RZ/N2L Group

R01AN7181EJ0100
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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	e² 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 e² studio installer
Flexible Software Package	FSP	1.2.0		Included with e² studio installer
GNU Arm Embedded Toolchain	GCC Toolchain	V9.3.1.20200408 (*1)		Included with e² 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 e² 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

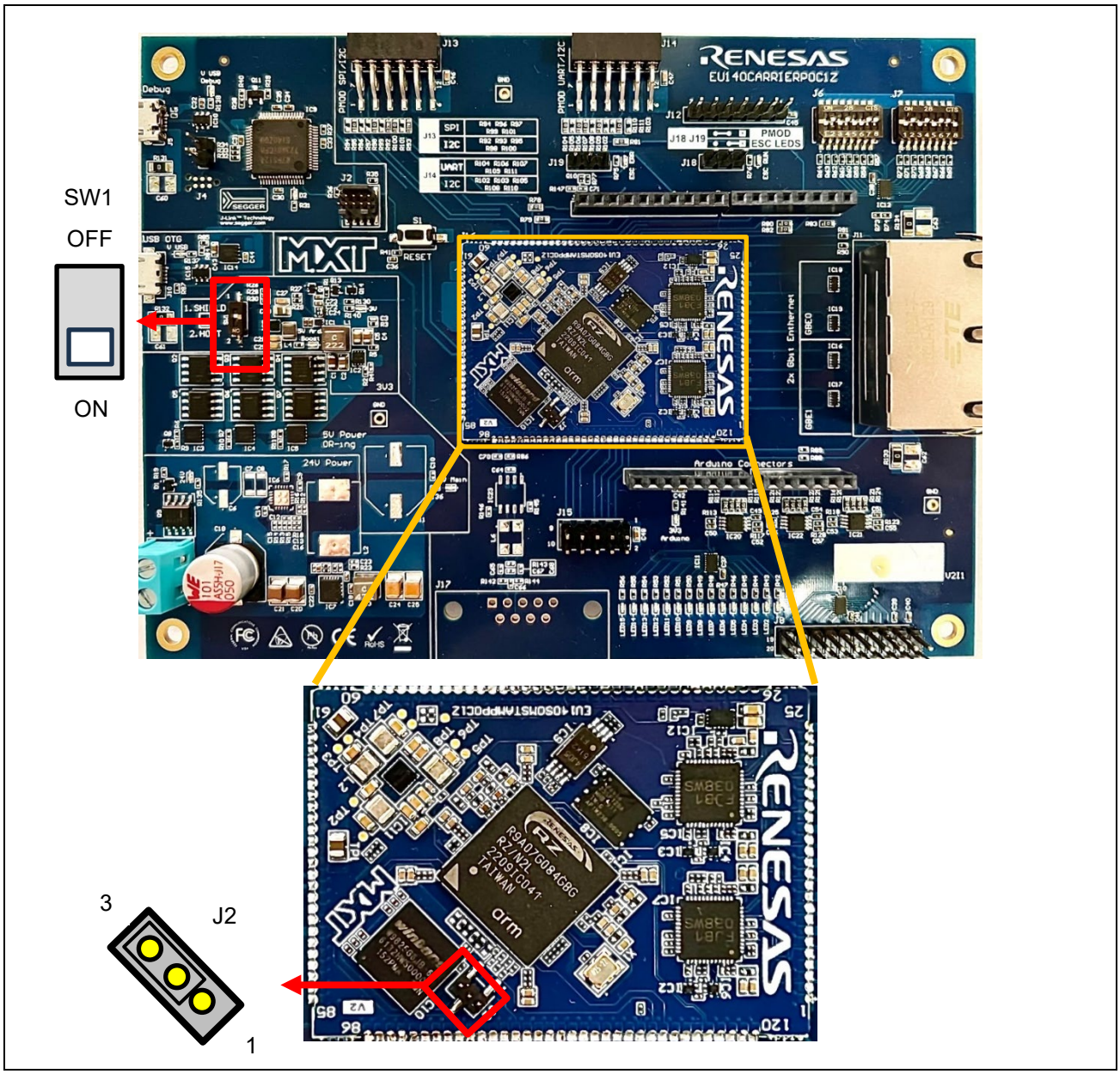


Fig 2-1 Board Configuration

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.

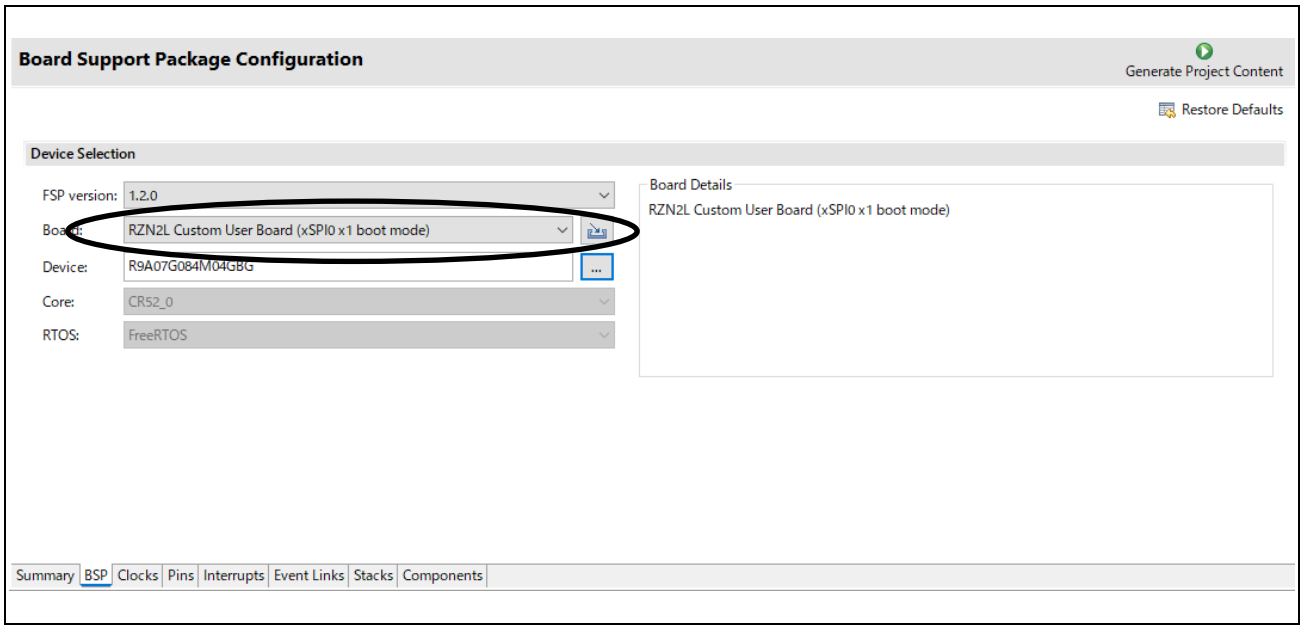


Fig 3-2 Boot mode

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.

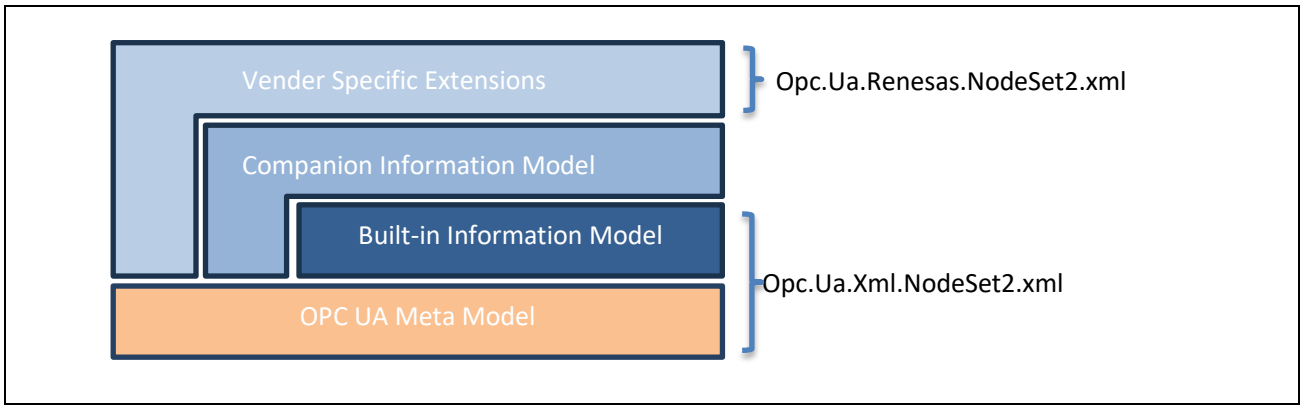


Fig 3-3 Information Model

(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 e² 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, e² 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”.

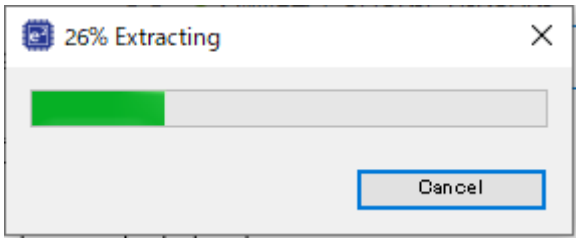


Fig 3-4 e² studio Install (1)

・Select Users

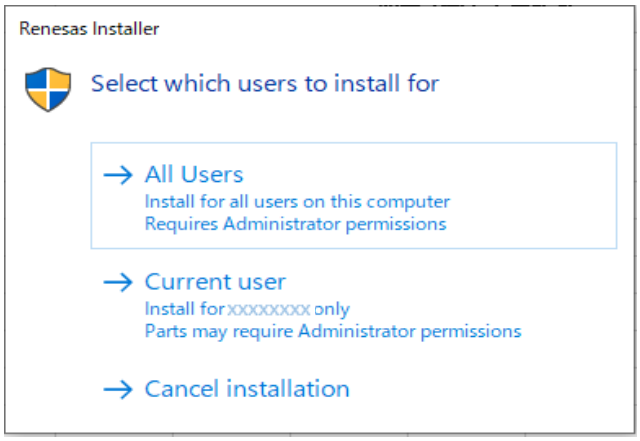


Fig 3-5 e² studio Install (2)

・Select Install Type

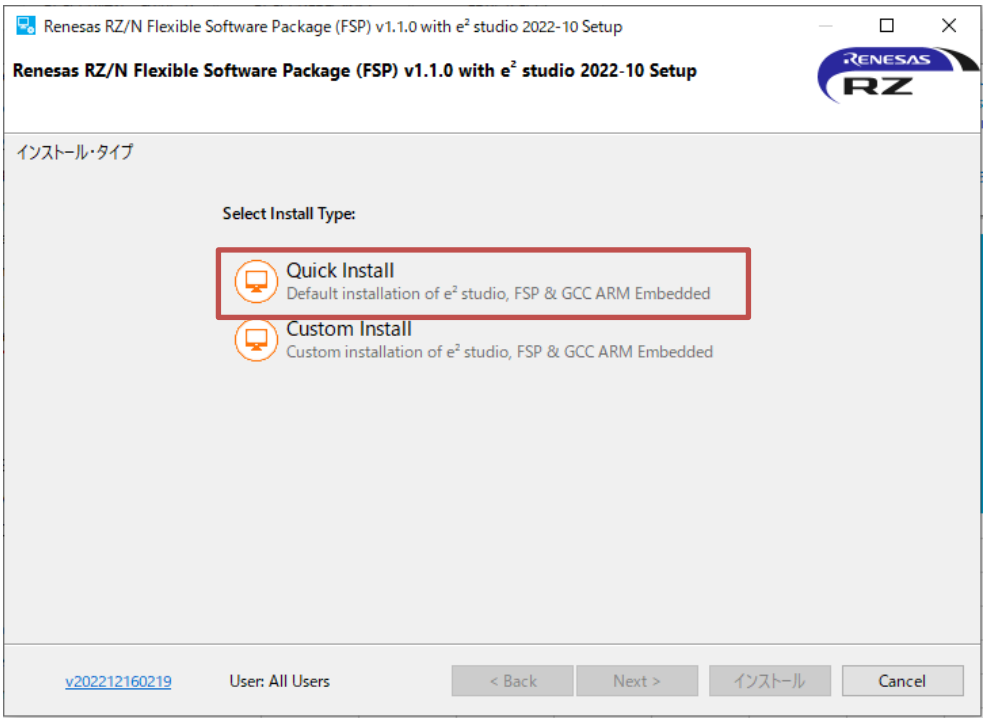


Fig 3-6 e² studio Install (3)

