R-IN32M3 Module (RY9012A0)

Industrial Ethernet Module Solution

Outline

This document describes the start-up procedure of R-IN32M3 Module starter kit that includes the R-IN32M3 Module. The R-IN32M3 Module starter kit with the application controller Synergy™ S7G2 development environment, SK-S7G2, takes care of the complex handling of several industrial Ethernet protocols (such as PROFINET, EtherNet/IP™ and EtherCAT®). Example software of the SK-S7G2 is provided as source code and can thus be ported to other development platforms such as for RX MCUs. Accordingly, this R-IN32M3 Module starter kit allows the quick development of software prototypes of the industrial network communications and applications.

The software package that comes with the R-IN32M3 Module starter kit includes not only an integrated software development environment and example software but includes a Management Tool (Industrial Communication Explorer) from the company "port industrial automation GmbH") which has the protocol master function of PROFINET, EtherNet/IP and EtherCAT and can configure and monitor the R-IN32M3 Module.

The R-IN32M3 Module starter kit enables the user
— to quickly become familiar with the industrial Ethernet protocols (such as PROFINET, EtherNet/IP or EtherCAT) by use of the example applications; and
— to quickly develop applications on the industry-standard arm microcontroller of the Renesas Synergy SK-S7G2 starter kit.

1. R-IN32M3 Module Starter Kit

1.1 System Requirements

The R-IN32M3 Module starter kit requires the following environment for the evaluation.

- Renesas Synergy SK-S7G2 starter kit rev. 3.3 or a later version
- PC
  - OS: Windows® 7/8/10
  - Memory: At least 8 GB
  - LAN ports
  - USB 2.0 ports

1.2 Hardware Configuration

1.2.1 Configuration of Adaptor board with R-IN32M3 module

The R-IN32M3 Module starter kit includes the Adaptor board with R-IN32M3 module for evaluation environment, which contains the R-IN32M3 Module. This board has Arduino™ connectors and Pmod™ connectors according to industry standards and enables the connection with the application controller.

The Pmod connector is mounted on the top side of this board. The male Arduino connectors are on the back side of the module board to be plugged into the sockets of the Synergy S7G2 starter kit. To connect and apply control from the SK-S7G2, the J13, J8, and J7 jumper blocks must be set as follows.

— J13:   Connect the Socket pin with the iRJ45 pin
— J8:   For the CS signal, select PB2
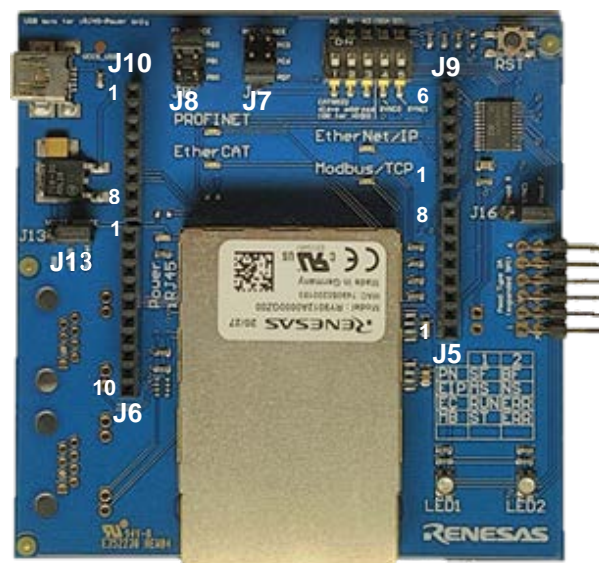— J7:   For the RST signal, select PD7

Figure 1.1   Adaptor board with R-IN32M3 module

This board has status LEDs conforming to the industrial Ethernet protocol. The lighting patterns of status LEDs differ with the communications standard.

Some examples of protocol state indicators were listed in the following table.

Table 1.1 Status LEDs

Industrial Ethernet Standard	State LED1	Colour	State LED2	Colour
PROFINET[Note1]	System failure	*Red*	Bus failure	*Red*
EtherNet/IP[Note2]	Module (MS)	*Green/ Red*	Network (NS)	*Green/ Red*
EtherCAT[Note3]	ESM (RUN)	*Green*	Error (ERR)	*Red*

[Note1] PROFINET Diagnosis Guideline V1.4 Chapter 6.7

[Note2] The CIP Networks Library Volume 2: EtherNet/IP Adaptation of CIP

[Note 3] EtherCAT   Indicator and Labeling ETG.1300S(R) Vx.x.x

1.2.2   Configuration for Using the Pmod Interfaces

The Synergy SK-S7G2 has two Pmod ports. If you will be using a Pmod interface, connect jumper J13 or J15 on the Synergy board to supply 3.3V power supply to the Pmod channel of choice of the R-IN32M3 Module.

For booting, follow the instructions in the Synergy Board Quick Start Guide Manual. Voltage supply for the Synergy SK-S7G2 is through the micro USB debug connector on the Synergy SK-S7G2. When connecting the Adaptor board with R-IN32M3 module in either mode, this board gets its power through the connectors. All operations for programming and debugging of the Synergy S7G2 are supported by this USB connection.

Note. EtherCAT function is not available for Pmod interfaces because two SYNC signals are required.

1.2.3   Configuration for Using the ARDUINO Interface

The R-IN32M3 Module board and the Synergy SK-S7G2 must be plugged together by using the Arduino connection of the boards.

Voltage supply for the Synergy SK-S7G2 is through the micro USB debug connector on the Synergy SK-S7G2. When connecting the Adaptor board with R-IN32M3 module in either mode, this board gets its power through the connectors. All operations for programming and debugging of the Synergy S7G2 are supported by this USB connection.

Note. When using EtherCAT DC mode, the SYNC0 and SYNC1 signals must be assigned to the host CPU interrupt port. When combining with Synergy SK-S7G2, short the 3pin and 6pin and 4pin and 7pin of J10 on the R-IN32M3 Module board.

1.3   Software Requirements

1.3.1   Integrated Software Development Environment "Renesas Synergy"

The environment for developing software for the Synergy SK-S7G2, which acts as the application controller, requires the following elements.

⸺ Renesas e2-studio version 7.5.1 or later
⸺ Renesas Synergy software package (SSP) version 1.7.8 or later

The e2-studio is an integrated software development environment (ISDE). The ISDE is available on the webpage of Renesas as seen in the quick start guide of the MCU board. A free Synergy license is required to use the SSP. The evaluation license is included with SSP installer, that can be downloaded after creating a Synergy account.

1.3.2   GOAL and Project Files

Unpack the GOAL headers and library to a local folder. This folder contains the GOAL library and the associated headers for the Synergy required to build an application for the R-IN32M3 Module. In addition, example projects for each protocol are included to be processed via e2-studio.

The GOAL is part of the OSAL interface (API) which is used on the embedded MCU of the R-IN32M3 Module and on the application controller (AC) to control the module. In this configuration with the Renesas Synergy board and the Adaptor board with R-IN32M3 module, the S7G2 MCU on the Renesas Synergy board acts as the AC. For details, refer to the r17us0001ed**** User's Manual for the Software API.

1.3.3   Industrial Communication Explorer (Management tool) -

The management tool called Industrial Communication Explorer (hereinafter called Management tool) is software tool which simulates a PROFINET master, an EtherNet/IP scanner as well as an EtherCAT master on a Windows PC and is a product of Renesas' partner *port industrial automation GmbH*. (*https://www.port.de/*).

The Management Tool is available on R-IN32M3 Module product web.

Here are some major hints for the installation of the Management tool:

The zip file with the Management tool has to be unpacked to a local folder. The resulting folder contains the executable *ICE.exe*, which can be started without an installation.

The Management Tool requires the NPF (NetGroup/Npcap Packet Filter) driver, that is installed with WinPcap/Npcap. For details, see next chapter.

Additionally, the Management Tool requires certain settings in the Windows firewall to receive data. If some software (such as antivirus) restricts the firewall of the Network to communication with the R-IN32M3 Module, allow (open) the port limitation of the Management Tool.

Open [Allow an app through Windows Firewall] from windows search with search word "through Windows Firewall".
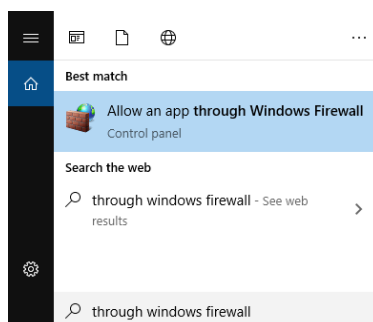

Figure 1.2 Search Windows Firewall

After the [Allowed apps] window is open, click on [Change settings] and then [Allow another app..].
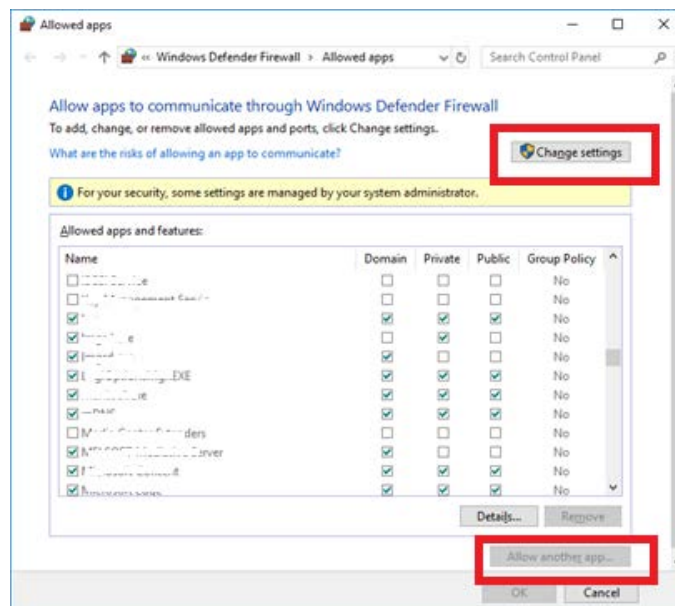
Figure 1.3 Allowed Applications

