PROFINET Configuration Guide, Cisco Catalyst IE31xx Series Switches

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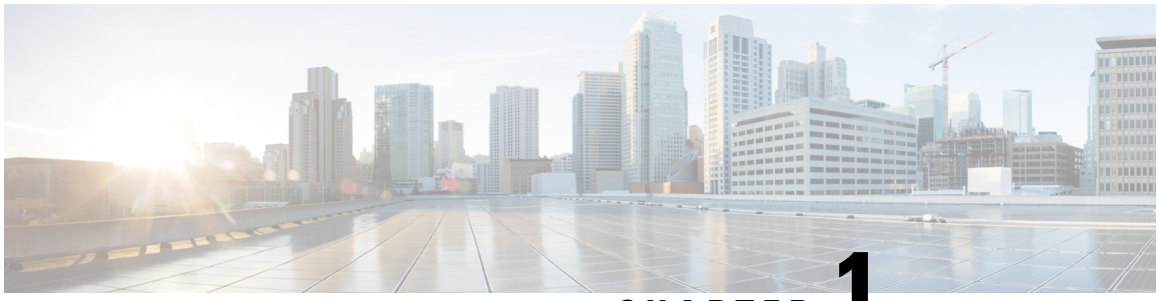

CHAPTER 1

Configuring PROFINET

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Information About Configuring PROFINET

PROFINET is the leading Industrial Ethernet standard that uses TCP/IP and IT standards to connect and control machines in real time. It is widely used in industrial automation and process control networks, especially for motion control and precision instrumentation. PROFINET emphasizes fast, reliable data exchange and defines communication paths to meet different speed requirements.

Conformance Classes: PROFINET has different conformance classes that define supported features.

- **Class B:** Common in factory automation, it supports fast, real-time communication and diagnostics — ideal for applications like production lines and equipment monitoring. Class B includes **PROFINET Real Time (RT)**, which prioritizes important data to reduce delays, with cycle times around 10 ms. This makes RT suitable for tasks like conveyor belt and packaging machine control. However, the switches do not support **Isochronous Real Time (IRT)**, which is required for ultra-precise synchronization.

Communication Levels: PROFINET communication is scalable across three levels:

- **Non-Real-Time (NRT):** Uses TCP/IP with bus cycle times around 100 ms.
- **Real-Time (RT):** Enables faster cycle times, approximately 10 ms.
- **Isochronous Real-Time (IRT):** Achieves highly precise synchronization with cycle times as low as 1 ms (not supported in Class B).

PROFINET I/O System: PROFINET I/O is a flexible communication framework for distributed automation. It uses cyclic data transfer to exchange information, alarms, and diagnostics between controllers, I/O devices, and automation systems like motion controllers.

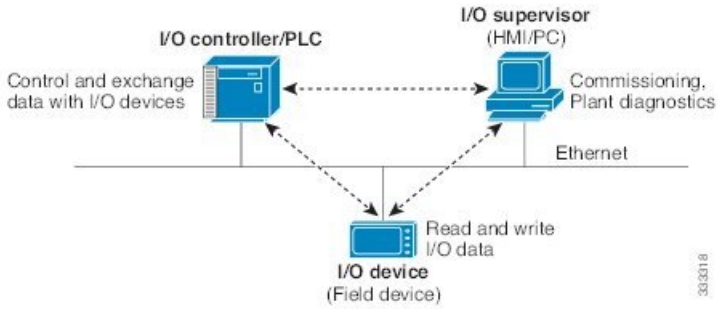
PROFINET Device Roles

An I/O controller is a programmable logic controller (PLC) that controls I/O devices and exchanges data such as configuration, alarms, and I/O data through an automation program. The I/O controller and the I/O supervisor exchange diagnostic information. The I/O controller shares configuration and I/O information with an I/O device and receives alarms from the I/O device.

There are three main types of I/O devices:

- **I/O Devices:** Field devices connected to controllers.
- **I/O Controllers:** Manage and control field devices.
- **I/O Supervisors:** Tools for diagnostics and configuration.

Figure 1: PROFINET Device Roles



PROFINET is designed to serve as the sole or primary management system platform for industrial networks. It streamlines device configuration and communication, reducing the need for manual setup.

Automatic Device Detection and Configuration: The I/O controller automatically detects switches using the Discovery and Configuration Protocol (DCP). It sets the device name and IP address, so you don't need to enter Cisco IOS commands for basic configurations.

Advanced Configuration with Cisco IOS: For advanced features, like Quality of Service (QoS), DHCP, and similar capabilities, you'll need to configure the switch using Cisco IOS commands. These advanced settings cannot be managed directly through PROFINET.

An I/O supervisor is an engineering station, such as a human machine interface (HMI) or PC, used for commissioning, monitoring, and diagnostic analysis. The I/O supervisor exchanges diagnostic, status, control, and parameter information with the I/O device.

An I/O device is a distributed I/O device such as a sensor, an actuator, or a motion controller.

Note If Profinet DCP cannot detect the switch, PLC, or IO mac addresses, temporarily disable the firewall or virus scan from the Windows PC that installed the Siemens STEP7 or TIA Portal Automation application.

In a PROFINET I/O system, all the I/O devices communicate over an Ethernet communication network to meet the automation industry requirement for bus cycle times of less than 100 ms. The network uses switches and full-duplex data exchange to avoid data collisions. The Cisco Catalyst IE31xx switches play the role of I/O device in Figure 1: PROFINET Device Roles, on page 2.

PROFINET Device Data Exchange

After PROFINET uses DCP to discover devices, including the switch, the devices establish application relationships (ARs) and communication relationships (CRs). After a connection is established and information about device parameters is exchanged, I/O data is exchanged. The switch uses non-real-time CRs to exchange the data attributes listed below.

Table 1: PROFINET I/O Switch Attributes

PROFINET I/O Switch Configuration Attributes	Value or Action
Device name	Configures a name for the device.
TCP/IP	IP address, subnet mask, default gateway, and switch virtual interface (SVI).
Primary temperature alarm	Enables or disables monitoring for the specified alarm.
Secondary temperature alarm	Enables or disables monitoring for the specified alarm.
SD card alarm	Enables or disables monitoring for the specified alarm.
RPS failed alarm	Enables or disables monitoring for the redundant power supply alarm. **Note** Before enabling monitoring for the RPS failed alarm, the user must configure the command "power-supply dual" in CLI to trigger an alarm when one of the power supplies is missing or inoperable.
Relay major alarm	Enables or disables monitoring for the specified alarm.
Reset to factory	Reset to factory (Mode 2: Communication parameter) Uses the PROFINET I/O controller to reset the switch communication parameter. This action removes the Profinet device ID, IP address, and configured SNMP writable MIBs.
Relay major configuration	Specifies the type of port alarm, for example, link fault, that triggers the major relay. Any port configured with the specified alarm type can trigger the major relay.

Table 2: PROFINET I/O Port Attributes

PROFINET I/O Port Configuration Attributes	Value or Action
Speed	10, 100, 1000, or auto.
Duplex	half, full, or auto.
Port mode	access or trunk.

PROFINET I/O Port Configuration Attributes	Value or Action
Link status	shut down or no shut down.
Configure rate limiting	Broadcast, unicast, or multicast threshold exceeds configured levels.
Port link fault alarm	Enables or disables monitoring for specified alarm.
Port not forwarding alarm	Enables or disables monitoring for specified alarm.
Port not operating alarm	Enables or disables monitoring for specified alarm.
Port FCS threshold alarm	Enables or disables monitoring for specified alarm.