・Select Install folder

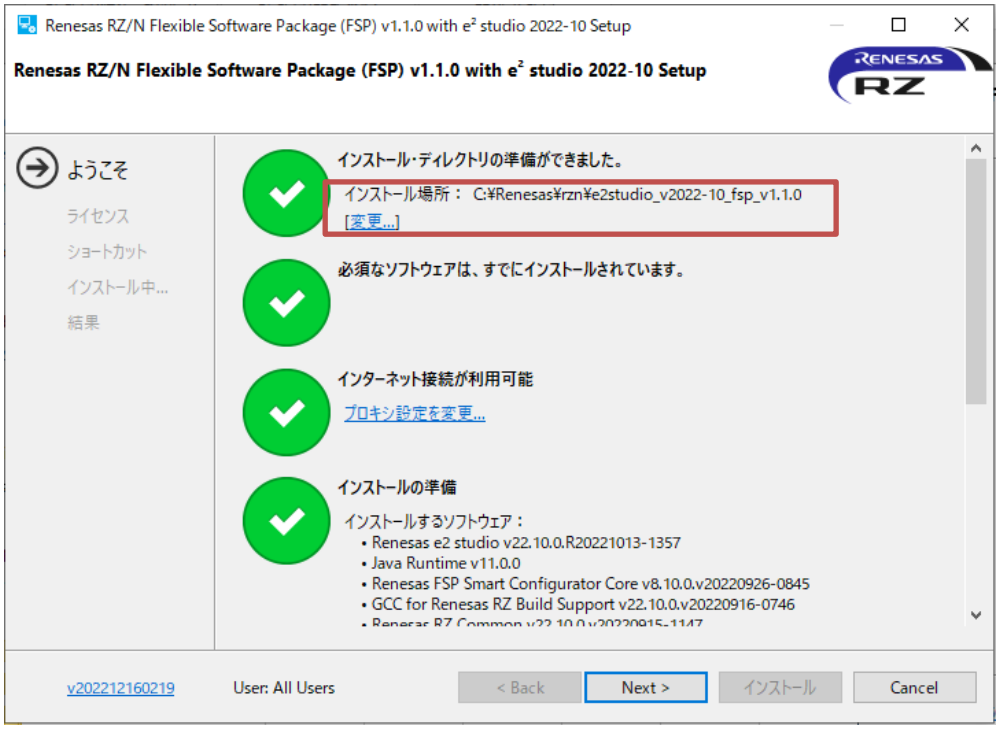


Fig 3-7 e² studio Install (4)

・Check and Click “Next”

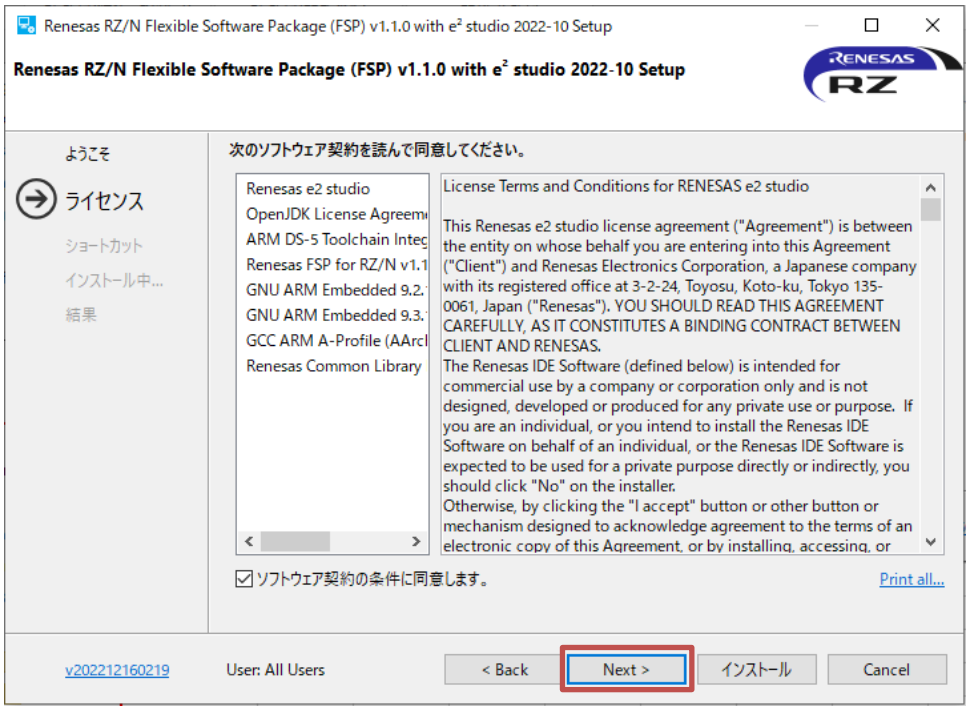


Fig 3-8 e² studio Install (5)

・Click “Install”

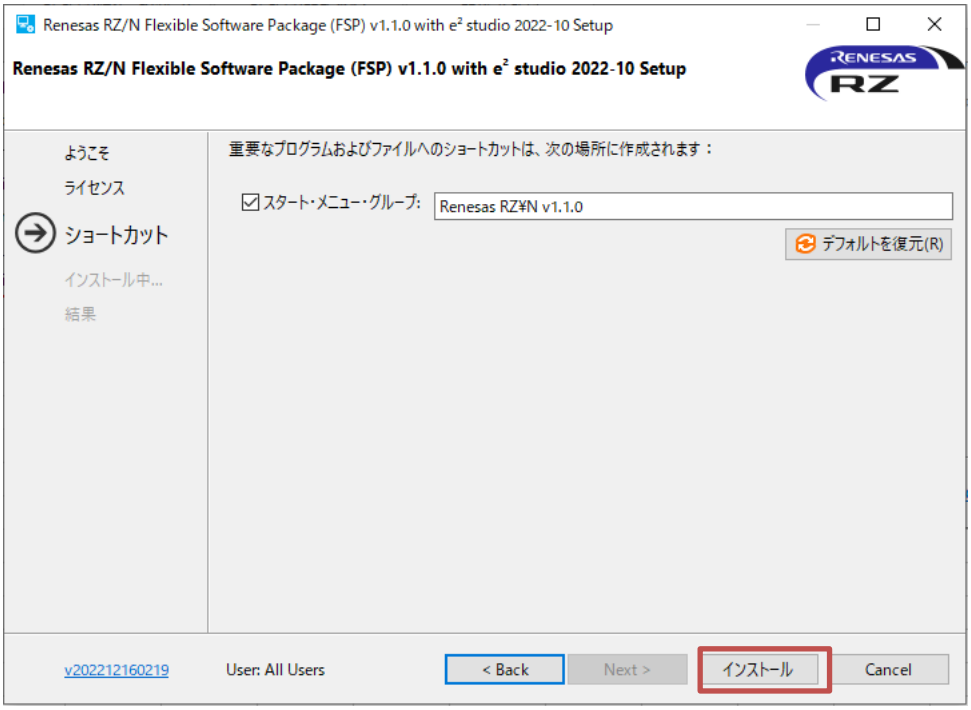


Fig 3-9 e² studio Install (6)

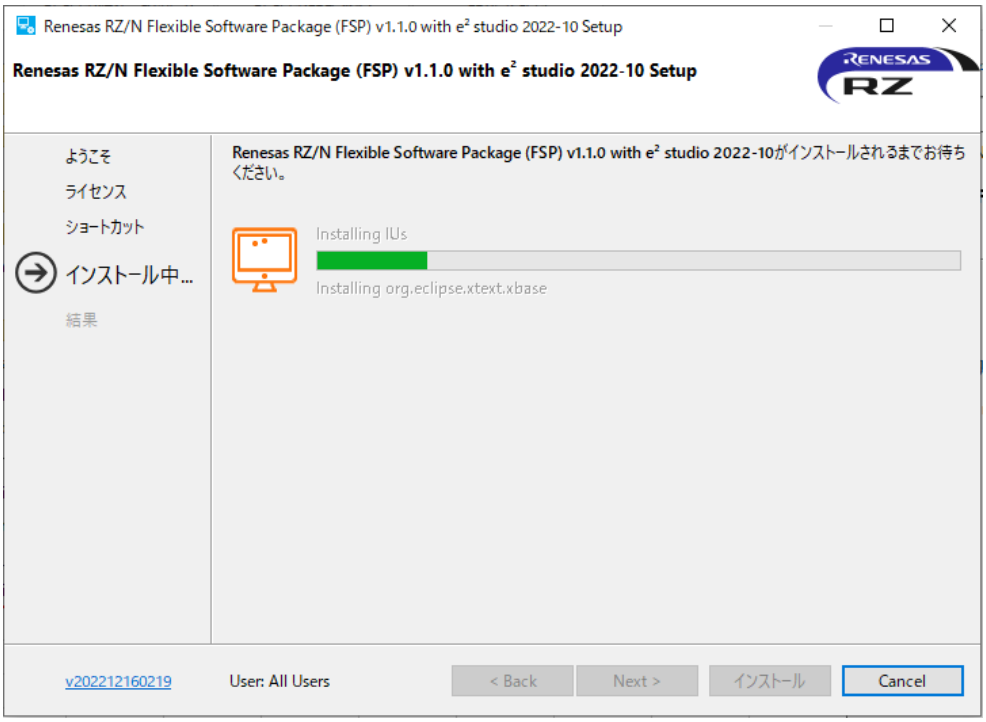


Fig 3-10 e² studio Install (7)

・Click “OK”

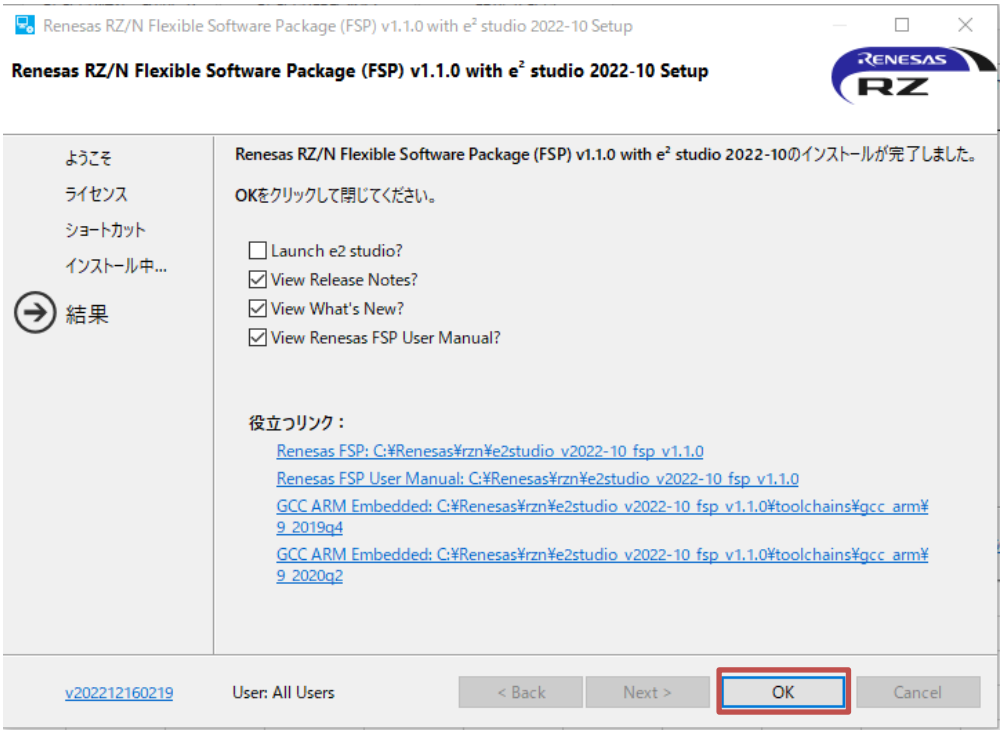


Fig 3-11 e² studio Install (8)

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

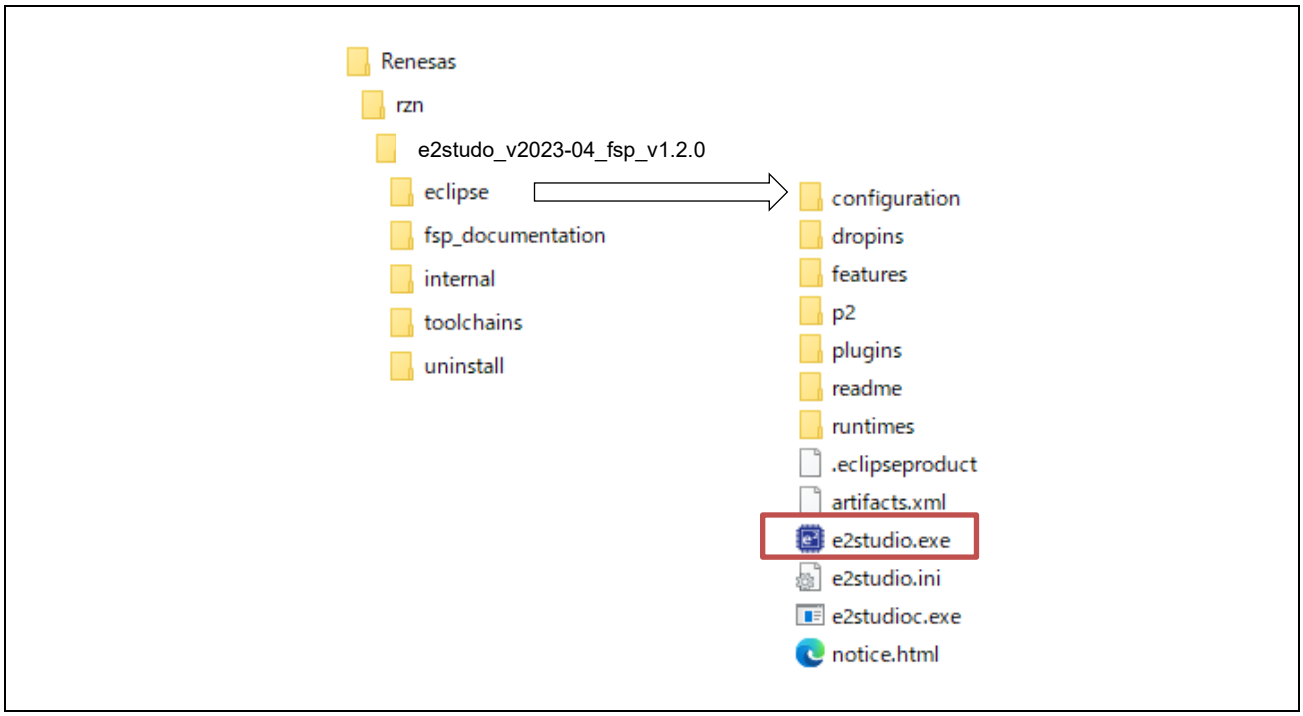


Fig 3-12 Launch project (1)

(3) Import Project

Enter any workspace directory and click “Launch”.

