R-IN32M3 Module (RY9012A0)

Software PLC Guide: TwinCAT

R30AN0380ED0201
Rev.2.01
2021.6.14

Introduction

This document explains the procedures for EtherCAT® slave functionalities with R-IN32M3 module.

Target Device

R-IN32M3 Module

Contents

List of Abbreviations and Acronyms

In this document, the terms below are defined as follows.

Terms	Description
EEPROM	Electrically Erasable Programmable Read-Only Memory
ESC	EtherCAT Slave Controller
PDO	Process Data Object
SII	Slave Information Interface

RELATED DOCUMENTS

Document Type	Document Title	Document No.
Data Sheet	R-IN32M3 Module Datasheet	R19DS0109ED****
User's Manual	R-IN32M3 Module User's Manual: Hardware	R19UH0122ED****
User's Manual	R-IN32M3 Module User's Manual: Software	R17US0002ED****
Quick Start Guide	R-IN32M3 Module Application Note: Quick Start Guide	R12QS0042ED****
Application Note	R-IN32M3 Module (RY9012A0) User's Implementation Guide	R30AN0386EJ****
User's Manual	Adaptor Board with R-IN32M3 module YCONNECT-IT-I-RJ4501	R12UZ0094EJ****
Quick Start Guide	Evaluation Kit for RA6M3 Microcontroller Group EK-RA6M3 Quick Start Guide	R20QS0011EU***
Application Note	R-IN32M3 Module (RY9012A0) Application Note RA6M3/RA6M4	R30AN0388EJ****
Application Note	R-IN32M3 Module (RY9012A0) Application Note RX66T	R12AN0111EJ****

1. Overview

1.1 Abstract

This document describes how to setup R-IN32M3 module with TwinCAT®. Configuration tool.

1.2 Operating environment

For details on the software environment and hardware environment, refer to the application note included in the sample package (r18an0052xx0 ***).

Table 1-1 Application Note

資料名	資料番号
R-IN32M3 Module Application Note RA6M3 / RA6M4	R30AN0388EJ****
R-IN32M3 Module Application Note RX66T	R12AN0111EJ****

The connection procedure described in this manual assumes that the following conditions are met. For the setup method of each evaluation board, refer to the application note corresponding to each sample software included in the sample package.

1.) EtherCAT support requires firmware version 2.0.0.0 or later for the R-IN32M3 module.
For the firmware update method, refer to the R-IN32M3 Module Quick Start Guide (R12QS0042ED****).

2.) EtherCAT sample project running on the host MCU and the environment are properly configured.
For the connection between R-IN32M3 module and the host MCU and the EtherCAT execution procedure, refer to the application note for the target host MCU.

1.2.1 Software environment

Table 1-2 shows the software operating environment.
Sample software and various documents are included in the sample package.

Table 1-3 Software environment

Name	DL Link
R-IN32M3module sample package	r18an0052xx0***
TwinCAT Beckhoff Automation	https://www.beckhoff.com/

1.2.2 Hardware environment

This document applies only to the following configurations:

1) R-IN32M3 module Adapter board with EK-RA6M3 / EK-RA6M4
2) R-IN32M3 module Adapter board with SK-S7G2
3) R-IN32M3 module CPU card

1) R-IN32M3 module + EK-RA6M4

2) R-IN32M3 module + SK-S7G2

3) R-IN32M3 module CPU card [SEMB1320]

Fig. 1.1 Evaluation environment

Table 1-4 Evaluation environment

Name	Type
R-IN32M3 Module Adapter board	YCONNECT-IT-I-RJ450
R-IN32M3 Module CPU card	SEMB1320
RA6M3 MCU Group Evaluation Board	EK-RA6M3
RA6M4 MCU Group Evaluation Board	EK-RA6M4
SK-S7G2 starter kit.	SK-S7G2

2. Features

R-IN32M3 Module function overview.

- ESM (EtherCAT State Machine)
- mailbox protocols:
  - ✓ CoE (CAN application protocol over EtherCAT)
  - ✓ EoE (Ethernet over EtherCAT)
  - ✓ FoE (File Access over EtherCAT)
- synchronization Modes
  - ✓ Free Run
  - ✓ Sync Manager Synchronization
  - ✓ DC Synchronization

3. TwinCAT3

3.1 Pre-setup

Settings before running TwinCAT.

3.1.1 ESI file

Before starting TwinCAT, put the ESI files that are included in the sample package to TwinCAT folder (“\TwinCAT\3.x\Config\IO\EtherCAT”). The ESI files are provided for each sample application.

Table 3-1 ESI file

Sample application	sample	ESI
RA sample	Mirror	RA6_CCM_V***\appl\mirror_sample\ac\03_ecat_slave_renesas\esi
	Remote IO	RA6_CCM_V***\appl\remote_io_sample\ac\03_ecat_slave_renesas\esi
	Sensor	RA6_CCM_V***\appl\sensor_sample\ac\03_ecat_slave_renesas\esi
Synergy sample	Mirror	Synergy_CCM_V***\appl\2015013_irj45\ac\09_ecat_slave\esi
RX66T sample	Mirror	RX66T_CCM_V***\appl\mirror_io_sample\03_ecat\esi
	Remote IO	RX66T_CCM_V***\appl\remote_io_sample\03_ecat\esi
	Motor	RX66T_CCM_V***\appl\motor_sample\03_ecat\esi

3.1.2 Network Adapter

The network configuration need to set enable a dedicated EtherCAT driver for real-time connections.

EtherCAT driver

- TwinCAT RT-Ethernet Filter Driver
- TwinCAT Ethernet Protocol for All Network Adapters

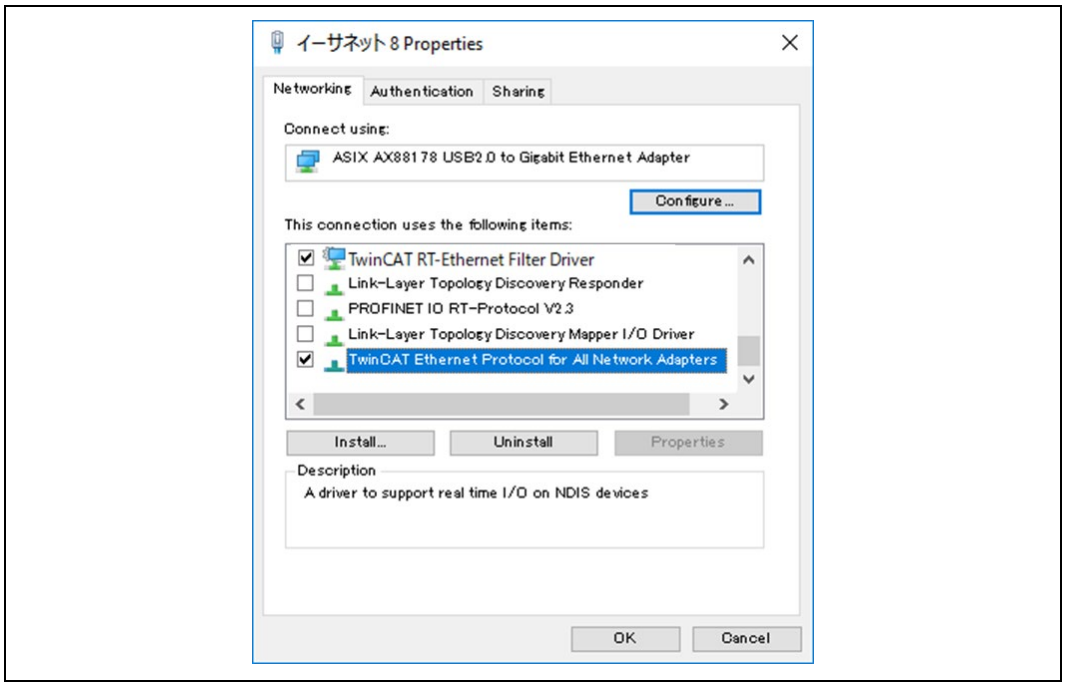


Fig. 3.1 Network Adapter

Depending on the type of network adapter, it may be available “TwinCAT Ethernet Protocol for All Network Adapters” only.