Click [Browse...] and select the "ice.exe" from Industrial Communication Explorer folder. Then, click [Network types…], check all network types to be enabled ("Domain", "Private", and "Public"), and click [OK] and [Add].
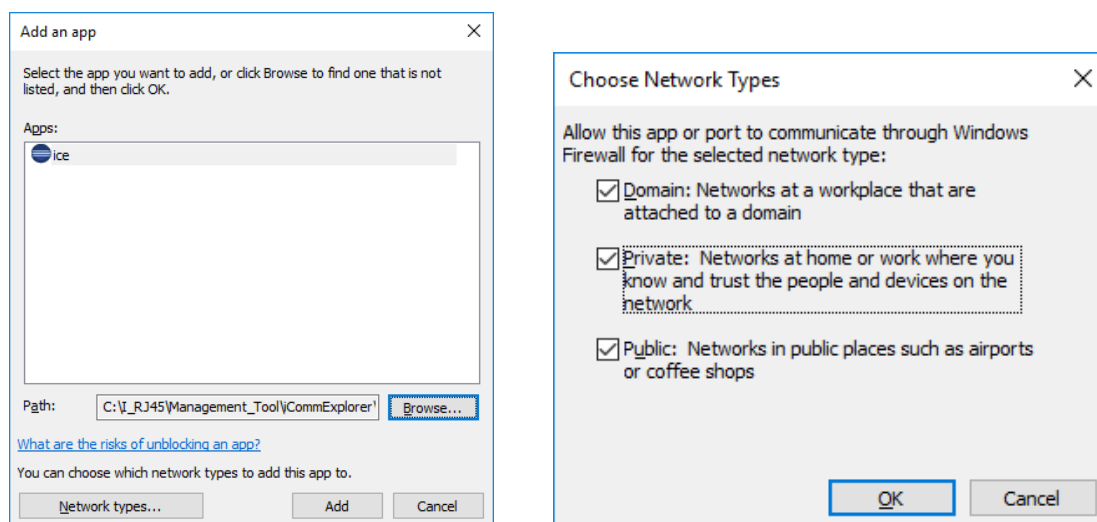
Figure 1.4 Select Network Types

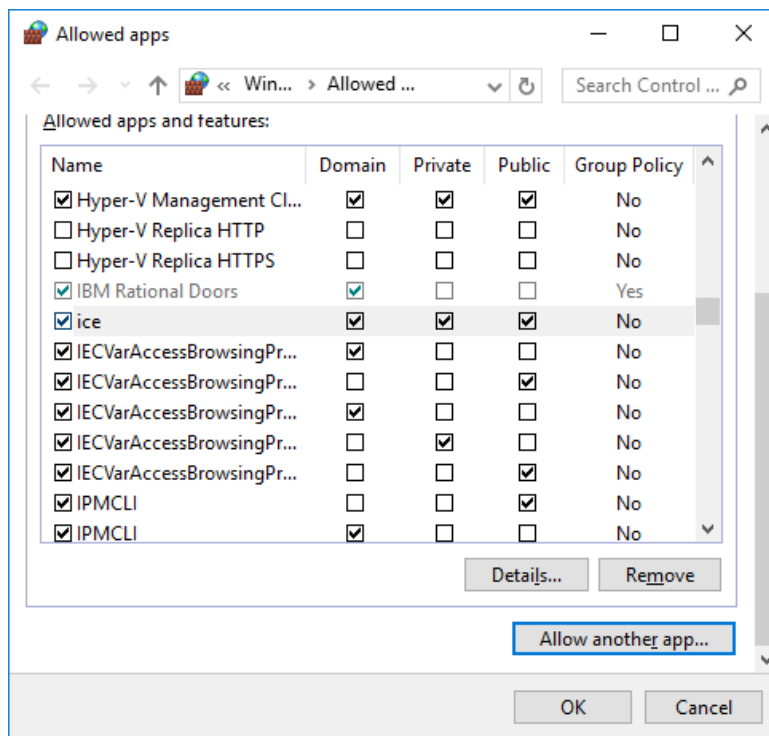"ice.exe" is indicated in the list of allowed apps list. After that, click on [OK].

Figure 1.5 Allowed applications

1.3.4   Setting the Host IP Address

This section describes device configuration, including the setting of an IP address for use in a network of devices.
Set the IP address before configuring the device.
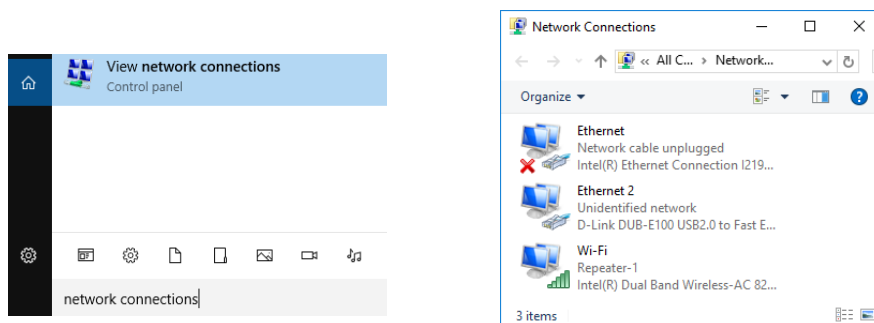Open "Network Connection".

Figure 1.6 View network connections

Double-click or right-click on the "Local Area Connection" icon.
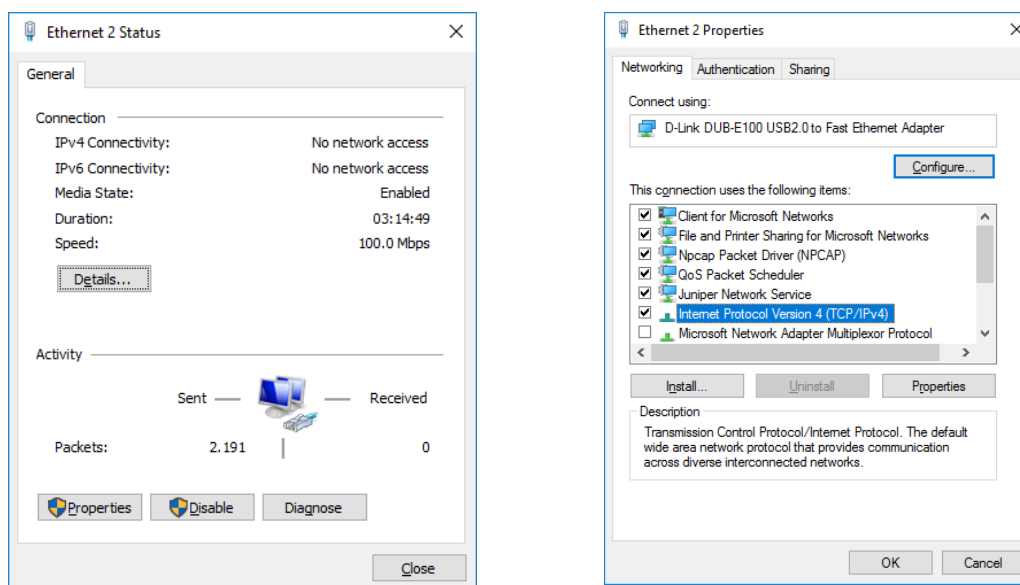In the "Local Area Connection Status" window, select "Properties".

Figure 1.7 Network Status

In the "Local Area Connection Properties" window, highlight "Internet Protocol Version 4 (TCP/IPv4)" then click on the "Properties" button.

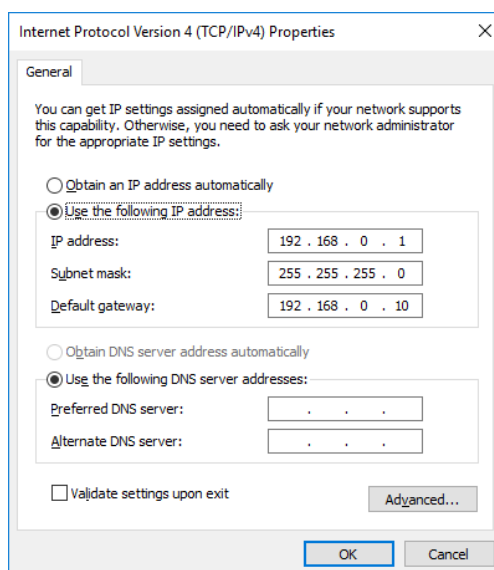Select the radio button "Use the following IP Address" and set IP and subnet mask.

Figure 1.8 TCP/IP configuration

Click on "OK" to finish the configuration.

1.3.5   WinPcap

To use the functionality of the Management Tool, WinPcap needs to be installed. WinPcap can be found at
https://www.winpcap.org

The Npcap also supports the Management Tool, if you have enabled "Winpcap API-compatible Mode" when installing Npcap. Npcap can be found at https://nmap.org/

1.3.6   Wireshark

The Management Tool also offers a function to create a log file of all relevant parameters of the R-IN32M3 Module. For a more detailed protocol analysis, it is recommended to install the Wireshark tools. The Wireshark tools is freeware and can be downloaded at https://www.wireshark.org.

2. e2studio Project

2.1 Installation

To use the sample projects with the e2studio, the e2studio and SSP must be installed.

2.2 Importing a Project

The example files provided by Renesas in the software for the R-IN32M3 Module starter kit can be imported into the e2-studio integrated system development environment (ISDE). In the [File] dropdown menu, use the [Import] dialog box of the e2studio to import the archive with its projects located in the unpacked project delivery into e2studio. Under [General], chose [Existing projects into workspace] when prompted for the import type. This will create new projects in the e2-studio.
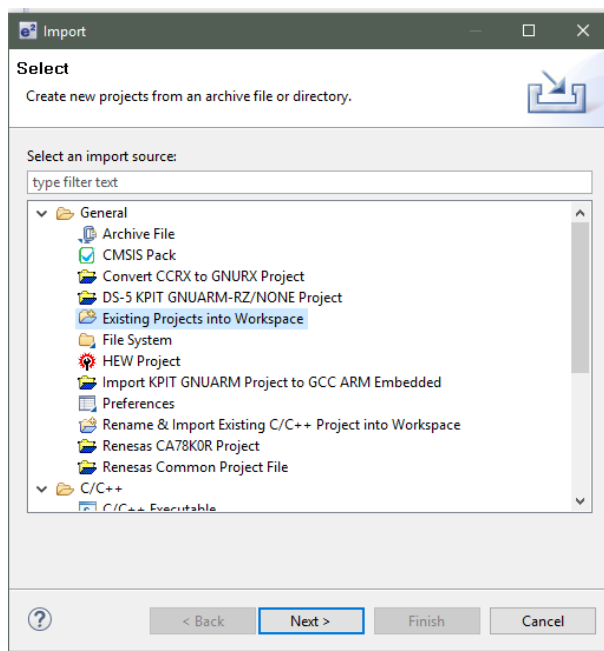

