OMRON

PROFINET Fieldbus

Industrial Robot Configuration

User's Guide

PROFINET

I685-E-01

NOTE

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Introduction

This manual is OMRON's original instructions describing the setup and operations of the PROFINET fieldbus.
Please read this manual and make sure you understand the functionality and performance of PROFINET fieldbus before attempting to use it.
Keep this manual in a safe place where it will be available for reference during operation.

Intended Audience

This manual is intended for the following personnel, who must also have knowledge of factory automation (FA) systems, robotic control methods, and Siemens controller configuration methods.

- Personnel in charge of introducing FA systems.
- Personnel in charge of designing FA systems.
- Personnel in charge of installing and maintaining FA systems.
- Personnel in charge of managing FA systems and facilities.

Applicable Models

This manual provides information for industrial robots that support PROFINET fieldbus. When information varies between different robot models, details are provided.

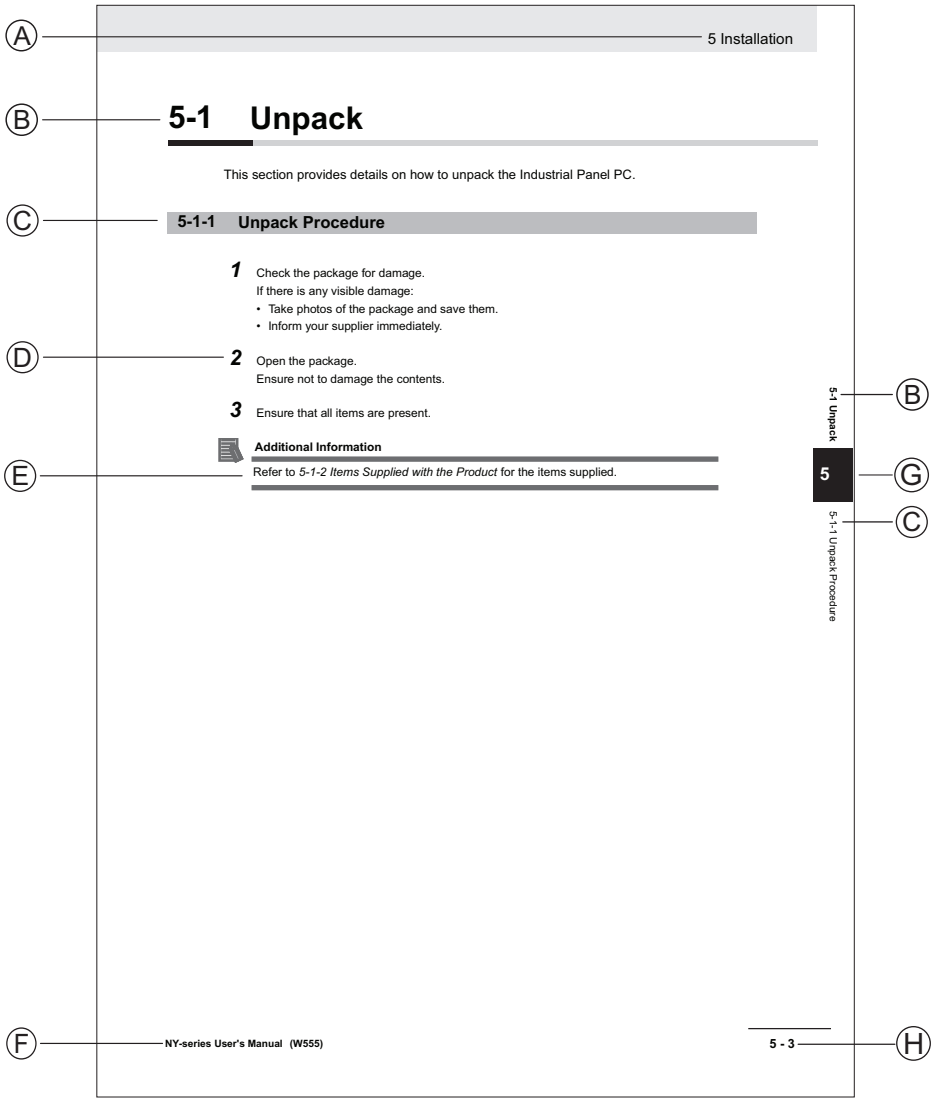
Units

All units are metric unless otherwise noted.

Manual Information

Page Structure

The following page structure is used in this manual.



Note: This illustration is provided as a sample. It will not literally appear in this manual.

Item	Explanation	Item	Explanation
A	Level 1 heading	E	Special Information
B	Level 2 heading	F	Manual name
C	Level 3 heading	G	Page tab with the number of the main section
D	Step in a procedure	H	Page number

Special Information

Special information in this manual is classified as follows:

Precautions for Safe Use

Precautions on what to do and what not to do to ensure safe usage of the product.

