OMRON

Industrial Robot

Fieldbus Configuration

User's Guide

M130-E-01

NOTE

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Introduction

This manual is OMRON's original instructions describing the setup and operation of the product.
Please read this manual and make sure you understand the set up, functionality, and performance of the fieldbus before attempting to use it.
The information in this document pertains to OMRON's Standard Control robot type.
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.

Version Information

The information in this document describes features and functionality for robots using the following hardware and software versions.

- Firmware version: 6.102C.
- ACE Software version: 4.8.3.
- i4L Robot Controller version: Revision B.
- i4H Robot Controller version: Revision C.

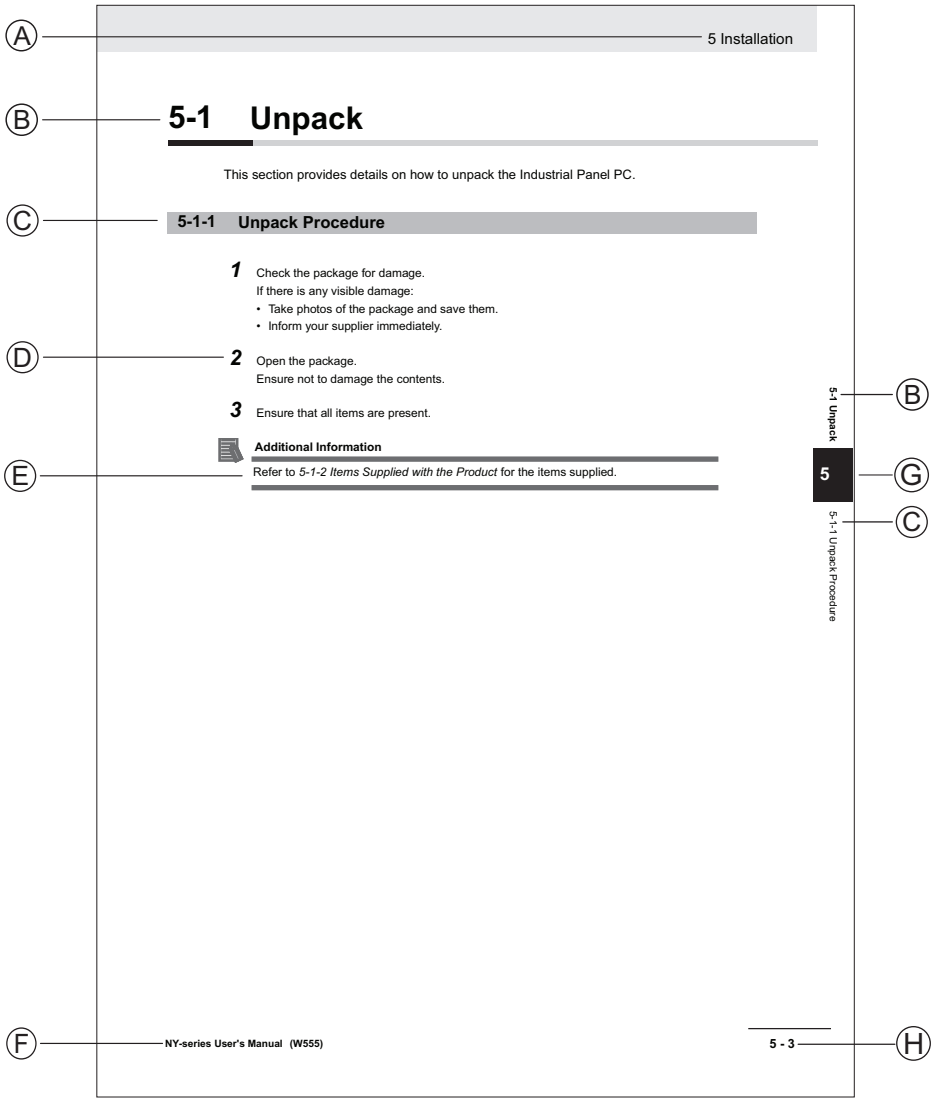
Units

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 OMRON Industrial Robots that support PROFINET communications. 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.

Caution

⚠ CAUTION

Always physically disconnect the robot from the EtherCAT network before disabling its EtherCAT communication.

Precautions for Safe Use

- Fieldbus communications are not secure. Additional measures must be taken if compliance with security standards is required.

Precautions for Correct Use

- Disconnecting EtherCAT communications while the robot is transitioning between control states may cause an invalid fieldbus state. Cycle power to the robot to recover from this condition.

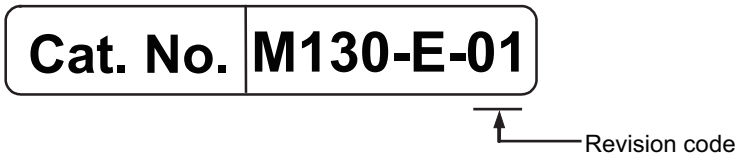
Related Manuals

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.
Sysmac Studio Version 1 Operation Manual (Cat. No. W504)	Instruction for the use of the Sysmac Studio software.

Revision History

A manual revision code appears as a suffix to the catalog number on the front and back covers of the manual.



Revision code	Date	Revised content
01	November, 2025	Original production

1

Overview

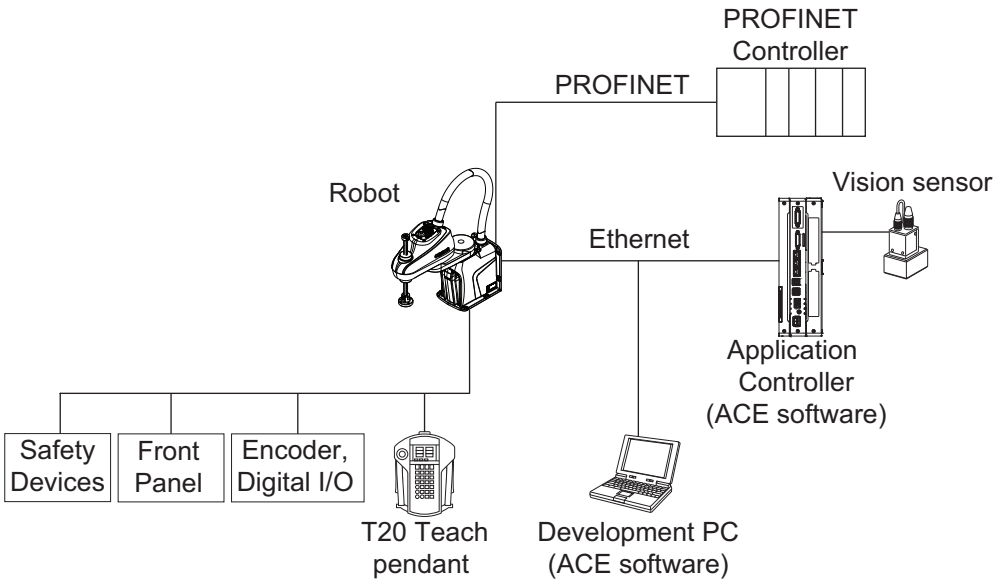
This section provides a general overview.

1-1 Introduction

This document provides information about setting up, configuring, and troubleshooting supported fieldbus communications for OMRON's industrial robot systems. The PROFINET and EtherCAT fieldbuses provide the ability for OMRON Industrial Robots to exchange data with other industrial devices. The robot supports both Profinet and EtherCAT fieldbus protocols. However, only one of these fieldbus protocols can be enabled at any given time.
Using the PROFINET fieldbus, the robot can be configured as a PROFINET device for communication with a PROFINET controller. In the EtherCAT fieldbus, the robot is configured as an EtherCAT SubDevice to communicate with an EtherCAT MainDevice, also called the EtherCAT Controller.
V+ variables and robot status information can be exchanged over the fieldbus.

1-1-1 PROFINET Details

The PROFINET implementation uses a vendor-specific device profile that is detailed in this document. The typical PROFINET system configuration is shown below.



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*1	4, 8, 16, 32, 64, 128, 512 ms
Maximum data payload	512 bytes for Input and 512 bytes for Output
Sub-slot limit	Slot 1 with V+ variable exchange can contain only 32 sub-slots.

*1. IO Connection Cycle Time controls communication interval independent of the robot controller data refresh rate.

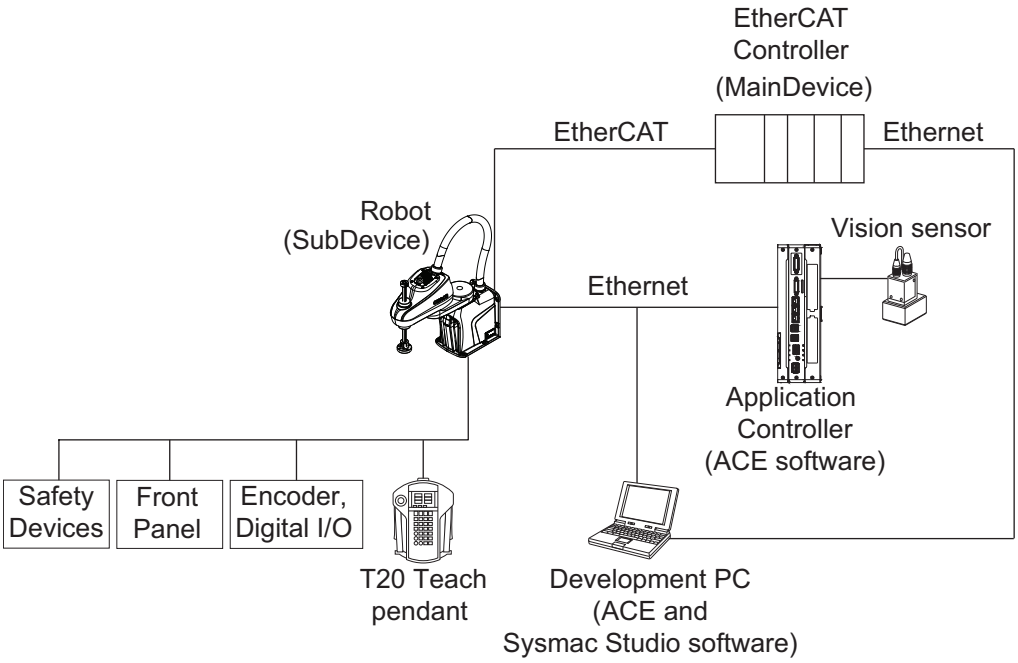
Data Types

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

Data Type	Byte Size	Array Option (Byte Size)
BOOL	1	8/16/32 (1/2/4)
INT	2	16/32 (32/64)
DINT	4	16/32 (64/128)
REAL	4	6/16/32 (24/64/128)
LREAL	8	6/16/32 (48/128/256)
String	32 (1 byte for each character)	Not Available
DATASTREAM	128, 256, 512	128/256/512 (128/256/512)

1-1-2 EtherCAT Details

The EtherCAT SubDevice functionality enables a single SubDevice (robot) or a group of connected SubDevices to be controlled and monitored by an EtherCAT Controller (MainDevice or Master) or any PLC with EtherCAT MainDevice capabilities over an EtherCAT network.
A typical EtherCAT system configuration is shown below.



EtherCAT Specifications

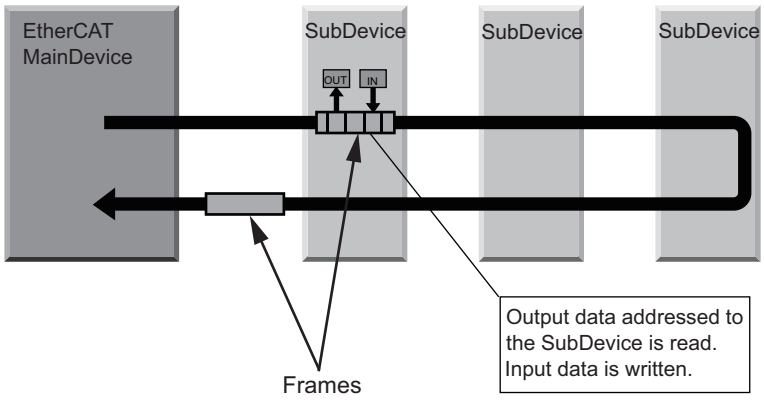
EtherCAT communication specifications are provided below.

Item	Specification
Synchronization	FreeRun and DC (Distributed Clock) with Sync0
Physical layer	100BASE-TX
Modulation	Baseband
Baud rate	100 Mbits/s
Duplex mode	Auto
Topology	Line, ring, and branching

Item	Specification
Transmission media	Twisted-pair cable of category 5 or higher Recommended cable: straight, double-shielded cable with aluminum tape and braiding
Maximum transmission distance between nodes	100 m
Communications cycle	1 ms, 2 ms, 4 ms when SubDevice (robot) configured in DC mode. Any cycle time allowed in the MainDevice when SubDevice configured in FreeRun mode. For both modes, real-time data about robot status is updated every 4 ms.
Maximum PDO data payload	512 bytes for input and 512 bytes for output.
Node address range	1 to 511 when set with hardware switches. 0 to 65534 when set with MainDevice software.
Robot firmware	6.102C or higher
Robot Controller	i4H: Revision C and above i4L: Revision B and above
ACE software	4.8.3 or higher
Vendor ID	0x0083 (OMRON Corporation)
Product code	0xA13B4001 (i4H) 0xA13B4000 (i4L)

EtherCAT Communication Basics

EtherCAT (Ethernet Control Automation Technology) is a high-performance industrial network system that enables fast and efficient communications based on the Ethernet.
The MainDevice does not send data to individual nodes or SubDevices on the network, instead, it passes Ethernet frames through all of the SubDevices. When a frame passes through a SubDevice, the SubDevice reads and writes data in the areas allocated to it in the frames within a few nanoseconds.
The Ethernet frames transmitted by the MainDevice pass through all SubDevices without stopping. The last SubDevice returns all of the frames, which again pass through all of the SubDevices before returning to the MainDevice.
This mechanism ensures high speed and real-time data transmission.

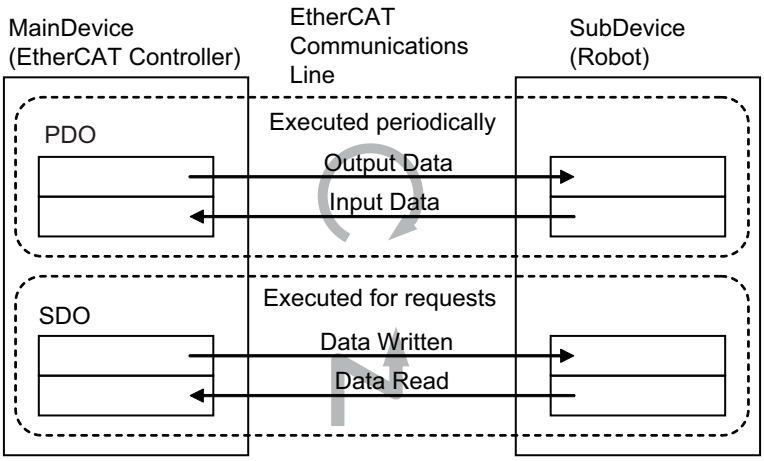


● PDO and SDO Communication

There are two primary communication mechanisms through which data is exchanged between the EtherCAT MainDevice and SubDevice(s): Process Data Objects (PDOs) and Service Data Objects (SDOs).