Figure 2.1 e2studio Import Dialog

In the next step, the root directory of the existing archive has to be selected by using the [Browse…] button. To select the directory of the unpacked archive, make sure that all projects for importing are selected in the checkboxes, and finish importing by clicking on [Finish] as shown in the figure below. In this example, the unpacked archive files are located in the directory "C:\Renesas_exampleSW".
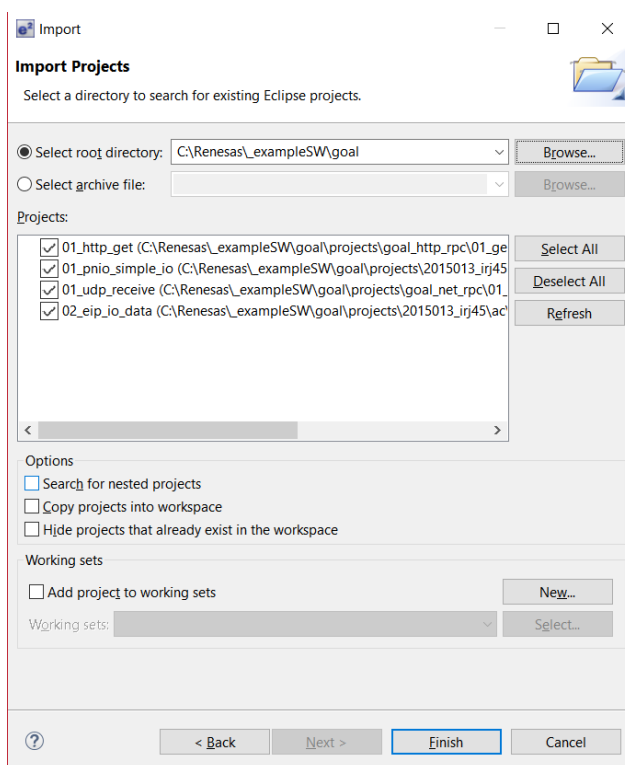
Figure 2.2 e2-studio Import Project Dialog

2.3   License Register

The license registration is required to use SSP. If e2-studio requests a license, register a license. The evaluation license is included in the SSP installer, that can be downloaded after creating a Synergy account.

Figure 2.3 License Request

2.4   Generate Project Content

Open the "configuration.xml" file from the selected project by double clicking. The pin assignment, clock configuration, and device selection are already registered, and run [Generate Project Content].
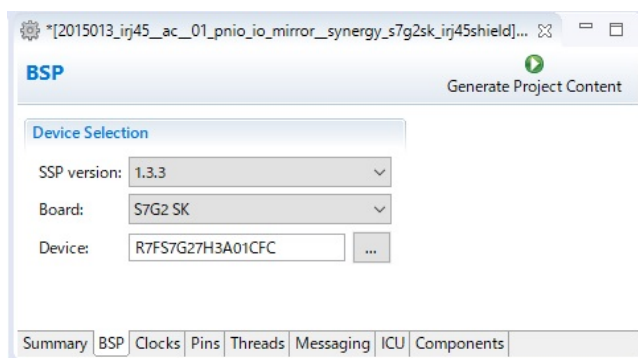

Figure 2.4 Generate Project Content

2.5   Project Configuration

To use the project context menu, menu item "Build Project" to do so. As a result, binary files for the projects are generated. The "Console" log of e2-studio should look like as shown in the following screenshot.
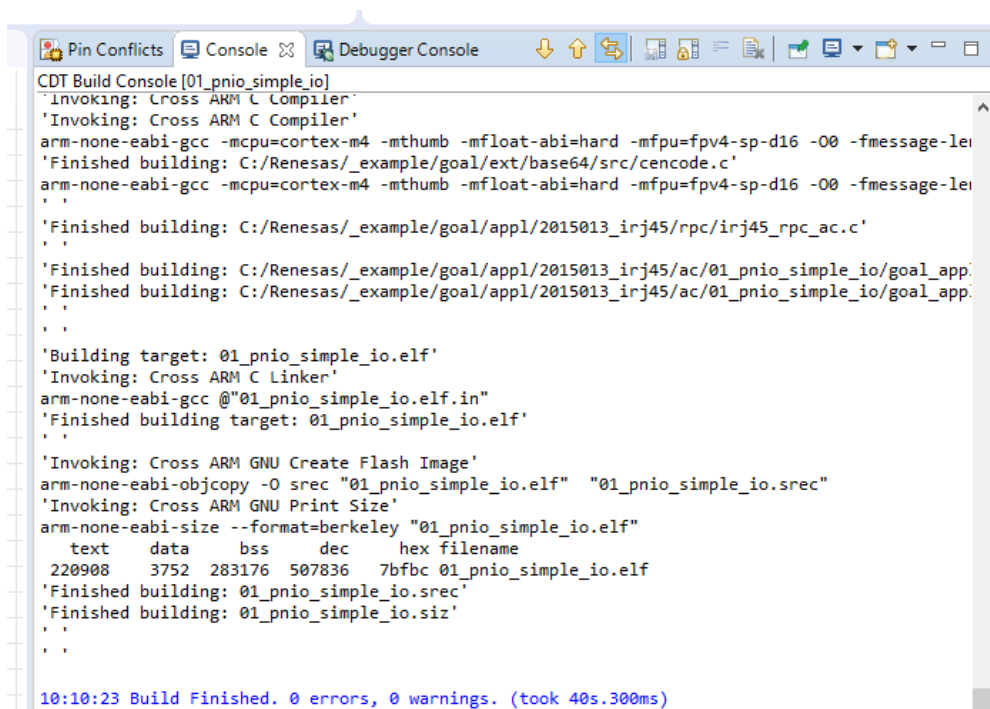

Figure 2.5 Console Log "Build Finished"

2.6   Project Debugging

When the Build is finished without errors and warnings, the compilation is successful. The resulting binary files can be started now. Be sure that the Renesas Synergy board is connected to the workstation via USB. Then, select the [Debug As] option from the drop-down menu and choose the item [3 Renesas GDB Hardware Debugging] as shown in the figure below.
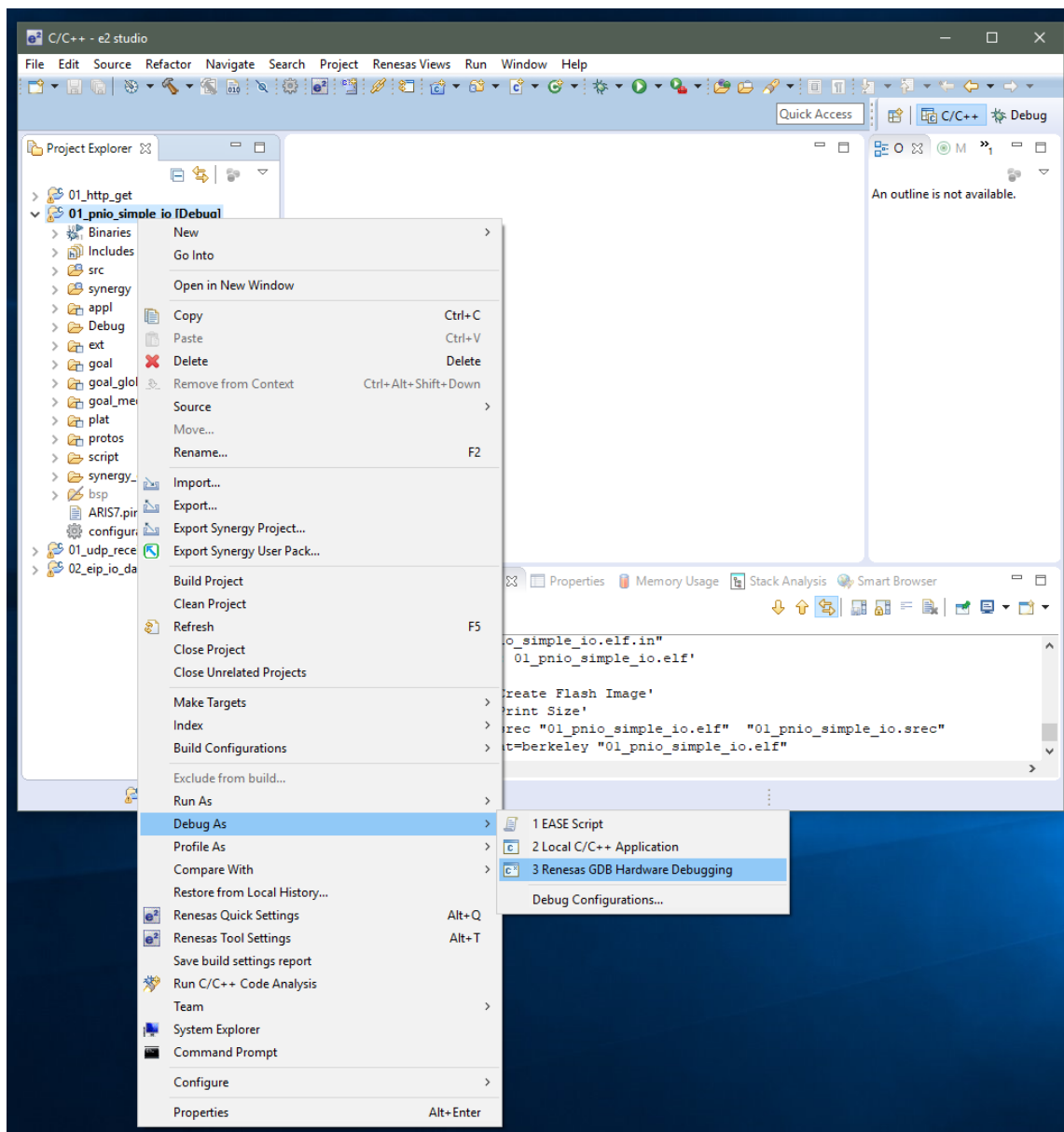

Figure 2.6 Initiate Debugging Session

In the next step, you will be prompted to select a debugging hardware. Choose "J-Link ARM" for the Renesas Synergy SK-S7G2 board. After selecting the debugging mode, it is necessary to select the chip model (R7FS7G27H).
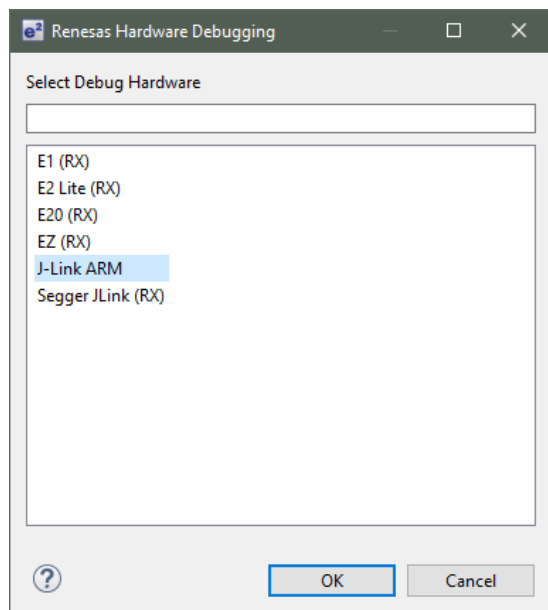

