RZ/N2L Group

R01AN7181EJ0100
Rev.1.00
Nov.30.2023

RZ/N2L Industrial Network SOM Kit Application Note: OPC UA Server

Introduction

This document describes sample software for running OPC UA server on RZ/N2L.

Target Device

RZ/N2L

Contents

List of Abbreviations and Acronyms

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

Terms	Description
FSP	Flexible Software Package
SOM Kit	RZ/N2L Industrial Network SOM Kit
OPC UA	Open Platform Communications Unified Architecture
XML	Extensible Markup Language

Related documents

Document Type	Document Title	Document No.
Data Sheet	RZ/N2L Group Datasheet	R01DS0397EJ****
User’s Manual	RZ/N2L Group User's Manual: Hardware	R01UH0955EJ****
User’s Manual	RZ/N2L Industrial Network SOM Kit User’s Manual	R12UT0020ED****
Application Note	RZ/N2L Group TCP/IP lwIP Sample Program Package	R01AN6588EJ****

1. Overview

1.1 Abstract

OPC UA, which enables interoperability of industrial applications, is becoming widely used not only in factory automation but also in various industries.

This document describes the sample software configuration and its usage to realize OPC UA server on RZ/N2L, which are the RZ processor for industrial networks.

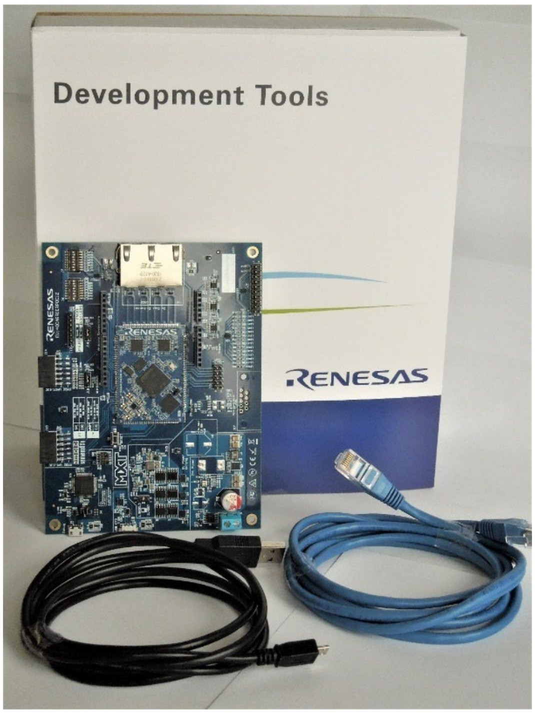


Fig 1-1 RZ/N2L Industrial Network SOM Kit

1.2 Operating Environment

1.2.1 Software Environment

The operating environment of this sample software is shown in Table 1-1.

Table 1-1 Operating Environment

Category	Name	Version	Link	Remarks
RZ/N2L OPC UA server sample software	Sample Package	1.0.1		
IDE	e^2 studio	23.4.0	https://github.com/renesas/rzn-fsp/releases/download/v1.2.0/setup_rznfsp_v1_2_0_e2s_v2023-04.exe	Included with e^2 studio installer
Flexible Software Package	FSP	1.2.0		Included with e^2 studio installer
GNU Arm Embedded Toolchain	GCC Toolchain	V9.3.1.20200408 (*1)		Included with e^2 studio installer
OPC UA Client Tool	UaExpert	1.7.1	OPC UA Clients - Unified Automation (unified-automation.com)	
Packet analyzer	Wireshark	4.0.7	Wireshark · Download	

(*1). V10.3.1.20210824 is also installed when installing e^2 studio, but we recommend using V9.3.1.20200408.

1.2.2 Hardware Environment

This sample software is tested under the hardware environment of Table 1-2.

Table 1-2 Hardware Environment

Name	Type Name	Maker	Link	Note
RZ/N2L Industrial Network SOM Kit	YCONNECT-IT-RZN2L	Renesas Electronics	www.renesas.com/yconnect-it-rzn2l	SOM Kit

2. Hardware configuration

This section describes the hardware configuration of executing the sample software.

2.1 Board Settings

When executing the sample software, configure the SOM Kit settings in Fig 2-1.

- SW1: ON
- J2: 2-3 Short: Use SD-RAM as external memory

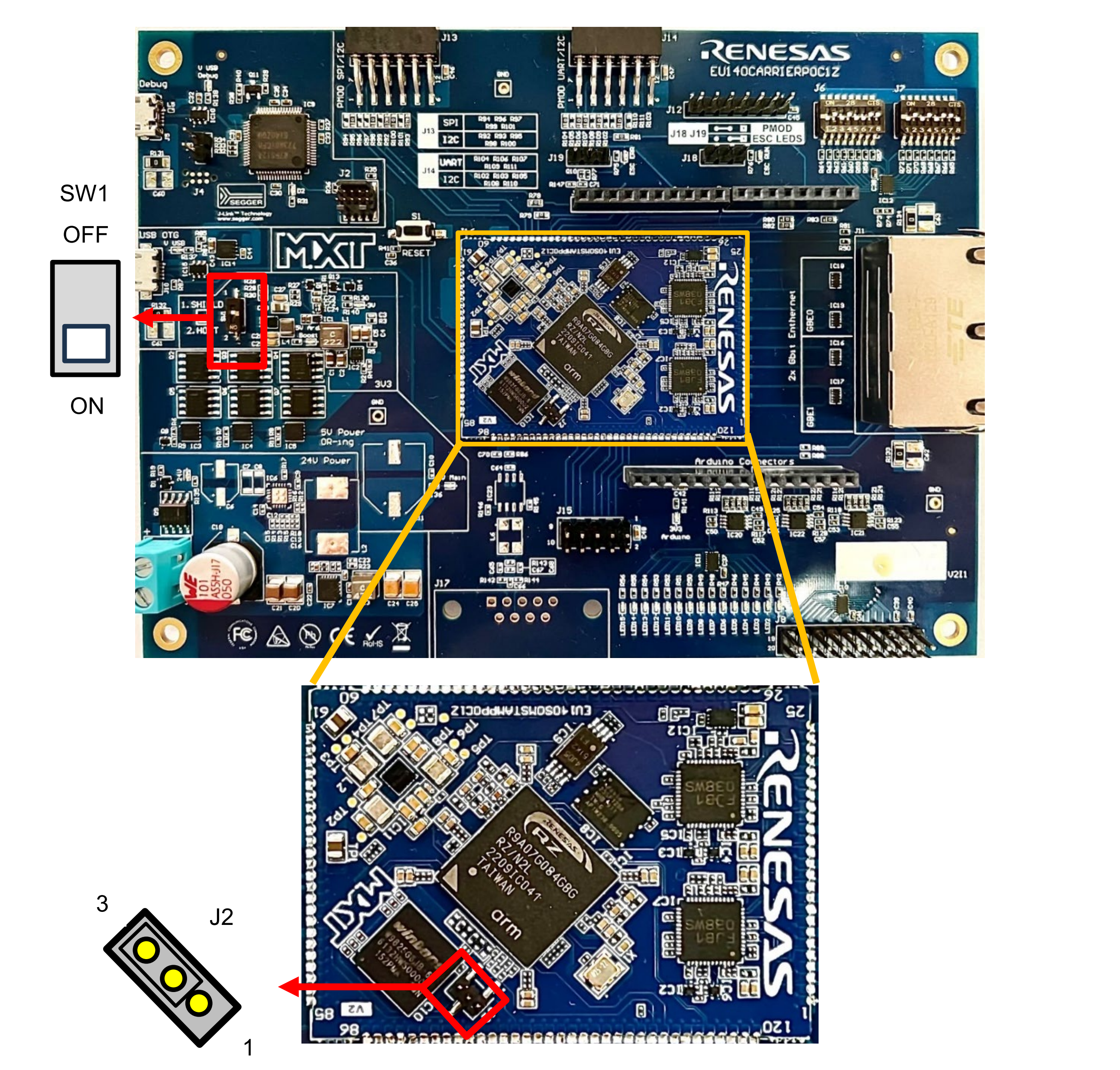


Fig 2-1 Board Configuration

3. Sample Software

This chapter describes the structure and usage of the sample software.

3.1 Folder structure

The folder structure of the sample software is shown below. As a guide, the bolded text indicates folders containing files that users will customize with this sample software.

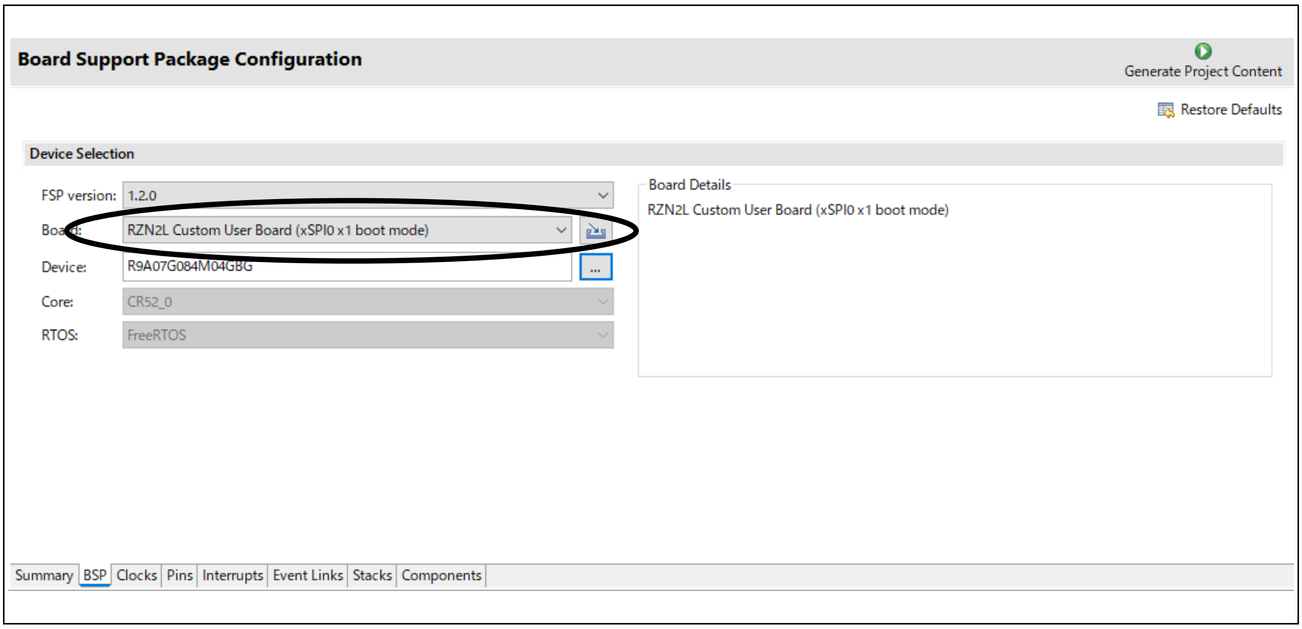
```
e2studio1
├─OPC_UA_SERVER              open62541
├─rzn                        RZ
│   ├─arm                    ARM
│   │   └─CMSIS_5            CMSIS
│   ├─aws                    AWS
│   │   └─amazon-freertos    FreeRTOS
│   ├─board                  Board
│   │   └─custom             Custom Board
│   └─fsp                    Flexible Software Package
├─rzn_cfg                    Configuration
│   ├─aws                    AWS
│   └─fsp_cfg                FSP
│      └─bsp                 Board Support Package
├─rzn_gen                    Generated files
├─script                     Linker Script
├─src                        User Thread Entry
└─user                       User files
   ├─oss                     Other OSS
   │   ├─amazon-freertos     AWS_OSS
   │   └─lwip                lwIP_OSS
   └─renesas                 Renesas common files
      ├─application          User lwIP application, User OPC UA application
      ├─module               User module
      └─oss_deps             OSS dependencies
```

Fig 3-1 Folder Structure

3.2 Boot Sequence

Describes the boot procedure and memory allocation.

The boot mode of this sample software is xSPI0 x1 boot mode. The figure below shows the BSP tag in the Smart Configurator.



Board Support Package Configuration

Device Selection

FSP version: 1.2.0

Board: RZN2L Custom User Board (xSPI0 x1 boot mode)

Device: R9A07G084M04GBG

Core: CR52_0

RTOS: FreeRTOS

Board Details

RZN2L Custom User Board (xSPI0 x1 boot mode)

Fig 3-2 Boot mode

After downloading the program to the flash memory, the board operates independently by pressing the RESET button on the SOM Kit or turning the power ON without a debugger connection. You can still connect the debugger for evaluation.

3.3 OPC UA Stack

3.3.1 OPC UA

OPC UA was developed by the OPC Foundation as an open communication standard to realize secure and reliable data exchange for various industries including the industrial automation field. OPC Classic, the predecessor of OPC UA, was Windows-based, but OPC UA is now multi-platform and able to run on various platforms from Windows systems including cloud computing to RTOS for field devices.

This sample software implements the open source open62541 protocol stack on FreeRTOS, which is provided as sample software for RZ/N2L.

3.3.2 Information Model

To achieve interoperability among vendors and industries, OPC UA provides a unified data model called the “Information Model” in xml file format. It includes built-in models commonly used in OPC UA, companion models used by each industry or organization, and vendor-specific models that can be customized by each vendor. (Fig 3-3)

In this sample software, the .xml file of the information model is converted to C language code. For details, please refer to chapter 5.1.

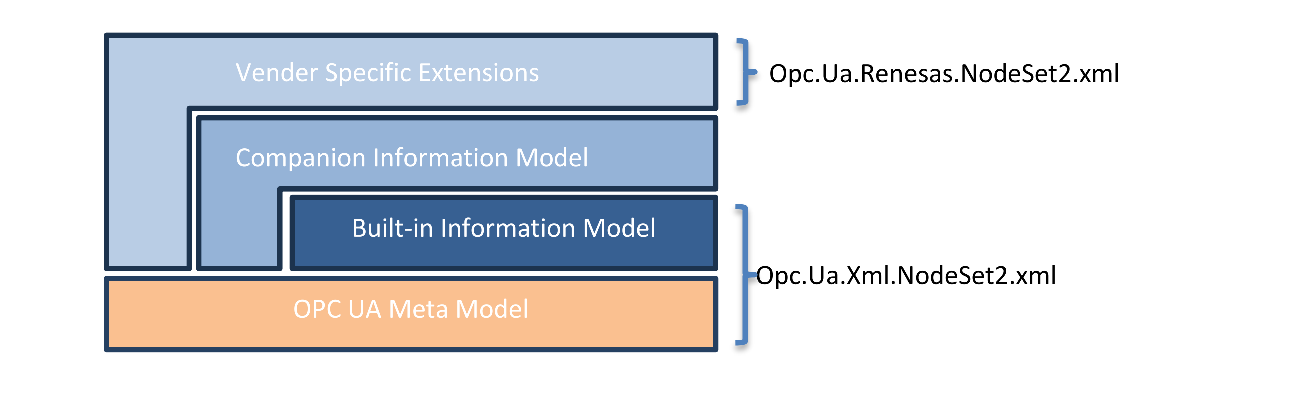

Vender Specific Extensions
Opc.Ua.Renesas.NodeSet2.xml
Companion Information Model
Built-in Information Model
Opc.Ua.Xml.NodeSet2.xml
OPC UA Meta Model

Fig 3-3 Information Model

(1) Opc.Ua.Xml.NodeSet2.xml

It provides the "Meta Model", which is a set of rules for describing the OPC UA information model, and the "Built-in Information Model", which is the basic information model of OPC UA described by the Meta Model.

In this sample software, the following versions are applied.

The OPC UA XML version 1.05.01 (UA-Nodeset/XML/Opc.Ua.Xml.NodeSet2.xml at d1bb6a22125bd7cd986272b1ee98a18a91d76fff · OPCFoundation/UA-Nodeset · GitHub)

(2) Opc.Ua.Renesas.NodeSet2.xml

This is one of the information models made for this sample software. The OPC UA modeler "SiOME" is used for creation. For details, please refer to the following link.

Siemens OPC UA Modeling Editor (SiOME) - ID: 109755133 - Industry Support Siemens

3.3.3 open62541

This sample software adopts the open source open62541 as the protocol stack for the OPC UA server. For more information on open62541, refer to the following Link.

open62541

(1) Version

Base version of open62541 in this sample software is the following.

Base Version : v1.3.4-564-gb7e5e49f3

(commit b7e5e49f32d00490be74c2eacef892c7fbd0be60)

(2) License

The license terms for the open62541 are MPL v2.0.

Please refer https://www.mozilla.org/en-US/MPL/2.0/ for more information and comply with the license terms and conditions.

(3) open62541 files

To run open62541 in the environment of freeRTOS + LwIP, the method to generate open62541.c and open62541.h files using CMake as described in the following link is applied

Building open62541 — open62541 1.3.0-dirty documentation

For more information, please refer to chapter 5.1 in the Appendix.

3.3.4 Restrictions

The released version V1.0.x of this sample software has the following restrictions.

- ✓ Not supported for security certificates.
- ✓ Not supported for NTP client.

3.4 Installation of Development Environment

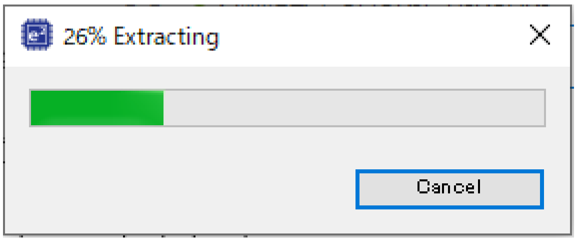
3.4.1 e^2 studio

3.4.1.1 Install

Download the version listed in Table 1-1 and install it on your PC. The latest version has a downloadable installer that includes FSP, e^2 studio, and the GCC toolchain as a single package.

Note) Replace the version in the following figures to be installed version.

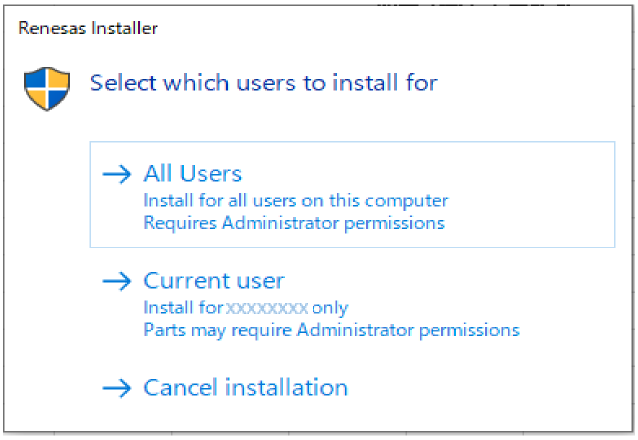
・Double-click the downloaded “setup_rz*fsp_v1_2_0_e2s_v2023-04.exe”.