PDO communication is a cyclic communication method in which high priority information essential for continuous control and monitoring is exchanged in a fixed cycle between the MainDevice and the SubDevices. The fixed cycle is called a PDO communication cycle. The MainDevice can exchange information with SubDevices in realtime in the PDO communication cycle.

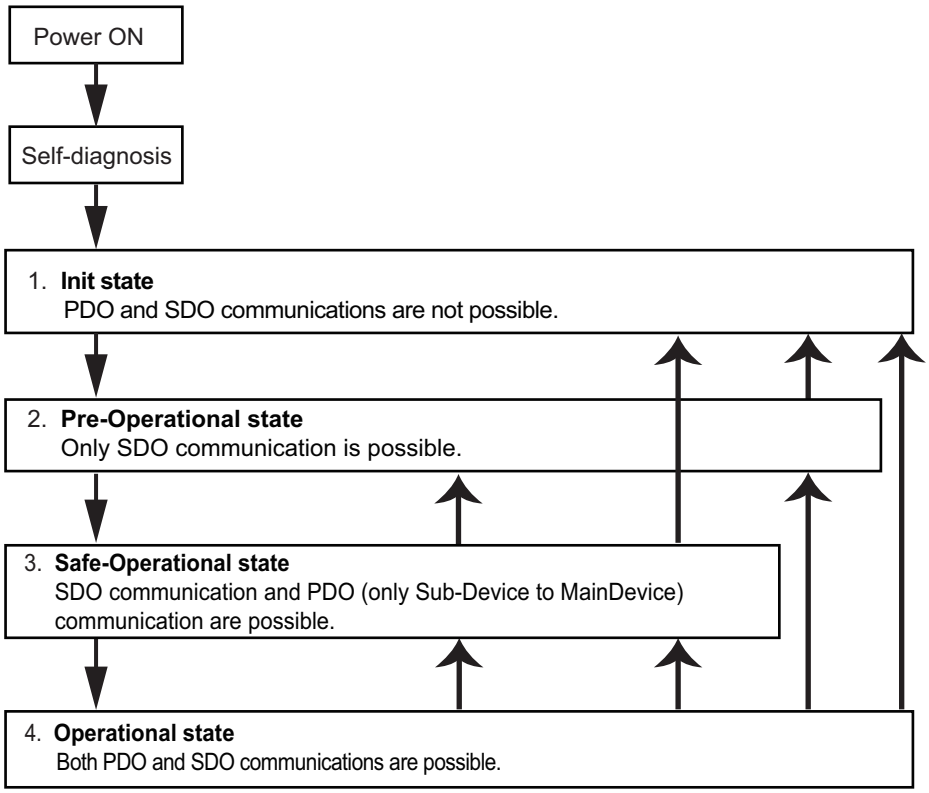
SDO communication, on the other hand, facilitates acyclic, on-demand, non-critical data exchange between the MainDevice and the SubDevices. SDO communication is primarily used for configuring devices, reading specific parameters, and performing diagnostics.



Refer to *Data Exchange* on page 1-6 for more information.

● Control States

EtherCAT communication provides four control states. Communication is controlled by moving between these states. After the power is turned ON, the MainDevice and SubDevice(s) progress from the Init state to the Pre-Operational state, Safe-Operational state, and then Operational state before starting EtherCAT communications. After EtherCAT communication is established, the connection could move back from operational state to another state due to error conditions.



The current fieldbus state can be determined by viewing the fieldbus status in the ACE interface or by using the FB.STATE keyword. Refer to the *Automation Control Environment (ACE) Version 4 User's Manual (Cat. No. I633)* and *3-3 EtherCAT Status* on page 3-6 for more information.

● Synchronization Modes

The EtherCAT SubDevice functionality supports FreeRun and Distributed Clock (DC) with Sync0 synchronization modes for managing the timing and coordination between the MainDevice and the SubDevices.

In FreeRun mode, the SubDevice(s) operates asynchronously with the MainDevice. In this mode, each SubDevice operates independently based on its own internal clock or a local timer. It does not synchronize its internal actions (like reading inputs or updating outputs) with the MainDevice's communication cycle or with other SubDevices.

In DC mode, the SubDevice operates synchronously with the MainDevice. In this mode, the MainDevice and all SubDevices share the same clock in precise alignment for EtherCAT network-wide synchronization.

Refer to *EtherCAT Specifications* on page 1-3 for more information about communication cycle times for the two modes.

Data Exchange

The EtherCAT SubDevice functionality allows for sharing of data between the MainDevice and the robot SubDevice using PDO and SDO communications. Data such as V+ External variables, information about robot parameters, and robot status can be shared with the MainDevice.

● Data Types for Mapping EtherCAT Objects

Use the following information to understand all data types and sizes supported for mapping EtherCAT objects to V+ variables.

Data Type	Size	Range
BYTE (Unsigned Char)	1 byte	0 to 255
INT (Signed Short)	2 bytes	-32768 to 32767
DINT (Signed Integer)	4 bytes	-2147483648 to 2147483647
REAL (Float IEEE754)	4 bytes	-3.4028E+38 to 3.4028E+38
LREAL (Double IEEE754)	8 bytes	-1.7977E+308 to 1.7977E+308
String (8 Bit ASCII Character Set)	128 bytes	0 to 255
Array of BYTE	Size of Array*1	0 to 255

*1. There are different fixed size of Array of Byte: 256 and 512.

For the INT, DINT, REAL and LREAL data types, you can map a single scalar V+ variable or a V+ array. The following table describes this.

EtherCAT						V+	
Object ID	Object Name	No. of Sub-indexes	MainDevice Data Type (size)	Access	Mappable in PDO	Scalar or Array	Data Type
0x6700	Cycle Count	1	UDINT	Read	0x1AF0 / 0x1AF1	-	-
0x6701	Actual Cartesian Position	6	REAL	Read	0x1AF0 / 0x1AF1	-	-
0x6702	Actual Joint Angles	4	REAL	Read	0x1AF0 / 0x1AF1	-	-
0x6703	Commanded Cartesian Position	6	REAL		0x1AF0 / 0x1AF1	-	-
0x6704	Commanded Joint Angles	4	REAL		0x1AF0 / 0x1AF1	-	-
0x6705	Robot Information	5	RECORD		0x1AF0 / 0x1AF1	-	-
0x6706	Robot Motor Torques	6	REAL		0x1AF0 / 0x1AF1	-	-
0x6710	BYTE	254	BYTE - 1	Read	0x1AF0 / 0x1AF1	Scalar	Double
0x6720	INT	254	INT - 2	Read	0x1AF0 / 0x1AF1	Scalar	Double
0x6730	DINT	128	DINT - 4	Read	0x1AF0 / 0x1AF1	Scalar	Double
0x6740	REAL	128	REAL - 4	Read	0x1AF0 / 0x1AF1	Scalar	Double
0x6750	LREAL	64	LREAL - 8	Read	0x1AF0 / 0x1AF1	Scalar	Double
0x6760	ARRAY [0...255] OF BYTE	1	ARRAY OF BYTE - 256	Read	0x1AF2	Array [256]	Double
0x6761	ARRAY [0...511] OF BYTE	1	ARRAY OF BYTE - 512	Read	0x1AF3	Array [512]	Double
0x6770	GROUP OF INT	254	INT - 2	Read	0x1AF0 / 0x1AF1	Array [1...254]	Double
0x6780	GROUP OF DINT	128	DINT - 4	Read	0x1AF0 / 0x1AF1	Array [1...128]	Double

EtherCAT						V+	
Object ID	Object Name	No. of Sub-indexes	MainDevice Data Type (size)	Access	Mappable in PDO	Scalar or Array	Data Type
0x6790	GROUP OF REAL	128	REAL - 4	Read	0x1AF0 / 0x1AF1	Array [1...128]	Double
0x68A0	GROUP OF LREAL	64	LREAL - 8	Read	0x1AF0 / 0x1AF1	Array [1...64]	Double
0x68B0	STRING	4	String - 128	Read	SDO access only	Scalar	String
0x7710	BYTE	254	BYTE - 1	Read / Write	0x16F0	Scalar	Double
0x7720	INT	254	INT - 2	Read / Write	0x16F0	Scalar	Double
0x7730	DINT	128	DINT - 4	Read / Write	0x16F0	Scalar	Double
0x7740	REAL	128	REAL - 4	Read / Write	0x16F0	Scalar	Double
0x7750	LREAL	64	LREAL - 8	Read / Write	0x16F0	Scalar	Double
0x7760	ARRAY [0...255] OF BYTE	8	ARRAY OF BYTE - 256	Read / Write	0x16F2	Array [256]	Double
0x7761	ARRAY [0...511] OF BYTE	4	ARRAY OF BYTE - 512	Read / Write	0x16F3	Array [128]	Double
0x7770	GROUP OF INT	254	INT - 2	Read / Write	0x16F0	Array [1...254]	Double
0x7780	GROUP OF DINT	128	DINT - 4	Read / Write	0x16F0	Array [1...128]	Double
0x7790	GROUP OF REAL	128	REAL - 4	Read / Write	0x16F0	Array [1...128]	Double
0x78A0	GROUP OF LREAL	64	LREAL - 8	Read / Write	0x16F0	Array [1...64]	Double
0x78B0	STRING	4	String - 128	Read / Write	SDO access only	Scalar	String

● PDO Types

EtherCAT objects are grouped in datasets called PDOs. This grouping process is called PDO mapping. You can configure the PDOs in the MainDevice. PDOs can be classified as flexible or fixed. The following table provides details about PDO types.

PDO Number	Direction	Type	Detail
0x1AF0	Inputs	Flexible	Contains the predefined objects corresponding to robot information / status but allows for adding any mappable object for inputs upto 255.
0x1AF1	Inputs	Flexible	Can contain mappable objects for inputs. Up to 255.
0x1AF2	Inputs	Fixed	Contains only ARRAY OF BYTE [256].

PDO Number	Direction	Type	Detail
0x1AF3	Inputs	Fixed	Contains only ARRAY OF BYTE [512].
0x16F1	Outputs	Flexible	Can contain mappable objects for outputs. Up to 255.
0x16F2	Outputs	Fixed	Contains only ARRAY OF BYTE [256].
0x16F3	Outputs	Fixed	Contains only ARRAY OF BYTE [512].

● Robot Information

Specific robot parameter or robot status information can be accessed in real-time from the robot by the MainDevice through dedicated objects of the robot's ESI file. These objects are accessed from the MainDevice and are not mapped to V+ External variables. They do not require extra configuration on the robot side.

The following table provides details about the different robot parameters that can be shared through their corresponding EtherCAT objects.

Object ID	Object Name	Sub Index	Sub Index Name	Data Type	Detail
0x6700	Cycle number*1	1	Cycle number	UDINT	V+ task cycles since the controller started
0x6701	Actual Cartesian Position	1	Actual X Position	REAL	In mm
		2	Actual Y Position		
		3	Actual Z Position		
		4	Actual Yaw		In degrees
		5	Actual Pitch		
		6	Actual Roll		
0x6702	Actual Joint Angles	1	Actual Joint 1 Angle	REAL	In degrees
		2	Actual Joint 2 Angle		
		3	Actual Joint 3 Angle		
		4	Actual Joint 4 Angle		
		5	Actual Joint 5 Angle		
		6	Actual Joint 6 Angle		
0x6703	Commanded Cartesian Position	1	Commanded X Position	REAL	In mm
		2	Commanded Y Position		
		3	Commanded Z Position		
		4	Commanded Yaw		In degrees
		5	Commanded Pitch		
		6	Commanded Roll		

Object ID	Object Name	Sub Index	Sub Index Name	Data Type	Detail
0x6704	Commanded Joint Angles	1	Commanded Joint 1 Angle	REAL	In degrees
		2	Commanded Joint 2 Angle		
		3	Commanded Joint 3 Angle		
		4	Commanded Joint 4 Angle		
		5	Commanded Joint 5 Angle		
		6	Commanded Joint 6 Angle		
0x6705	Robot Information	1	Robot Configuration	BYTE	Bits meaning (starting Bit 0): isRighty, isBelow, isFlip
		2	Robot Status		Bits meaning (starting Bit 0):isAuto, isPowerEnabled, isCalibrated, isDryRun, isESTOP, isEnabled
		3	Robot Control Mode		0: No Selection, 1: Free Joint, 2: Individual Joint, 3: World Coordinates, 4: Tool Coordinates, 5: Computer Control, 7: JogTo Mode, 8: Align Mode, 9: Frame Mode
		4	Robot Actual Movement Progress	REAL	Percentage of completed current movement. Progress is returned with an accuracy of 0.8%
		5	Robot Monitor Speed		Value relative to the max speed of the robot
0x6706	Robot Motor Torques	1	Motor 1 Torque	REAL	Percentage of the max torque available for the motor.
		2	Motor 2 Torque		
		3	Motor 3 Torque		
		4	Motor 4 Torque		
		5	Motor 5 Torque		
		6	Motor 6 Torque		

*1. Each time the cycle number changes, it indicates the arrival of new data.

2

Configuration

This section provides general configuration examples for the different fieldbus types.

2-1 PROFINET Configuration

The following topics provide PROFINET configuration details.

2-1-1 Basic Configuration Steps

Basic PROFINET configuration steps are provided below. Refer to *2-1-2 Configuration Example* on page 2-4 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.
- Ethernet network equipment and cabling.

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

Precautions for Safe Use

Fieldbus communications are not secure. Additional measures must be taken if compliance with security standards is required.

Additional Information

- To activate the PROFINET fieldbus, you must configure at least one variable in addition to enabling the checkbox in the Configure PROFINET Settings Window in ACE. If no variables are defined, PROFINET will not be enabled.
- Enabling the PROFINET or EtherCAT fieldbus automatically configures and activates the robot's network ports for that specific fieldbus communication. By default, all ports are set for Ethernet communication when neither fieldbus is active.
- PROFINET fieldbus configuration and set up are possible in emulation mode; however, active PROFINET communication is not supported in emulation mode.

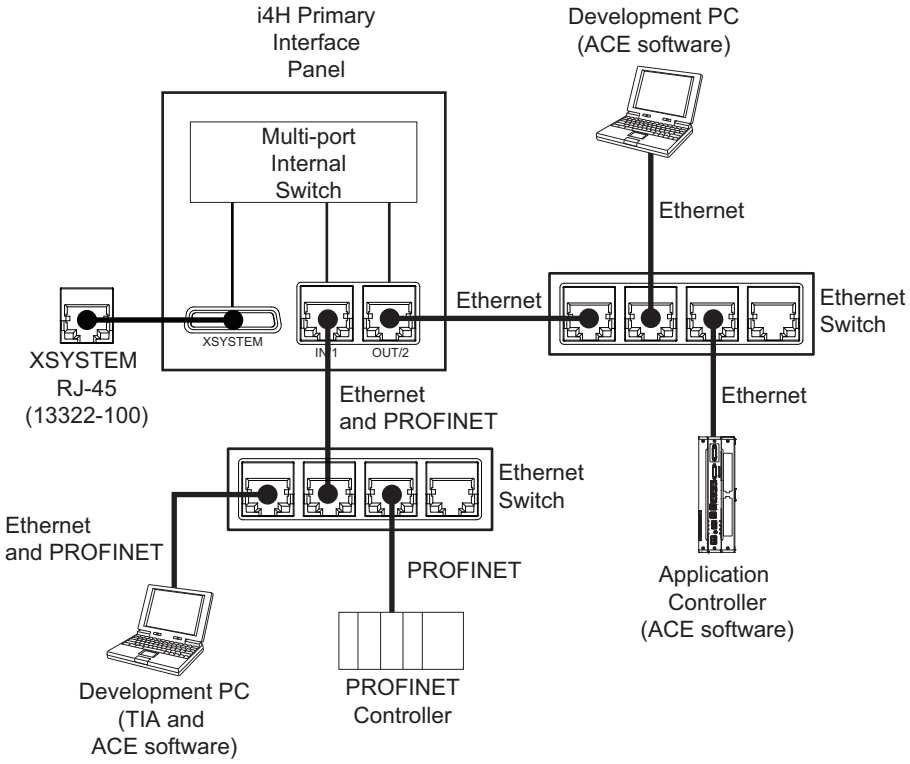
1. Connect all required network equipment and cabling.
2. Obtain the GSDML file using ACE.
3. Install the GSDML file using TIA Portal.
4. Add the robot device and make configuration settings in TIA Portal.
5. Add, compile, and download the TIA Portal configuration to the PLC.
6. Make robot configuration settings with ACE software.
7. Confirm data exchange between the robot and PLC.
8. Scan for the new robot device.

i4H Typical Connections

The following figure shows typical PROFINET connections for an i4H robot.

