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RZ/N2L Group

RZ/N2L Industrial Network SOM Kit Application Note: EtherCAT CiA402 Slave Software

Introduction

This document explains Sample Program setup procedures for EtherCAT® slave functionalities with the adapted EtherCAT Stack Code for Renesas RZ/N2L platform. This describes steps to confirm slave behavior and stack features using TwinCAT®Master Configuration tool.

Target Device

RZ/N2L

Contents

1. Overview

This document describes how to run EtherCAT on the RZ/N2L Group. Run the standalone variant using only one core.

EtherCAT(Ethernet for Control Automation Technology) is an Ethernet based fieldbus system, developed by Beckhoff Automation. Development of EtherCAT was to apply Ethernet for automation applications (e.g., for motion control, I/O, sensors) requiring short data update times with low communication jitter and reduced hardware costs.

Tool to generate EtherCAT Slave Stack Code (SSC Tool) is available to the ETG members free of charge. This can be downloaded from the ETG website. SSC tool can be used to generate customized stack, device description files (ESI) and individual source code documentation to suit the developer's own needs.

This document describes the procedure for testing the EtherCAT slave function using EtherCAT stack code compatible with the Renesas RZ/N2L platform. Scope of the documentation is limited to explaining how to use the SSC tool for EtherCAT slave stack code generation and testing its behavior against TwinCAT masters and test applications.

1.1 Abbreviations/Definitions

Table 1. Abbreviations/Definitions

Index	Abbreviations /Definitions	Description
1	CoE	CAN application protocol over EtherCAT
2	EEPROM	Electrically Erasable Programmable Read-Only Memory
3	ESC	EtherCAT Slave Controller
4	ESI	EtherCAT Slave Information
5	FoE	File Access Over EtherCAT
6	I2C	Inter-Integrated Circuit
7	MB	Mail Box
8	PDO	Process Data Object
9	SSC	Slave Stack Code
10	EoE	Ethernet Over EtherCAT

1.2 Reference

Technical information about EtherCAT is available via ETG member site, and information about RZ/N2L is available via Renesas.

Table 2. Technical Inputs

Index	Technical Inputs
1	r01uh0955ejxxxx-rzn2l.pdf (RZ/N2L User's Manual: Hardware)
2	r01an6434ejxxxx-rzt2-rzn2-fsp-getting-started.pdf (Getting started with Flexible Software Package)
3	r12ut0020edxxxx-rzn2l-som-kit-hw.pdf (RZ/N2L Industrial Network SOM Kit Use's Manual)

2. Features

EtherCAT slave stack code generated by SSC Tool provides the functionality of EtherCAT slave controller.

Includes the following features :

- ESM (EtherCAT State Machine)
- Mailbox protocols:
  - CoE (CAN application protocol over EtherCAT)
- Synchronization Modes:
  - Free Run
  - Sync Manager Synchronization
  - DC Synchronization
- CiA402 Drive Profile:
  - csp Mode
  - csv Mode

EtherCAT is a registered trademark and patented technology, licensed by Beckhoff Automation GmbH, Germany.

3. Project Setup

3.1 Requirements

Table 3. Requirements

Item	Vender	Description
Board	Renesas Electronics	RZ/N2L Industrial Network SOM Kit
IDE	IAR Systems	● Embedded Workbench® for ARM Version 9.30.1 Please apply patch (EWARM_Patch_for_RZN2L) which is available in http://www.renesas.com/rzn2l. Regarding how to apply the patch, please read the readme file in patch file.
	Renesas Electronics	● e² studio 2023-04 ● FSP Smart Configurator 2023-04 ● RZ/N2L Flexible Software Package (FSP) v1.2.0 Please download from the link below. https://github.com/renesas/rzn-fsp/releases/tag/v1.2.0
Emulator	IAR Systems	I-jet
	SEGGER	Hardware: J-Link Software: J-Link Commander V7.82f *1
SSC Tool	Beckhoff Automation	Slave Stack Code (SSC) Tool Version 5.13
Software PLC	Beckhoff Automation	TwinCAT3

*1: J-Link Commander is used for erasing flash memory.
J-Link Commander is included in “J-Link Software and Documentation Pack” on the following site.
https://www.segger.com/downloads/jlink/

3.2 Hardware

This document describes the major hardware. Refer to RZ/N2L Industrial Network SOM Kit user's manual and schematic for more board details.

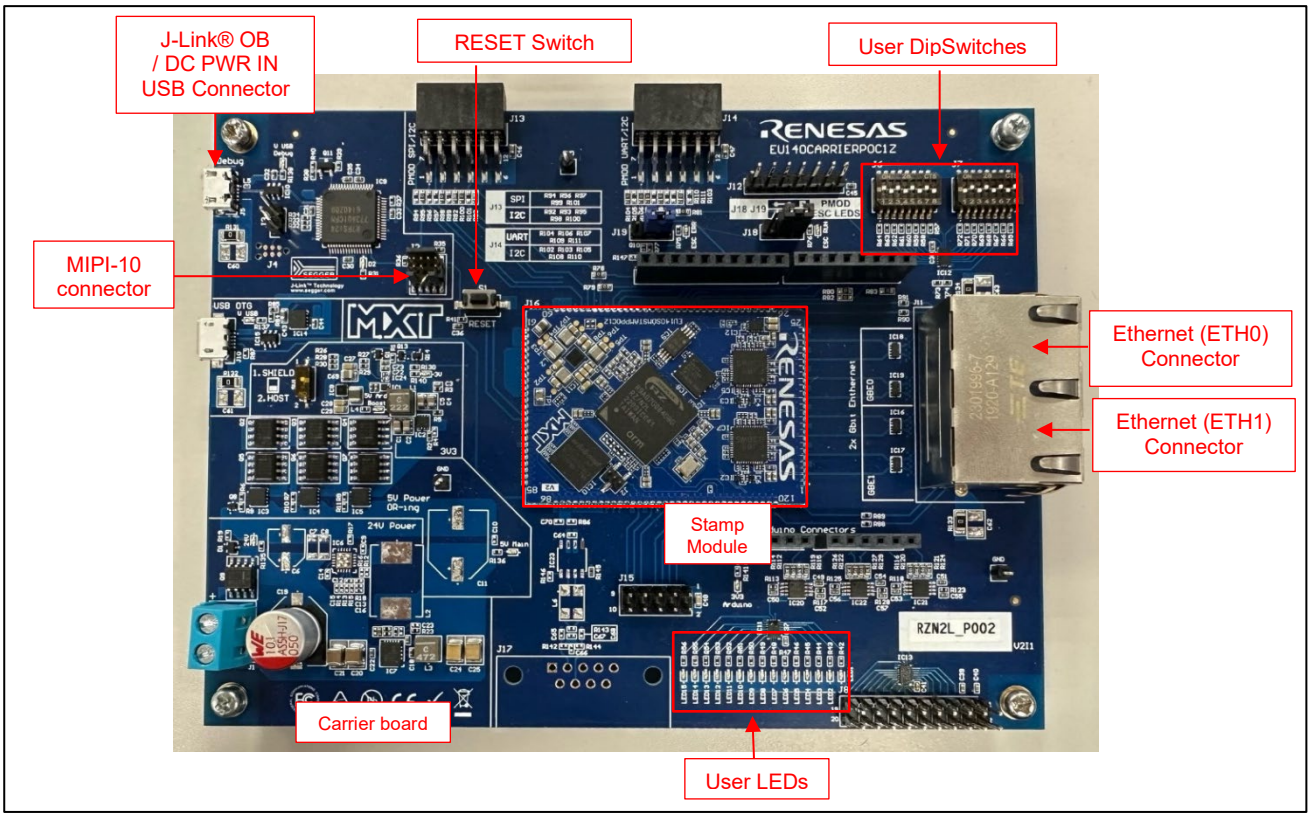


Figure 3-1 RZ/N2L Industrial Network SOM Kit

3.3 Note about Ethernet PHY driver using FSP

This SOM Kit has VSC8531 that is not compatible with FSP as PHY chip. Therefore, we have modified the PHY driver for VSC8531. For details, see "Appendix: FSP Configuration for VSC8531".

3.4 Setup the Board

Setting the board for running sample program is shown below.

1. Connect the I-jet to J2 or the USB cable to J5 for J-link OB on Carrier board.

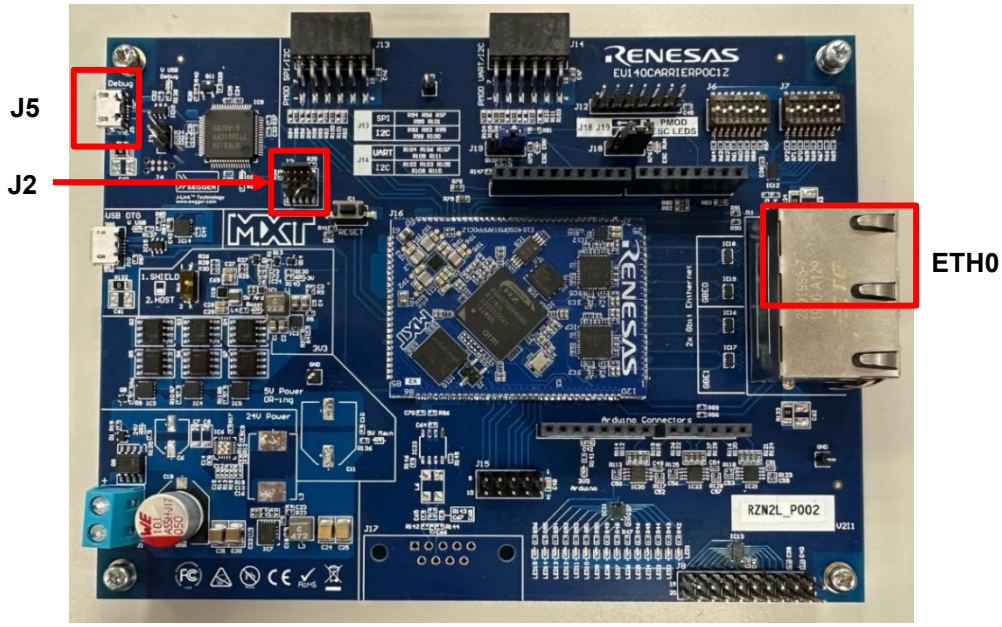


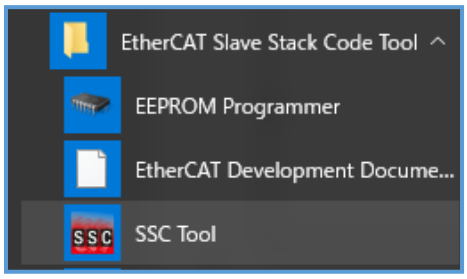
Figure 3-2 Setup the SOM Kit

2. Power is supplied by connecting USB Micro-B cable to the USB connector “J5) of the Carrier board.
3. Connect Ethernet Cable to the Ethernet Connector “ETH0”.

