R-IN32M3 Module (RY9012A0)

Industrial Ethernet Module Solution

1. Introduction

This document describes the integration of R-IN32M3 Module on the Renesas Synergy™ platform with the e2studio development environment. Synergy S7G2 microcontroller on the Synergy board is used as the application controller and communicates with the embedded MCU of R-IN32M3 Module. The module takes care for the complex handling of the Industrial Ethernet protocols (like PROFINET® or EtherNet/IP®) under control of the application processor. The example SW is provided in source code and thus can be ported to other development platforms and target MCUs. Thus, it is possible with this R-IN32M3 Module Starter Kit to quickly develop a prototype for a target application for the Industrial Ethernet market.

The software package which is available with R-IN32M3 Module Starter Kit is not only the integrated software development environment and example software but includes a Management Tool (of company “port GmbH”) which can be used for protocol monitoring and control system. R-IN32M3 Module Starter Kit prototype application and its communication module can be configured and monitored. Even an update of R-IN32M3 Module’s firmware is possible via Ethernet.

With its ARM® core based S7G2 controller the starter kit enables the user

- to quickly familiarize with the Industrial Ethernet protocols (like PROFINET or EtherNet/IP) by use of an application example
- to quickly develop an application on the industry-standard ARM microcontroller of the Renesas Synergy SK-S7G2 Starter Kit
- to have a protocol monitoring and control system

2. Hardware of R-IN32M3 Module Starter Kit

2.1 Preparations System Requirements

To work with Renesas Synergy SK-S7G2 Starter Kit Rev.3.3 or higher, a PC with the following features is required:

- Microsoft® Windows® with Intel® Core family processor or equivalent running at ≥ 2.0 GHz
  - ≥ 8 GB system RAM
  - ≥ 2 GB free hard drive space
  - ≥ 2 USB 2.0 ports
- Internet connection

2.2 Hardware configuration

2.2.1 Configuration of R-IN32M3 Module board

Renesas provides a hardware board for evaluation which contains R-IN32M3 Module with two Ethernet connectors and an integrated Ethernet switch. On-board connectors according to industry standards can be operated in Arduino™ compatible mode and in Pmod™ mode.

On the top side the Pmod connector is mounted. The male Arduino connectors are on the backside of the shield to be plugged into the socket of Synergy S7G2 Starter Kit board. Female connectors on the front side allow for connection to other Arduino compatible shields. To connect and control from SK-S7G2 it is necessary to configure the connectors J13, J8 and J7 as follows:

- J13: Connect “Socket” with “iRJ45”
- J8: Connect “PB2”
- J7: Connect “PD7”

For complete industrial Ethernet conformance, two additional bi-color (red/green) LED are recommended to design in the target device. This specific protocol state visualization is perceptive according to communication standard. Therefore, the application controller (who processed R-IN32M3 Module data) should ensure those specific indication signals.

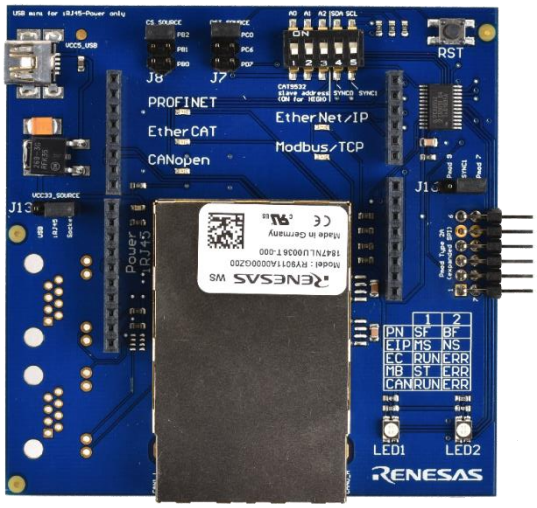


Figure 1: R-IN32M3 Module board

Exemplary some protocol status conditions were listed in following Table.

Table 1: State Indication

Industrial Ethernet standard	State LED1	Color	State LED2	Color
PROFINET[Note1]	System Fail	*Green/ Red*	Bus Fail	*Red*
EtherNet/IP[Note2]	Module (MS)	*Green/ Red*	Network (NS)	*Green/ Red*

Each Ethernet port got a RJ45 female connector with two indication LED. The green LED signalled the link status and the yellow LED lights the network activity.

2.2.2 Configuration for using Pmod Interface

The Synergy board has two Pmod ports. In case of using Pmod mode, connect jumpers J15 and J13 on the Synergy board to supply 3.3V power supply on the Pmod channel of choice to R-IN32M3 Module.

Before connecting the Synergy board with R-IN32M3 Module board is recommended first to get the Synergy board up and running. To do so, please follow the instructions in the quick start guide manual of that processor board. As soon as the e2-studio ISDE and the Synergy board are working you can continue as described in this manual.

2.2.3 Configuration for using ARDUINO Interface

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

Voltage supply for the Synergy board is done through the micro USB debug connector on the Synergy board. When connection R-IN32M3 Module board in either mode, the shield gets its power through the connectors. All operations for programming (flashing) and debugging of the Synergy S7G2 MCU are supported by this USB connection.

Note1 PROFINET Diagnosis Guideline V1.4 Chapter 6.7 Signaling recommended an additional (third) maintenance LED

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

2.3 Software Requirements

2.3.1 Integrated Software Development Environment “Renesas Synergy”

The development of software for the Synergy MCU – which here acts as application controller - requires an environment consisting of:

— Renesas e2-studio Version 7.5.1
— Renesas Synergy Software Package (SSP) Version 1.7.0

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.

2.3.2 R-IN32M3 Module SW files

Two files are available:

- Goal Library and Headers
- Management Tool

2.3.3 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 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 R-IN32M3 Module and on the application controller (AC) to control the module. In this configuration with Renesas Synergy board and R-IN32M3 Module board the S7G2 MCU on the Renesas Synergy board acts as AC. For details please refer to the User’s Manual for the API.

2.3.4 Management Tool

The Management Tool is a software which simulates a PROFINET master as well as EtherNet/IP scanner on a Windows PC and is a product of Renesas’ cooperation partner *port industrial automation GmbH* in Germany. A detailed manual is available from company *port (https://www.port.de/)*.

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

The file “Management Tool-*-win32.win32.x86_64.zip” has to be unpacked to a local folder. The resulting folder contains the executable *mantool.exe*, which can be started without an installation.

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

Additionally, the Management Tool requires certain settings in the Windows firewall to receive data. To allow the communication to R-IN32M3 Module. And also, if some software (such as antivirus) restricts the firewall of the Network, have to 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”.

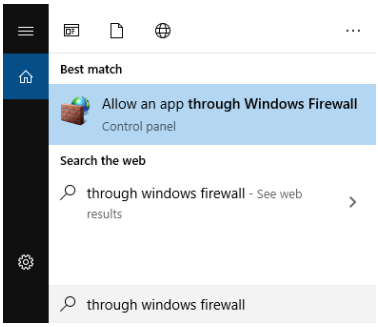


Figure 2: Search Windows firewall

"*Allowed apps"* window open, click "*Change settings*" and then click "*Allow another app..*".