Precautions for Correct Use

Precautions on what to do and what not to do to ensure proper operation and performance.

Additional Information

Additional information to read as required.
This information is provided to increase understanding or make operation easier.

Version Information

Information on differences in specifications and functionality between different versions.

Sections in this Manual

CONTENTS

Terms and Conditions Agreement

Warranty and Limitations of Liability

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Safety Precautions

Definition of Precautionary Information

The following notation is used in this manual to provide precautions required to ensure safe usage of the LD-series AMR. The safety precautions that are provided are extremely important to safety. Always read and heed the information provided in all safety precautions.
The following notation is used.

⚠ **DANGER**	Identifies an imminently hazardous situation which, if not avoided, is likely to result in serious injury, and might result in fatality or severe property damage.
⚠ **WARNING**	Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury. Additionally, there may be severe property damage.
⚠ **CAUTION**	Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury, or property damage.

Symbols

	The circle and slash symbol indicates operations that you must not do. The specific operation is shown in the circle and explained in text. This example indicates prohibiting disassembly.
	The triangle symbol indicates precautions (including warnings). The specific operation is shown in the triangle and explained in text. This example indicates a precaution for electric shock.
	The triangle symbol indicates precautions (including warnings). The specific operation is shown in the triangle and explained in text. This example indicates a general precaution.
	The filled circle symbol indicates operations that you must do. The specific operation is shown in the circle and explained in text. This example shows a general precaution for something that you must do.
	The triangle symbol indicates precautions (including warnings). The specific operation is shown in the triangle and explained in text. This example indicates a precaution for high temperatures.

Warnings

⚠ WARNING

Cybersecurity

To maintain the security and reliability of the system, a robust cybersecurity defense program should be implemented, which may include some or all of the following:

Anti-virus protection

- Install the latest commercial-quality anti-virus software on the computer connected to the control system and keep the software and virus definitions up-to-date.
- Scan USB drives or other external storage devices before connecting them to control systems and equipment.

Security measures to prevent unauthorized network access

- Install physical controls so that only authorized personnel can access control systems and equipment.
- Reduce connections to control systems and equipment via networks to prevent access from untrusted devices.
- Install firewalls to block unused communications ports and limit communication between systems. Limit access between control systems and systems from the IT network.
- Control remote access and adopt multifactor authentication to devices with remote access to control systems and equipment.
- Set strong password policies and monitor for compliance frequently.

Data input and output protection

- Backup data and keep the data up-to-date periodically to prepare for data loss.
- Validate backups and retention policies to cope with unintentional modification of input/output data to control systems and equipment.
- Validate the scope of data protection regularly to accommodate changes.
- Check validity of backups by scheduling test restores to ensure successful recovery from incidents.
- Safety design, such as emergency shutdown and fail-soft operations in case of data tampering and incidents.

Additional recommendations

- When using an external network environment to connect to an unauthorized terminal such as a SCADA, HMI or to an unauthorized server may result in network security issues such as spoofing and tampering.
- You must take sufficient measures such as restricting access to the terminal, using a terminal equipped with a secure function, and locking the installation area by yourself.
- When constructing network infrastructure, communication failure may occur due to cable disconnection or the influence of unauthorized network equipment.
- Take adequate measures, such as restricting physical access to network devices, by means such as locking the installation area.
- When using devices equipped with an SD Memory Card, there is a security risk that a third party may acquire, alter, or replace the files and data in the removable media by removing or unmounting the media.
- Please take sufficient measures, such as restricting physical access to the Controller or taking appropriate management measures for removable media, by means of locking and controlling access to the installation area.
- Educate employees to help them identify phishing scams received via email on systems that will connect to the control network.

Related Manuals

Use the following related manuals for reference.

Manual Title	Description
Automation Control Environment (ACE) Version 4 User's Manual (Cat. No. I633)	Instruction for the use of the ACE Version 4 software.
V+ User's Manual (Cat. No. I671)	Provides a description of the V+ programming language and functionality.
V+ Keyword Reference Manual (Cat. No. I672)	Provides reference to V+ Keyword use and functionality.
Robot User's Manual	User Manual for specific robot types.