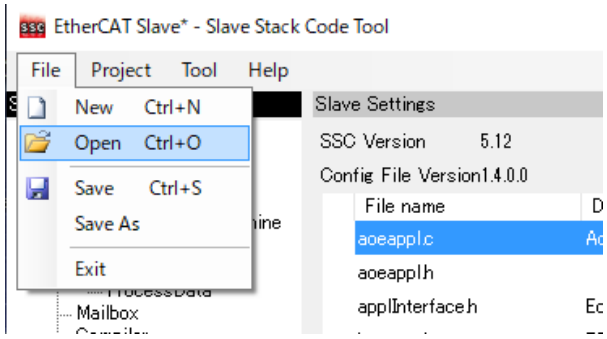
3.5 Generating the Slave Stack Code

SSC Tool is used for generating the slave stack code.
Note). Replace the folder name in the following description according to the tool to be used.

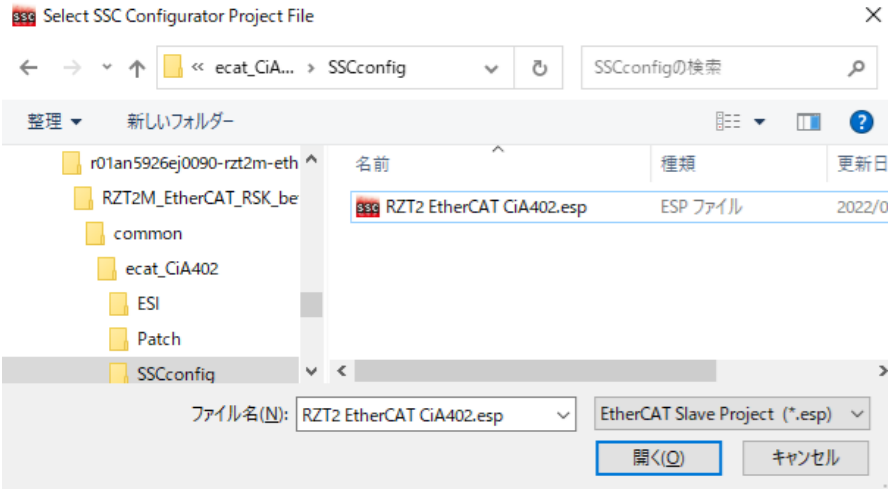
1. Start the SSC Tool from the Window Start menu.



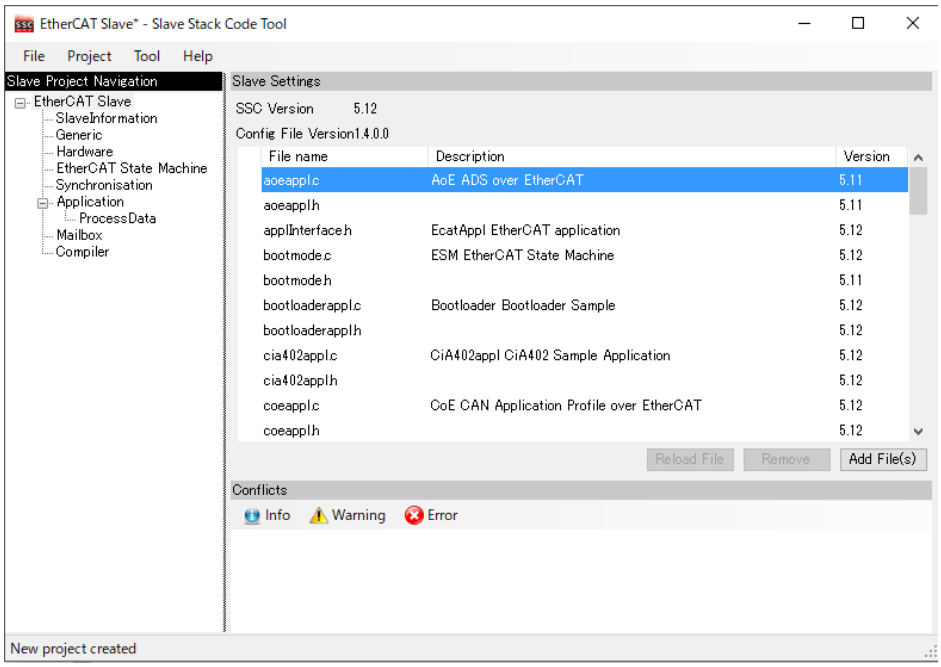
2. Select File > Open.



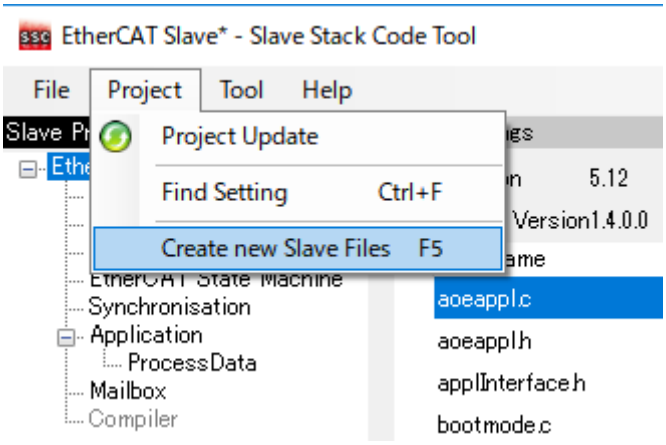
1. Select the following file,
"common\ecat_CiA402\SSCconfig\ RZN2 EtherCAT CiA402.esp"



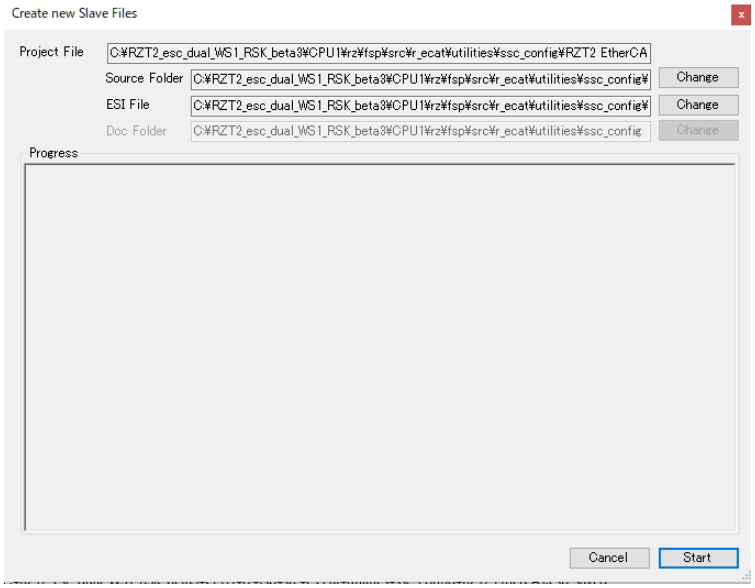
2. After clicking the [OK] button, the following window opens.



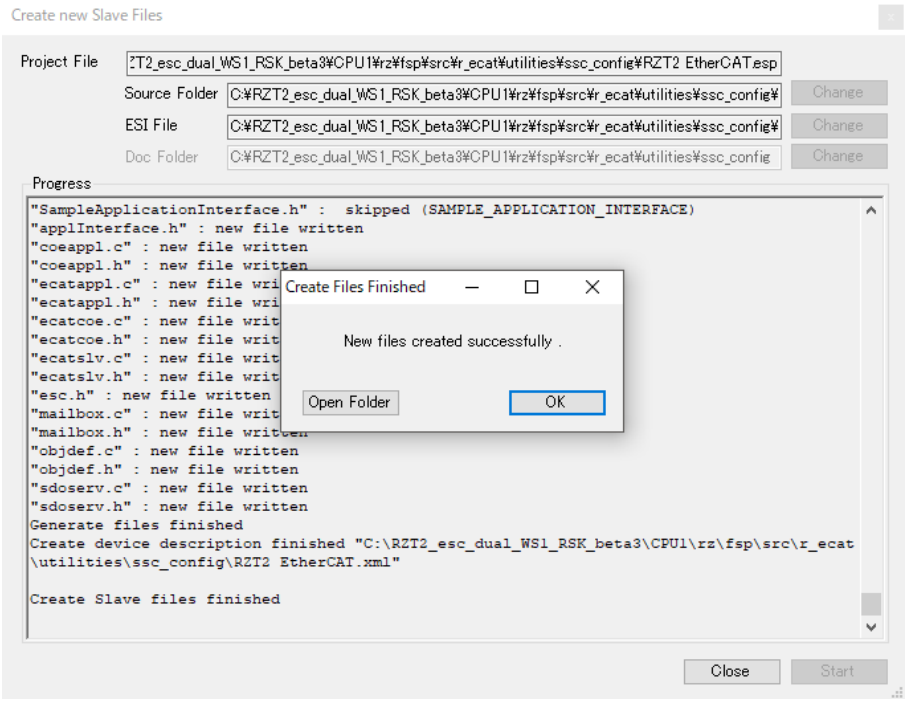
3. Select Project > Create new Slave Files.



4. Click the [Start] button to start creating the EtherCAT Slave Stack Code.



5. When a message “New file created successfully” appears, the creation processing is completed, and the source files are located in the following folder.
“common\ecat_CiA402\SSCconfig\Src”

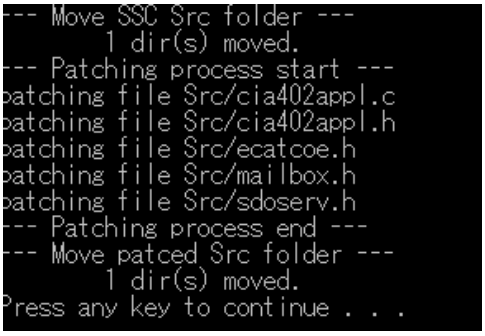


Note), If an error occurs during generation, uncheck "Create device description" in [Tool]-> [Option]-> [Create Files] of the SSC tool.

6. Right-click on the apply_patch.bat file and select [Run as an administrator] → [Yes]
   The patch file contains modifications to make the SSC source file suitable for the RZ/N2L.