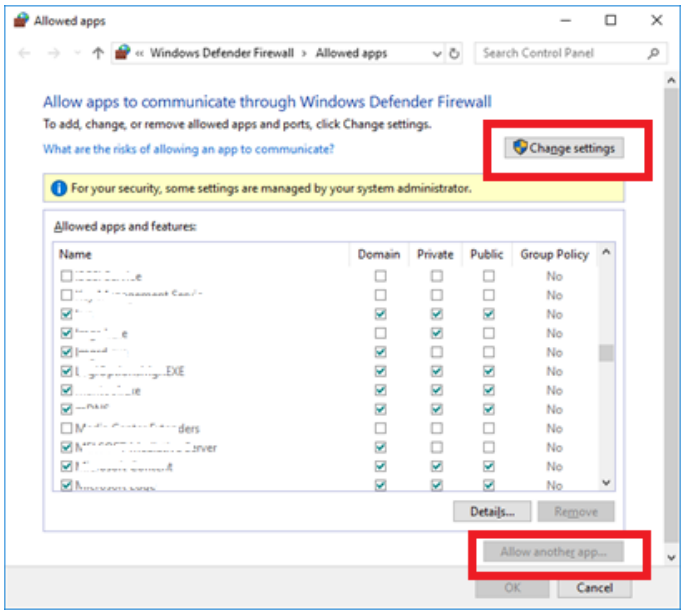
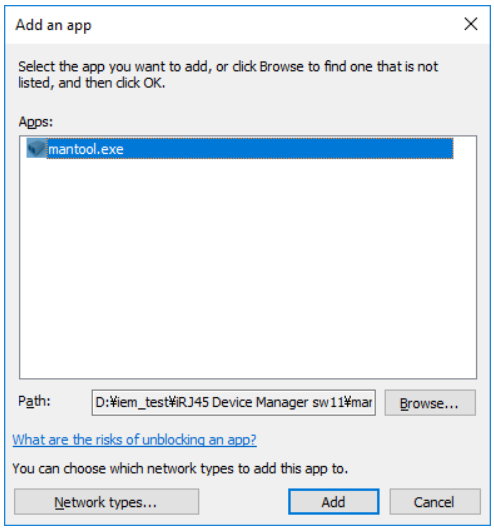


Figure 3: Allowed applications

Click "*Browse..*" and select the "*mantool.exe*" from Management tool folder. Then, click "*Network types…*" and set enabled all network type ("Domain", "Private" and "Public") and click "OK" and "Add".



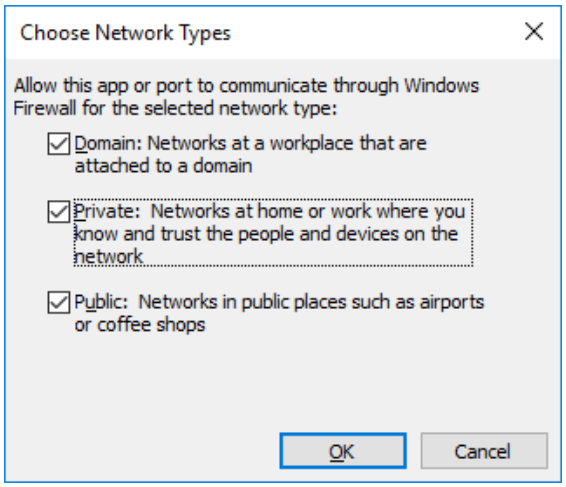


Figure 4: Select Management Tool

“mantool.exe” show on allowed apps list. Then, click “OK”.

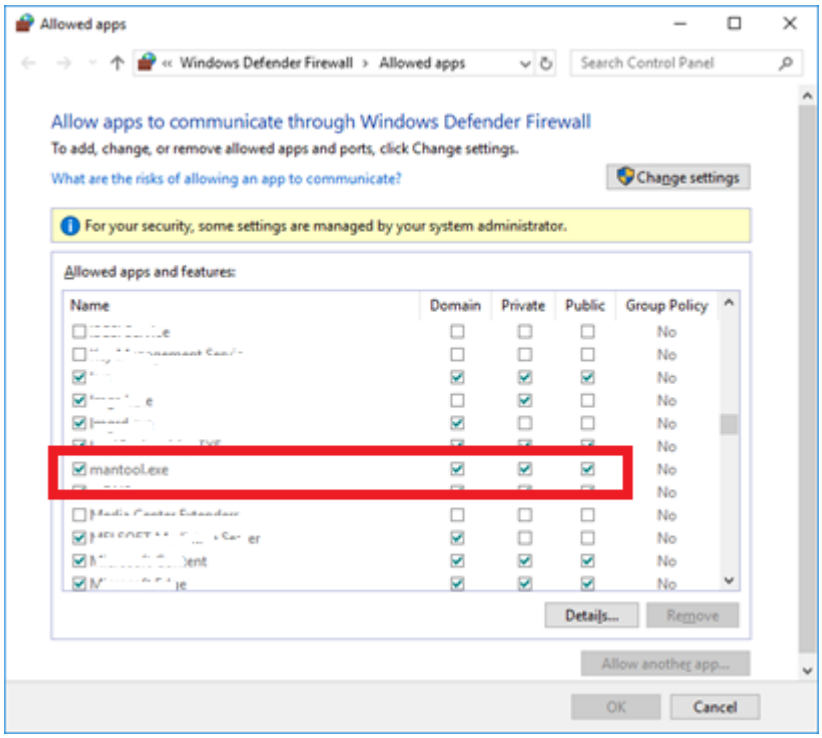


Figure 5: Allowed Management Tool

2.3.5 WinPcap

To use the functionality of the Management Tool, the 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/

2.3.6 Wireshark

The Management Tool also offers a function to create a log file of all relevant parameters of 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.

3. e2studio Project

3.1 Installation

To use the sample projects with the e2studio the correct version of e2studio and SSP must be installed.

3.2 Project Import

The example files provided by Renesas with R-IN32M3 Module starter kit SW (see chapter “5.Examples”) can be imported into the e2-studio ISDE. In the “File” dropdown use the import dialog of 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 import type. This will create new projects in e2-studio.

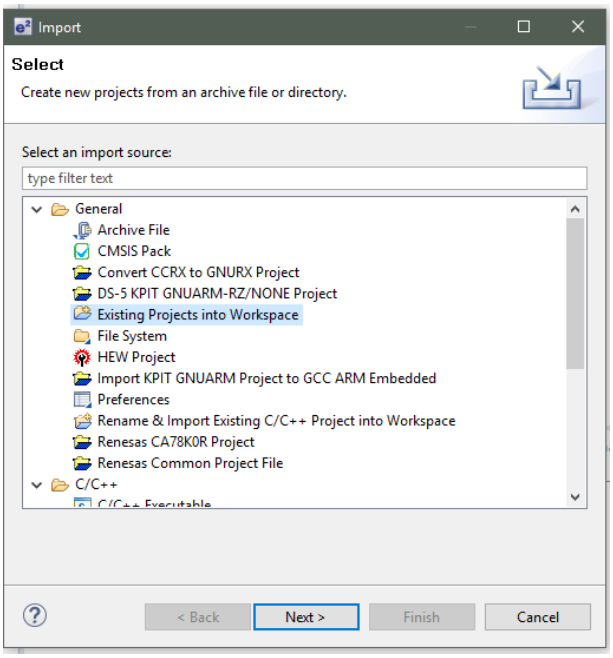


Figure 6: e2studio Import dialog

In the next step the root directory of the existing archive has to be selected by use of the “Browse…” button. Select the directory of the unpacked archive, make sure that all projects are selected in the check-boxes for import and “Finish” import as shown in the figure below. In this example, the unpacked archive files are located in the directory “C:\Renesas_exampleSW”.