Additional Information

When PROFINET is enabled, Port IN/1 is reserved for PROFINET communications only.

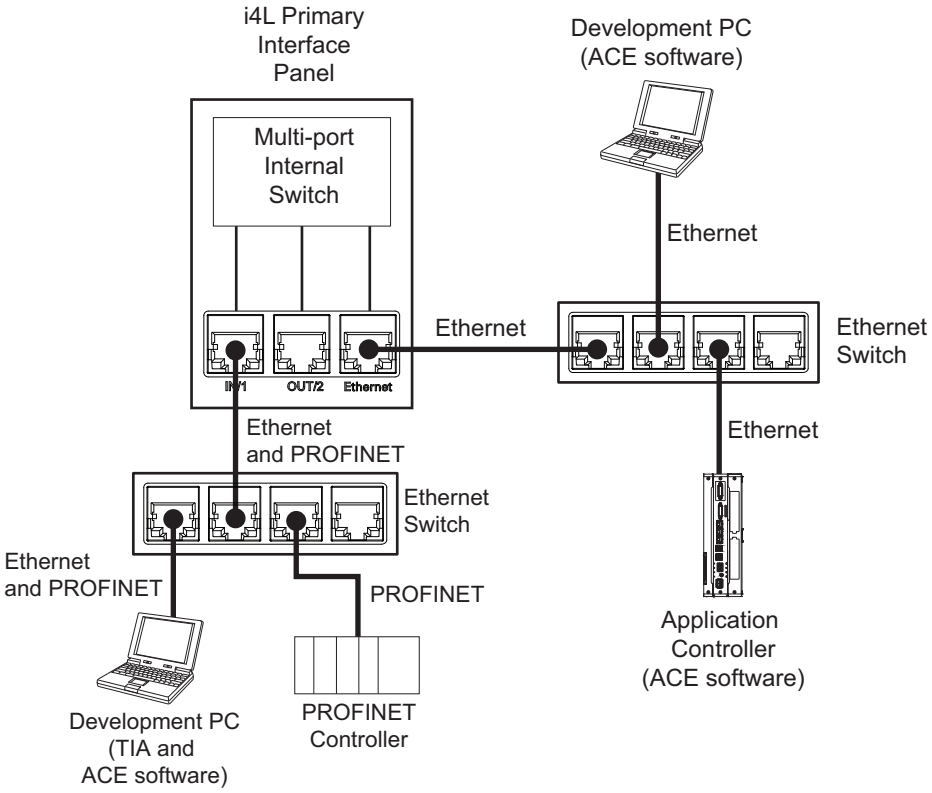


i4L Typical Connections

The following figure shows typical PROFINET connections for an i4L robot.

Additional Information

When PROFINET is enabled, Port IN/1 is reserved for PROFINET communications only.

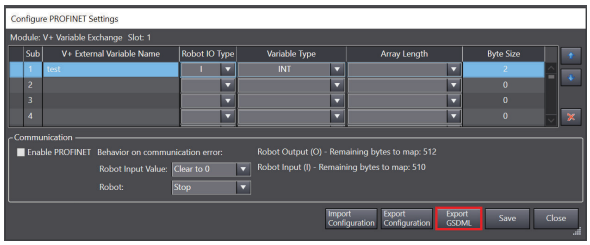


2-1-2 Configuration Example

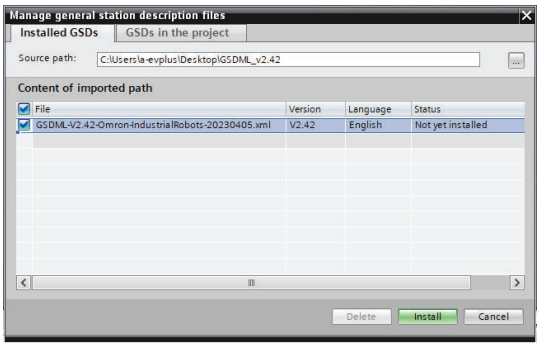
This configuration example provides step-by-step instructions to configure the robot in a PROFINET network under the following conditions.

- 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).

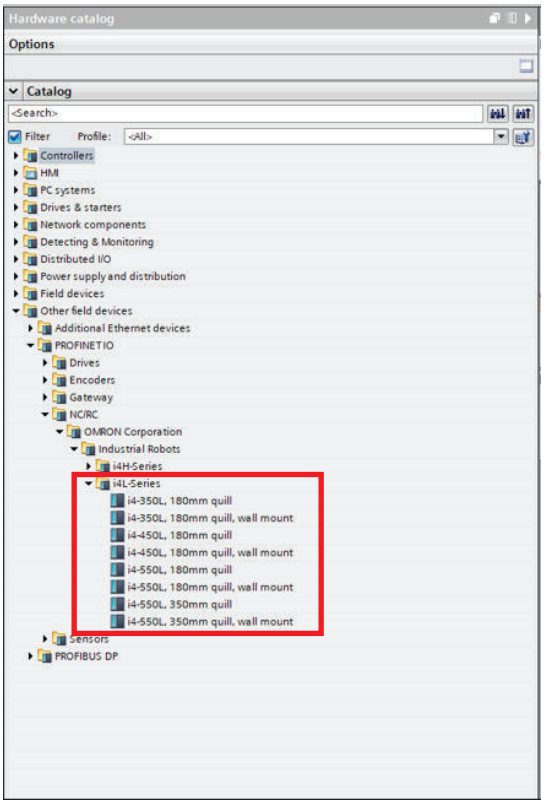
1 Obtain the GSDML xml file for the robot using ACE.
The GSDML file is stored in the robot controller. Connect to the robot controller using ACE.
Open the *Configure PROFINET Settings* area and then click the **Export GSDML** Button.



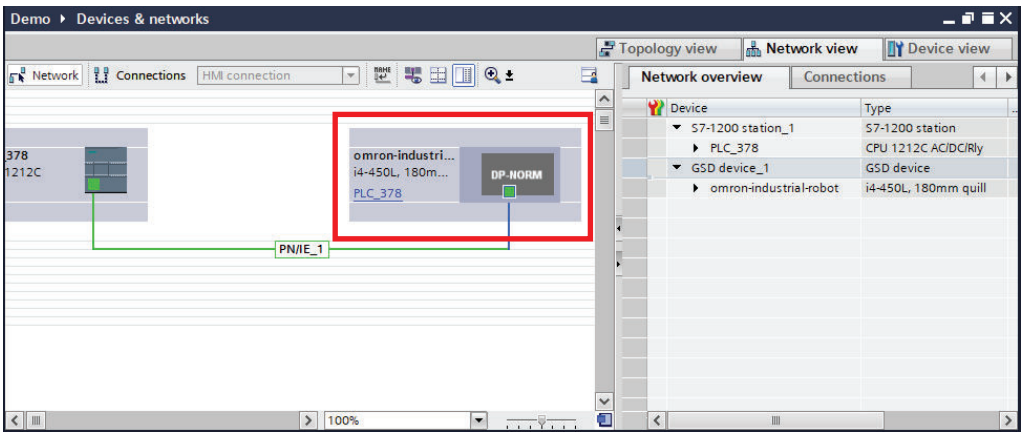
2 Install the GSDML file using TIA Portal.



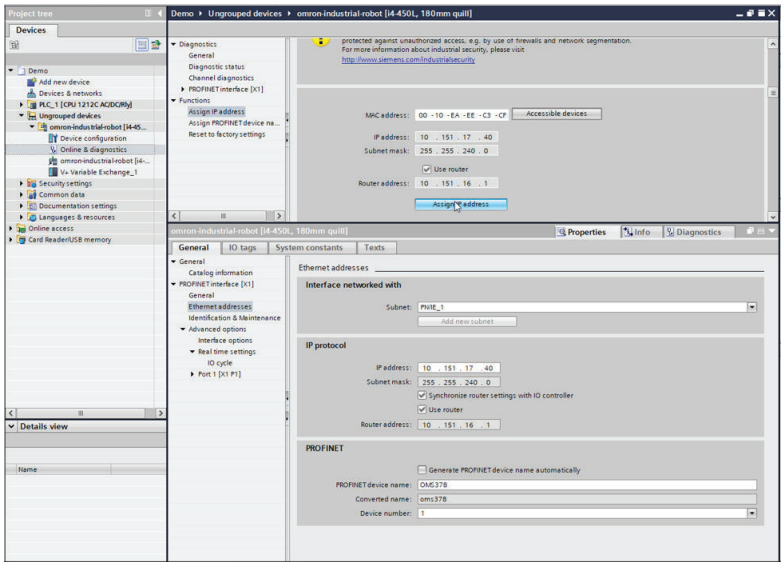
3 Confirm that OMRON Corporation robots are listed in the Catalog area.



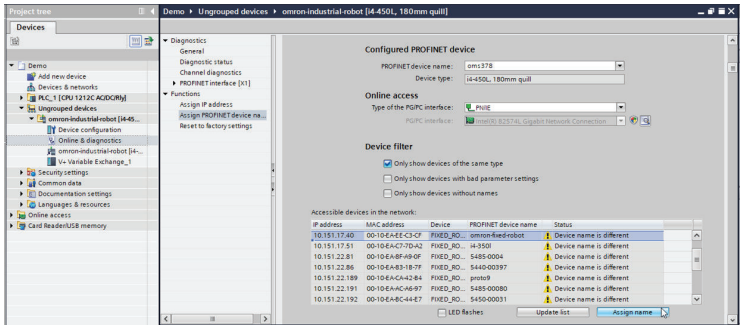
4 Add the robot device to the Network view with TIA Portal.



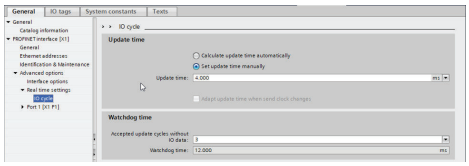
5 Assign the IP address of the robot with TIA Portal.



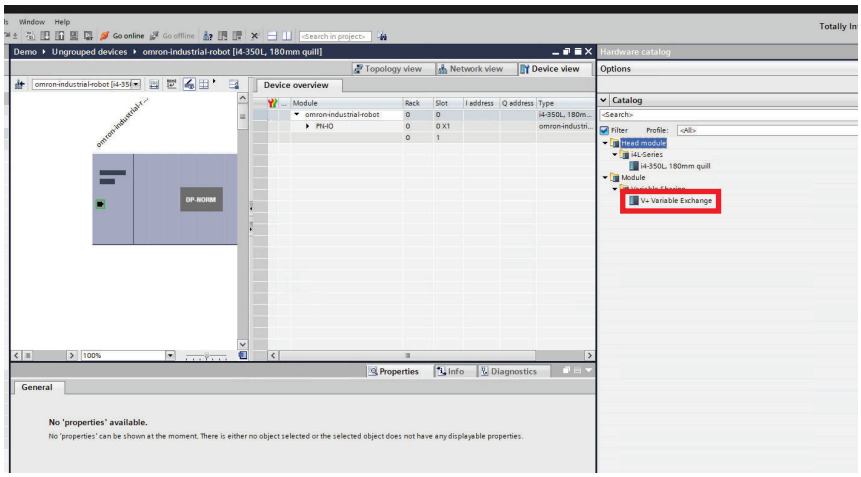
6 Assign a unique device name to the robot in TIA Portal.



7 Set the IO cycle update time with TIA Portal.

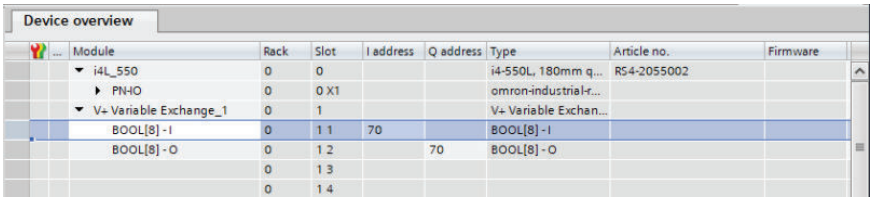


8 Add the V+ Variable Exchange Module to the Device Overview.

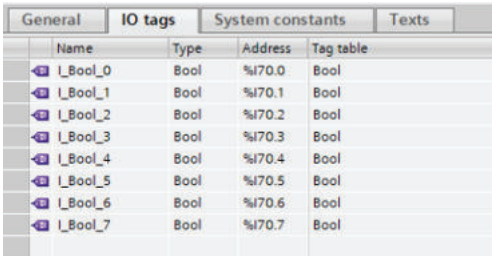


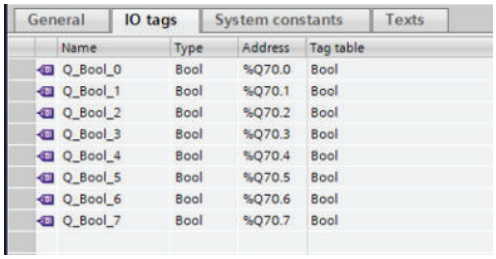
9 Configure the data to exchange with TIA Portal.

Set the input and output data to exchange between the robot and PLC in the following manner.



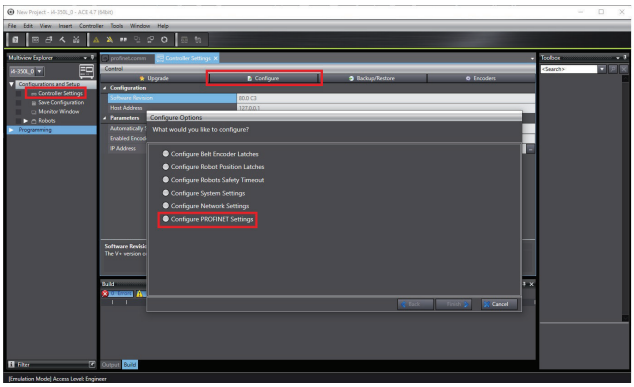
10 Assign symbolic names for each address.





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

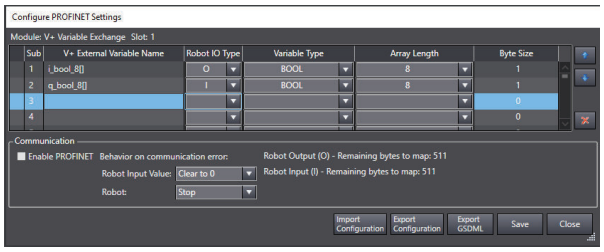
12 Access the robot controller *Configure Options* area with the ACE software and then proceed with the *Configure PROFINET Settings* option.