   [ewarm]
   "common\ecat_CiA402\Patch\apply_patch_ewarm.bat"

   [e2studio]
   "common\ecat_CiA402\Patch\apply_patch_e2studio.bat"



After execution of the patch, the modified source file is stored in the following folder.
[ewarm]
"project\rzn2l_som\ecat_CiA402\ewarm\src\ethercat\beckhoff"

[e2studio]
"project\rzn2l_som\ecat_CiA402\e2studio\src\ethercat\beckhoff"

Note) If the patch command is not installed on your PC, you will need to install ver. 2.5.9 or a later version of GNU patch.
If it is already installed, skip this step.
Download the patch command (currently ver. 2.5.9) from the following Web page and store "patch.exe" in a folder on a path that makes the file executable from the command prompt.
http://gnuwin32.sourceforge.net/packages/patch.htm

4. Setting up a TwinCAT3

4.1 Copying the ESI Files

Before starting TwinCAT, copy the ESI files that are included in the release folder to TwinCAT destination "\TwinCAT\3.x\Config\IO\EtherCAT"

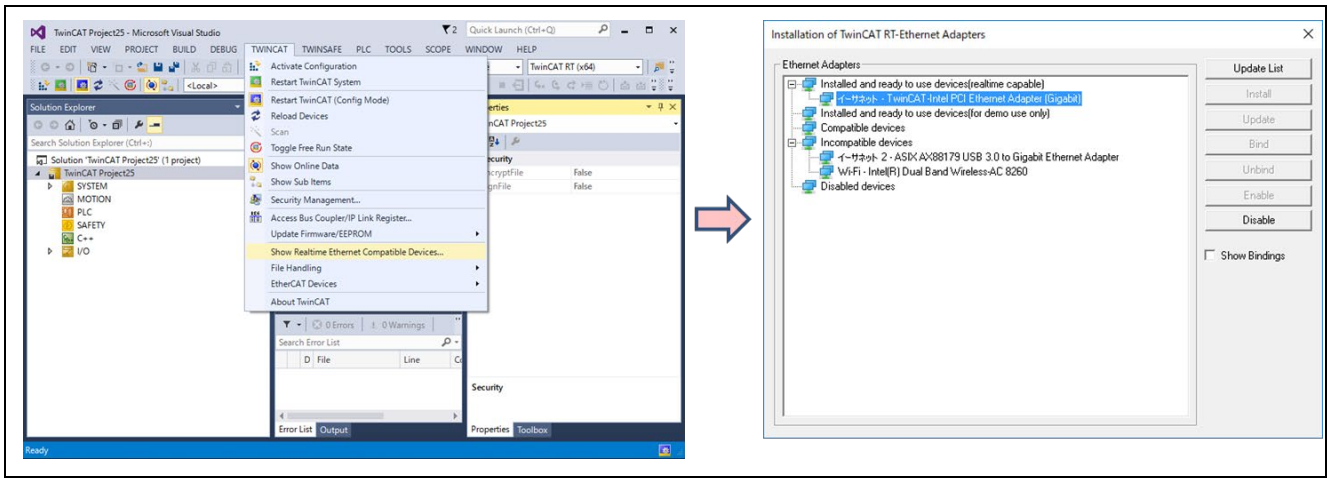
ESI file for current release available at,
"*common\ecat_CiA402\ESI\ Renesas EtherCAT RZN2 CiA402.xml*"

4.2 Add Driver

Add the Ether driver for TwinCAT. (First time only)

From the start menu, select [TwinCAT3] → [Show Realtime Ethernet Compatible Devise].

Select the connected Ether port from the communication ports and install it.



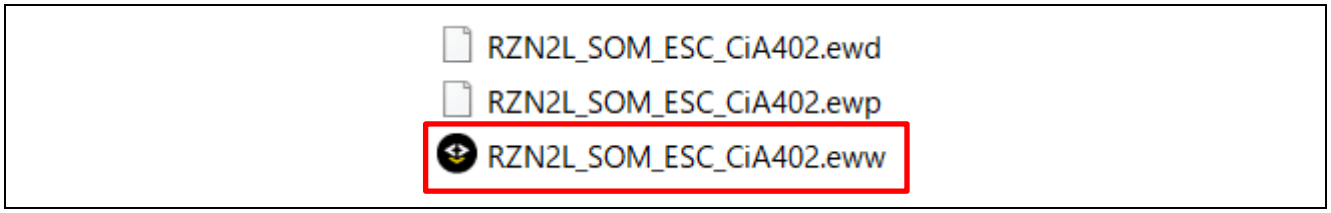
5. Running the sample application

5.1 Setting sample code for EWARM

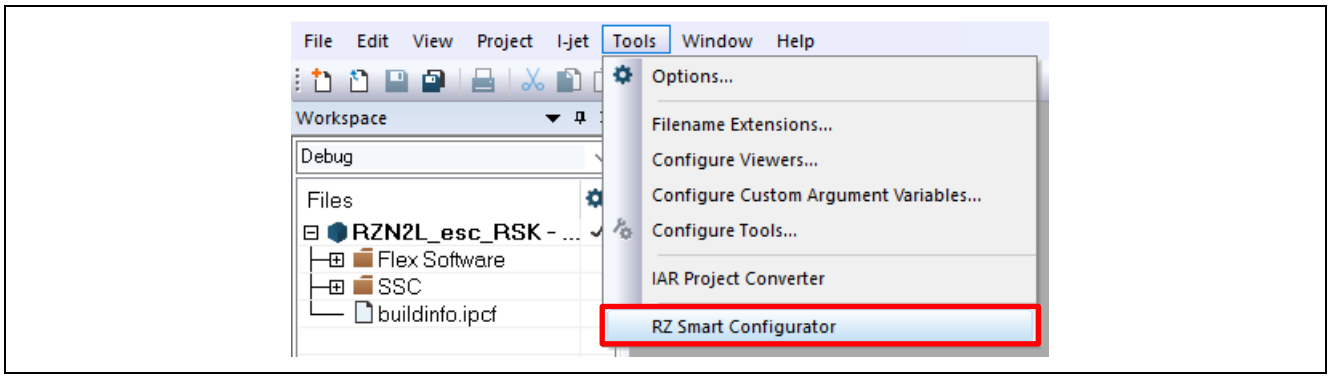
Build the sample code and load it into RAM using IAR Embedded Workbench.

Note). Please install FSP Smart Configurator in advance.
Refer to the latest getting started guide.(R01an6434ejxxxx-rzt2-rzn2.pdf)
Replace the project name in the figure with the project name of this sample project.

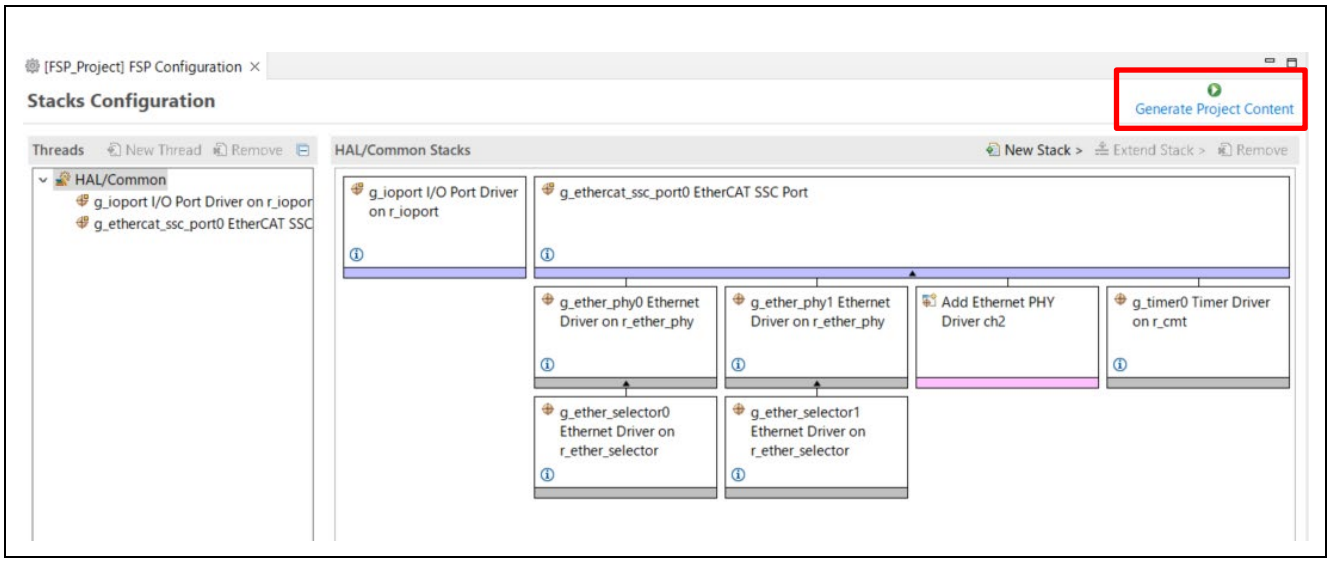
1. Open the sample project. **“project\rzn2l_som\ ecat_CiA402\ewarm \RZN2L_SOM_ESC_CiA402.eww”**



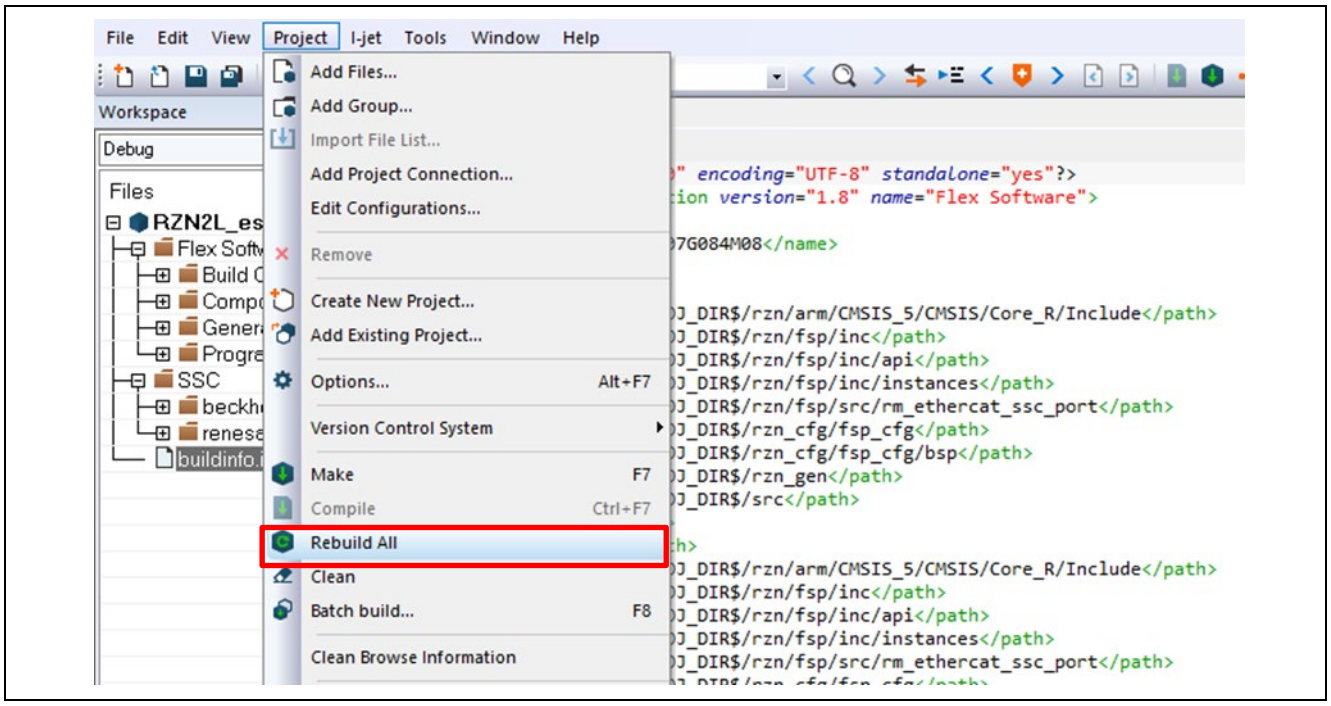
2. Open the “RZ Smart Configurator”