26% Extracting

Fig 3-4 e^2 studio Install (1)

・Select Users



Renesas Installer

Select which users to install for

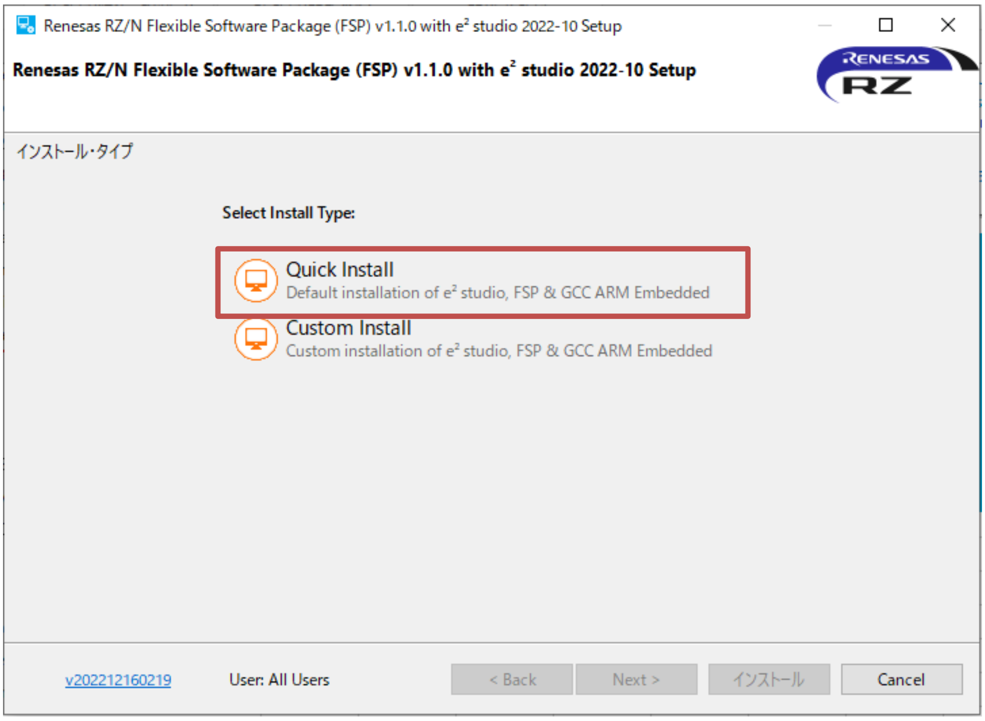
→ All Users
Install for all users on this computer
Requires Administrator permissions

→ Current user
Install for xxxxxxxx only
Parts may require Administrator permissions

→ Cancel installation

Fig 3-5 e^2 studio Install (2)

- Select Install Type



Renesas RZ/N Flexible Software Package (FSP) v1.1.0 with e^2 studio 2022-10 Setup

Renesas RZ/N Flexible Software Package (FSP) v1.1.0 with e^2 studio 2022-10 Setup

インストール･タイプ

Select Install Type:

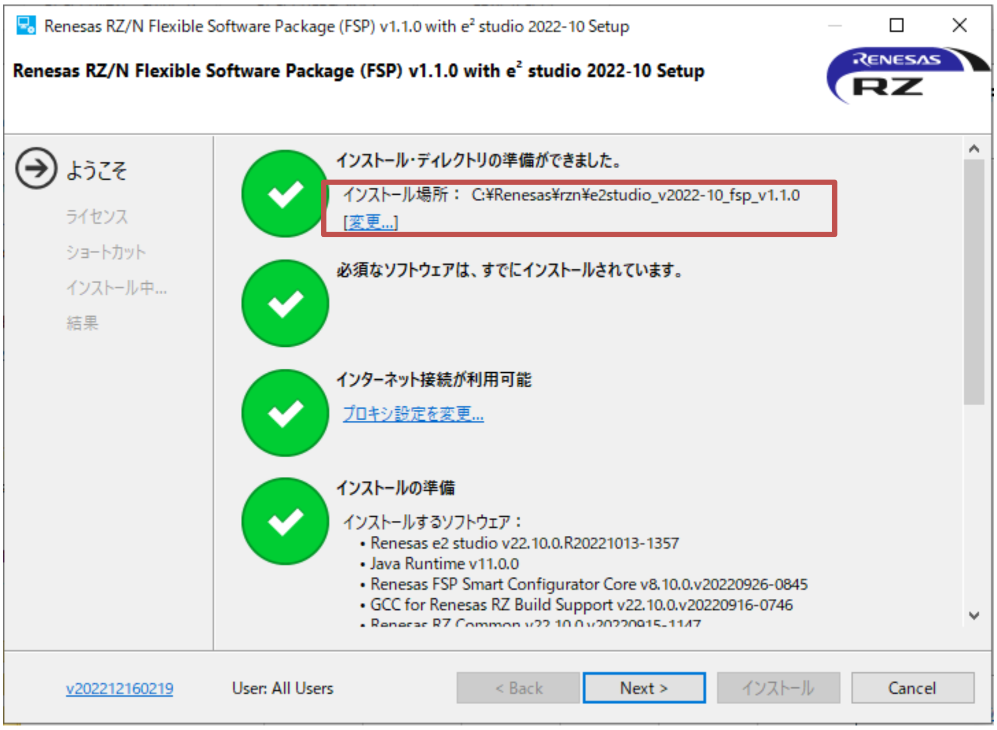
Quick Install
Default installation of e^2 studio, FSP & GCC ARM Embedded

Custom Install
Custom installation of e^2 studio, FSP & GCC ARM Embedded

v202212160219 User: All Users

Fig 3-6 e^2 studio Install (3)

- Select Install folder



Renesas RZ/N Flexible Software Package (FSP) v1.1.0 with e^2 studio 2022-10 Setup

Renesas RZ/N Flexible Software Package (FSP) v1.1.0 with e^2 studio 2022-10 Setup

インストール･ディレクトリの準備ができました。
インストール場所： C:¥Renesas¥rzn¥e2studio_v2022-10_fsp_v1.1.0
[変更...]

必須なソフトウェアは、すでにインストールされています。

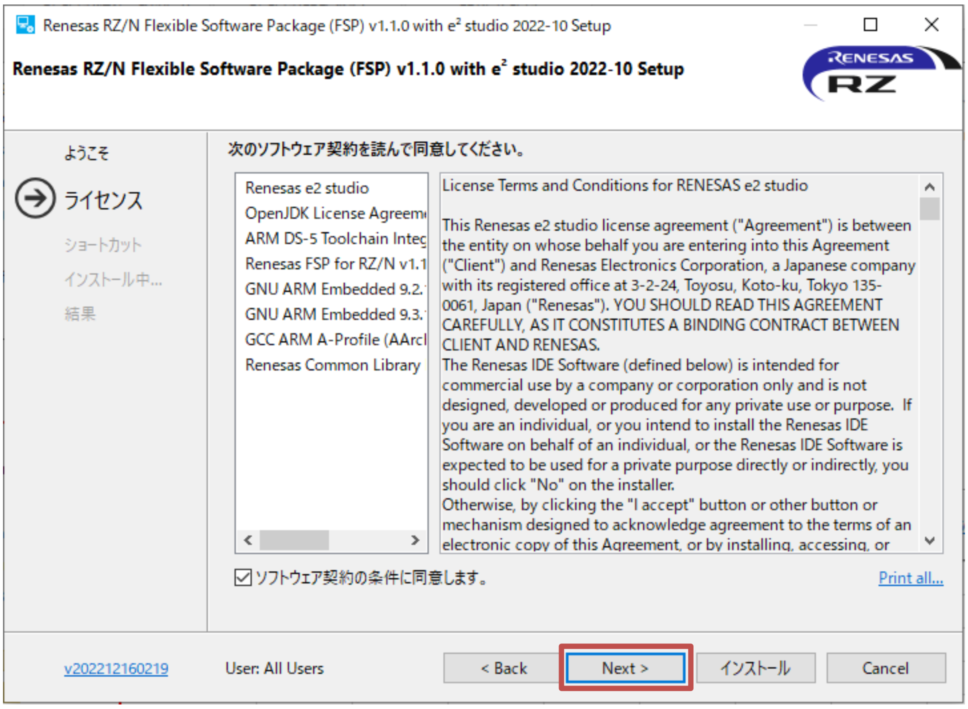
インターネット接続が利用可能
プロキシ設定を変更...

インストールの準備
インストールするソフトウェア：
- Renesas e2 studio v22.10.0.R20221013-1357
- Java Runtime v11.0.0
- Renesas FSP Smart Configurator Core v8.10.0.v20220926-0845
- GCC for Renesas RZ Build Support v22.10.0.v20220916-0746
- Renesas RZ Common v22.10.0.v20220915-1147

v202212160219 User: All Users

Fig 3-7 e^2 studio Install (4)

・Check and Click “Next”



Renesas RZ/N Flexible Software Package (FSP) v1.1.0 with e^2 studio 2022-10 Setup

Renesas RZ/N Flexible Software Package (FSP) v1.1.0 with e^2 studio 2022-10 Setup

次のソフトウェア契約を読んで同意してください。

Renesas e2 studio
OpenJDK License Agreem
ARM DS-5 Toolchain Integ
Renesas FSP for RZ/N v1.1
GNU ARM Embedded 9.2.
GNU ARM Embedded 9.3.
GCC ARM A-Profile (AArcl
Renesas Common Library

License Terms and Conditions for RENESAS e2 studio

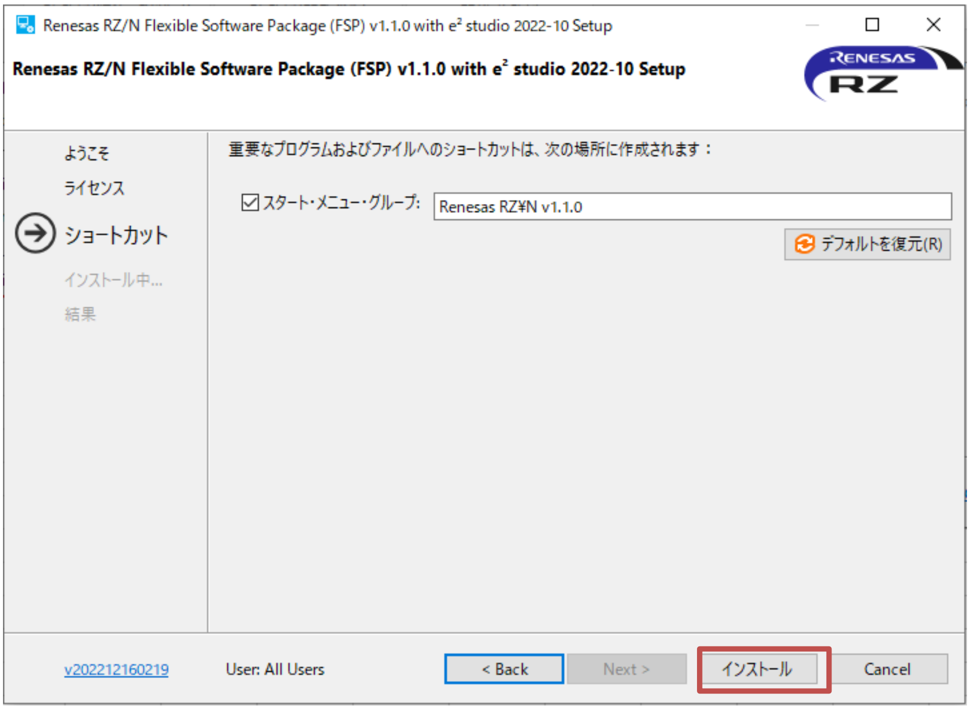
This Renesas e2 studio license agreement ("Agreement") is between the entity on whose behalf you are entering into this Agreement ("Client") and Renesas Electronics Corporation, a Japanese company with its registered office at 3-2-24, Toyosu, Koto-ku, Tokyo 135-0061, Japan ("Renesas"). YOU SHOULD READ THIS AGREEMENT CAREFULLY, AS IT CONSTITUTES A BINDING CONTRACT BETWEEN CLIENT AND RENESAS.
The Renesas IDE Software (defined below) is intended for commercial use by a company or corporation only and is not designed, developed or produced for any private use or purpose. If you are an individual, or you intend to install the Renesas IDE Software on behalf of an individual, or the Renesas IDE Software is expected to be used for a private purpose directly or indirectly, you should click "No" on the installer.
Otherwise, by clicking the "I accept" button or other button or mechanism designed to acknowledge agreement to the terms of an electronic copy of this Agreement, or by installing, accessing, or

☑ソフトウェア契約の条件に同意します。

v202212160219 User: All Users

Fig 3-8 e^2 studio Install (5)

・Click “Install”



Renesas RZ/N Flexible Software Package (FSP) v1.1.0 with e^2 studio 2022-10 Setup

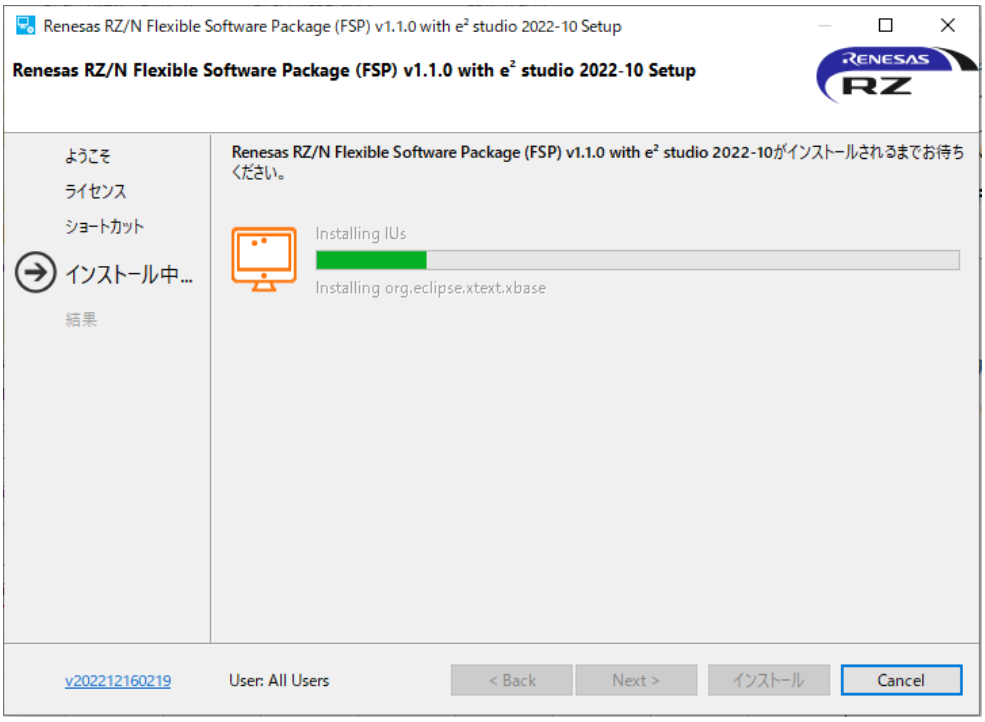
Renesas RZ/N Flexible Software Package (FSP) v1.1.0 with e^2 studio 2022-10 Setup

重要なプログラムおよびファイルへのショートカットは、次の場所に作成されます：

☑スタート・メニュー・グループ: Renesas RZ¥N v1.1.0

v202212160219 User: All Users

Fig 3-9 e^2 studio Install (6)



Renesas RZ/N Flexible Software Package (FSP) v1.1.0 with e² studio 2022-10 Setup

Renesas RZ/N Flexible Software Package (FSP) v1.1.0 with e² studio 2022-10 Setup

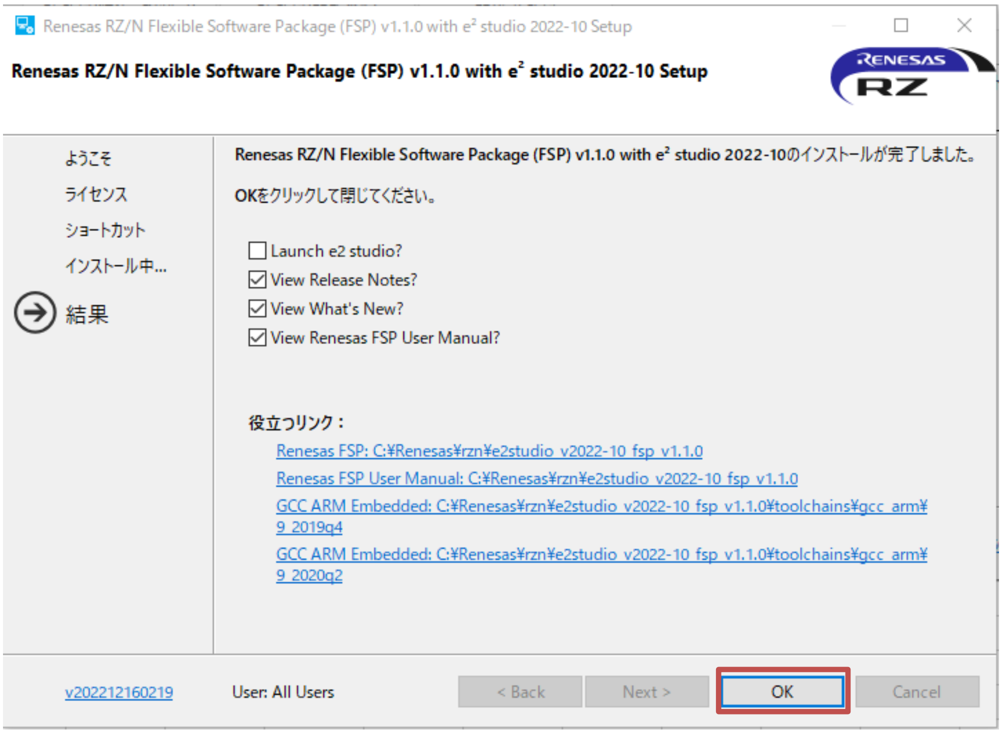
Renesas RZ/N Flexible Software Package (FSP) v1.1.0 with e² studio 2022-10がインストールされるまでお待ちください。

Installing IUs

Installing org.eclipse.xtext.xbase

Fig 3-10 e^2 studio Install (7)

・Click “OK”



Renesas RZ/N Flexible Software Package (FSP) v1.1.0 with e² studio 2022-10 Setup

Renesas RZ/N Flexible Software Package (FSP) v1.1.0 with e² studio 2022-10 Setup

Renesas RZ/N Flexible Software Package (FSP) v1.1.0 with e² studio 2022-10のインストールが完了しました。

OKをクリックして閉じてください。

□ Launch e2 studio?
☑ View Release Notes?
☑ View What's New?
☑ View Renesas FSP User Manual?

役立つリンク：

Renesas FSP: C:¥Renesas¥rzn¥e2studio_v2022-10_fsp_v1.1.0
Renesas FSP User Manual: C:¥Renesas¥rzn¥e2studio_v2022-10_fsp_v1.1.0
GCC ARM Embedded: C:¥Renesas¥rzn¥e2studio_v2022-10_fsp_v1.1.0¥toolchains¥gcc_arm¥9_2019q4
GCC ARM Embedded: C:¥Renesas¥rzn¥e2studio_v2022-10_fsp_v1.1.0¥toolchains¥gcc_arm¥9_2020q2

Fig 3-11 e^2 studio Install (8)

3.4.1.2 Project start-up

(1) Unzip package

First, unzip the archived sample software package and store it in any folder. Because e^2 studio cannot recognize project properly if file path is too long in the folder hierarchy, place it in shorter path. Also, do not use multi-byte character, such as Japanese, in the folder path.

(2) Execute e^2 studio

Execute "e2studio.exe" to start e^2 studio in the following folder (default case) installed:

\Renesas\rzn\e2studio_v2023-04_fsp_v1.2.0\eclipse¥e2studio.exe

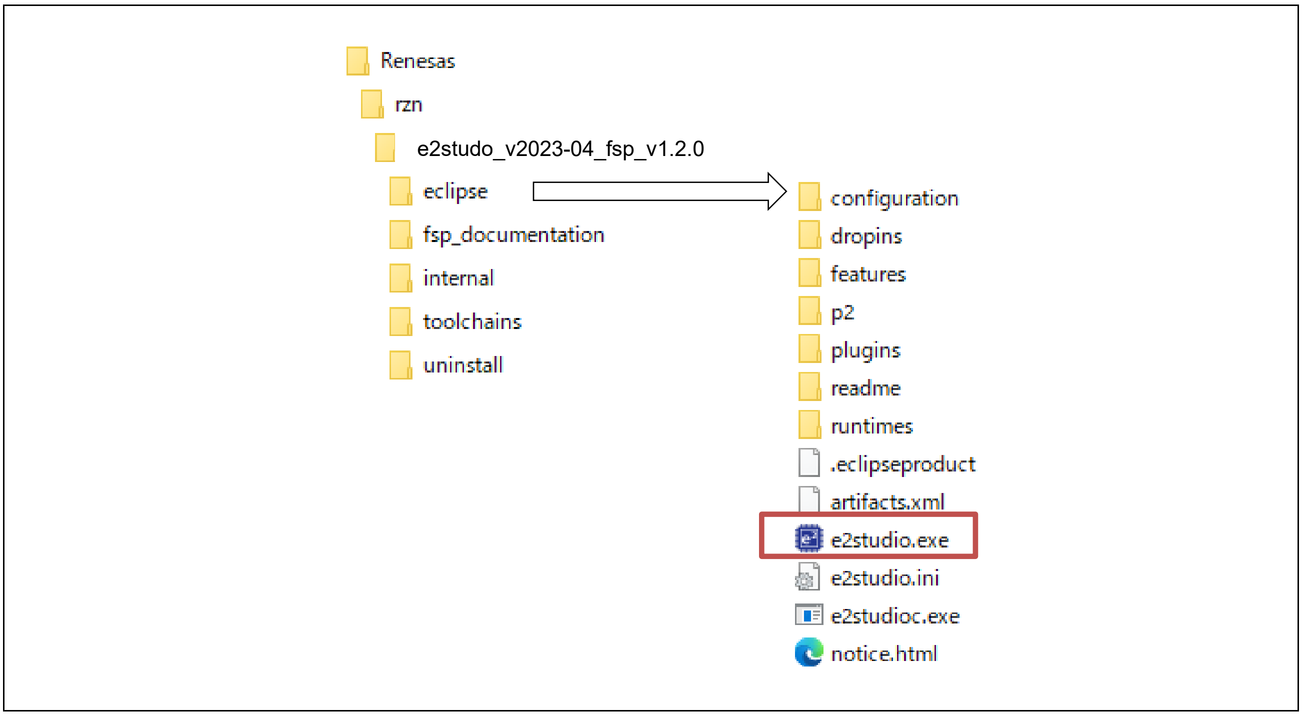
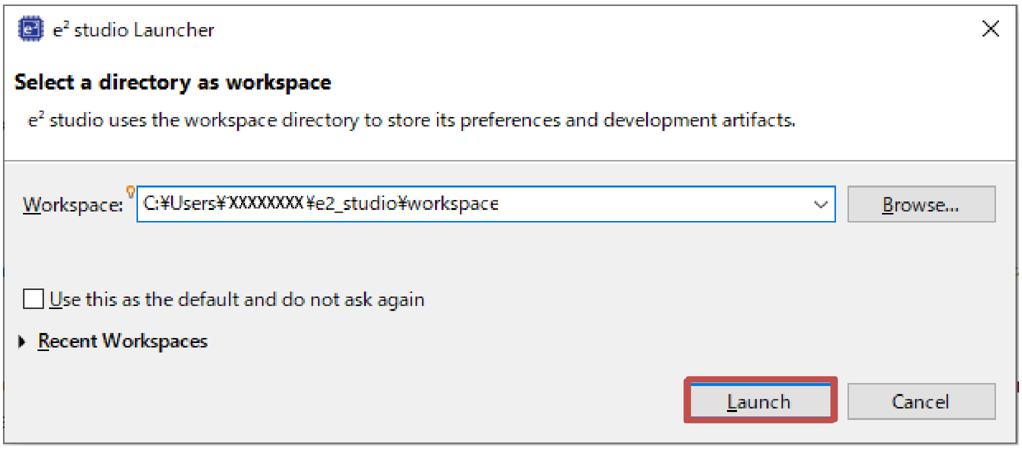


Fig 3-12 Launch project (1)

(3) Import Project

Enter any workspace directory and click “Launch”.



e² studio Launcher

Select a directory as workspace

e² studio uses the workspace directory to store its preferences and development artifacts.