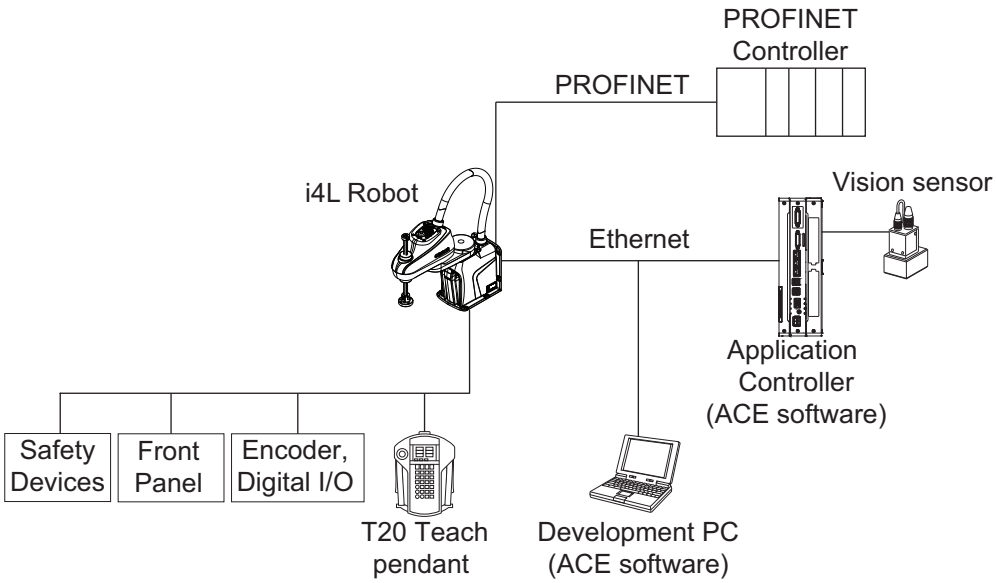
1

Overview

This section provides a general overview.

1-1 Introduction

This document provides information about PROFINET configuration and programming methods for OMRON Industrial Robots.
PROFINET fieldbus provides the ability for OMRON Industrial Robots to exchange data with other industrial devices. The robot can be configured as a PROFINET device for communications with a PROFINET controller.
V+ variables and robot status information can be shared over the PROFINET fieldbus allowing movement and control with simple programming methods.
The PROFINET implementation uses a vendor-specific device profile that is detailed in this document.
The typical PROFINET system configuration is shown below.



1-1-1 PROFINET Specifications

PROFINET communication specifications are provided below.

Item	Specification
Protocol	PROFINET v2.4
Class	B
Device profile	Vendor specific I/O
IO connection cycle time	4, 8, 16, 32, 64, 128, 512 ms
Maximum data payload	512 bytes
Sub-slot limit	Slot 1 with V+ variable exchange can contain up to 32 sub-slots.

1-1-2 Robot Firmware and Software Requirements

The following firmware and software versions are required for PROFINET support.

- Firmware: version 6.0Cx or higher.
- Software: ACE version 4.7 or higher.
- i4L Robot Controller: Revision B and above.

- i4H Robot Controller: Revision C and above.

Additional Information

Contact your local OMRON representative for more information about robot controller types not listed above.

1-1-3 Data Types

Use the following information to understand all data types and sizes.

Data Type	Minimum Byte Length	Array Option (Byte Length)
BOOL	1	8/16/32 (1/2/4)
INT	2	1/16/32 (2/4/8)
DINT	4	1/16/32 (4/64/128)
REAL	4	1/16/32 (4/64/128)
LREAL	8	1/16/32 (8/128/256)
BYTE	32 (1 byte for each character)	32/64/128 (32/64/128)

2

Configuration

2-1 Basic Configuration Steps

Basic PROFINET configuration steps are provided below. Refer to *2-2 Configuration Example* on page 2-3 for a specific configuration example.

The following items are required for PROFINET configuration:

- Siemens TIA Portal configuration software.
- A Siemens PLC that supports PROFINET controller functionality.
- An OMRON Industrial Robot that supports PROFINET device functionality.
- ACE software version 4.7 or higher.
- An installed robot device and a PLC controller with proper network connections.

Refer to the *Automation Control Environment (ACE) Version 4 User's Manual (Cat. No. I633)* for more information about the *Configure PROFINET Settings* area.

1 Obtain the GSDML file using ACE.

2 Install the GSDML file using TIA Portal.

3 Add the robot device and make configuration settings in TIA Portal.

4 Add, compile, and download the TIA Portal configuration to the PLC.

5 Make robot configuration settings with ACE software.

6 Confirm data exchange between the robot and PLC.

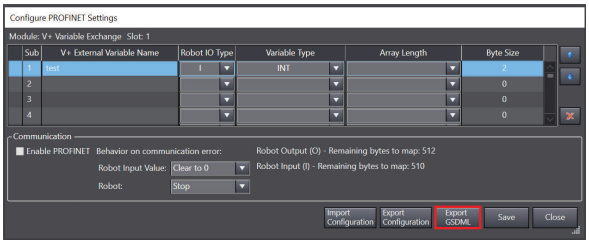
7 Scan for the new robot device.