3. Generate the code with "Generate Project Content".

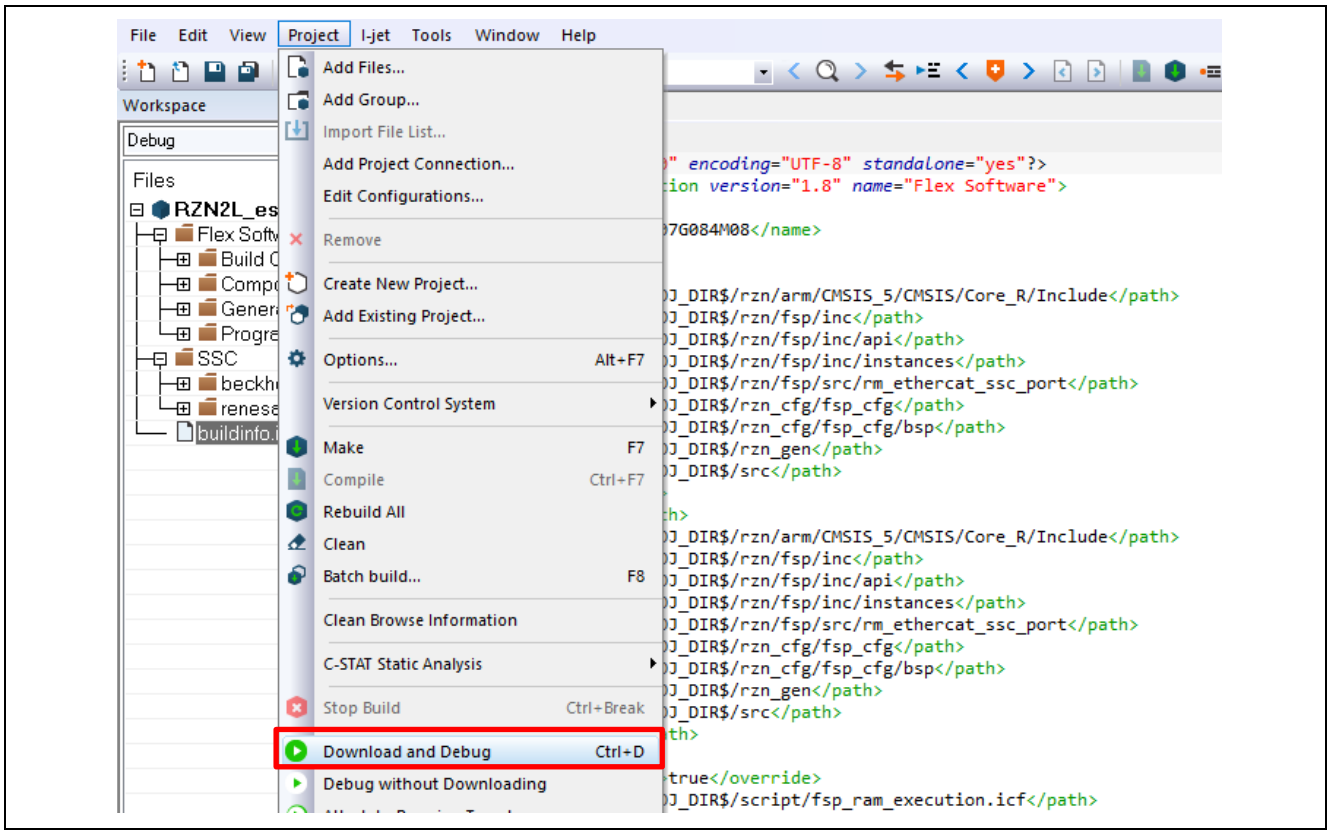


4. Select the “Rebuild All” item from the “Project” menu to rebuild the project.

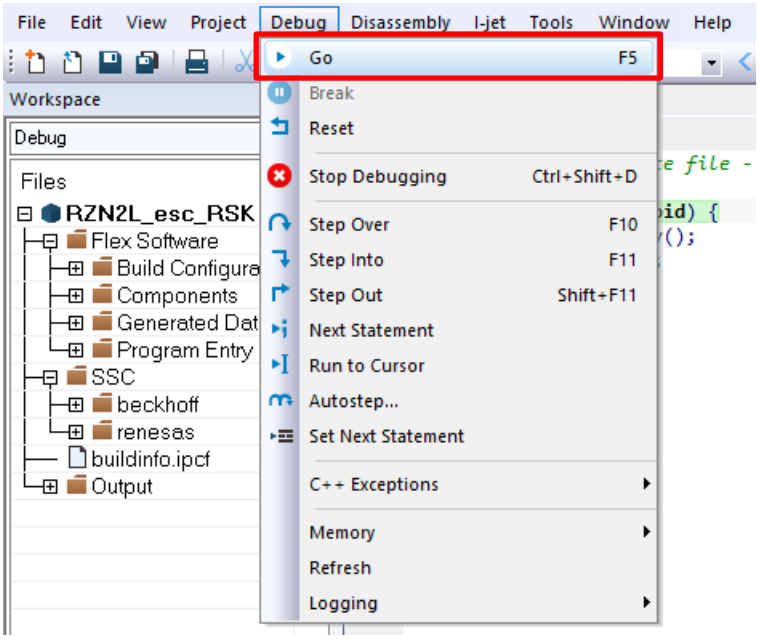


5. Press the “RESET” switch of the RZ/N2L Industrial Network SOM Kit.

6. After connecting the board and I-jet, click the Download and Debug button on the Project toolbar.



7. Press the "Resume" button for the project. Program will run.



5.2 Setting sample code for GCC

5.2.1 Erasing the flash memory

First, erase the flash memory by following the steps below. This step can be skipped after erasing the flash memory.

Open the J-Link Commander.

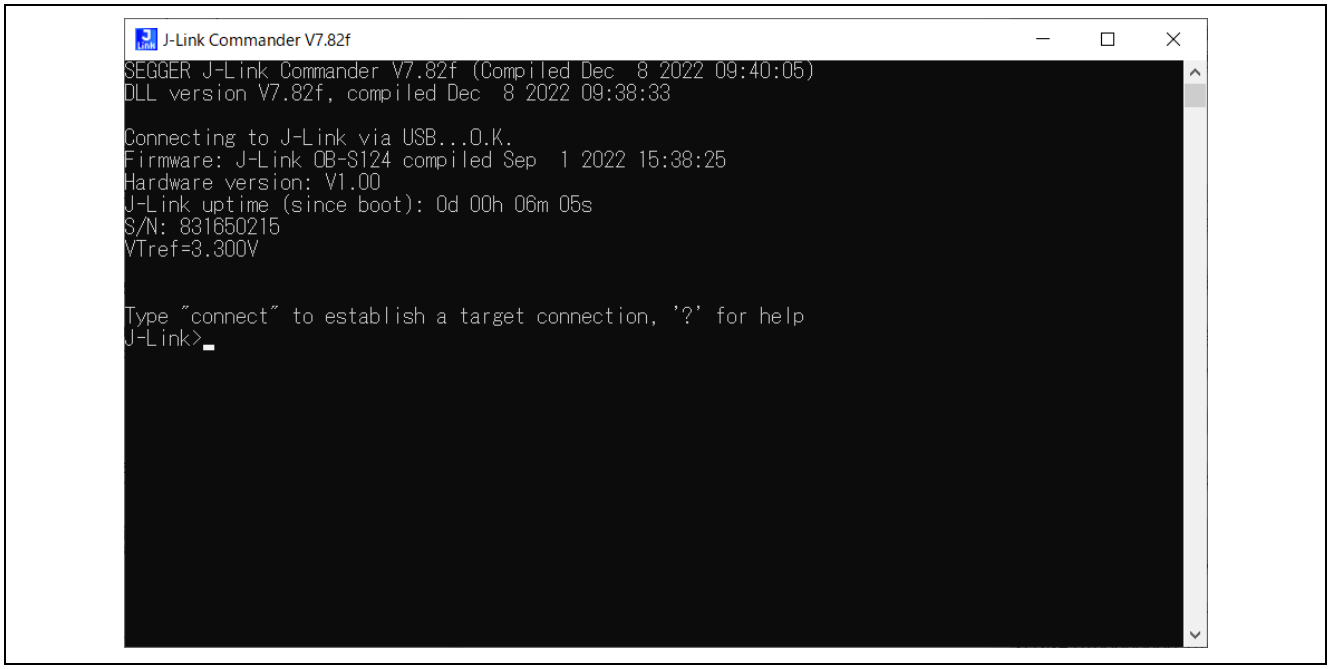


Figure 5-1 Open J-Link Commander

First, type “connect” to establish a target connection and press enter.

Next, specify the connection conditions as follows.

- Device> (Default = press enter)
- TIF>S
- Speed> (Default = press enter)

After that, confirm the message “Cortex-R52 identified.” Is displayed.

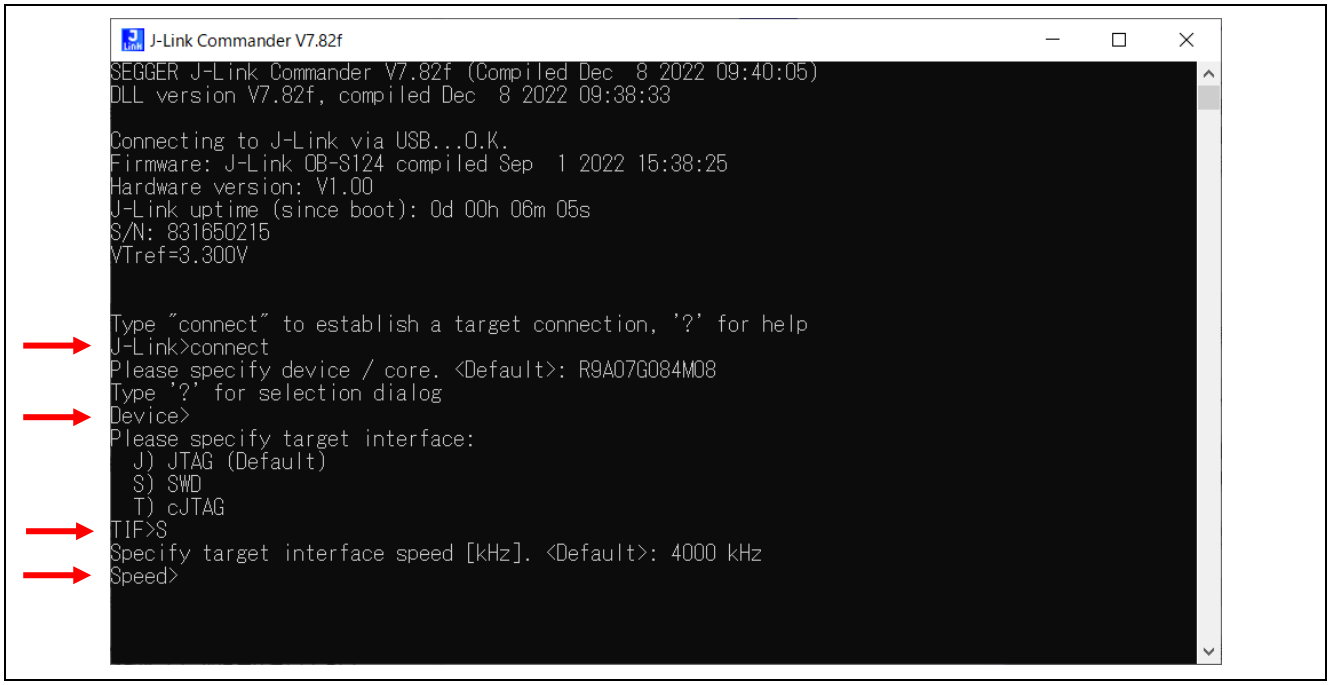


Figure 5-2 Connection conditions (1/2)