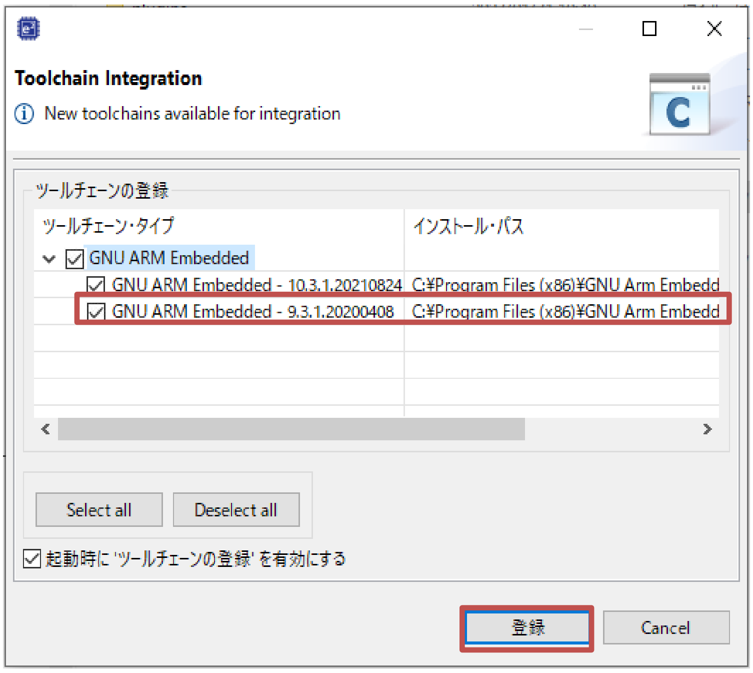
Workspace: C:¥Users¥XXXXXXXX¥e2_studio¥workspace

☐ Use this as the default and do not ask again

Recent Workspaces

Fig 3-13 Launch project (2)

Select the toolchain “GNU ARM Embedded – 9.3.1.20200408”



Toolchain Integration

New toolchains available for integration

ツールチェーンの登録

ツールチェーン・タイプ	インストール・パス
☑ GNU ARM Embedded	
☑ GNU ARM Embedded - 10.3.1.20210824	C:¥Program Files (x86)¥GNU Arm Embedd
☑ GNU ARM Embedded - 9.3.1.20200408	C:¥Program Files (x86)¥GNU Arm Embedd

☑ 起動時に 'ツールチェーンの登録' を有効にする

Fig 3-14 Launch project (3)

・Select “Import existing projects”

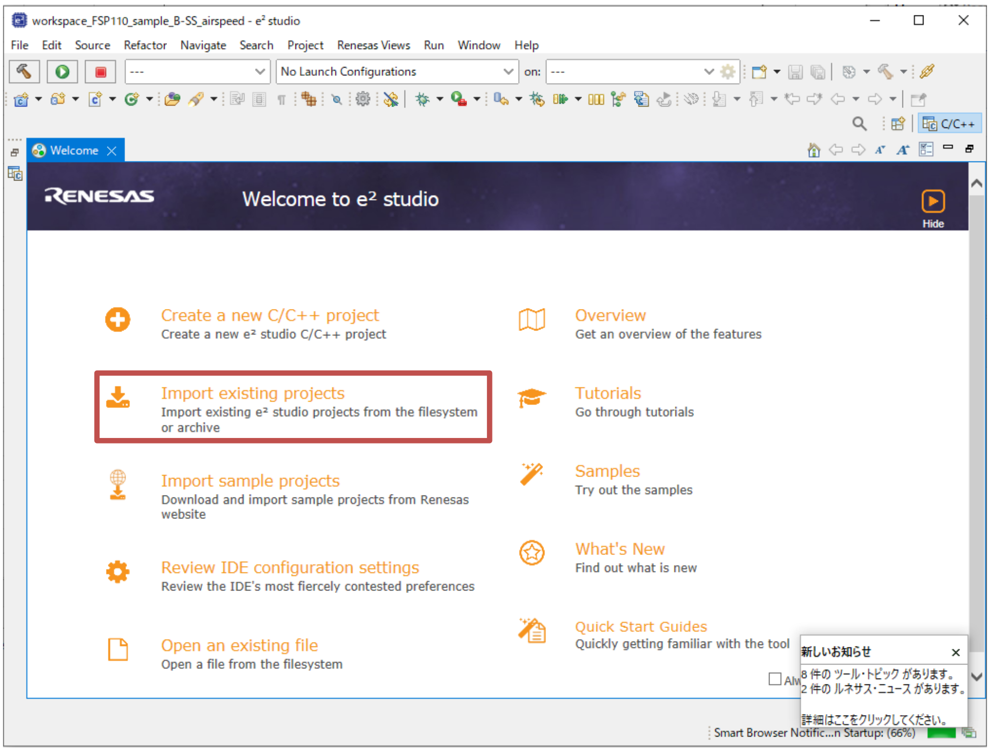
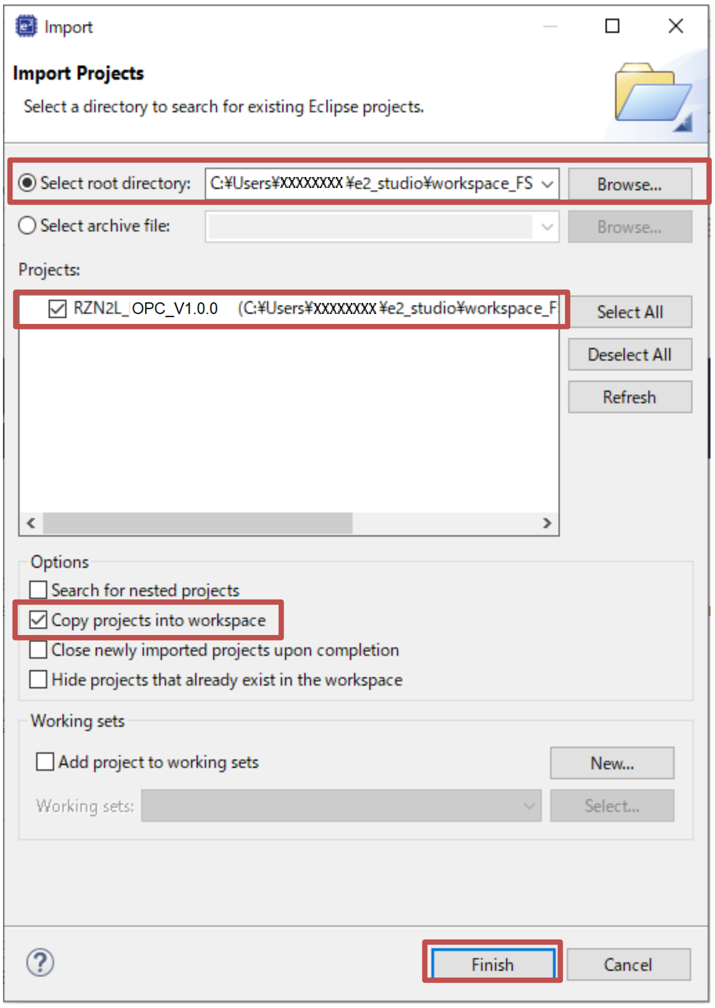

workspace_FSP110_sample_B-SS_airspeed - e² studio
File Edit Source Refactor Navigate Search Project Renesas Views Run Window Help
No Launch Configurations
on:
C/C++
Welcome
RENESAS
Welcome to e² studio
Hide
Create a new C/C++ project
Create a new e² studio C/C++ project
Import existing projects
Import existing e² studio projects from the filesystem or archive
Import sample projects
Download and import sample projects from Renesas website
Review IDE configuration settings
Review the IDE's most fiercely contested preferences
Open an existing file
Open a file from the filesystem
Overview
Get an overview of the features
Tutorials
Go through tutorials
Samples
Try out the samples
What's New
Find out what is new
Quick Start Guides
Quickly getting familiar with the tool
新しいお知らせ
8 件の ツール・トピック があります。
2 件の ルネサス・ニュース があります。
詳細はここをクリックしてください。
Smart Browser Notific...n Startup: (66%)

Fig 3-15 Launch project (4)

Click ”Browse” at “Select root directory” and enter the project folder to be imported.

Check the “Copy projects into workspace” checkbox to copy the import project.



Import

Import Projects

Select a directory to search for existing Eclipse projects.

● Select root directory: C:¥Users¥XXXXXXXX¥e2_studio¥workspace_FS

○ Select archive file:

Projects:

☑ RZN2L_OPC_V1.0.0 (C:¥Users¥XXXXXXXX¥e2_studio¥workspace_F

Options

☐ Search for nested projects

☑ Copy projects into workspace

☐ Close newly imported projects upon completion

☐ Hide projects that already exist in the workspace

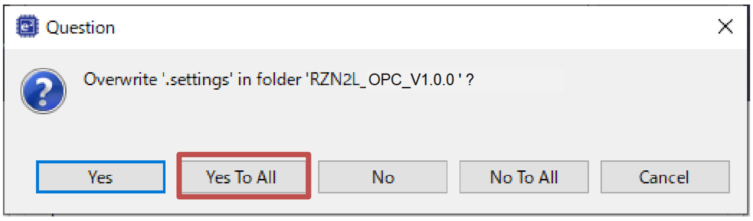
Working sets

☐ Add project to working sets

Working sets:

Fig 3-16 Launch project (5)

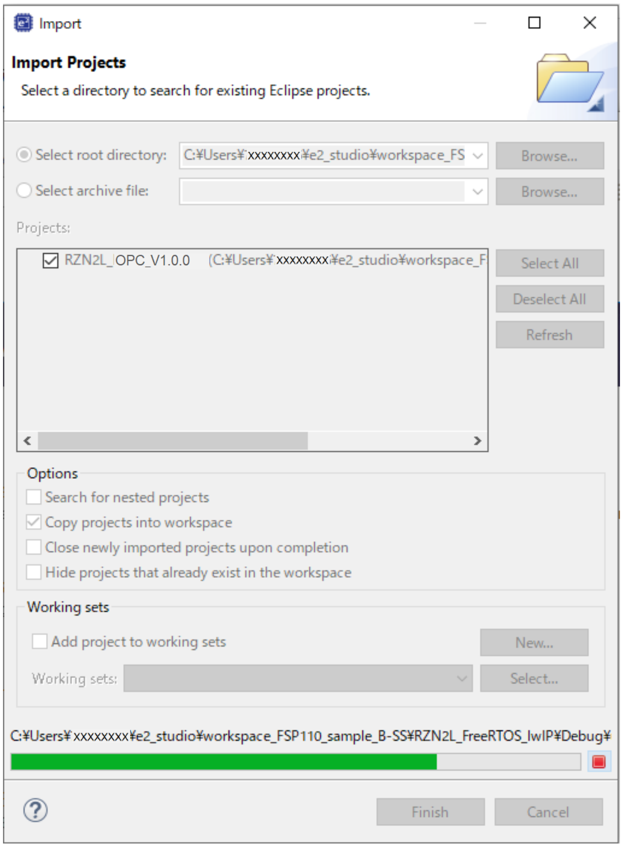
Click “Finish” in Fig 3-16 to display the following and click “Yes To All”.



Question

Overwrite '.settings' in folder 'RZN2L_OPC_V1.0.0 ' ?

Fig 3-17 Launch project (6)



Import

Import Projects

Select a directory to search for existing Eclipse projects.

● Select root directory: C:¥Users¥xxxxxxxx¥e2_studio¥workspace_FS Browse...

○ Select archive file: Browse...

Projects:

☑ RZN2L_OPC_V1.0.0 (C:¥Users¥xxxxxxxx¥e2_studio¥workspace_F

Select All

Deselect All

Refresh

Options

□ Search for nested projects

☑ Copy projects into workspace

□ Close newly imported projects upon completion

□ Hide projects that already exist in the workspace

Working sets

□ Add project to working sets New...

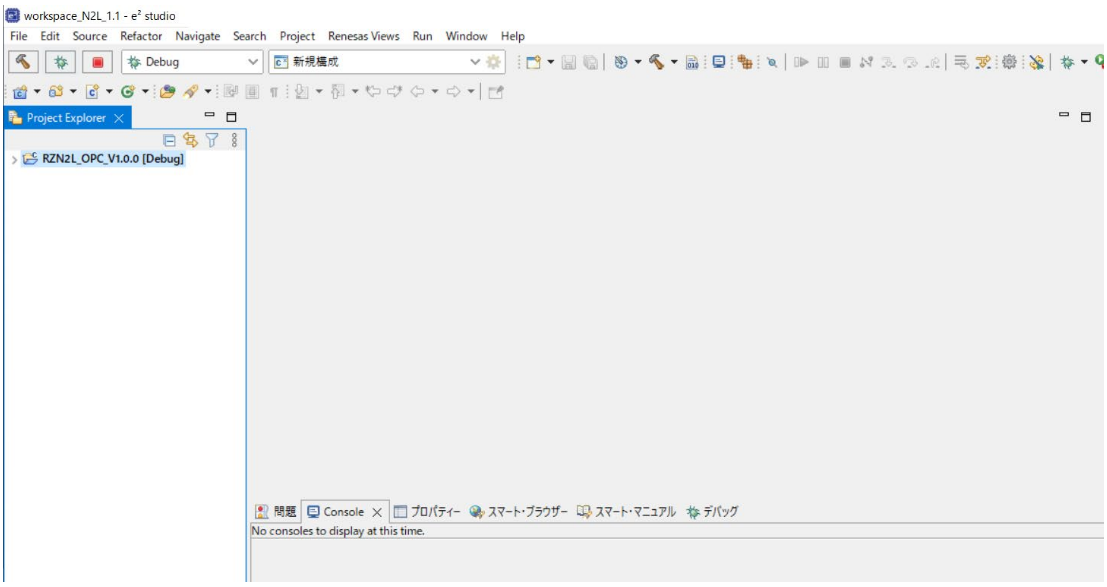
Working sets: Select...

C:¥Users¥xxxxxxxx¥e2_studio¥workspace_FSP110_sample_B-SS¥RZN2L_FreeRTOS_lwIP¥Debug¥

Finish Cancel

Fig 3-18 Launch project (7)

・When the project import is complete, the following will be displayed. The subsequent sections will be explained in chapter 4.3.1.



workspace_N2L_1.1 - e² studio

File Edit Source Refactor Navigate Search Project Renesas Views Run Window Help

Debug 新規構成

Project Explorer

RZN2L_OPC_V1.0.0 [Debug]

問題 Console プロパティー スマート･ブラウザー スマート･マニュアル デバッグ

No consoles to display at this time.

Fig 3-19 Launch project (8)

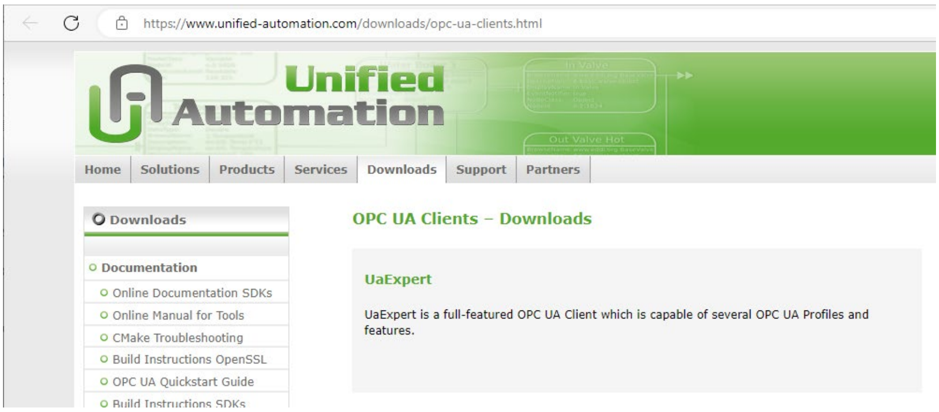
3.4.2 UaExpert

UaExpert is an OPC UA client tool. In this document, it is used to connect to the OPC UA server to access the object nodes.

Download the version listed in Table 1-1 from the website and install it on your PC. Before downloading, you must register on the Unified Automation website and activate your account. All content is provided free of charge, but by downloading or installing the software from this web page, you automatically accept the Unified Automation Software License Agreement (SLA). For license terms for software and information, please refer to the following link.

https://www.unified-automation.com/products/sdk-overview/licenses.html#c341

Please check the above conditions of use before usage.



https://www.unified-automation.com/downloads/opc-ua-clients.html

OPC UA Clients – Downloads

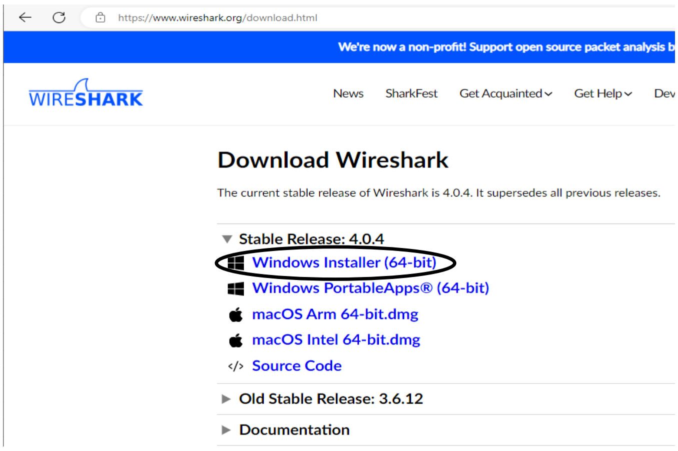
UaExpert

UaExpert is a full-featured OPC UA Client which is capable of several OPC UA Profiles and features.

Fig 3-20 UaExpert

3.4.3 Wireshark

Wireshark is a free network protocol analyzer. Download and install Wireshark from the link in Table 1-1.



https://www.wireshark.org/download.html

We're now a non-profit! Support open source packet analysis b

Download Wireshark

The current stable release of Wireshark is 4.0.4. It supersedes all previous releases.

▼ Stable Release: 4.0.4
- Windows Installer (64-bit)
- Windows PortableApps® (64-bit)
- macOS Arm 64-bit.dmg
- macOS Intel 64-bit.dmg
- Source Code

▶ Old Stable Release: 3.6.12

▶ Documentation

Fig 3-21 download Wireshark

4. Operation check

4.1 Connection

Fig 4-1 shows a connection diagram when running the sample software. Connect PC and SOM Kit with Ethernet cable and USB micro cable.

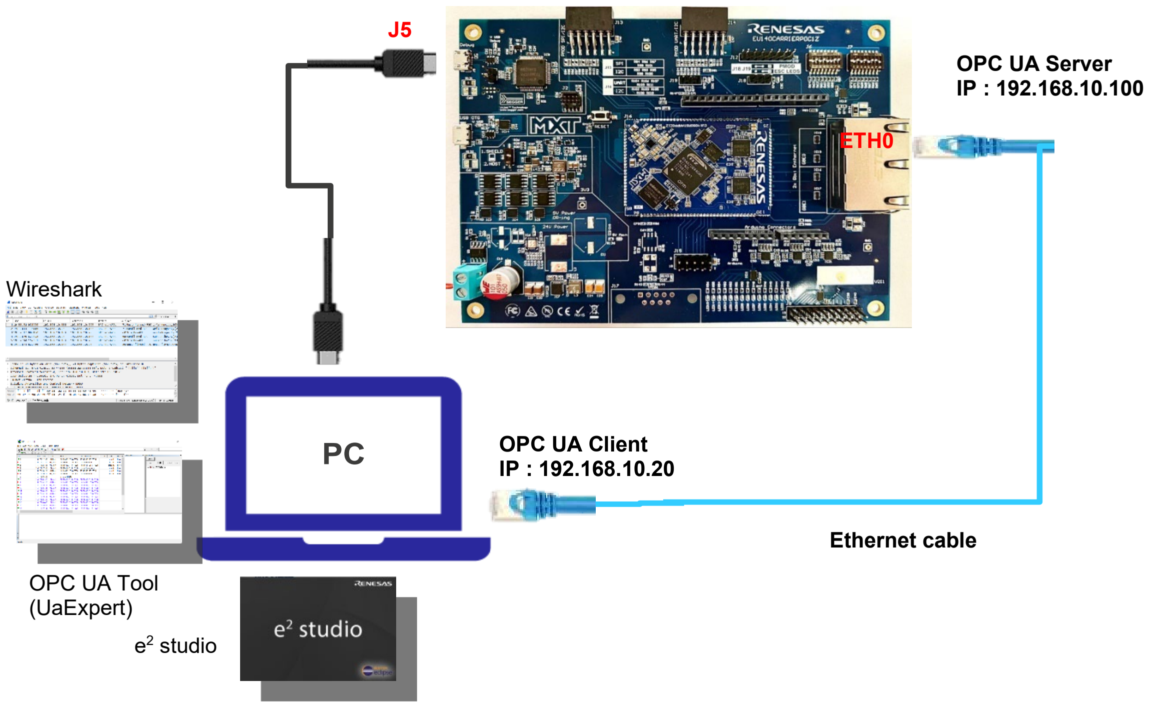


Fig 4-1 OPC UA Server Hardware Diagram

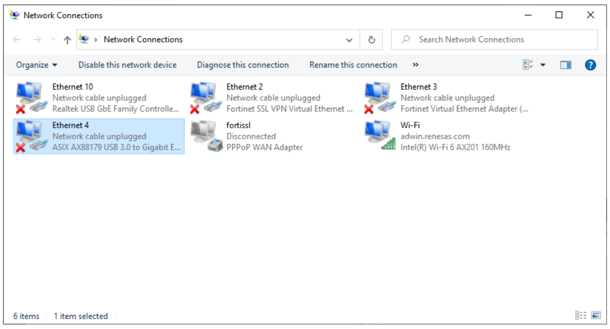
4.2 IP Address Settings

Set the address of the Ethernet on the PC that serves as the OPC UA Client.