If TwinCAT RT-Ethernet Filter Driver is not indicated or the driver is not installed, install the driver according to Appendix A.

3.2 Run TwinCAT3

3.2.1 TwinCAT setup

Start TwinCAT3,

・start menu: [Beckhoff] → [TwinCAT3] → [TwinCAT XAE ****]

or

・task bar: [Beckhoff] → [TwinCAT3] → [TwinCAT XAE ****]

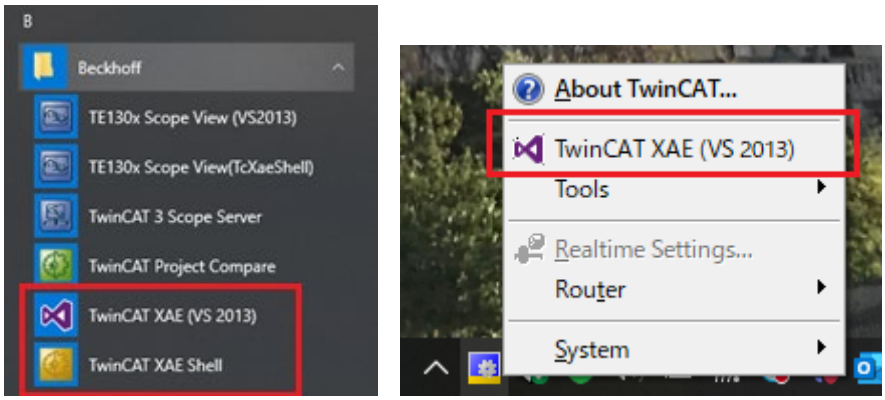


Fig. 3.2 Start TwinCAT

After the TwinCAT is started, selecting [File] → [New] → [Project], create a new project of the TwinCAT XAE Project type.

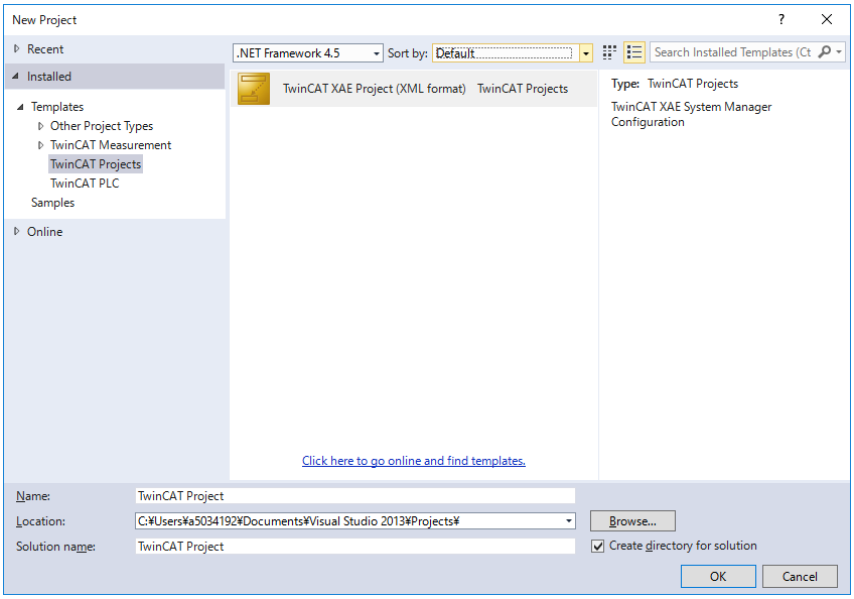


Fig. 3.3 Open Project

3.2.2 Scan module

- (Scan for device): Under solution explorer -> I/O -> Devices, select ‘Scan’.

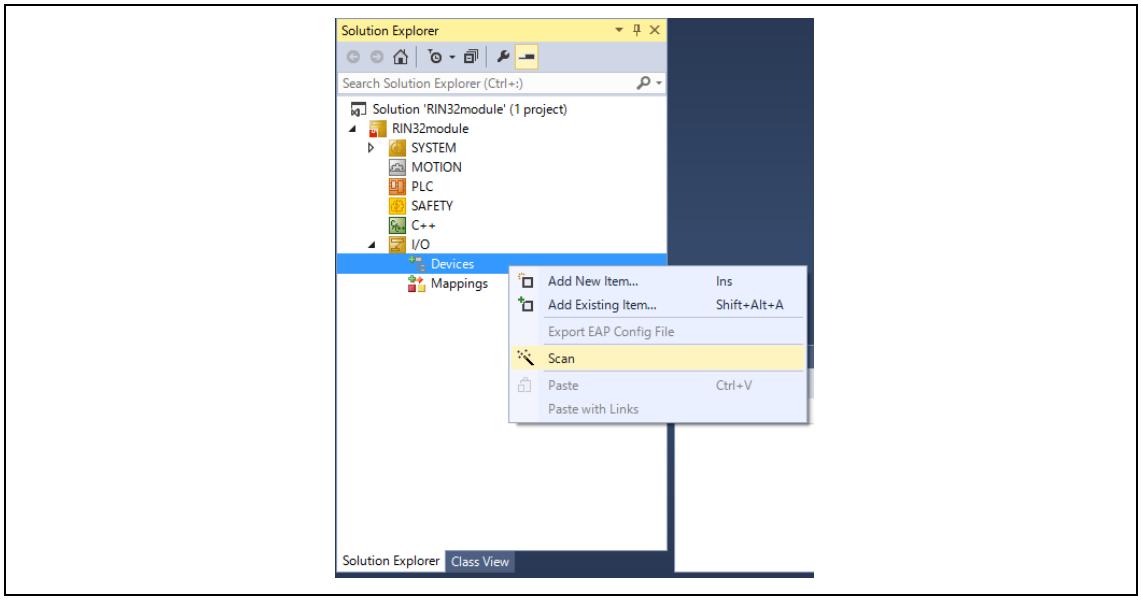


Fig. 3.4 Scan Device

- (I/O driver set): The EtherCAT I/O driver with EtherCAT enabled is automatically selected (☑).
- Then, select OK and run "Scan for box".

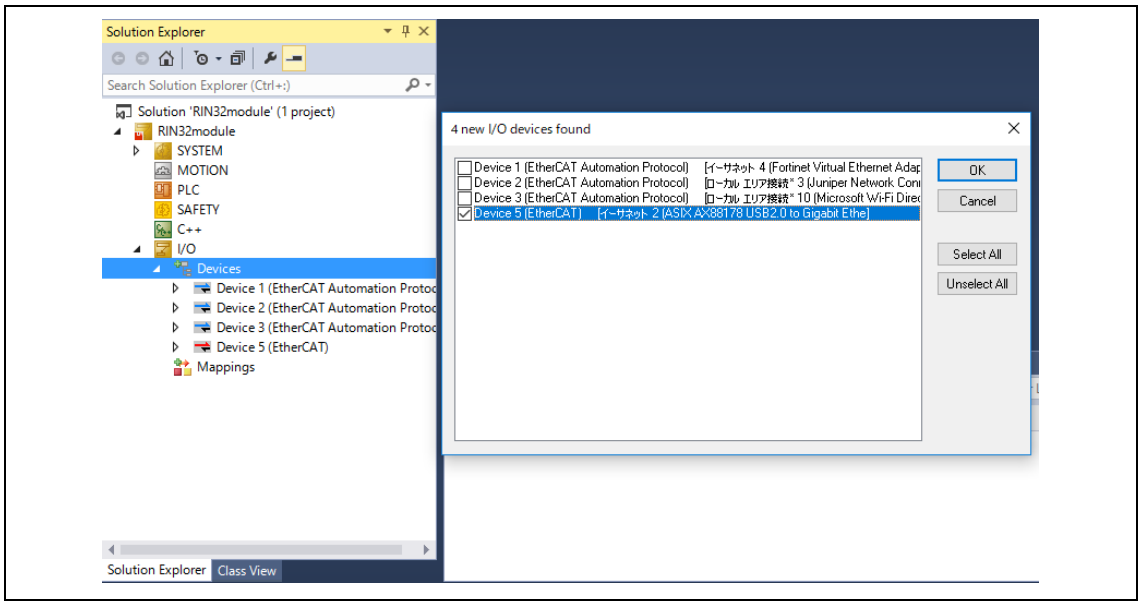


Fig. 3.5 Select I/O device

- (Activate slave): R-IN32M3 module is listed in the boxes, in this reference case “Renesas Module” in box.
- And start “activate free-run”.

