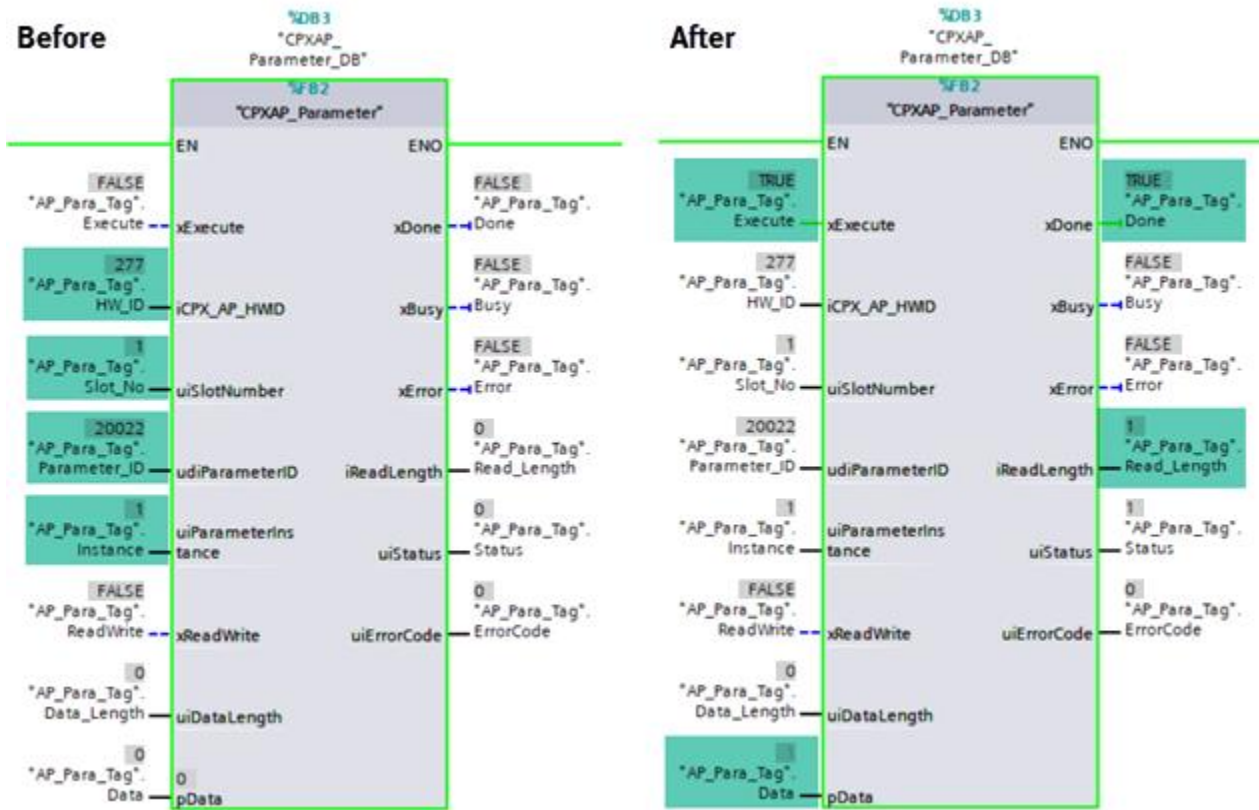
Example to Modify the Data Type in Data Block.

CPXAP_Para				
	Name	Data type	Start value	Retain
1	Static			☐
2	Execute	Bool	false	☐
3	HW_ID	HW_ANY	0	☐
4	Slot_No	UInt	0	☐
5	ParameterID	UDInt	0	☐
6	Instance	UInt	0	☐
7	ReadWrite	Bool	false	☐
8	Data_Leanth	USInt	0	☐
9	Data	USInt	0	☐
10	Done	Bool	false	☐
11	Busy	Bool	false	☐
12	Error	Bool	false	☐
13	Read_Lenght	Int	0	☐
14	Status	UInt	0	☐
15	ErrorCode	UInt	0	☐

Change the required data type of the data variable in the **Data Block** to **USINT**.

6.1.1 Sample Code for Read a Parameter Using CPXAP_Parameter Function block

This sample code is used to read the port mode of the CPX-AP IOLink Master. The module number, Parameter ID, and instance are available in the CPX-AP manual, as shown above.



1. Enter the Hardware ID in the **iCPX_AP_HWID** input tag.
2. Enter the corresponding slot number in the **uiSlotNumber** input tag.
3. Enter the Parameter ID number in the **uiParameterID** input tag.
4. Enter the instance number in the **uiInstance** input tag.
5. Set **xReadWrite** to **FALSE** if the Parameter read function is executed.
6. Once all the Parameters entered in the input tags then toggle the **xExecute** tag to proceed read process.
7. Once Parameters value reading are successful then the monitor tag **xDone** will be in true state.
8. And user will get the Read data length in the **iReadLength** monitor tag.
9. And Read data will be stored in the **pData** tag as shown in above picture.



Note

- Refer Chapter 3.4.7 or Chapter 3.4.8 to know the Hardware ID of CPX-AP-PN-M12.
- Refer Chapter 3.4.6 to know the Slot number of CPX-AP-PN-M12.