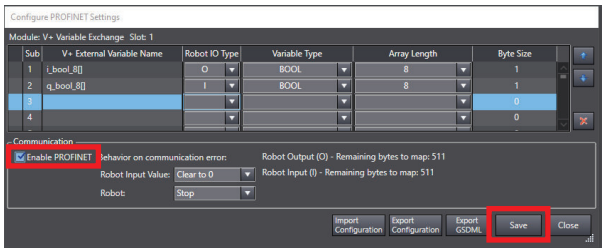
13 Enter the V+ External Variable Name and then set the IO Type, Variable Type and Array Length in the *Configure PROFINET Settings* area.

Make the following considerations when creating V+ External Variables in this area.

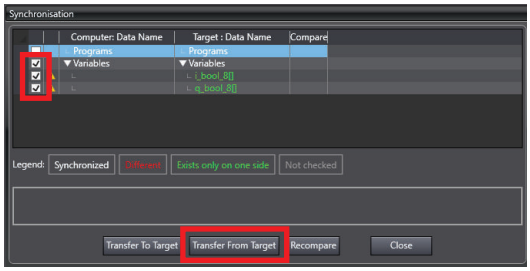
- Ensure the order (top to bottom) of the variables corresponds with the order established in TIA Portal.
- V+ External Variables standard types are 64 bit floating point.
- Brackets [] must follow the variable name when declaring an array variable type. Array variables must also have an array length set.
- A $ character must precede 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.



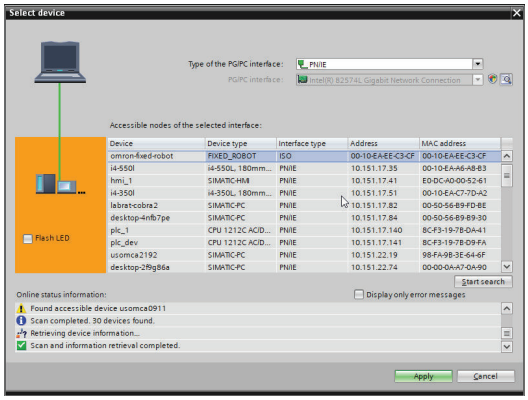
14 Select the *Enable PROFINET* check-box and adjust the communication error behavior settings.
Click the **Save** Button to implement the changes.
Saving triggers a robot controller reboot request.



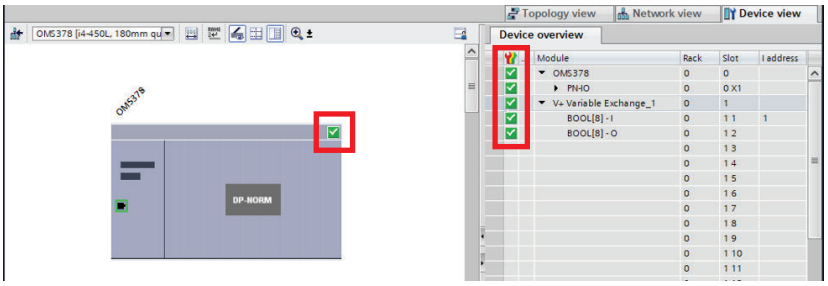
15 Synchronize the new variables created in the robot controller after the reboot.
Select the new variables and then click **Transfer from Target** to bring the new variables into the ACE project.



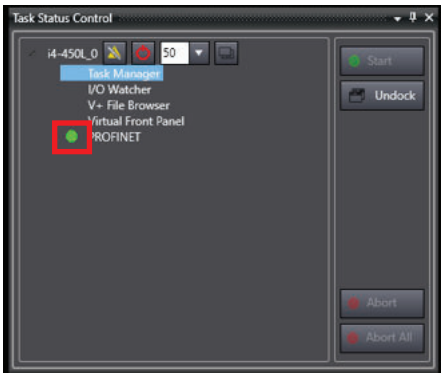
16 Scan for the new robot device.
If the new robot is not detected, check network connections and repeat previous steps. Refer to *Section 3 Troubleshooting* on page 3-1 for more information.

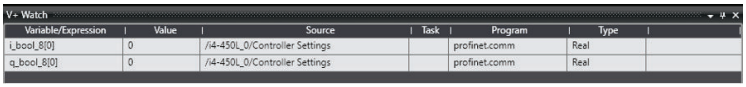


17 Check the *Device Overview* area in TIA Portal to ensure the connection status is valid.
If the connection status is not valid, check network connections and repeat previous steps. Refer to *Section 3 Troubleshooting* on page 3-1 for more information.



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.