General Station Description File

PROFINET devices interwork by using a general station description (GSD) file that contains the data for engineering and data exchange between the I/O controller, the I/O supervisor, and the I/O devices, including the switch. Each PROFINET I/O device must have an associated GSD file that describes the properties of the device and contains all this information required for configuration:

- Device identification information (device ID, vendor ID and name, product family, number of ports)
- Number and types of pluggable modules
- Error text for diagnostic information
- Communication parameters for I/O devices, including the minimum cycle time, the reduction ratio, and the watch dog time
- Configuration data for the I/O device modules, including speed, duplex, VLAN, port security information, alarms, and broadcast rate limiting thresholds
- Parameters configured for I/O device modules for the attributes listed above

The PROFINET GSD file is bundled with the Cisco IOS release. After the switch boots at least one time, the GSD files for the switch are located in a directory called ProfinetGSD. In this directory, there is a zip file containing all the GSDs for all switch SKUs. The file is called CISCO_*product_id*.zip, for example, CISCO_IE3xxx.zip.

The GSD file is in the switch and the I/O supervisor uses this file to manage the switch. For IOS XE-based platforms, the GSD file can be found in the Flash: or SDFlash: file system. If you want to load the GSD file for the Cisco IOS XE platform into the I/O supervisor, you need to copy it from the switch.

Note You must use the GSD file that is associated with the Cisco IOS release on the switch to manage your PROFINET network. Both the I/O supervisor and the Cisco IOS software alert you to a mismatch between the GSD file and the switch's Cisco IOS software version.

The status of GSD match or mismatch can be determined using the **show profinet status** command.

Configuring PROFINET

You can use either the SIMATIC STEP7 or TIA Portal Automation application on the I/O supervisor, or you can use the Cisco IOS software to configure PROFINET on the switch.

After you enable PROFINET, Link Layer Discovery Protocol (LLDP) is automatically enabled on the switch because PROFINET relies on LLDP to fully function. If you disable PROFINET, you can enable or disable LLDP as needed.

Default Configuration

PROFINET is enabled by default on all switch ports. The default configuration is enabled on VLAN 1, but you can change it to another VLAN ID. Out of the box, VLAN 1 is shut down. When bringing up an out-of-the-box switch for PROFINET, unshut VLAN 1 as follows:

```
Switch#configure term
Enter configuration commands, one per line.  End with CNTL/Z.
Switch(config)#interface vlan 1
Switch(config-if)#no shut
Switch(config-if)#end
Switch#
```

If PROFINET has been disabled, follow the instructions in Enabling PROFINET, on page 5.

Enabling PROFINET

To enable PROFINET, follow these steps:

Procedure

Step 1 Enter global configuration mode:

```
Switch# configure terminal
```

Step 2 Enable PROFINET on the switch:

```
Switch(config)# profinet
```

After PROFINET is enabled, you can configure the device as described in Configuring the Switch with STEP7/TIA, on page 6 (recommended) or by using the Cisco IOS commands provided in the subsequent steps.

Step 3 (Optional) Set the PROFINET device identifier (ID) by using the Cisco IOS software:

```
Switch(config)# profinet id line
```

The maximum length of the ID string can be 240 characters. The only special characters allowed are period (.) and hyphen (-), and they are allowed only in specific positions within the ID string. The ID can have multiple labels within the string. Each label can be from 1 to 63 characters, and labels must be separated by a period (.). The final character in the string must not be zero (0).

For more details about configuring the PROFINET ID, see the PROFINET specification, document number TC2-06-0007a, filename PN-AL-protocol_2722_V22_Oct07, available at PROFIBUS.

This step is optional and can be done through STEP7 or TIA PORTAL STEP 7 or the TIA Portal Automation application installed on the Supervisor (recommended).

Step 4 (Optional) Change the VLAN number. The default VLAN number is 1. The VLAN ID range is from 1 to 4096. One PROFINET VLAN is supported per switch.

```
Switch(config)# profinet vlan vlan_id
```

Note
You must create a VLAN before assigning a new VLAN to PROFINET if you are using a nondefault VLAN.

Step 5 Return to privileged EXEC mode:

```
Switch(config)# end
```

Step 6 Verify your entries:

```
Switch# show running-config
```

Step 7 (Optional) Save your entries in the configuration file:

```
Switch# copy running-config startup-config
```

Configuring the Switch with STEP7/TIA

Complete the following steps to configure the switch with STEP7/TIA. TIA v15.1 is used in the following example. Ensure that you do not use the CLI to configure or modify the switch configuration when PROFINET and TIA are in use.

Procedure

Step 1 Check the availability of the GSD file on the switch. You must use the same version that matches the GSD file bundled with the Cisco IOS release image.

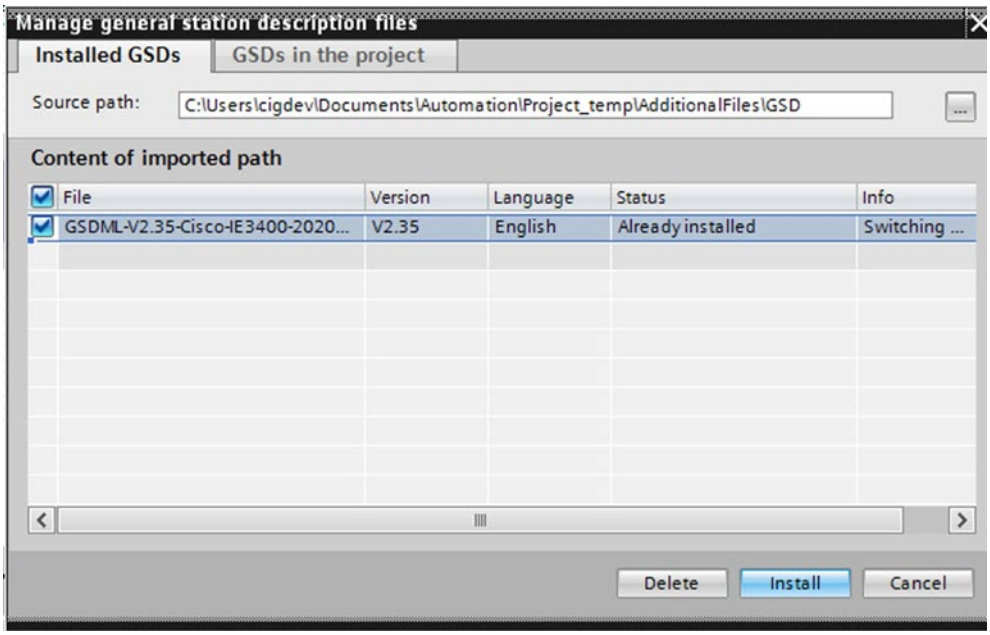
See General Station Description File, on page 4 for more information.

Step 2 Install the GSD file in STEP7/ TIA:

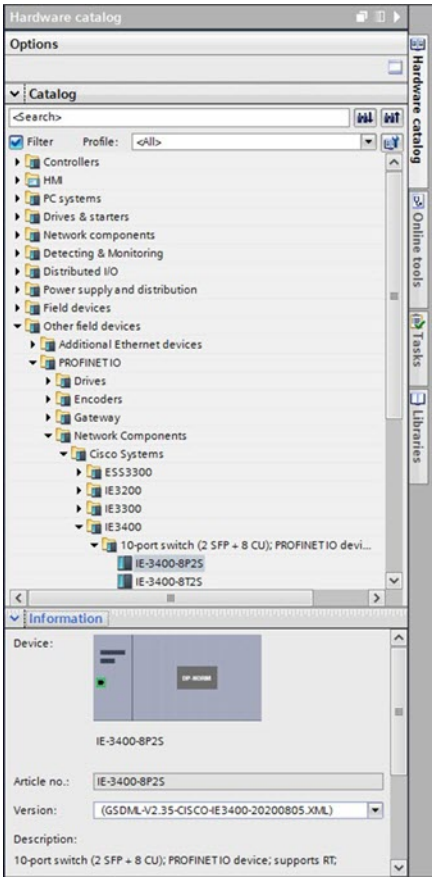
a) In STEP7/TIA, choose **Options** > **Manage general stations description files**, and browse to the location of the GSD file on the PC through source path.