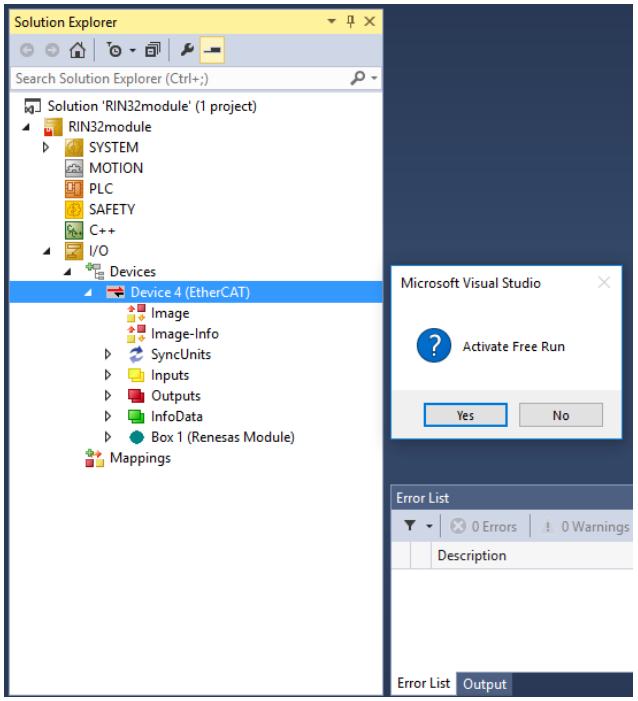


Fig. 3.6 Activate Slave

Note1: If "Box 1 (PFFFFFFFF RFFFFFFFF)" appears, the Slave Information Interface (SII) may not have been programmed in the EEPROM on the RIN32M3 module. In this case, program the EEPROM according to Appendix-B EEPROM Program.
The EEPROM of RIN32M3 module is not programmed at the factory release.

3.2.3 Communication Status

(Check for slave state): Check the state of EtherCAT slave in ‘Online’ tab. If the connection is completed correctly, “Current State” show "OP".

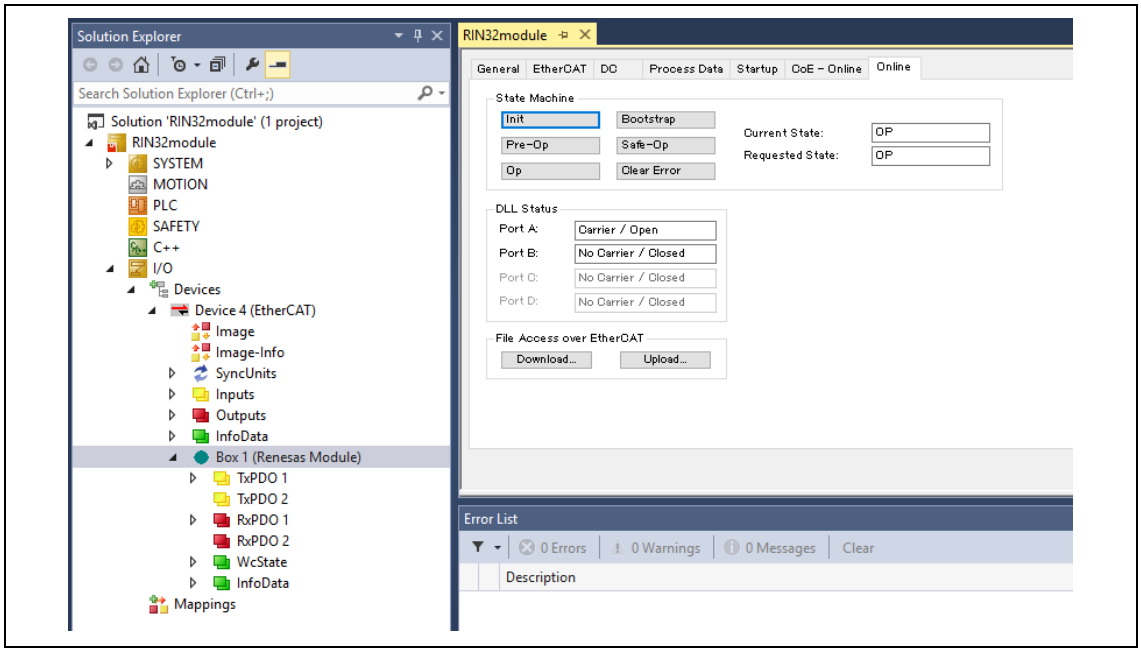


Fig. 3.7 State Machine

4. Sample Program

This section describes the method of TxPDO/RxPDO communication between the TwinCAT master and R-IN32M3 module. The following sample application is provided in the sample package.

For the implementation procedure of various sample software and the method of setting up the hardware environment, refer to the application note for the target host MCU. 1.2 Operating environment

Table 4-1 Sample application

Sample project	Mirror	Remote IO	Sensor	Motor
RA sample software	✔	✔	✔	
Synergy sample software	✔			
RX66T sample software	✔	✔		✔

4.1 Mirror Sample

In the mirror sample, the 1-byte data received from the master is controlled to be sent back to the master. Therefore, in the master, the data written in RxPDO can be read as TxPDO.

RxPDO [digital Outputs 1-8]: 1-byte Output value from the TwinCAT master to R-IN32M3 module

TxPDO [digital Inputs 1-8]: Receive the mirror 1-byte data Input value from R-IN32M3 module

Mirror sample software

Target MCU: RA sample, Synergy sample, RX66T sample

1. **Write RxPDO [digital Outputs 1-8]**

1-1. Click “digital Outputs 1-8”, and select ”Online Write”

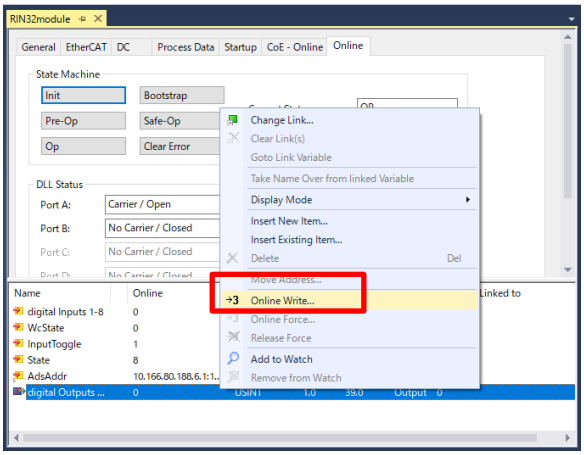


Fig.4.1 Write Output

1-2. Set the value on “Set Value Dialog” , and ”OK”.