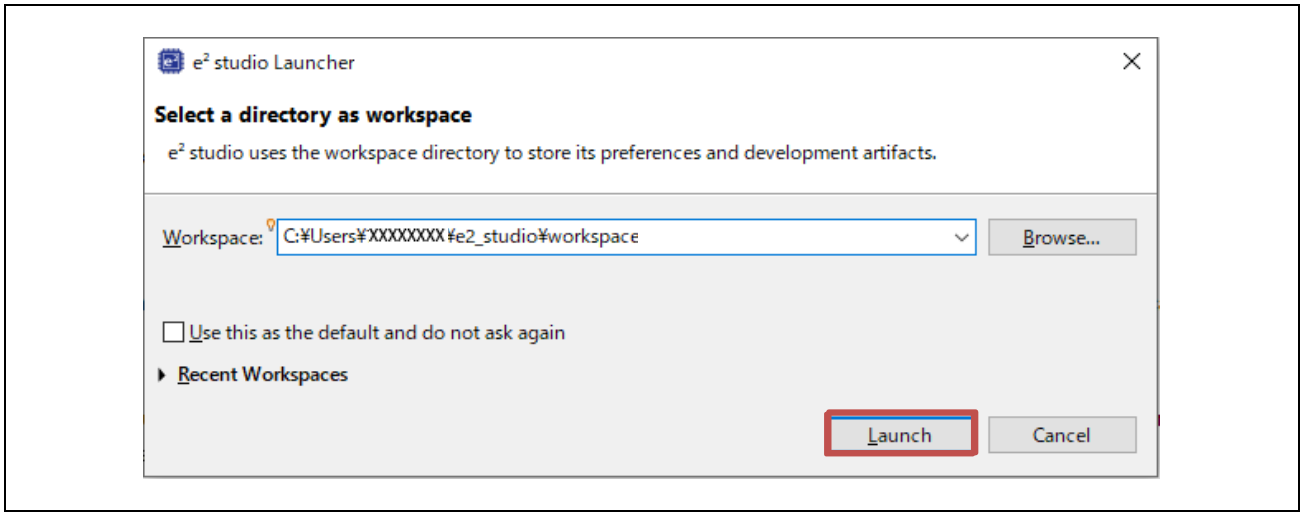


Fig 3-13 Launch project (2)

Select the toolchain “GNU ARM Embedded – 9.3.1.20200408”

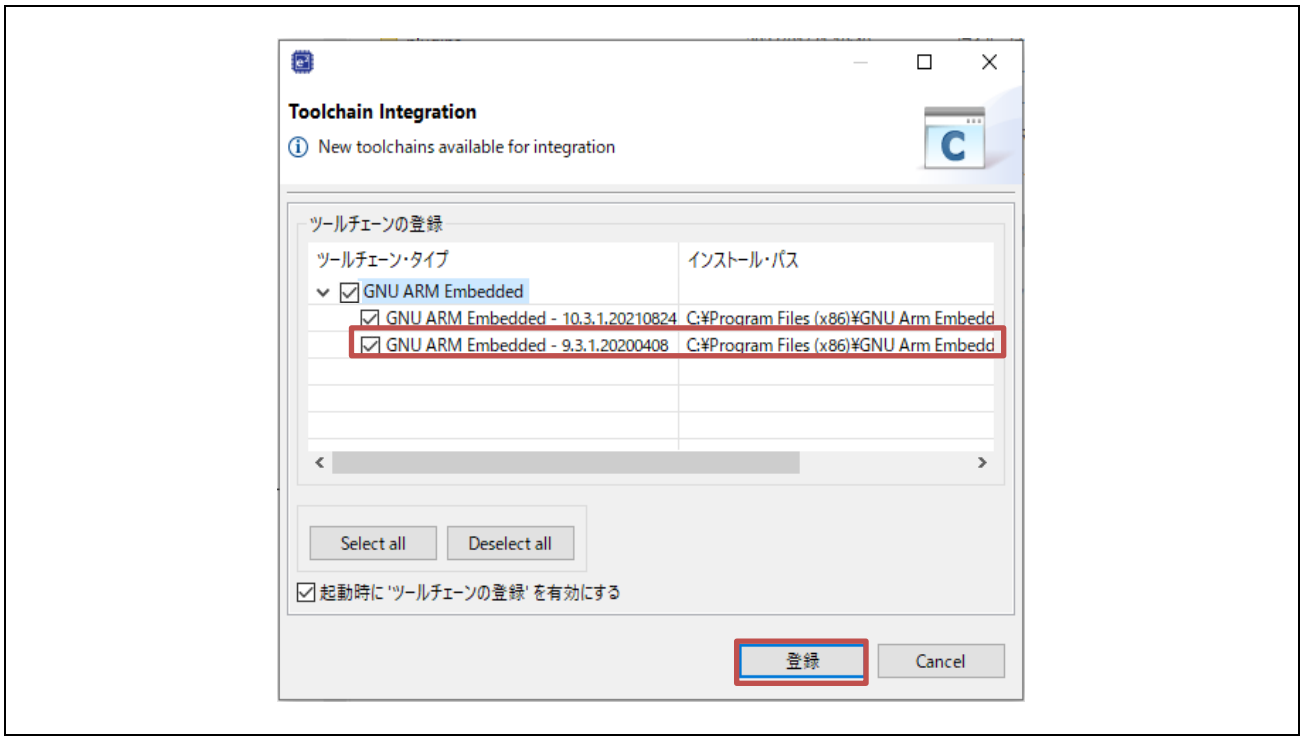


Fig 3-14 Launch project (3)

・Select “Import existing projects”

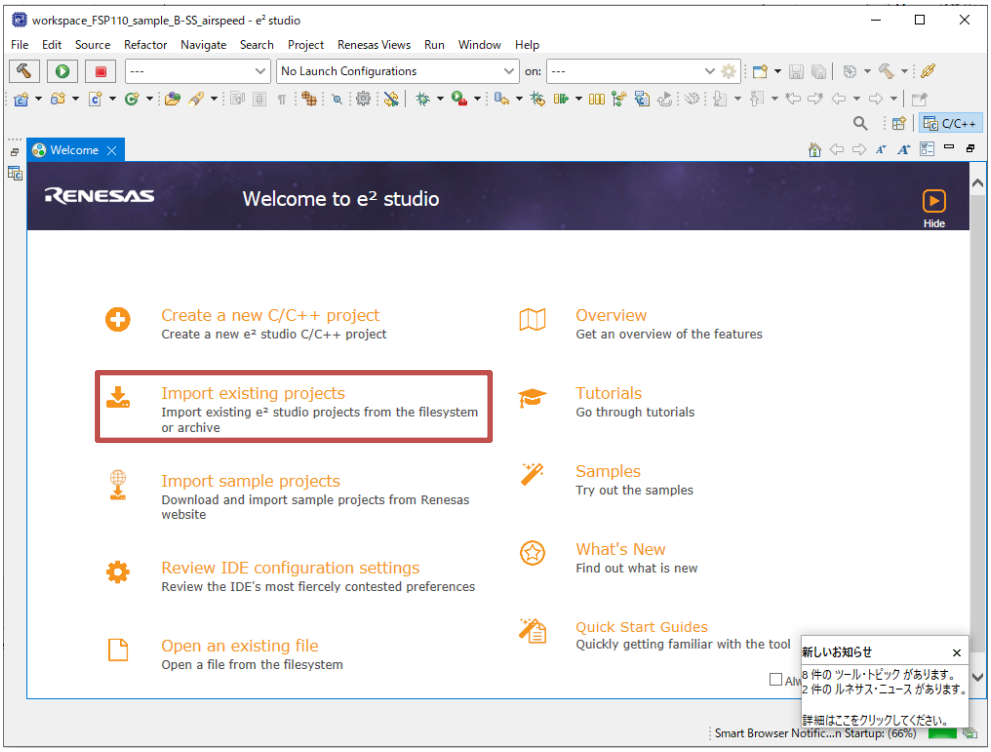


Fig 3-15 Launch project (4)

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.

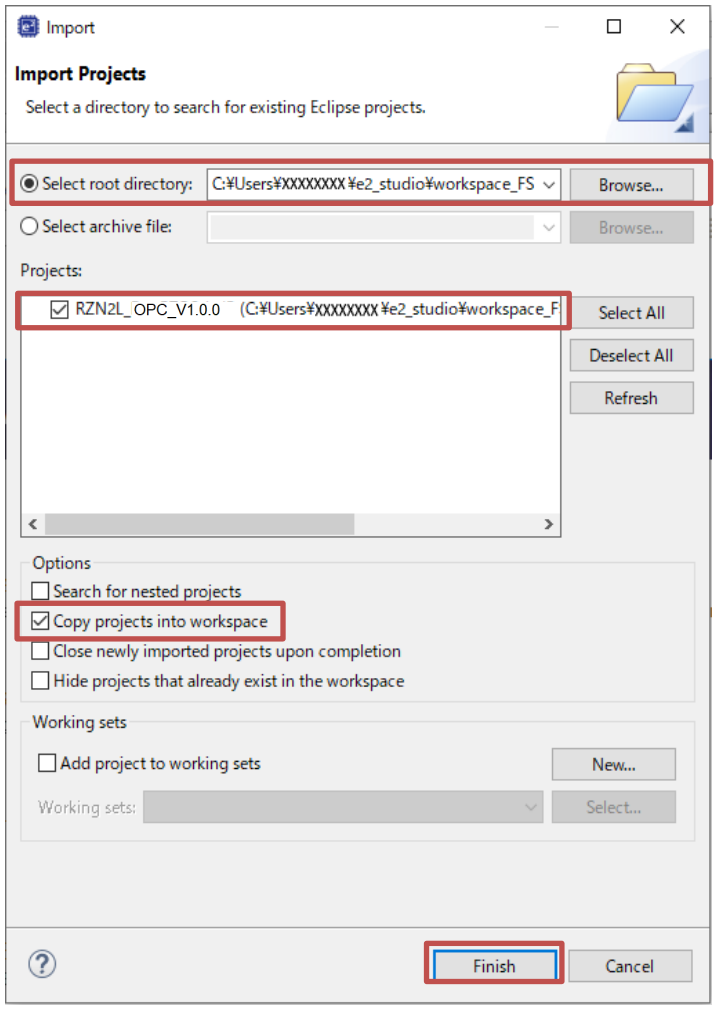


Fig 3-16 Launch project (5)

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

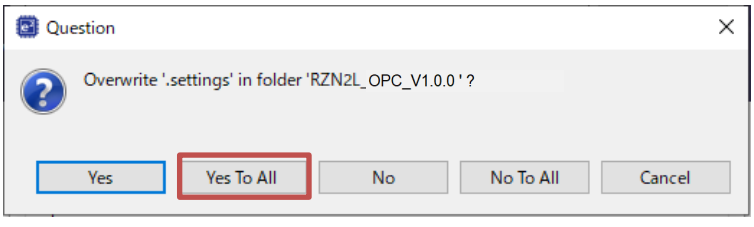


Fig 3-17 Launch project (6)

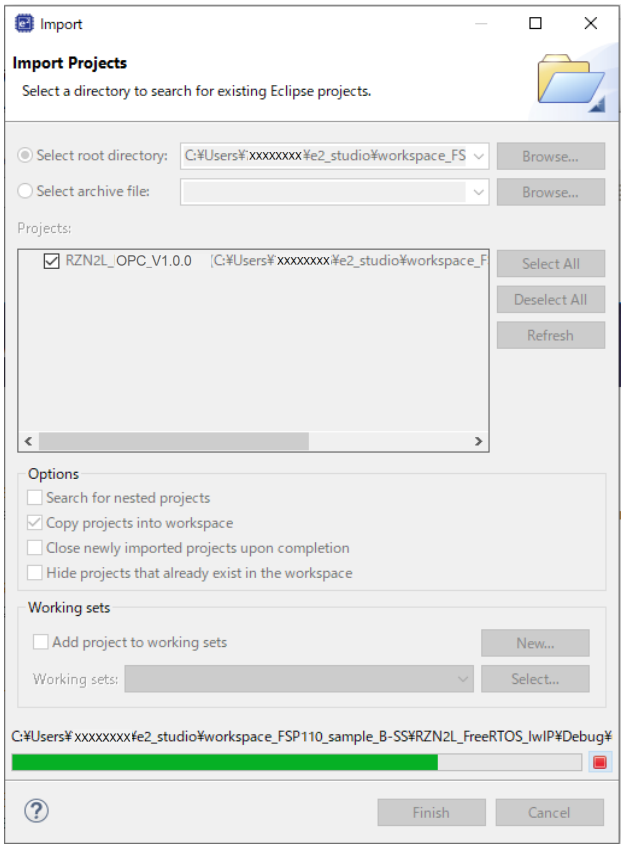


Fig 3-18 Launch project (7)