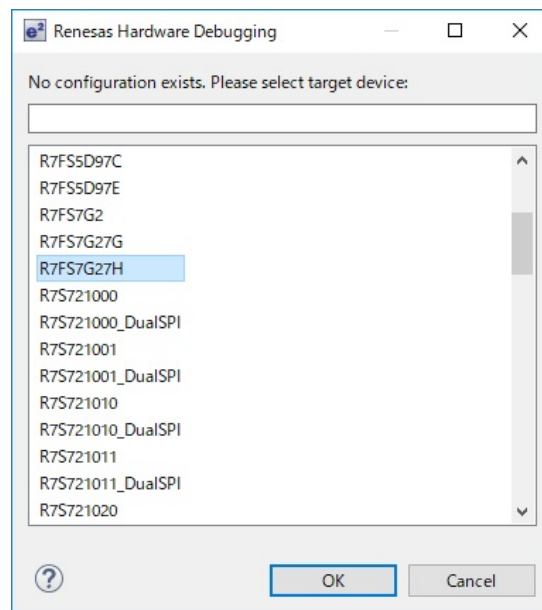**Figure 2.7 Select Debugging Hardware**

Figure 2.8 Select Target Device

After initiating the debugging session, the "Debug perspective" is shown, where the application can be started by [Resuming] execution. This needs to be done twice since two breakpoints are automatically set at the start-up.
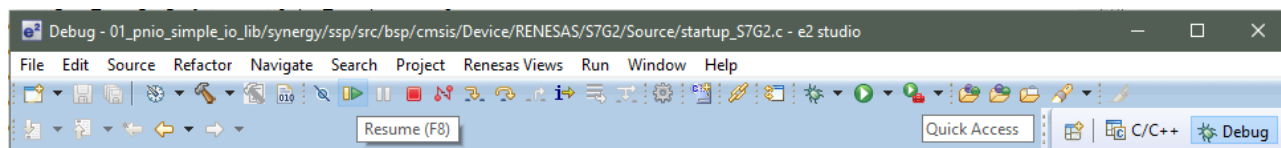

Figure 2.9 e2studio Toolbox

3.   Industrial Communication Explorer (ICE)

The Management Tool -ICE- allows the development related configuration and management of the Renesas sample application. This tool is based on a UDP broadcast communication. Thus, it works independently from IP settings of the used PC and the R-IN32M3 Module.
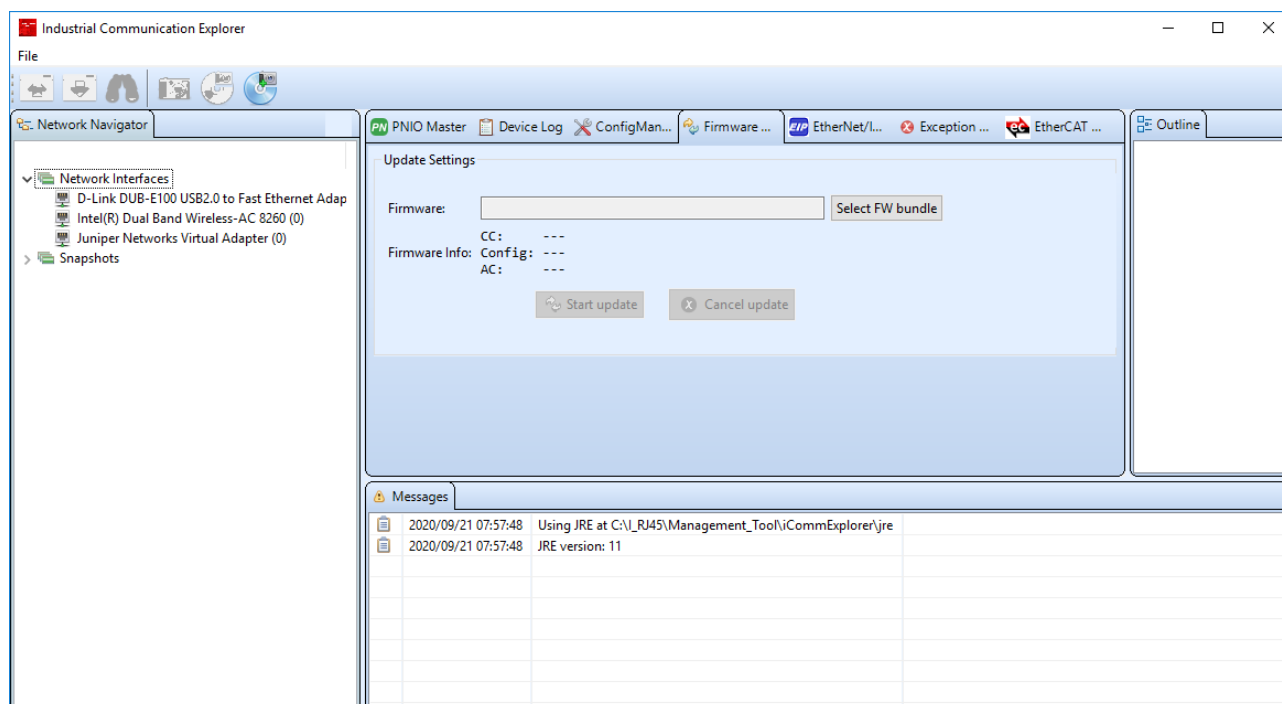

Figure 3.1 Industrial Communication Explorer (ICE)

This tool is organized in panels.

— The panel [Network Navigator] shows a list of available networks.
— The panel [Messages] shows the information regarding actions.
— The panel [Outline] shows the additional information relating to the selected function panel.

The following function panels are available.

Panel	Function
PNIO Master	Simple PROFINET IO master functionality
EtherNet/IP Master	Simple EtherNet/IP scanner functionality
EtherCAT Master	Simple EtherCAT master functionality
Config Manager	Access to the config manager variables
Firmware Update	Allows update the R-IN32M3 module firmware.
Device Log	Shows log messages under operation from both the R-IN32M3 Module and application controller.
Exception Log	Not in the scope of this manual

3.1   Device Detection

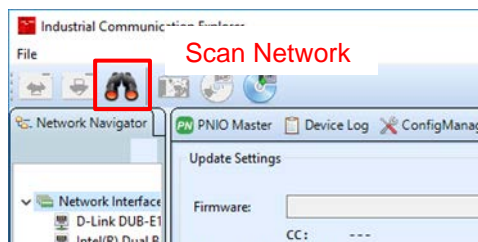Connect the R-IN32M3 Module to the PC, and then execute the scan network.

Figure 3.2 Network Scan

To communicate with the R-IN32M3 Module, open the "Networks" list in [Network Navigator]. Then, chose the network interface where the R-IN32M3 Module is reachable. Select the [Scan Network] button in the toolbar.

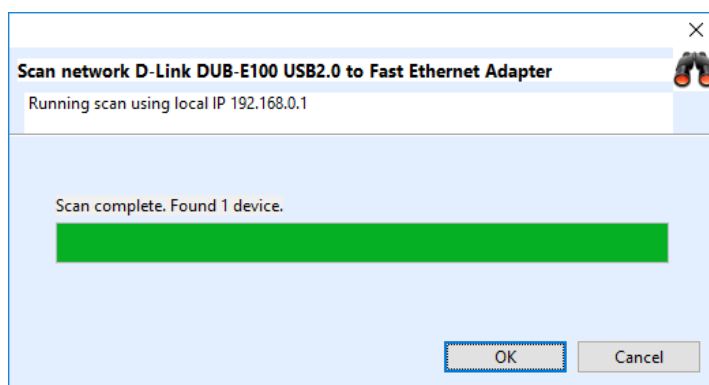The following dialog appears and 1 found device will be reported.

Figure 3.3 Scan Network Dialog

As a result, the R-IN32M3 Module will be shown as a new device in [Network Navigator] within the scanned network.
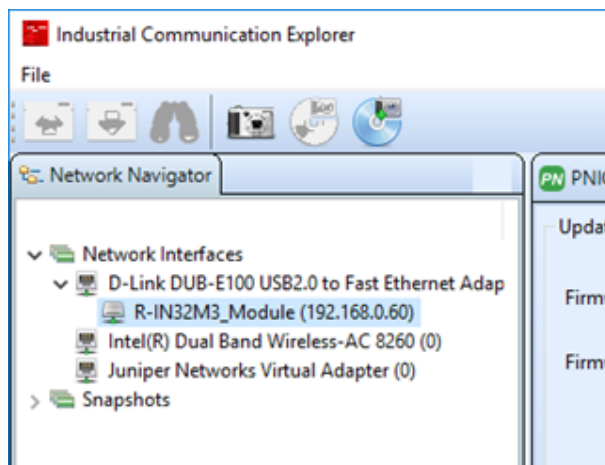

Figure 3.4 Detected R-IN32M3 Module

3.2 Config Manager / IP Configuration

This panel provides access to the config manager variables of the R-IN32M3 Module (volatile memory and non-volatile memory stored configuration variables).

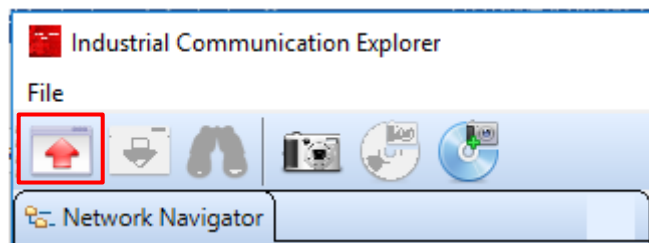To read a list of all variables, select the [Read configuration] button.