2-2 Configuration Example

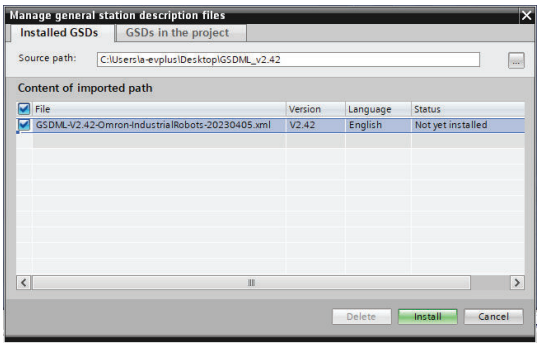
This configuration example provides step-by-step instructions to configure the robot in a PROFINET network under the following conditions.

- A Siemens S7-1200 or 1500 PLC is used as the PROFINET controller.
- An i4L robot is used as the PROFINET device.
- TIA Portal version 15 is used with the PLC added.
- ACE software version 4.7 is used with the robot added and online.
- The robot will exchange data using i_bool_8[] and q_bool_8[] BOOL array variables (array length is 8, 1 byte).

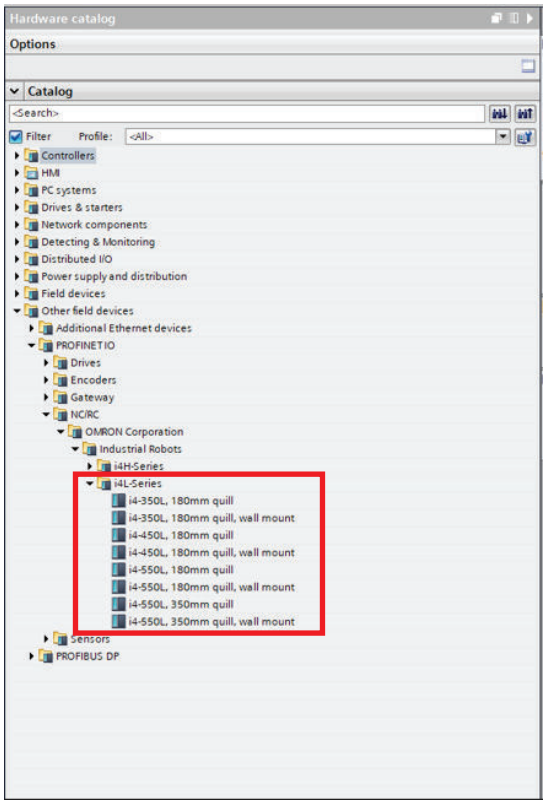
1 Obtain the GSDML xml file for the robot using ACE.
The GSDML file is stored in the robot controller. Connect to the robot controller using ACE. Open the *Configure PROFINET Settings* area and then click the **Export GSDML** Button.



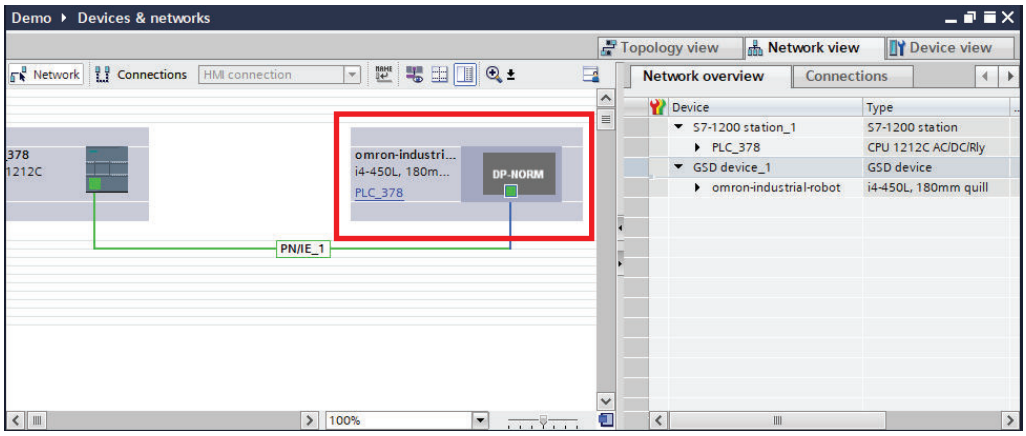
2 Install the GSDML file using TIA Portal.