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

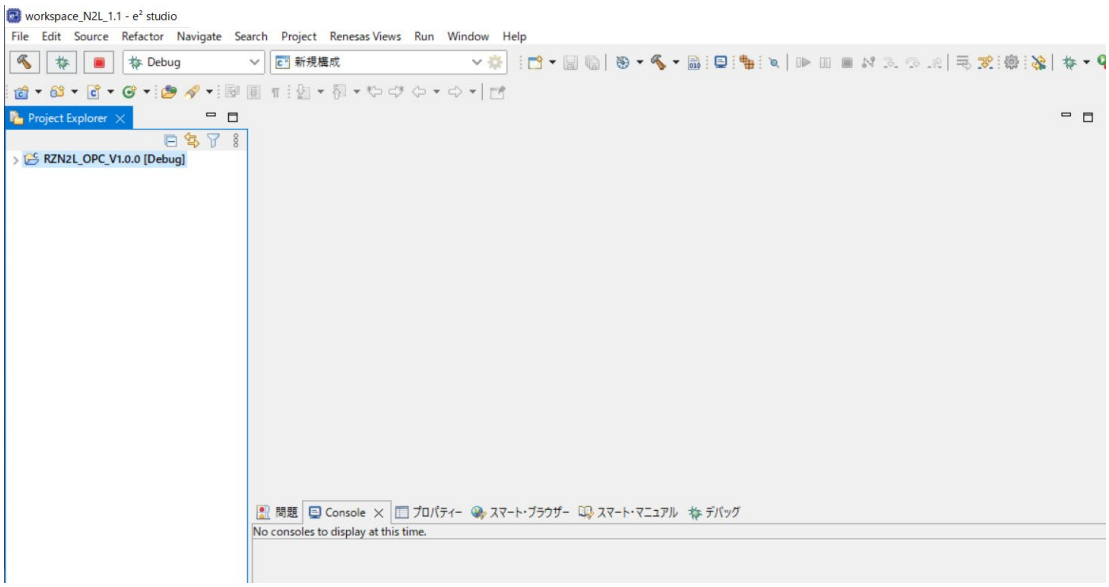


Fig 3-19 Launch project (8)

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.

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.

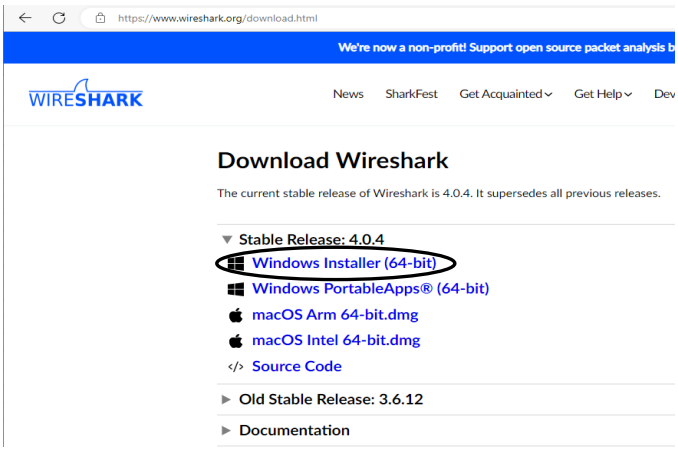


Fig 3-21 download Wireshark

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.

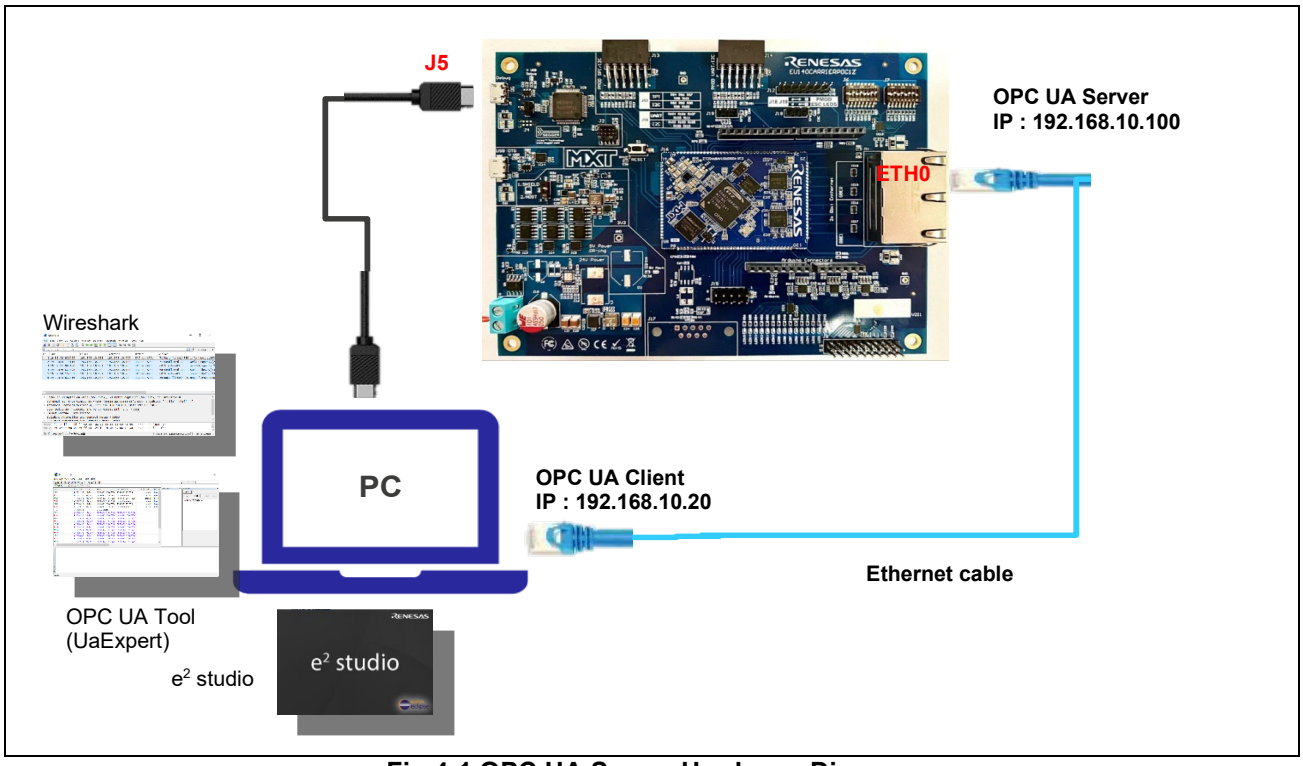


Fig 4-1 OPC UA Server Hardware Diagram

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

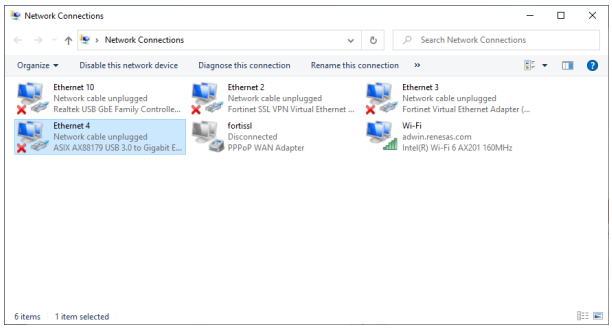


Fig 4-2 network connection

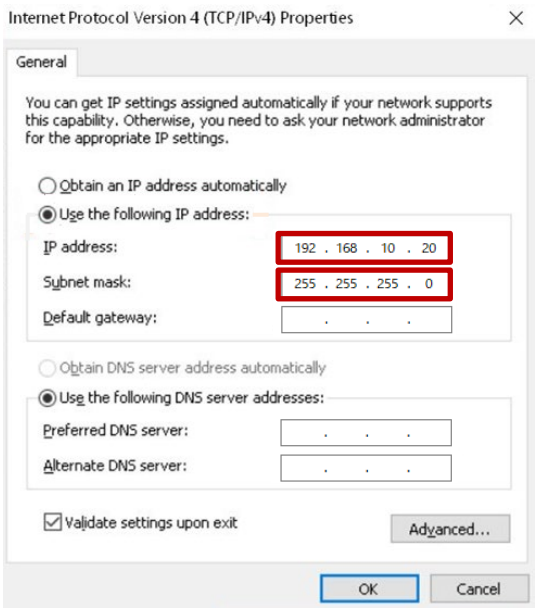


Fig 4-3 TCP/IPv4 properties

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.

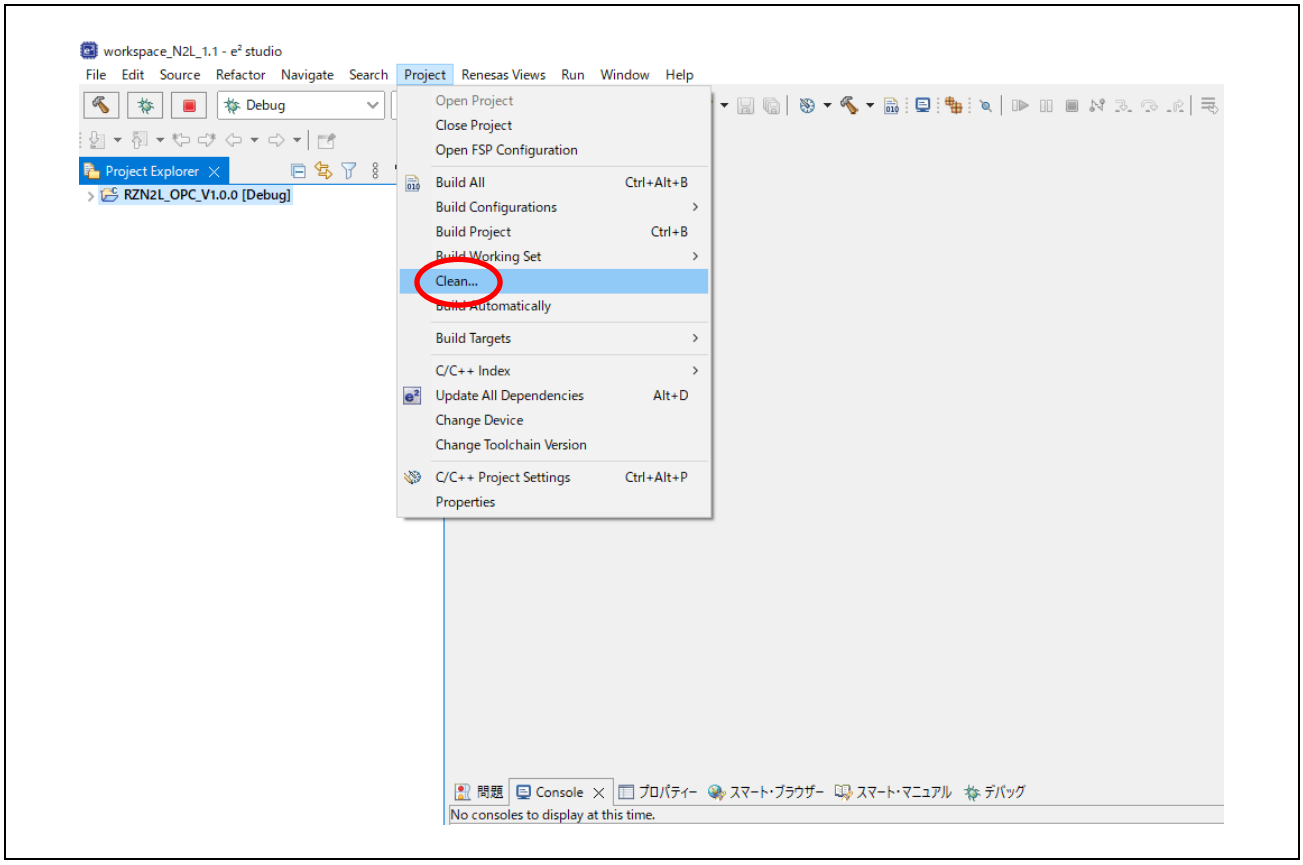


Fig 4-4 Open project Clean…

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

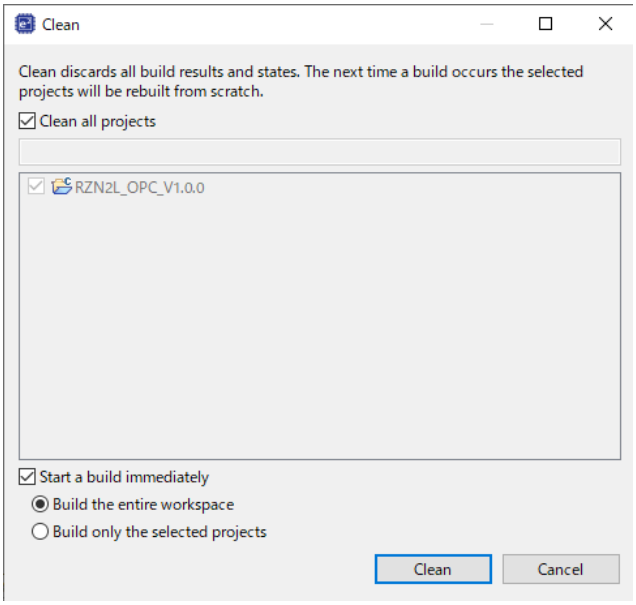


Fig 4-5 clean and rebuild

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.