Figure 3.5 Read Configuration

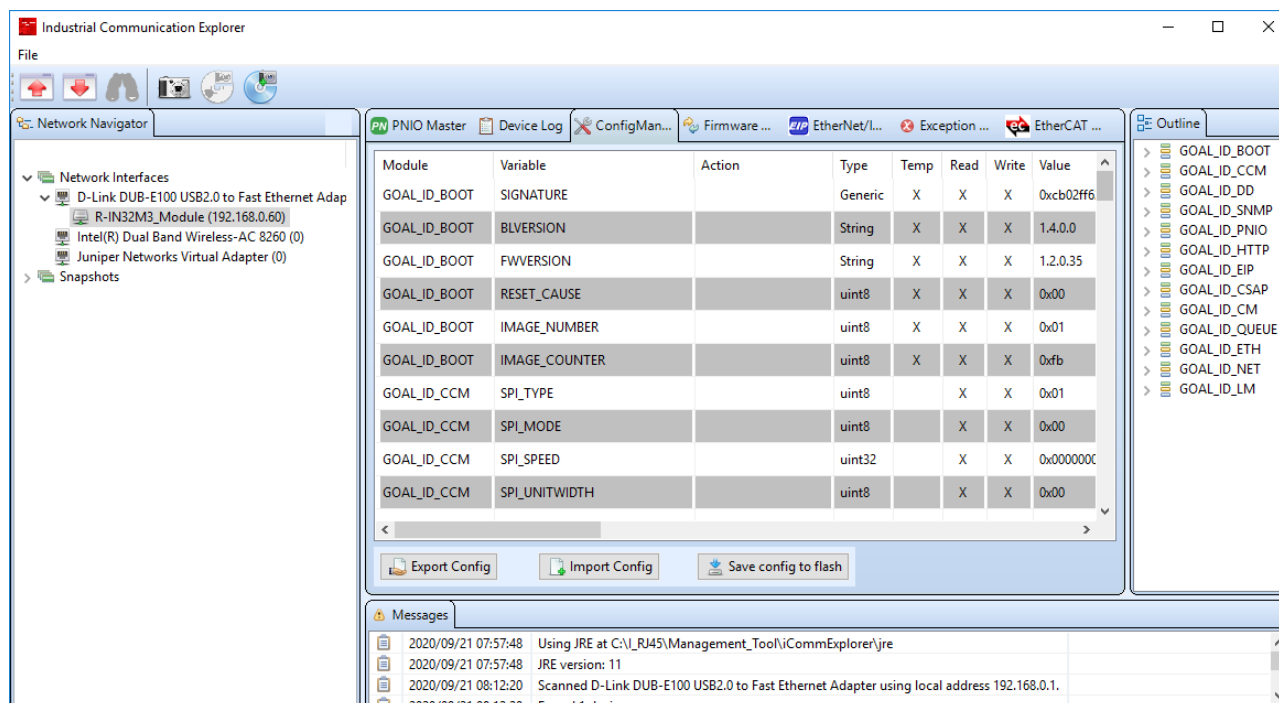As a result, all variables with a value are shown.

Figure 3.6 Configuration Manager

To communicate with the R-IN32M3 Module, the IP address of the R-IN32M3 Module must be within the same IP network as the IP address of the used PC. Thus, chose a valid IP address and configure the R-IN32M3 Module accordingly.

To configure an IP address, navigate to the variables of the "Module" GOAL_ID_NET. There it is possible to configure IP, NETMASK, and GW. Modify required values. Make sure the variable "VALID" is set to 1.

Variables modified by the user will be highlighted in yellow.
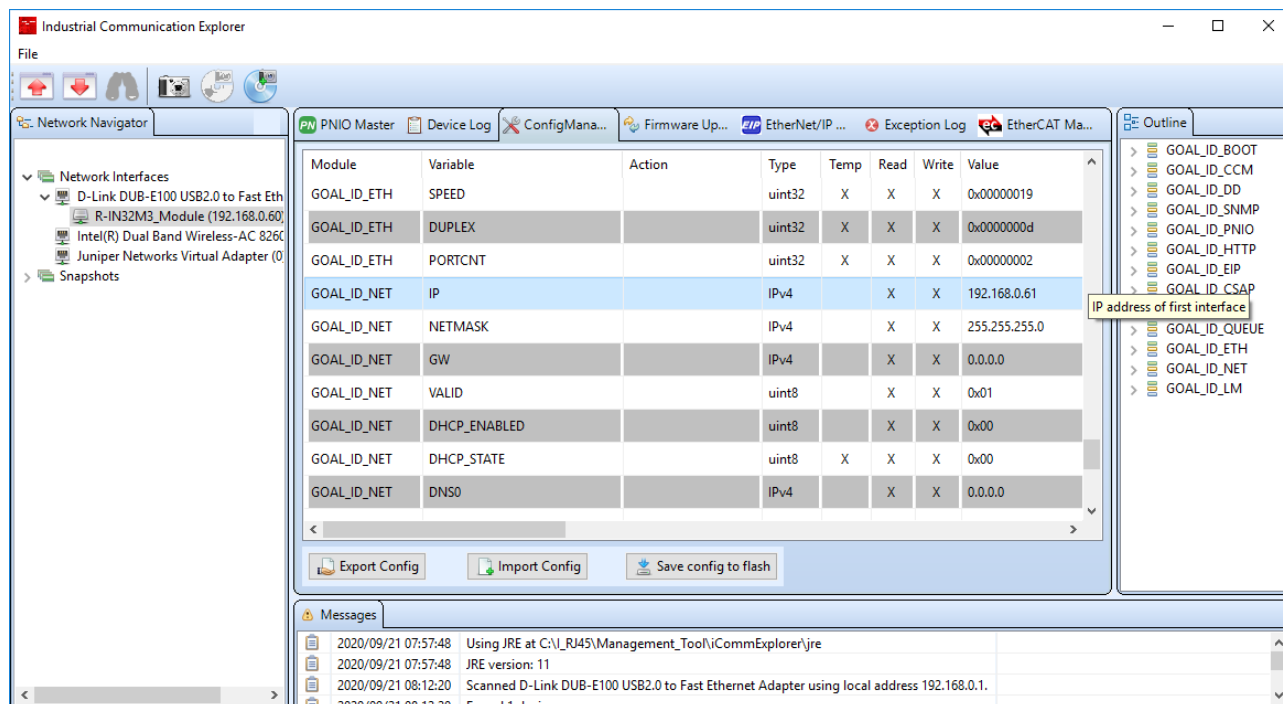
Figure 3.7 Modified Variables

Those modified variables are downloaded to the R-IN32M3 Module using the [Write configuration] button in the toolbar.
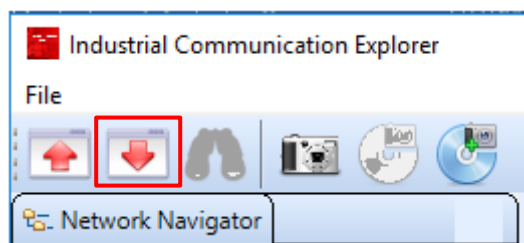
Figure 3.8 Write Configuration

When the confirmation window for changes is displayed, click "Yes". Afterwards the locally modified values are transferred to the R-IN32M3 Module, where there are only modified in RAM. Press the [Save config to flash] button to change the value of Flash installed in the R-IN32M3 Module. The changed IP settings will be applied after a reboot (Restarting Synergy board and R-IN32M3 Module).

3.3   Updating the R-IN32M3 Module Firmware

Under control of the Management Tool, the firmware of the R-IN32M3 Module can be updated. The firmware file will be sent to the R-IN32M3 Module via the Ethernet connection.
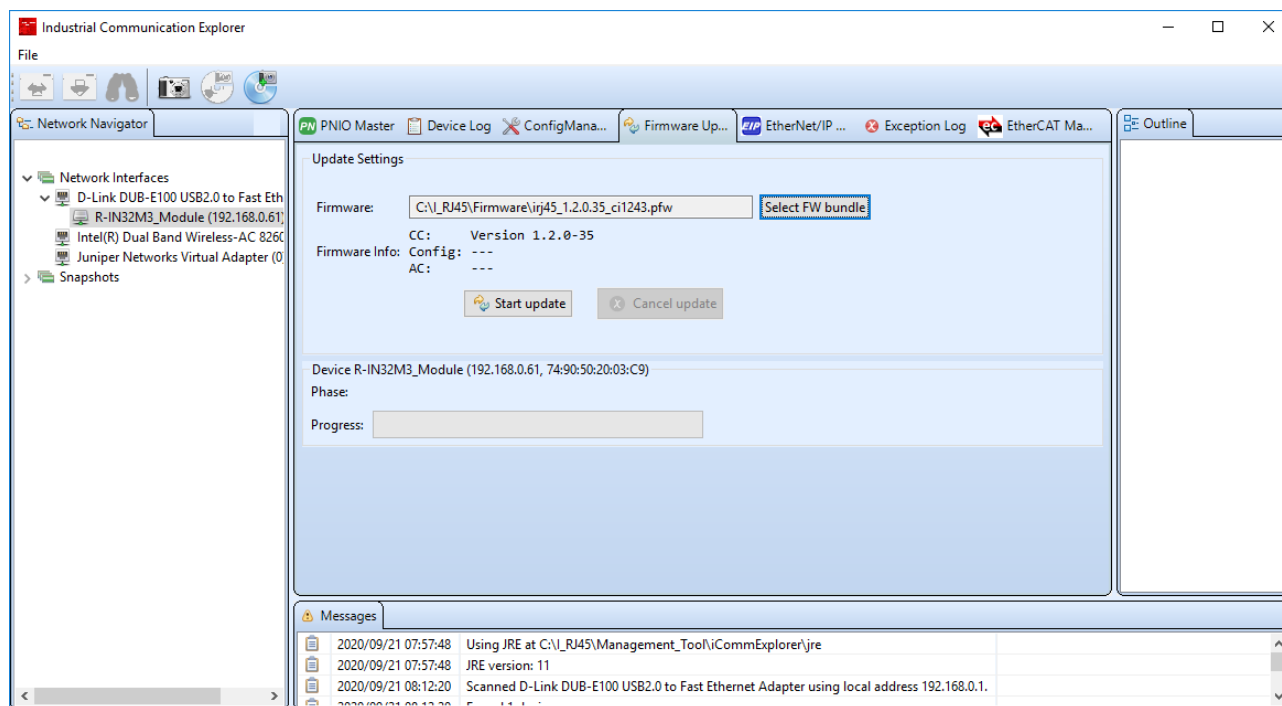

Figure 3.9 R-IN32M3 Module Firmware Update

To check the current firmware version, select [ConfigureManager] function panel and then the [Read configuration] button (**Figure 3.5**). The value of "FWVERSION" indicates the firmware version.

Figure 3.10 R-IN32M3 Module Firmware version

4.   Sample Software

4.1   PROFINET Sample Application (01_pnio_io_mirror)

Start the example "01_pnio_io_mirror" according to the previous description.