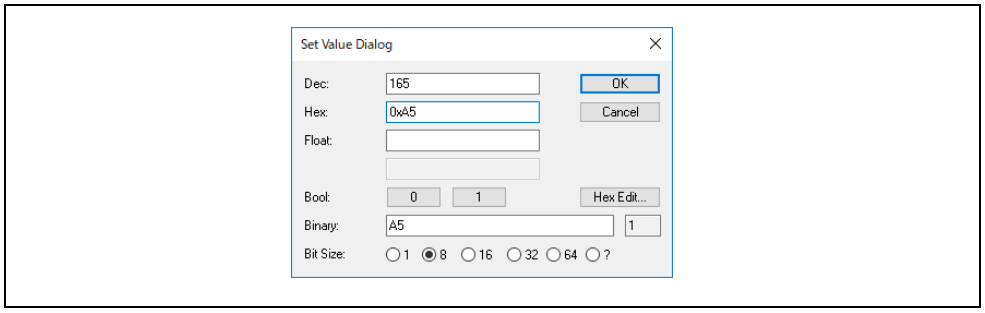
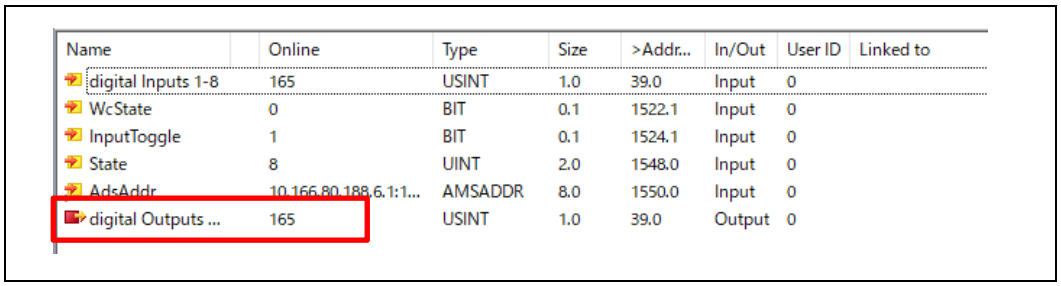


Fig.4.2 Set write Output Value

1-3. Reflected in “digital Outputs 1-8”

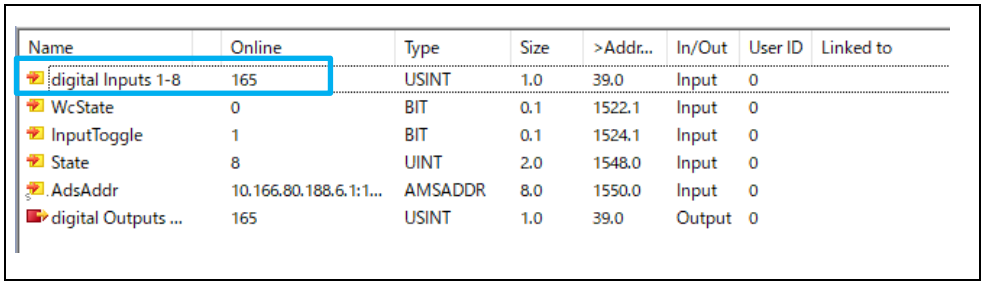


Name	Online	Type	Size	>Addr...	In/Out	User ID	Linked to
digital Inputs 1-8	165	USINT	1.0	39.0	Input	0	
WcState	0	BIT	0.1	1522.1	Input	0	
InputToggle	1	BIT	0.1	1524.1	Input	0	
State	8	UINT	2.0	1548.0	Input	0	
AdsAddr	10.166.80.188.6.1:1...	AMSADDR	8.0	1550.0	Input	0	
digital Outputs ...	165	USINT	1.0	39.0	Output	0	

Fig.4.3 Reflected Write Output Value

2. Read TxPDO [digital Inputs 1-8]

2-1. Reflect the received value from slave in “digital Inputs 1-8”



Name	Online	Type	Size	>Addr...	In/Out	User ID	Linked to
digital Inputs 1-8	165	USINT	1.0	39.0	Input	0	
WcState	0	BIT	0.1	1522.1	Input	0	
InputToggle	1	BIT	0.1	1524.1	Input	0	
State	8	UINT	2.0	1548.0	Input	0	
AdsAddr	10.166.80.188.6.1:1...	AMSADDR	8.0	1550.0	Input	0	
digital Outputs ...	165	USINT	1.0	39.0	Output	0	

Fig,4.4 Input Value (TxPDO)

4.2 Remote IO Sample

In the remote io sample, Controls the slave's 4-bit-LED or 4-bit switch data to be sent to the master based on the data received from the master.

RxPDO [LED]: 4-bit LED data to Slave

TxPDO [Switch]: 4-bit Switch data from Slave

Remote IO sample software

Target MCU: RA sample*, RX66T sample

* RA requires Pmod™ extension of LED and SW on the EK-RA6M3 / EK-RA6M4.

1. Write RxPDO [LED]

1-1. Click “LDE”, and select ”Online Write”

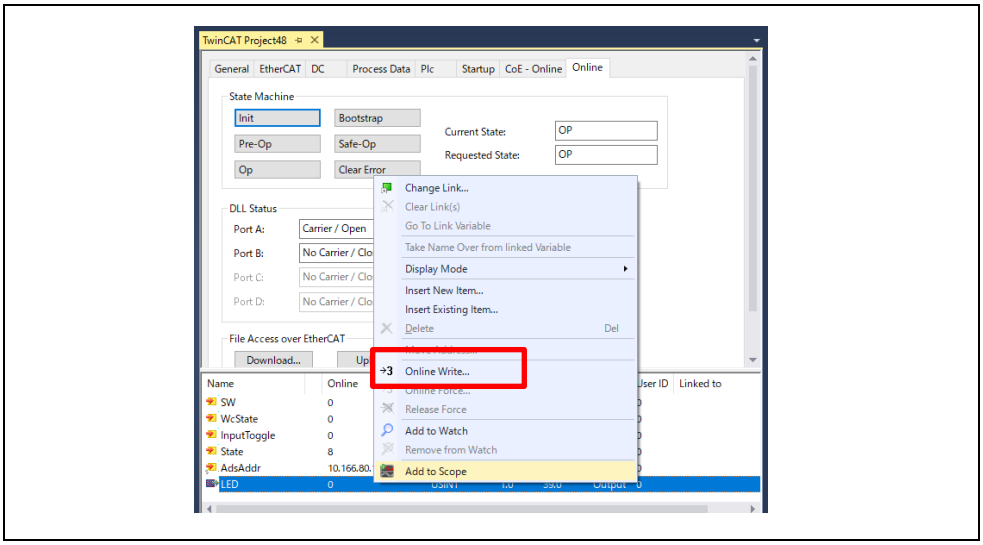


Fig.4.5 Write Output

1-2. Set the value on “Set Value Dialog”, and ”OK”.