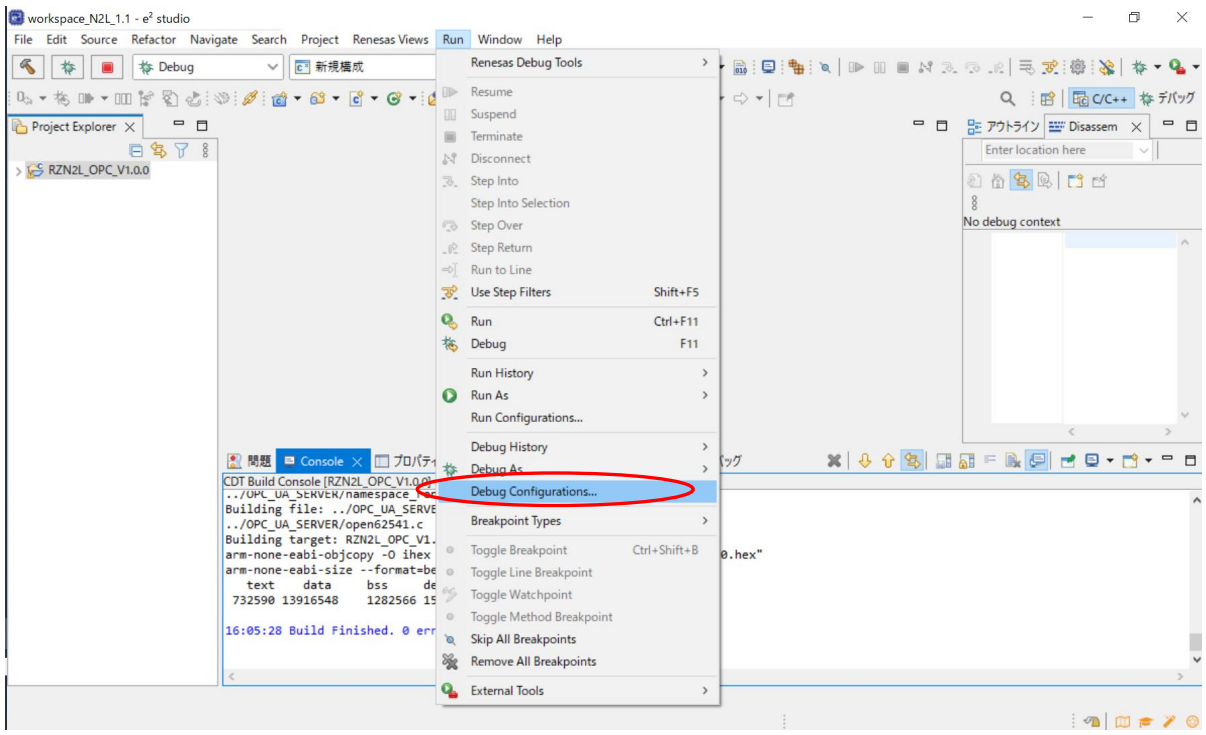


Fig 4-6 Open Debug Configurations…

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]

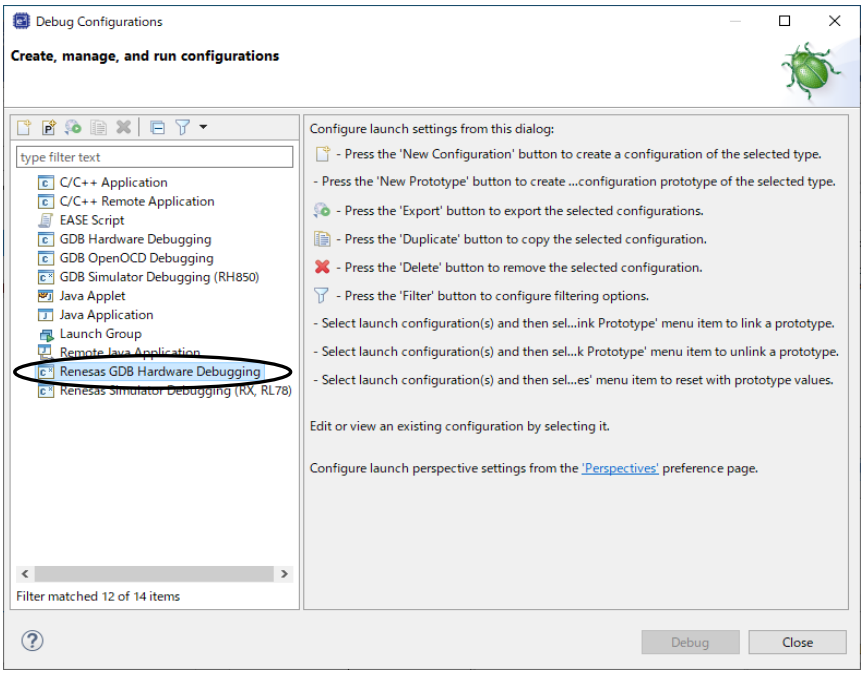


Fig 4-7 Debug Configurations(1)

b. Select Target Device

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

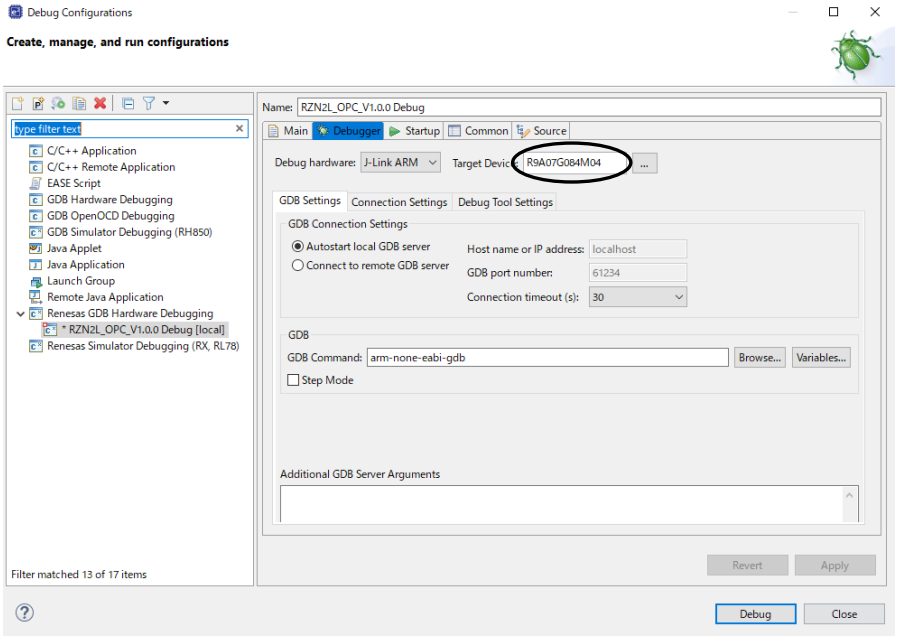


Fig 4-8 Debug Configurations(2)

RZ/N2L : Select R9A07G084M04 and click OK.

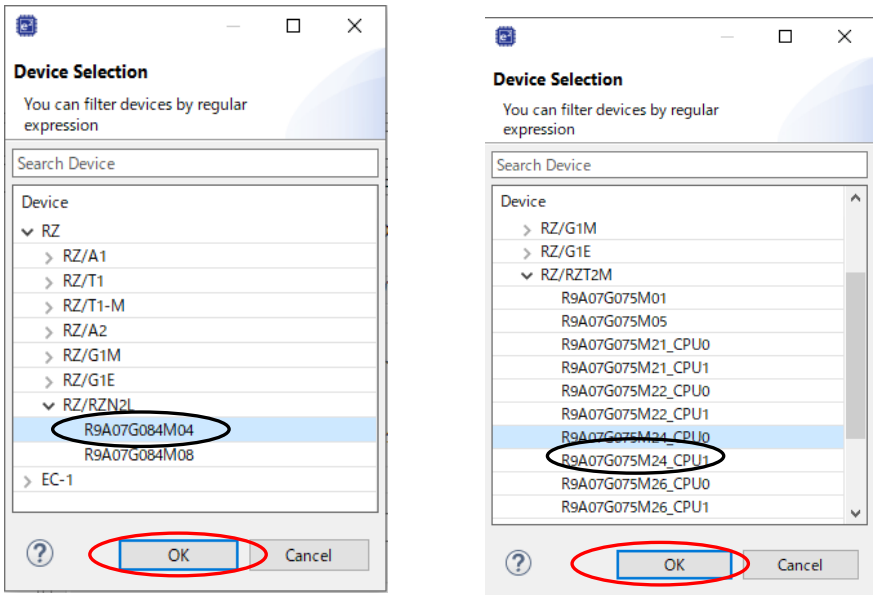


Fig 4-9 Debug Configurations(3)

c. Debug Tool Settings

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

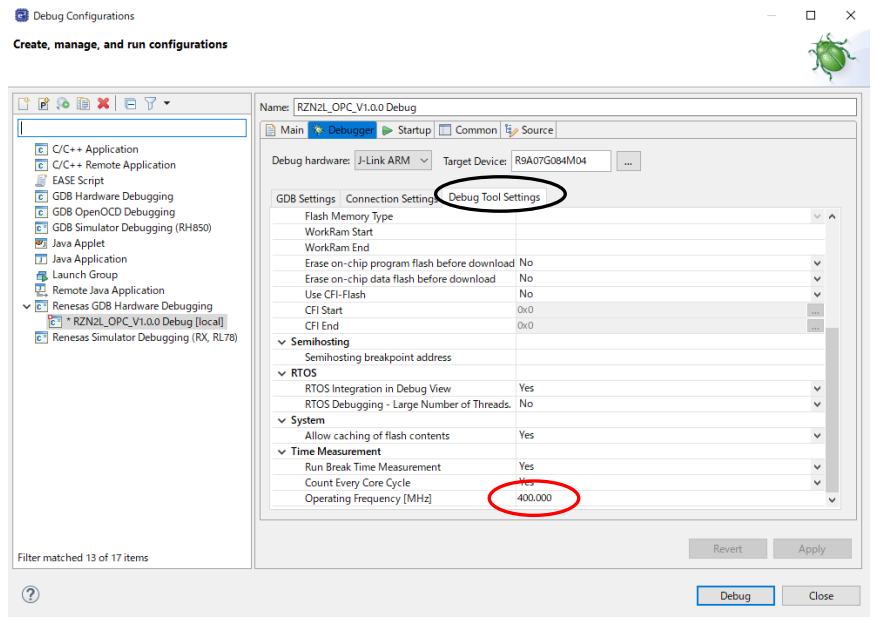


Fig 4-10 Debug Configurations(4)

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.

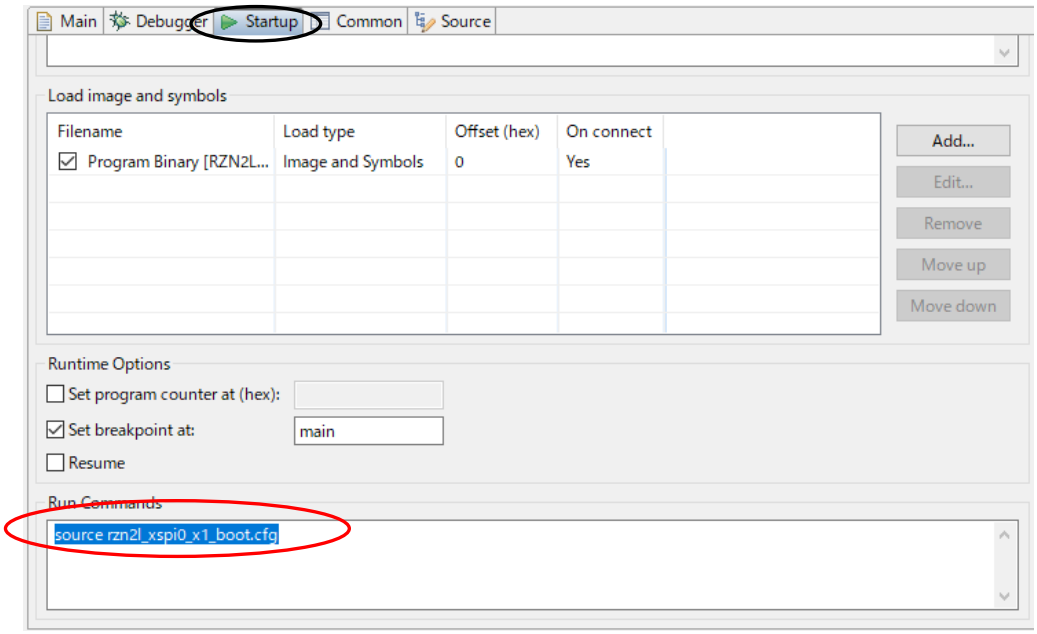


Fig 4-11 Debug Configurations(4)

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".