Click on settings ⚙ in Windows Start ⊞. Configure the IP address as follows.

Settings > Network and Internet > Change adapter options > Ethernet

＞Properties > Internet Protocol Version 4 (TCP/IPv4) > Properties



Ethernet 10
Network cable unplugged
Realtek USB GbE Family Controlle...

Ethernet 2
Network cable unplugged
Fortinet SSL VPN Virtual Ethernet ...

Ethernet 3
Network cable unplugged
Fortinet Virtual Ethernet Adapter (...

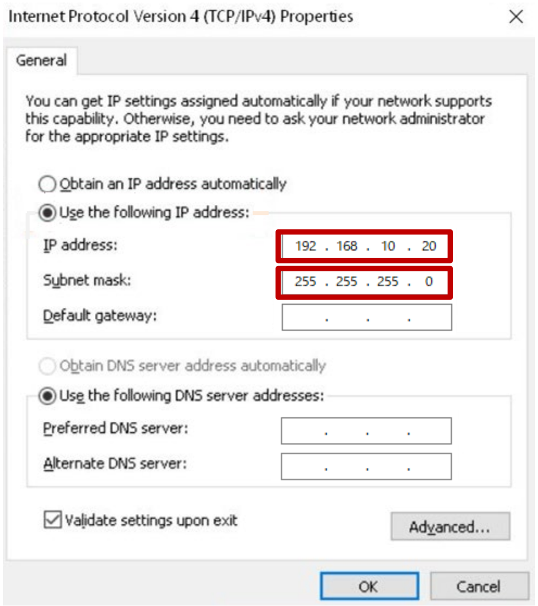
Ethernet 4
Network cable unplugged
ASIX AX88179 USB 3.0 to Gigabit E...

fortissl
Disconnected
PPPoP WAN Adapter

Wi-Fi
adwin.renesas.com
Intel(R) Wi-Fi 6 AX201 160MHz

6 items 1 item selected

Fig 4-2 network connection



Internet Protocol Version 4 (TCP/IPv4) Properties

General

You can get IP settings assigned automatically if your network supports this capability. Otherwise, you need to ask your network administrator for the appropriate IP settings.

○ Obtain an IP address automatically

● Use the following IP address:

IP address: 192 . 168 . 10 . 20

Subnet mask: 255 . 255 . 255 . 0

Default gateway: . . .

○ Obtain DNS server address automatically

● Use the following DNS server addresses:

Preferred DNS server: . . .

Alternate DNS server: . . .

☑ Validate settings upon exit

Fig 4-3 TCP/IPv4 properties

The IP address of the SOM Kit set in the OPC UA server sample software is 192.168.10.100. The IP address of the PC needs to be set to 192.168.10.XXX. In this document, 192.168.10.20 is used.

4.3 Start Project

First, import the project as described in section 3.4.1.2.

4.3.1 Build

Select the project name in the Project Explorer window and click "Clean..." in the Project menu.

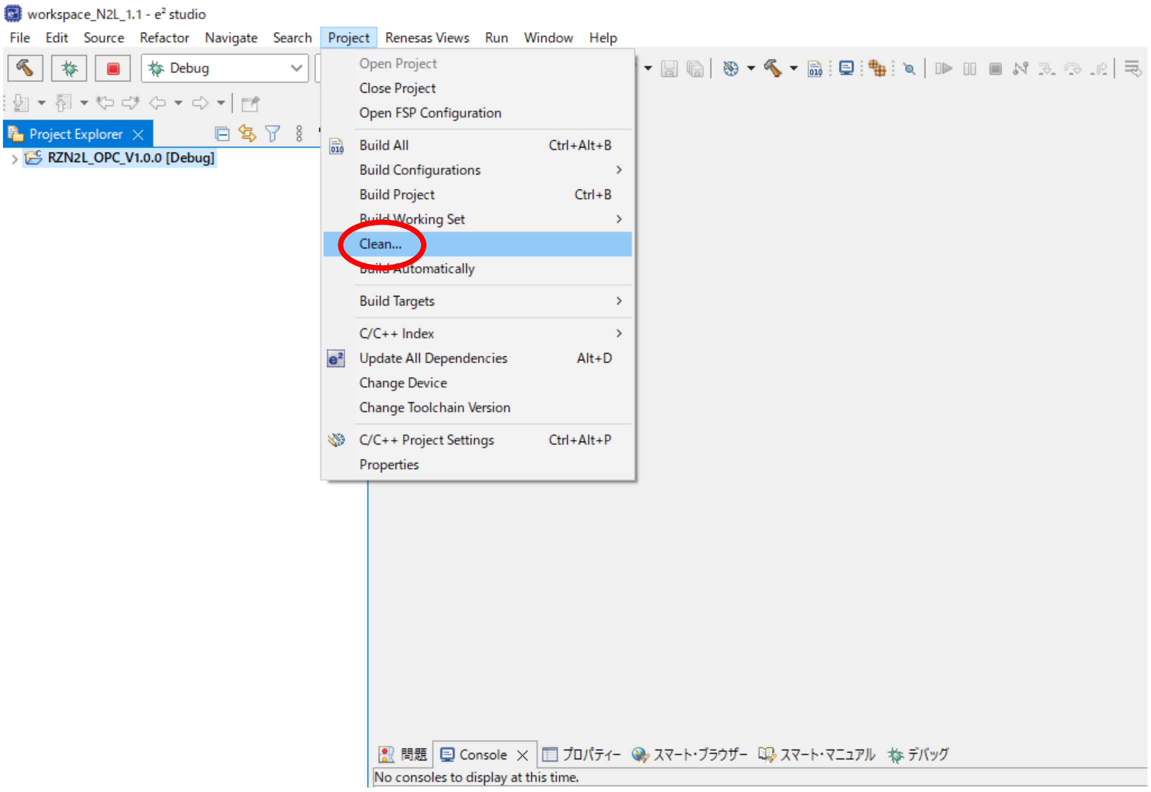
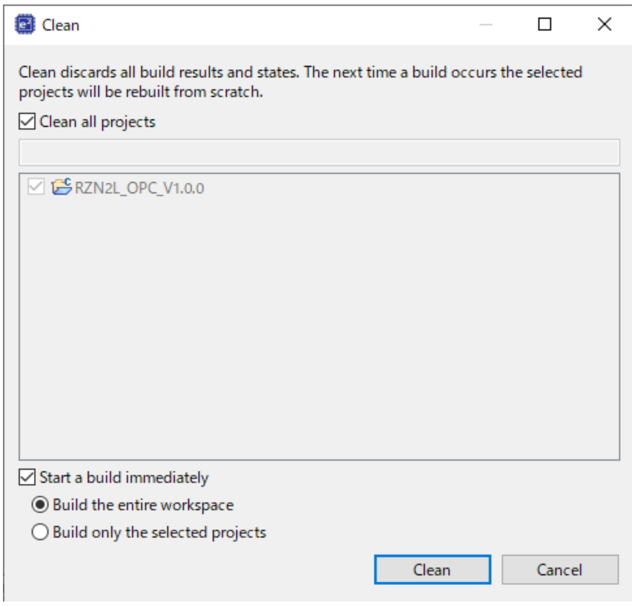

workspace_N2L_1.1 - e² studio
File Edit Source Refactor Navigate Search Project Renesas Views Run Window Help
Debug
Project Explorer
RZN2L_OPC_V1.0.0 [Debug]
Open Project
Close Project
Open FSP Configuration
Build All Ctrl+Alt+B
Build Configurations
Build Project Ctrl+B
Build Working Set
Clean...
Build Automatically
Build Targets
C/C++ Index
Update All Dependencies Alt+D
Change Device
Change Toolchain Version
C/C++ Project Settings Ctrl+Alt+P
Properties
問題 Console プロパティー スマート・ブラウザー スマート・マニュアル デバッグ
No consoles to display at this time.

Fig 4-4 Open project Clean…

Enable the followings in the pop-up dialog and click "Clean" to start all builds.



Clean discards all build results and states. The next time a build occurs the selected projects will be rebuilt from scratch.

☑ Clean all projects

☑ RZN2L_OPC_V1.0.0

☑ Start a build immediately

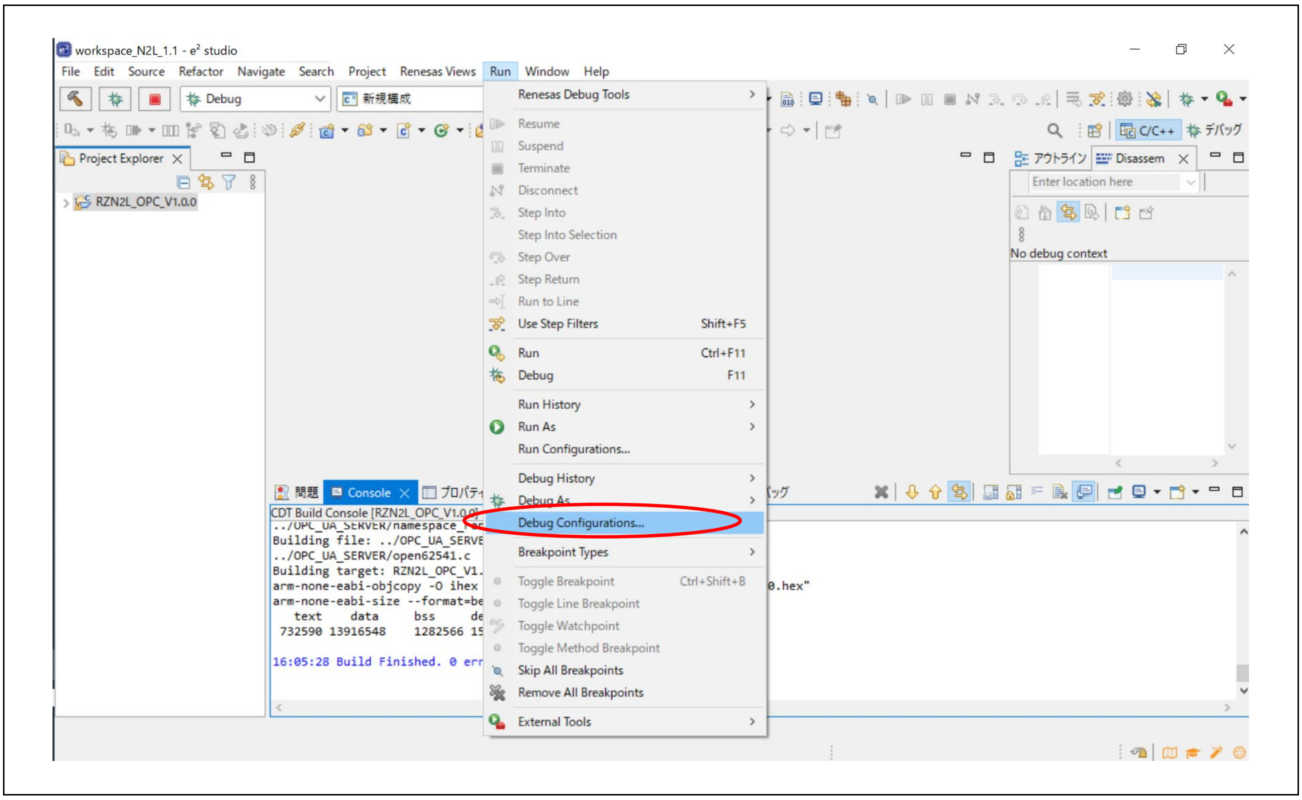
● Build the entire workspace

○ Build only the selected projects

Fig 4-5 clean and rebuild

4.3.2 Debug Configurations

After confirming that the build result is 0 errors, select the project name in the Project Explorer window and click “Debug Configurations...” in the Run menu. Ignore the warning message that appears.



```
../OPC_UA_SERVER/namespace_
Building file: ../OPC_UA_SERVE
../OPC_UA_SERVER/open62541.c
Building target: RZN2L_OPC_V1.
arm-none-eabi-objcopy -O ihex                                          0.hex"
arm-none-eabi-size --format=be
   text    data     bss     de
 732590 13916548    1282566 15

16:05:28 Build Finished. 0 err
```

Fig 4-6 Open Debug Configurations…

Operations when starting the debugger for the first time after importing a project

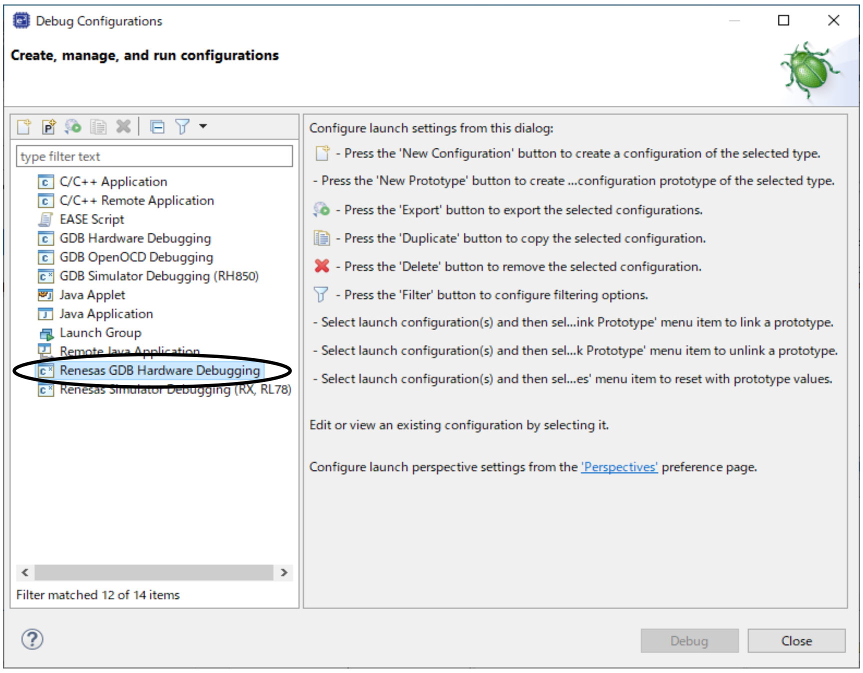
Only when importing a project and launching the debugger for the first time, the following operations should be performed.

- Create RZ***_OPC_V*** Debug[local]
- Select Target Device
- Debut Tool Settings

See the following explanation for details.

a. Create RZ***_OPC_V*** Debug[local]

Double click on Renesas GDB Hardware Debugging to generate RZ***_OPC_V*** Debug[local]



Debug Configurations

Create, manage, and run configurations

type filter text

- C/C++ Application
- C/C++ Remote Application
- EASE Script
- GDB Hardware Debugging
- GDB OpenOCD Debugging
- GDB Simulator Debugging (RH850)
- Java Applet
- Java Application
- Launch Group
- Remote Java Application
- Renesas GDB Hardware Debugging
- Renesas Simulator Debugging (RX, RL78)

Filter matched 12 of 14 items

Configure launch settings from this dialog:

- Press the 'New Configuration' button to create a configuration of the selected type.
- Press the 'New Prototype' button to create ...configuration prototype of the selected type.
- Press the 'Export' button to export the selected configurations.
- Press the 'Duplicate' button to copy the selected configuration.
- Press the 'Delete' button to remove the selected configuration.
- Press the 'Filter' button to configure filtering options.
- Select launch configuration(s) and then sel...ink Prototype' menu item to link a prototype.
- Select launch configuration(s) and then sel...k Prototype' menu item to unlink a prototype.
- Select launch configuration(s) and then sel...es' menu item to reset with prototype values.

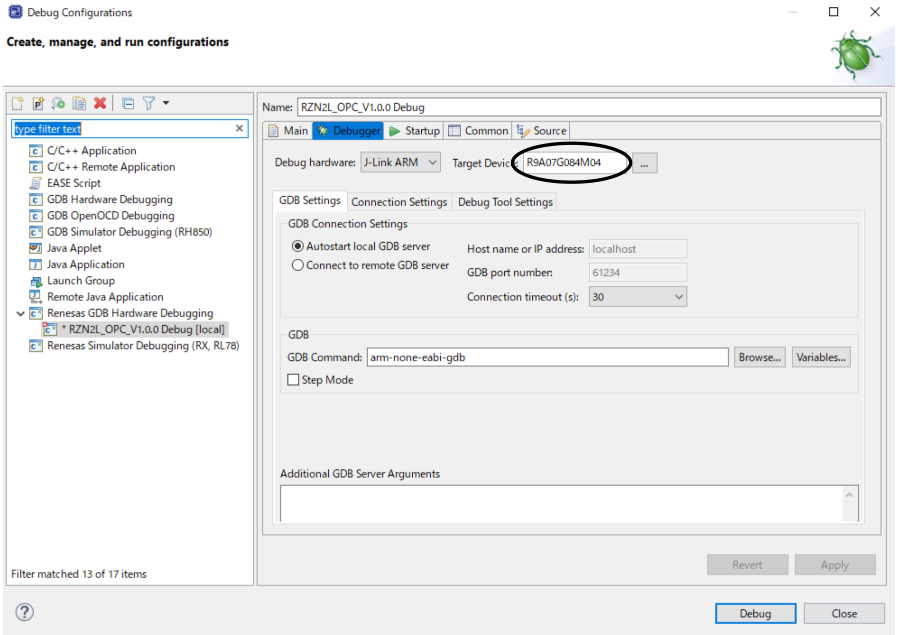
Edit or view an existing configuration by selecting it.

Configure launch perspective settings from the 'Perspectives' preference page.

Fig 4-7 Debug Configurations(1)

b. Select Target Device

Click on the Debugger tag in the displayed dialog and select Target Device.



Debug Configurations

Create, manage, and run configurations

type filter text

- C/C++ Application
- C/C++ Remote Application
- EASE Script
- GDB Hardware Debugging
- GDB OpenOCD Debugging
- GDB Simulator Debugging (RH850)
- Java Applet
- Java Application
- Launch Group
- Remote Java Application
- Renesas GDB Hardware Debugging
  - * RZN2L_OPC_V1.0.0 Debug [local]
- Renesas Simulator Debugging (RX, RL78)

Filter matched 13 of 17 items

Name: RZN2L_OPC_V1.0.0 Debug

Debug hardware: J-Link ARM Target Device: R9A07G084M04

GDB Connection Settings

● Autostart local GDB server
○ Connect to remote GDB server

Host name or IP address: localhost
GDB port number: 61234
Connection timeout (s): 30

GDB

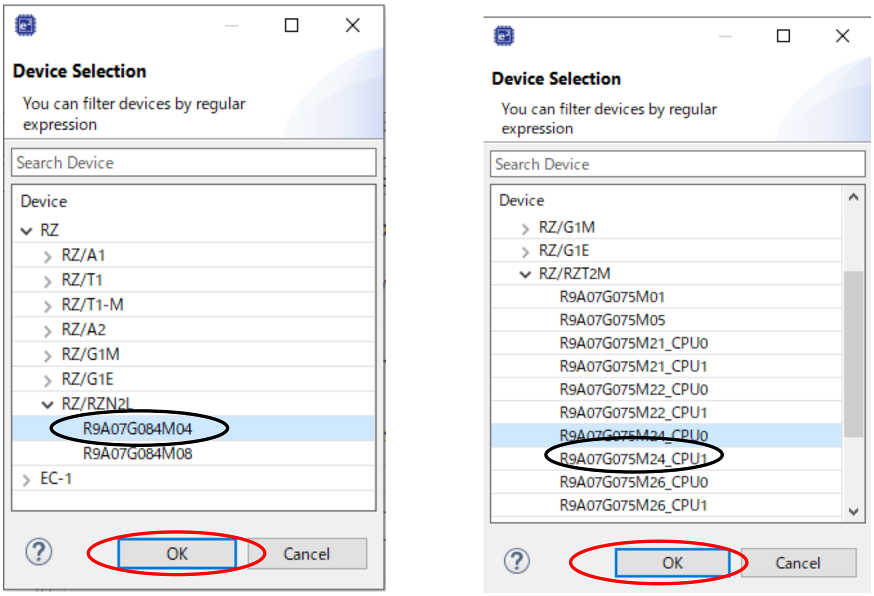
GDB Command: arm-none-eabi-gdb

□ Step Mode

Additional GDB Server Arguments

Fig 4-8 Debug Configurations(2)

RZ/N2L : Select R9A07G084M04 and click OK.