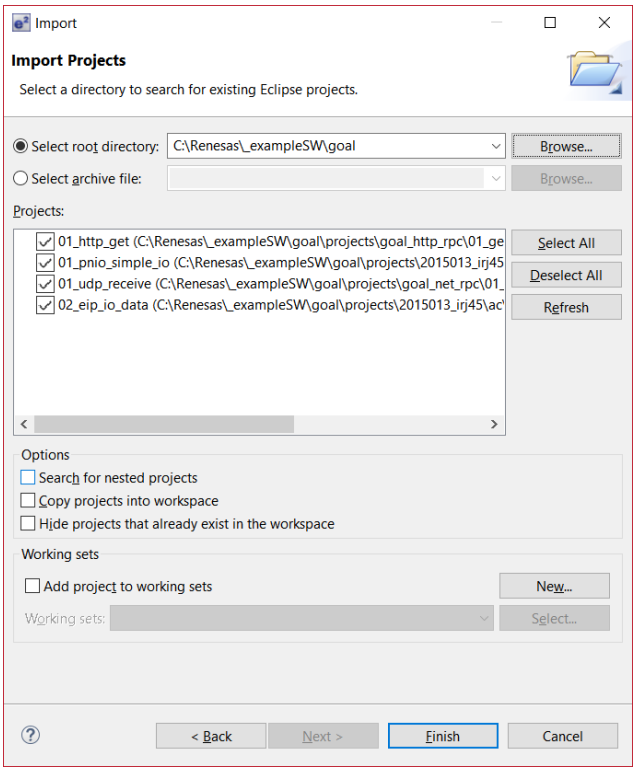


Figure 7: e2-studio import project dialog

3.3 License Register

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

Figure 8: License request

3.4 Generate project Content

Open the *configuration.xml* file from selected project by double clicking. The Pin assignment, Clock configure and Device Selection are already registered, and run “Generate Project Content”.

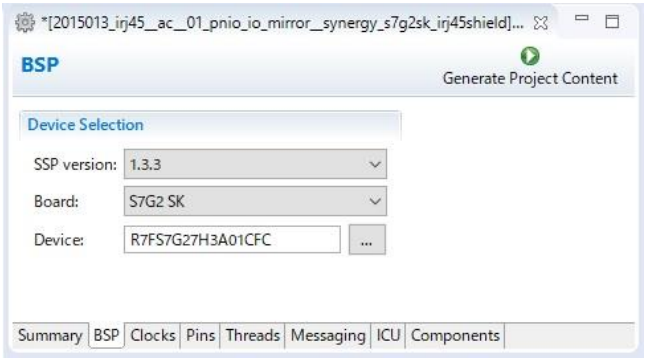


Figure 9: Generate Project Content

3.5 Project Configuration

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 the following screenshot:

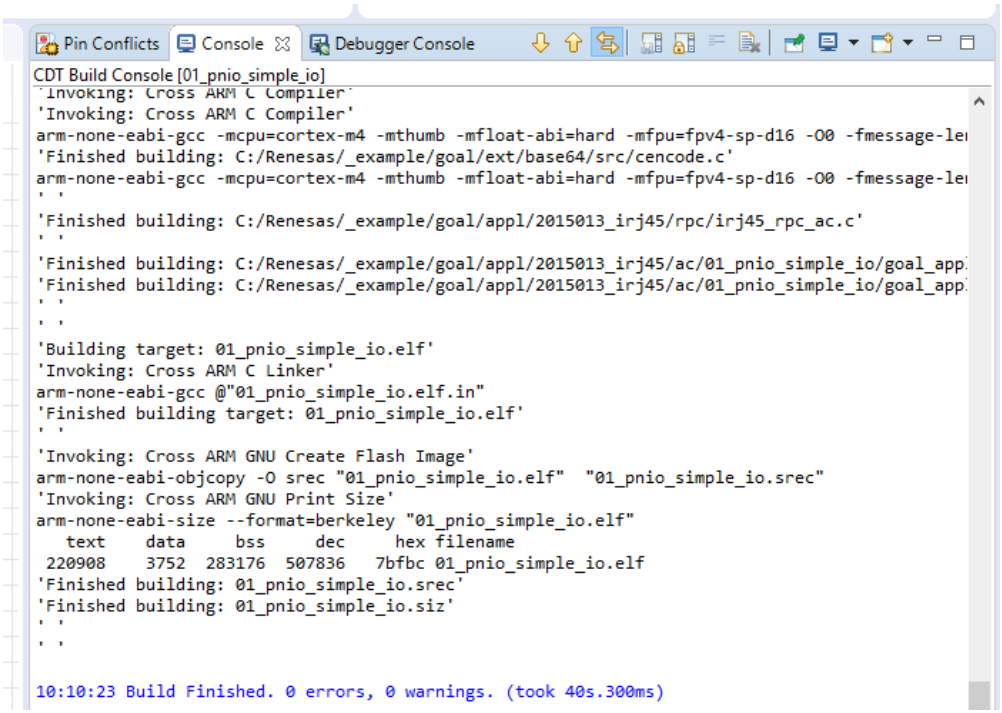


Figure 10: Console log "Build Finished"

3.6 Project Debug

After the Build is finished without errors and warnings, the compilation was successful. The resulting binary 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 item “3 Renesas GDB Hardware Debugging” as shown in the figure below.