2-1-3 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
```

2-2 EtherCAT Configuration

The following topics provide EtherCAT configuration details. An overview of configuration steps and a detailed configuration example are provided.
The configuration example includes steps utilizing an OMRON MainDevice. The procedure might vary if you use another MainDevice. Please refer to the documentation associated with your MainDevice for more information.

2-2-1 Basic Configuration Steps

Basic EtherCAT configuration steps are provided below. Refer to *Configuration Procedure* on page 2-14 for a specific configuration example.
The following items are required for EtherCAT configuration:

- An OMRON Industrial Robot, such as i4H or i4L that supports EtherCAT SubDevice functionality.
- ACE software version 4.8.3 or higher for configuring the robot.
- EtherCAT Controller such as OMRON NX or NJ series CPU Unit or another PLC that supports EtherCAT MainDevice functionality.
- Sysmac Studio Automation software (for OMRON EtherCAT MainDevices) or the software application for your MainDevice.
- Ethernet network equipment and cabling for EtherCAT network.

Refer to the *Automation Control Environment (ACE) Version 4 User's Manual (Cat. No. I633)* for more information about configuring EtherCAT settings.

⚠ CAUTION

Always physically disconnect the robot from the EtherCAT network before disabling its EtherCAT communication.

Precautions for Safe Use

Fieldbus communications are not secure. Additional measures must be taken if compliance with security standards is required.

Precautions for Correct Use

Disconnecting EtherCAT communications while the robot is transitioning between control states may cause an invalid fieldbus state. Cycle power to the robot to recover from this condition.

Additional Information

- Enabling the PROFINET or EtherCAT fieldbus automatically configures and activates the robot's network ports for that specific fieldbus communication. By default, all ports are set for Ethernet communication when neither fieldbus is active.
- EtherCAT fieldbus configuration and set up are possible in emulation mode; however, active EtherCAT communication is not supported in emulation mode.
- Avoid changing the EtherCAT control state or synchronization mode while the robot High Power is enabled.

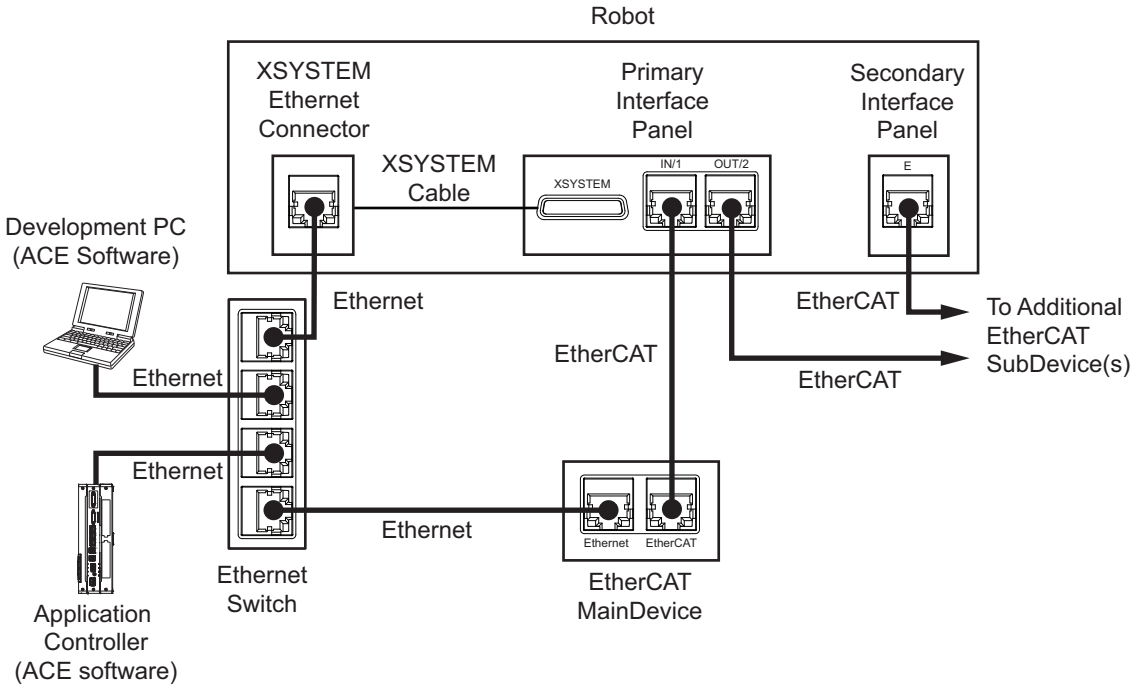
1. Ensure the robot (SubDevice) firmware version is 6.102C or higher.
2. Connect all EtherCAT devices, other network equipment, and cabling.
3. Enable EtherCAT communication using ACE.
4. Obtain the robot's ESI file using ACE. An ESI (EtherCAT SubDevice information) file is an XML file that describes the connection information and profile of the EtherCAT SubDevice.
5. Define V+ external variables in the robot for data exchange with the MainDevice using ACE.
6. Import the saved ESI file (refer to step 4 above) into the MainDevice using Sysmac Studio or the application for your MainDevice.
7. Scan the EtherCAT network to ensure the robot is added.
8. Set node address for the robot.
9. Configure the same external variables (as defined in ACE previously) in the MainDevice using Sysmac Studio or the application for your MainDevice. This process is also called PDO data mapping.
10. Define EtherCAT network speed.
11. Confirm data exchange between the robot and MainDevice.

i4H Typical Connections

The following figure shows typical EtherCAT connections for an i4H robot.

Additional Information

When EtherCAT is enabled, Ports IN/1 and OUT/2 are reserved for EtherCAT communications only.

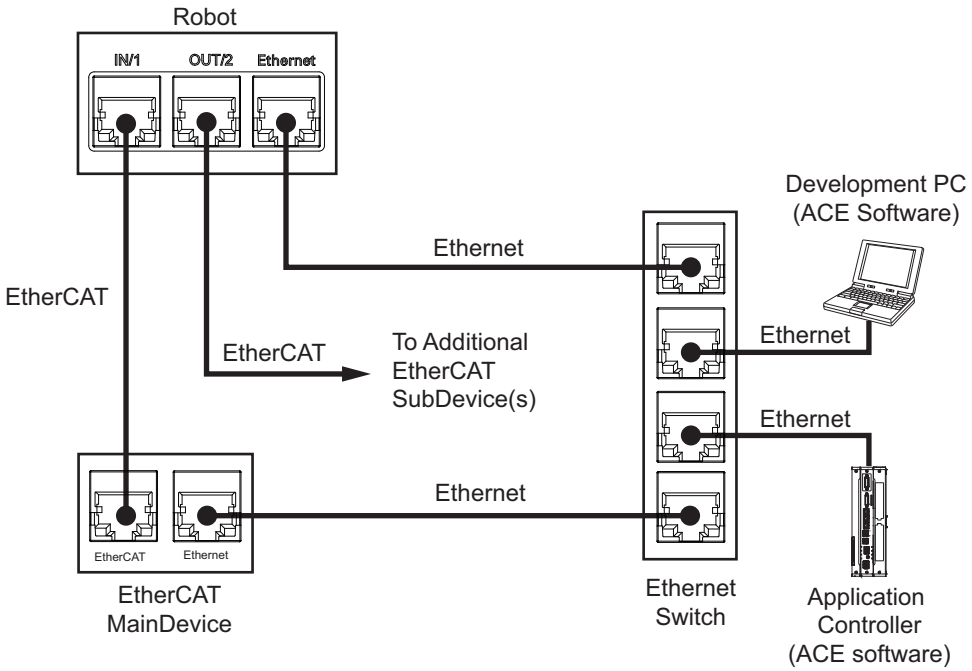


i4L Typical Connections

The following figure shows typical EtherCAT connections for an i4L robot.

Additional Information

When EtherCAT is enabled, Ports IN/1 and OUT/2 are reserved for EtherCAT communications only. Port 3 is used for Ethernet communication.



2-2-2 Configuration Example

The following sections provide an example procedure for configuring the robot for communication with the MainDevice (EtherCAT Controller or Master), considerations for mapping V+ External Variables to EtherCAT objects in ACE, and considerations for configuring PDO settings in the Sysmac Studio interface.

V+ External Variables Considerations

Make the following considerations when creating V+ External Variables in the *Configure EtherCAT Settings* area in the ACE interface.

- The information in this area is available for data exchange with the MainDevice.
- Variable names must begin with an alphabetic character. V+ variable naming convention must be followed. Refer to *V+ User's Manual (Cat. No. I671)* for more information.
- Variable names can consist of alphanumeric characters (0-9, A-Z, a-z), as well as period and underscore.