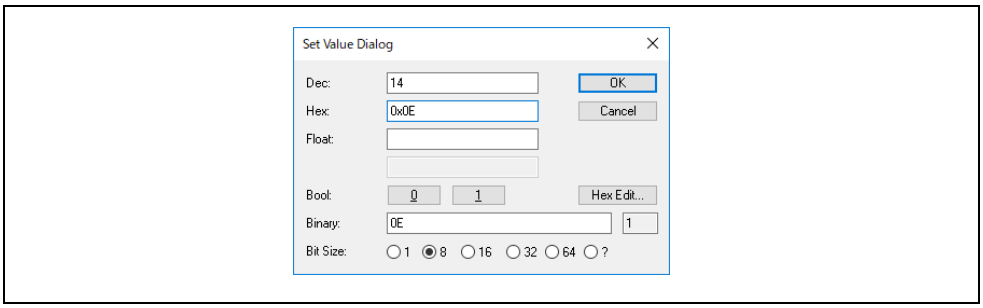
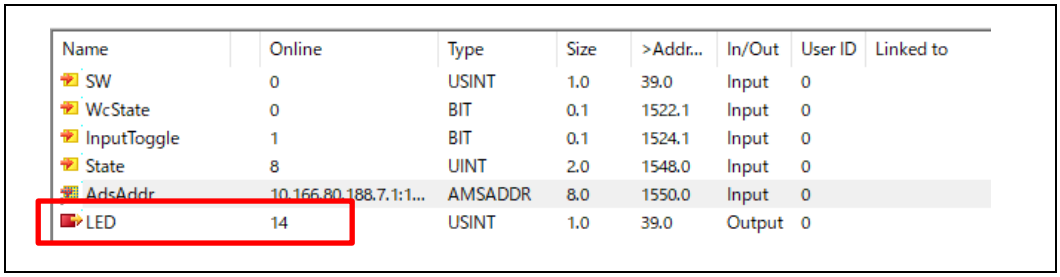


Fig.4.6 Set write Output Value

1-3. Reflected in “LED” also LED turn ON in the slave

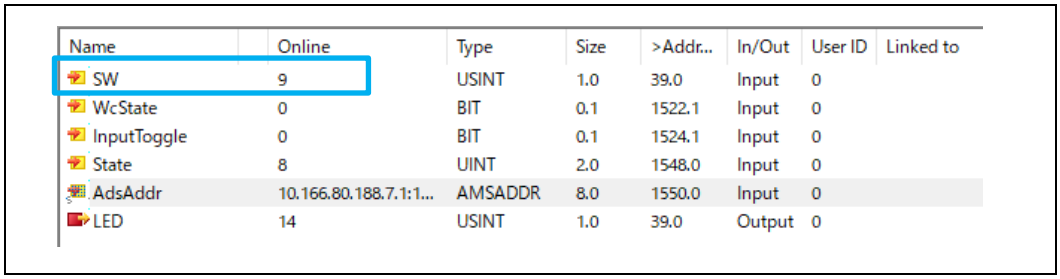


Name	Online	Type	Size	>Addr...	In/Out	User ID	Linked to
SW	0	USINT	1.0	39.0	Input	0	
WcState	0	BIT	0.1	1522.1	Input	0	
InputToggle	1	BIT	0.1	1524.1	Input	0	
State	8	UINT	2.0	1548.0	Input	0	
AdsAddr	10.166.80.188.7.1:1...	AMSADDR	8.0	1550.0	Input	0	
LED	14	USINT	1.0	39.0	Output	0	

Fig.4.7 Reflected Write Output Value

2. Read TxPDO [SW]

2-1. Reflect the received value from slave in “Switch”



Name	Online	Type	Size	>Addr...	In/Out	User ID	Linked to
SW	9	USINT	1.0	39.0	Input	0	
WcState	0	BIT	0.1	1522.1	Input	0	
InputToggle	0	BIT	0.1	1524.1	Input	0	
State	8	UINT	2.0	1548.0	Input	0	
AdsAddr	10.166.80.188.7.1:1...	AMSADDR	8.0	1550.0	Input	0	
LED	14	USINT	1.0	39.0	Output	0	

Fig.4.8 Reflected Read Input Value (TxPDO)

4.3 Sensor Sample

In the sensor sample, Shows the received data from the slave sensor Pmod™.

RxPDO: Setting of Sampling Interval [ms]

TxPDO: ToF sensor data from slave

Sensor sample software

Target MCU: RA sample (EK-RA6M4)*

* EK-RA6M4 board requires Pmod™ extension of ToF sensor.

1. Write RxPDO and Read TxPDO [SW]

1-1. Right click at “Sampling Interval [ms]”. Select ”Online Write”

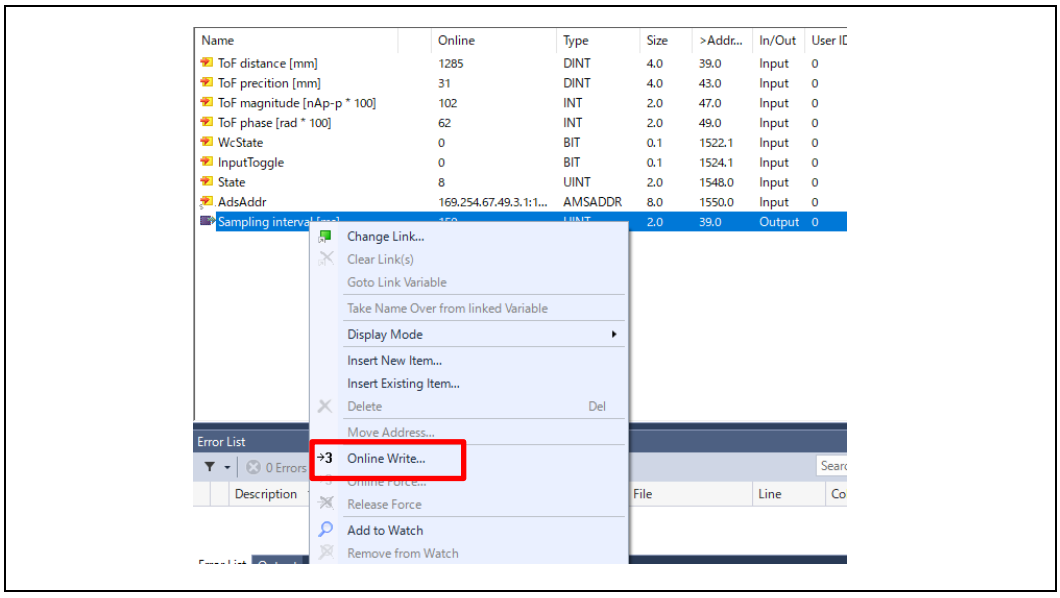


Fig.4.9 Write Output

1-2. Input any RxPDO data in “Set Value Dialog”, select ”OK”.

Sampling Interval range is from 150 to 12000 (0x0096 to 0x2EE0) in intervals of 150 msec.

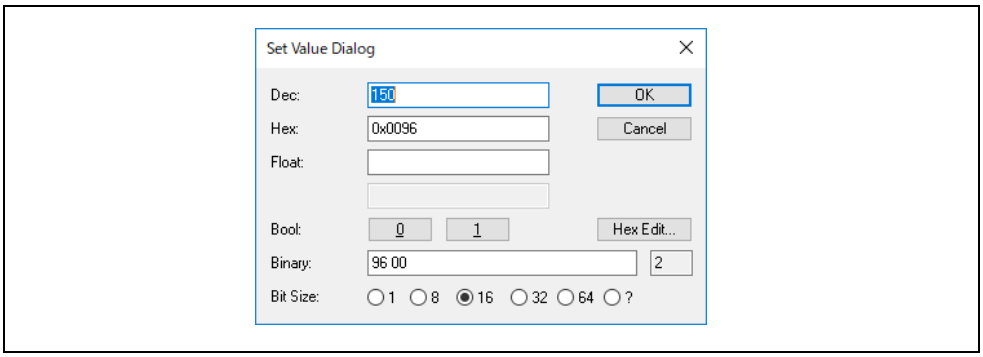
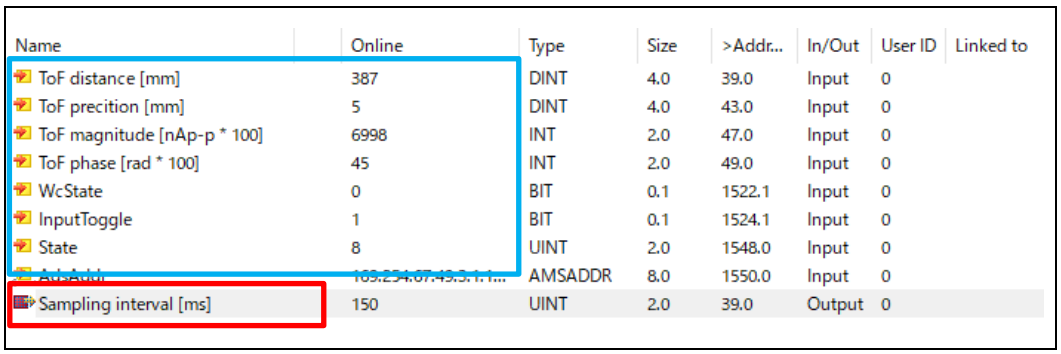


Fig.4.10 Write Output Value

1-3. The input RxPDO data is reflected in the Sampling Interval, and the detection data from the ToF sensor is updated to TxPDO at set intervals.