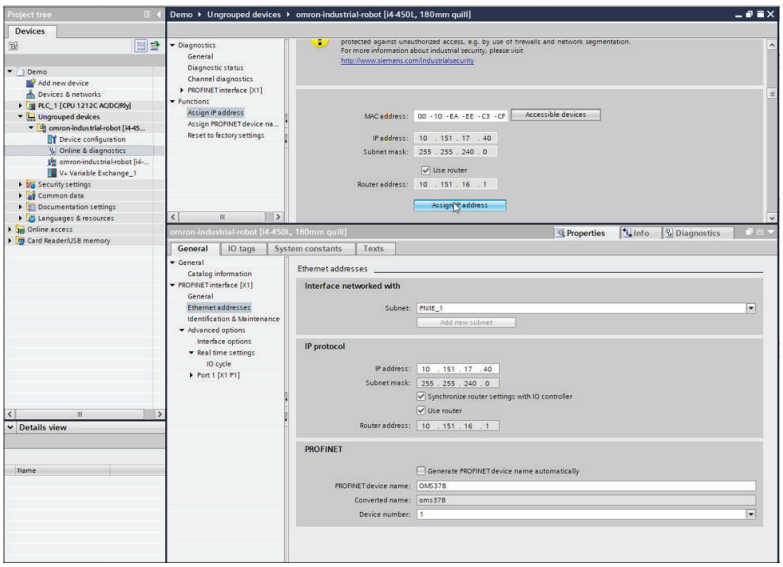
3 Confirm that OMRON Corporation robots are listed in the Catalog area.



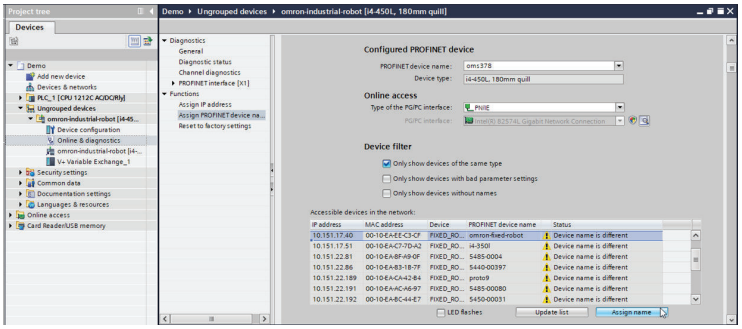
4 Add the robot device to the Network view with TIA Portal.



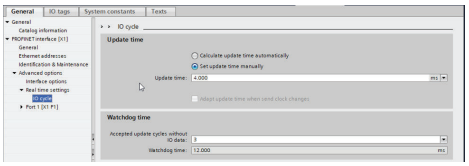
5 Assign the IP address of the robot with TIA Portal.



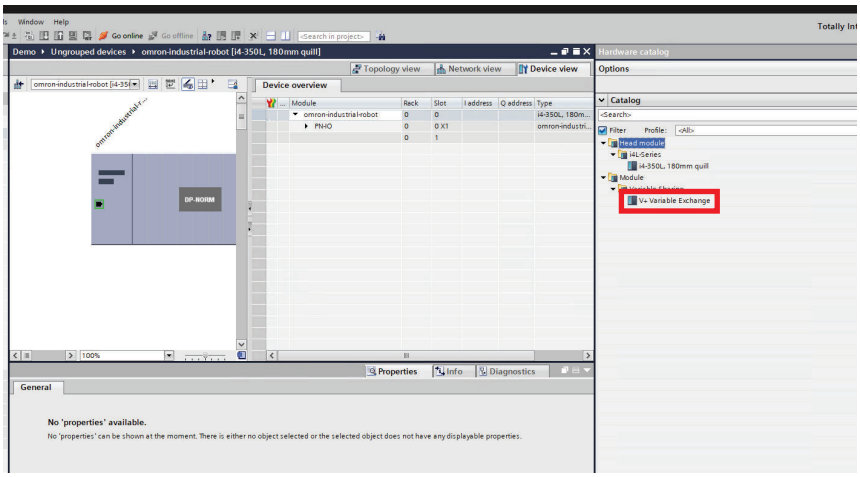
6 Assign a unique device name to the robot in TIA Portal.



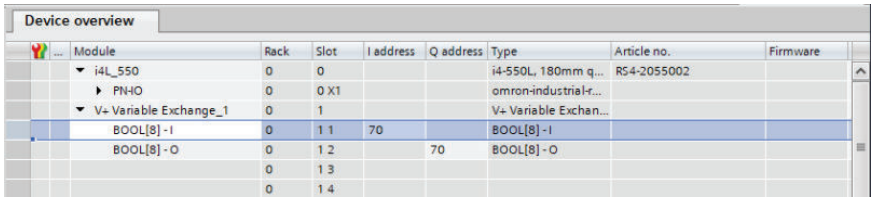
7 Set the IO cycle update time with TIA Portal.