- The maximum length of a variable name is limited to 15 bytes.
- Brackets [] must follow the variable name when declaring an array variable type.
- A $ character must precede the variable name when declaring a string variable type.
- Refer to *Data Types for Mapping EtherCAT Objects* on page 1-6 for more information.

PDO Settings Considerations

Make the following considerations when configuring PDO settings for the MainDevice.

- If you try to configure an EtherCAT object (or its subindex) in a PDO that is not in the list of mapped EtherCAT objects defined in ACE previously, an error message is returned (in ACE Error Log and the MainDevice) and the SubDevice stays in pre-op state.
- Flexible PDOs allow the inclusion of any object defined in the ESI file, with the exception of string data types, which are limited to SDO access.
- Objects under the name “GROUP OF” that can be mapped only with V+ array variables, must start from the first subindex and must always be consecutive such as subindex 1, 2 and 3. Refer to *Data Types for Mapping EtherCAT Objects* on page 1-6 for more information.
- Objects under the name “GROUP OF” must not be repeated and must always be ordered in PDO settings.
- "ARRAY OF BYTES" objects exceeding 30 bytes cannot be added to flexible PDOs (such as 1AF1) because these PDOs cannot accommodate the entire object.

Configuration Procedure

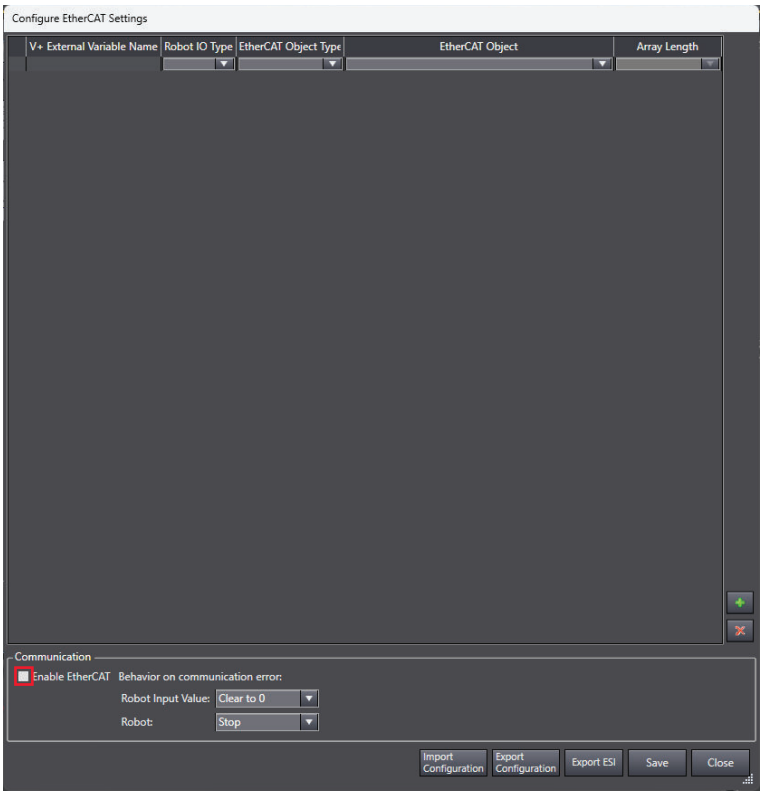
This configuration example provides step-by-step instructions to configure the robot for communication with the MainDevice under the following conditions.

- An OMRON NX1P2 series CPU Unit is used as the MainDevice.
- An i4L robot is used as the EtherCAT SubDevice.
- Sysmac Studio software installed on the PC for configuring the MainDevice.
- ACE software version 4.8.3 installed on the PC for configuring the robot.
- All EtherCAT devices and other network equipment are connected using proper cabling.

- Robot firmware version is 6.102C.

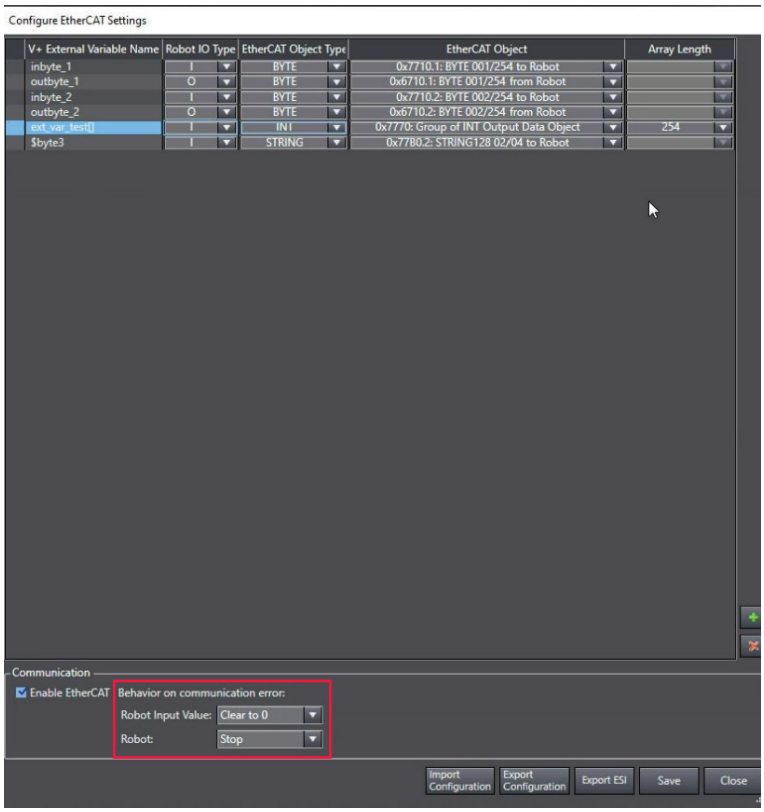
1 Enable EtherCAT communication using ACE.

- Connect to the robot controller using ACE.
- Access the *Configure EtherCAT Settings* area in the Multiview Explorer by selecting **Configurations and Setup** > **Controller Settings** > **Configure** > **Configure EtherCAT Settings** and clicking the **Finish** Button to display the dialog box below.
- Click the **Enable EtherCAT** Checkbox.



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

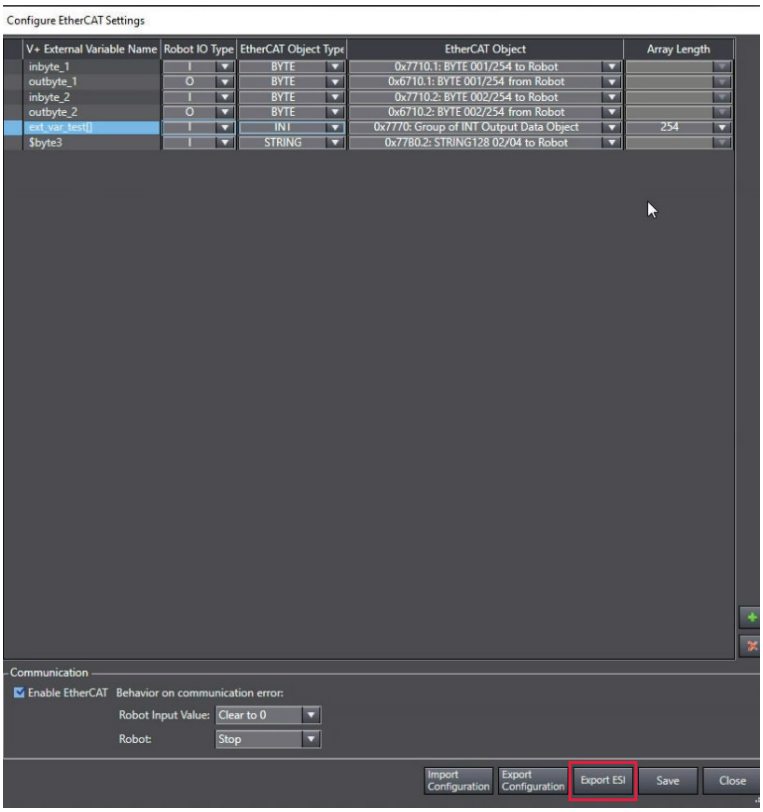
2 Adjust the robot behavior when a communication error occurs.



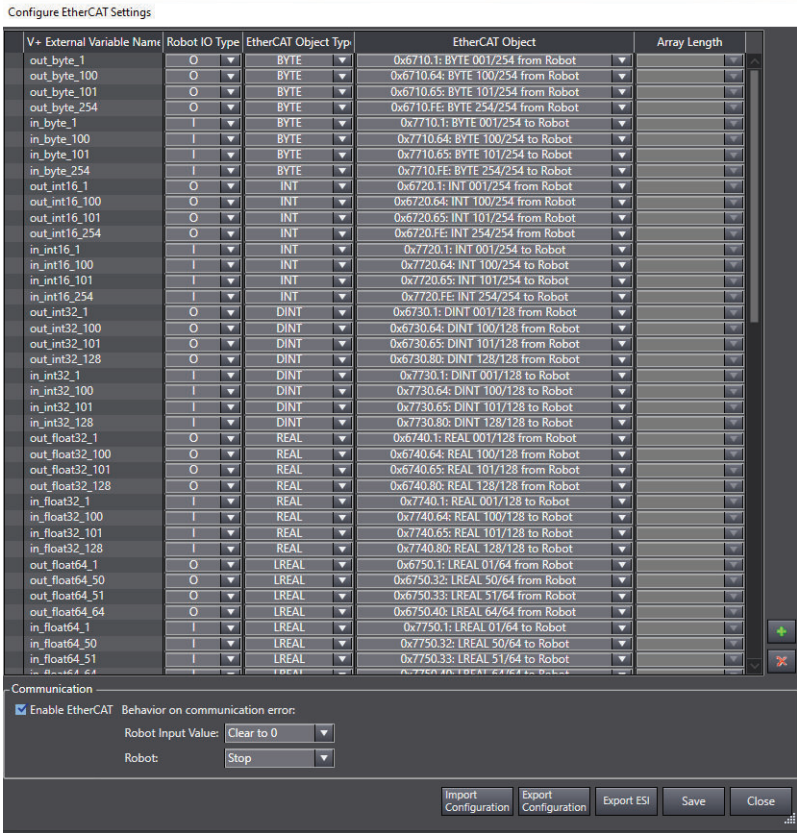
- Choose from the following for *Robot Input Value* setting.
  - **Clear to 0** (default). All Input variables have a 0 value.
  - **hold last value**. All Input variables retain their values when the error occurred.
- Choose from the following for *Robot* setting.
  - **Stop** (default). The robot stops motion.
  - **Stop and Disable Power**. The robot stops and then disables High Power.
  - **Ignore**. No change to robot behavior.

3 Obtain the ESI xml file for the robot.

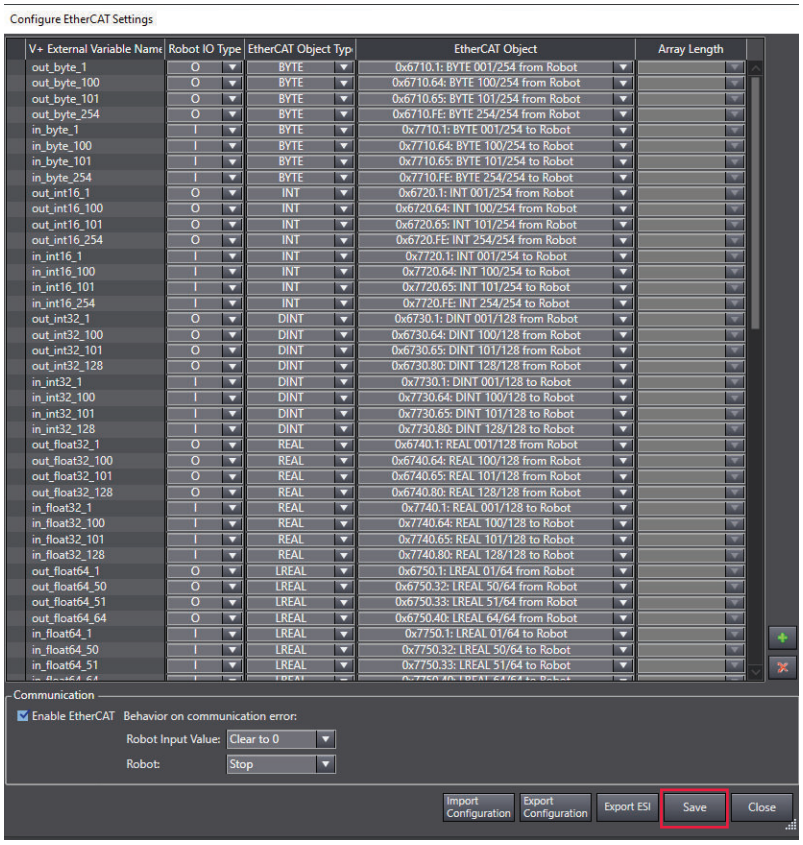
In the *Configure EtherCAT Settings* area in ACE, click the **Export ESI** Button and save the file on the local disk.



4 Enter the V+ External Variable Name, then set the IO Type, EtherCAT Object Type, EtherCAT Object, and Array Length in the *Configure EtherCAT Settings* area in ACE.
Refer to *V+ External Variables Considerations* on page 2-14 for more information.



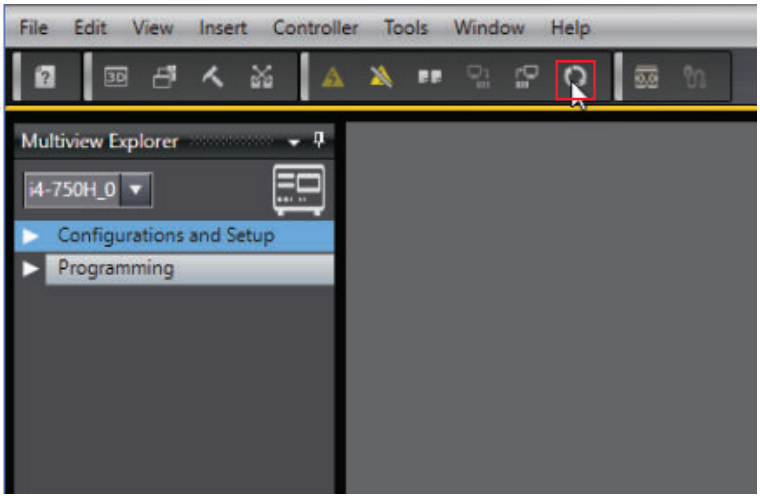
5 Click the **Save** Button to implement the changes.



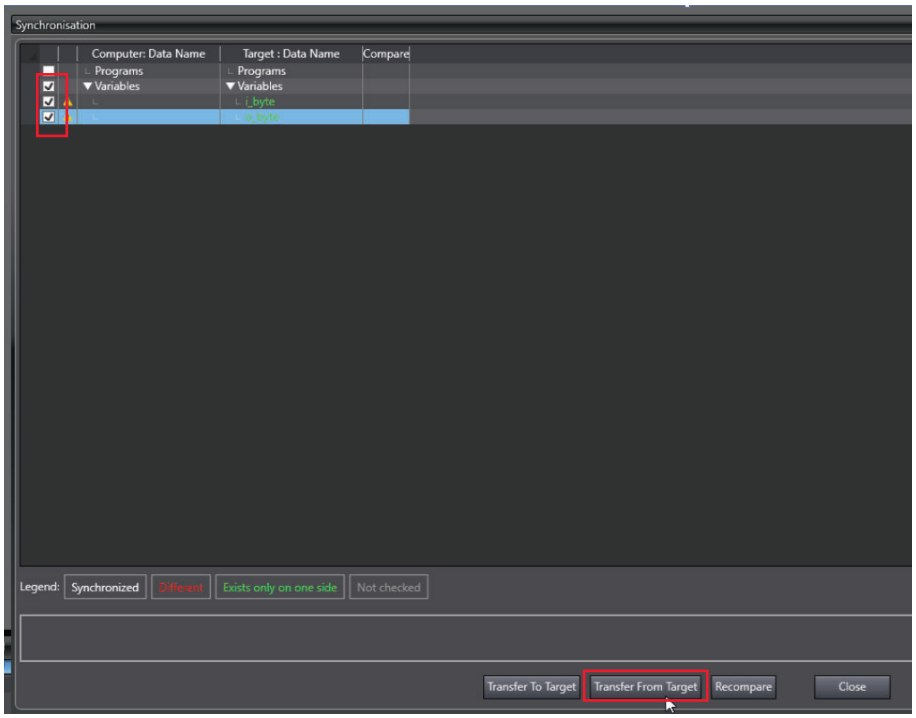
Saving triggers a robot controller reboot request.

6 Synchronize the new variables created in the robot controller after the reboot. Complete this step using one of the two methods described below.

- Select the Synchronize icon on the toolbar in the ACE interface.



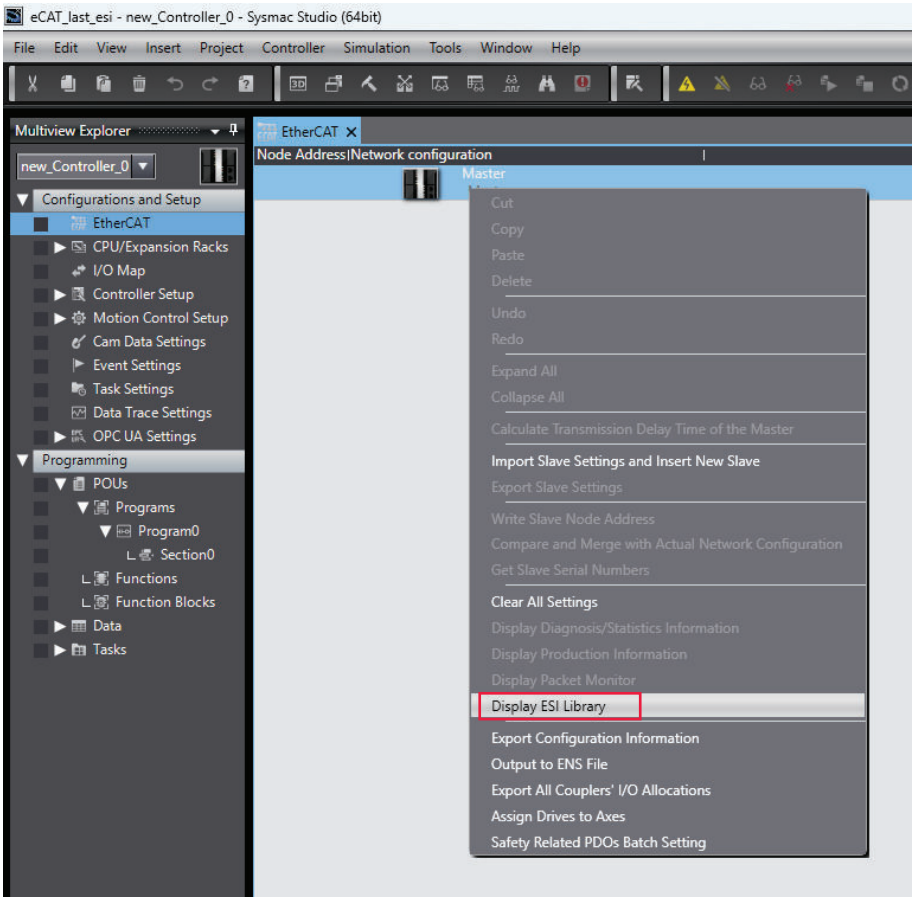
- Select the new variables and then click **Transfer from Target** to bring the new variables into the ACE project.



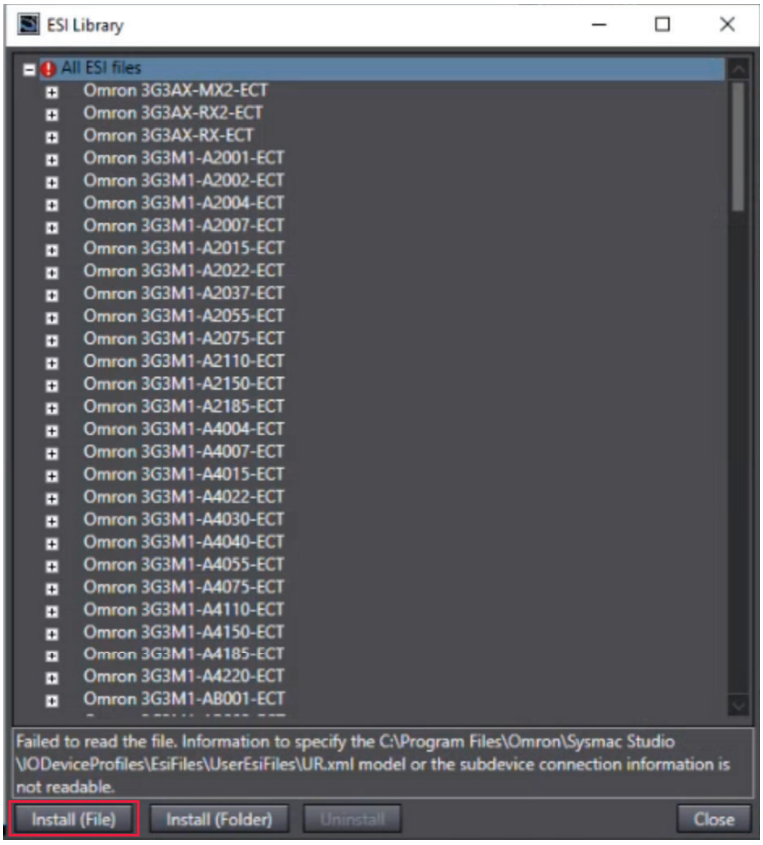
- Alternatively, execute the **Pull V+ Memory** function to upload all variables from the robot controller to the ACE project. Refer to the *Automation Control Environment (ACE) Version 4 User's Manual (Cat. No. I633)* for more information.

7 Import the saved ESI file (refer to Step 3 above) into the MainDevice using Sysmac Studio.

- Ensure you are offline.
- Right-click the MainDevice that is displayed in the *EtherCAT* Tab Page and select **Display ESI Library**.



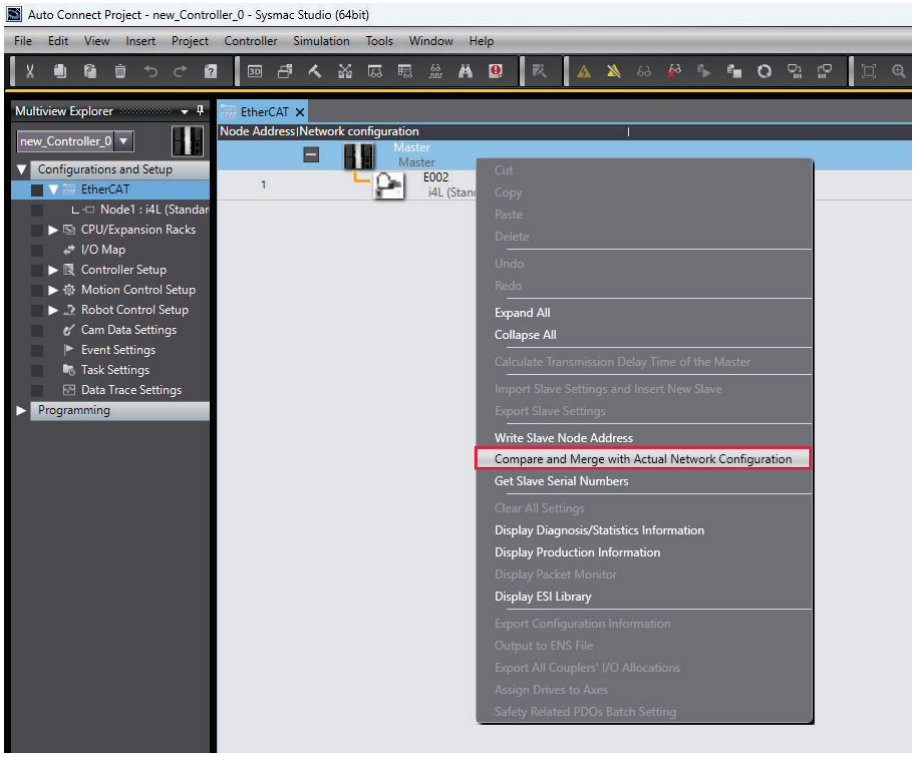
- Click the **Install (File)** Button.