Name	Online	Type	Size	>Addr...	In/Out	User ID	Linked to
ToF distance [mm]	387	DINT	4.0	39.0	Input	0	
ToF precition [mm]	5	DINT	4.0	43.0	Input	0	
ToF magnitude [nAp-p * 100]	6998	INT	2.0	47.0	Input	0	
ToF phase [rad * 100]	45	INT	2.0	49.0	Input	0	
WcState	0	BIT	0.1	1522.1	Input	0	
InputToggle	1	BIT	0.1	1524.1	Input	0	
State	8	UINT	2.0	1548.0	Input	0	
AdsAddr	169.254.87.43.3.1.1...	AMSADDR	8.0	1550.0	Input	0	
Sampling interval [ms]	150	UINT	2.0	39.0	Output	0	

Fig.4.11 Write Output / Read Input Value

4.4 Motor Sample

In the motor sample, Controls the inverter evaluation system from master.

RxPDO: Control the motor

TxPDO: set value (same value with RxPDO)

Motor sample software

Target MCU: RX66T sample

An inverter board [24V Motor Control Evaluation System for RX23T (RTK0EM0006S01212BJ)] that connects to the RX66T CPU card is required for this evaluation.

1. **Write RxPDO**

1-1. Click the set parameter, and select ”Online Write”

Table 4-2 motor control RxPDO

RxPDO	Value	Control
Motor start/stop switch	0x00	Stop
	0x01	FWD (CW)
	0x02	RVS (CCW)
	Other	reserved
Motor velocity	0x0000 ~ 0xFFFF	speed *Big endian

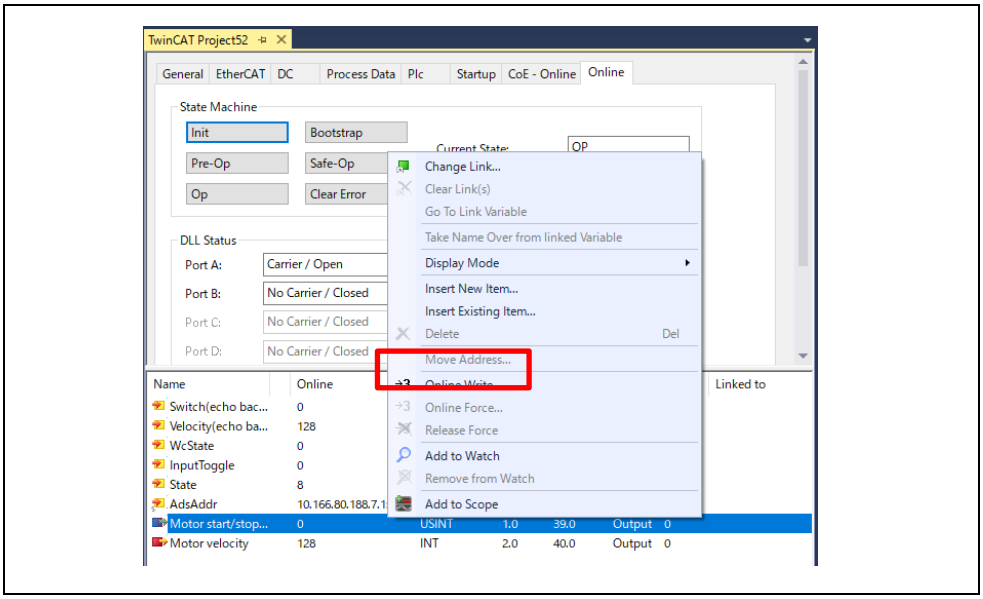


Fig. 4.12 Write Output

1-2. Set the value on “Set Value Dialog”, and ”OK”.

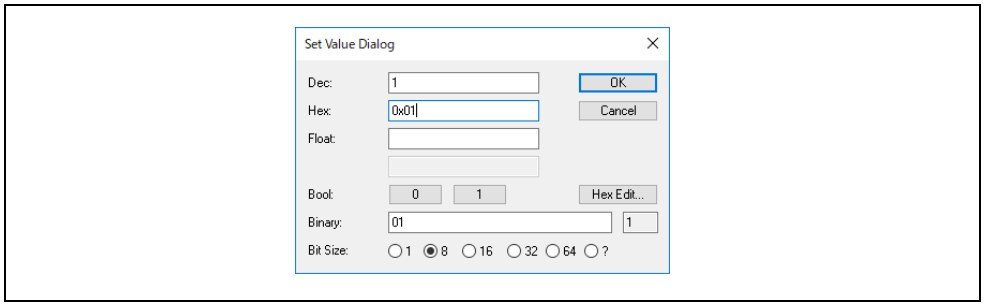
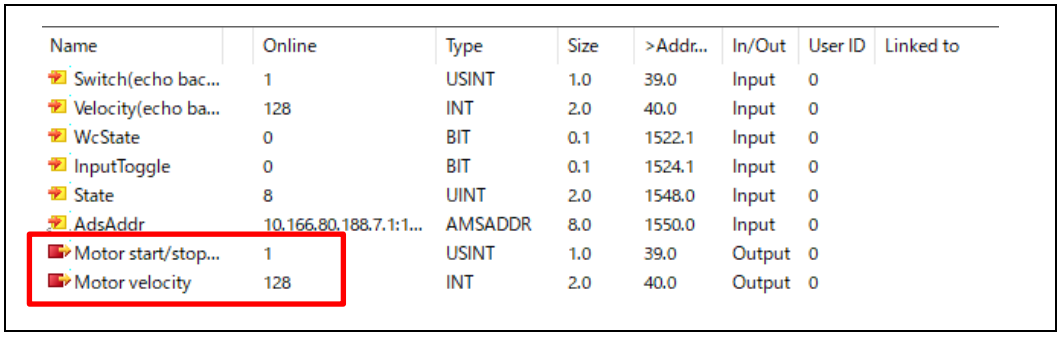


Fig.4.13 Set write Output Value

1-3. Reflected in parameter also move the Motor system in the slave

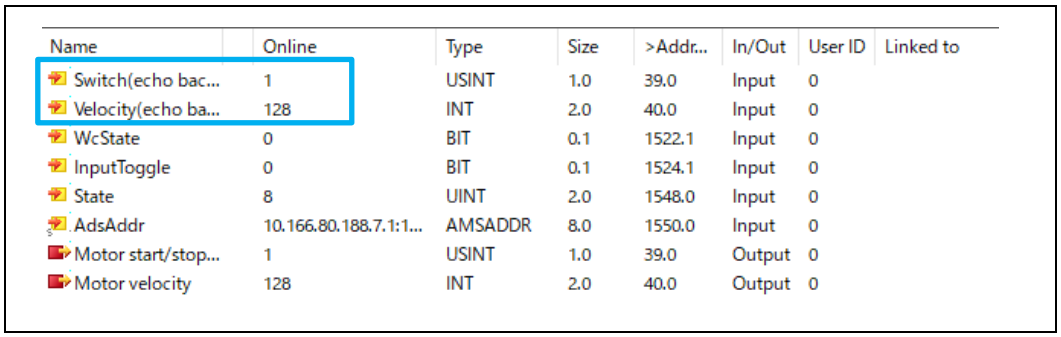


Name	Online	Type	Size	>Addr...	In/Out	User ID	Linked to
Switch(echo bac...	1	USINT	1.0	39.0	Input	0	
Velocity(echo ba...	128	INT	2.0	40.0	Input	0	
WcState	0	BIT	0.1	1522.1	Input	0	
InputToggle	0	BIT	0.1	1524.1	Input	0	
State	8	UINT	2.0	1548.0	Input	0	
AdsAddr	10.166.80.188.7.1:1...	AMSADDR	8.0	1550.0	Input	0	
Motor start/stop...	1	USINT	1.0	39.0	Output	0	
Motor velocity	128	INT	2.0	40.0	Output	0	