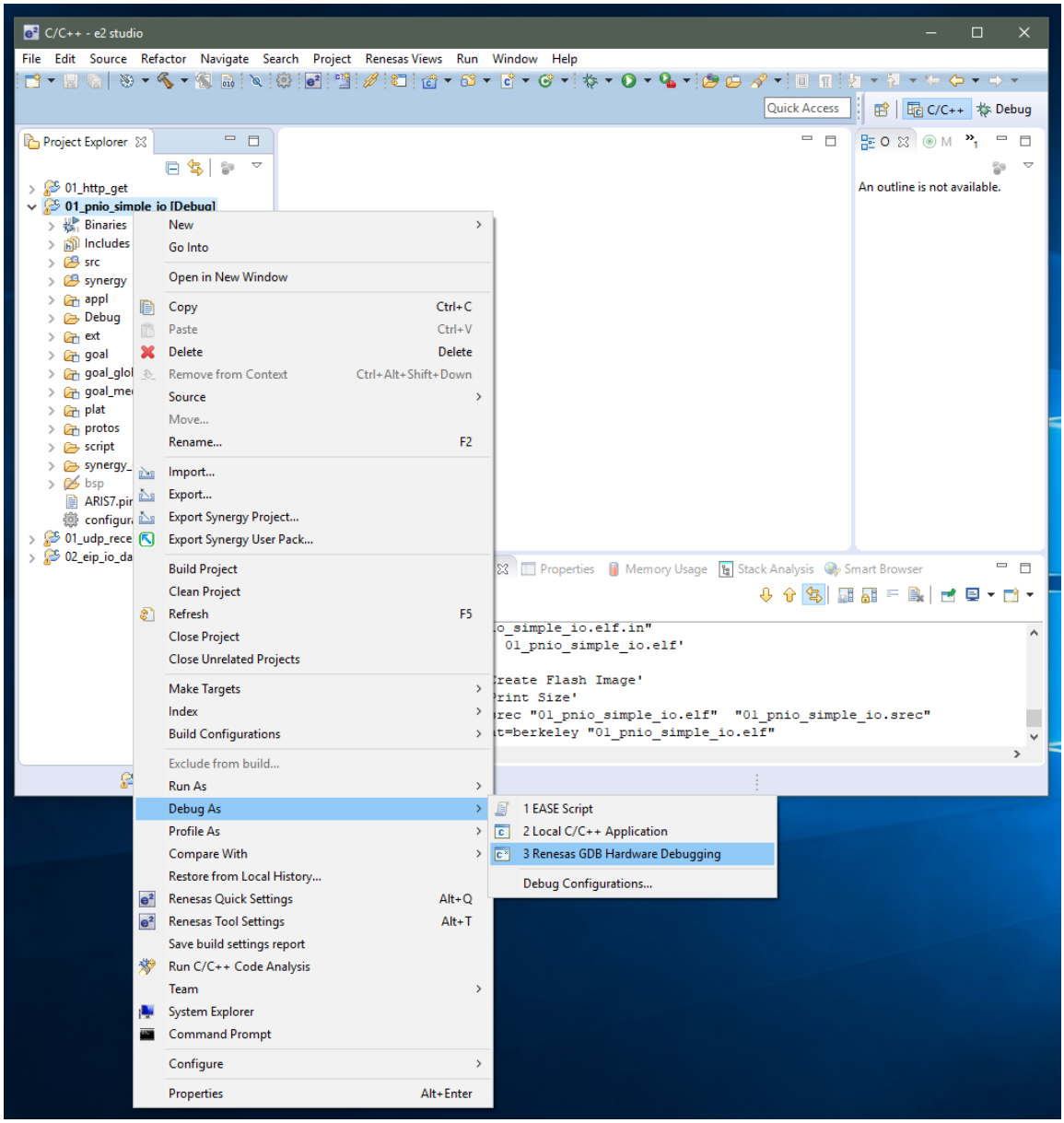


Figure 11: Initiate debug session

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 Debug mode, it is necessary to select chip model (R7F5G26H).

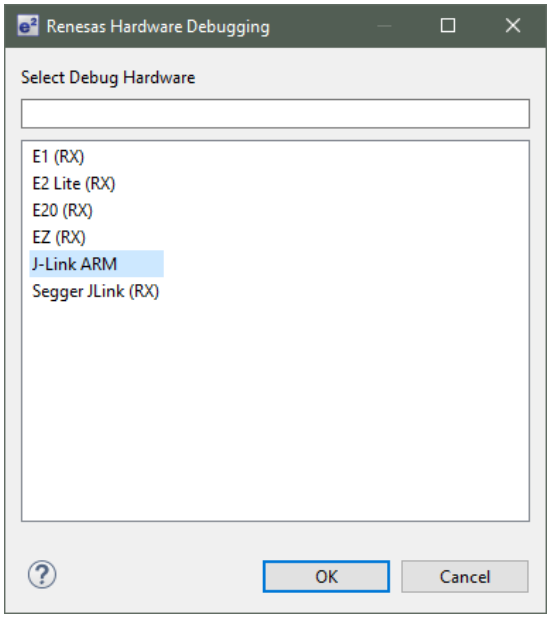


Figure 12: Select Debug Hardware

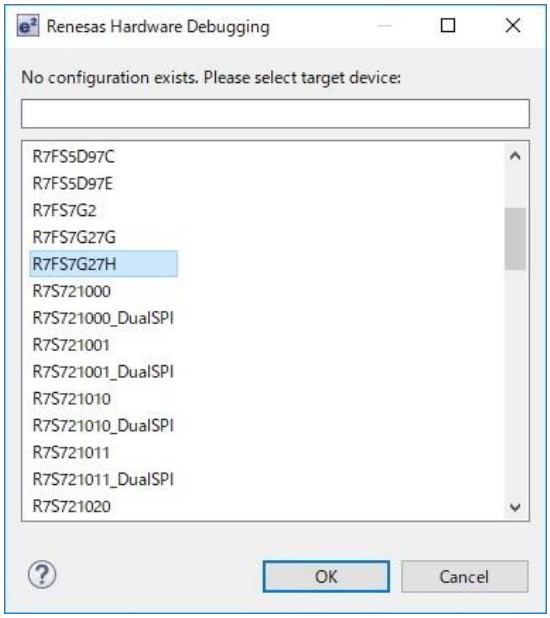


Figure 13: Select Target Device

After initiating the debug session, the “Debug perspective” will be shown, where the application can be started by “Resuming” execution. This needs to be done twice since there are two breakpoints automatically set on startup.

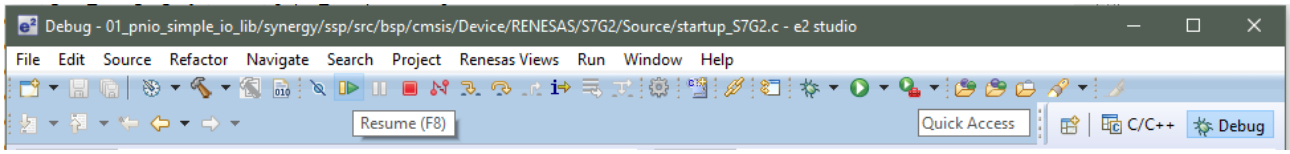


Figure 14: e2studio Toolbox

4. Management Tool

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

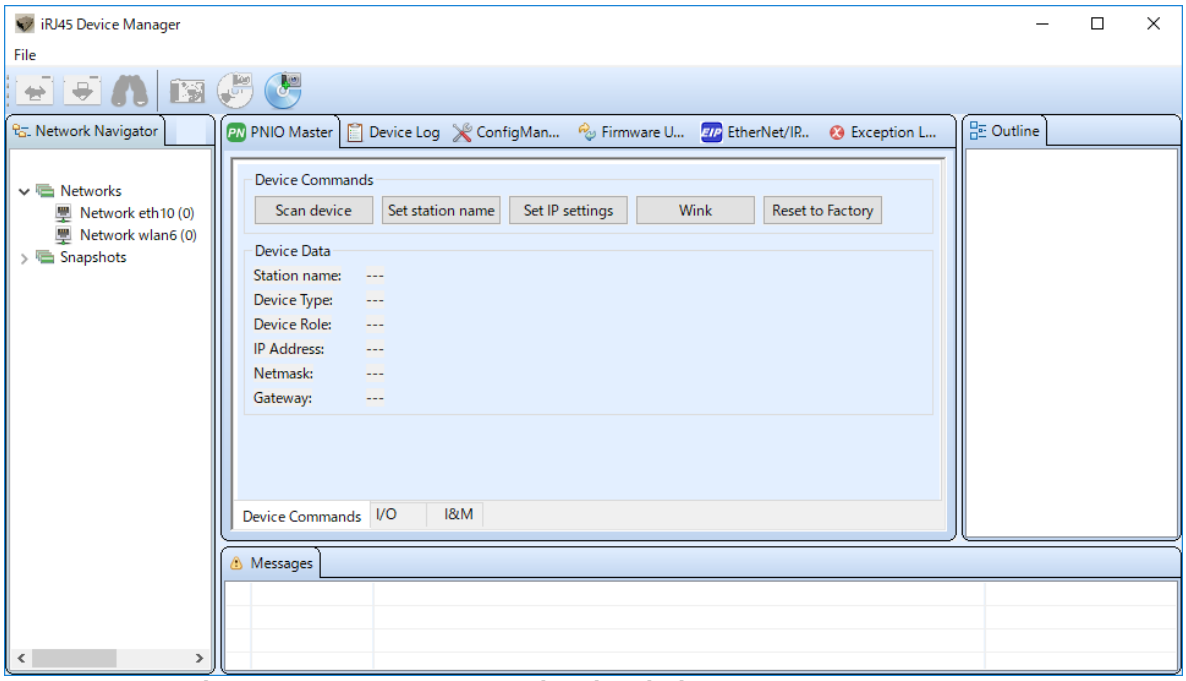


Figure 15: Management Tool main window

This tool is organized in panels.

- The “Network Navigator” shows a list of available networks.
- The panel “Messages” shows information regarding actions.
- The panel “Outline” shows additional information depending on the selected function panel.