6.1.2 Sample Code for Write a Parameter Using CPXAP_Parameter Function block



1. Enter the Hardware ID in the **ICPX_AP_HWID** input tag.
2. Enter the corresponding slot number in the **uiSlotNumber** input tag.
3. Enter the Parameter ID number in the **uiParameterID** input tag.
4. Enter the instance number in the **uiInstance** input tag.
5. Toggle the **xReadWrite** control tag from false to true to enable the write sequence.
6. Enter the write Parameter length in the **uiDataLength** input tag.
7. Enter the write data value in **pData** tag as shown in above picture.
8. Once all the Parameters entered in the input tags then toggle the **xExecute** tag to proceed write process.
9. Once Parameters value reading are successful then the monitor tag **xDone** will be in true state.



Note

- Refer Chapter 3.4.7 or Chapter 3.4.8 to know the Hardware ID of CPX-AP-PN-M12.
- Refer Chapter 3.4.6 to know the Slot number of CPX-AP-PN-M12.

6.2 Sample Code for Read and Write the Parameter Using CPXAP_IOLink_Parameter FB

This sample code gives an example to read and write the **Speed In** Parameter of Simplified motion series device. The ISDU details of Speed In Parameter is inserted below. The Index & Subindex values of the Parameter to write operation is highlighted in below image.

For this sample code, a **Festo Simplified Motion Series device** is connected to **Port 1** of the **CPX-AP-.-4IOL-M12** IO-Link master module.

To read the Parameter of an IO-Link device, follow the procedures below:

Index (dec)	Sub- index	Name	Value / unit / gradi- ent	Access ¹⁾			Length (byte)	Format
				U	M	S		
Control parameters („Master » Device“)								
0x0100 (256)	0	Speed "In"	1 = 10% (default) ... 10 = 100%,	-	R/ W	R/ W	1	UInteger8

From the Parameter details, we find that the length of the Parameter **Speed In** is **UINT8**. Since the length of the Parameter is **UINT8**, we need to use a variable of the data type **USINT** to **read/write** the Parameter data.

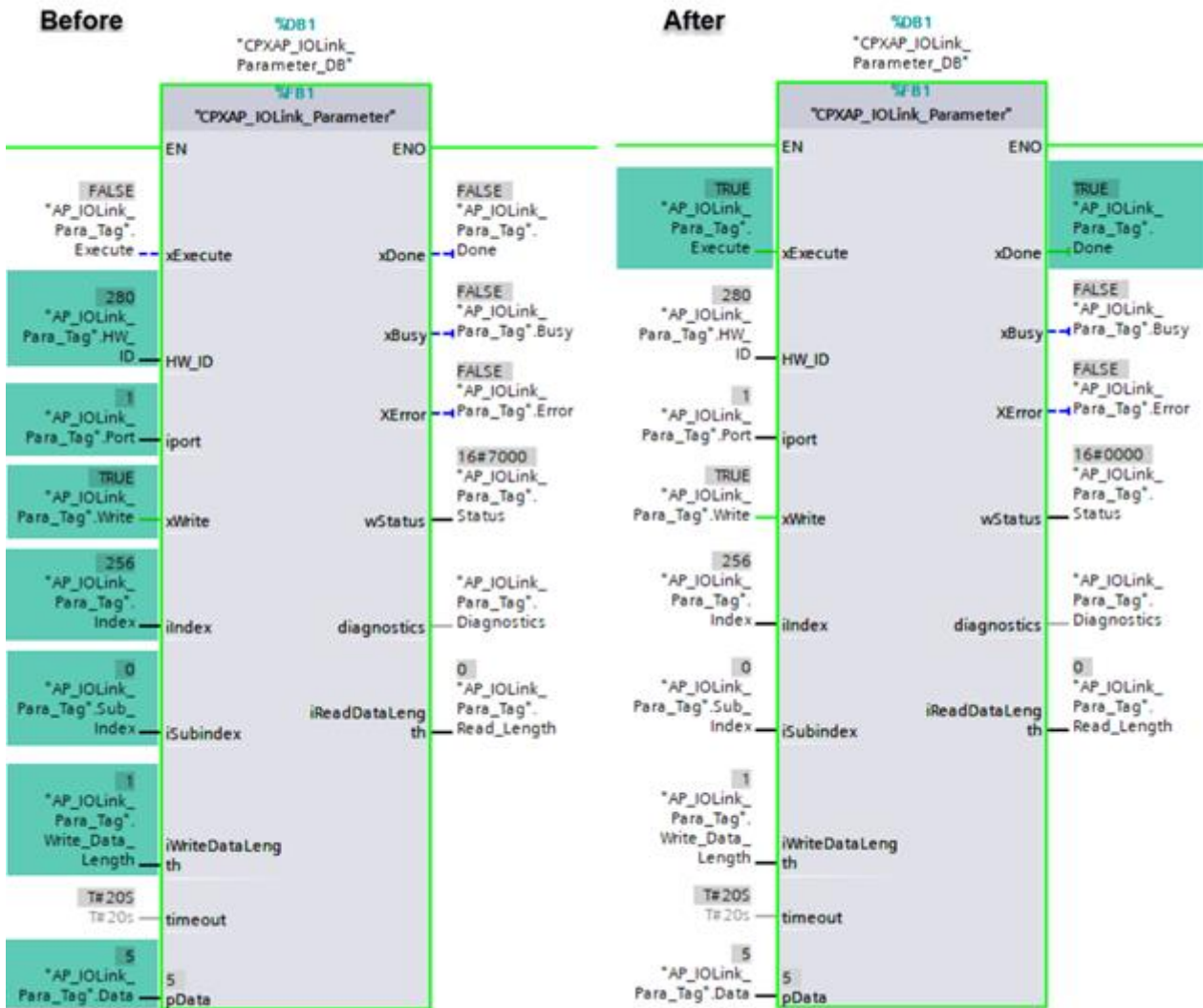
Let us consider an example where we need to read the Parameter **Speed In** of the Festo SMS device