The tool displays all the available GSD files.

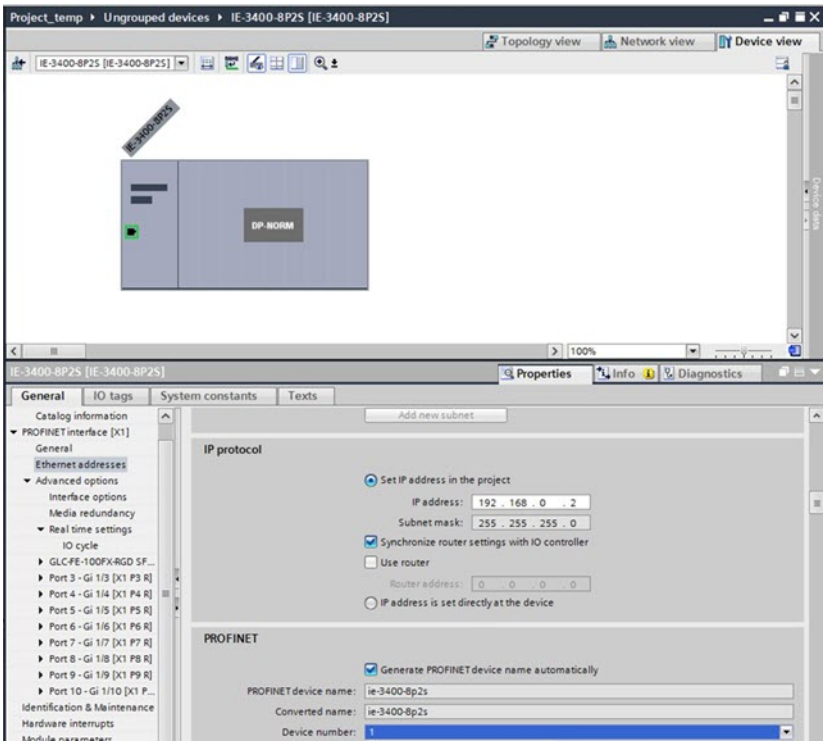
b) Check the check box adjacent to the appropriate the desired GSD file and click **Install**.



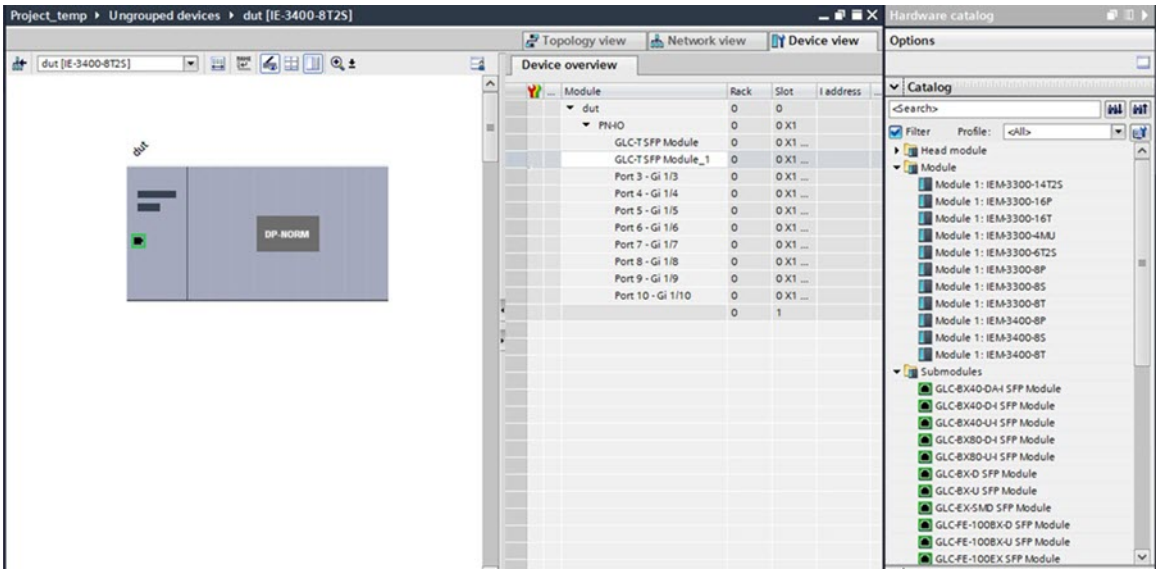
Step 3 After the installation is completed, give it a few seconds to update the **Hardware catalog**. Add the switch from the **Hardware catalog**:



a) In the Device view, configure **IP address** and **PROFINET device name** and save the configuration. These settings are for STEP7/TIA only; the switch is actually configured later during discovery steps.



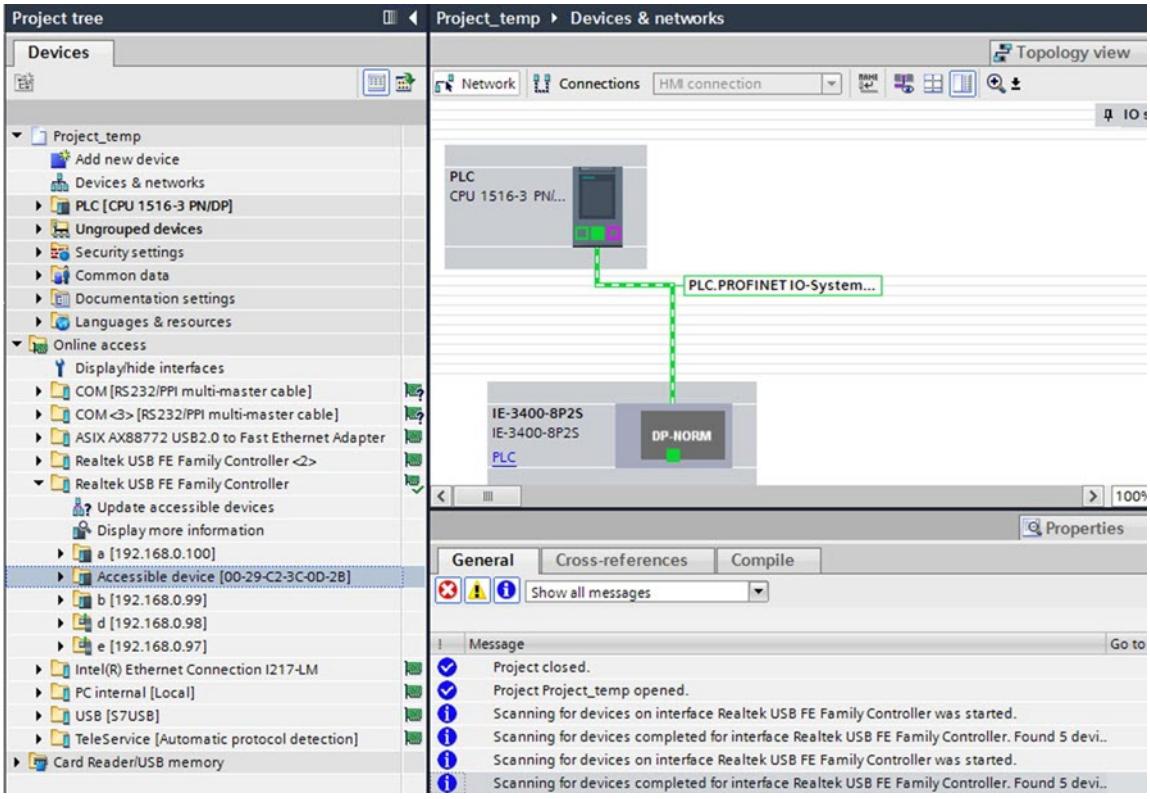
b) Configure the required expansion module or pluggable modules in Device view.