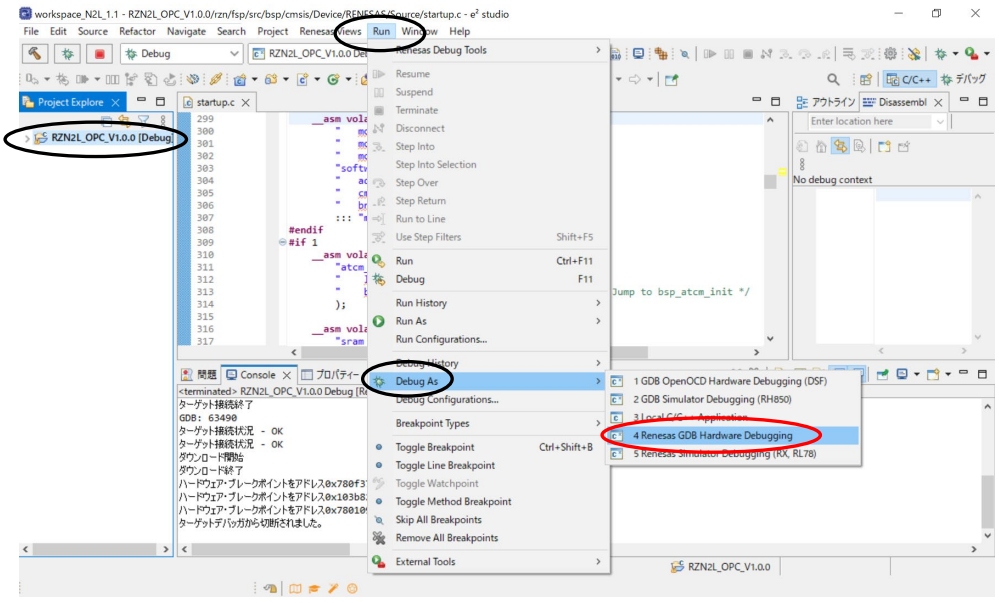


Fig 4-12 Run menu Debug As

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

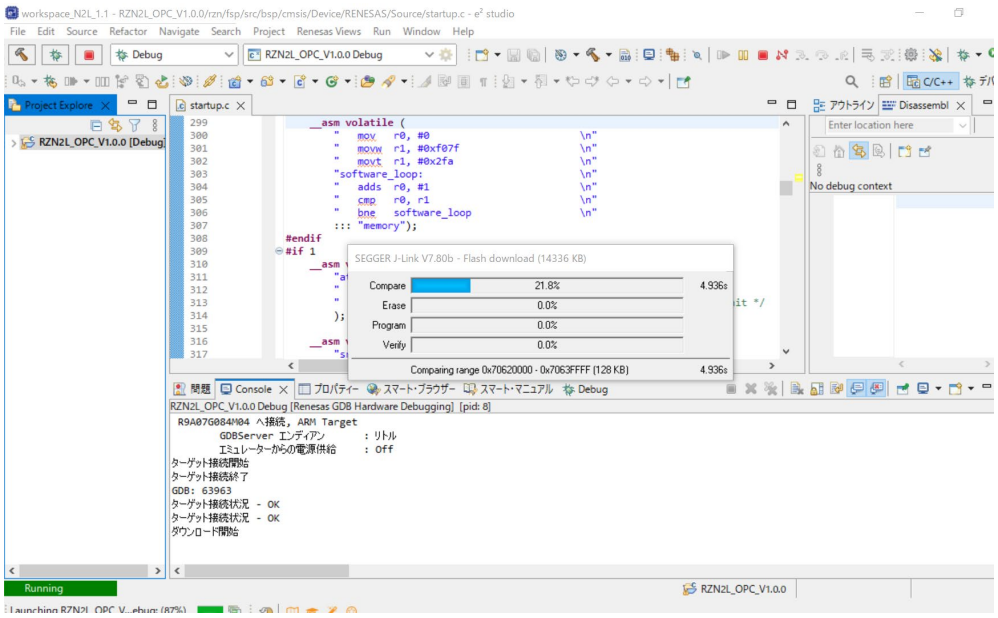


Fig 4-13 Download

Click Switch to change to debug view.

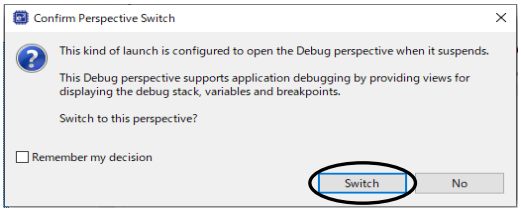


Fig 4-14 Perspective Switch

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.

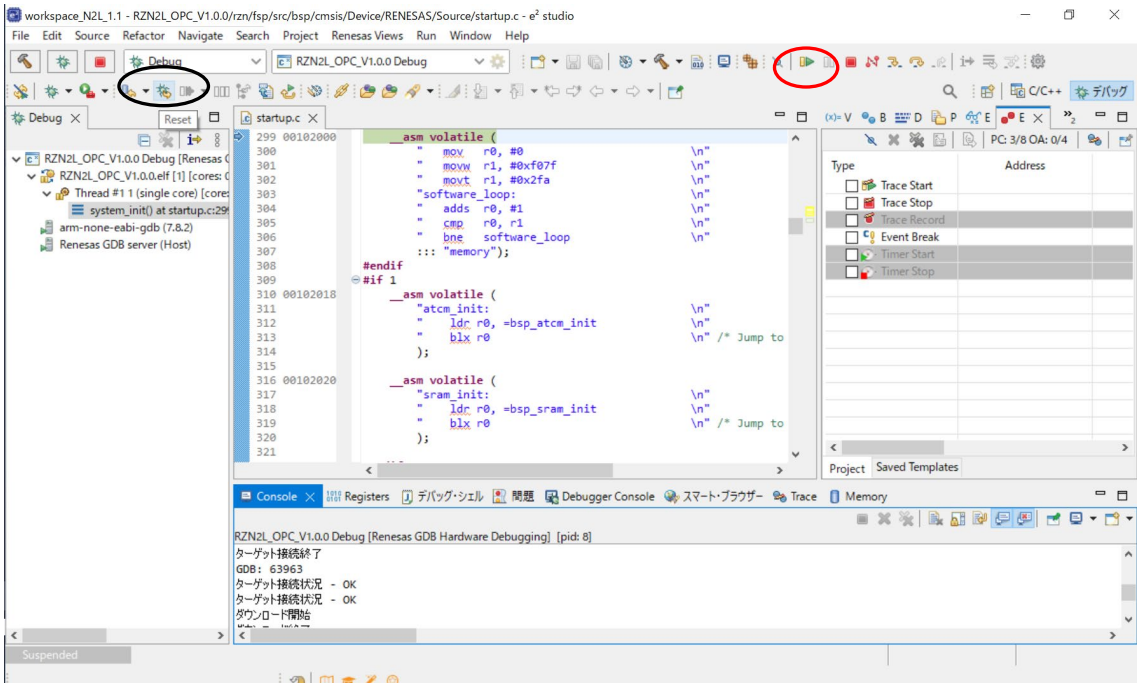


Fig 4-15 Break at system_init()

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

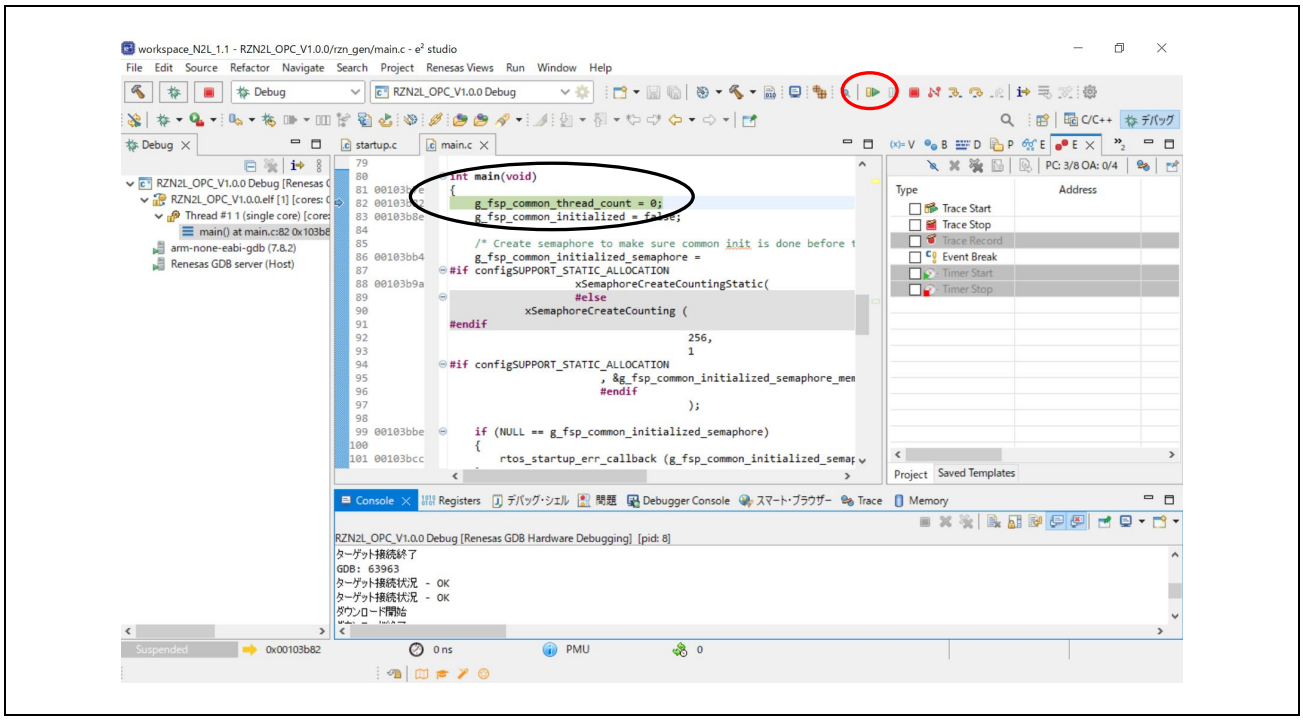


Fig 4-16 Break at main()

4.4 OPC UA Communication Check

- Launch UaExpert

Open Windows Start menu and click UaExpert

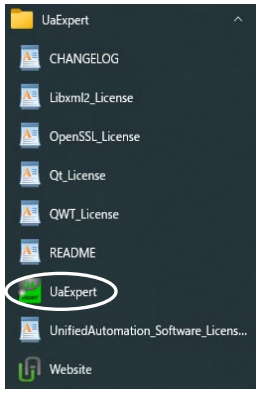


Fig 4-17 Launch UaExpert

- 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.

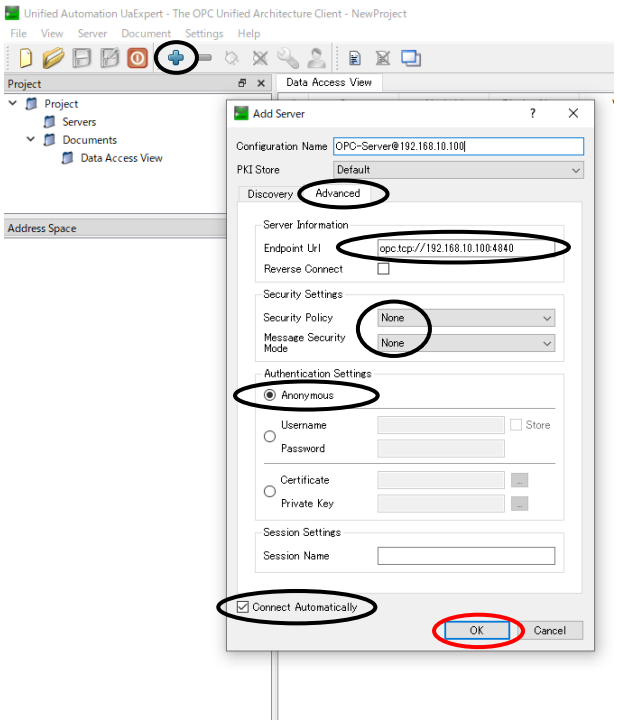


Fig 4-18 UaExpert Add server

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.