Example to Modify the Data Type in Data Block.

CPXAP_IOLink_Param				
	Name	Data type	Start value	Retain
1	▼ Static			☐
2	Execute	Bool	false	☐
3	HW_ID	HW_IO	0	☐
4	iport	Int	0	☐
5	Write	Bool	false	☐
6	Index	Int	0	☐
7	Subindex	Int	0	☐
8	WriteDataLength	Int	0	☐
9	Timeout	Time	T#0ms	☐
10	Done	Bool	false	☐
11	Busy	Bool	false	☐
12	Error	Bool	false	☐
13	wStatus	Word	16#0	☐
14	► Diagnostics	*IOLink_typeDiagn...		☐
15	ReadDataLength	Int	0	☐
16	Data	USInt	0	☐

Create a variable of the data type **USINT** in the Data Block.

6.2.1 Sample Code for Write a Parameter Using CPXAP_IOLink_Parameter Function block



1. Enter the Hardware ID of the CPX-AP.-4IOL-M12 module in the **HW_ID** input tag.
2. Enter the corresponding Port number in the **iPort** input tag.
3. Enter the Index number in the **iIndex** input tag.
4. Enter the Subindex number in the **iSubindex** input tag.
5. Toggle the **xWrite** control tag from false to true to enable the write sequence.
6. Enter the write Parameter memory size in bytes in the **iWriteDataLength** input tag.
7. Enter the write data value in the **pData** tag, as shown in the picture above.
8. Once all the Parameters are entered in the input tags, toggle the **xExecute** tag to proceed with the write process.
9. Once the Parameter values are successfully written, the monitor tag **xDone** will be in a true state.