8 Add the V+ Variable Exchange Module to the Device Overview.

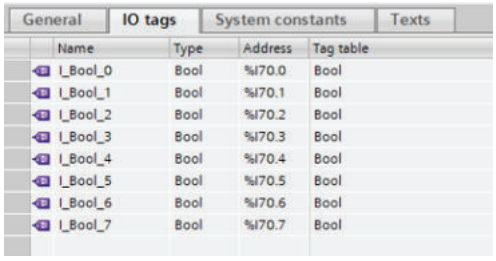


9 Configure the data to exchange with TIA Portal.
Set the input and output data to exchange between the robot and PLC in the following manner.

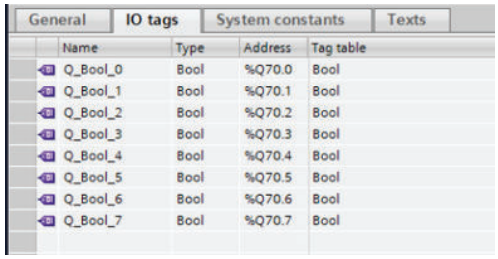


Module	Rack	Slot	I address	Q address	Type	Article no.	Firmware
i4L_550	0	0			i4-550L, 180mm q...	RS4-2055002	
PN-IO	0	0 X1			omron-industrial-r...		
V+ Variable Exchange_1	0	1			V+ Variable Exchan...		
BOOL[8] - I	0	1 1	70		BOOL[8] - I		
BOOL[8] - O	0	1 2		70	BOOL[8] - O		
	0	1 3					
	0	1 4					

10 Assign symbolic names for each address.



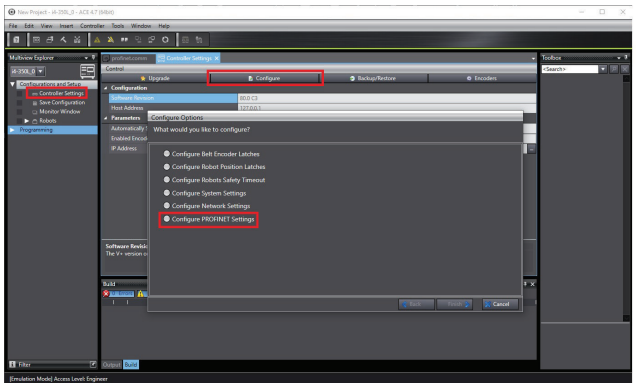
Name	Type	Address	Tag table
I_Bool_0	Bool	%I70.0	Bool
I_Bool_1	Bool	%I70.1	Bool
I_Bool_2	Bool	%I70.2	Bool
I_Bool_3	Bool	%I70.3	Bool
I_Bool_4	Bool	%I70.4	Bool
I_Bool_5	Bool	%I70.5	Bool
I_Bool_6	Bool	%I70.6	Bool
I_Bool_7	Bool	%I70.7	Bool



Name	Type	Address	Tag table
Q_Bool_0	Bool	%Q70.0	Bool
Q_Bool_1	Bool	%Q70.1	Bool
Q_Bool_2	Bool	%Q70.2	Bool
Q_Bool_3	Bool	%Q70.3	Bool
Q_Bool_4	Bool	%Q70.4	Bool
Q_Bool_5	Bool	%Q70.5	Bool
Q_Bool_6	Bool	%Q70.6	Bool
Q_Bool_7	Bool	%Q70.7	Bool

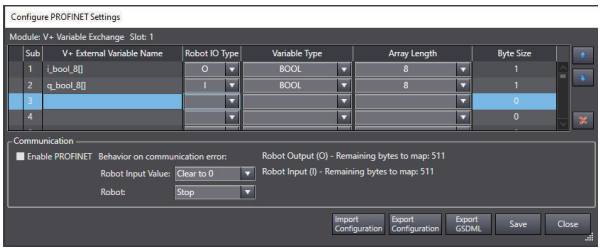
11 Add, compile, and download the TIA Portal configuration to the PLC.

12 Access the robot controller *Configure Options* area with the ACE software and then proceed with the *Configure PROFINET Settings* option.

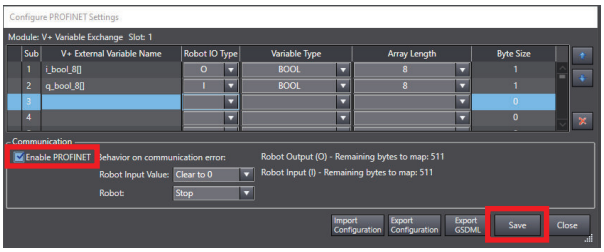


13 Enter the V+ External Variable Name and then set the IO Type, Variable Type and Array Length in the *Configure PROFINET Settings* area.
Make the following considerations when creating V+ External Variables in this area.