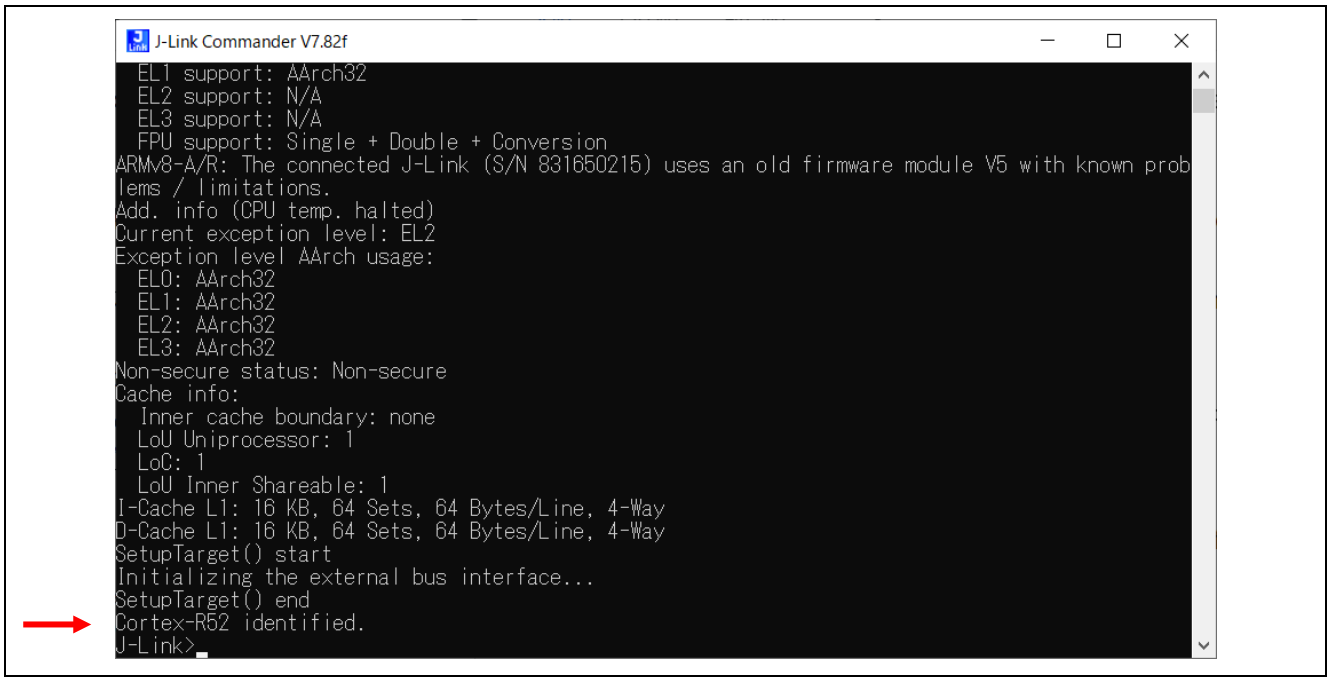


Figure 5-3 Connection conditions (2/2)

Use the commands below to enable flash erase and erase the flash memory.

- >exec EnableEraseAllFlashBanks
- >Erase 0x60000000, 0x60100000

After that, confirm the message “Erasing done.” Is displayed.

Enter “q” to exit J-Link Commander.

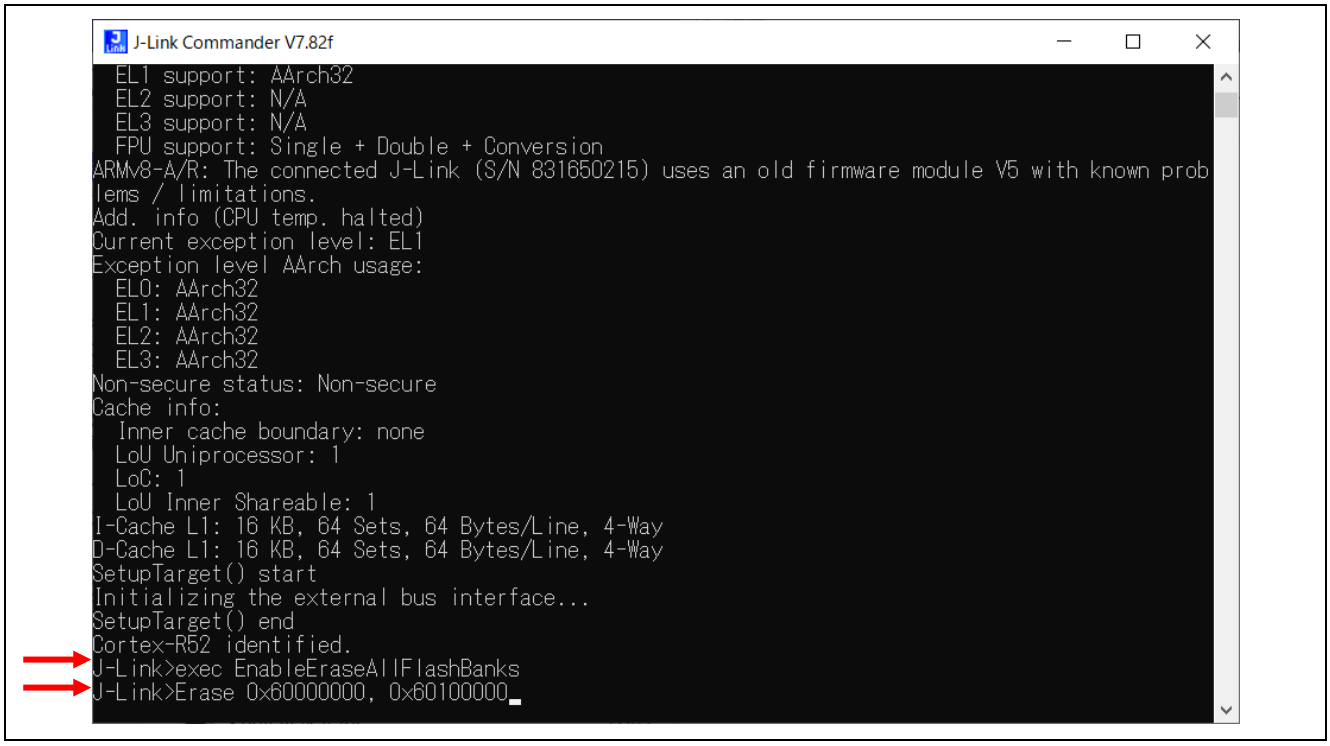


Figure 5-4 Erase flash memory (1/2)

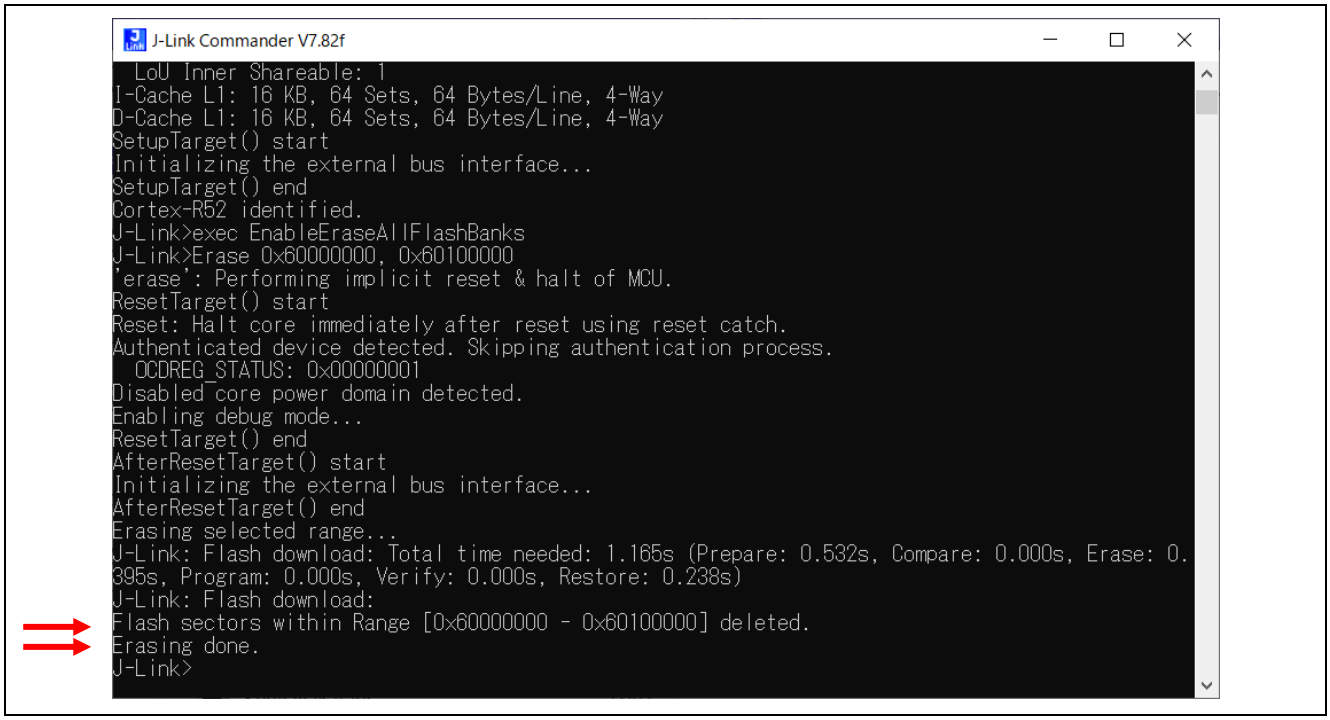


Figure 5-5 Erase flash memory (2/2)

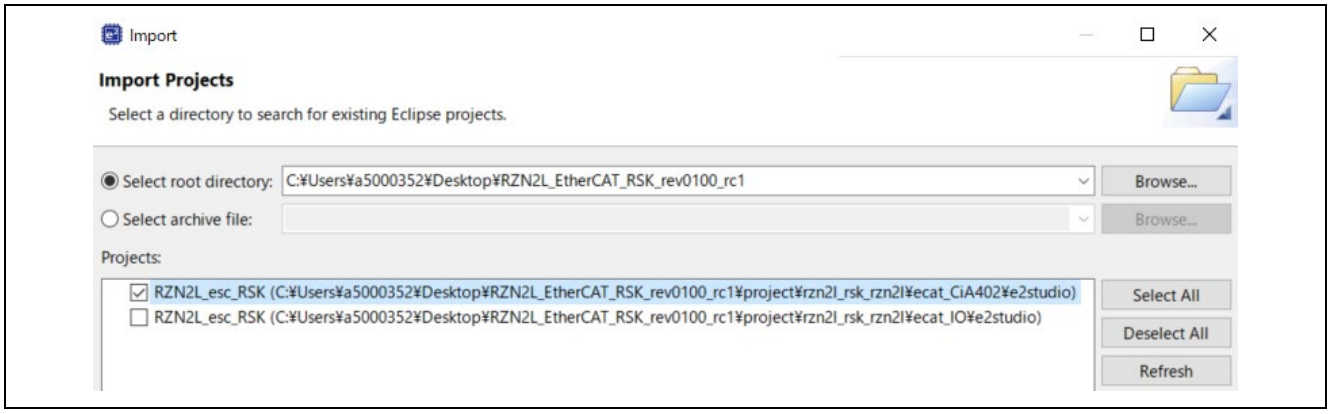
5.2.2 Setting sample code for GCC

Build the sample code and load it into RAM using Renesas Electronics e² studio.