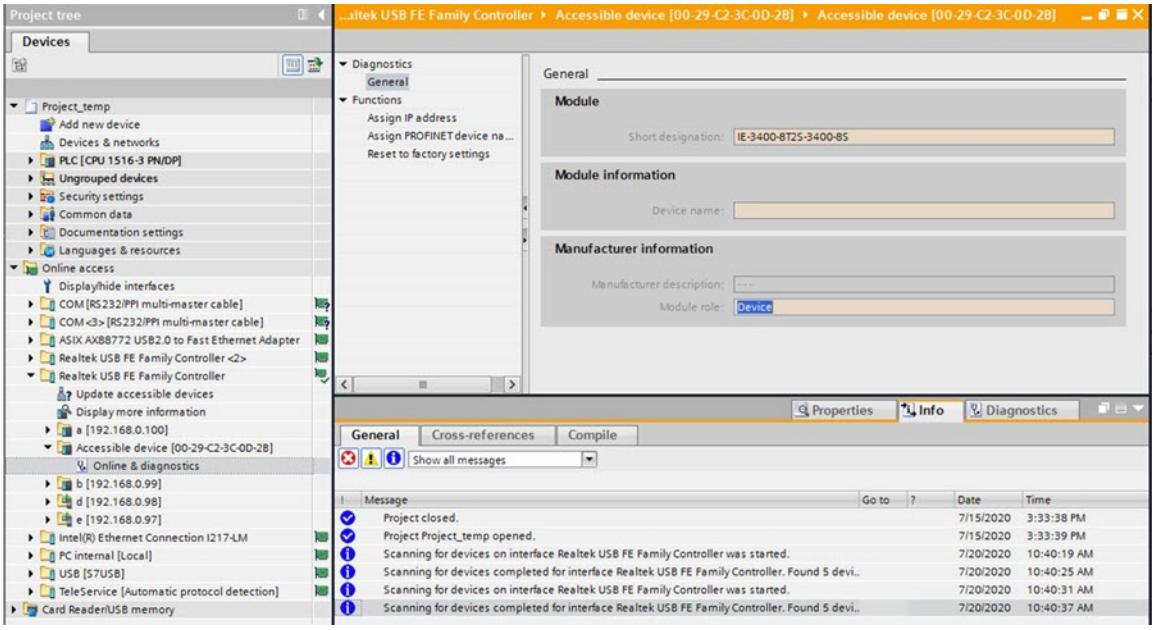
Step 4 After the device is added in the program, discover the device through the interface of the PC connected to the PROFINET topology.

Topology discovery uses LLDP for discovery. LLDP is enabled by default on the switch. You will see the new device listed as **Accessible device** followed by the MAC address under the network card of the PC.

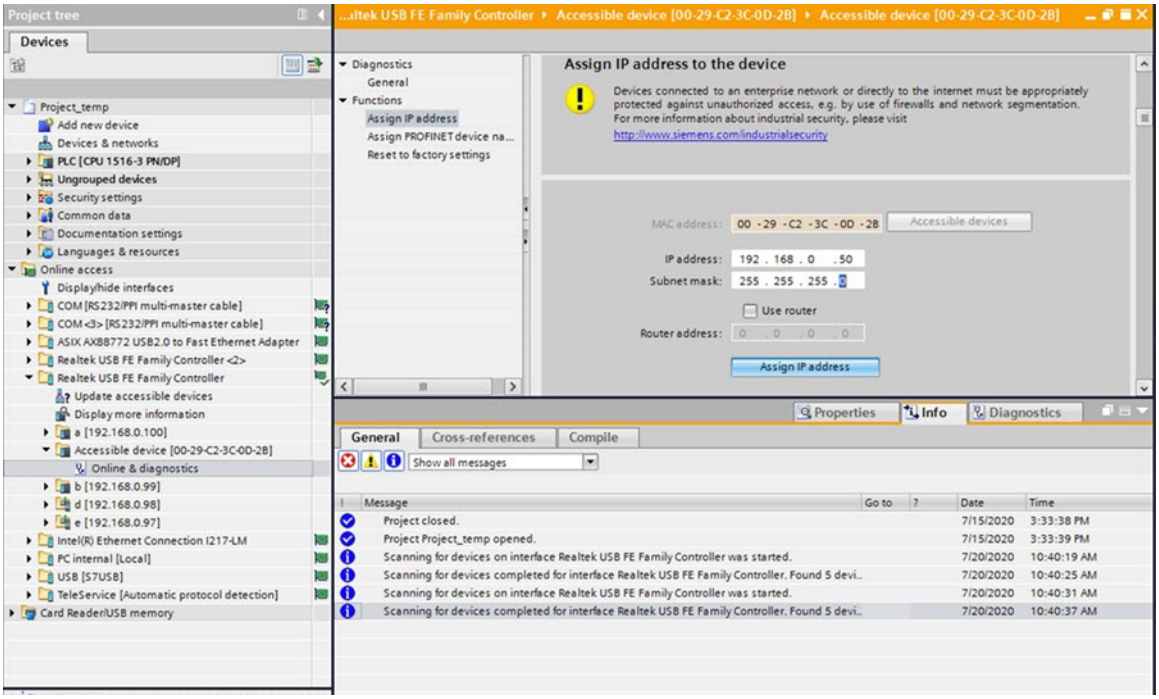
In the **Devices** pane on the left, under **Online access**, find the PC network card and click **Update accessible device**. This initiates the discovery of all the devices in the network.



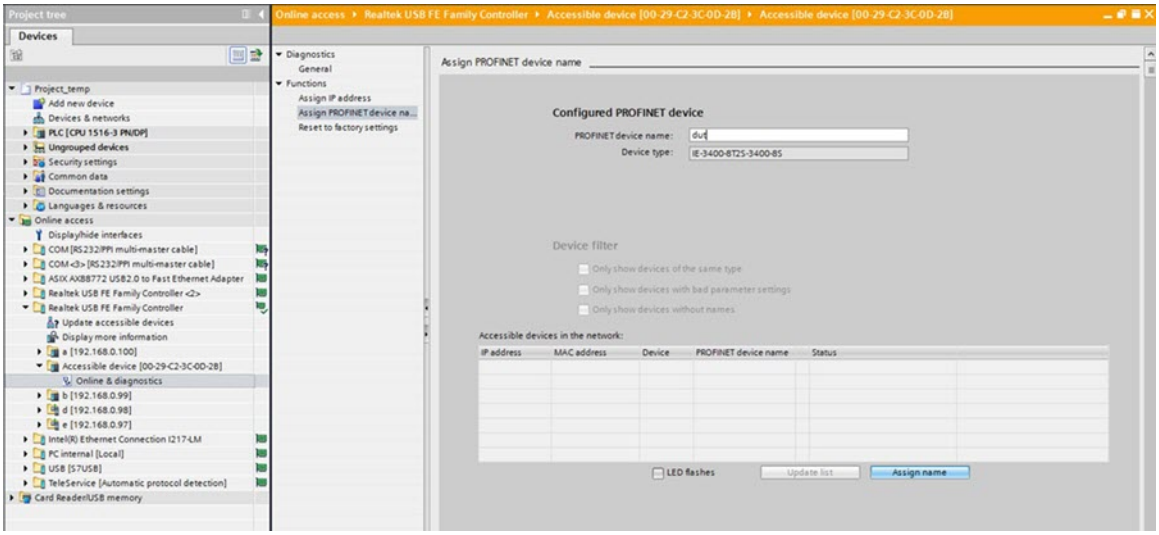
Step 5 In the **Devices** pane, expand the **Accessible device** folder, and click **Online & diagnostics** to further configure the device.



a) In the **IP address** field, enter the IP address and click **Assign IP address** to push the IP address configuration to the switch.