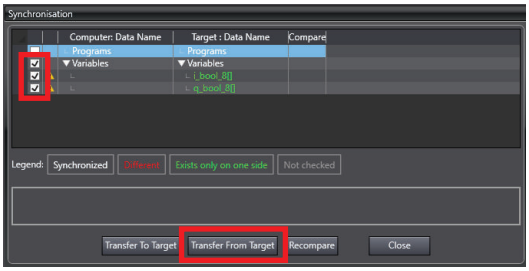
- Ensure the order (top to bottom) of the variables corresponds with the order established in TIA Portal.
- V+ External Variables standard types are 64 bit floating point.
- Brackets [] must follow the variable name when declaring an array variable type. Array variables must also have an array length set.
- A $ character must proceed the variable name when declaring a string variable type. String variables must also have an array length set.
- V+ variable naming convention must be followed. Refer to the *V+ User's Manual (Cat. No. I671)* for more information.



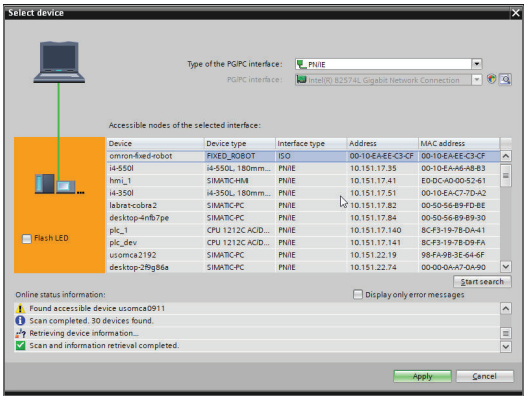
14 Select the *Enable PROFINET* check-box and adjust the communication error behavior settings.
Click the **Save** Button to implement the changes.
Saving triggers a robot controller reboot request.



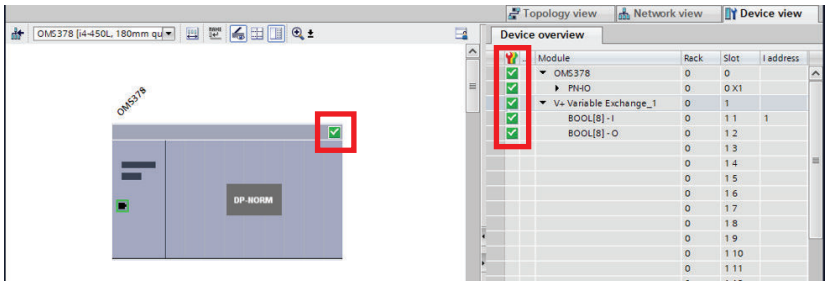
15 Synchronize the new variables created in the robot controller after the reboot.
Select the new variables and then click **Transfer from Target** to bring the new variables into the ACE project.



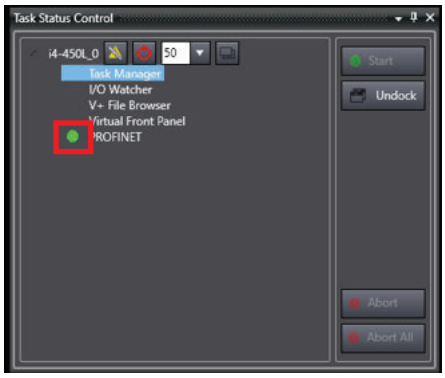
16 Scan for the new robot device.
If the new robot is not detected, check network connections and repeat previous steps. Refer to *Section 3 Troubleshooting* on page 3-1 for more information.

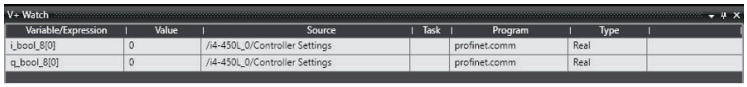


17 Check the *Device Overview* area in TIA Portal to ensure the connection status is valid.
If the connection status is not valid, check network connections and repeat previous steps. Refer to *Section 3 Troubleshooting* on page 3-1 for more information.



18 Confirm data exchange by checking the following areas in the ACE software.
If the data exchange is not occurring, check network connections and repeat previous steps.
Refer to *Section 3 Troubleshooting* on page 3-1 for more information.