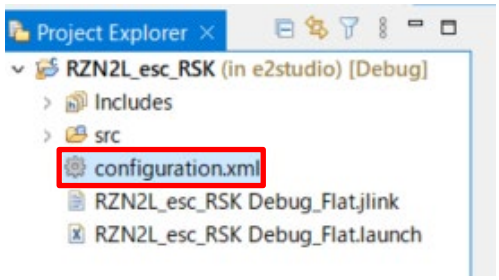
Note). Please install e2studio and adapt the FSP_Packs_v1.0.0 in advance.
Refer to the latest getting started guide.(R01an6434ejxxxx- rzt2-rzn2.pdf)

Replace the project name in the figure with the project name of this sample project

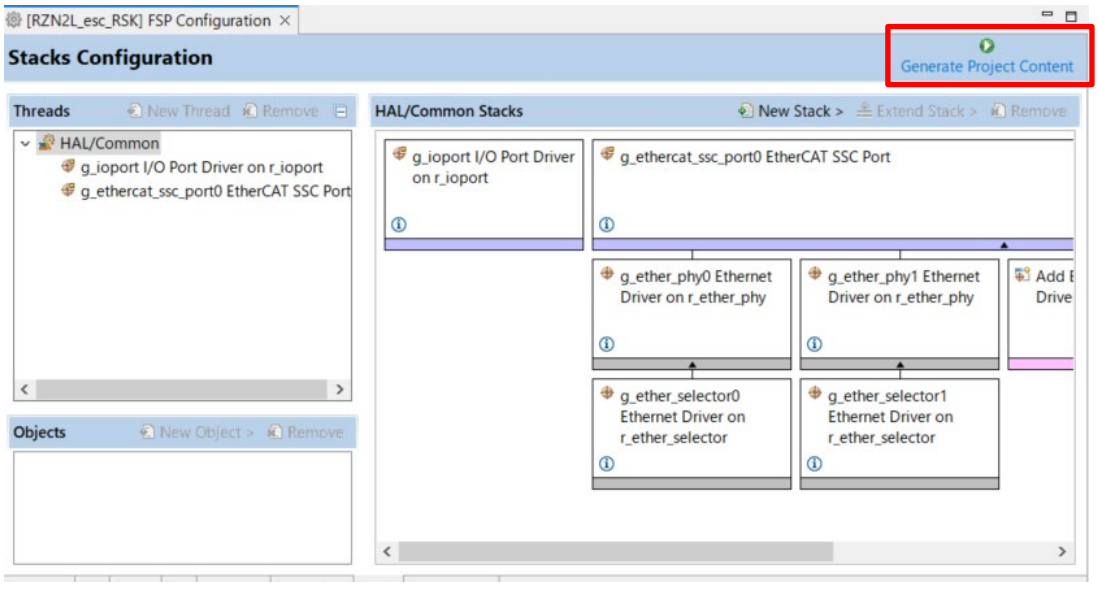
1. Import the sample project. After the program is started, by selecting [File] → [Import] → [Existing Projects into Workspace]. Check the "select root directory" and select “project\rzn2l_som\ecat_CiA402\e2studio” folder →[Finish].



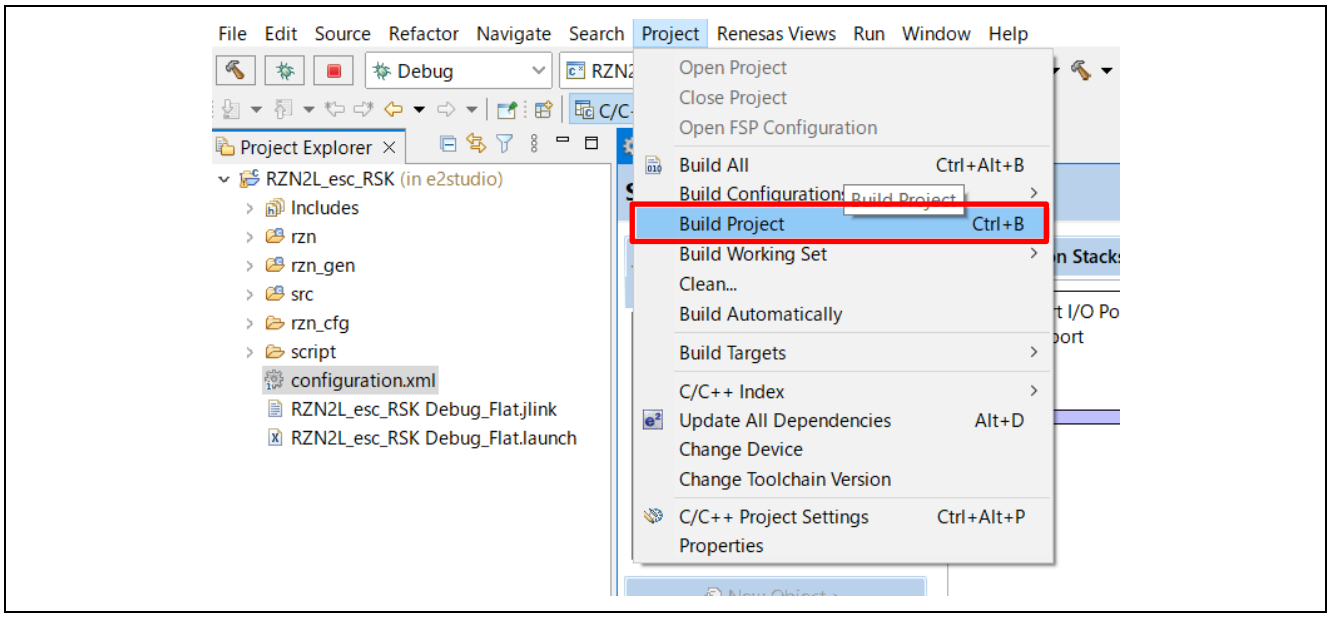
2. Open "cofiguration.xml" in the "RZN2L_SOM_ESC_CiA402" project