To establish a PROFINET communication, select the R-IN32M3 Module in [Network Navigator]. Then, select the [PNIO Master] function panel. Use [Scan device] to detect the PROFINET device.

When the "Wink" button is pressed, the detected "LED1" on the R-IN32M3 Module flashes.
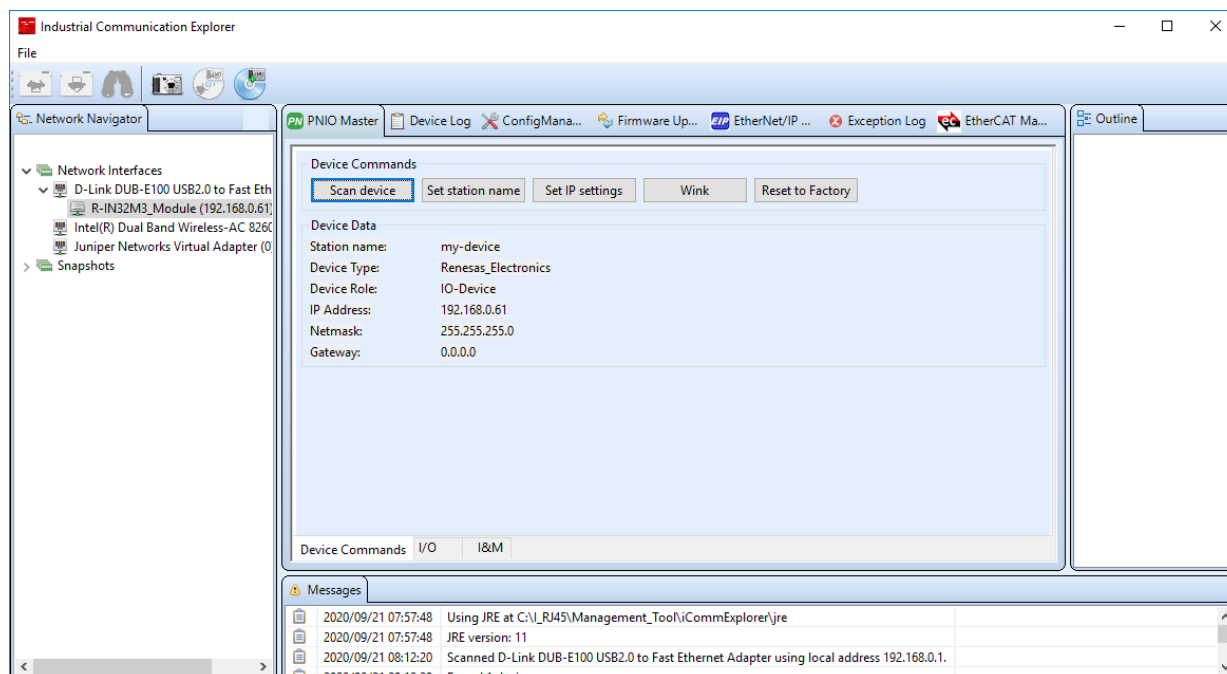
Figure 4.1 PROFINET Master

To establish a cyclic PROFINET communication, select the I/O panel of the PNIO Master.

To continue, load the GSDML file provided with the sample application.
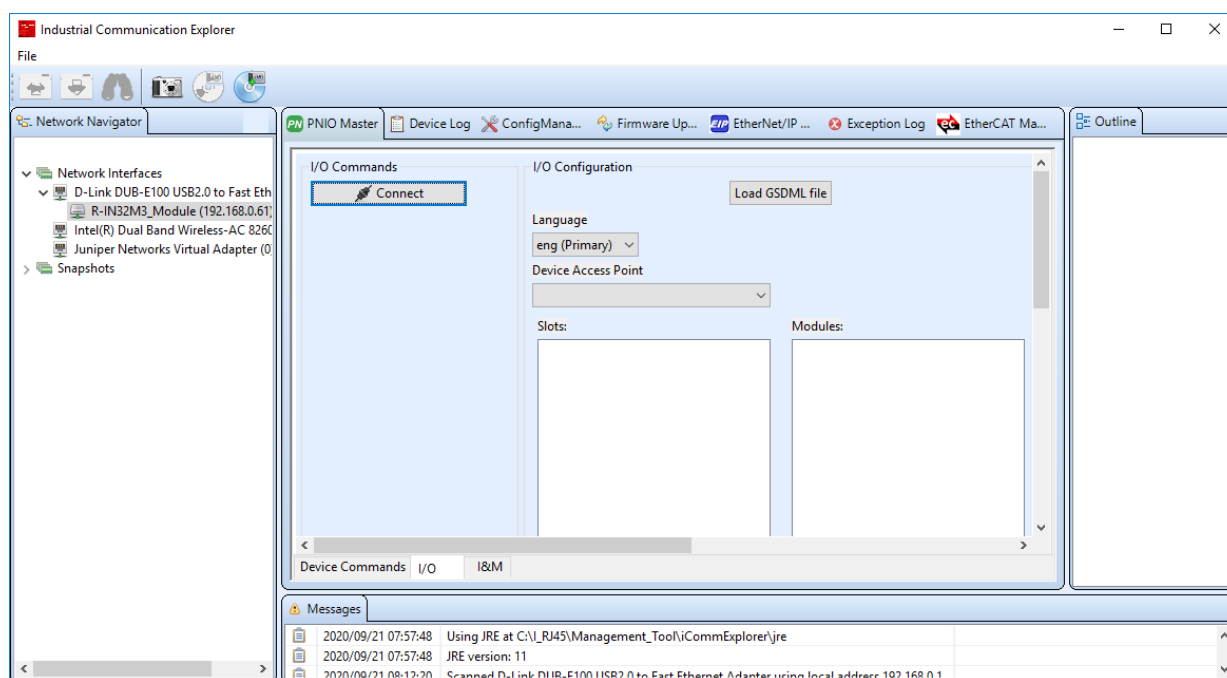
Figure 4.2 PNIO Master

After that, press the [Connect] button. This button starts cyclic PROFINET communications.
The example application on the application controller will mirror the output data to the input data.
The I/O data can be manipulated and monitored in the I/O data table. Furthermore, once a connection is
established, LED1 on the Adaptor board with R-IN32M3 module will be illuminated.
Process data can be monitored and manipulated using the [IO Data] panel.

Module/Submodule	Data Type	PS/CS	Input Data	Output Data
I/O Data				
⌄ I Signed8				
⌄ I Signed8		128/0		
Input 64 bytes	Integer8		0x00	
⌄ O Signed8				
⌄ O Signed8		0 /128		
Output 64 bytes	Integer8			0x00
⌄ I Signed16				
⌄ I Signed16		128/0		
Input 64 bytes	Integer16		0xcafe	
⌄ O Signed16				
⌄ O Signed16		0 /128		
Output 64 bytes	Integer16			0xcafe

Figure 4.3 IO Data Panel

4.2   EtherNet/IP Sample Application (06_eip_io_data_static)

Start the example "06_eip_io_data_static " according to the previous description.

Make IP settings to establish EtherNet / IP communication with the device. You can verify the current settings using the Management tool.

Then, select the [EtherNet/IP Master] function panel. Use [Scan device] to detect the EtherNet/IP device.
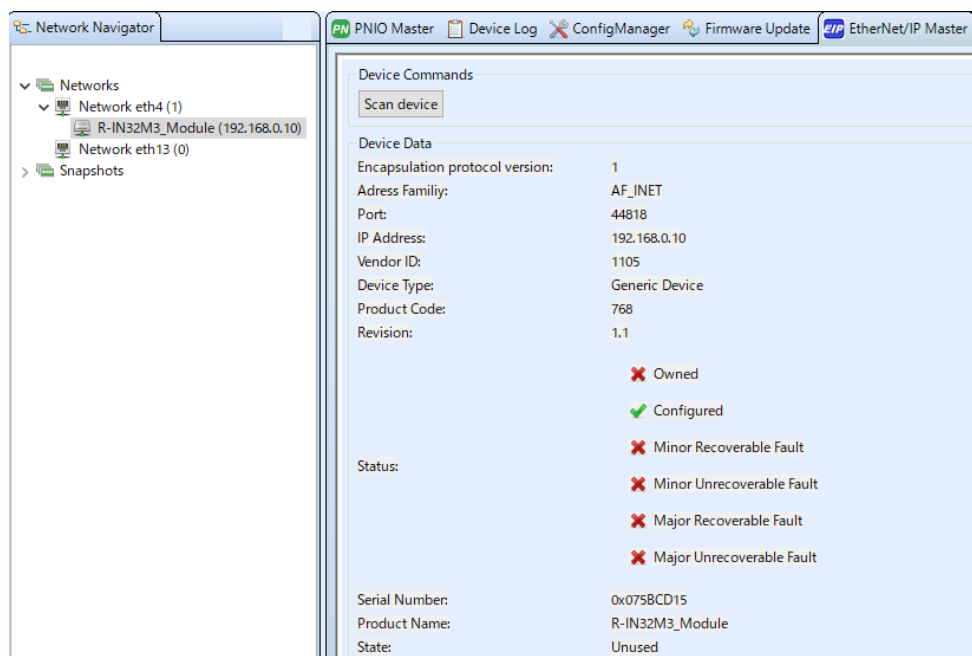

Figure 4.4 EtherNet/IP Scanner – Device Scan

To establish a cyclic EtherNet/IP communication, use the I/O panel of the EtherNet/IP scanner.
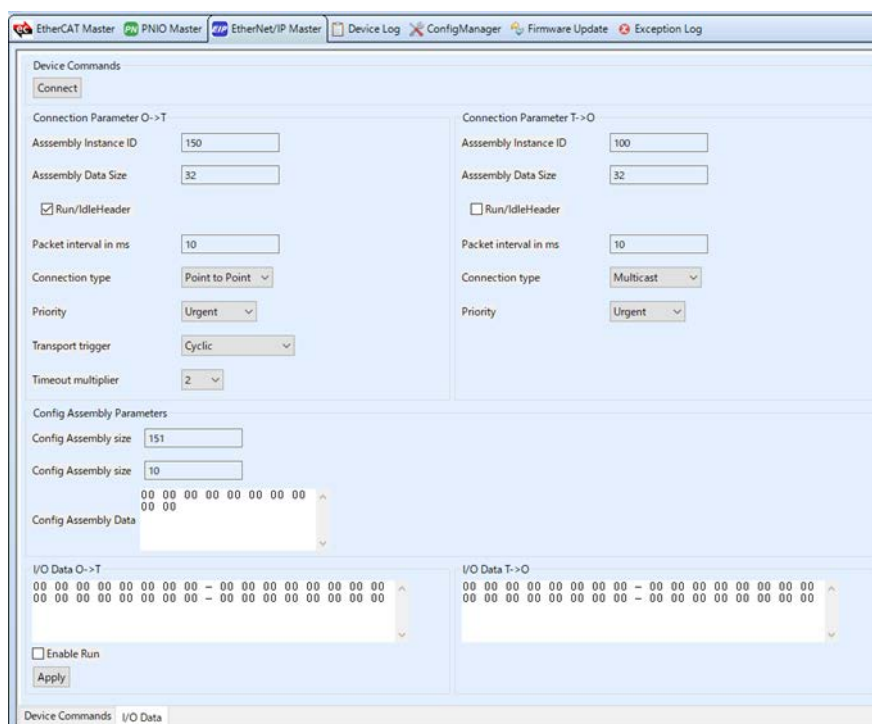
Figure 4.5 EtherNet/IP Scanner Configuration

Press the [Connect] button. This button initiates a cyclic communication. Once the connection is established, both LED1 and LED2 on the Adaptor board with R-IN32M3 module will turn green. The application controller sample application mirrors the output data to the input data. Send / receive data can be operated / checked in the I / O data table.