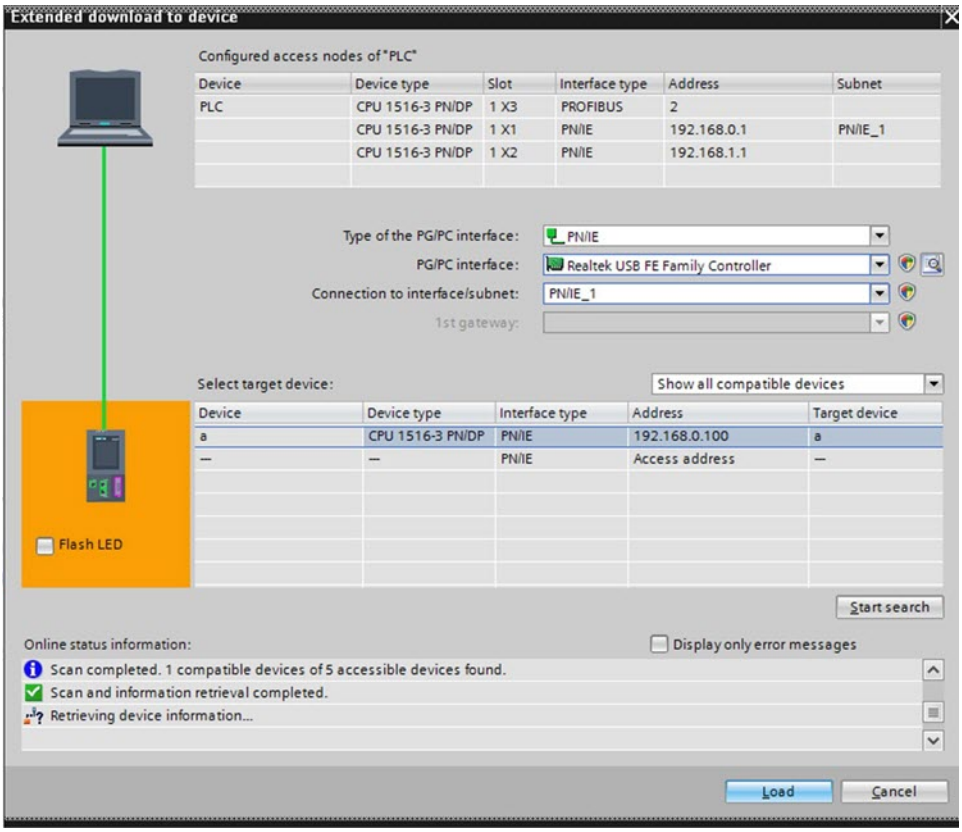


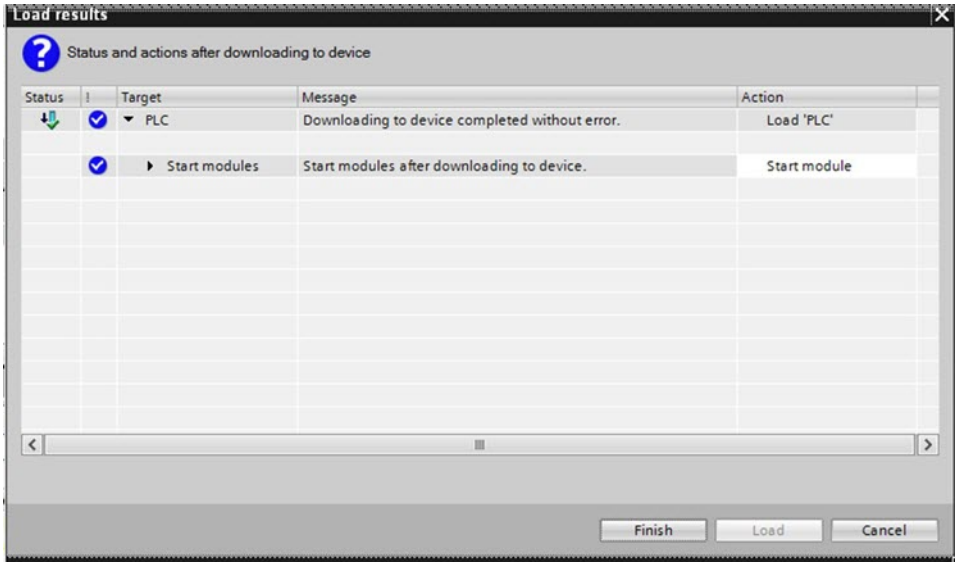
b) In the **PROFINET device name** field, enter the device name and click **Assign name** to push the device name configuration to the switch.



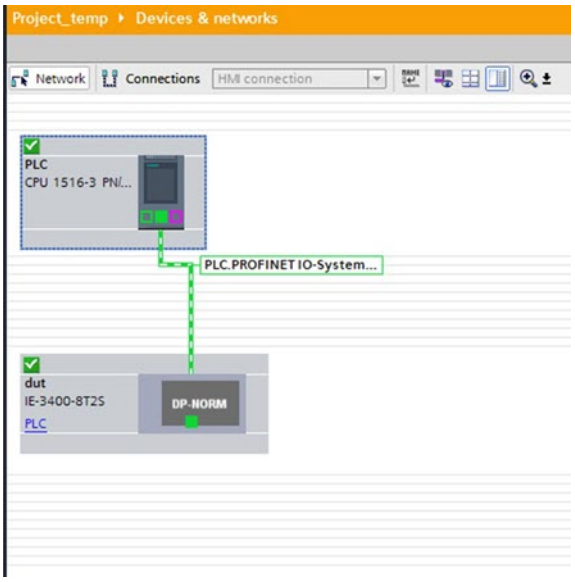
Step 6 Download the project from STEP7/TIA and go online.

a) Compile, download, and load the project to the PLC (I/O Controller).


Extended download to device
Configured access nodes of "PLC"
Device
Device type
Slot
Interface type
Address
Subnet
PLC
CPU 1516-3 PN/DP
1 X3
PROFIBUS
2
CPU 1516-3 PN/DP
1 X1
PN/IE
192.168.0.1
PN/IE_1
CPU 1516-3 PN/DP
1 X2
PN/IE
192.168.1.1
Type of the PG/PC interface:
PN/IE
PG/PC interface:
Realtek USB FE Family Controller
Connection to interface/subnet:
PN/IE_1
1st gateway:
Select target device:
Show all compatible devices
Device
Device type
Interface type
Address
Target device
a
CPU 1516-3 PN/DP
PN/IE
192.168.0.100
a
—
—
PN/IE
Access address
—
Flash LED
Start search
Online status information:
Display only error messages
Scan completed. 1 compatible devices of 5 accessible devices found.
Scan and information retrieval completed.
Retrieving device information...
Load
Cancel


Load results
Status and actions after downloading to device
Status
!
Target
Message
Action
PLC
Downloading to device completed without error.
Load 'PLC'
Start modules
Start modules after downloading to device.
Start module
Finish
Load
Cancel

b) Go online.