Following function panels are available:

Panel	Function
PNIO Master	Simple PROFINET IO master functionality
Device Log	Shows log messages of the running application from both the embedded CC of R-IN32M3 Module and AC on the Synergy board.
Config Manager	Provides access to the config manager variables of R-IN32M3 Module.
Firmware Update	Allows update of the firmware in R-IN32M3 Module.
EtherNet/IP Master	Simple EtherNwet/IP master functionality
Exception Log	not in scope of this manual

4.1 Device Detection

At first a communication needs to be established with R-IN32M3 Module. Thus, connect R-IN32M3 Module to the Ethernet network connector of the PC. Between the management PC and R-IN32M3 Module a

network connection must be possible. For power supply an USB connection is required as well – in this case it is possible to only connect R-IN32M3 Module board without the Renesas Synergy board.

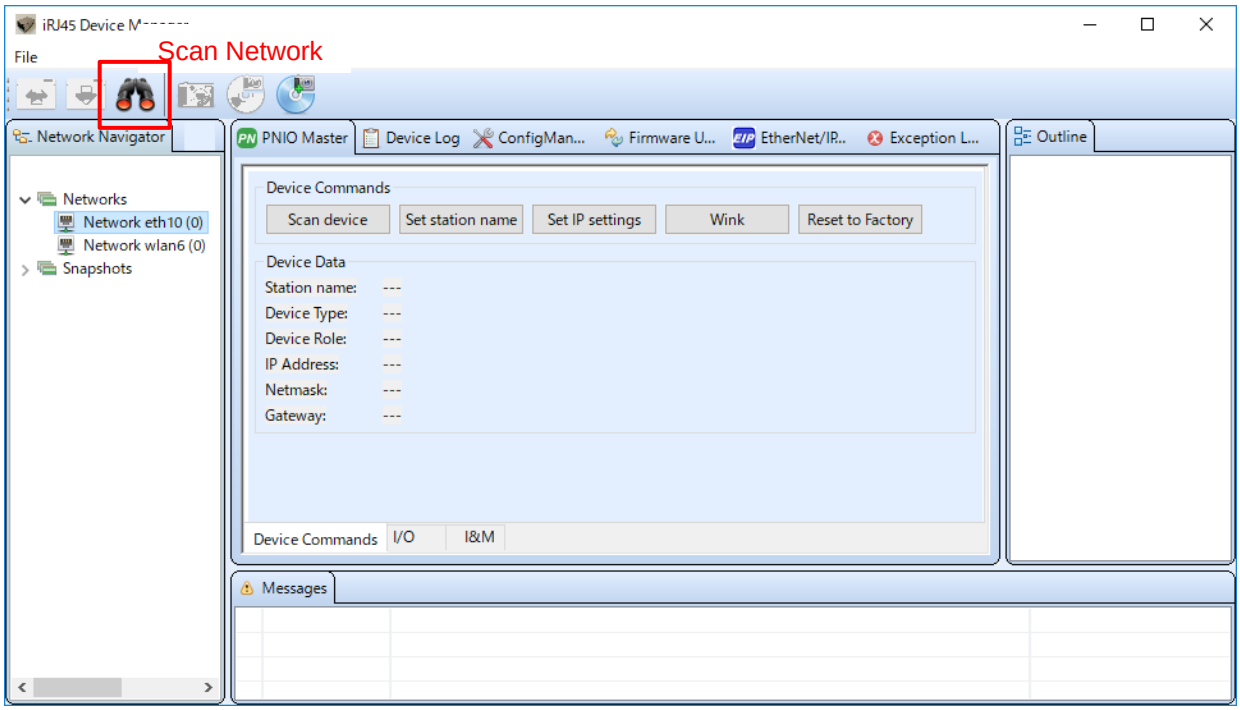


Figure 16: Management Tool network scan

To communicate with R-IN32M3 Module, at first open the “Networks” list in the “Network Navigator”. Chose the network interface where R-IN32M3 Module is reachable. The select the “Scan Network” button in the toolbar.

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

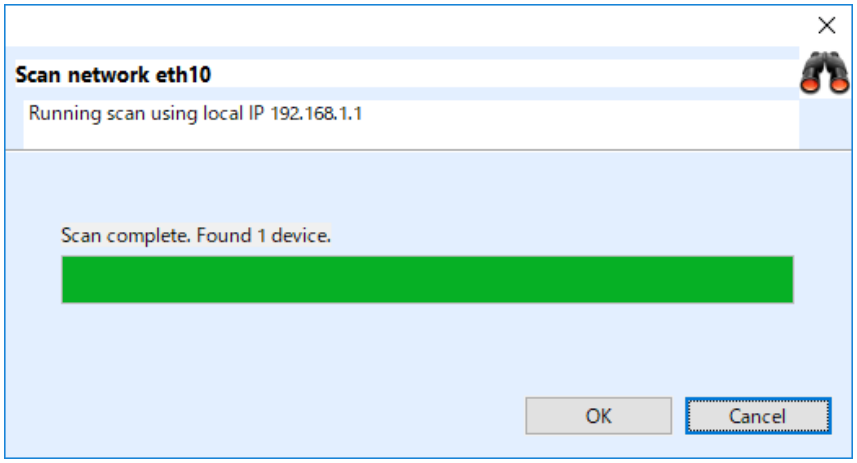


Figure 17: Scan Network dialog

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

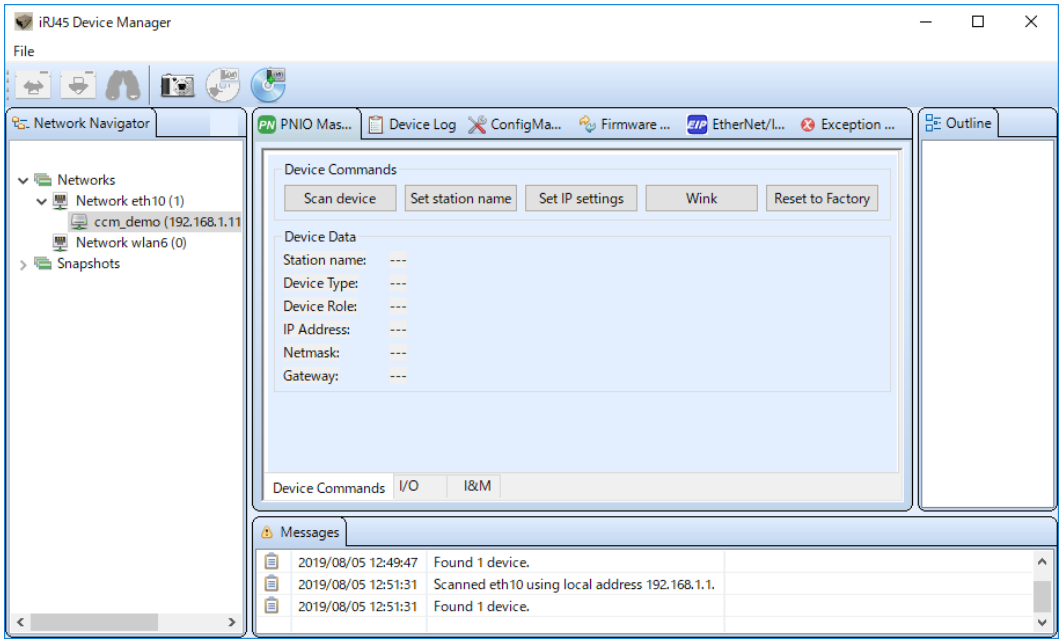


Figure 18: Management Tool with a detected R-IN32M3 Module

Please select the newly found R-IN32M3 module for further steps.