3. Generate the code with "Generate Project Content".

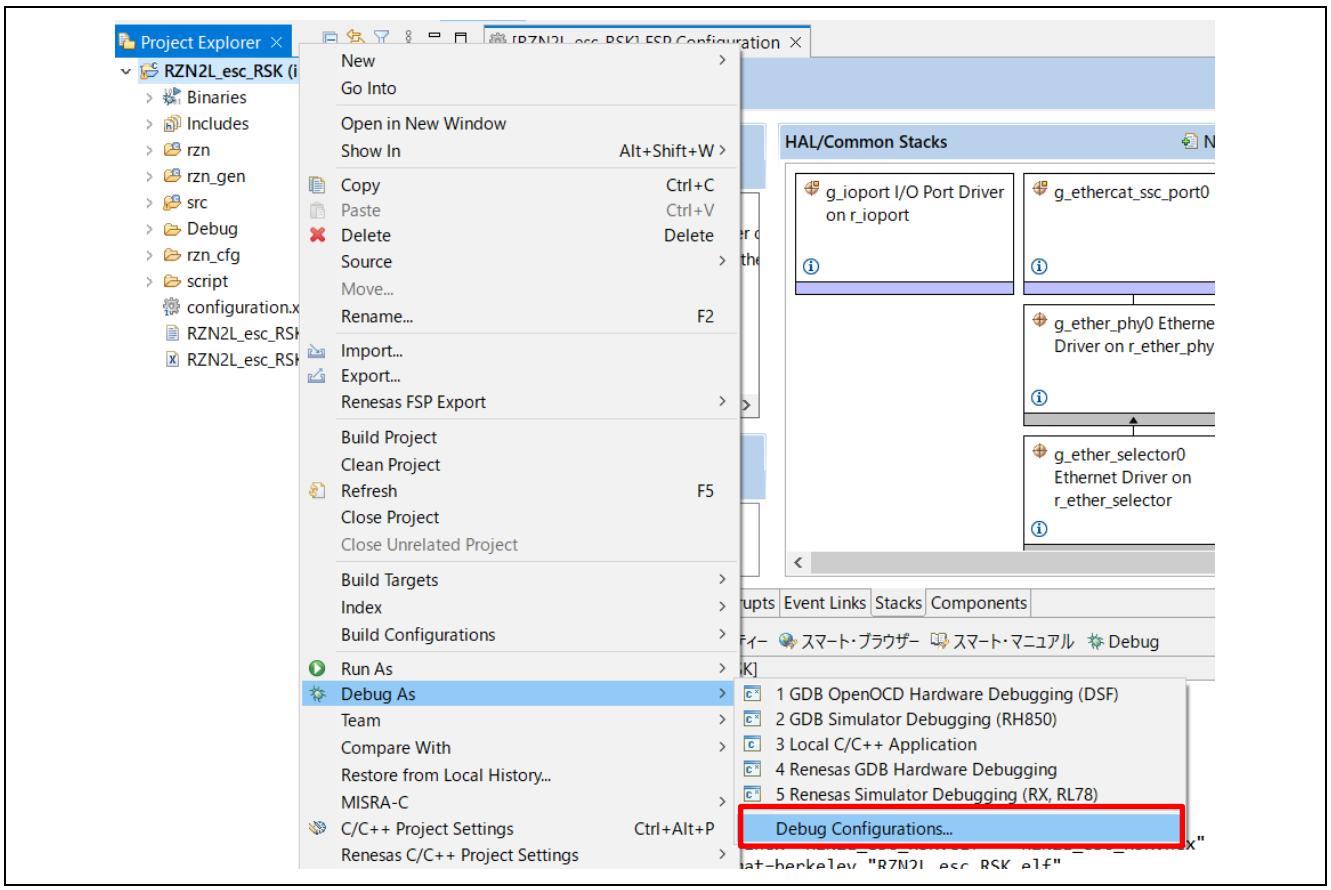


4. Select and build the "RZN2L_SOM_ESC_CiA402" project.

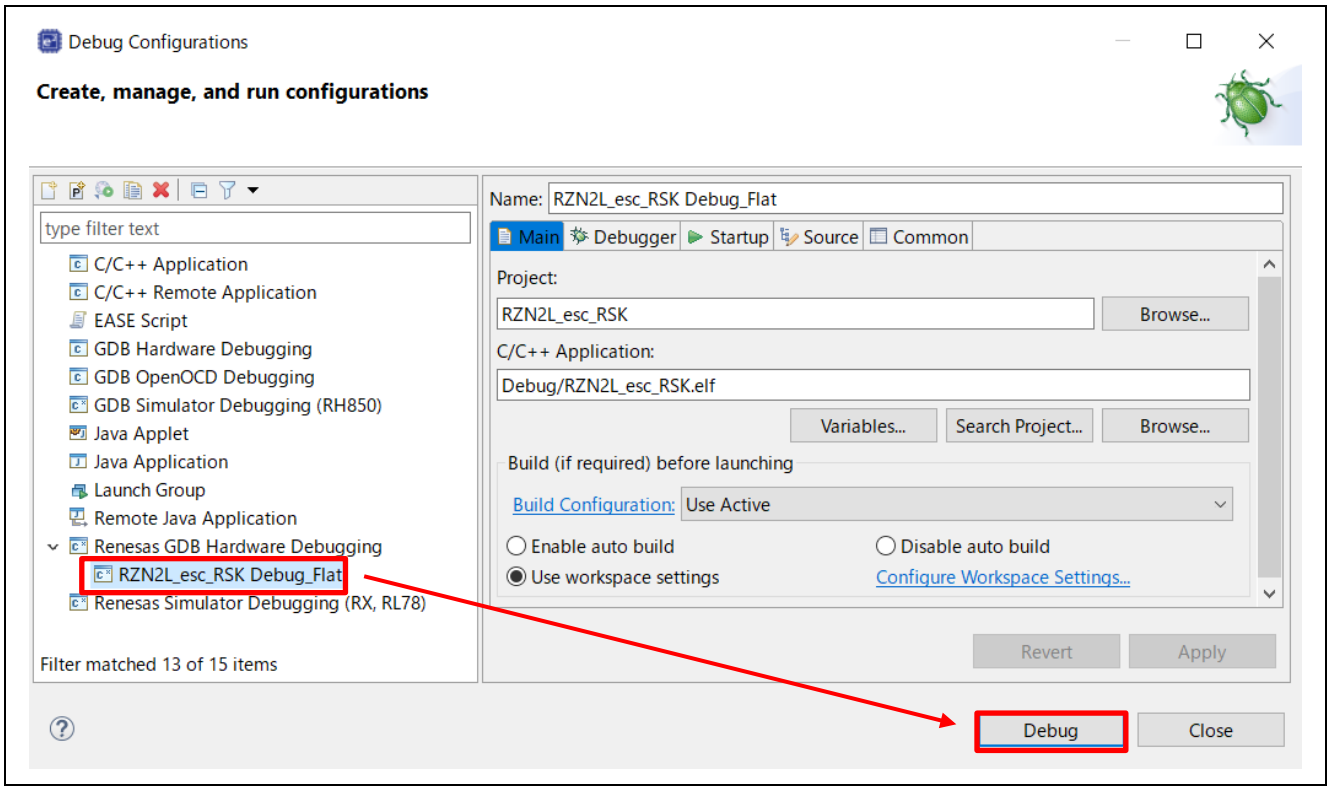


5. Press the “RESET” switch of the RZ/N2L Industrial Network SOM Kit.

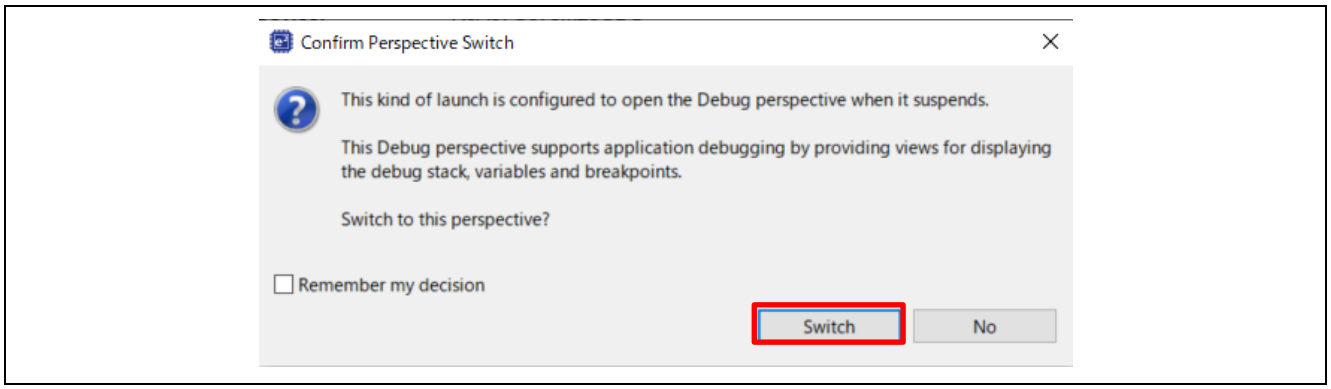
6. Connect J-Link to the SOM Kit, start debugging in the following procedure.
In [Project Explorer] view, right click the node of project to be debugged and select [Debug As] → [Debug Configurations].



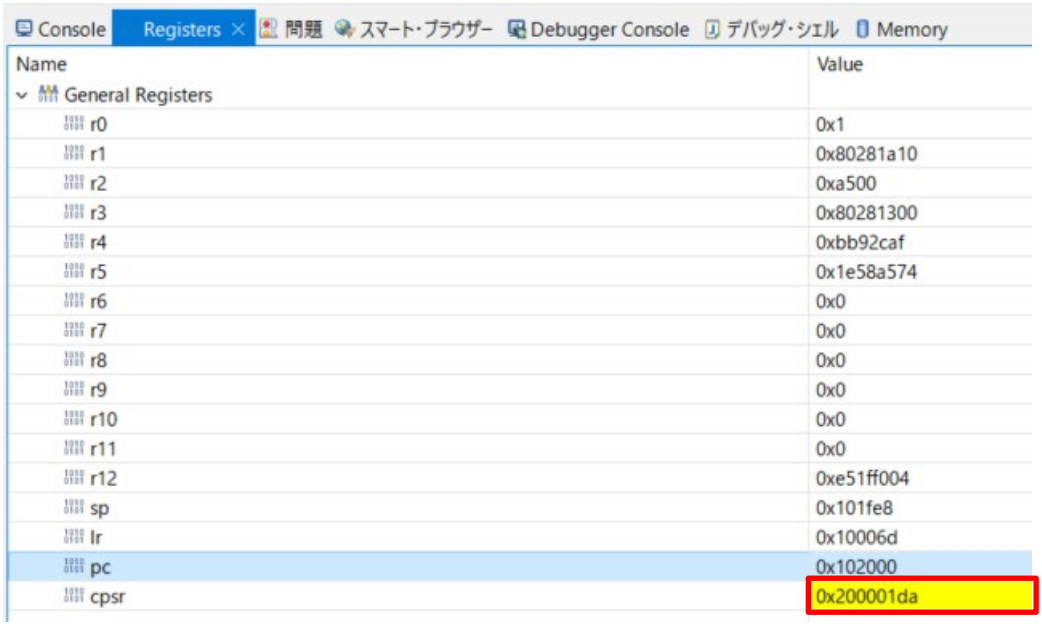
[Renesas DBG Hardware Debugging] → [RZN2L_SOM_ESC_CiA402 Debug_Flat] item, then press [Debug]



Following dialog will appear, so switch to the debug screen.



7. Before running the loaded program, change the CPSR register of CR52 general register on Registers tabs.
   Change the register value from “0x200001fa” to “**0x200001da**”.
   If the CPSR register value has not changed, program will stop at Default_Handler () at run time.



8. Press the "Resume" button for the project. Program will stop at hal_entry ().
   Press the "Resume" button again. Program is running.

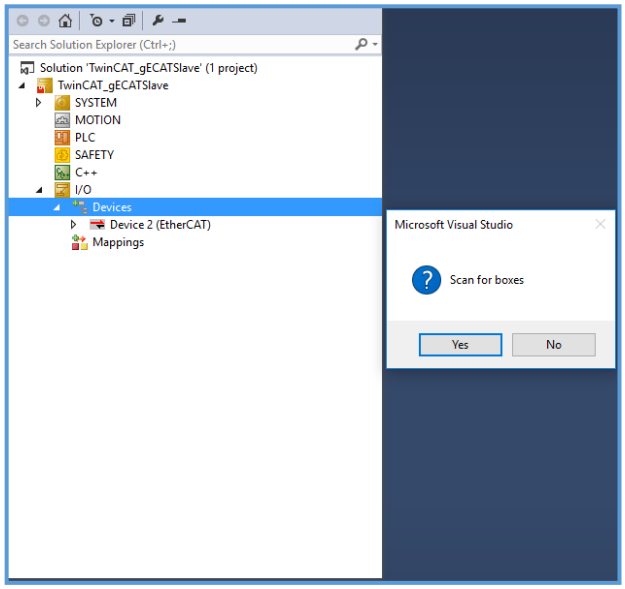
6. Connecting to TwinCAT3

Start TwinCAT3 by using the procedure described below,
From the start menu, select [Beckhoff] → [TwinCAT3] → [TwinCAT XAE].

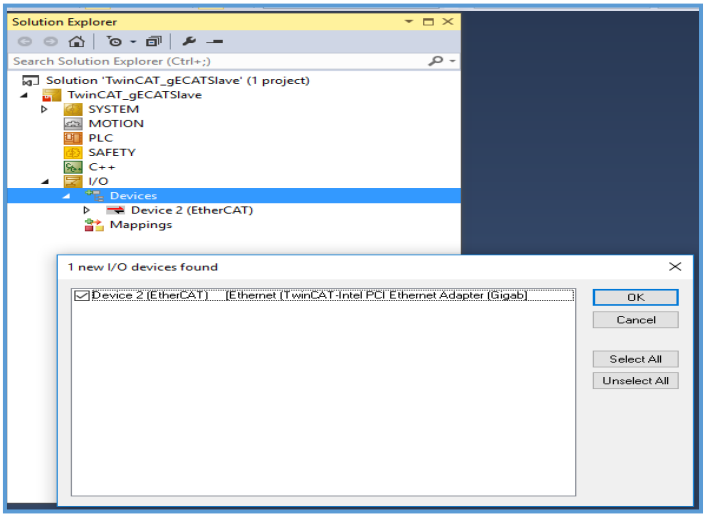
After the program is started, by selecting [File] → [New] → [Project], create a new project of the TwinCAT XAE Project type. The subsequent procedure is described below.