Quality of Service for PROFINET

The switch prioritizes PROFINET traffic using a quality of service (QoS) policy, which is configured when the switch goes into Connected mode. The default configuration for PROFINET QoS is shown here:

```
class-map match-all profinet-cos-2
match cos  2
class-map match-all profinet-cos-3
match cos  3
class-map match-all profinet-cos-1
match cos  1
class-map match-all profinet-cos-6
match cos  6
class-map match-all profinet-cos-7
match cos  7
class-map match-all profinet-cos-4
match cos  4
class-map match-all profinet-cos-5
match cos  5
!
policy-map profinet-qos
class profinet-cos-7
  priority percent 10
class profinet-cos-6
  bandwidth percent 1
class profinet-cos-5
  bandwidth percent 1
class profinet-cos-4
  bandwidth percent 1
class profinet-cos-3
  bandwidth percent 1
class profinet-cos-2
  bandwidth percent 1
class profinet-cos-1
  bandwidth percent 1
```

```
 interface GigabitEthernet1/1
service-policy output profinet-qos
!
interface GigabitEthernet1/2
service-policy output profinet-qos
```

To change the QoS policy, for example, for a PROFINET QoS configuration that works regardless of the VLAN tagging on interfaces, it is best to match on PROFINET Ethertype.

COS is a value found in the VLAN tag of an Ethernet frame. To match on COS value, the PROFINET Ethernet frames must have a VLAN tag associated with them. If PROFINET Ethernet frames are being forwarded through the network without VLAN tags, as shown above, then this QoS policy may not work as expected.

```
mac access-list extended Profinet_macacl
permit any any 0x8892 0x0
!
!
class-map match-any COS_6_Class
match cos  6
class-map match-any class_match_profinet_in
match access-group name Profinet_macacl
!
policy-map Profinet_out_policy
class COS_6_Class
  priority
policy-map Profinet_in_policy
class class_match_profinet_in
  set cos 6
!
!

interface GigabitEthernet1/8
service-policy input Profinet_in_policy
!
interface GigabitEthernet1/9
service-policy output Profinet_out_policy
!
```

Note Use the Cisco IOS **show running-config** command to view the IE switch configuration.

Profinet Connection Configuration

When a Profinet connection/session is established, the network device automatically applies and saves the CLI configurations (including SNMP) given in the table below.

Table 3: CLI for the PROFINET Configuration

CLI	Purpose
snmp-server community private RW **snmp-server community public RO**	Configure two Simple Network Management Protocol (SNMP) community strings, each with a read-write and read-only access.

CLI	Purpose
LLDP **lldp timer 5** **lldp holdtime 20** **lldp run**	Enable the Link Layer Discovery Protocol (LLDP) with a frame transmission interval of 5 seconds and a holdtime of 20 seconds.
CDP **no cdp run**	Disable the Cisco Discovery Protocol (CDP).
Power-supply **power-supply dual**	Set up the device to manage dual power supplies, ensuring it can operate redundantly if one power supply fails.

Preventing Default Gateway and CDP Loss During Reloads and Upgrades

Cisco IE switches have Profinet (PN) enabled by default to facilitate management through the Siemens TIA application portal, similar to other I/O devices, Programmable Logic Controllers (PLCs), and I/O devices within the Local Area Network (LAN).

Upon reloading an Industrial Ethernet (IE) switch operating on Cisco IOS XE 17.x or performing an upgrade from version 16.x, you may experience unexpected network connectivity disruptions. This phenomenon arises because the default gateway configuration fails to persist in the running configuration, resulting in its silent disappearance. Moreover, the Cisco Discovery Protocol (CDP) may also be disabled during this process. To rectify the loss of default gateway and CDP configurations, see the *Recommended Solution* section. While both the default gateway and CDP configurations are retained in the startup configuration, they do not appear in the running configuration post-reload or upgrade.

Technical Evaluation

When the Profinet feature is active, the Profinet subsystem conducts several critical checks to ensure proper configuration:

- Non-Zero Values: The switch IP address configured on the Profinet VLAN, gateway address, and netmask must all be non-zero.
- Subnet Consistency: The IP address and gateway address must reside within the same subnet.
- Uniqueness: The IP address and gateway address must not be identical.

If any of these conditions are not met while the Profinet feature is enabled, the default gateway configuration is removed from the running configuration. Additionally, if you save this incomplete configuration to the startup configuration using the **write mem** command, the erroneous settings will persist through power cycles.

Recommended Solution

To rectify the loss of default gateway and CDP configurations, execute the following steps:

1. Disable Profinet.

   Enter the **no profinet** command to disable the Profinet feature.

2. Reconfigure settings.

   Manually re-enter the CDP and default gateway configurations.

3. Save configuration.

   Use the **write mem** command to save the updated configuration.

4. Verify configuration.

   Optionally, reload the switch to confirm that the configurations are correctly reflected in the running configuration post-reload.

5. Check Profinet status.

   Use the **show profinet status** to ensure that Profinet is disabled.

Monitoring and Maintaining PROFINET

Table 4: Commands for Displaying the PROFINET Configuration

Command	Purpose
show profinet alarm	Displays all the alarms supported by PROFINET.
show profinet lldp	Displays whether LLDP is active or inactive on the ports.
show profinet sessions	Displays the currently connected PROFINET sessions.
show profinet status	Displays the status of the PROFINET subsystem.
show profinet mrp ring 1	Displays the status of the MRP ring. **Note** PROFINET MRP is not supported for Cisco Catalyst IE3100 Rugged Series Switches in Cisco IOS XE Dublin 17.10.1b.
show lldp neighbor interface *interface_number* **detail**	Displays information about the adjacent interface.

The following example displays the PROFINET status and currently connected PROFINET sessions.

```
Switch#sh profinet status
Profinet                        : Enabled
Connection Status               : Connected
Vlan                            : 1
Profinet ID                     : dut
GSD version                     : Match
Reduct Ratio                    : 128
MRP                             : Enabled
```

```
MRP License Status              : Active
MRP Max Rings Allowed           : 3

Switch#sh profinet session
Session #1
----------
Connected: Yes
Number Of IO CR's: 2
Number Of DiffModules: 0

Session #2
----------
Connected: No
Number Of IO CR's: 0
Number Of DiffModules: 2

Session #3
----------
Connected: No
Number Of IO CR's: 0
Number Of DiffModules: 0

Session #4
----------
Connected: No
Number Of IO CR's: 0
Number Of DiffModules: 0
*************************
Mode = Standard Mode
```

Monitoring Configuration Changes in PROFINET Sub-Systems

The PROFINET sub-system operates in real-time and adjusts the configuration of the device based on provisions made by remote engineering tools such as TIA Portal or in response to incoming network traffic. These dynamic updates to the running configuration often occur without your awareness. As a result, this can potentially lead to unexpected changes in system behavior.

To enhance user awareness and system transparency, syslog messages are generated whenever modifications occur in critical configuration fields. By monitoring these syslog messages, you can stay informed about real-time changes to the system configuration, ensuring better management and understanding of the PROFINET environment.