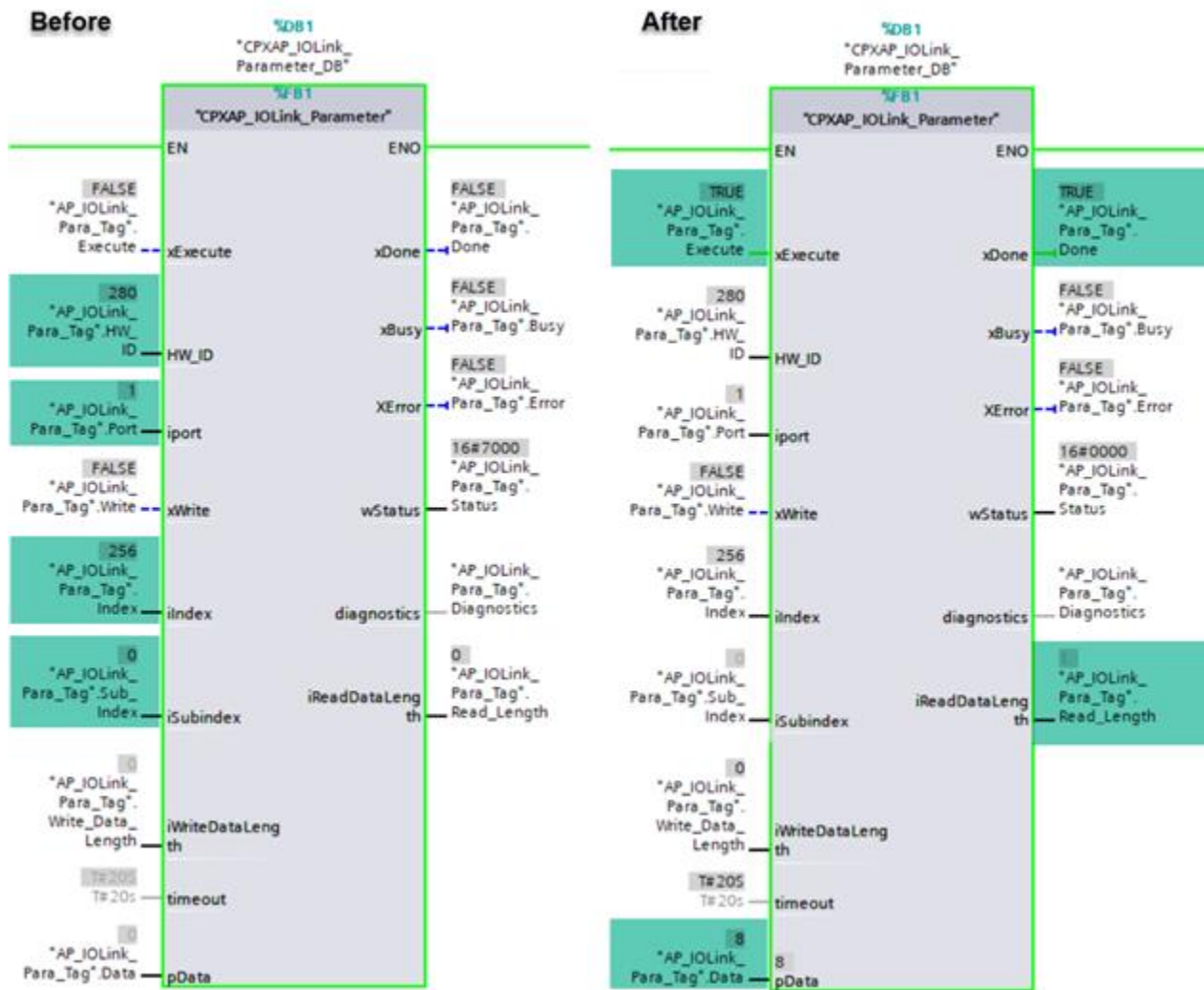


Note

Parameter read or write will be unsuccessful for any of the following reasons:

- The wrong Hardware ID of the CPX-AP.-4IOL-M12 module is entered.
- The Function Block is given the wrong Parameter Index or Parameter Subindex.
- An incorrect Port number is provided as input, along with an incorrect Data Length for reading or writing.

6.2.2 Sample Code for Read a Parameter Using CPXAP_IOLink_Parameter Function block



1. Enter the Hardware ID of the CPX-AP.-4IOL-M12 module in the **HW_ID** input tag.
2. Enter the corresponding Port number in the **iPort** input tag.
3. Enter the Index number in the **iIndex** input tag.
4. Enter the Subindex number in the **iSubindex** input tag.
5. Ensure that the **xWrite** control tag is set to false.
6. Once all the Parameters are entered in the input tags, toggle the **xExecute** tag to proceed with the read process.
7. Once the Parameter values have been successfully read, the monitor tag **xDone** will be in a true state.
8. The user will receive the read data length in the **iReadDataLength** monitor tag.
9. The read data will be stored in the **pData** tag, as shown in the picture above.