The [I/O Data] tab is split into five different sections:

- **Connection Parameter O→T:** Scanner connection parameters
  Define the output assembly to connect to and define the parameters for that assembly.

- **Connection Parameter T→O:** Adapter connection parameters
  Define the input assembly to connect and define the parameters for that assembly

- **Config Assembly Parameters:** Parameters for the configuration assembly to use.
  Define parameters to be sent to the assembly for configuration

- **I/O Data O→T:** Data sent from the scanner to the adapter.
- **I/O Data T→O:** Data received by the scanner from the adapter.

To close the connection, click [Disconnect].

4.3   EtherCAT Sample Application (09_ecat_slave)

To use this example, you need to update the firmware version of the R-IN32M3 Module to 2.0.0.0 or later.
For the firmware update method, refer to **3.3**.

The EtherCAT simple Master provides a master implementation with the following functionality:

- test I/O data exchange with the device via EtherCAT.
- identify the device via the EtherCAT.
- read object dictionary values.
- adjust RxPDO and TxPDO mapping

Note that connection with multiple slaves is not supported.

When using the EtherCAT Simple Master, you need to set enable only "Internet Protocol Version 4
(TCP/IPv4)" on configuration of network connections. Recommend disable other drivers.

Figure 4.6 Properties of network connection

The EtherCAT master implementation always assumes, that the device is the first and only slave in the EtherCAT network. Working with more than one slave is currently not supported.

To work with the EtherCAT Master, the EtherCAT mode must be activated for the according network interface. To activate the mode, make right click on a network and click on "Enable EtherCAT" as shown in **Figure 4.7** below. This will launch the EtherCAT proxy program.
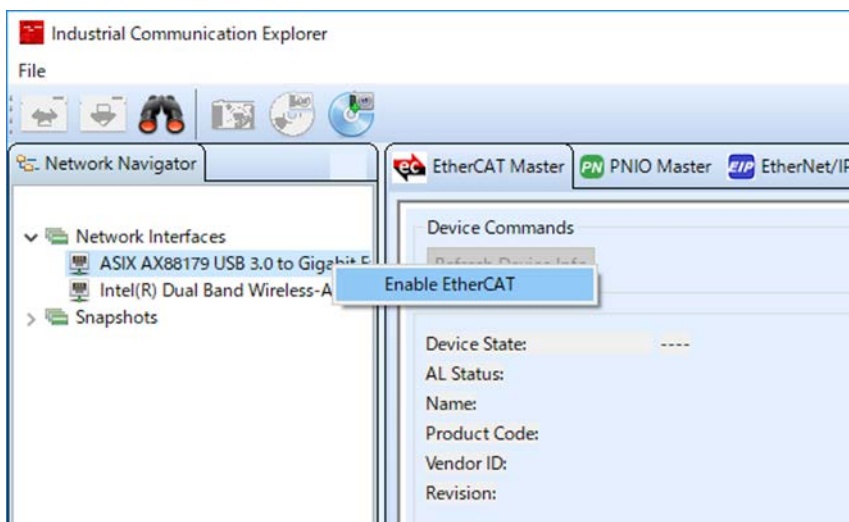
Figure 4.7 Enable EtherCAT connection

Network interfaces with the EtherCAT proxy program enabled are marked with a red font color.

In this state, you can search for EtherCAT slave devices on the network.
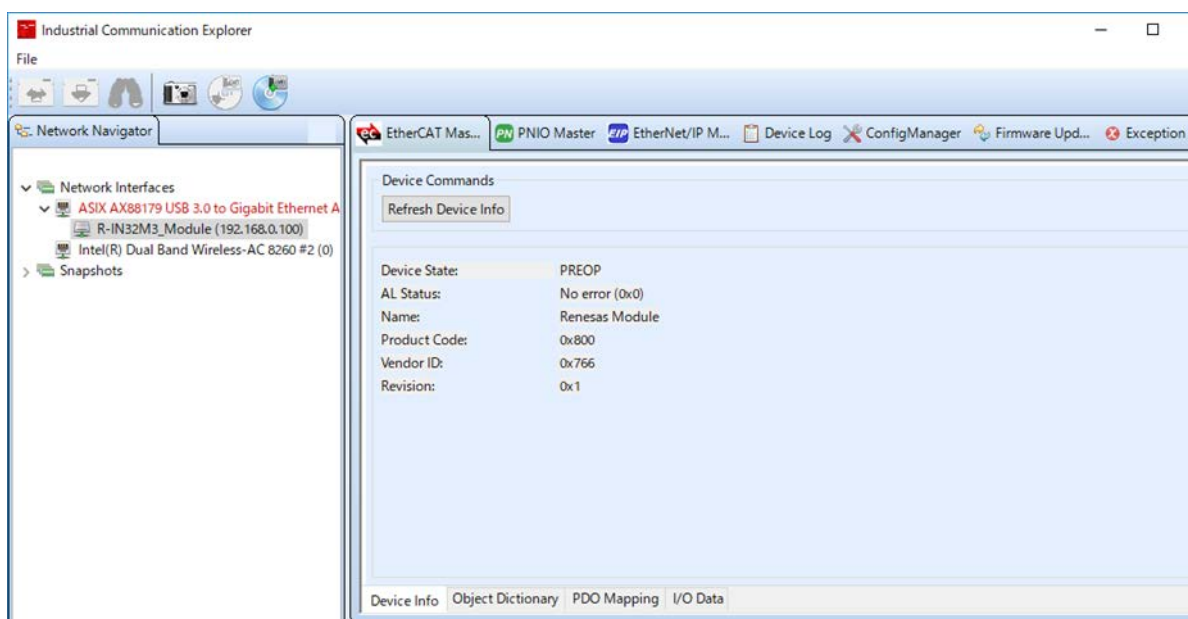
Figure 4.8 EtherCAT slave detect

The EtherCAT Master consists of 4 different tabs. Each function is explained below.

On the Device Info tab, you can get basic EtherCAT device information such as the device's EtherCAT State and product name.

The Object Dictionary tab allows you to read the object dictionary of your device.
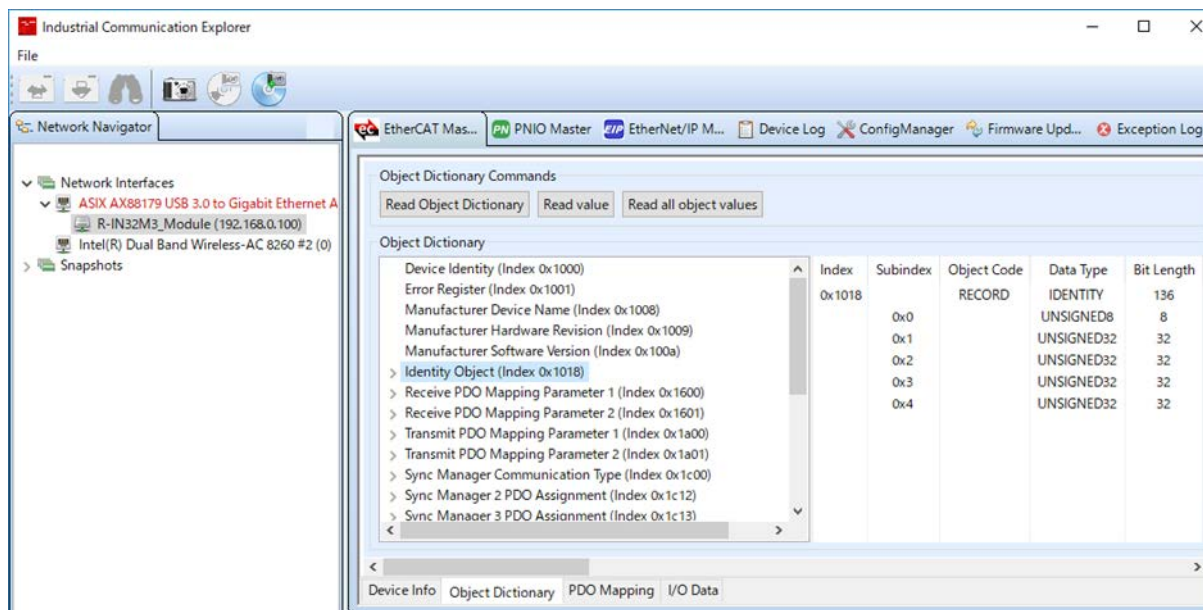
Figure 4.9 EtherCAT object directory tab

Reading the object dictionary is split into phases:

- Read Object Dictionary   : Read all the entered Object List.
- Read Value   : SDO access to selected Objects.
- Read all object value   : SDO access to all Objects.