The following fields or protocols generate syslogs:

- Link Layer Discovery Protocol (LLDP)
- Cisco Discovery Protocol (CDP)
- Simple Network Management Protocol (SNMP)
- IP address and gateway configurations

Example of the syslog messages:

```
*Jun 19 14:41:11.247: %PROFINET_MODULE-6-PN_RUNNING_CONFIG: IP / netmask: persistent
configuration applied
*Jun 19 14:41:11.248: %PROFINET_MODULE-6-PN_RUNNING_CONFIG: Gateway IP criteria met,
configuring default gateway
*Jun 19 14:41:11.260: %SYS-5-CONFIG_I: Configured from console by vty0
*Jun 19 14:41:11.260: %PROFINET_MODULE-6-PN_RUNNING_CONFIG: CDP Global: service stopped
*Jun 19 14:41:11.276: %SYS-5-CONFIG_I: Configured from console by vty0
*Jun 19 14:41:11.280: %SYS-5-CONFIG_I: Configured from console by vty0
```

```
*Jun 19 14:41:11.280: %PROFINET_MODULE-6-PN_RUNNING_CONFIG: SNMP Global: service started
%PROFINET_MODULE-6-PN_RUNNING_CONFIG: LLDP Global: Tx Freq = 5 secs & Holdtime = 20 secs
*Jun 19 14:41:44.283: %PROFINET_MODULE-6-PN_RUNNING_CONFIG: Applying dot1p config on one
or more interfaces
```

Troubleshooting PROFINET

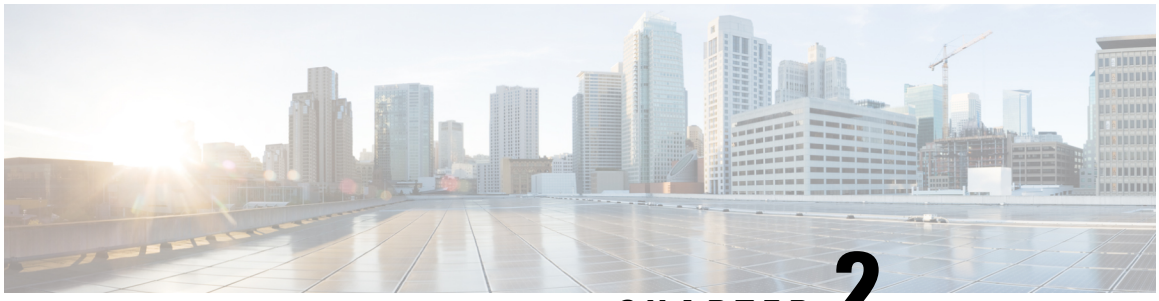
The PLC has LEDs that display red for alarms. The I/O supervisor software monitors those alarms.

To troubleshoot PROFINET, use the **debug profinet** privileged EXEC command with the keywords listed in the following table.

Caution Be aware that the output of a **debug** command might cause a Telnet connection to fail due to long debug outputs. When you use this command, use the serial or console port rather than Telnet using Ethernet to access the Cisco IOS CLI. You should use these commands only under the guidance of a Cisco Technical Support engineer.

Table 5: Commands for Troubleshooting the PROFINET Configuration

Command	Purpose
debug profinet alarm	Displays the alarm status (on or off) and content of the PROFINET alarms.
debug profinet cyclic	Displays information about the time-cycle-based PROFINET Ethernet frames.
debug profinet error	Displays the PROFINET session errors.
debug profinet packet ethernet	Displays information about the PROFINET Ethernet packets.
debug profinet packet udp	Displays information about the PROFINET Upper Layer Data Protocol (UDP) packets.
debug profinet platform	Displays information about the interaction between the Cisco IOS software and PROFINET.
debug profinet topology	Displays the PROFINET topology packets received.
debug profinet trace	Displays a group of traced debug output logs.



CHAPTER 2

Adding SFP Modules to Step 7/TIA

- Supported Small Form-Factor Pluggables, on page 19
- Adding SFPs to the Hardware Configuration in SS7/TIA, on page 20
- Feature History, on page 22

Supported Small Form-Factor Pluggables

This chapter describes how to add Small Form-Factor Pluggable (SFP) modules to the SIMATIC STEP7 or TIA Portal Automation applications to enable these applications to recognize the SFP modules in the PROFINET environment.

The following SFPs are supported for these Catalyst switches: IE3100. They can be added to the STEP 7 or TIA Portal Automation application installed on the supervisor.

- GLC-T
- GLC-TE
- GLC-T-RGD
- GLC-FE-100FX-RGD
- GLC-FE-100LX-RGD
- GLC-SX-MM-RGD
- GLC-LX-SM-RGD
- GLC-FE-100FX
- GLC-FE-100LX
- GLC-SX-MMD
- GLC-LH-SMD
- GLC-SX-MM
- GLC-LH-SM

Adding SFPs to the Hardware Configuration in SS7/TIA

Follow this procedure to add SFPs to the hardware configuration in STEP7 or TIA.

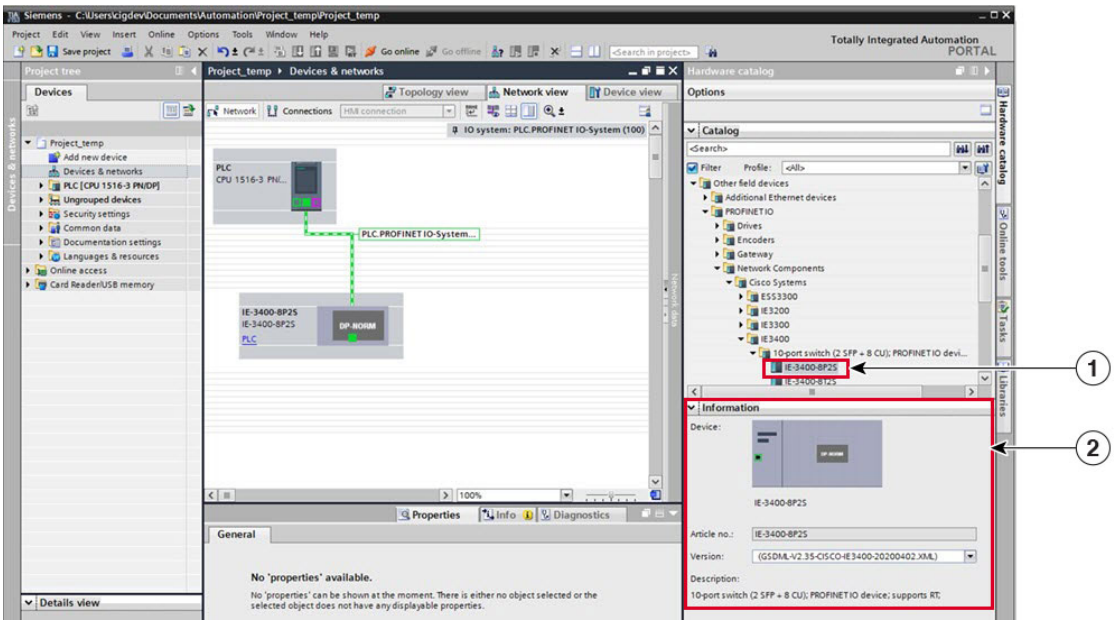
Before you begin

Install the latest GSD file for your IE switches in STEP7 or TIA (see Configuring the Switch with STEP7/TIA, on page 6 for more information). The GSD file is not backward compatible. Combination ports do not have defaults and must be re-created in STEP7 or TIA with the new GSD file.