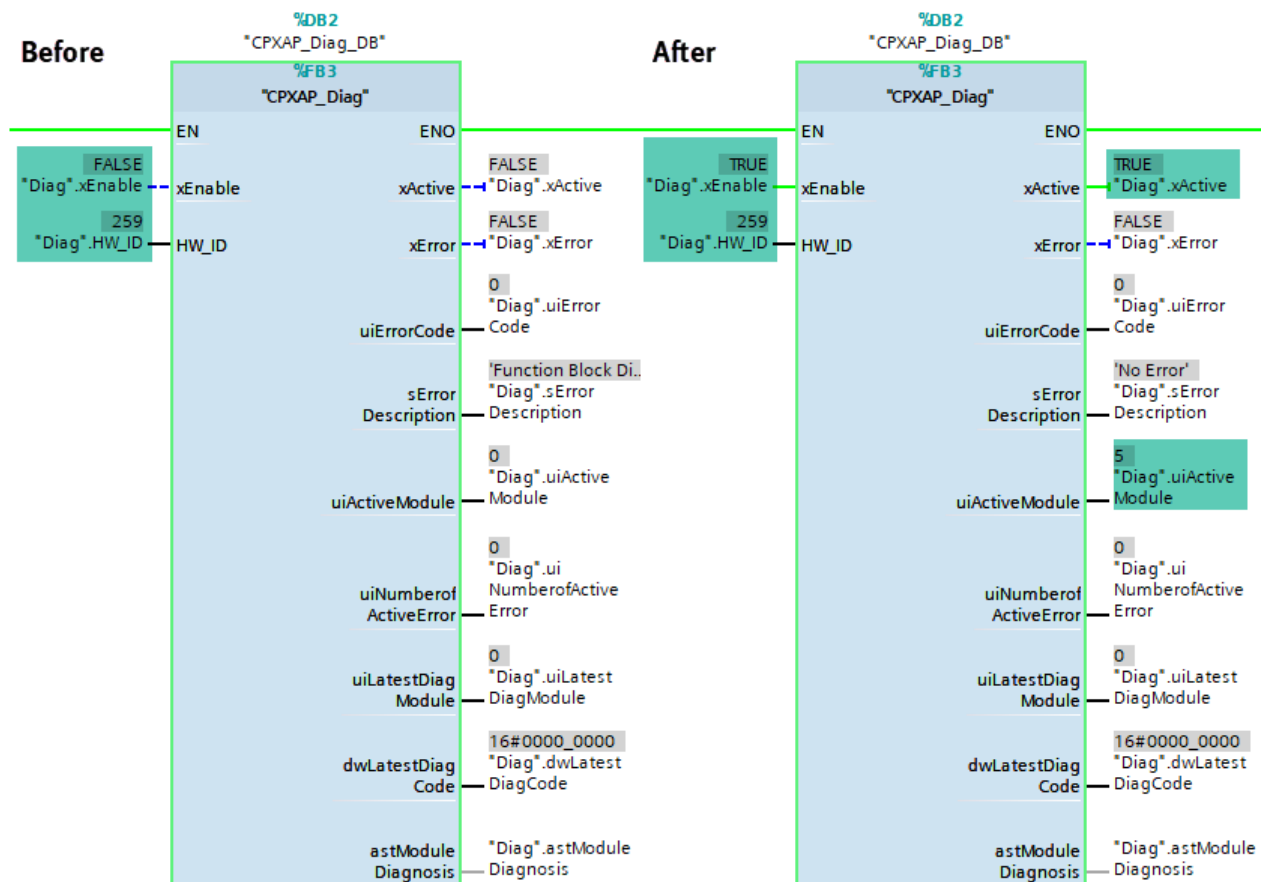


Note

- Refer [Chapter 3.4.7](#) or [Chapter 3.4.8](#) to know the Hardware ID of CPX-AP.-4IOL.

6.3 Sample Code For CPXAP_Diag Function Block

6.3.1 Sample Code for the CPXAP-Diag Function Block

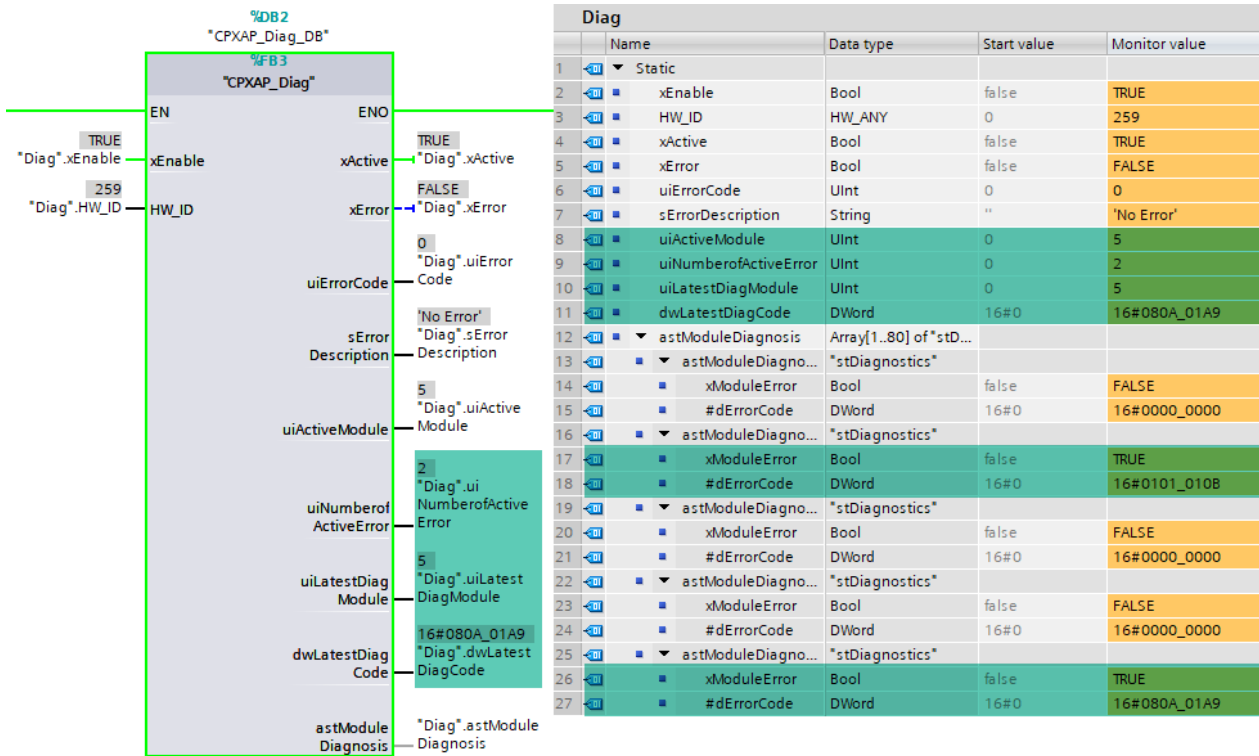


1. Enter the **HW_ID** value (e.g., 259) in the **HW_ID** input tag. [Refer Chapter 3.4.7](#) or [Refer Chapter 3.5.7](#) for more details.
2. Set the input tag **xEnable** to **TRUE** to activate the CPXAP-Diag function block.
3. Observe the **xActive** output tag change to **TRUE**, indicating the function block is running.
4. Check the **xError** output tag remains **FALSE**, meaning no error is detected.
5. Verify the **uiErrorCode** output tag is **0**, confirming no error code is present.
6. Review the **sErrorDescription** output tag to confirm it displays "**No Error**".
7. Note the **uiActiveModule** output tag updates to reflect the currently active module (e.g., 5).

6.3.2 Sample Code of Diagnostic Using CPXAP-Diag Function Block

In the example below, a of short circuits and No IO-Link device connected (SMS)are present in the following modules.