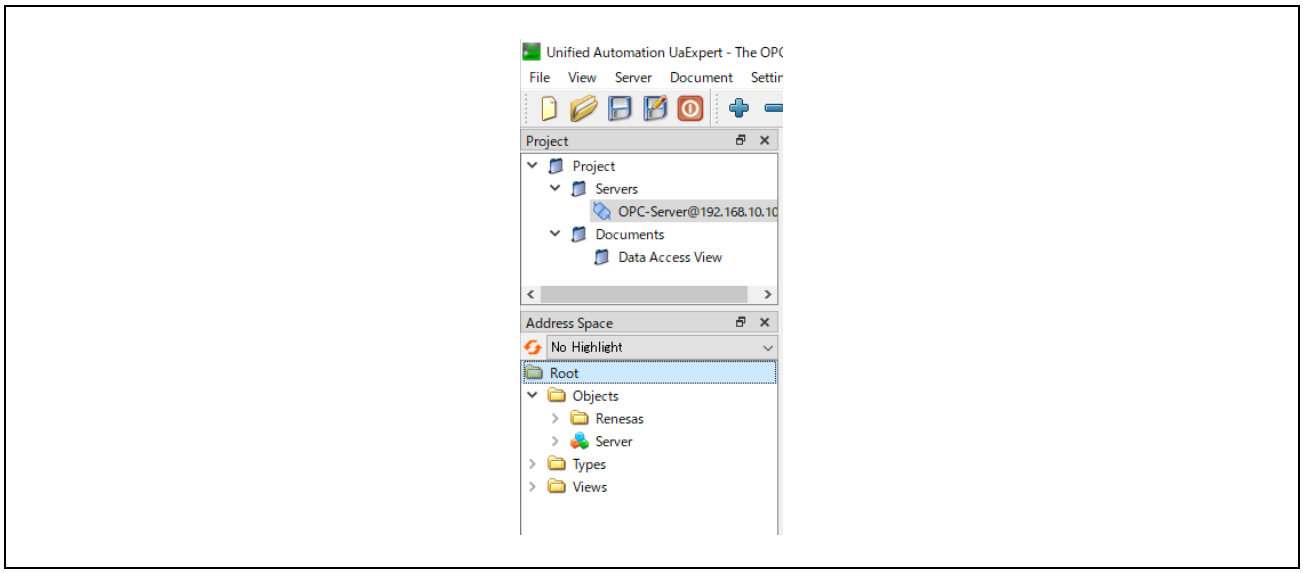


Fig 4-19 UaExpert OPC UA server connection

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.

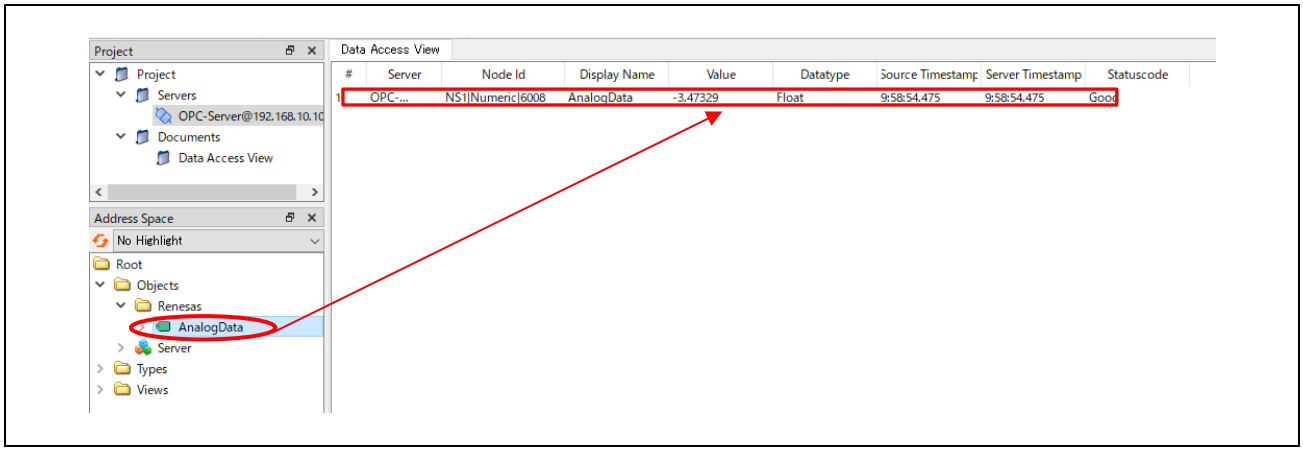


Fig 4-20 AnalogData value reading

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 e² 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

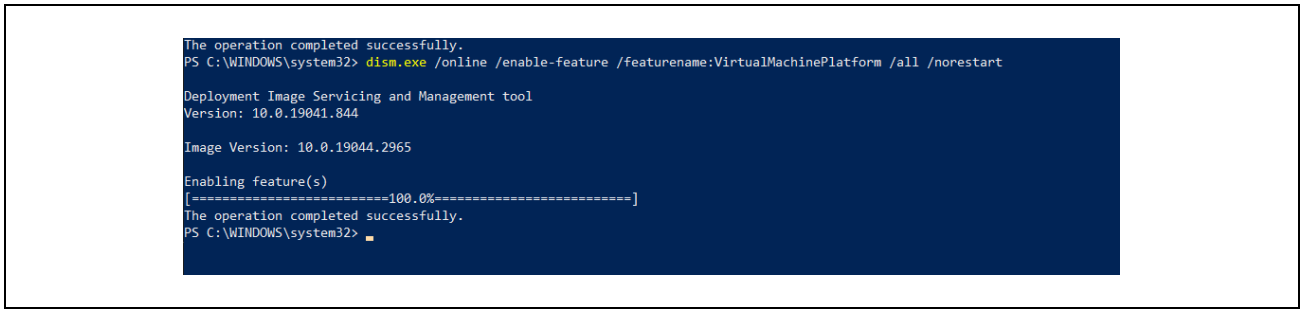


Fig 5-1 Microsoft-Windows-Subsystem-Linux

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

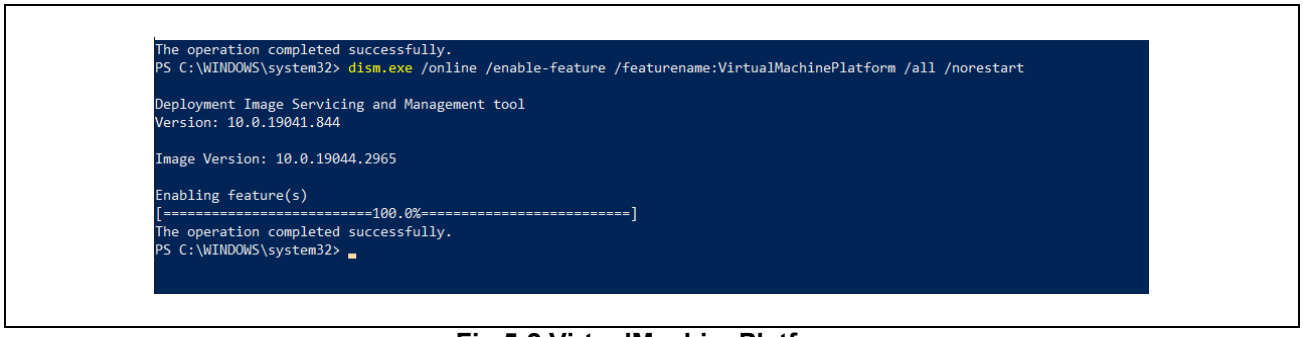


Fig 5-2 VirtualMachinePlatform

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

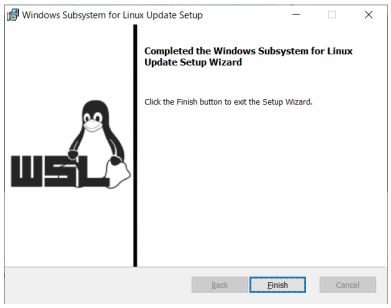


Fig 5-3 wsl_update_x64.msi

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.

Fig 5-4 Ubuntu Install

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

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.

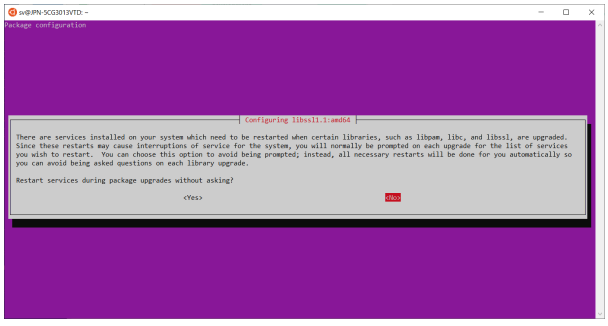


Fig 5-8 restart

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
```

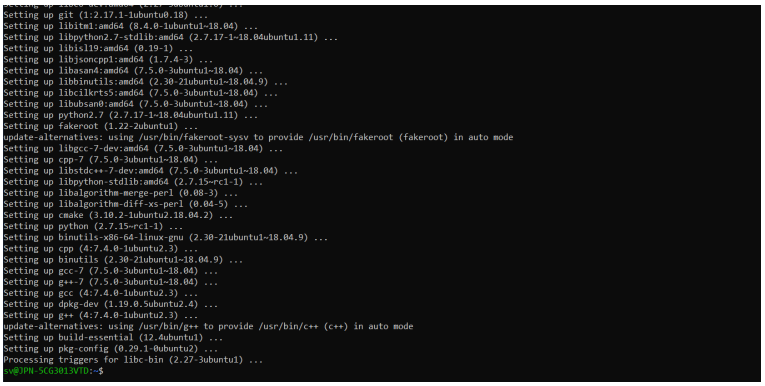


Fig 5-9 install

5.1.3 open62541 File Generation

14) Clone open62541 to any folder

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

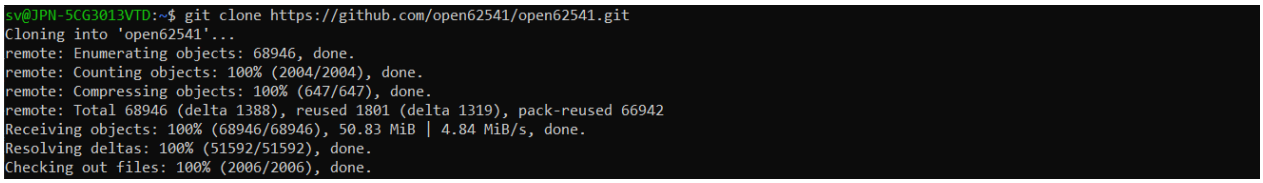


Fig 5-10 git clone

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
```

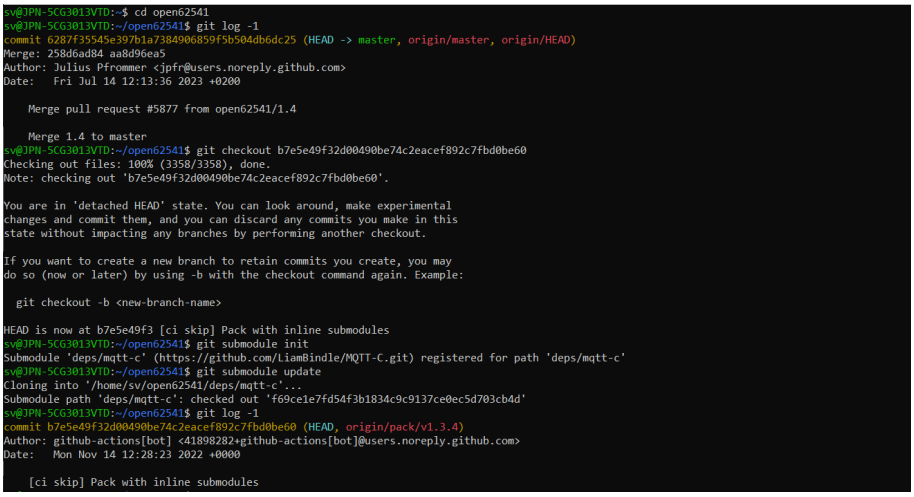


Fig 5-11 git submodule

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

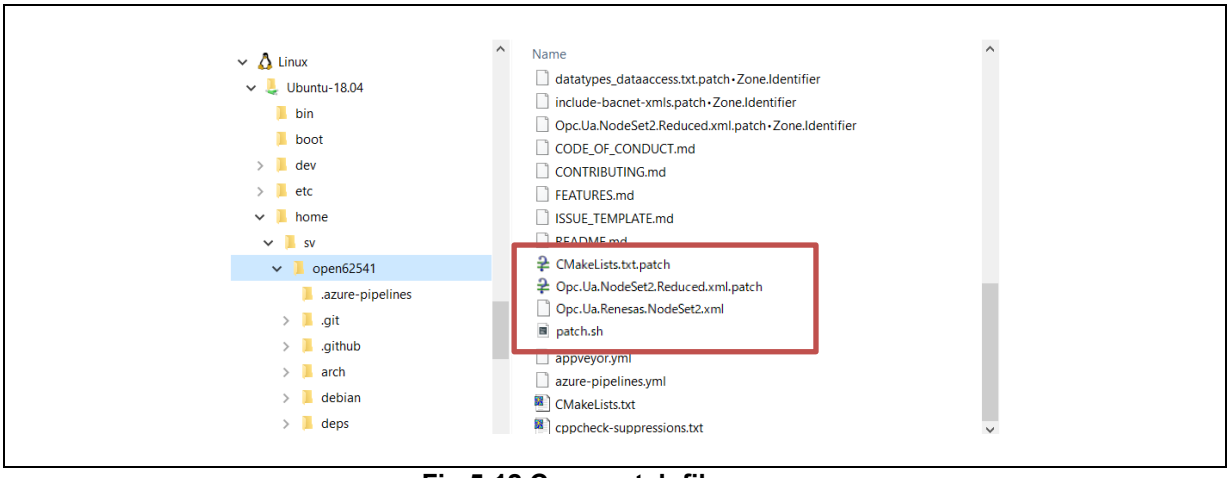


Fig 5-12 Copy patch files

17) Execute following command in /open62541 directory

bash patch.sh

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 ..