Device Selection

You can filter devices by regular expression

Search Device

Device
- RZ
  - RZ/A1
  - RZ/T1
  - RZ/T1-M
  - RZ/A2
  - RZ/G1M
  - RZ/G1E
  - RZ/RZN2L
    - R9A07G084M04
    - R9A07G084M08
- EC-1

OK Cancel

Device Selection

You can filter devices by regular expression

Search Device

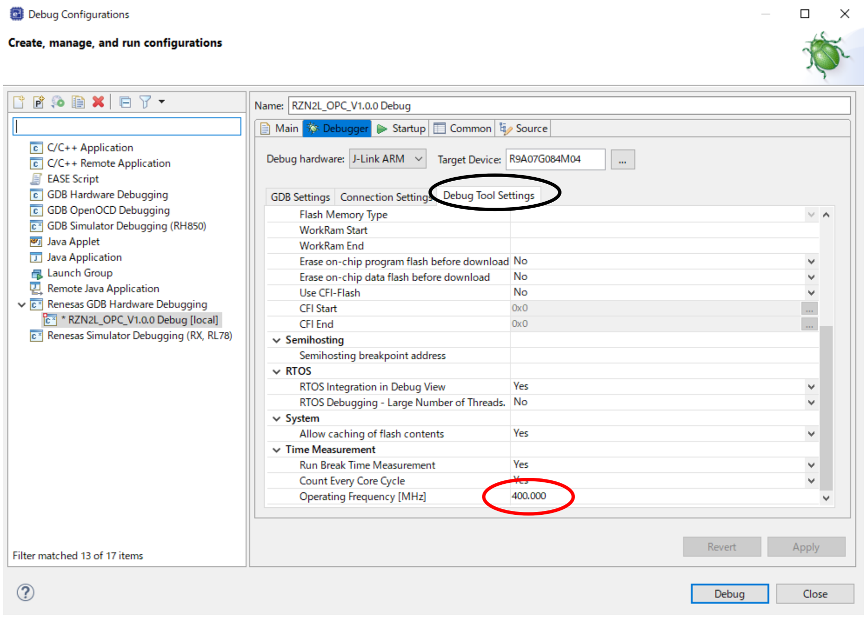
Device
- RZ/G1M
- RZ/G1E
- RZ/RZT2M
  - R9A07G075M01
  - R9A07G075M05
  - R9A07G075M21_CPU0
  - R9A07G075M21_CPU1
  - R9A07G075M22_CPU0
  - R9A07G075M22_CPU1
  - R9A07G075M24_CPU0
  - R9A07G075M24_CPU1
  - R9A07G075M26_CPU0
  - R9A07G075M26_CPU1

OK Cancel

Fig 4-9 Debug Configurations(3)

c. Debug Tool Settings

Click the Debut Tool Settings tag and write 400 at Operating Frequency [MHz].



Debug Configurations

Create, manage, and run configurations

Name: RZN2L_OPC_V1.0.0 Debug

Debug hardware: J-Link ARM   Target Device: R9A07G084M04

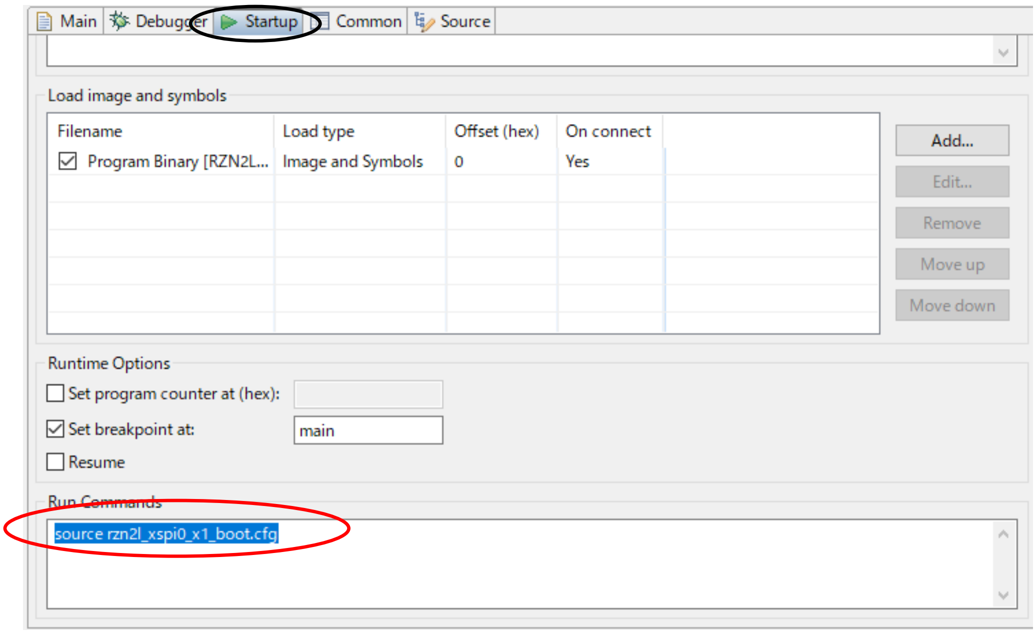
Flash Memory Type	
WorkRam Start	
WorkRam End	
Erase on-chip program flash before download	No
Erase on-chip data flash before download	No
Use CFI-Flash	No
CFI Start	0x0
CFI End	0x0
Semihosting	
Semihosting breakpoint address	
RTOS	
RTOS Integration in Debug View	Yes
RTOS Debugging - Large Number of Threads.	No
System	
Allow caching of flash contents	Yes
Time Measurement	
Run Break Time Measurement	Yes
Count Every Core Cycle	Yes
Operating Frequency [MHz]	400.000

Fig 4-10 Debug Configurations(4)

d. Run Command Setting

Click the Startup and Add the Run Commands: “source rzn2l_xspi0_x1_boot.cfg”.

Click on "Debug" to start the download. Continue to Fig 4-14 for instructions.



Load image and symbols

Filename	Load type	Offset (hex)	On connect
☑ Program Binary [RZN2L...	Image and Symbols	0	Yes

Runtime Options

☐ Set program counter at (hex):

☑ Set breakpoint at: main

☐ Resume

Run Commands

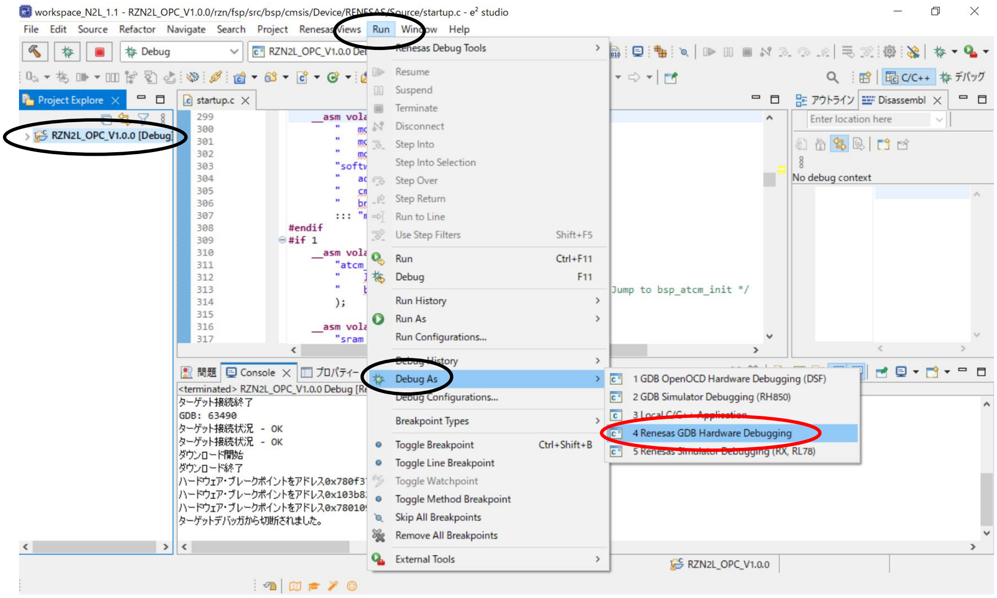
```
source rzn2l_xspi0_x1_boot.cfg
```

Fig 4-11 Debug Configurations(4)

4.3.3 Debug

The download procedure after completing the build is shown below.

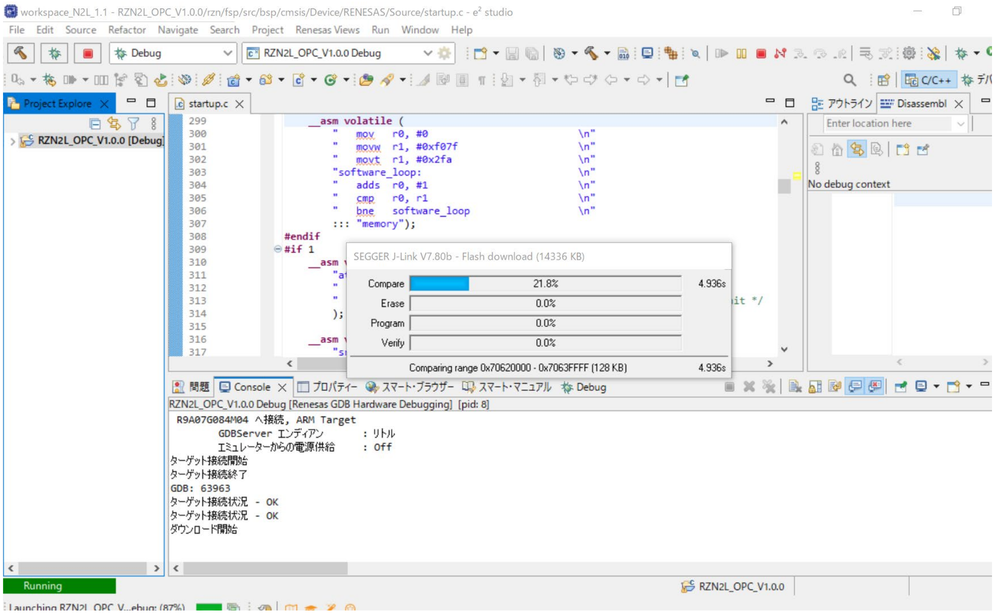
At the second and subsequent debugger launches, click the Run menu with the project name selected in the C/C++ view. Place the cursor on "Debug As" and click on "Renesas GDB Hardware Debugging".



```
<terminated> RZN2L_OPC_V1.0.0 Debug [Re
ターゲット接続終了
GDB: 63490
ターゲット接続状況 - OK
ターゲット接続状況 - OK
ダウンロード開始
ダウンロード終了
ハードウェア・ブレークポイントをアドレス0x780f3
ハードウェア・ブレークポイントをアドレス0x103b8
ハードウェア・ブレークポイントをアドレス0x78010
ターゲットデバッガから切断されました。
```

Fig 4-12 Run menu Debug As

Download the program to the flash memory. (It will take a few minutes.)



```
    __asm volatile (
        "   mov   r0, #0                \n"
        "   movw  r1, #0xf07f           \n"
        "   movt  r1, #0x2fa            \n"
        "software_loop:                 \n"
        "   adds  r0, #1                \n"
        "   cmp   r0, r1                \n"
        "   bne   software_loop         \n"
        ::: "memory");
#endif
#if 1
```

SEGGER J-Link V7.80b - Flash download (14336 KB)

Compare	21.8%	4.936s
Erase	0.0%	
Program	0.0%	
Verify	0.0%	

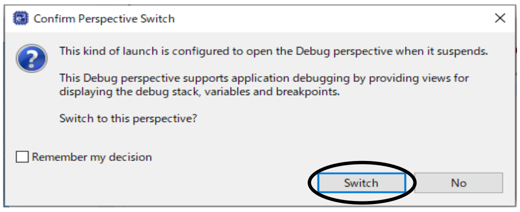
Comparing range 0x70620000 - 0x7063FFFF (128 KB) 4.936s

RZN2L_OPC_V1.0.0 Debug [Renesas GDB Hardware Debugging] [pid: 8]

```
 R9A07G084M04 へ接続, ARM Target
        GDBServer エンディアン        : リトル
        エミュレーターからの電源供給  : Off
ターゲット接続開始
ターゲット接続終了
GDB: 63963
ターゲット接続状況 - OK
ターゲット接続状況 - OK
ダウンロード開始
```

Fig 4-13 Download

Click Switch to change to debug view.



Confirm Perspective Switch

This kind of launch is configured to open the Debug perspective when it suspends.

This Debug perspective supports application debugging by providing views for displaying the debug stack, variables and breakpoints.

Switch to this perspective?

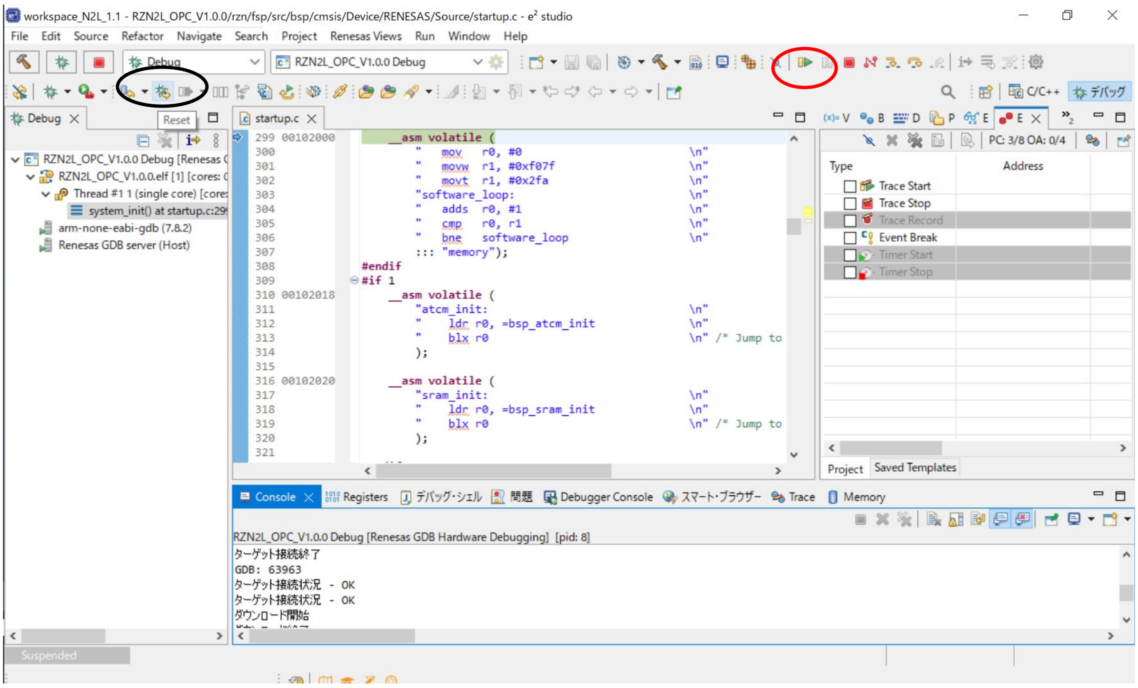
☐ Remember my decision

Fig 4-14 Perspective Switch

The CPU automatically extracts the loader program included in the download data to the BTCM. After extraction, it breaks in system_init() at the beginning of the initialization on the loader program.

- In case of operating the SOM Kit alone without using the debugger, turn off the board power supply, disconnect the debugger cable, and then turn on the board power supply again.

When using the debugger, **click the "reset"** **icon and then "resume"** after switching to the Debug screen.



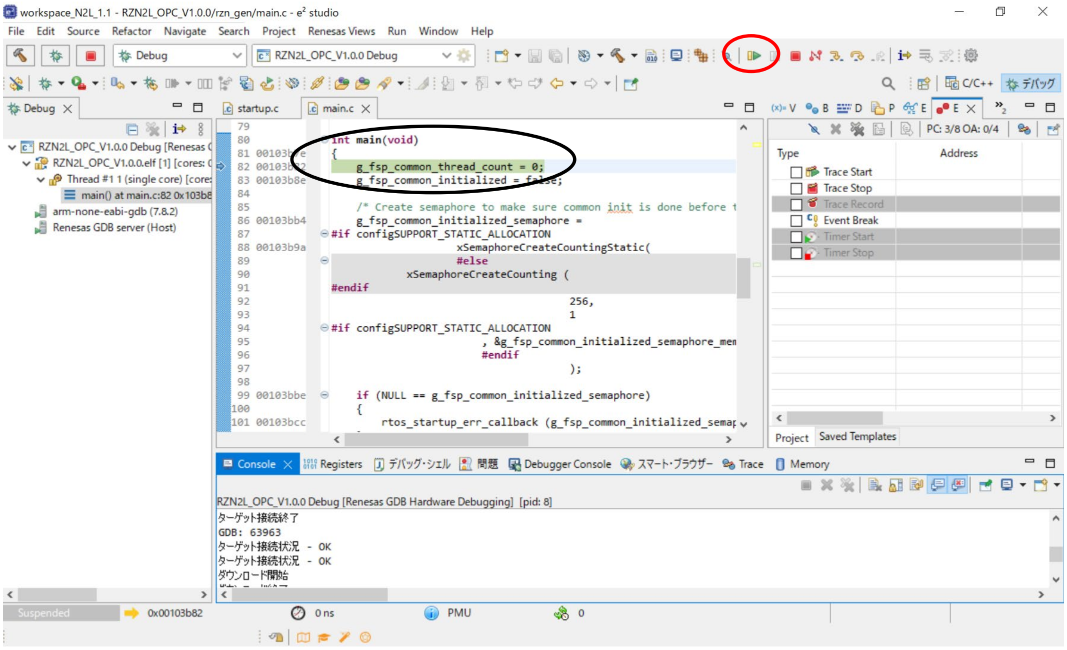
RZN2L_OPC_V1.0.0 Debug [Renesas (
RZN2L_OPC_V1.0.0.elf [1] [cores: (
Thread #1 1 (single core) [core:
system_init() at startup.c:29
arm-none-eabi-gdb (7.8.2)
Renesas GDB server (Host)

```
00102000     __asm volatile (
                 "    mov    r0, #0                        \n"
                 "    movw   r1, #0xf07f                   \n"
                 "    movt   r1, #0x2fa                    \n"
                 "software_loop:                           \n"
                 "    adds   r0, #1                        \n"
                 "    cmp    r0, r1                        \n"
                 "    bne    software_loop                 \n"
                 ::: "memory");
             #endif
             #if 1
00102018         __asm volatile (
                 "atcm_init:                               \n"
                 "     ldr r0, =bsp_atcm_init              \n"
                 "     blx r0                              \n" /* Jump to
                 );

00102020         __asm volatile (
                 "sram_init:                               \n"
                 "     ldr r0, =bsp_sram_init              \n"
                 "     blx r0                              \n" /* Jump to
                 );
```

```
RZN2L_OPC_V1.0.0 Debug [Renesas GDB Hardware Debugging]  [pid: 8]
ターゲット接続終了
GDB: 63963
ターゲット接続状況 - OK
ターゲット接続状況 - OK
ダウンロード開始
```

Fig 4-15 Break at system_init()

After completing initialization, the loader program stops at the beginning of main(), Then, click "resume" to return to the running state.


workspace_N2L_1.1 - RZN2L_OPC_V1.0.0/rzn_gen/main.c - e² studio
File Edit Source Refactor Navigate Search Project Renesas Views Run Window Help
Debug
RZN2L_OPC_V1.0.0 Debug
C/C++
デバッグ
Debug
RZN2L_OPC_V1.0.0 Debug [Renesas (
RZN2L_OPC_V1.0.0.elf [1] [cores: (
Thread #1 1 (single core) [core:
main() at main.c:82 0x103b8
arm-none-eabi-gdb (7.8.2)
Renesas GDB server (Host)
startup.c
main.c
PC: 3/8 OA: 0/4
Type
Address
Trace Start
Trace Stop
Trace Record
Event Break
Timer Start
Timer Stop
Project
Saved Templates
Console
Registers
デバッグ·シェル
問題
Debugger Console
スマート·ブラウザー
Trace
Memory
Suspended
0x00103b82
0 ns
PMU
0

```
int main(void)
{
    g_fsp_common_thread_count = 0;
    g_fsp_common_initialized = false;

    /* Create semaphore to make sure common init is done before t
    g_fsp_common_initialized_semaphore =
#if configSUPPORT_STATIC_ALLOCATION
                            xSemaphoreCreateCountingStatic(
                            #else
                    xSemaphoreCreateCounting (
#endif
                                                256,
                                                1
#if configSUPPORT_STATIC_ALLOCATION
                                , &g_fsp_common_initialized_semaphore_mem
                                #endif
                                                );

    if (NULL == g_fsp_common_initialized_semaphore)
    {
        rtos_startup_err_callback (g_fsp_common_initialized_semap
```

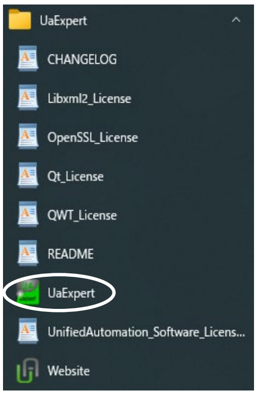
```
RZN2L_OPC_V1.0.0 Debug [Renesas GDB Hardware Debugging]  [pid: 8]
ターゲット接続終了
GDB: 63963
ターゲット接続状況 - OK
ターゲット接続状況 - OK
ダウンロード開始
```

Fig 4-16 Break at main()

4.4 OPC UA Communication Check

- Launch UaExpert

Open Windows Start menu and ⊞ click UaExpert



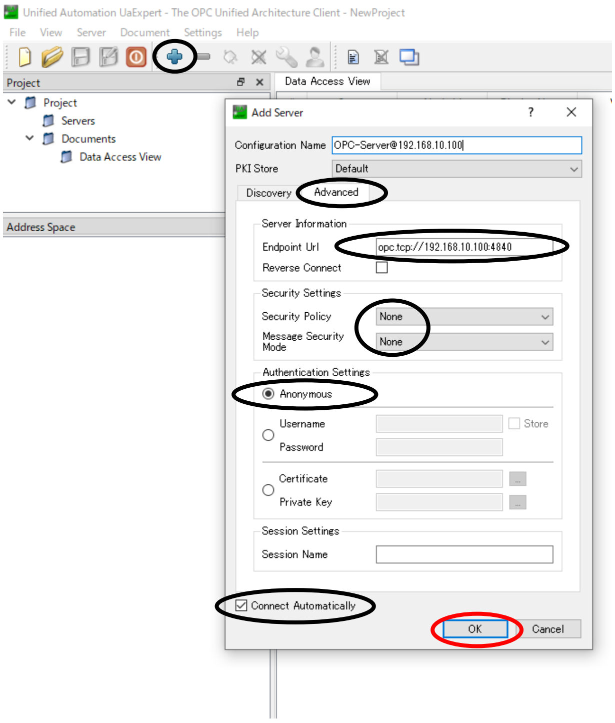
UaExpert
CHANGELOG
Libxml2_License
OpenSSL_License
Qt_License
QWT_License
README
UaExpert
UnifiedAutomation_Software_Licens...
Website

Fig 4-17 Launch UaExpert

- Add OPC UA server

Click ✚ on the tool bar in UaExpert.