4.2 Config Manager / IP Configuration

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

To read a list of all variables, select the “Read configuration” button.

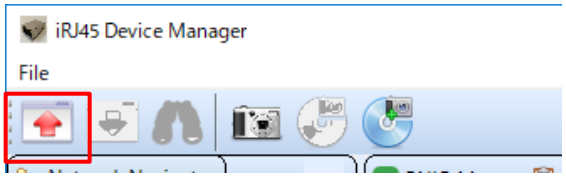


Figure 19: Read configuration

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

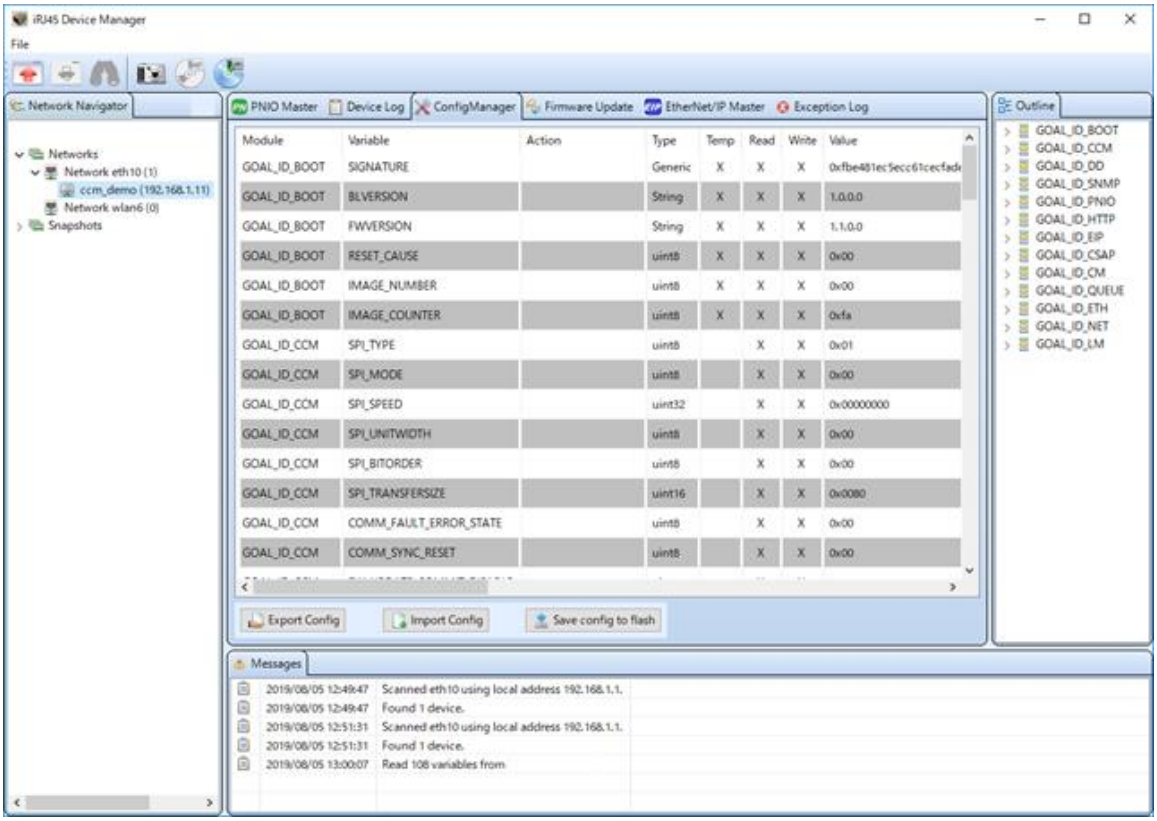


Figure 20: Management Tool Configuration Manager

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

The Management Tool will show locally modified variables with a yellow highlight.

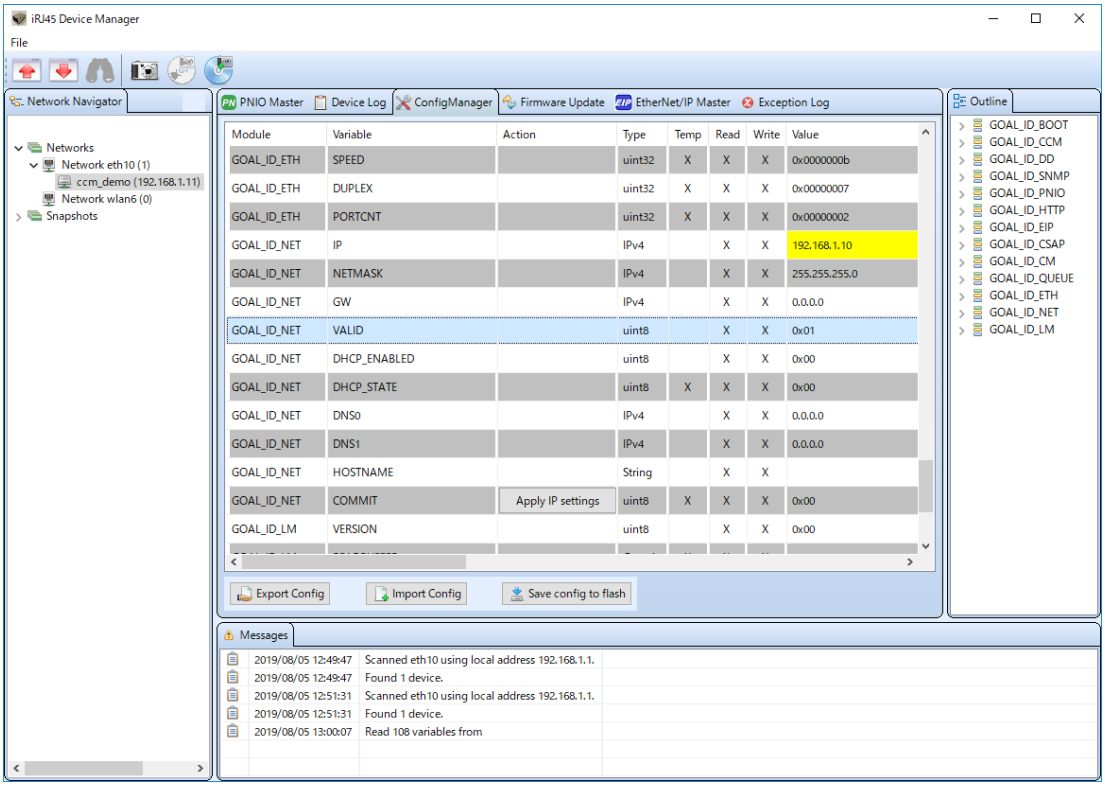


Figure 21: Management Tool with modified variables

Those locally modified variables are downloaded to R-IN32M3 Module using the “Write configuration” button in the toolbar.

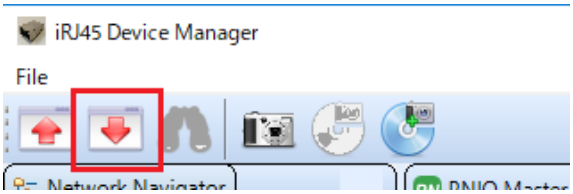


Figure 22: Write configuration

When prompted if changed values shall be written, answer “Yes”. Afterwards the locally modified values are transferred to R-IN32M3 Module, where there are only modified in RAM. To make permanent changes, use the “Save config to flash” button. Modified IP settings are applied after restart of the system (a power off / power on cycle the Renesas Synergy board and R-IN32M3 Module).