- Module 2 - CPX-AP-I-8DI-M8-3P.
- Module 5 – CPX-AP-I-4IOL-M12



1. Note the **uiActiveModule** output, which shows the active module number (e.g., 5).
2. Check **uiNumberOfActiveError** to see how many active errors are present (e.g., 2).
3. Check **uiLatestDiagModule** and **dwLatestDiagCode** for the latest diagnostic information.
4. Review the **astModuleDiagnosis** array for each module's error status and error codes:
 - Modules with **ModuleError = TRUE** have active errors, indicated by their corresponding **dwErrorCode** values.
 - Modules with **ModuleError = FALSE** have no errors, and their **dwErrorCode** value will be 0.

6.4 Sample Code For Extended Submodule Diagnosis

Follow the device configuration as outlined in [Refer Chapter 3.4.5](#), step 3. Additionally, highlight the diagnosis structure and status bits submodule to be added under the CPX-AP-I-PN-M12 module, as shown in the image below.

6.4.1 Diagnosis Structure

The diagnosis structure for the submodule is available starting from firmware version 1.5.8 and can be added with basic diagnosis information in the process data input.

Structure Variables	Offset	Data Type	Description
Category Status	0	Unsigned32	Refer Chapter 6.5.2 to find the details description.
Count	4	Unsigned16	Number of diagnosis.
Slot Number	6	Unsigned16	Slotnumber of first AP device with diagnosis.
DiagnosisID	8	Unsigned32	Diagnosis ID of first AP device with diagnosis.
Status Bit	12	Unsigned8	Refer Chapter 6.5.3 to find the Submodule status byte.

Table 6.1: Diagnosis Structure descriptions

6.4.2 Category Status

Bit	Status Description
0	Reserved
1	Current
2	Voltage
3	Temperature
4	Pressure
5	Movement
6	Configuration/Parameter
7	Monitoring
8	Communication
9	Safety
10	Internal Hardware
11	Software
12	Maintenance
13	Misc
14	Reserved
15	Reserved
16	External Device

Bit	Status Description
17	Security
18	Encoder
19-31	Reserved

Table 6.2: Category Status descriptions

6.4.3 Status Byte

The submodule status byte can be added starting from firmware version 1.4.28, with the status bit designated as process data input of data type **Unsigned 8**. The qualifier requires firmware version 1.5.4 or higher.

Bit	Status Name	Description
0	Information	At least 1 diagnosis with AP severity information
1	Maintenance	At least 1 diagnosis with AP severity maintenance
2	Warning	At least 1 diagnosis with AP severity warning
3	Error	At least 1 diagnosis with AP severity error
4	Reserved	
5	Reserved	
6	Qualifier	Always 1
7	Reserved	

Table 6.3: Status Byte descriptions

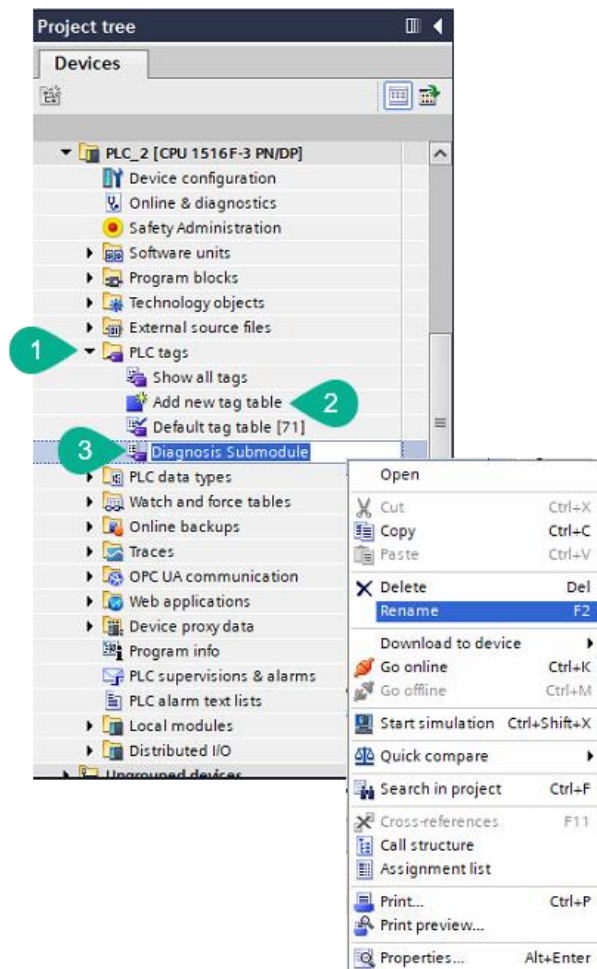
The screenshot shows the 'Device overview' table with columns: Module, Rack, Slot, I address, Q address, Type, and Article number. The 'Diagnosis structure' and 'Status bits' rows are highlighted in green. The 'I address' for 'Status bits' is highlighted in yellow. The 'Catalog' tree on the right shows the hierarchy: Head module > Module > Submodules > Diagnosis structure > Status bits.