Fig.4.14 Reflected Write Output Value

2. Read TxPDO

2-1. Reflect the received value from slave



Name	Online	Type	Size	>Addr...	In/Out	User ID	Linked to
Switch(echo bac...	1	USINT	1.0	39.0	Input	0	
Velocity(echo ba...	128	INT	2.0	40.0	Input	0	
WcState	0	BIT	0.1	1522.1	Input	0	
InputToggle	0	BIT	0.1	1524.1	Input	0	
State	8	UINT	2.0	1548.0	Input	0	
AdsAddr	10.166.80.188.7.1:1...	AMSADDR	8.0	1550.0	Input	0	
Motor start/stop...	1	USINT	1.0	39.0	Output	0	
Motor velocity	128	INT	2.0	40.0	Output	0	

Fig.4.15 Reflected Read Input Value (TxPDO)

Appendix-A. EtherCAT Driver Install

The TwinCAT driver must be installed to use the TwinCAT. Perform the following installation procedure.

1. Ethernet adapter

Select TwinCAT > Show real Time Ethernet Compatible Devices.

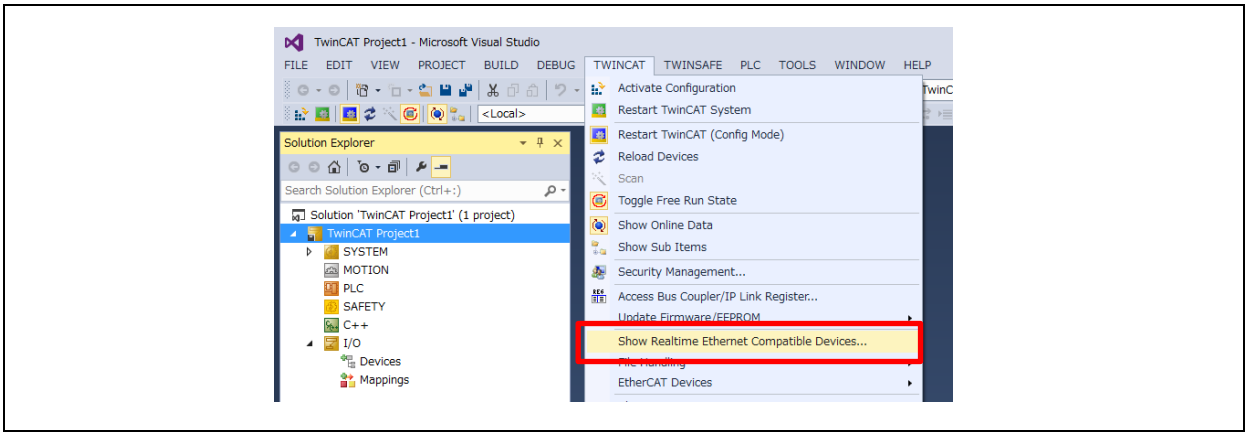


Figure A.1: Show Ethernet Adapter

2. Install TwinCAT driver.

Select the network adapter to be an installation destination and click the [Install].

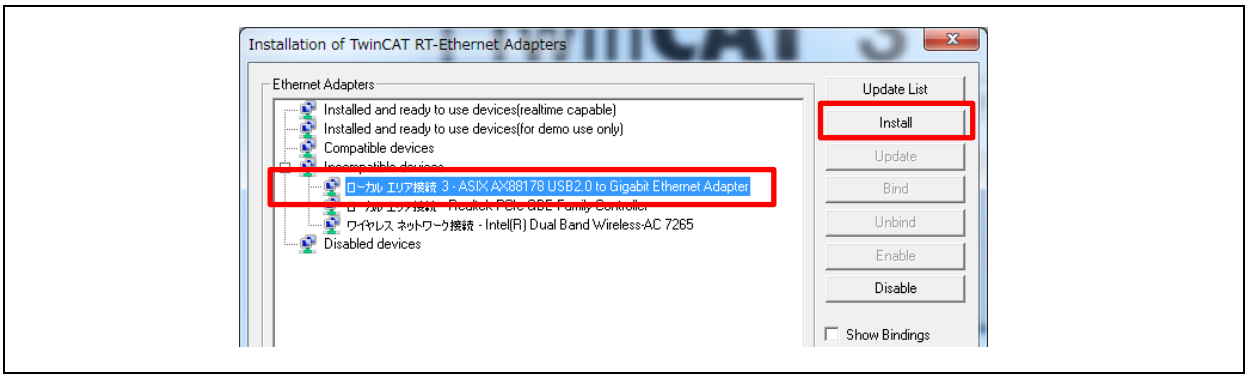


Figure A.2: Install

When the installed network adapter is displayed in "Installed and ready to use devices" at the end of installation, the installation has been successfully completed.

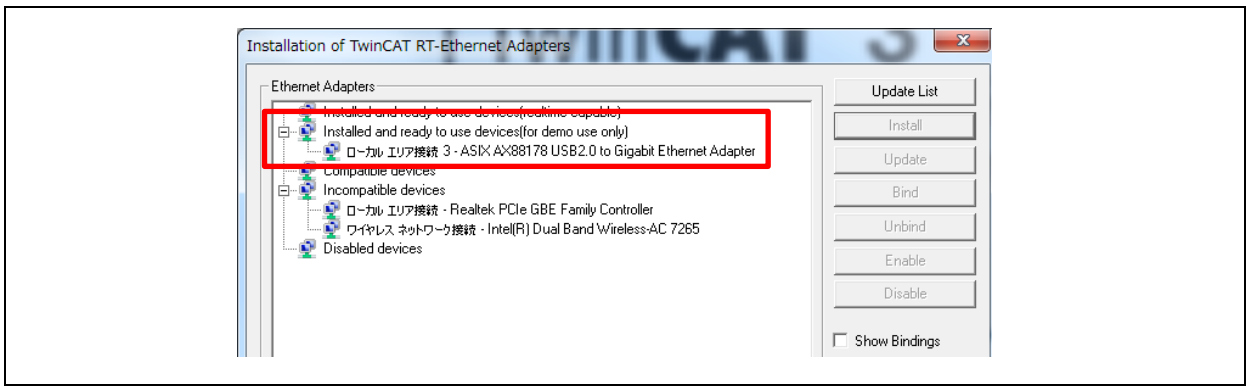


Figure A.3: Installed

If the installation is unsuccessful, it means that the Ethernet adapter is not compatible with the driver.

Appendix-B. EEPROM program

The Slave Information Interface (SII) must have been programmed in the EEPROM. The EEPROM is blank in the initial state of the board. Perform the following procedure to program the SII.

1. Start Advanced Setting

Double-click the box of the slave in which the SII is programmed, and then select the EtherCAT tab. Click “Advanced Setting”.