The PDO Mapping tab allows to configure the mapping of the different PDOs.
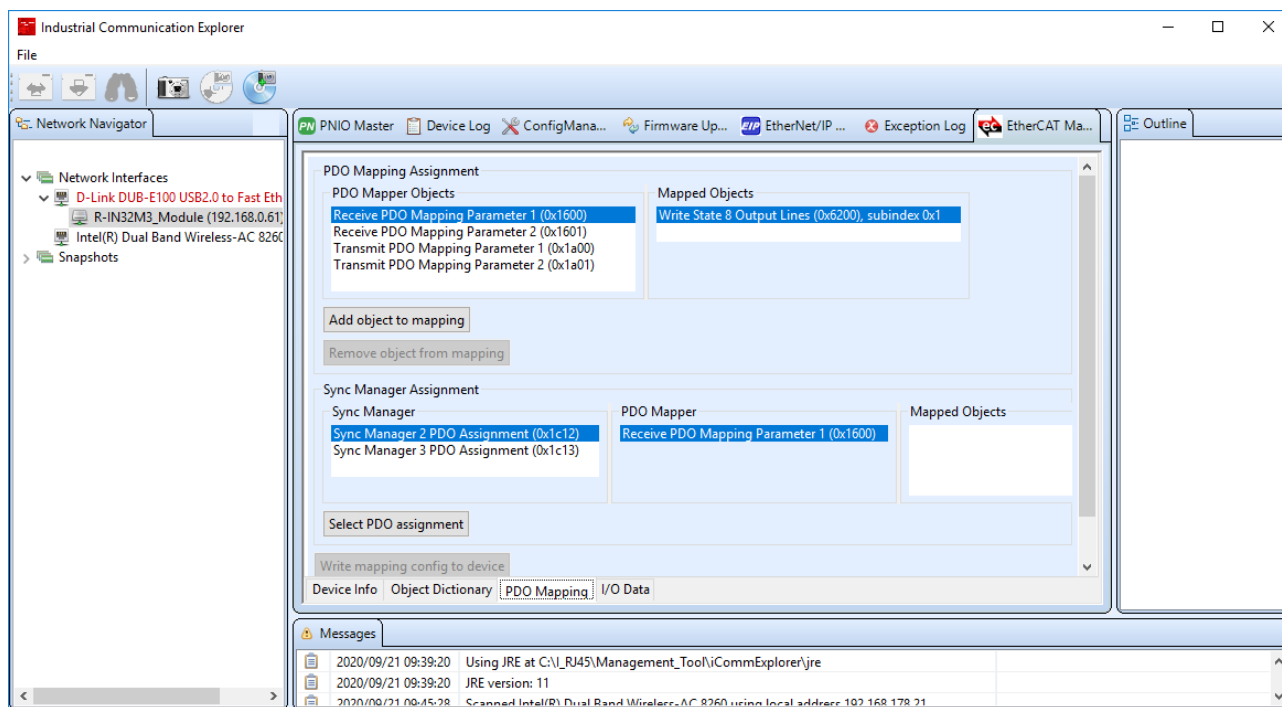
Figure 4.10 PDO mapping tab

Mappings can be assigned to the different mapping parameter objects via the "Add object to mapping" button. First select the PDO mapping object that shall be changed in the PDO Mapper Objects list and then click on the button. Mappings can be removed via the "Remove object from mapping" button.

Which mapping objects are assigned to RxPDO and TxPDOs can be selected via the "Select PDO assignment" button.

When the mapping is changed, the data is not written to the device immediately. Once the assigned mapping is changed as required, click on "Write mapping config to device". This triggers the update of the object dictionary within the device itself.

The use of the I / O Data tab allows to view process data.
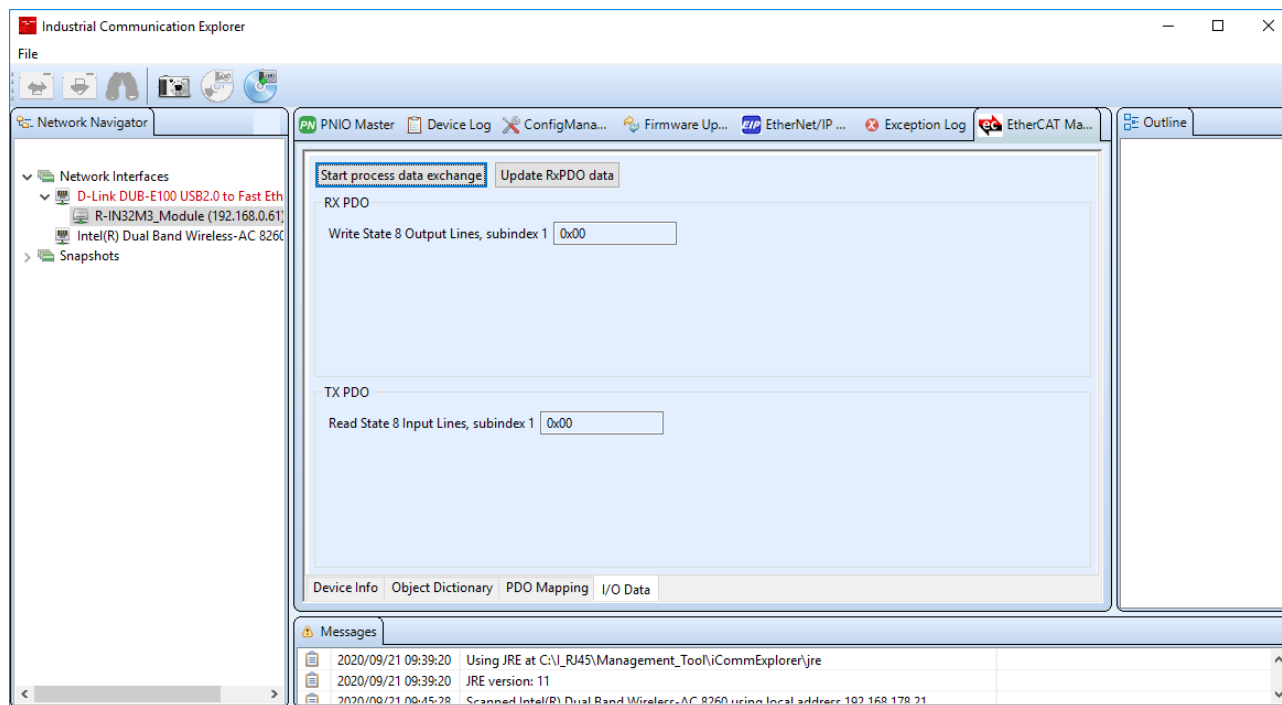
Figure 4.11 I/O data tab

[I / O Data] tab

   RX PDO: Data to send to the device

   RXPDO: Data received from the device

The data exchange itself is started by clicking on "Start process data exchange".
When changing the value of RXPDO while sending / receiving data, click [Update RxPDO data] after entering the value to update it.

Revision History		R-IN32M3 Module (RY9012A0) Quick Start Guide	

		Description	
Rev.	**Date**	**Page**	**Summary**
1.00	Aug 03, 2020	-	First Edition issued
2.00	Nov 06, 2020	4	Optimized Chapter 1.2.2
		1, 5,15-20	Update to Industrial Communication Explorer
		21-24	Optimized Chapter 4
		1,3,25-30	Additional chapter for EtherCAT
2.01	Dec 10, 2020	8-9	Add Chapter 1.3.4
2.02	Jan 15, 2021	25	Add version and update method of FW
		25	Add recommendation about properties of PC network connection
2.03	Jan 29, 2021	5	Updated Synergy Software Package (SSP) version
		20	Added how to check FW version

General Precautions in the Handling of Microprocessing Unit and Microcontroller Unit Products

The following usage notes are applicable to all Microprocessing unit and Microcontroller unit products from Renesas. For detailed usage notes on the products covered by this document, refer to the relevant sections of the document as well as any technical updates that have been issued for the products.

1. Precaution against Electrostatic Discharge (ESD)

   A strong electrical field, when exposed to a CMOS device, can cause destruction of the gate oxide and ultimately degrade the device operation. Steps must be taken to stop the generation of static electricity as much as possible, and quickly dissipate it when it occurs. Environmental control must be adequate. When it is dry, a humidifier should be used. This is recommended to avoid using insulators that can easily build up static electricity. Semiconductor devices must be stored and transported in an anti-static container, static shielding bag or conductive material. All test and measurement tools including work benches and floors must be grounded. The operator must also be grounded using a wrist strap. Semiconductor devices must not be touched with bare hands. Similar precautions must be taken for printed circuit boards with mounted semiconductor devices.

2. Processing at power-on

   The state of the product is undefined at the time when power is supplied. The states of internal circuits in the LSI are indeterminate and the states of register settings and pins are undefined at the time when power is supplied. In a finished product where the reset signal is applied to the external reset pin, the states of pins are not guaranteed from the time when power is supplied until the reset process is completed. In a similar way, the states of pins in a product that is reset by an on-chip power-on reset function are not guaranteed from the time when power is supplied until the power reaches the level at which resetting is specified.

3. Input of signal during power-off state

   Do not input signals or an I/O pull-up power supply while the device is powered off. The current injection that results from input of such a signal or I/O pull-up power supply may cause malfunction and the abnormal current that passes in the device at this time may cause degradation of internal elements. Follow the guideline for input signal during power-off state as described in your product documentation.

4. Handling of unused pins

   Handle unused pins in accordance with the directions given under handling of unused pins in the manual. The input pins of CMOS products are generally in the high-impedance state. In operation with an unused pin in the open-circuit state, extra electromagnetic noise is induced in the vicinity of the LSI, an associated shoot-through current flows internally, and malfunctions occur due to the false recognition of the pin state as an input signal become possible.

5. Clock signals

   After applying a reset, only release the reset line after the operating clock signal becomes stable. When switching the clock signal during program execution, wait until the target clock signal is stabilized. When the clock signal is generated with an external resonator or from an external oscillator during a reset, ensure that the reset line is only released after full stabilization of the clock signal. Additionally, when switching to a clock signal produced with an external resonator or by an external oscillator while program execution is in progress, wait until the target clock signal is stable.

6. Voltage application waveform at input pin

   Waveform distortion due to input noise or a reflected wave may cause malfunction. If the input of the CMOS device stays in the area between V_{IL} (Max.) and V_{IH} (Min.) due to noise, for example, the device may malfunction. Take care to prevent chattering noise from entering the device when the input level is fixed, and also in the transition period when the input level passes through the area between V_{IL} (Max.) and V_{IH} (Min.).

7. Prohibition of access to reserved addresses

   Access to reserved addresses is prohibited. The reserved addresses are provided for possible future expansion of functions. Do not access these addresses as the correct operation of the LSI is not guaranteed.

8. Differences between products

   Before changing from one product to another, for example to a product with a different part number, confirm that the change will not lead to problems. The characteristics of a microprocessing unit or microcontroller unit products in the same group but having a different part number might differ in terms of internal memory capacity, layout pattern, and other factors, which can affect the ranges of electrical characteristics, such as characteristic values, operating margins, immunity to noise, and amount of radiated noise. When changing to a product with a different part number, implement a system-evaluation test for the given product.

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Corporate Headquarters

TOYOSU FORESIA, 3-2-24 Toyosu,
Koto-ku, Tokyo 135-0061, Japan
www.renesas.com

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