Module	Rack	Slot	I address	Q address	Type	Article number
CPX-AP4-PN	0	0			CPX-AP4 V1	CPX-AP4
PN-IO Interface	0	0 X1			CPX-AP4-PN	
CPX-AP4-PN-M12_1	0	1			CPX-AP4-PN-M12	8086607
CPX-AP4-PN-M12	0	1 1			CPX-AP4-PN-M12	8086607
Diagnosis structure	0	1 2	4...16		Diagnosis structure	
Status bits	0	1 3	17		Status bits	
	0	1 4				
	0	1 5				
CPX-AP4-4DI4DO-M12-5P_1	0	2	18	2	CPX-AP4-4DI4DO-M12-5P	8086603
CPX-AP4-8DI-M12-5P_1	0	3	3		CPX-AP4-8DI-M12-5P	8086602
CPX-AP4-4IOL-M12_1	0	4			CPX-AP4-4IOL-M12	8086604
CPX-AP4-4IOL-M12	0	4 1			CPX-AP4-4IOL-M12	8086604
Port deactivated	0	4 Port 1			Port deactivated	Port deactivated
Port deactivated_1	0	4 Port 2			Port deactivated	Port deactivated
Port deactivated_2	0	4 Port 3			Port deactivated	Port deactivated
Port deactivated_3	0	4 Port 4			Port deactivated	Port deactivated

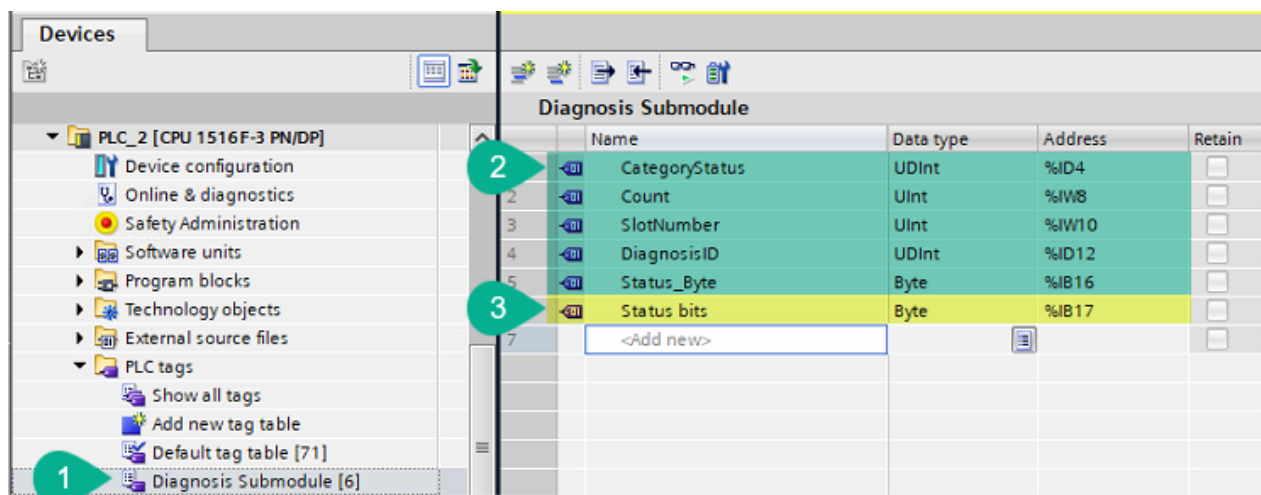
Highlight the submodule input address in **yellow** to point it out in the image above.

Follow the steps below to configure the diagnosis structure and status bits input address:

Step 1



1. Expand the **PLC tags** to add a new tag table.
2. Double-click on **Add new tag table** to create a new table, which will appear below the default tag table.
3. Right-click on the recently created table, then click on **Rename** and assign an appropriate name as required.

Step 2

1. Double-click on the recently created **Diagnosis Submodule** table to create the submodule input address.
2. Create **diagnosis structure** submodule tags as highlighted in **Dark Cyan**, ensuring that the data type of the input address is correct.
3. Create a tag for the **status bits** submodule as highlighted in **yellow**, ensuring that the data type of the input address is correct.

**Note**

- For creating submodule tags of the diagnosis structure, [Refer Chapter 6.5.1](#) to find the data type and offset. For the submodule input address highlighted in Dark Cyan below the image.
- For creating a tag for the status bits, [Refer Chapter 6.5.3](#) to find the input data type. For the submodule input address highlighted in yellow below the image.

The image below shows the submodule input addresses and configured tag addresses, highlighted in **blue** and **yellow** respectively.

...C DC/DC/DC] > PLC tags > Diagnosis Submodule [6]									
Tags									
Diagnosis Submodule									
	Name	Data type	Address						
1	CategoryStatus	UDInt	%ID4						
2	Count	UInt	%IW8						
3	SlotNumber	UInt	%IW10						
4	DiagnosisID	UDInt	%ID12						
5	Status_Byte	Byte	%IB16						
6	Status bits	Byte	%IB17						
7	<Add new>								