Procedure

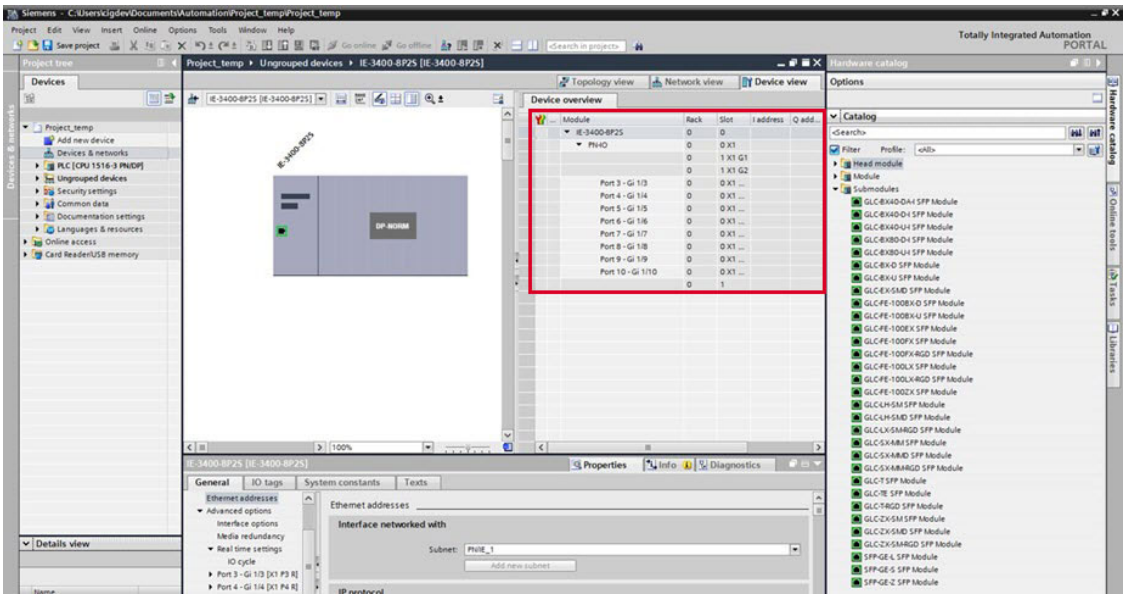
Step 1 In STEP7 or TIA, open the project containing the Cisco IE switch, and double-click **Devices & networks** in the **Project tree**.

Step 2 From the **Hardware catalog** in the devices and network editor, select the Device Access Point (DAP) name for your switch.

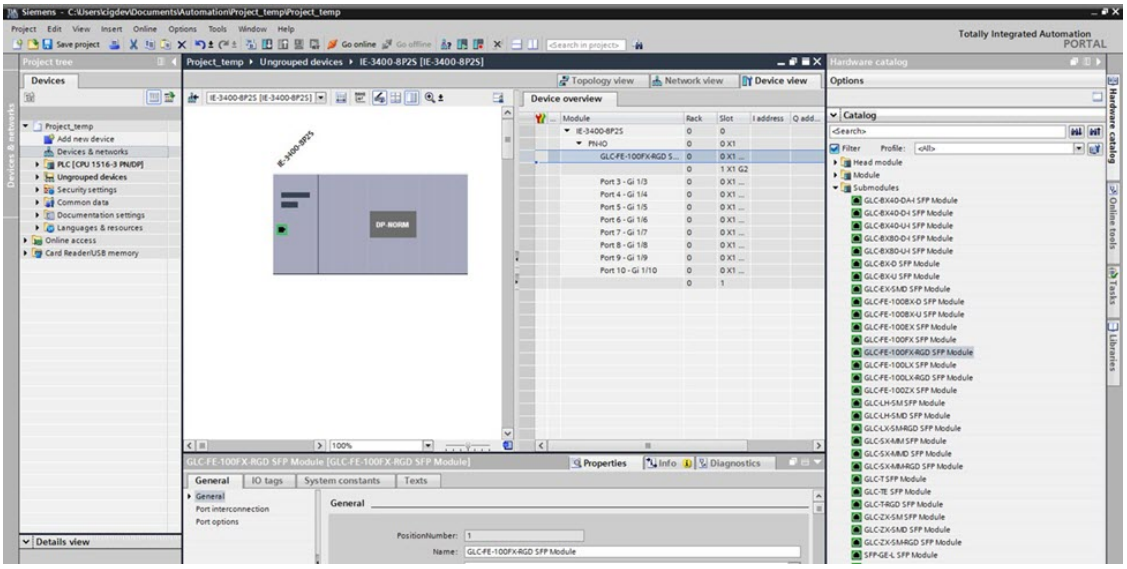


Step 3 Double-click the DAP name to go to **Device view** tab (see callout 1).

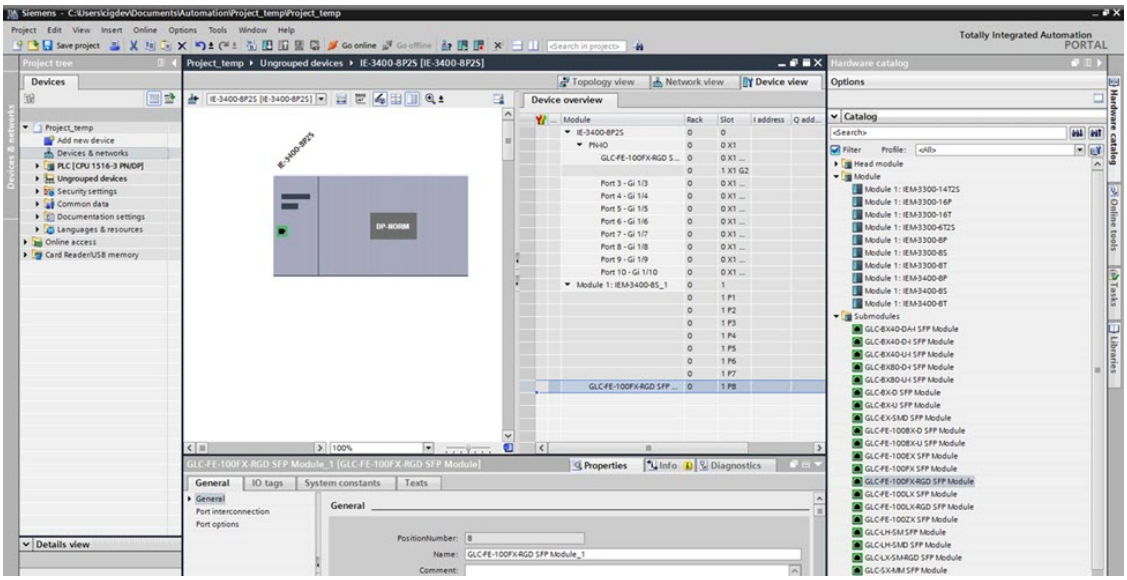
Step 4 Expand the PN-IO row (see callout 2) in Device overview section if the port list is not displayed.



Step 5 Select the modules that you have installed in the switch from the **Hardware catalog** and drag them to the appropriate rows in the table area of **Device view**: Appropriate SFP module for port type (combo port or fiber-only port)



The following figure shows the **Device view** and **Hardware catalog** with SFP modules . The device in TIA is now ready to compile and download.



Feature History

Platform	Feature	First Supported Release
IE31xx	Support new SFPs for PROFINET	17.4.1
IE31xx	SFP support enabled for PROFINET	17.3.1