4.3 Updating the R-IN32M3 Module Firmware

Under control of the management tool the firmware of the embedded communication controller of R-IN32M3 Module can be updated. The firmware file will be sent via the Ethernet connection.

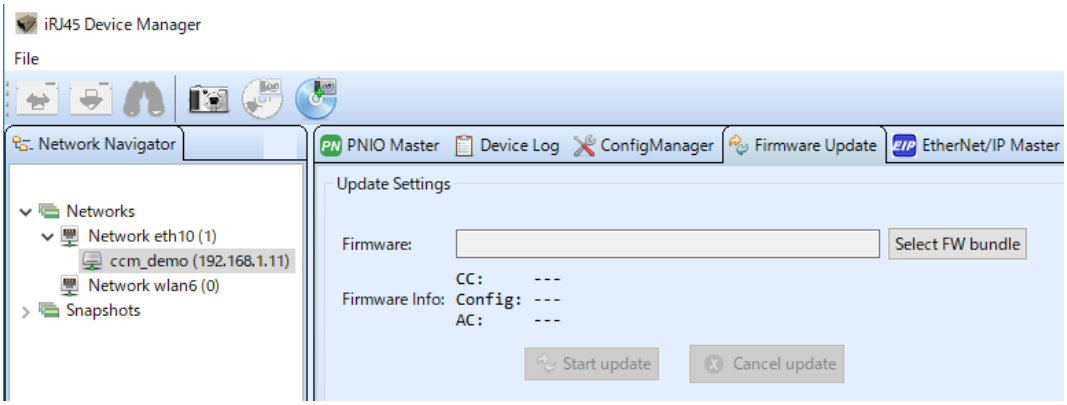


Figure 23: R-IN32M3 Module firmware update

5. Examples

5.1 PROFINET sample application (01_pnio_simple_io)

Please start the example “01_pnio_simple_io” according to the previous description.

To establish a PROFINET communication, at first R-IN32M3 Module must be selected in the “Network Navigator”. Then select the PNIO Master function panel. At first use “Scan device” to detect the PROFINET device.

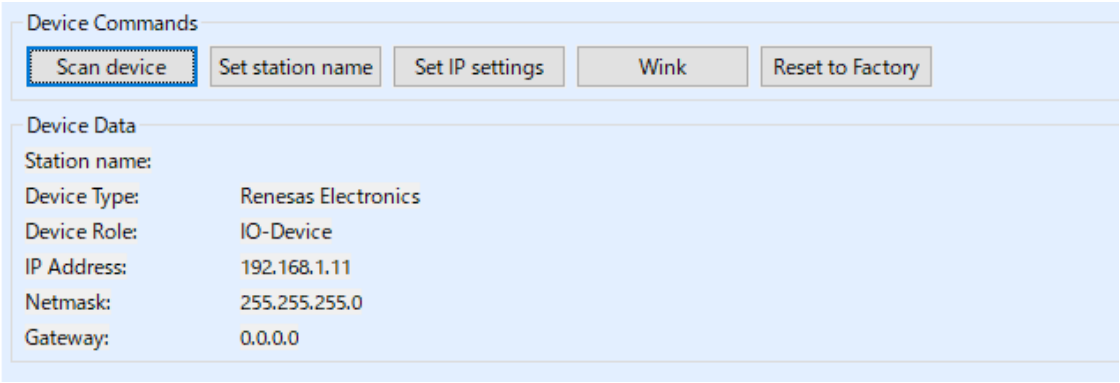


Figure 24: Management PROFINET master

Use the “Wink” command to identify the connected R-IN32M3 Module, which will be shown with a flashing “LED1” on R-IN32M3 Module board.

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

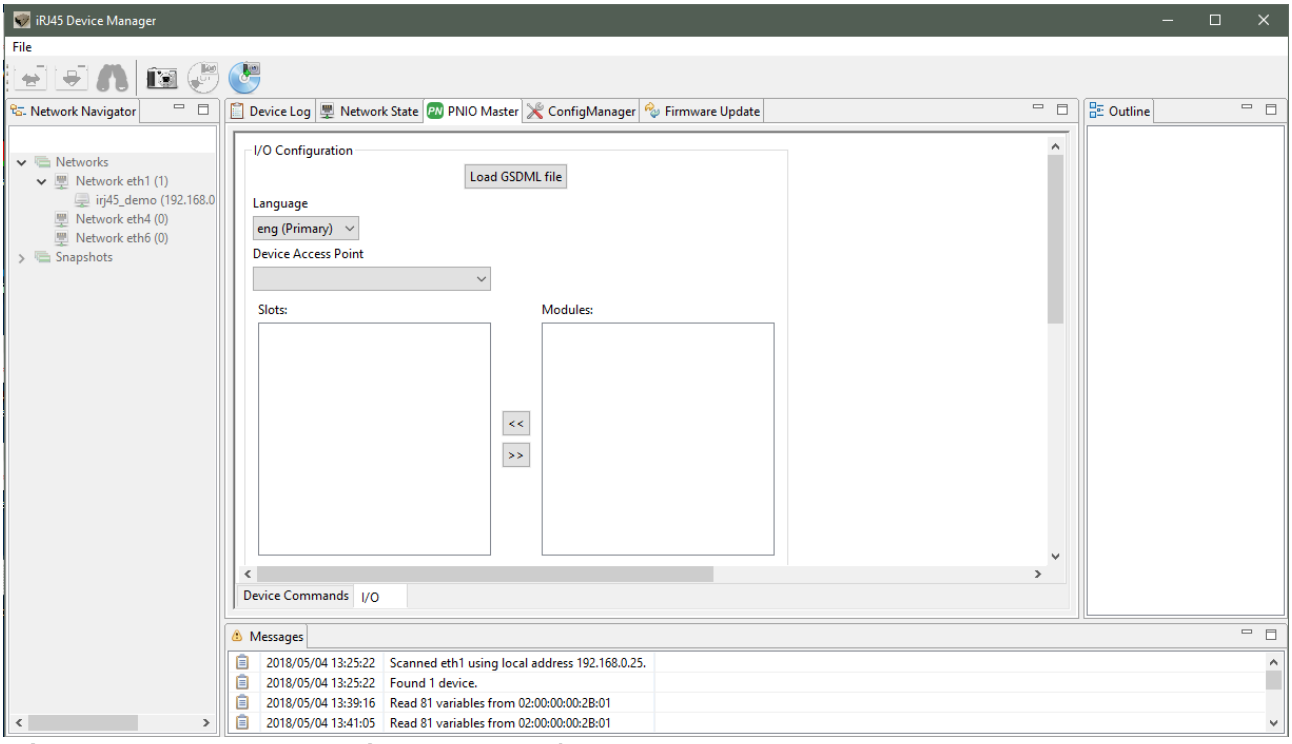


Figure 25: Management Tool PNIO Master I/O

To continue, load the GSDML file provided with the distribution of the Renesas sample application.

In the selector “Device Access Point” select “2-port Device”.

Afterwards press the “Connect” button. This button initiated a cyclic PROFINET communication.

The example application on the application controller will mirror the output data to the input data.

I/O data can be manipulated and monitored in the I/O Data table. Beside that if a connection is established, the “LED1” Led on R-IN32M3 Module board will be enabled.

Process data can be monitored and manipulated using the “IO Data” panel.