2-3 V+ Program Example

This section shows an example V+ program.
While the robot is active and connected, the program checks for the status of the first bit in the q_bool_8 array, and then based on that bool value, sets the value of the first bit of the i_bool_8 array to match and prints the values of both bits.
If there is an error, the program will instead print information about the error.

```
.PROGRAM profinet.comm()

      ;Main loop
      WHILE TRUE DO
      ;While PROFINET State is ACTIVE (enabled, connected, and communicating)
          WHILE FB.STATE == 3 DO
              ;Reflect input to output from PLC point of view
              IF q_bool_8[0] THEN
                  i_bool_8[0] = TRUE
              END
              IF NOT q_bool_8[0] THEN
                  i_bool_8[0] = FALSE
              END
              ;Delay of 2ms
              WAIT.EVENT , 2E-03
              ;Print values of PROFINET Input and Output Data
              TYPE "q_bool_8[0]: ", q_bool_8[0], ",    i_bool_8[0]: ", i_bool_8[0]
          END

          $additional_info = ""
          ;Get PROFINET Error Code and Additional Information (FB.ERROR)
          fieldbus_error = FB.ERROR($additional_info)
          ;If there is a PROFINET Error
          IF (fieldbus_error <> 1) THEN
              ;Print Error Information
              TYPE "General Profinet error: ", fieldbus_error
              TYPE "Additional Information: ", $additional_info
          END
          ;Delay of 2ms
          WAIT.EVENT , 2E-03
      END


.END
```

3

Troubleshooting

Use the information in this section to troubleshoot PROFINET communication issues.

3-1 PROFINET Status

Use the FB.STATE keyword to return the current state of the fieldbus. This keyword returns the following information.

Additional Information

Refer to the *V+ Keyword Reference Manual (Cat. No. I672)* for more information about the FB.STATE keyword and usage.

Value Returned	Fieldbus State	Description
0	Disabled	Initialization fails or PROFINET is disabled.
1	Inactive	PROFINET is enabled but there is no connection
2	Idle	PROFINET is enabled and connected, but there is not data exchange between the Controller and the robot.
3	Active	PROFINET is enabled, connected, and communicating. Data is being actively exchanged between the Controller and the robot.

3-2 PROFINET Errors

Use the FB.ERROR keyword to obtain detailed PROFINET error information. Fieldbus error code and error description details returned from the FB.ERROR keyword are provided below.

Additional Information

- Refer to the *V+ Keyword Reference Manual (Cat. No. I672)* for more information about the FB.ERROR keyword and usage.
- The robot behavior when communication errors occur can be configured in the ACE software. Refer to the *Automation Control Environment (ACE) Version 4 User's Manual (Cat. No. I633)* for more information about configuring PROFINET settings.

Error Code	Error Description	Fieldbus State	Cause	Details
-1202 (field-bus system initialization fault)	Error Code 1	Disabled	Device configuration failed.	• I&M configuration corrupted. • Memory not initialized. • Network interface not available.
	Error Code 2		PROFINET stack initialization failed.	
	Error Code 3		LLDP system description corrupted.	LLDP system description in illegal status. • Port description TLV (port 0). • System name TLV. • System description TLV.
	Error Code 4			LLDP port description in illegal status. Port description TLV (port 1).
	Error Code 5		LLDP PHY not initialized.	
	Error Code 6		Profile version mismatch	PROFINET cannot be initialized because of a version mismatch.
-1201 (connection lost)	Connection rejected x y z a where: • x = Error code • y = Error decode • z = Error code 1 • a = Error code 2	Inactive	Connection request rejected.	The connection request was rejected by the PROFINET controller.
	Communication closed because of a comm loss		Connection timeout.	The connection has been aborted by the PROFINET controller.

Error Code	Error Description	Fieldbus State	Cause	Details
-1203 (invalid data)	Not able to read data because the PLC has stopped	IdleIdle	The controller stopped.	Communication data is invalid because the Controller has stopped.
	Not able to read data because supervisor is blocking submodule		The supervisor blocked the submodule.	Communication data is invalid because the supervisor is blocking the communication.
	Not able to read data because the submodule is invalid		The submodule is invalid.	Communication data is invalid because the submodule is invalid.
-1200 (invalid configuration)	Module Diff (Expected x, y, Actual z a) at b, c where: • x, z = Module ident number • y, a = Submodule ident number • b = slot number • c = subslot number		A profile/robot mismatch occurred.	A mismatch between the PROFINET I/O and ACE submodule configuration exists.
	Peer Mismatch x where x = extended channel error type		A peer mismatch occurred.	The peer port is mismatched in the port name.
	MAU Type Mismatch: Expected x, Actual y where x, y = MAU Type		A MAU type mismatch occurred.	The peer port mismatched in the MAU type.
	Link State Mismatched (Expected x y, Actual z a) where: • x, z = Link State • y, a = Port State		A link mismatch occurred.	The peer port is mismatched in the link.
	Variable Type Mismatch (Expected: 0xY, Real: 0xA) at slot b, subslot c where: • Y, A = submodule Ident Number in hex • b = slot number • c = subslot number		A variable mismatch occurred.	A mismatch between PROFINET I/O and the ACE submodule configuration occurred.
	Robot Type Mismatch (Expected: 0xY, Real: 0xA) at slot b, subslot c where: • Y, A = Module Ident Number in hex • b = slot number • c = subslot number		A robot type mismatch occurred.	The actual robot is different than the one configured in the PROFINET controller.

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