Open the Advanced tab, set the “Endpoint Url” to "opc.tcp://192.168.10.100:4840", select “Anonymous”. Check "Connect Automatically" and then click OK at the end.



Unified Automation UaExpert - The OPC Unified Architecture Client - NewProject
File View Server Document Settings Help
Project
Data Access View
Project
Servers
Documents
Data Access View
Address Space
Add Server
?
Discovery
Advanced
OK
Cancel

Configuration Name: OPC-Server@192.168.10.100
PKI Store: Default

Server Information
Endpoint Url: opc.tcp://192.168.10.100:4840
Reverse Connect □

Security Settings
Security Policy: None
Message Security Mode: None

Authentication Settings
● Anonymous
○ Username / Password □ Store
○ Certificate / Private Key

Session Settings
Session Name:

☑ Connect Automatically

Fig 4-18 UaExpert Add server

When the OPC UA server is connected, an indicator icon is displayed in the "Project" window to show that the server is connected. "Renesas" displayed under the Object tree in the "Address Space" window is an object of OPC UA server.

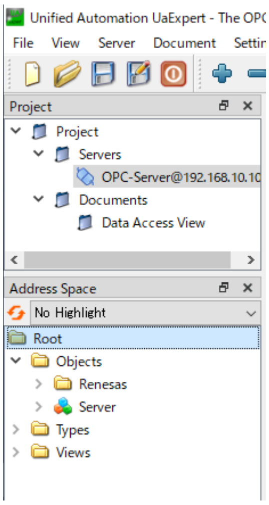
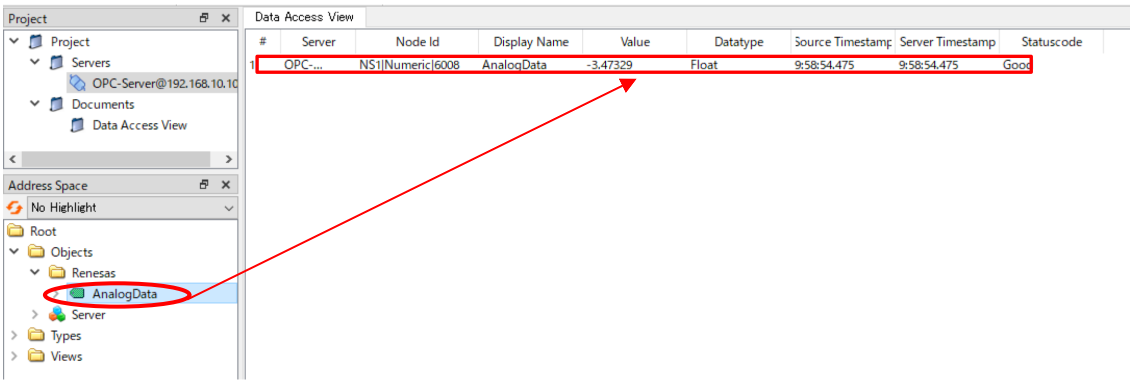


Fig 4-19 UaExpert OPC UA server connection

As shown in the following figure, drag and drop the *Root>Objects>Renesas>AnalogData* node in the "Address Space" window to the "Data Access View" window to change the value in the Value column.

The value repeatedly changes in the range of -5.0 ~ 5.0.



#	Server	Node Id	Display Name	Value	Datatype	Source Timestamp	Server Timestamp	Statuscode
1	OPC-...	NS1|Numeric|6008	AnalogData	-3.47329	Float	9:58:54.475	9:58:54.475	Good

Fig 4-20 AnalogData value reading

5. Appendix

5.1 File Generation of open62541

The open source open62541 is used for the OPC UA stack of this sample software. To run open62541 in a freeRTOS + LwIP environment, the following link recommends an approach to generate open62541.c and open62541.h using CMake, which is also used in this sample software.

Building open62541 — open62541 1.3.0-dirty documentation

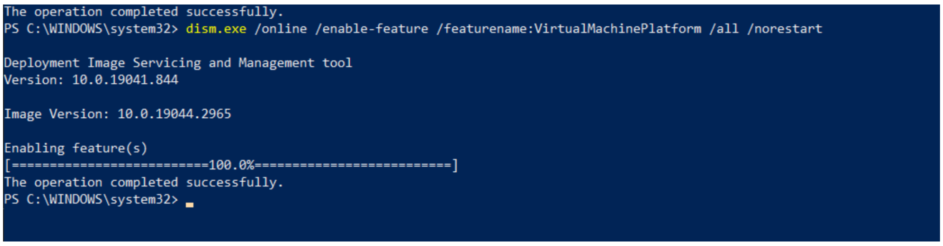
This chapter describes the procedure for generating open62541 and Renesas sample information models as files for e^2 studio execution in a Windows 10 environment. Here Window 10 version 1903 or later (OS Build 19044.2965) is used, in which WSL2 is executable.

5.1.1 Linux environment Setup

Set up a Linux environment to run CMake. In this document, we will run CMake on a Linux (Ubuntu 18.04) environment installed using WSL2 with reference to the following linked pages.

(Reference) Manual installation steps for older versions of WSL | Microsoft Learn

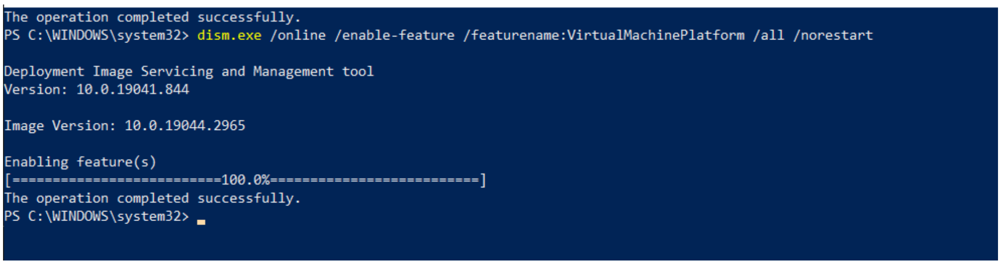
1) Launch PowerShell as Administrator. Search PowerShell > right-click > Run as Administrator
2) Enter the following command to enable the Windows Subsystem for Linux.
   dism.exe /online /enable-feature /featurename:Microsoft-Windows-Subsystem-Linux /all /norestart



```
The operation completed successfully.
PS C:\WINDOWS\system32> dism.exe /online /enable-feature /featurename:VirtualMachinePlatform /all /norestart

Deployment Image Servicing and Management tool
Version: 10.0.19041.844

Image Version: 10.0.19044.2965

Enabling feature(s)
[==========================100.0%==========================]
The operation completed successfully.
PS C:\WINDOWS\system32>
```

Fig 5-1 Microsoft-Windows-Subsystem-Linux

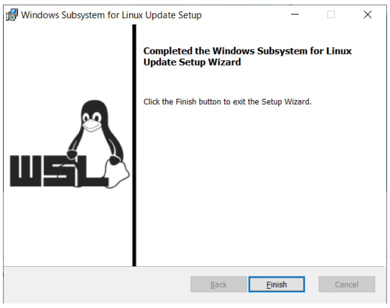
3) Enter the following command to enable the virtual machine platform feature:
   dism.exe /online /enable-feature /featurename:VirtualMachinePlatform /all /norestart



```
The operation completed successfully.
PS C:\WINDOWS\system32> dism.exe /online /enable-feature /featurename:VirtualMachinePlatform /all /norestart

Deployment Image Servicing and Management tool
Version: 10.0.19041.844

Image Version: 10.0.19044.2965

Enabling feature(s)
[==========================100.0%==========================]
The operation completed successfully.
PS C:\WINDOWS\system32>
```

Fig 5-2 VirtualMachinePlatform

4) Restart your PC and complete the WSL installation.
5) Download and run the WSL2 Linux kernel update package for x64 machines below.
   WSL2 Linux kernel update package for x64 machines


Windows Subsystem for Linux Update Setup

Completed the Windows Subsystem for Linux Update Setup Wizard

Click the Finish button to exit the Setup Wizard.

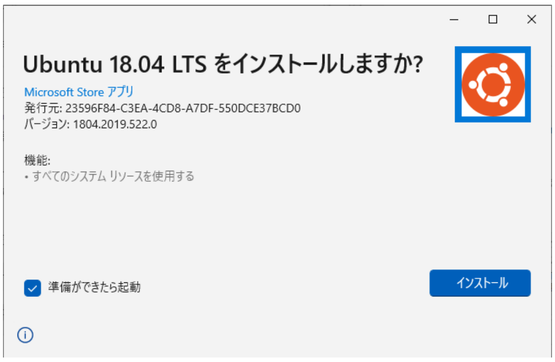
Fig 5-3 wsl_update_x64.msi

6) Run the following command to set WSL 2 as the default version.
   wsl --set-default-version 2

7) Download Linux distribution. Here download Ubuntu 18.04 below.
   Ubuntu 18.04

8) Go to the folder containing the downloaded file and execute the following command.
   Add-AppxPackage . \Ubuntu_1804.2019.522.0_x64.appx

9) Double-click Ubuntu_1804.2019.522.0_x64.appx to install.


Ubuntu 18.04 LTS をインストールしますか?

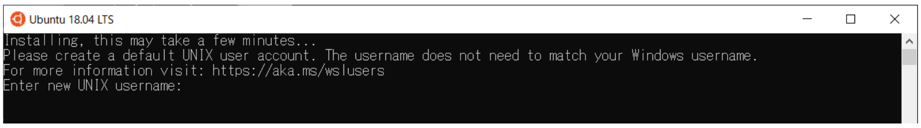
Microsoft Store アプリ
発行元: 23596F84-C3EA-4CD8-A7DF-550DCE37BCD0
バージョン: 1804.2019.522.0

機能:
• すべてのシステム リソースを使用する

☑ 準備ができたら起動

Fig 5-4 Ubuntu Install

10) Set the Linux username and password.
    (Reference) Set up a WSL development environment | Microsoft Learn


Ubuntu 18.04 LTS

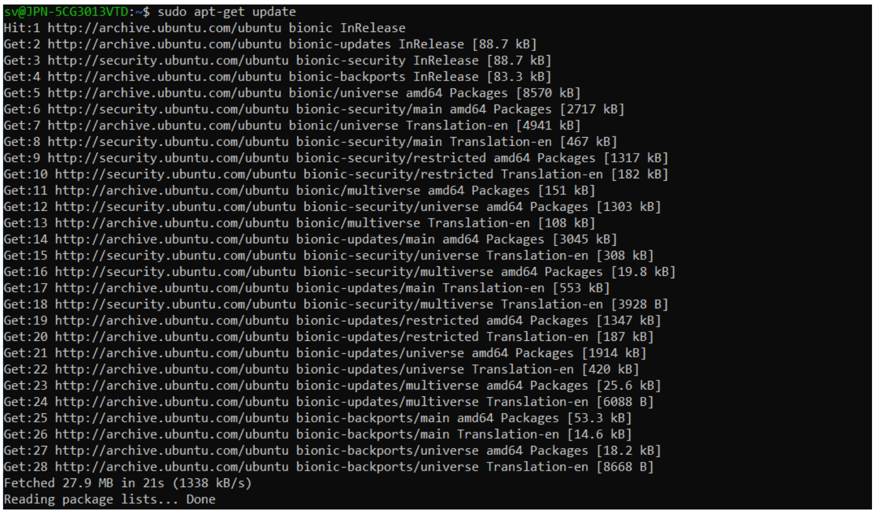
```
Installing, this may take a few minutes...
Please create a default UNIX user account. The username does not need to match your Windows username.
For more information visit: https://aka.ms/wslusers
Enter new UNIX username:
```

Fig 5-5 UNIX username

5.1.2 Install CMake

11) Execute the following Linux command to update apt-get

sudo apt-get update

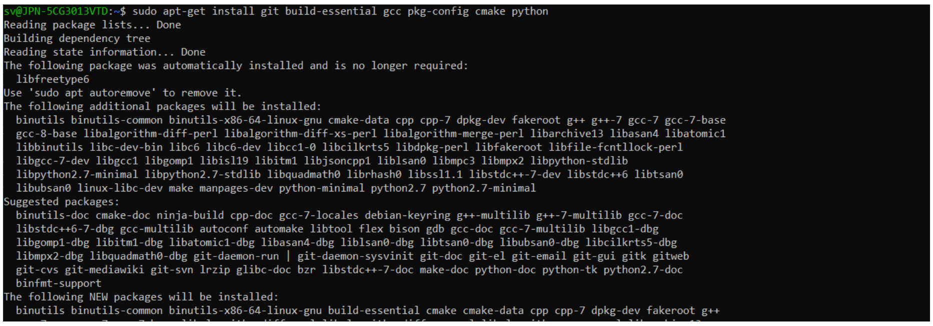


```
sv@JPN-5CG3013VTD:~$ sudo apt-get update
Hit:1 http://archive.ubuntu.com/ubuntu bionic InRelease
Get:2 http://archive.ubuntu.com/ubuntu bionic-updates InRelease [88.7 kB]
Get:3 http://security.ubuntu.com/ubuntu bionic-security InRelease [88.7 kB]
Get:4 http://archive.ubuntu.com/ubuntu bionic-backports InRelease [83.3 kB]
Get:5 http://archive.ubuntu.com/ubuntu bionic/universe amd64 Packages [8570 kB]
Get:6 http://security.ubuntu.com/ubuntu bionic-security/main amd64 Packages [2717 kB]
Get:7 http://archive.ubuntu.com/ubuntu bionic/universe Translation-en [4941 kB]
Get:8 http://security.ubuntu.com/ubuntu bionic-security/main Translation-en [467 kB]
Get:9 http://security.ubuntu.com/ubuntu bionic-security/restricted amd64 Packages [1317 kB]
Get:10 http://security.ubuntu.com/ubuntu bionic-security/restricted Translation-en [182 kB]
Get:11 http://archive.ubuntu.com/ubuntu bionic/multiverse amd64 Packages [151 kB]
Get:12 http://security.ubuntu.com/ubuntu bionic-security/universe amd64 Packages [1303 kB]
Get:13 http://archive.ubuntu.com/ubuntu bionic/multiverse Translation-en [108 kB]
Get:14 http://archive.ubuntu.com/ubuntu bionic-updates/main amd64 Packages [3045 kB]
Get:15 http://security.ubuntu.com/ubuntu bionic-security/universe Translation-en [308 kB]
Get:16 http://security.ubuntu.com/ubuntu bionic-security/multiverse amd64 Packages [19.8 kB]
Get:17 http://archive.ubuntu.com/ubuntu bionic-updates/main Translation-en [553 kB]
Get:18 http://security.ubuntu.com/ubuntu bionic-security/multiverse Translation-en [3928 B]
Get:19 http://archive.ubuntu.com/ubuntu bionic-updates/restricted amd64 Packages [1347 kB]
Get:20 http://archive.ubuntu.com/ubuntu bionic-updates/restricted Translation-en [187 kB]
Get:21 http://archive.ubuntu.com/ubuntu bionic-updates/universe amd64 Packages [1914 kB]
Get:22 http://archive.ubuntu.com/ubuntu bionic-updates/universe Translation-en [420 kB]
Get:23 http://archive.ubuntu.com/ubuntu bionic-updates/multiverse amd64 Packages [25.6 kB]
Get:24 http://archive.ubuntu.com/ubuntu bionic-updates/multiverse Translation-en [6088 B]
Get:25 http://archive.ubuntu.com/ubuntu bionic-backports/main amd64 Packages [53.3 kB]
Get:26 http://archive.ubuntu.com/ubuntu bionic-backports/main Translation-en [14.6 kB]
Get:27 http://archive.ubuntu.com/ubuntu bionic-backports/universe amd64 Packages [18.2 kB]
Get:28 http://archive.ubuntu.com/ubuntu bionic-backports/universe Translation-en [8668 B]
Fetched 27.9 MB in 21s (1338 kB/s)
Reading package lists... Done
```

Fig 5-6 apt-get update

12) Execute the following Linux command

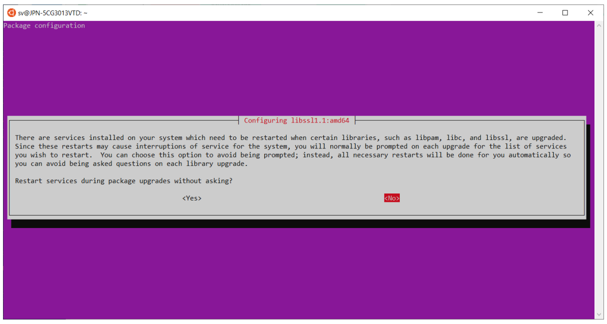
sudo apt-get install git build-essential gcc pkg-config cmake python



```
sv@JPN-5CG3013VTD:~$ sudo apt-get install git build-essential gcc pkg-config cmake python
Reading package lists... Done
Building dependency tree
Reading state information... Done
The following package was automatically installed and is no longer required:
  libfreetype6
Use 'sudo apt autoremove' to remove it.
The following additional packages will be installed:
  binutils binutils-common binutils-x86-64-linux-gnu cmake-data cpp cpp-7 dpkg-dev fakeroot g++ g++-7 gcc-7 gcc-7-base
  gcc-8-base libalgorithm-diff-perl libalgorithm-diff-xs-perl libalgorithm-merge-perl libarchive13 libasan4 libatomic1
  libbinutils libc-dev-bin libc6 libc6-dev libcc1-0 libcilkrts5 libdpkg-perl libfakeroot libfile-fcntllock-perl
  libgcc-7-dev libgcc1 libgomp1 libisl19 libitm1 libjsoncpp1 liblsan0 libmpc3 libmpx2 libpython-stdlib
  libpython2.7-minimal libpython2.7-stdlib libquadmath0 librhash0 libssl1.1 libstdc++-7-dev libstdc++6 libtsan0
  libubsan0 linux-libc-dev make manpages-dev python-minimal python2.7 python2.7-minimal
Suggested packages:
  binutils-doc cmake-doc ninja-build cpp-doc gcc-7-locales debian-keyring g++-multilib g++-7-multilib gcc-7-doc
  libstdc++6-7-dbg gcc-multilib autoconf automake libtool flex bison gdb gcc-doc gcc-7-multilib libgcc1-dbg
  libgomp1-dbg libitm1-dbg libatomic1-dbg libasan4-dbg liblsan0-dbg libtsan0-dbg libubsan0-dbg libcilkrts5-dbg
  libmpx2-dbg libquadmath0-dbg git-daemon-run | git-daemon-sysvinit git-doc git-el git-email git-gui gitk gitweb
  git-cvs git-mediawiki git-svn lrzip glibc-doc bzr libstdc++-7-doc make-doc python-doc python-tk python2.7-doc
  binfmt-support
The following NEW packages will be installed:
  binutils binutils-common binutils-x86-64-linux-gnu build-essential cmake cmake-data cpp cpp-7 dpkg-dev fakeroot g++
```

Fig 5-7 install

When the following screen appears during the process, select OK.