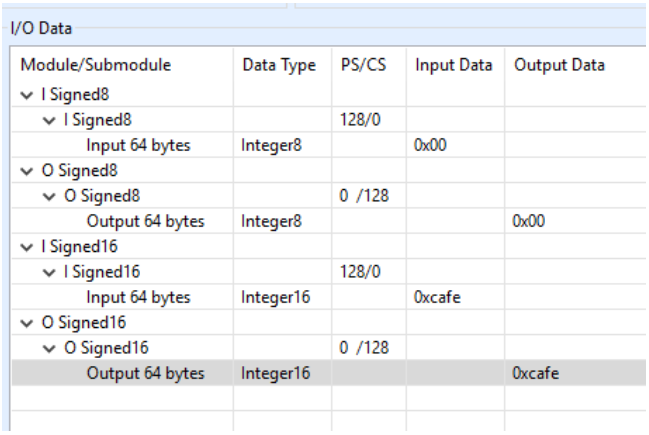


Figure 26: PNIO IO Data panel

5.2 EtherNet/IP sample application (06_eip_io_data_static)

Please start the example “06_eip_io_data_static” according to the previous description.

To establish an EtherNet/IP communication, at first R-IN32M3 Module must be selected in the “Network Navigator”. Then select the “EtherNet/IP Master” function panel. At first use “Scan device” to detect the EtherNet/IP device.

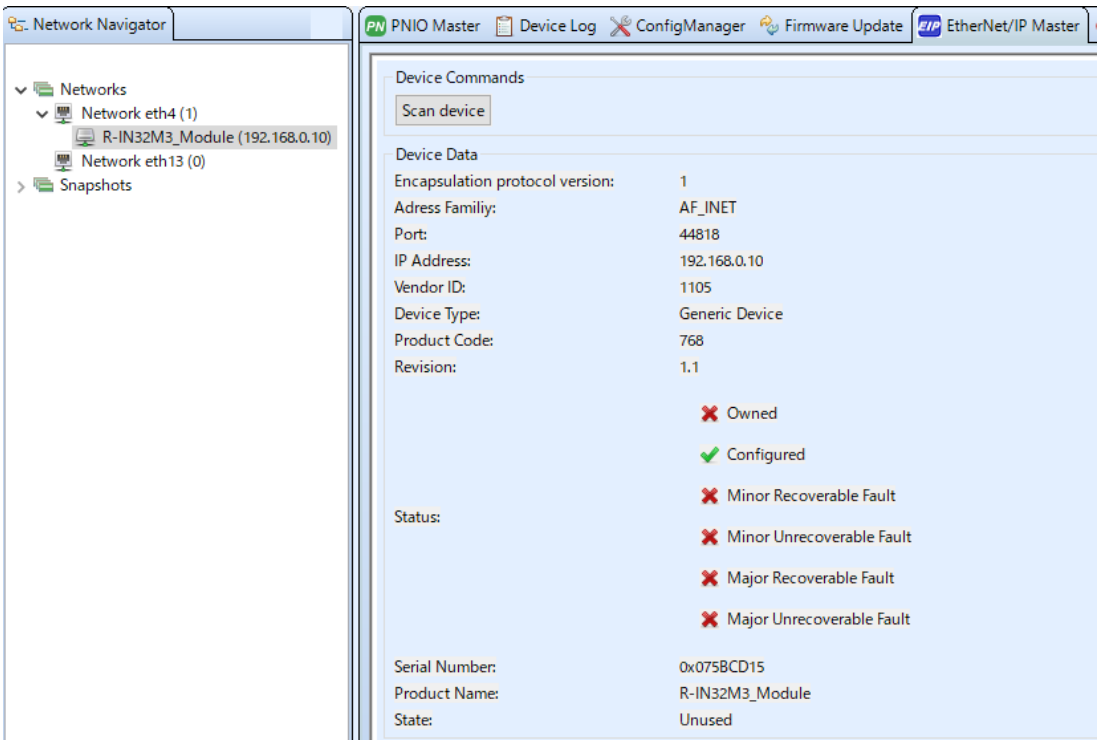


Figure 27: Management Tool EtherNet/IP scanner – Device Scan

To establish an EtherNet/IP communication with the device, IP settings must be set according to the previous description. You can verify the current settings using the Management Tool.

To establish a cyclic EtherNet/IP communication use the I/O panel of the EtherNet/IP scanner.

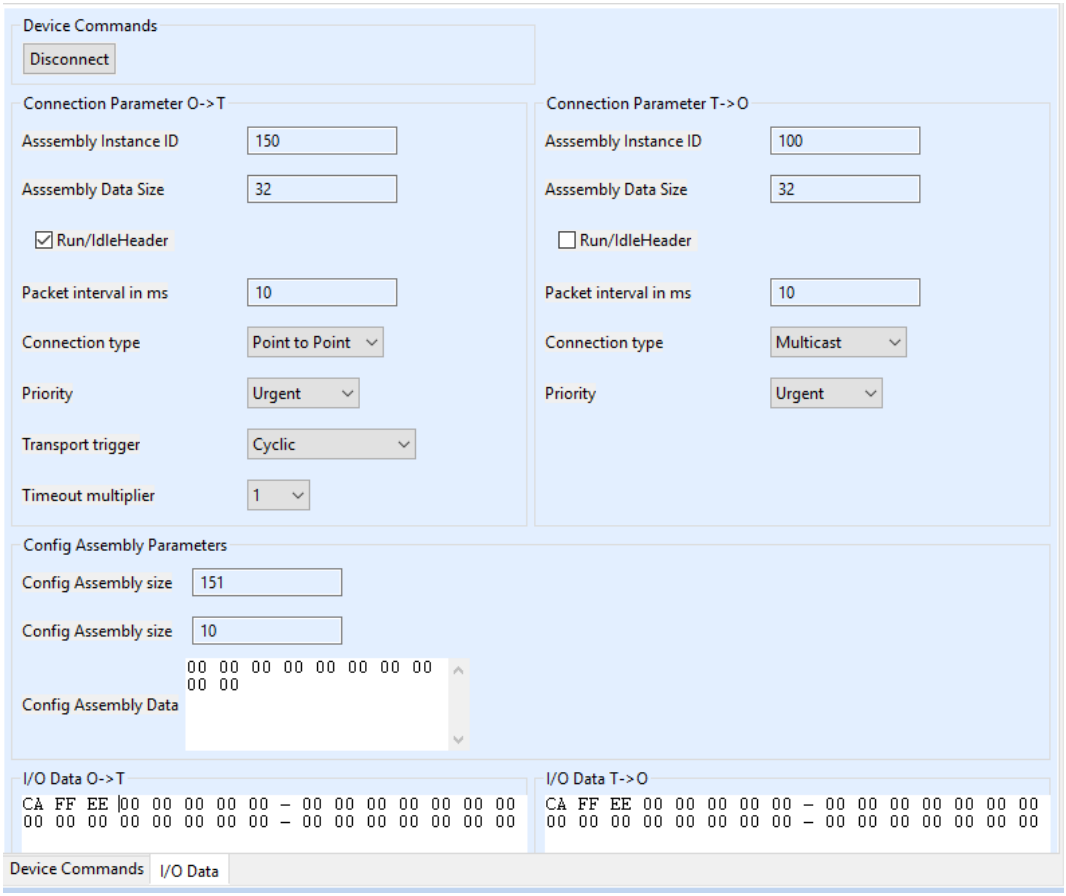


Figure 28: Management Tool EtherNet/IP scanner - Configuration

Default settings are compatible with the example. Press the “Connect” button. This button initiated a cyclic EtherNet/IP communication.

The example application on the application controller will mirror the output data to the input data.

I/O data can be manipulated and monitored in the I/O Data tables. Beside that if a connection is established, the “LED1” and “LED2” Leds on R-IN32M3 Module board will both be green.

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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