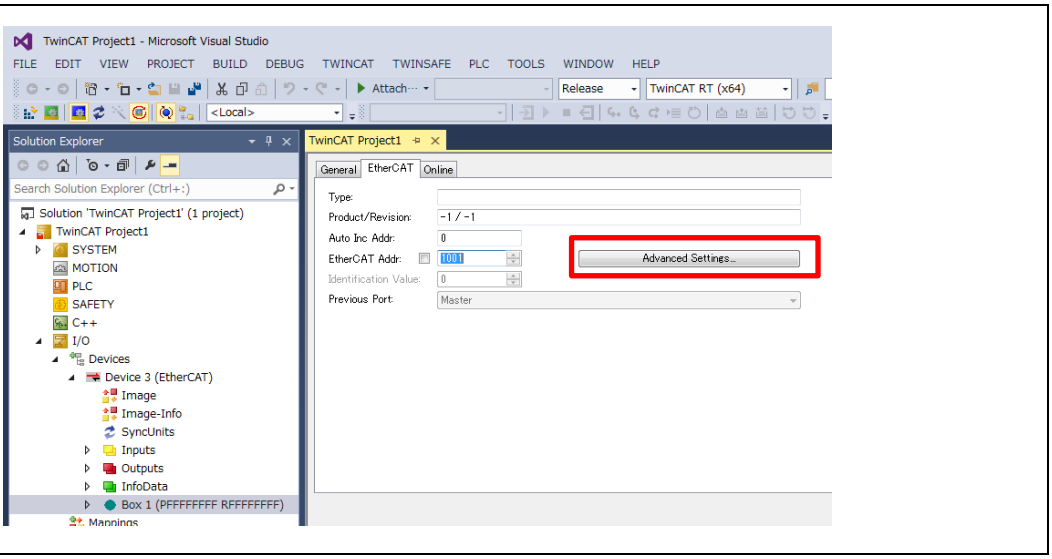


Figure B.1: Select Advanced Setting

2. Hex Editor

Select ESC Access > E2PROM > Hex Editor. Click the [Download from List] button.

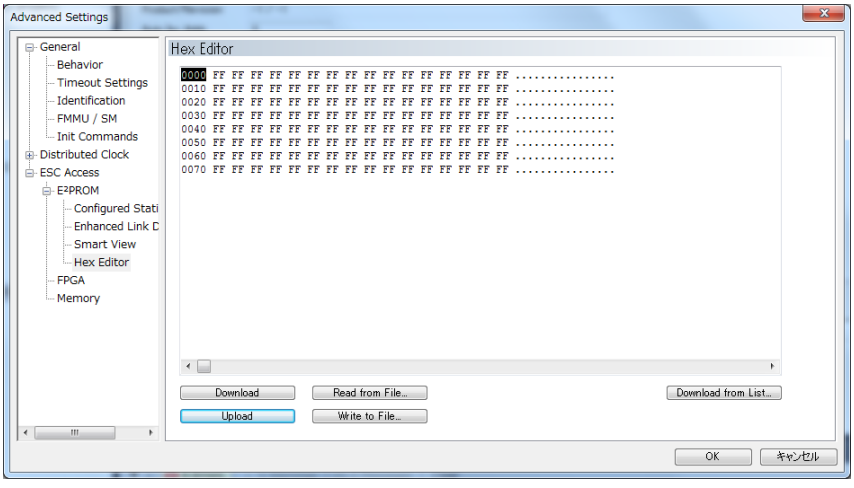


Figure B.2: EEPRON Editor

3. Select the ESI file

Select the ESI file stored in section 3.3.1 ESI File, and then click [OK].

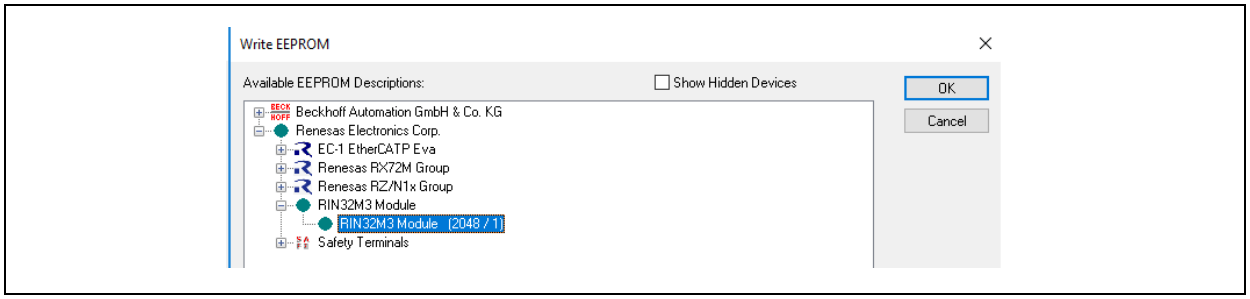


Figure B.3: Select ESI File

4. Download

When hexadecimal information is displayed as shown below, the programming has been completed.

After the EEPROM has been reprogrammed, turn off and on the board. and then click [OK].

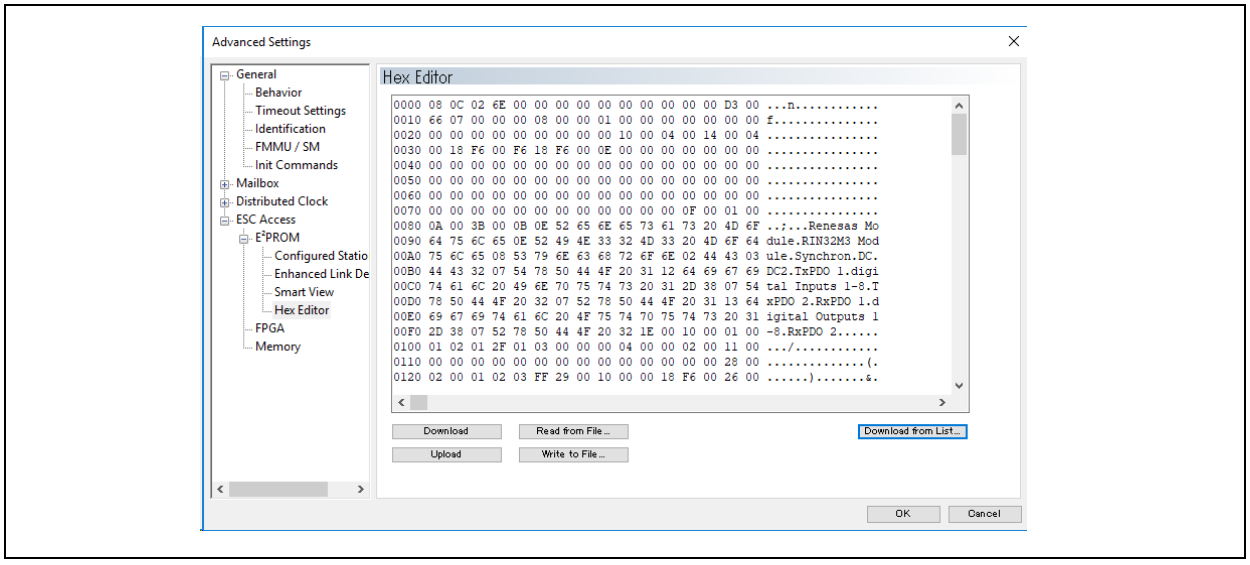


Figure B.4: Program EEPROM

Restart TwinCAT and R-IN32M3 module and rerun 3.2 Run TwinCAT.

Revision History

		Description	
Rev.	**Date**	**Page**	**Summary**
1.00	Dec 15, 2020	—	First edition
1.01	Feb 1, 2021		Add a supplementary explanation
		P.3	- Chapter 3
		P.5, 8	- Chapter 4
2.00	Apr 26, 2021	—	Add RA sample software and minor changes
2.01	Jun 14, 2021	16	Update Section 4.3

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