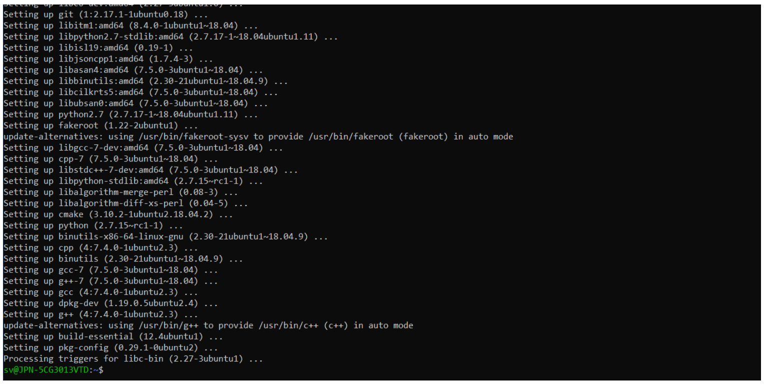


```
Package configuration

┤ Configuring libssl1.1:amd64 ├

There are services installed on your system which need to be restarted when certain libraries, such as libpam, libc, and libssl, are upgraded.
Since these restarts may cause interruptions of service for the system, you will normally be prompted on each upgrade for the list of services
you wish to restart.  You can choose this option to avoid being prompted; instead, all necessary restarts will be done for you automatically so
you can avoid being asked questions on each library upgrade.

Restart services during package upgrades without asking?

                    <Yes>                                        <No>
```

Fig 5-8 restart

13) Execute each of the following commands.

```
sudo apt-get install cmake-curses-gui             # Needed for CMAKE GUI
sudo apt-get install libmbedtls-dev               # For encryption
sudo apt-get install liburcu-dev                  # For multithreading
sudo apt-get install check                        # For unit tests
sudo apt-get install python-sphinx graphviz       # For doc generation
sudo apt-get install python-sphinx-rtd-theme      # For doc's style
```



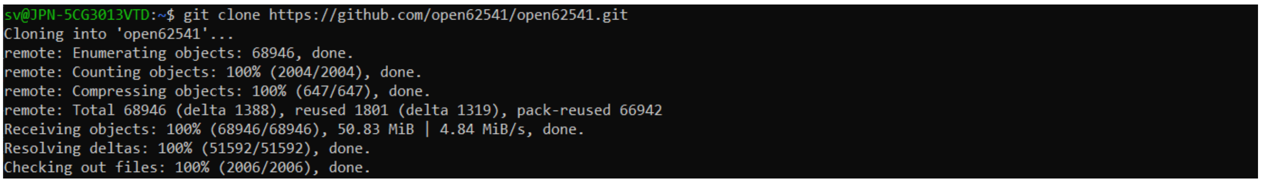
```
Setting up git (1:2.17.1-1ubuntu0.18) ...
Setting up libitm1:amd64 (8.4.0-1ubuntu1~18.04) ...
Setting up libpython2.7-stdlib:amd64 (2.7.17-1~18.04ubuntu1.11) ...
Setting up libisl19:amd64 (0.19-1) ...
Setting up libjsoncpp1:amd64 (1.7.4-3) ...
Setting up libasan4:amd64 (7.5.0-3ubuntu1~18.04) ...
Setting up libbinutils:amd64 (2.30-21ubuntu1~18.04.9) ...
Setting up libcilkrts5:amd64 (7.5.0-3ubuntu1~18.04) ...
Setting up libubsan0:amd64 (7.5.0-3ubuntu1~18.04) ...
Setting up python2.7 (2.7.17-1~18.04ubuntu1.11) ...
Setting up fakeroot (1.22-2ubuntu1) ...
update-alternatives: using /usr/bin/fakeroot-sysv to provide /usr/bin/fakeroot (fakeroot) in auto mode
Setting up libgcc-7-dev:amd64 (7.5.0-3ubuntu1~18.04) ...
Setting up cpp-7 (7.5.0-3ubuntu1~18.04) ...
Setting up libstdc++-7-dev:amd64 (7.5.0-3ubuntu1~18.04) ...
Setting up libpython-stdlib:amd64 (2.7.15~rc1-1) ...
Setting up libalgorithm-merge-perl (0.08-3) ...
Setting up libalgorithm-diff-xs-perl (0.04-5) ...
Setting up cmake (3.10.2-1ubuntu2.18.04.2) ...
Setting up python (2.7.15~rc1-1) ...
Setting up binutils-x86-64-linux-gnu (2.30-21ubuntu1~18.04.9) ...
Setting up cpp (4:7.4.0-1ubuntu2.3) ...
Setting up binutils (2.30-21ubuntu1~18.04.9) ...
Setting up gcc-7 (7.5.0-3ubuntu1~18.04) ...
Setting up g++-7 (7.5.0-3ubuntu1~18.04) ...
Setting up gcc (4:7.4.0-1ubuntu2.3) ...
Setting up dpkg-dev (1.19.0.5ubuntu2.4) ...
Setting up g++ (4:7.4.0-1ubuntu2.3) ...
update-alternatives: using /usr/bin/g++ to provide /usr/bin/c++ (c++) in auto mode
Setting up build-essential (12.4ubuntu1) ...
Setting up pkg-config (0.29.1-0ubuntu2) ...
Processing triggers for libc-bin (2.27-3ubuntu1) ...
sv@JPN-5CG3013VTD:~$
```

Fig 5-9 install

5.1.3 open62541 File Generation

14) Clone open62541 to any folder

git clone https://github.com/open62541/open62541.git

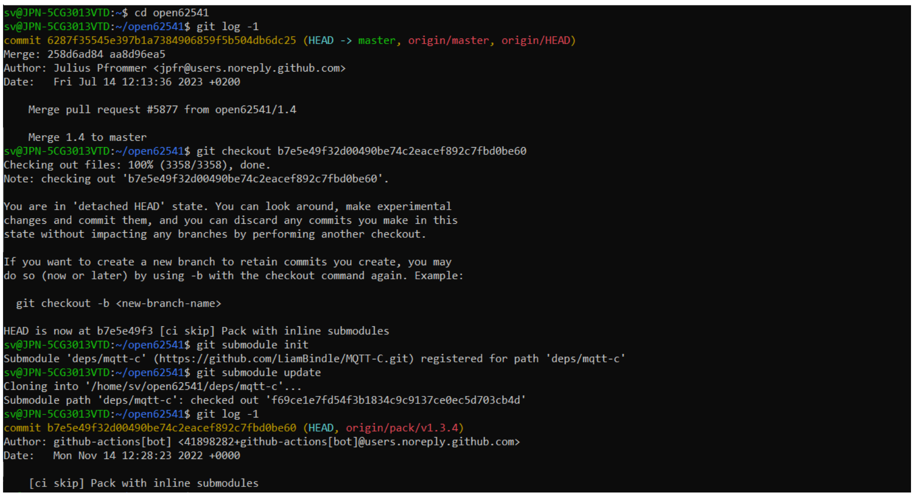


```
sv@JPN-5CG3013VTD:~$ git clone https://github.com/open62541/open62541.git
Cloning into 'open62541'...
remote: Enumerating objects: 68946, done.
remote: Counting objects: 100% (2004/2004), done.
remote: Compressing objects: 100% (647/647), done.
remote: Total 68946 (delta 1388), reused 1801 (delta 1319), pack-reused 66942
Receiving objects: 100% (68946/68946), 50.83 MiB | 4.84 MiB/s, done.
Resolving deltas: 100% (51592/51592), done.
Checking out files: 100% (2006/2006), done.
```

Fig 5-10 git clone

15) Go to /open62541 directory and check out the specific version (here, version v1.3.4-564-gb7e5e49f3).

```
cd open62541/
git log -1
git checkout b7e5e49f32d00490be74c2eacef892c7fbd0be60
git submodule init
git submodule update
```



```
sv@JPN-5CG3013VTD:~$ cd open62541
sv@JPN-5CG3013VTD:~/open62541$ git log -1
commit 6287f35545e397b1a7384906859f5b504db6dc25 (HEAD -> master, origin/master, origin/HEAD)
Merge: 258d6ad84 aa8d96ea5
Author: Julius Pfrommer <jpfr@users.noreply.github.com>
Date:   Fri Jul 14 12:13:36 2023 +0200

    Merge pull request #5877 from open62541/1.4

    Merge 1.4 to master
sv@JPN-5CG3013VTD:~/open62541$ git checkout b7e5e49f32d00490be74c2eacef892c7fbd0be60
Checking out files: 100% (3358/3358), done.
Note: checking out 'b7e5e49f32d00490be74c2eacef892c7fbd0be60'.

You are in 'detached HEAD' state. You can look around, make experimental
changes and commit them, and you can discard any commits you make in this
state without impacting any branches by performing another checkout.

If you want to create a new branch to retain commits you create, you may
do so (now or later) by using -b with the checkout command again. Example:

  git checkout -b <new-branch-name>

HEAD is now at b7e5e49f3 [ci skip] Pack with inline submodules
sv@JPN-5CG3013VTD:~/open62541$ git submodule init
Submodule 'deps/mqtt-c' (https://github.com/LiamBindle/MQTT-C.git) registered for path 'deps/mqtt-c'
sv@JPN-5CG3013VTD:~/open62541$ git submodule update
Cloning into '/home/sv/open62541/deps/mqtt-c'...
Submodule path 'deps/mqtt-c': checked out 'f69ce1e7fd54f3b1834c9c9137ce0ec5d703cb4d'
sv@JPN-5CG3013VTD:~/open62541$ git log -1
commit b7e5e49f32d00490be74c2eacef892c7fbd0be60 (HEAD, origin/pack/v1.3.4)
Author: github-actions[bot] <41898282+github-actions[bot]@users.noreply.github.com>
Date:   Mon Nov 14 12:28:23 2022 +0000

    [ci skip] Pack with inline submodules
```

Fig 5-11 git submodule

16) Open the Linux folder from File Explorer. Confirm that CMakeLists.txt is present in */home/(username)/open62541* directory. Copy the following four patch files obtained by unzipping patch_open62541.zip attached to the sample software to this directory.

CMakeLists.txt.patch

Opc.Ua.NodeSet2.Reduced.xml.patch

Opc.Ua.Renesas.NodeSet2.xml

patch.sh

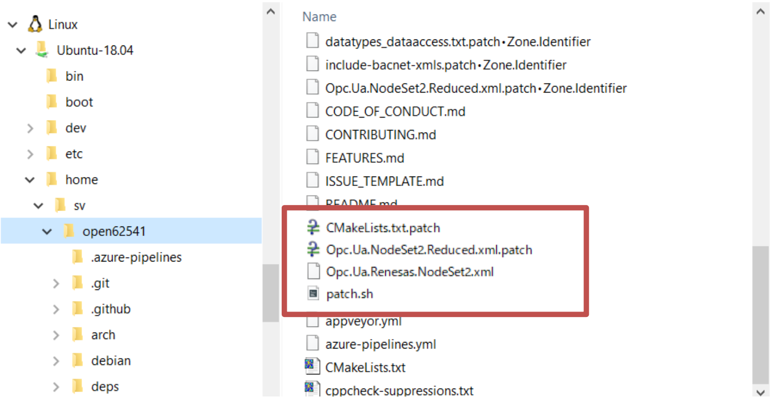
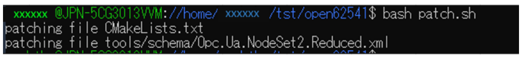


Fig 5-12 Copy patch files

17) Execute following command in /open62541 directory

bash patch.sh



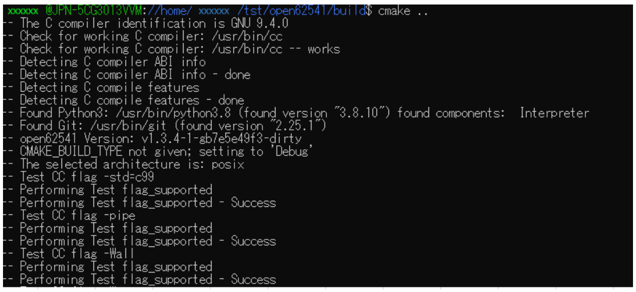
```
 xxxxxx @JPN-5CG3013VVM://home/ xxxxxx /tst/open62541$ bash patch.sh
patching file CMakeLists.txt
patching file tools/schema/Opc.Ua.NodeSet2.Reduced.xml
```

Fig 5-13 patch command

18) Compile the library according to the standard procedures of the cmake project. Create /open62541/build directory and run cmake . (Some items will be Failed, but there is no problem. (Some items will be Failed, but that is not a problem.)

mkdir build && cd build

cmake ..



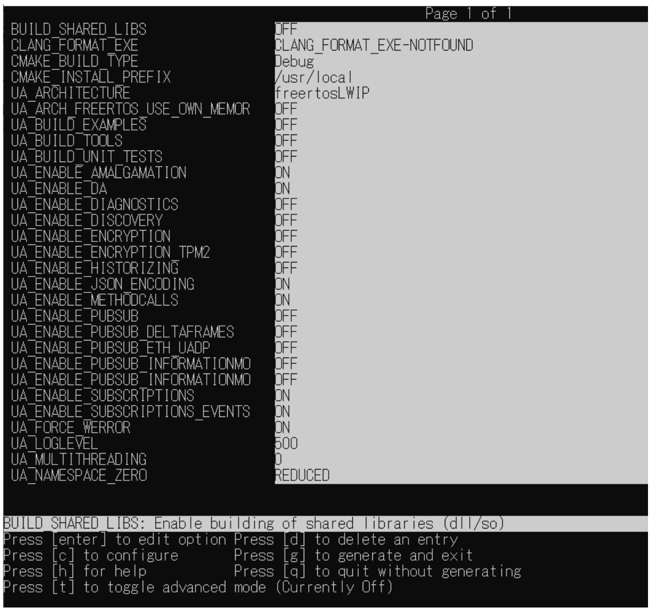
```
xxxxxx @JPN-5CG3013VVM://home/ xxxxxx /tst/open62541/build$ cmake ..
-- The C compiler identification is GNU 9.4.0
-- Check for working C compiler: /usr/bin/cc
-- Check for working C compiler: /usr/bin/cc -- works
-- Detecting C compiler ABI info
-- Detecting C compiler ABI info - done
-- Detecting C compile features
-- Detecting C compile features - done
-- Found Python3: /usr/bin/python3.8 (found version "3.8.10") found components:  Interpreter
-- Found Git: /usr/bin/git (found version "2.25.1")
-- open62541 Version: v1.3.4-1-gb7e5e49f3-dirty
-- CMAKE_BUILD_TYPE not given; setting to 'Debug'
-- The selected architecture is: posix
-- Test CC flag -std=c99
-- Performing Test flag_supported
-- Performing Test flag_supported - Success
-- Test CC flag -pipe
-- Performing Test flag_supported
-- Performing Test flag_supported - Success
-- Test CC flag -Wall
-- Performing Test flag_supported
-- Performing Test flag_supported - Success
```

Fig 5-14 cmake

19) Execute the following command to start the ccmake setting window.

ccmake ..

20) Change the settings as follows, and after executing [c] to configure, close it by [q] to quit without generating.

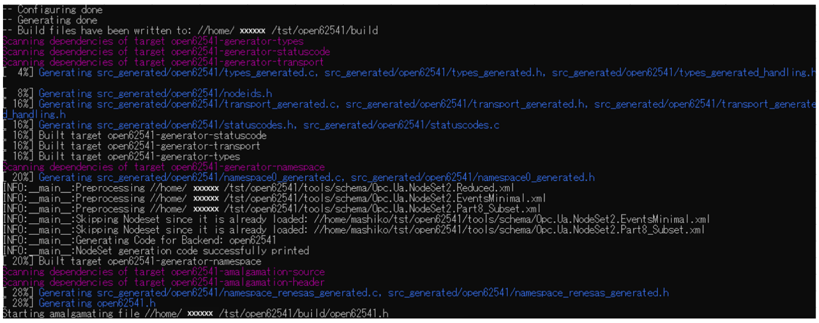


```
                                                   Page 1 of 1
 BUILD_SHARED_LIBS                OFF
 CLANG_FORMAT_EXE                 CLANG_FORMAT_EXE-NOTFOUND
 CMAKE_BUILD_TYPE                 Debug
 CMAKE_INSTALL_PREFIX             /usr/local
 UA_ARCHITECTURE                  freertosLWIP
 UA_ARCH_FREERTOS_USE_OWN_MEMOR   OFF
 UA_BUILD_EXAMPLES                OFF
 UA_BUILD_TOOLS                   OFF
 UA_BUILD_UNIT_TESTS              OFF
 UA_ENABLE_AMALGAMATION           ON
 UA_ENABLE_DA                     ON
 UA_ENABLE_DIAGNOSTICS            OFF
 UA_ENABLE_DISCOVERY              OFF
 UA_ENABLE_ENCRYPTION             OFF
 UA_ENABLE_ENCRYPTION_TPM2        OFF
 UA_ENABLE_HISTORIZING            OFF
 UA_ENABLE_JSON_ENCODING          ON
 UA_ENABLE_METHODCALLS            ON
 UA_ENABLE_PUBSUB                 OFF
 UA_ENABLE_PUBSUB_DELTAFRAMES     OFF
 UA_ENABLE_PUBSUB_ETH_UADP        OFF
 UA_ENABLE_PUBSUB_INFORMATIONMO   OFF
 UA_ENABLE_PUBSUB_INFORMATIONMO   OFF
 UA_ENABLE_SUBSCRIPTIONS          ON
 UA_ENABLE_SUBSCRIPTIONS_EVENTS   ON
 UA_FORCE_WERROR                  ON
 UA_LOGLEVEL                      500
 UA_MULTITHREADING                0
 UA_NAMESPACE_ZERO                REDUCED


BUILD_SHARED_LIBS: Enable building of shared libraries (dll/so)
Press [enter] to edit option Press [d] to delete an entry
Press [c] to configure       Press [g] to generate and exit
Press [h] for help           Press [q] to quit without generating
Press [t] to toggle advanced mode (Currently Off)
```

Fig 5-15 ccmake

21) Execute the following command to make in the */open62541/build* directory. The make process will finish with an error, but it does not matter.

make -j

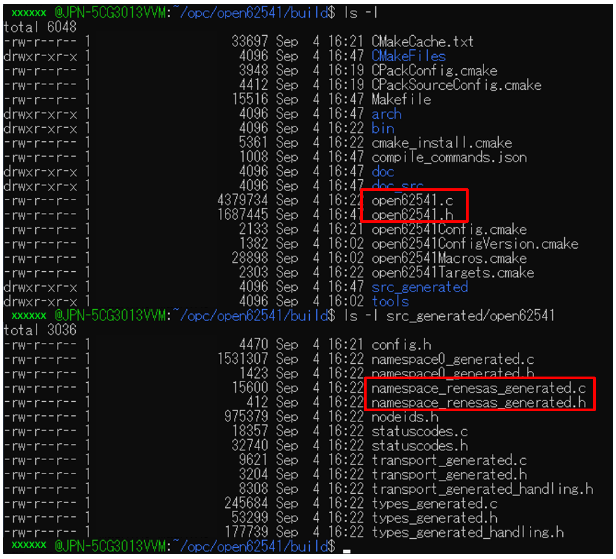


```
-- Configuring done
-- Generating done
-- Build files have been written to: //home/ xxxxxx /tst/open62541/build
Scanning dependencies of target open62541-generator-types
Scanning dependencies of target open62541-generator-statuscode
Scanning dependencies of target open62541-generator-transport
[  4%] Generating src_generated/open62541/types_generated.c, src_generated/open62541/types_generated.h, src_generated/open62541/types_generated_handling.h

[  8%] Generating src_generated/open62541/nodeids.h
[ 16%] Generating src_generated/open62541/transport_generated.c, src_generated/open62541/transport_generated.h, src_generated/open62541/transport_generate
d_handling.h
[ 16%] Generating src_generated/open62541/statuscodes.h, src_generated/open62541/statuscodes.c
[ 16%] Built target open62541-generator-statuscode
[ 16%] Built target open62541-generator-transport
[ 16%] Built target open62541-generator-types
Scanning dependencies of target open62541-generator-namespace
[ 20%] Generating src_generated/open62541/namespace0_generated.c, src_generated/open62541/namespace0_generated.h
INFO:__main__:Preprocessing //home/ xxxxxx /tst/open62541/tools/schema/Opc.Ua.NodeSet2.Reduced.xml
INFO:__main__:Preprocessing //home/ xxxxxx /tst/open62541/tools/schema/Opc.Ua.NodeSet2.EventsMinimal.xml
INFO:__main__:Preprocessing //home/ xxxxxx /tst/open62541/tools/schema/Opc.Ua.NodeSet2.Part8_Subset.xml
INFO:__main__:Skipping Nodeset since it is already loaded: //home/mashiko/tst/open62541/tools/schema/Opc.Ua.NodeSet2.EventsMinimal.xml
INFO:__main__:Skipping Nodeset since it is already loaded: //home/mashiko/tst/open62541/tools/schema/Opc.Ua.NodeSet2.Part8_Subset.xml
INFO:__main__:Generating Code for Backend: open62541
INFO:__main__:NodeSet generation code successfully printed
[ 20%] Built target open62541-generator-namespace
Scanning dependencies of target open62541-amalgamation-source
Scanning dependencies of target open62541-amalgamation-header
[ 28%] Generating src_generated/open62541/namespace_renesas_generated.c, src_generated/open62541/namespace_renesas_generated.h
[ 28%] Generating open62541.h
Starting amalgamating file //home/ xxxxxx /tst/open62541/build/open62541.h
```

Fig 5-16 make

22) Confirm that the following files are generated in /opn62541/build and /src_generated/open62541 directories.