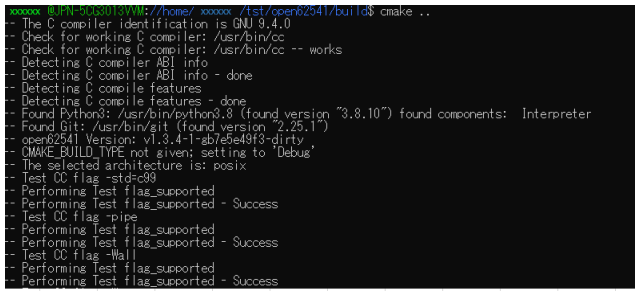


Fig 5-14 cmake

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.

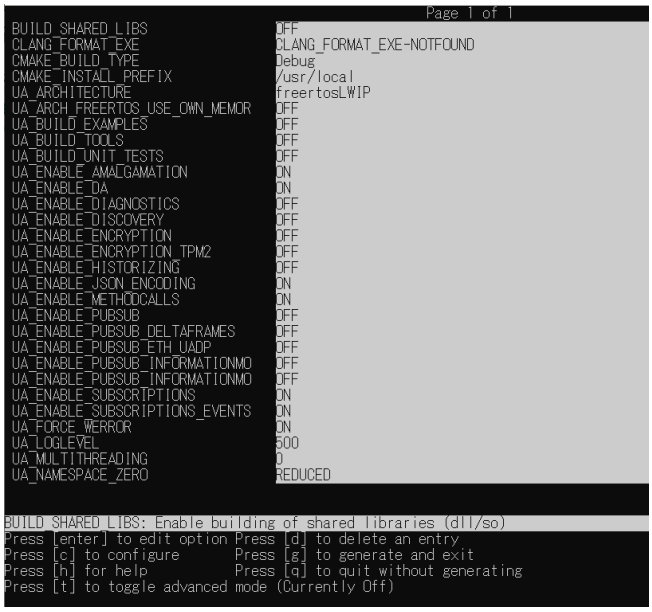


Fig 5-15 ccmake

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

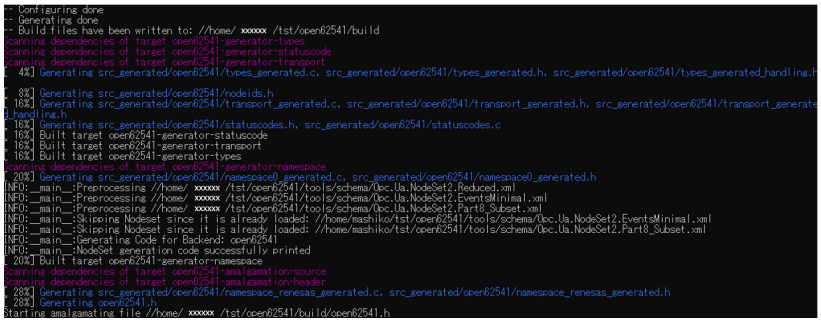


Fig 5-16 make

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*

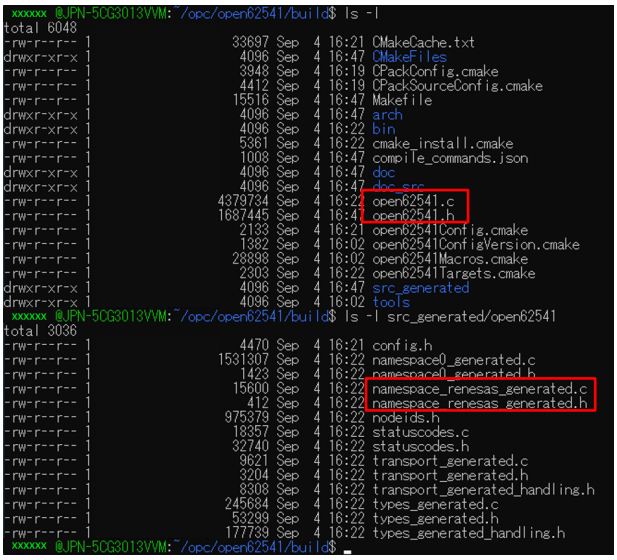


Fig 5-17 Generated Files

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.

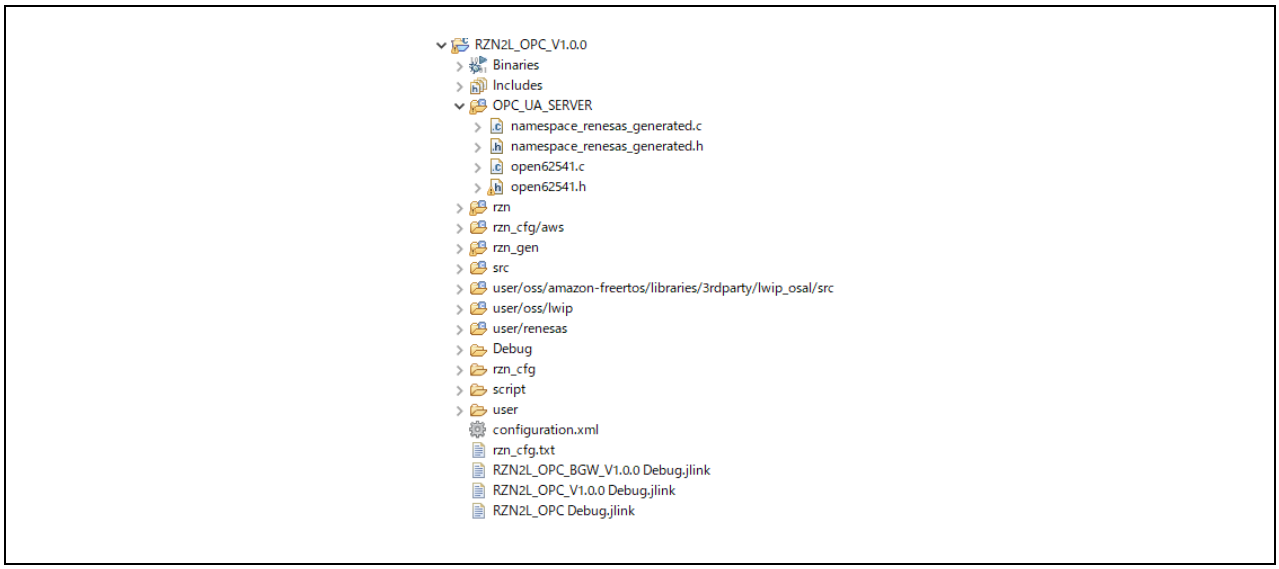
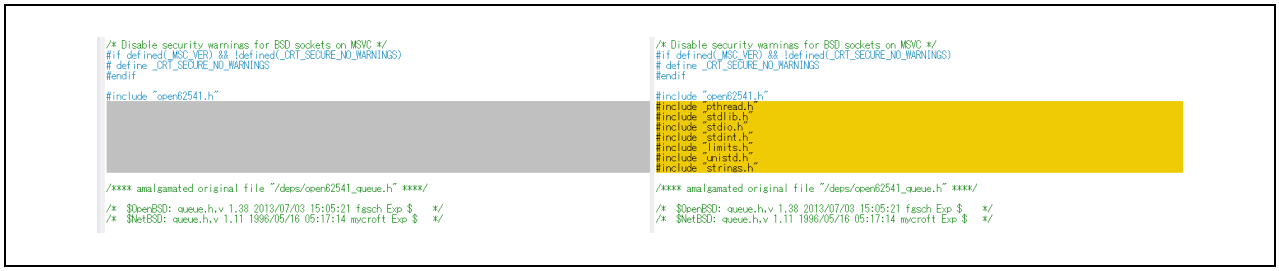


Fig 5-18 Import

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 $   */
```

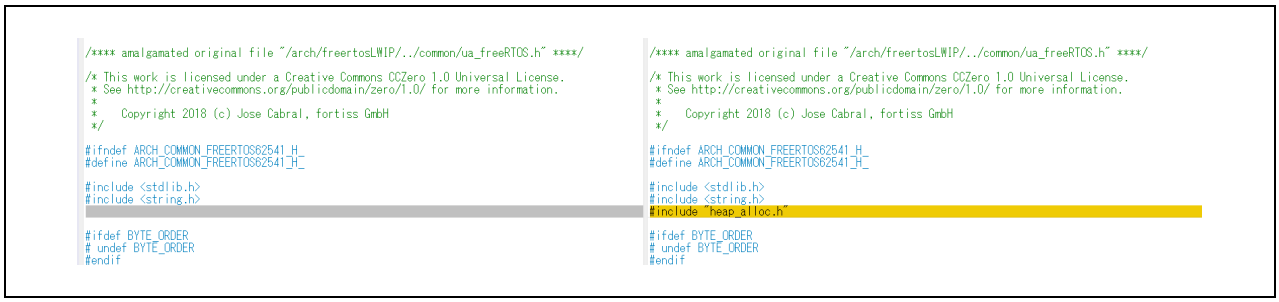
```
/* Disable security warnings for BSD sockets on MSVC */
#if defined(_MSC_VER) && !defined(_CRT_SECURE_NO_WARNINGS)
# define _CRT_SECURE_NO_WARNINGS
#endif

#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

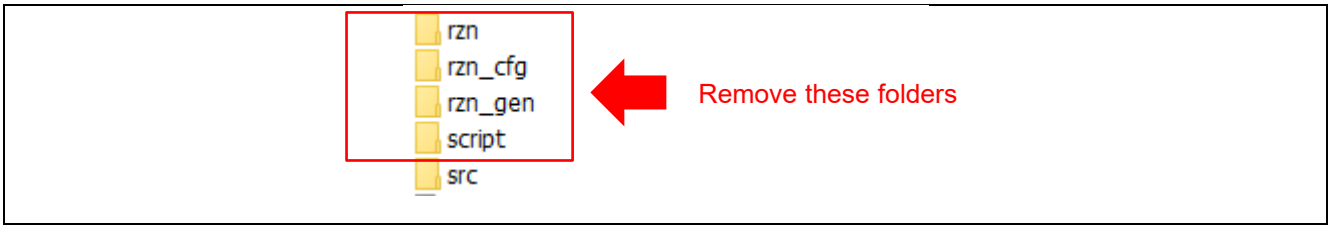


Figure 5-1 Remove folder generated by FSP

(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.

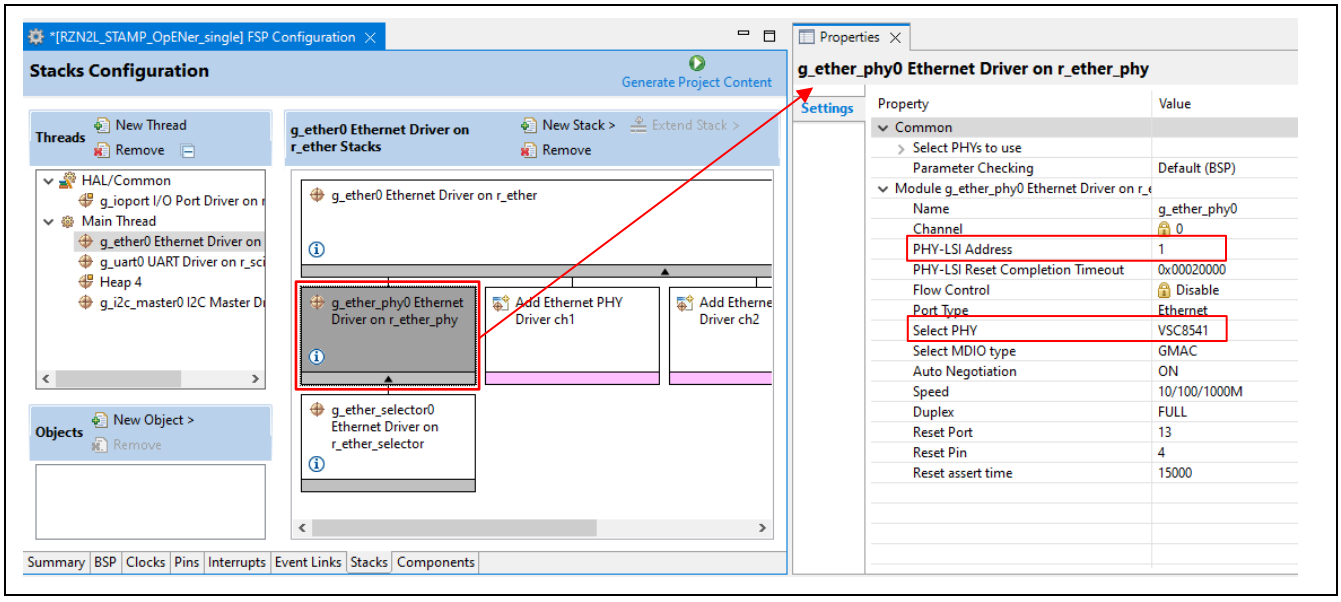


Figure 5-2 Ethernet Driver Configuration for VSC8531 (e.g. ETH0)

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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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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