Device overview									
Module	Rack	Slot	I address	Q address	Type	Article number	Firm...		
CPX-AP4-PN	0	0			CPX-AP4 V1	CPX-AP4			
PN-IO Interface	0	0 X1			CPX-AP4-PN				
CPX-AP4-PN-M12_1	0	1			CPX-AP4-PN-M12	8086607			
CPX-AP4-PN-M12	0	1 1			CPX-AP4-PN-M12	8086607			
Diagnosis structure	0	1 2	4...16		Diagnosis structure				
Status bits	0	1 3	17		Status bits				
	0	1 4							
	0	1 5							
CPX-AP4-4DI4DO-M12-5P_1	0	2	18	2	CPX-AP4-4DI4DO-M12-5P	8086603			
CPX-AP4-8DI-M12-5P_1	0	3	3		CPX-AP4-8DI-M12-5P	8086602			
CPX-AP4-4IOL-M12_1	0	4			CPX-AP4-4IOL-M12	8086604			
CPX-AP4-4IOL-M12	0	4 1			CPX-AP4-4IOL-M12	8086604			
Port deactivated_3	0	4 Port 1			Port deactivated	Port deactivated			
Port deactivated_1	0	4 Port 2			Port deactivated	Port deactivated			
Port deactivated_2	0	4 Port 3			Port deactivated	Port deactivated			
	0	4 Port 4			Port deactivated	Port deactivated			

Step 3

In the example below, a couple of short circuits are present in the following module.

- Module 3 - CPX-AP-I-8DI-M8-3P.

Name	Data type	Address	Retain	Access	Write	Visible	Monitor value
CategoryStatus	UDint	%ID4					2
Count	UInt	%IW8					2
SlotNumber	UInt	%WI0					2
DiagnosisID	UDint	%ID12					16#43019
Status_Byte	Byte	%IB16					16#48
Status bits	Byte	%IB17					16#08

Module	Rack	Slot	I address	Q address	Type	Article number
CPX-AP-I-PN	0	0			CPX-AP-I V1	CPX-AP-I
PNIO interface	0	0 X1			CPX-AP-I-PN	
CPX-AP-I-PN-M12_1	0	1			CPX-AP-I-PN-M12	8086607
CPX-AP-I-PN-M12	0	11			CPX-AP-I-PN-M12	8086607
Diagnosis structure	0	12	4...16		Diagnosis structure	
Status bits	0	13	17		Status bits	
	0	14				
	0	15				
CPX-AP-I-IOL-M12_1	0	2			CPX-AP-I-IOL-M12	8086604
CPX-AP-I-IOL-M12	0	21			CPX-AP-I-IOL-M12	8086604
IO-Link In/Out 2/2 Byte ...	0	2 Port 1	68...70	68...69	IO-Link In/Out 2/2 ...	
Port deactivated_1	0	2 Port 2			Port deactivated	Port deactivat...
Port deactivated_2	0	2 Port 3			Port deactivated	Port deactivat...
Port deactivated_3	0	2 Port 4			Port deactivated	Port deactivat...
CPX-AP-I-8DI-M8-3P_1	0	3	2		CPX-AP-I-8DI-M8-3P	8086600

As shown in the above image, the monitored value of the diagnosis structure tags [Refer Chapter 6.5.1](#) for descriptions. The category status shows a value of **02** in decimal, indicating that the **2nd** bit is **true (Current)**, as referenced in [Refer Chapter 6.5.2](#). The status bits display a value of **08**, which means that **4th** bits is **true (Error)**, as referenced in [Refer Chapter 6.5.3](#).

Step 4

In the example below, remove the communication cable from the following module:

- Module 2 - CPX-AP-I-4IOL-M12.

Name	Data type	Address	Retain	Access	Write	Visible	Monitor value
CategoryStatus	UDint	%ID4					256
Count	UInt	%IW8					3
SlotNumber	UInt	%WI0					1
DiagnosisID	UDint	%ID12					134_318_091
Status_Byte	Byte	%IB16					16#44
Status bits	Byte	%IB17					16#04

Module	Rack	Slot	I address	Q address	Type	Article number
CPX-AP-I-PN	0	0			CPX-AP-I V1	CPX-AP-I
PNIO interface	0	0 X1			CPX-AP-I-PN	
CPX-AP-I-PN-M12_1	0	1			CPX-AP-I-PN-M12	8086607
CPX-AP-I-PN-M12	0	11			CPX-AP-I-PN-M12	8086607
Diagnosis structure	0	12	4...16		Diagnosis structure	
Status bits	0	13	17		Status bits	
	0	14				
	0	15				
CPX-AP-I-IOL-M12_1	0	2			CPX-AP-I-IOL-M12	8086604
CPX-AP-I-IOL-M12	0	21			CPX-AP-I-IOL-M12	8086604
IO-Link In/Out 2/2 Byte ...	0	2 Port 1	68...70	68...69	IO-Link In/Out 2/2 ...	
Port deactivated_1	0	2 Port 2			Port deactivated	Port deactivat...
Port deactivated_2	0	2 Port 3			Port deactivated	Port deactivat...
Port deactivated_3	0	2 Port 4			Port deactivated	Port deactivat...
CPX-AP-I-8DI-M8-3P_1	0	3	2		CPX-AP-I-8DI-M8-3P	8086600

As shown in the above image, the monitored value of the diagnosis structure tags [Refer Chapter 6.5.1](#) for descriptions. The category status shows a value of **256** in decimal, indicating that the **9th** bit is **true (communication)**, as referenced in [Refer Chapter 6.5.2](#). The status bits display a value of **04**, which means that **3rd** bits is **true (warning)**, as [Refer Chapter 6.5.3](#).