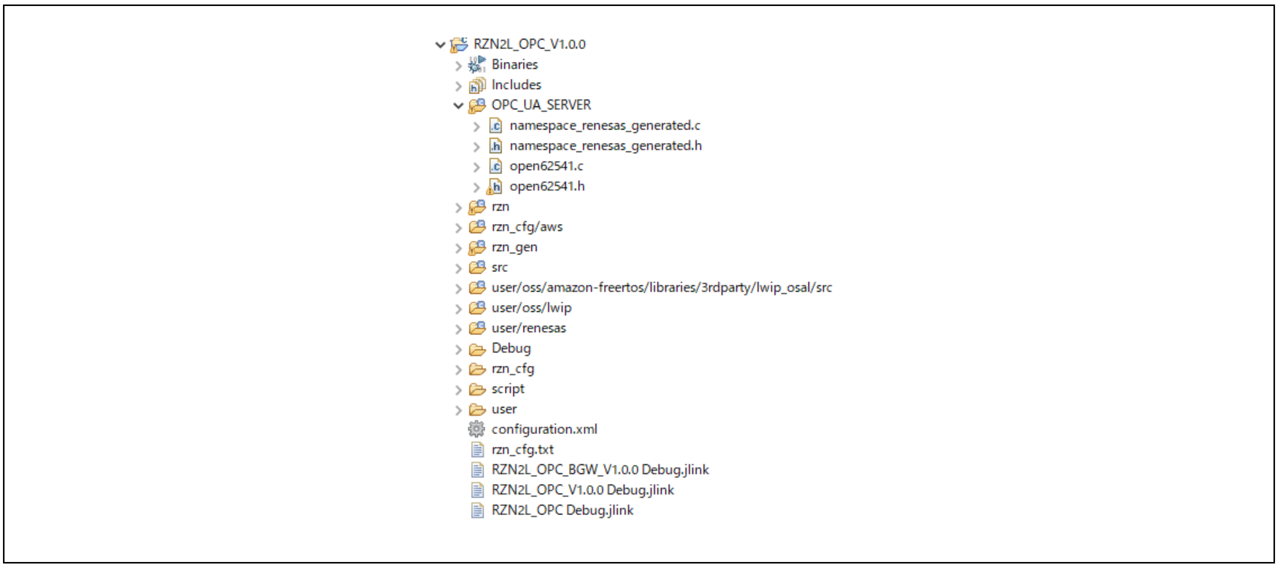
- *open62541.c*
- *open62541.h*
- *namespace_renesas_generated.c*
- *namespace_renesas_generated.h*



```
 xxxxxx @JPN-5CG3013VVM:~/opc/open62541/build$ ls -l
total 6048
-rw-r--r-- 1                  33697 Sep  4 16:21 CMakeCache.txt
drwxr-xr-x 1                   4096 Sep  4 16:47 CMakeFiles
-rw-r--r-- 1                   3948 Sep  4 16:19 CPackConfig.cmake
-rw-r--r-- 1                   4412 Sep  4 16:19 CPackSourceConfig.cmake
-rw-r--r-- 1                  15516 Sep  4 16:47 Makefile
drwxr-xr-x 1                   4096 Sep  4 16:47 arch
drwxr-xr-x 1                   4096 Sep  4 16:22 bin
-rw-r--r-- 1                   5361 Sep  4 16:22 cmake_install.cmake
-rw-r--r-- 1                   1008 Sep  4 16:47 compile_commands.json
drwxr-xr-x 1                   4096 Sep  4 16:47 doc
drwxr-xr-x 1                   4096 Sep  4 16:47 doc_src
-rw-r--r-- 1                4379734 Sep  4 16:22 open62541.c
-rw-r--r-- 1                1687445 Sep  4 16:47 open62541.h
-rw-r--r-- 1                   2133 Sep  4 16:21 open62541Config.cmake
-rw-r--r-- 1                   1382 Sep  4 16:02 open62541ConfigVersion.cmake
-rw-r--r-- 1                  28898 Sep  4 16:02 open62541Macros.cmake
-rw-r--r-- 1                   2303 Sep  4 16:22 open62541Targets.cmake
drwxr-xr-x 1                   4096 Sep  4 16:47 src_generated
drwxr-xr-x 1                   4096 Sep  4 16:02 tools
 xxxxxx @JPN-5CG3013VVM:~/opc/open62541/build$ ls -l src_generated/open62541
total 3036
-rw-r--r-- 1                   4470 Sep  4 16:21 config.h
-rw-r--r-- 1                1531307 Sep  4 16:22 namespace0_generated.c
-rw-r--r-- 1                   1423 Sep  4 16:22 namespace0_generated.h
-rw-r--r-- 1                  15600 Sep  4 16:22 namespace_renesas_generated.c
-rw-r--r-- 1                    412 Sep  4 16:22 namespace_renesas_generated.h
-rw-r--r-- 1                 975379 Sep  4 16:22 nodeids.h
-rw-r--r-- 1                  18357 Sep  4 16:22 statuscodes.c
-rw-r--r-- 1                  32740 Sep  4 16:22 statuscodes.h
-rw-r--r-- 1                   9621 Sep  4 16:22 transport_generated.c
-rw-r--r-- 1                   3204 Sep  4 16:22 transport_generated.h
-rw-r--r-- 1                   8308 Sep  4 16:22 transport_generated_handling.h
-rw-r--r-- 1                 245684 Sep  4 16:22 types_generated.c
-rw-r--r-- 1                  53299 Sep  4 16:22 types_generated.h
-rw-r--r-- 1                 177739 Sep  4 16:22 types_generated_handling.h
 xxxxxx @JPN-5CG3013VVM:~/opc/open62541/build$ _
```

Fig 5-17 Generated Files

23) Create a folder in the IDE project and import the generated files into the project as shown in the figure. Where OPC_UA_SERVER is the file created under the e^2 studio project.

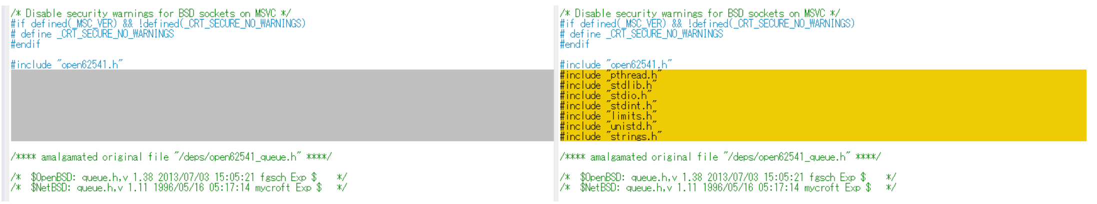


```
RZN2L_OPC_V1.0.0
  Binaries
  Includes
  OPC_UA_SERVER
    namespace_renesas_generated.c
    namespace_renesas_generated.h
    open62541.c
    open62541.h
  rzn
  rzn_cfg/aws
  rzn_gen
  src
  user/oss/amazon-freertos/libraries/3rdparty/lwip_osal/src
  user/oss/lwip
  user/renesas
  Debug
  rzn_cfg
  script
  user
  configuration.xml
  rzn_cfg.txt
  RZN2L_OPC_BGW_V1.0.0 Debug.jlink
  RZN2L_OPC_V1.0.0 Debug.jlink
  RZN2L_OPC Debug.jlink
```

Fig 5-18 Import

5.1.4 Changes in Generated Files

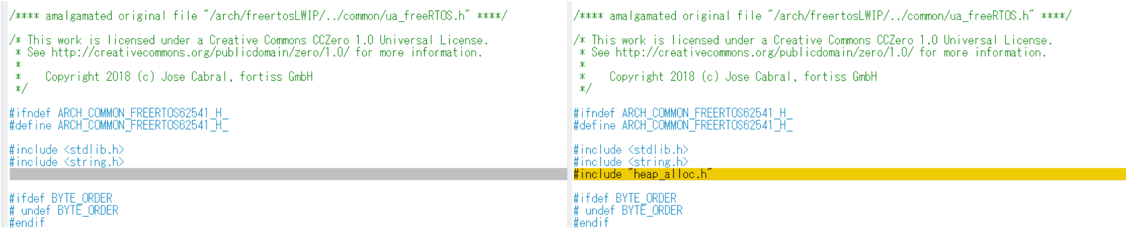
Several changes have been made to the open62541.c, h file generated by this procedure. The changes are shown in Fig 5-19 and Fig 5-20.



```
/* Disable security warnings for BSD sockets on MSVC */
#if defined(_MSC_VER) && !defined(_CRT_SECURE_NO_WARNINGS)
# define _CRT_SECURE_NO_WARNINGS
#endif

#include "open62541.h"

/**** amalgamated original file "/deps/open62541_queue.h" ****/

/*  $OpenBSD: queue.h,v 1.38 2013/07/03 15:05:21 fgsch Exp $    */
/*  $NetBSD: queue.h,v 1.11 1996/05/16 05:17:14 mycroft Exp $   */
```

```
/* Disable security warnings for BSD sockets on MSVC */
#if defined(_MSC_VER) && !defined(_CRT_SECURE_NO_WARNINGS)
# define _CRT_SECURE_NO_WARNINGS
#endif

#include "open62541.h"
#include "pthread.h"
#include "stdlib.h"
#include "stdio.h"
#include "stdint.h"
#include "limits.h"
#include "unistd.h"
#include "strings.h"

/**** amalgamated original file "/deps/open62541_queue.h" ****/

/*  $OpenBSD: queue.h,v 1.38 2013/07/03 15:05:21 fgsch Exp $    */
/*  $NetBSD: queue.h,v 1.11 1996/05/16 05:17:14 mycroft Exp $   */
```

Fig 5-19 Difference in open62541.c



```
/**** amalgamated original file "/arch/freertosLWIP/../common/ua_freeRTOS.h" ****/

/* This work is licensed under a Creative Commons CCZero 1.0 Universal License.
 * See http://creativecommons.org/publicdomain/zero/1.0/ for more information.
 *
 *    Copyright 2018 (c) Jose Cabral, fortiss GmbH
 */

#ifndef ARCH_COMMON_FREERTOS62541_H_
#define ARCH_COMMON_FREERTOS62541_H_

#include <stdlib.h>
#include <string.h>


#ifdef BYTE_ORDER
# undef BYTE_ORDER
#endif
```

```
/**** amalgamated original file "/arch/freertosLWIP/../common/ua_freeRTOS.h" ****/

/* This work is licensed under a Creative Commons CCZero 1.0 Universal License.
 * See http://creativecommons.org/publicdomain/zero/1.0/ for more information.
 *
 *    Copyright 2018 (c) Jose Cabral, fortiss GmbH
 */

#ifndef ARCH_COMMON_FREERTOS62541_H_
#define ARCH_COMMON_FREERTOS62541_H_

#include <stdlib.h>
#include <string.h>
#include "heap_alloc.h"

#ifdef BYTE_ORDER
# undef BYTE_ORDER
#endif
```

Fig 5-20 Difference in open62541.h

5.2 FSP Configuration for VSC8531 and SSC port

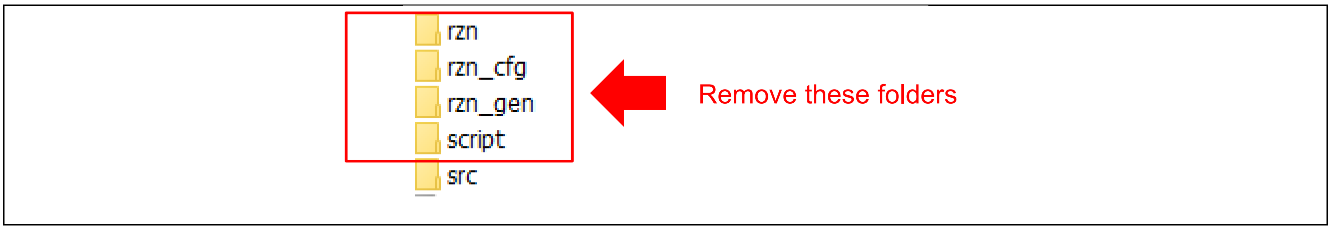
RZ/N2L Industrial Network SOM Kit has VSC8531 as PHY chip.
If reconfiguring by latest FSP, FSP configuration and source code needs to change from default.

In addition, since interrupts are used for IO control, SSC port driver also needs to change.

(1) Regenerate source files by lates FSP

Remove the following four folders. After that, open the project according to section 5.

- When using e2studio, \project\rzn2l_som\ecat_IO\e2studio
- When using EWARM, \project\rzn2l_som\ecat_IO\ewarm



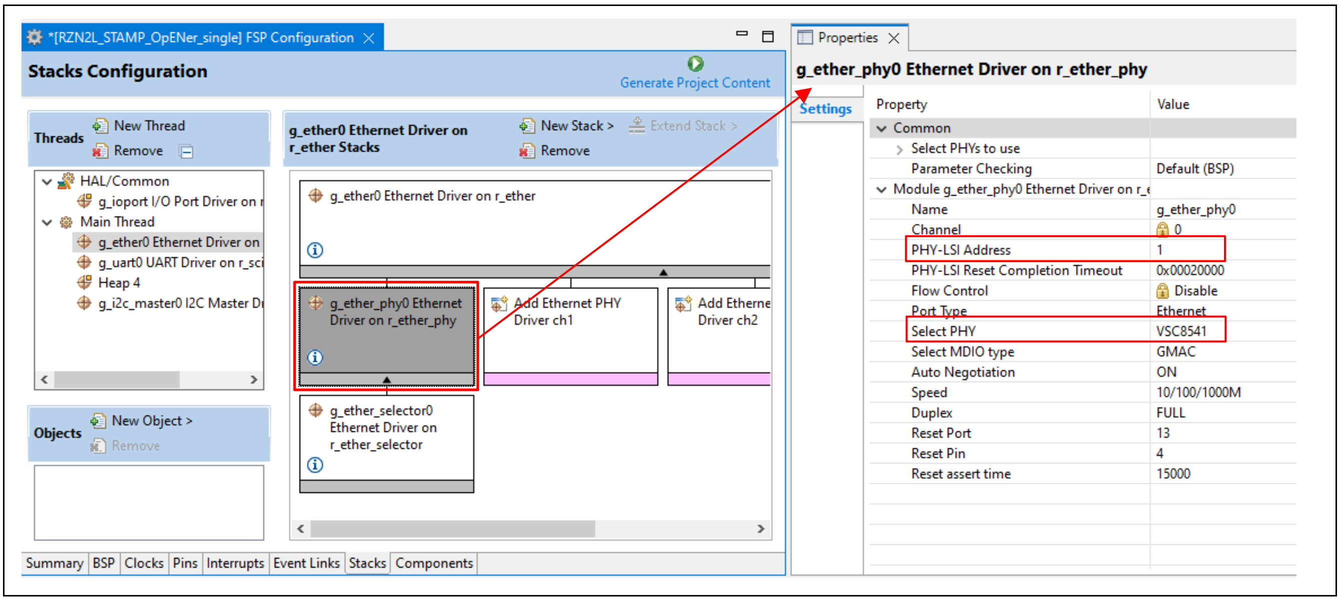
rzn
rzn_cfg
rzn_gen
script
src

Remove these folders

Figure 5-1 Remove folder generated by FSP

(2) Change ethernet driver configuration for VSC8531

Configure g_ether_phy0 Ethernet Driver on r_ether_phy for VSC8531 as shown in Figure 5-2. Configuration value for VSC8531 shows in Table 5-1.


*[RZN2L_STAMP_OpENer_single] FSP Configuration
Stacks Configuration
Generate Project Content
Threads
New Thread
Remove
HAL/Common
g_ioport I/O Port Driver on r
Main Thread
g_ether0 Ethernet Driver on
g_uart0 UART Driver on r_sci
Heap 4
g_i2c_master0 I2C Master Dr
Objects
New Object >
Remove
g_ether0 Ethernet Driver on r_ether Stacks
New Stack >
Extend Stack >
Remove
g_ether0 Ethernet Driver on r_ether
g_ether_phy0 Ethernet Driver on r_ether_phy
Add Ethernet PHY Driver ch1
Add Etherne Driver ch2
g_ether_selector0 Ethernet Driver on r_ether_selector
Summary
BSP
Clocks
Pins
Interrupts
Event Links
Stacks
Components
Properties
Settings

g_ether_phy0 Ethernet Driver on r_ether_phy

Property	Value
Common	
Select PHYs to use	
Parameter Checking	Default (BSP)
Module g_ether_phy0 Ethernet Driver on r_e	
Name	g_ether_phy0
Channel	0
PHY-LSI Address	1
PHY-LSI Reset Completion Timeout	0x00020000
Flow Control	Disable
Port Type	Ethernet
Select PHY	VSC8541
Select MDIO type	GMAC
Auto Negotiation	ON
Speed	10/100/1000M
Duplex	FULL
Reset Port	13
Reset Pin	4
Reset assert time	15000

Figure 5-2 Ethernet Driver Configuration for VSC8531 (e.g. ETH0)

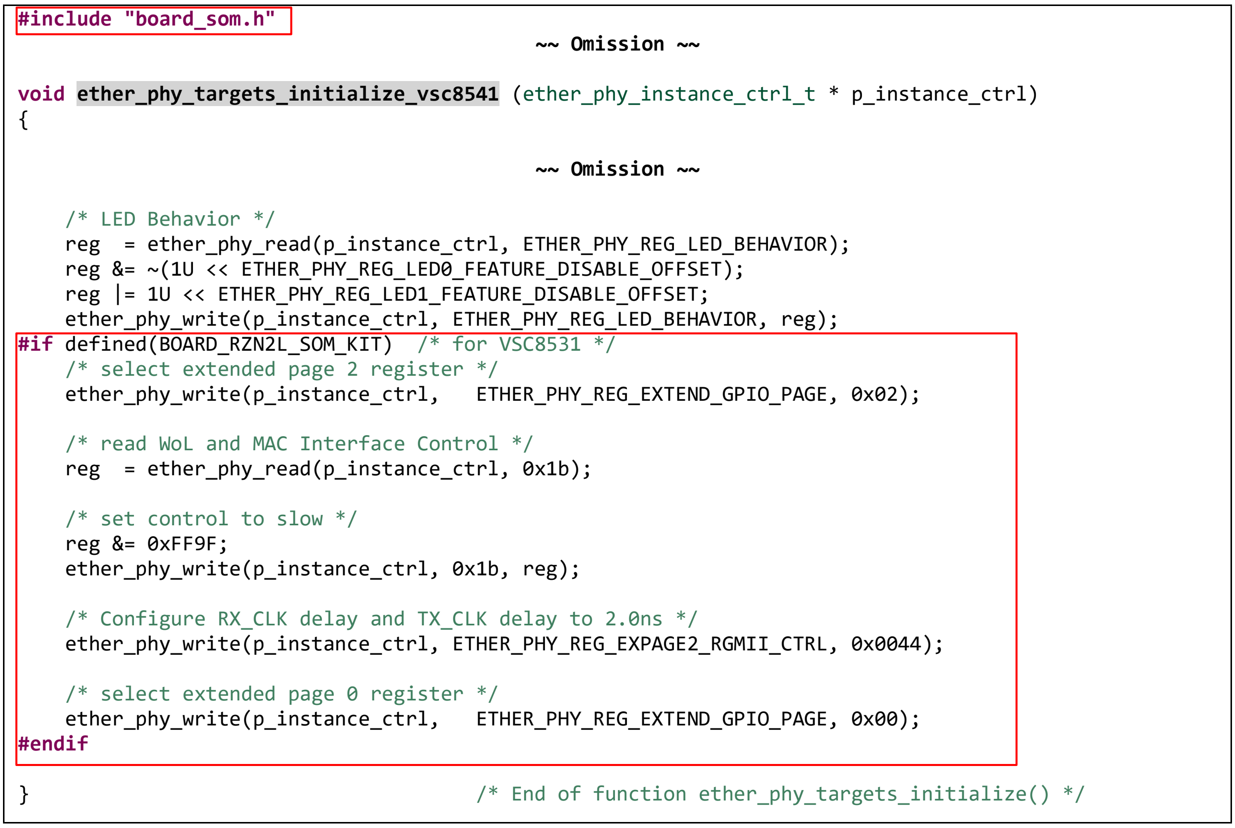
Table 5-1 FSP Configuration Value for VSC8531

Items	Default value	Config value for VSC8531	
		ETH0	ETH1
PHY-LSI Address	0	0	1
Select PHY	Default	VSC8541	VSC8541

(3) Add initialization code for VSC8531

The following code for VSC8531 initialization should be added to “ether_phy_targets_initialize_vsc8541” function in rzn/fsp/src/r_ether_phy/r_ether_phy.c.

The inclusion of “board_som.h” is aiso required for code activation.



```
#include "board_som.h"
                                        ~~ Omission ~~

void ether_phy_targets_initialize_vsc8541 (ether_phy_instance_ctrl_t * p_instance_ctrl)
{

                                        ~~ Omission ~~

    /* LED Behavior */
    reg  = ether_phy_read(p_instance_ctrl, ETHER_PHY_REG_LED_BEHAVIOR);
    reg &= ~(1U << ETHER_PHY_REG_LED0_FEATURE_DISABLE_OFFSET);
    reg |= 1U << ETHER_PHY_REG_LED1_FEATURE_DISABLE_OFFSET;
    ether_phy_write(p_instance_ctrl, ETHER_PHY_REG_LED_BEHAVIOR, reg);
#if defined(BOARD_RZN2L_SOM_KIT)  /* for VSC8531 */
    /* select extended page 2 register */
    ether_phy_write(p_instance_ctrl,   ETHER_PHY_REG_EXTEND_GPIO_PAGE, 0x02);

    /* read WoL and MAC Interface Control */
    reg  = ether_phy_read(p_instance_ctrl, 0x1b);

    /* set control to slow */
    reg &= 0xFF9F;
    ether_phy_write(p_instance_ctrl, 0x1b, reg);

    /* Configure RX_CLK delay and TX_CLK delay to 2.0ns */
    ether_phy_write(p_instance_ctrl, ETHER_PHY_REG_EXPAGE2_RGMII_CTRL, 0x0044);

    /* select extended page 0 register */
    ether_phy_write(p_instance_ctrl,   ETHER_PHY_REG_EXTEND_GPIO_PAGE, 0x00);
#endif

}                                       /* End of function ether_phy_targets_initialize() */
```

Revision History

Rev.	Date	Description	
		Page	Summary
1.00	Nov/30/2023	-	First Edition

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   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.
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   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.
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   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.
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