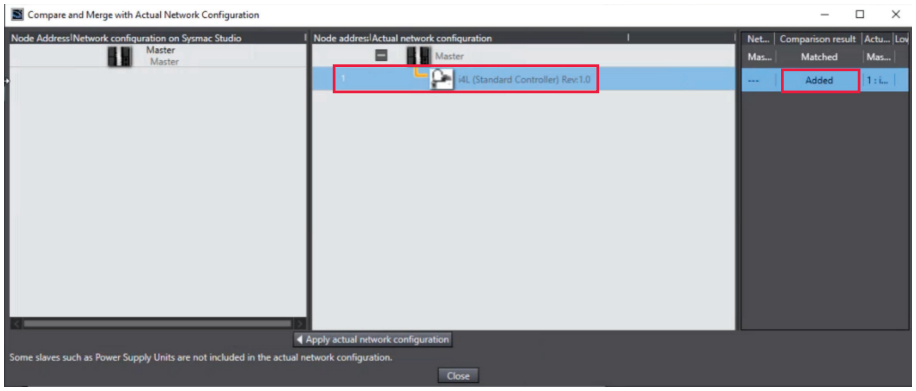
- Navigate to the saved ESI file on your local disk, select it, and click the **Open** Button. The ESI file is installed and the robot is displayed in the *ESI Library* dialog box.

8 In the Sysmac Studio interface, scan the EtherCAT network to ensure the robot is added.

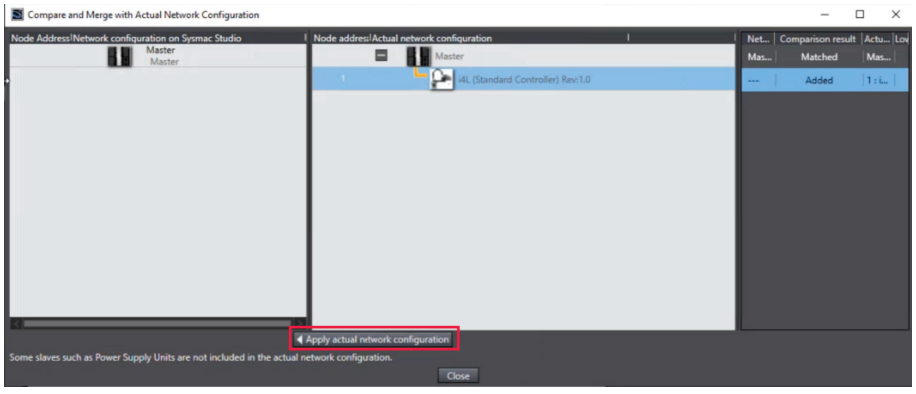
- Ensure you are online.
- Right-click the MainDevice that is displayed in the *EtherCAT* Tab Page and choose **Compare and Merge with Actual Network Configuration**.



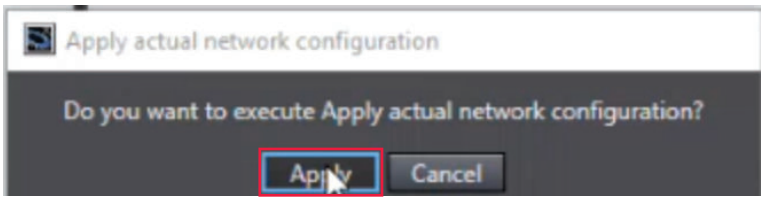
The comparison result indicates that the SubDevice is added under the MainDevice.



- Click the **Apply actual network configuration** Button.



- Click **Apply** in the confirmation dialog box.



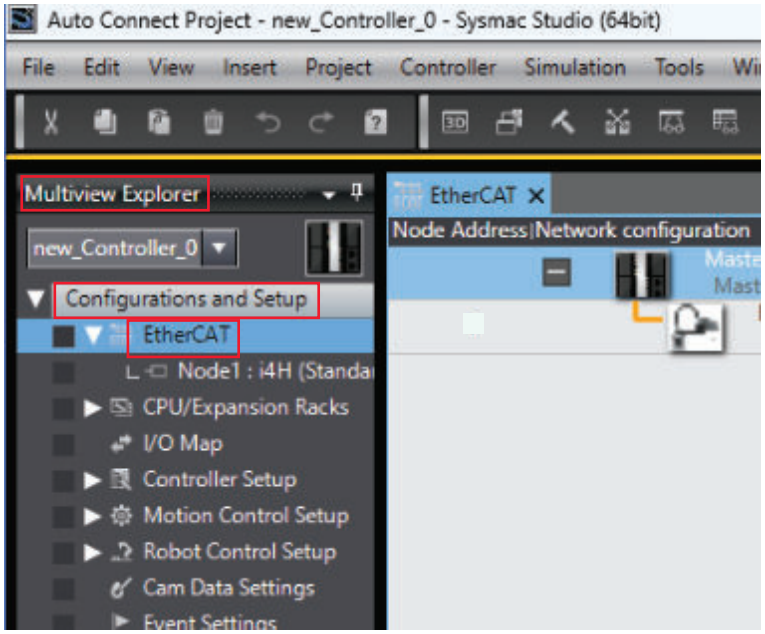
9 Set the node address for the robot in the MainDevice. Complete this step using one of the two methods described below.

- Use the hardware switches on the robot interface panel to set the node address. Refer to the appropriate robot user's manual for more information.
- Use the Sysmac Studio interface.

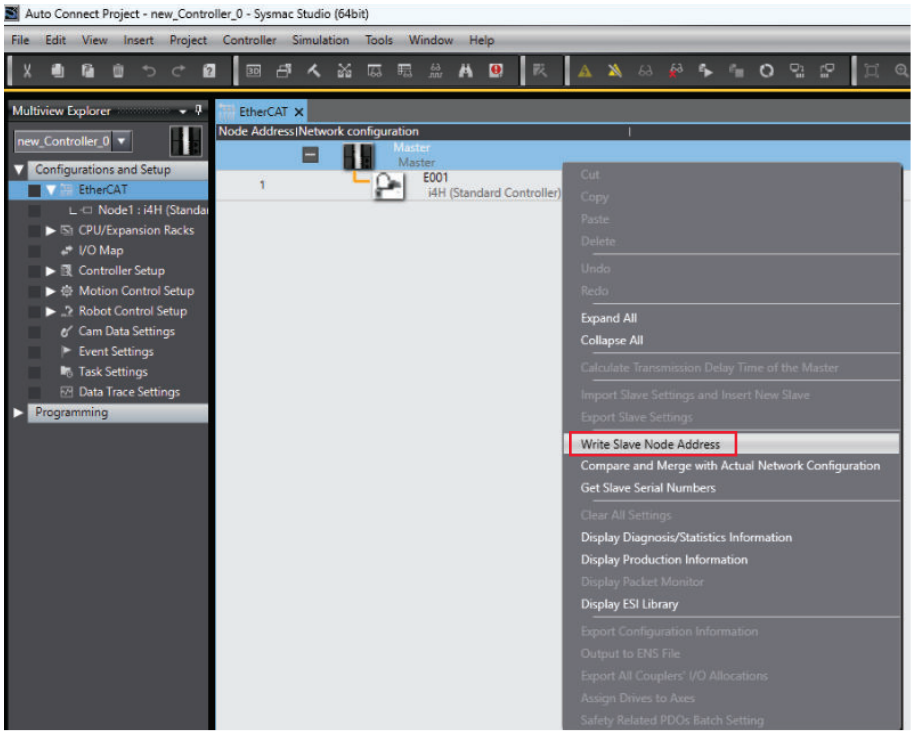
1) Ensure the node address is set to 0 in the rotary switch on the robot.

2) In Sysmac Studio go online with the EtherCAT Controller (MainDevice).

3) Double-click **EtherCAT** under **Configurations and Setup** on the Multiview Explorer or, right-click **EtherCAT** under **Configurations and Setup** and select **Edit**.

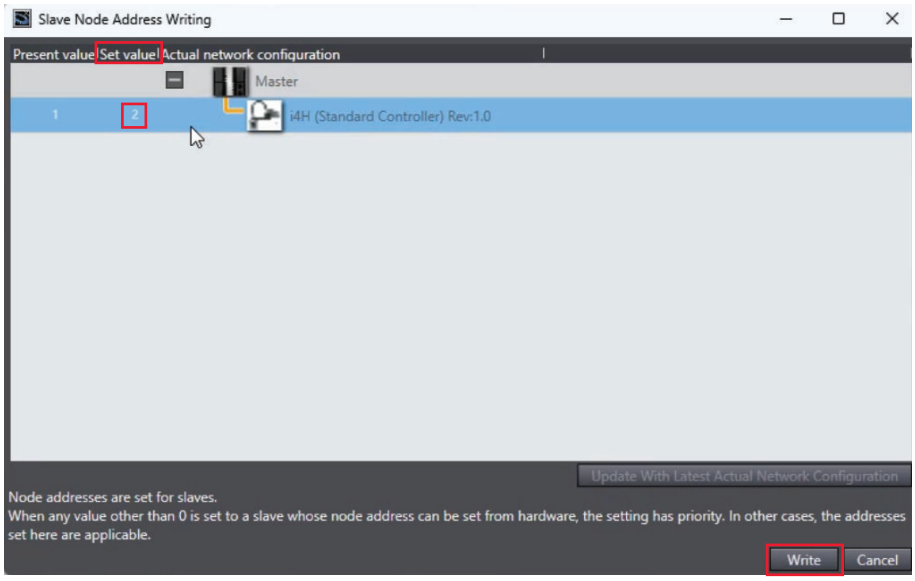


4) Right-click the MainDevice (Master) that is displayed in the *EtherCAT* Tab Page and select **Write Slave Node Address**.



The *Slave Node Address Writing* window opens.

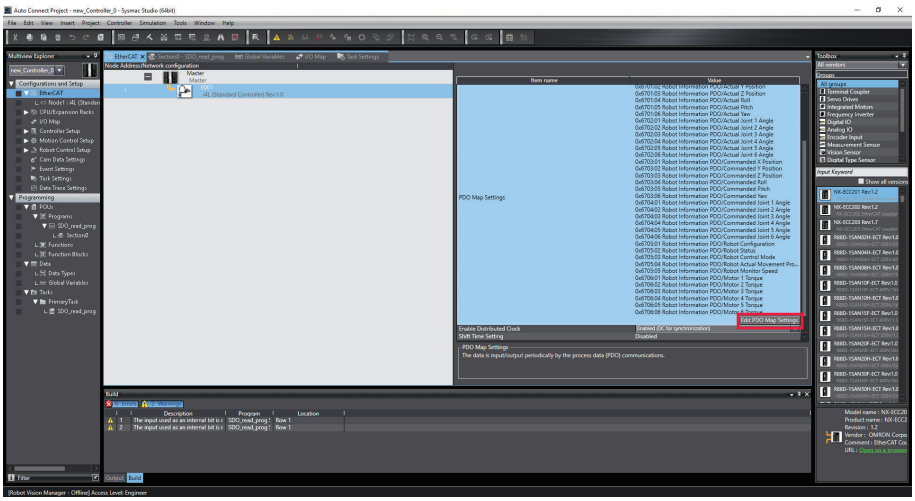
5) In the **Set Value** column, add the correct node address (1 to 192 for the NX1P2 series EtherCAT Controller), and then click the **Write** Button. Ensure the node address is not 0.



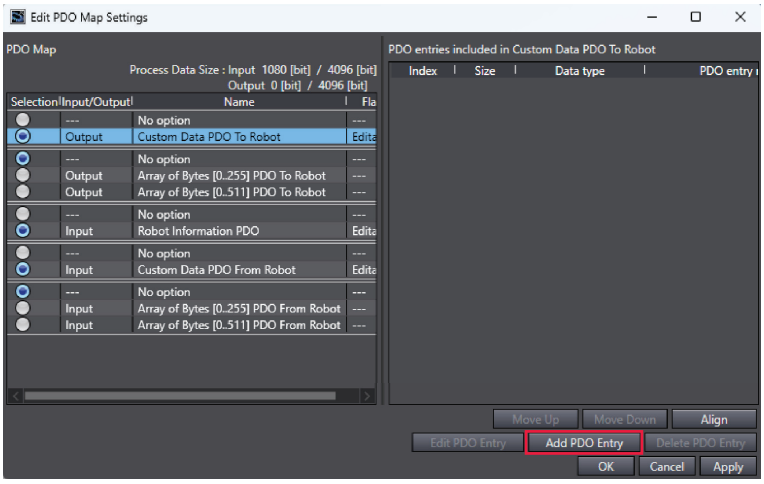
6) Cycle power to the robot for which the node address was set.

10 Using Sysmac Studio, configure the same External Variables for the MainDevice that were defined previously in ACE (refer to step 4) for the SubDevice.
Refer to *PDO Settings Considerations* on page 2-14 for more information.

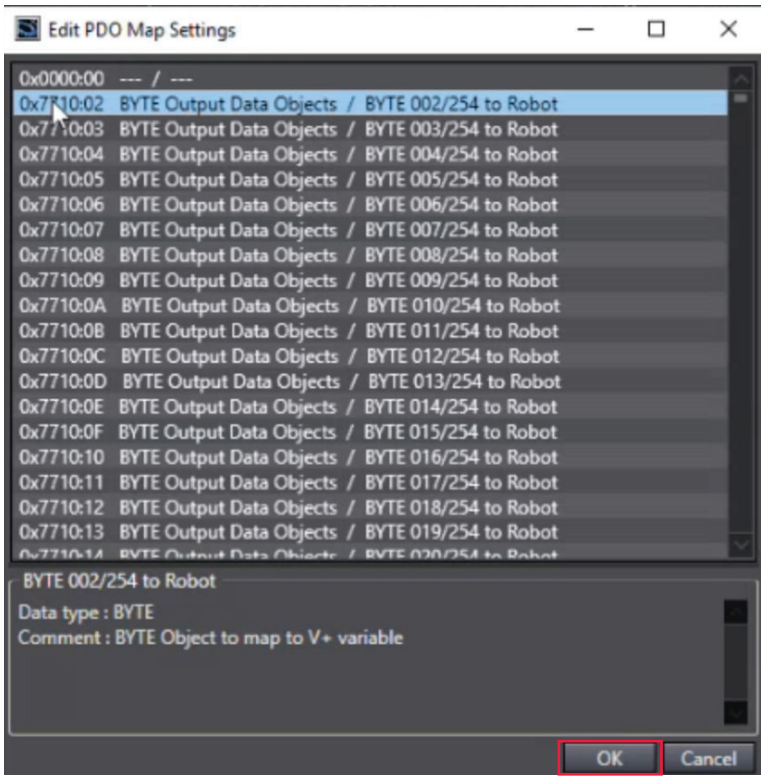
- Ensure you are offline.
- Click the robot that is displayed under the MainDevice in the *EtherCAT* Tab Page.
  The robot information is displayed on the right.
- Scroll down and click the **Edit PDO Map Settings** Button.



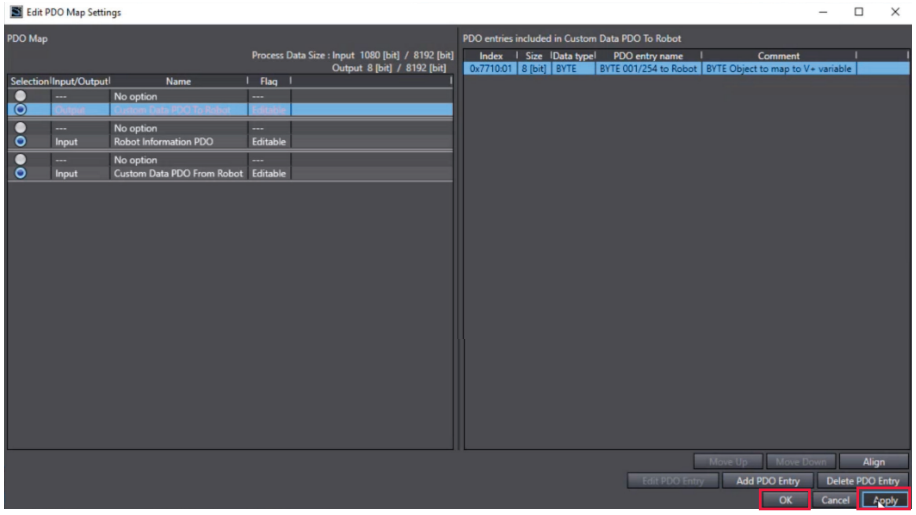
- In the **Edit PDO Map Settings** Window, click **Add PDO Entry**.



- In the second *Edit PDO Map Settings* Window, select an entry of an EtherCAT Object which was mapped to an External Variable in ACE and click **OK**.



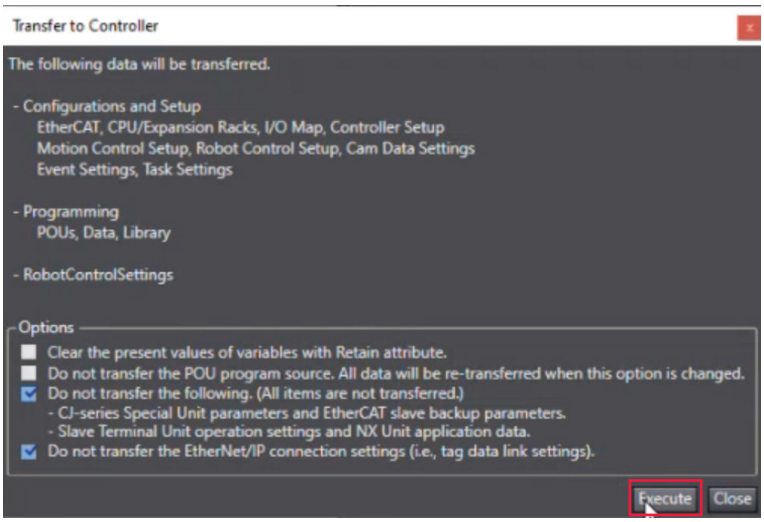
- When the EtherCAT object appears in the PDO entries area of the *Edit PDO Map Settings* window, click **Apply** and **OK** to save the configuration settings.



11 Transfer the new PDO entries configuration saved in the above step to the MainDevice.

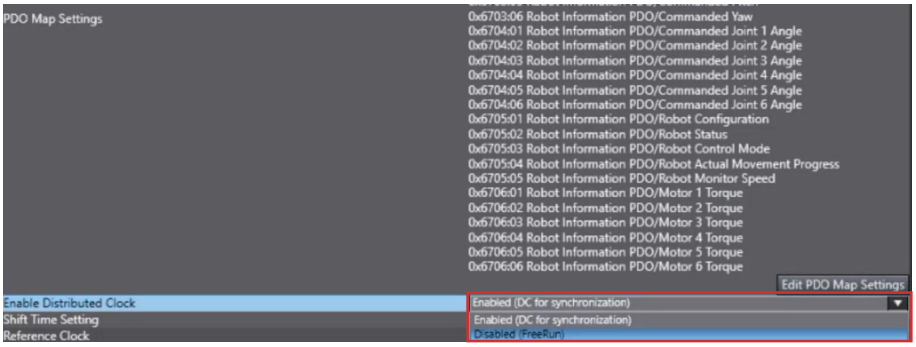
- In Sysmac Studio, go online with the robot controller.
- Click the **To Controller** icon on the tool bar to initiate the transfer of the configuration to the MainDevice.

- Click **Execute** and then click **Yes** in the subsequent dialog boxes to complete the process.



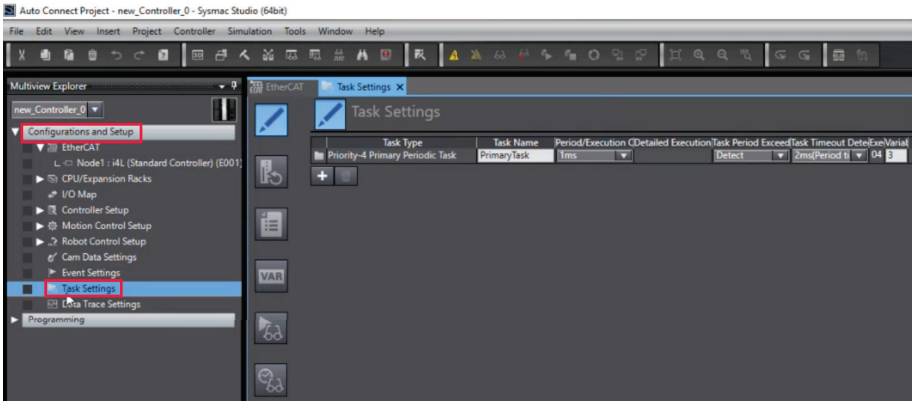
12 Set synchronization mode.

- In Sysmac Studio, click the robot that is displayed under the MainDevice in the *EtherCAT* Tab Page.
  The robot information is displayed on the right.
- Scroll down and click the **Enable Distributed Clock** Drop-down menu to choose DC or FreeRun mode.

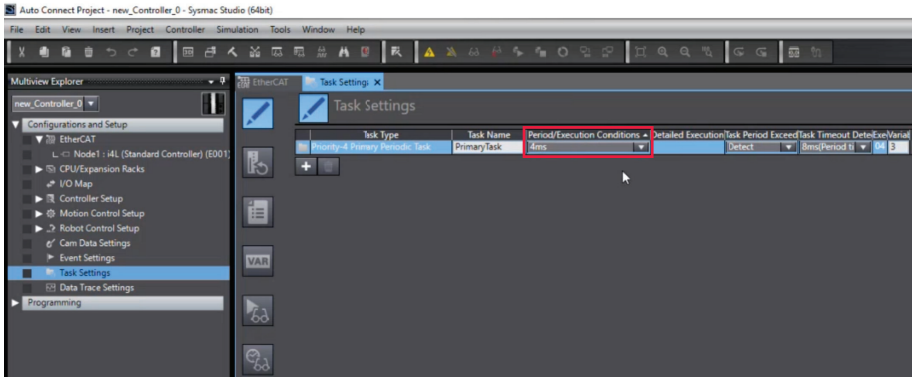


13 Define network speed. If you chose DC mode, follow the steps below to set cycle time. You can skip this step if you enabled Free Run mode.

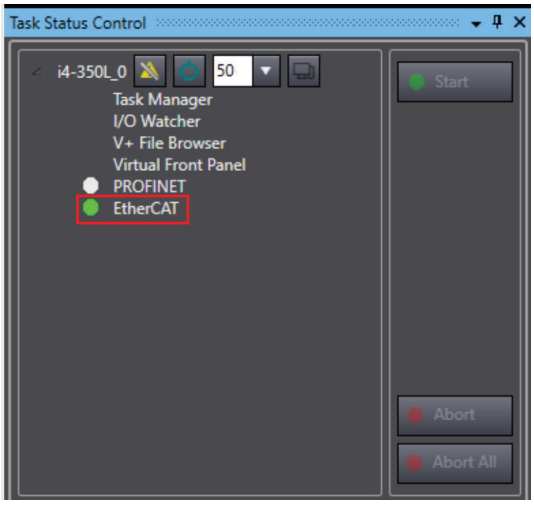
- In Sysmac Studio, double-click **Task Settings** under **Configurations and Setup** on the Multiview Explorer.

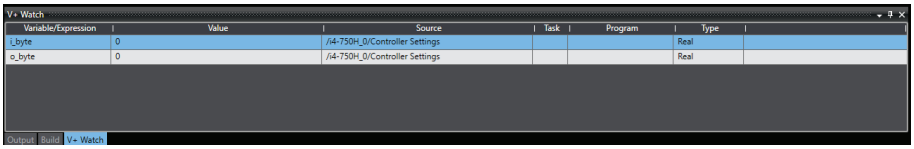


- Click the drop down menu under *Period/Execution Condition* and choose a time option.



14 Confirm data exchange between the robot and the MainDevice by checking the following areas in the ACE software to complete the procedure.





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.

2-2-3 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_byte_8 variable, and then based on that byte value, sets the value of the first bit of the i_byte_8 variable to match and prints the values of both bytes.
If there is an error, the program will instead print information about the error.

```
.PROGRAM etherCAT.comm()

    ;Main loop
    WHILE TRUE DO
    ;While etherCAT State is ACTIVE (enabled, connected, and communicating)
        WHILE FB.STATE == 3 DO
            ;Reflect input to output from PLC point of view
```

```
            IF q_byte_8 == 1 THEN
                i_byte_8 = 1
            END
            IF q_byte_8 == 0 THEN
                i_byte_8 = 0
            END
            ;Delay of 2ms
            WAIT.EVENT , 2E-03
            ;Print values of etherCAT Input and Output Data
            TYPE "q_byte_8: ", q_byte_8, ",    i_byte_8: ", i_byte_8
        END

        $additional_info = ""
        ;Get etherCAT Error Code and Additional Information (FB.ERROR)
        fieldbus_error = FB.ERROR($additional_info)
        ;If there is an etherCAT Error
        IF (fieldbus_error <> 1) THEN
            ;Print Error Information
            TYPE "General etherCAT 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 fieldbus communication issues. Use the ACE interface to access information about fieldbus communication errors or use the FB.STATE and FB.ERROR keywords to obtain detailed fieldbus error information.

3-1 PROFINET Status

Use the FB.STATE keyword to return the current state of the fieldbus. This keyword returns the following information. Refer to the *V+ Keyword Reference Manual (Cat. No. I672)* for more information about the FB.STATE keyword and usage.

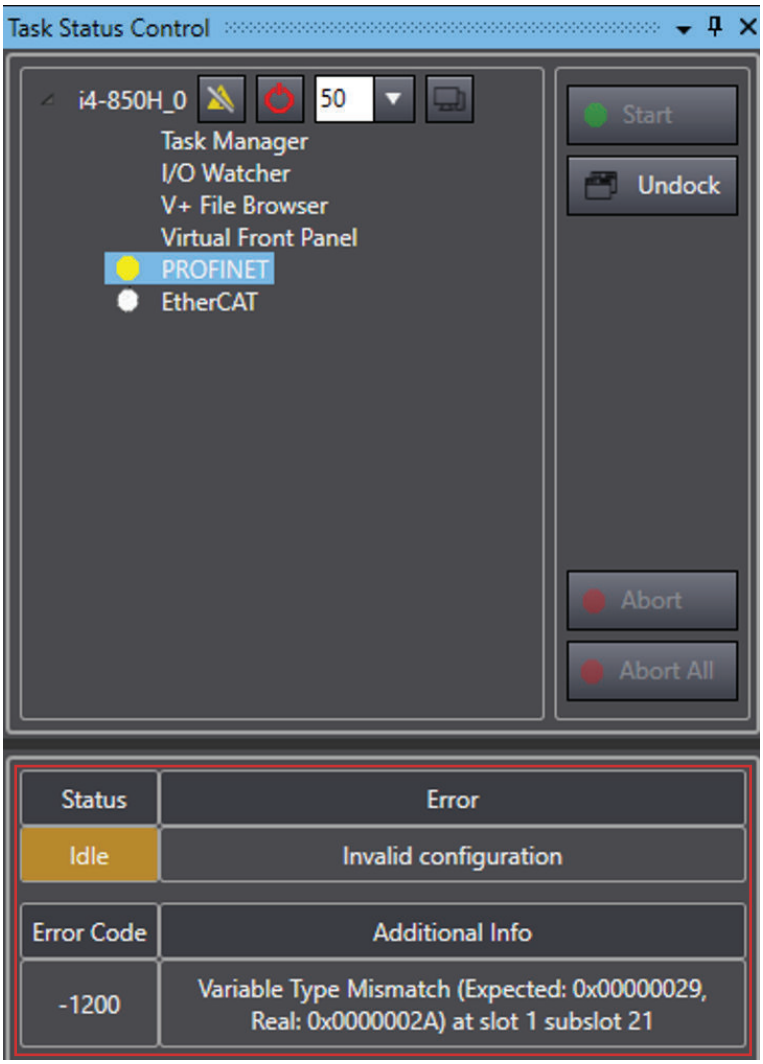
Value Returned	Fieldbus State	Description
0	Disabled	Initialization fails or PROFINET is disabled.
1	Inactive	PROFINET is enabled but there is no connection
2	Idle	PROFINET is enabled and connected, but there is not data exchange between the Controller and the robot.
3	Active	PROFINET is enabled, connected,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

Additional Information

PROFINET and EtherCAT fieldbus states are disabled by default.

3-2 PROFINET Errors

Use the FB.ERROR keyword to obtain detailed PROFINET error information.
The error information can also be accessed through the fieldbus diagnostic table of the *Task Status control* Window in the ACE interface.
Fieldbus error code and error description details returned from the FB.ERROR keyword or the fieldbus diagnostic table in ACE 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 can be configured in the ACE software when communication errors occur . 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 (fieldbus 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	Idle	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.

3-3 EtherCAT Status

Use the FB.STATE keyword to return the current state of the fieldbus. This keyword returns the following 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 EtherCAT is disabled.
1	Inactive	EtherCAT is enabled but there is no connection
2	Idle	EtherCAT is enabled and connected, but there is limited data exchange between the MainDevice and the robot. PDO communication from the robot to the MainDevice is active but not from MainDevice to robot. SDO communication is active. Refer to *PDO and SDO Communication* on page 1-5 for more information.
3	Active	EtherCAT is enabled, connected, and communicating. Data is being actively exchanged between the MainDevice and the robot. Both PDO and SDO communications are active.

Precautions for Correct Use

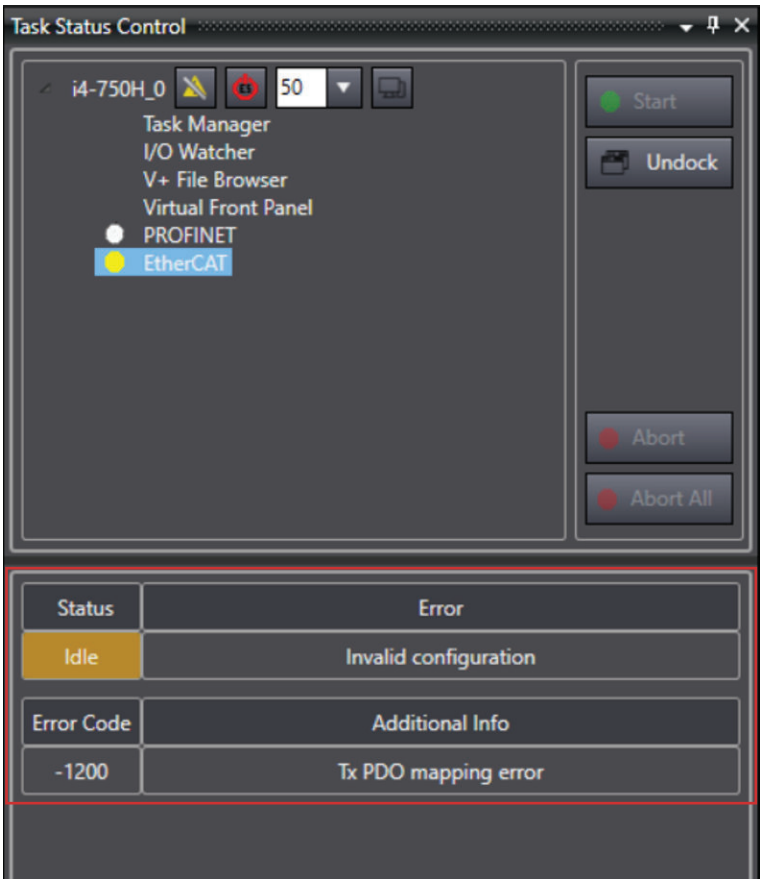
Disconnecting EtherCAT communications while the robot is transitioning between control states may cause an invalid fieldbus state. Cycle power to the robot to recover from this condition.

Additional Information

PROFINET and EtherCAT fieldbus states are disabled by default.

3-4 EtherCAT Errors

Use the FB.ERROR keyword to obtain detailed EtherCAT error information. The error information can also be accessed through the fieldbus diagnostic table of the *Task Status control* Window in the ACE interface.
Fieldbus error code and error description details returned from the FB.ERROR keyword or the fieldbus diagnostic table in ACE 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 can be configured in the ACE software when communication errors occur. Refer to the *Automation Control Environment (ACE) Version 4 User's Manual (Cat. No. I633)* for more information about configuring EtherCAT settings.
- Refer to the documentation associated with your EtherCAT MainDevice for more information about troubleshooting details for the Main Device.

The following table provides error codes, error description details, and corrective action.

Error Code	Error Description	Fieldbus State	Detail	Action
-1200 (invalid configuration)-	Failed to create PDO mapping	Idle	General MainDevice invalid configuration error.	Refer to the documentation associated with your MainDevice for troubleshooting MainDevice configuration errors.
	Tx / Rx PDO setting error		Invalid SyncManager (SM) configuration in the MainDevice.	
	Tx / Rx PDO mapping error		Invalid PDO or EtherCAT Objects assignment in MainDevice configuration.	Follow PDO configuration settings considerations for the MainDevice listed in *PDO Settings Considerations* on page 2-14.
	The Tx / Rx mapping object to be assigned does not exist		Invalid MainDevice PDO configuration.	Ensure the SubDevice ESI file imported into the MainDevice is up to date.
	A value that does not exist in the data type of the mapped entry is used in Tx / Rx			
	The assigned size exceeds the registered input buffer size for Tx / Rx			
	Length mismatch between the mapped object and the object dictionary table in Tx / Rx			
	The entry index in mapping parameter of a Tx / Rx is not registered in the object dictionary			
	The number of subindexes requested to assign to Subindex0 exceeds the maximum number of assignments			
	For SDO complete access, the data size exceeds the maximum number of assignments			
	For SDO single access, the size assigned to the Subindex0 is not 1 byte			
	For SDO access to write 0x1C12 / 0x1C13, Subindex1 size is not 2 bytes			

Error Code	Error Description	Fieldbus State	Detail	Action
-1200 (invalid configuration)	The index to assign to 0x1C12 is out of the range from 0x1600 to 0x17FF	Idle	Invalid MainDevice PDO configuration.	Ensure the SubDevice ESI file imported into the MainDevice is up to date.
	The index assigned to 0x1C13 is out of the range from 0x1A00 to 0x1AFF			
	Flexible PDO configured with a subindex that does not exist in Tx / Rx			
	The mapped entry does not exist in the table for Rx / Tx			
	The number of subindexes requested to map to Subindex0 exceeds the maximum number in Tx / Rx			
	For SDO complete access, data size following the Subindex1 exceeds the maximum number in Tx / Rx			
	For SDO single access, the size mapped to the Subindex0 is not 1 byte in TX / Rx			
	For SDO access to configure flexible PDO, Subindex1 is not 4 bytes in Tx / Rx			
	Input object has been assigned to output PDO or vice versa			
	Output / Input object 0xXXXX:YY configured in MainDevice is not configured in SubDevice		XXXX is the object ID and YY is the subindex. MainDevice configuration has one or more objects that has not been configured in ACE.	In the MainDevice, remove those objects that have not been configured for the SubDevice previously in ACE.
	Unsupported sync cycle time		Invalid cycle time that is not compatible with the robot has been set in MainDevice.	Set a valid cycle time such as 1, 2, or 4 ms.

Error Code	Error Description	Fieldbus State	Detail	Action
-1200 (invalid configuration)	The subindex of a mapping parameter to one following the Subindex1 does not exist in Tx / Rx	Idle	Invalid MainDevice PDO configuration	Ensure the SubDevice ESI file imported into the MainDevice is up to date.
	Length mismatch between mapped object and object dictionary table in Tx / Rx			
	The entry index in mapping parameter of a Tx / Rx is not registered in the object dictionary			
	For SDO single access, the number of subindexes requested to map exceeds the maximum in Tx / Rx			
	Input/Output PDO configuration has subindexes of an object of type 'GROUP OF' that does not start from 1		First configured subindex of all objects called “GROUP OF” must be number 1.	Ensure the “GROUP OF” objects start from subindex 1.
	Input / Output PDO configuration has subindexes of an object of type 'GROUP OF' that are not consecutive		All configured subindex of all objects called “GROUP OF” must be consecutive (such as {1, 2, 3} and not {1, 3, 4}).	Ensure that “GROUP OF” objects have consecutive subindexes.
	Input / Output PDO configuration has subindexes of an object of type 'GROUP OF' that are duplicated		All configured subindex of all objects under “GROUP OF” cannot be duplicated (such as. {1, 2, 3} and not {1, 2, 2}).	Ensure “GROUP OF” objects don’t have duplicated subindexes.
	Input / Output object ARRAY OF BYTE has been added to a flexible PDO		Objects ARRAY OF BYTES (676x and 776x) cannot be added to any flexible PDO but just selected using their fixed PDO.	Remove “ARRAY OF BYTES” objects from flexible PDOs.
-1201 (connection lost)	FreeRun mode watchdog timer triggered	Idle	In FreeRun mode, time out happens between packets.	Check EtherCAT network connection. The Default Watchdog value is 100 ms. Contact OMRON Service representative to increase it.
	PDO sync lost		In DC mode, more than 1 EtherCAT packet has been lost.	Check EtherCAT network connection. Refer to the documentation associated with your MainDevice for troubleshooting MainDevice configuration errors.

Error Code	Error Description	Fieldbus State	Detail	Action
-1202 (system init fault)	Mismatch in contents of first 8 words of the SII EEPROM (EtherCAT SubDevice Information Electrically Erasable Programmable Read-Only Memory)	Disabled	SubDevice internal non-volatile memory corruption.	Contact local OMRON service representative.
	EEPROM loaded signal timeout or PDO access error			
	SII error			
	CPU error		System fault	
	Bootstrap not supported		MainDevice requested SubDevice to transit to Bootstrap state	Avoid this transition as bootstrap state is not supported. Reboot robot and restart ACE software to recover from this transition to bootstrap state.
	No sync when trying to pass to OP (operational) state		System fault	Contact local OMRON service representative.
	Mailbox SM setting error		Invalid MainDevice Mailbox setting.	Refer to the documentation associated with your MainDevice for more information.
	The length of SM is 0 even when it is active.		Invalid MainDevice SM configuration	
	The mapping size does not agree with the size set to SM.			
	Invalid SM direction			
	The operation mode of SM Control Register is set to Reserved even when SM is active			
	The start address is set to a value less than 0x1000 in the Pre-Op state even when SM is active			

Error Code	Error Description	Fieldbus State	Detail	Action
-1202 (system init fault)	The buffer size and start address of SM exceed 0x2FFF in the Pre-Op state even when SM is active	Disabled	Invalid MainDevice SM configuration	Refer to the documentation associated with your MainDevice for more information.
	The SM address configured in PreOp has been changed when passing to OP			
	A size other than 0 is set to SM or the mapping size is not 0 even when SM is not active			
	The start address is odd even when SM is active			
	The SM3 buffer overlaps the SM2 buffer, or vice versa.			
	Unknown error		Abnormal situation not covered by error cases	Contact local OMRON service representative.
-1024 (invalid write input variable)	--	--	Write read-only variables	Update V+ program to avoid writing in read-only variables. Refer to the *V+ User's Manual (Cat. No. I671)* for more information.
-1025 (conversion overflow)	--	--	Write V+ variable out of range	Update V+ program to avoid out of range values. Refer to the *V+ User's Manual (Cat. No. I671)* for more information.

THIS DOCUMENT CONTAINS IMPORTANT SAFETY INSTRUCTIONS. SAVE THIS DOCUMENT.

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