6.1 Scanning I/O Devices

1. (Scan for devices): Under solution explorer -> I/O -> Devices, select ‘Scan’ as in Figure below

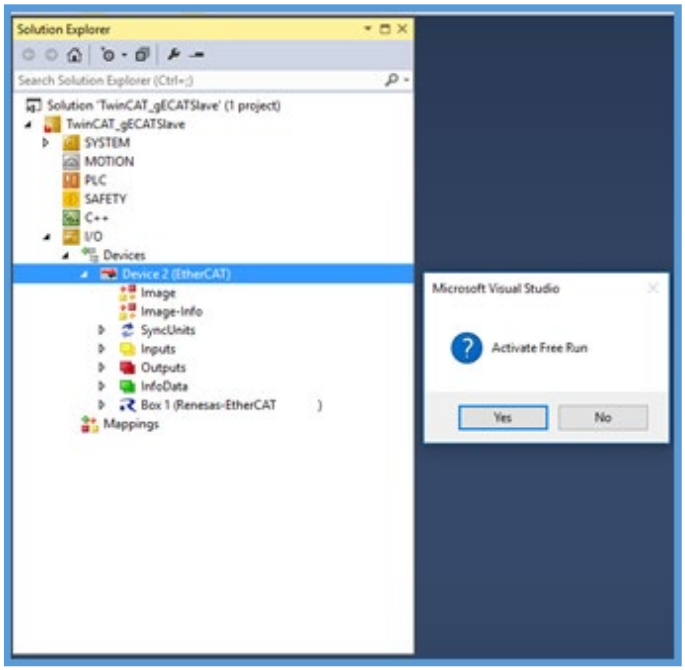


2. (Selecting port): The EtherCAT port will be displayed as below. Select and press OK.



Note). This will list EtherCAT master if a valid slave is present in the network.

3. (Activate slave): The slave is listed in the boxes, in our case “Renesas EtherCAT” in box1 shown in figure below. Press activate free run.



6.2 Updating EEPROM Data

If the data of another application has already been written to the EEPROM, replace the data.
The following shows the procedure for replacing the data on the EEPROM:

1. Double-click [Box 1] to display a panel on the right side of the window.

2. Select the [EtherCAT] tab.

3. Click the [Advanced Setting] button.

4. Select [ESC Access] → [EEPROM] → [Hex Editor].

5. Select [Download from List] → Select ESI File
   "*common\ecat_CiA402\ESI\Renesas EtherCAT RZN2 CiA402.xml*"

6. Select "Renesas EtherCAT RZ/N2 Cia402 2port" or "Renesas EtherCAT RZ/N2 CiA402 3port"

7. OK and Download.

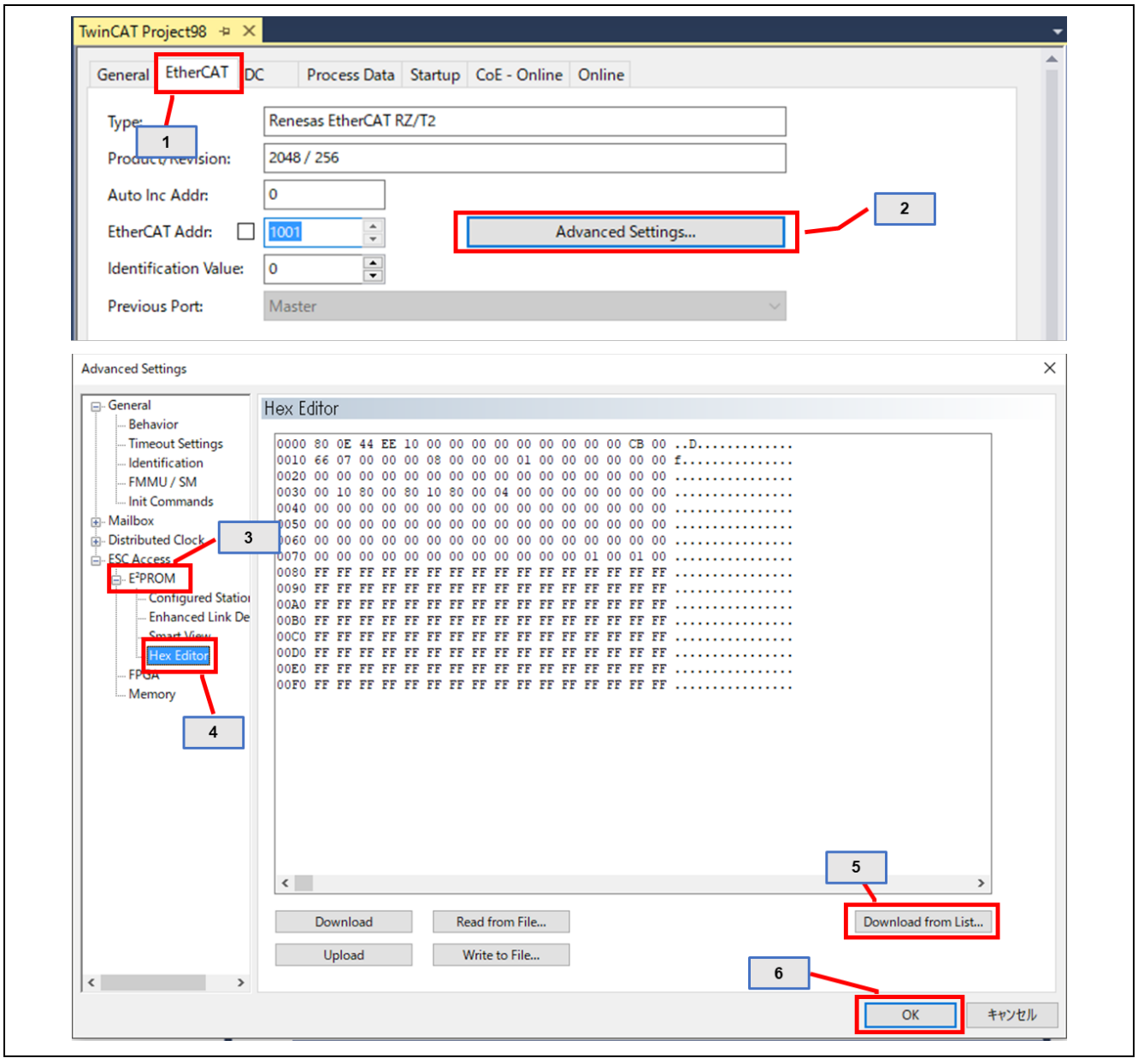


Figure 6.1: EEPROM update

Option A - Create ESI binary file from ESI XML and download.

1. SSC Tool → [Tool] → [EEPROM Programmer].
2. [FILE] → [OPEN] →Browse and select the ESI file.
3. [FILE] → [Save AS] → Select type as binary.
4. A binary file will be generated in the specified folder.
5. [Read from File] Select the ESI binary file → [Download].
6. Confirm the write status using [Upload] option.

After the data is replaced, restart the RZ/N2L (by turning it off and on, or resetting it) so that the new data is applied to the microcomputer. Execute [Restart TwinCAT System].

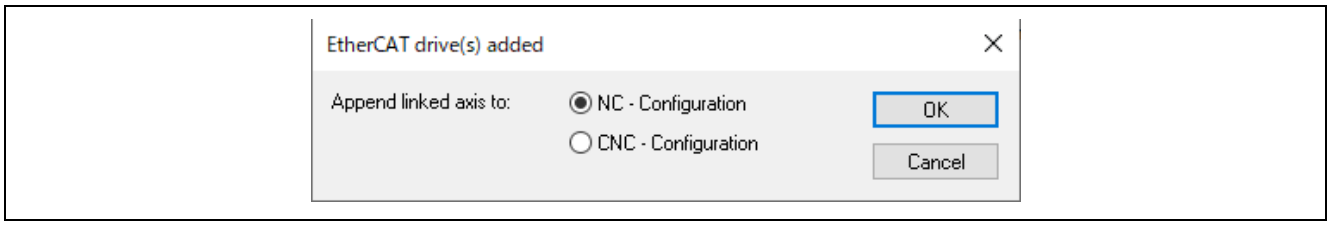
6.3 CiA402 Drive Profile check

In this chapter, check the operation of the CiA402 drive profile.

6.3.1 Rescanning the Device

1. Press the [Restart TwinCAT (Config Mode)] button.
2. In the [Restart TwinCAT System in Config Mode] dialog box, click on [OK].
3. In the [Load I/O Devices] dialog box, click on [Yes].
4. In the [Active Free Run] dialog box, click on [Yes].
   This will be OK if "Box 1" in the System Manager tree has turned to "Box 1 (RZ/N2 EtherCAT CiA402)".

Note). When scanning the device, the CiA402's ESI is used, so the axis configuration settings are displayed. Select [NC-Configuration]



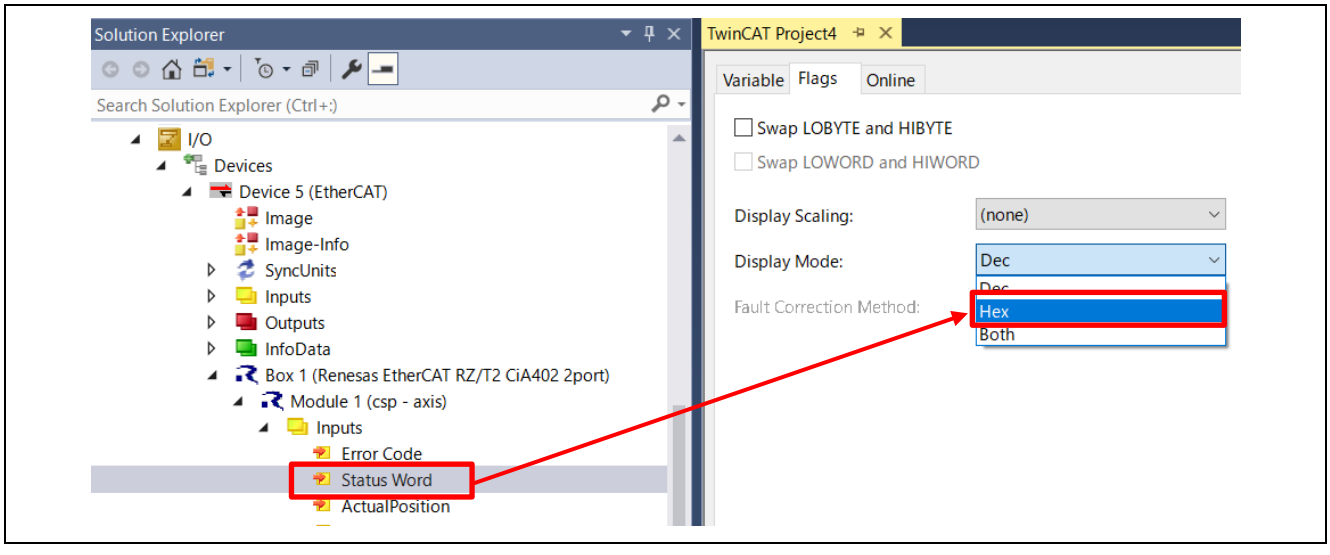
6.3.2 Checking the Operation Mode

(1) If double-click on [Box 1] in the System Manager tree, panel will be displayed on the right side of the screen.
(2) Select the [Online] tab and check that "Current Status" has turned to "OP".
(3) In the System Manager tree, expand + on the left side of "Box 1".

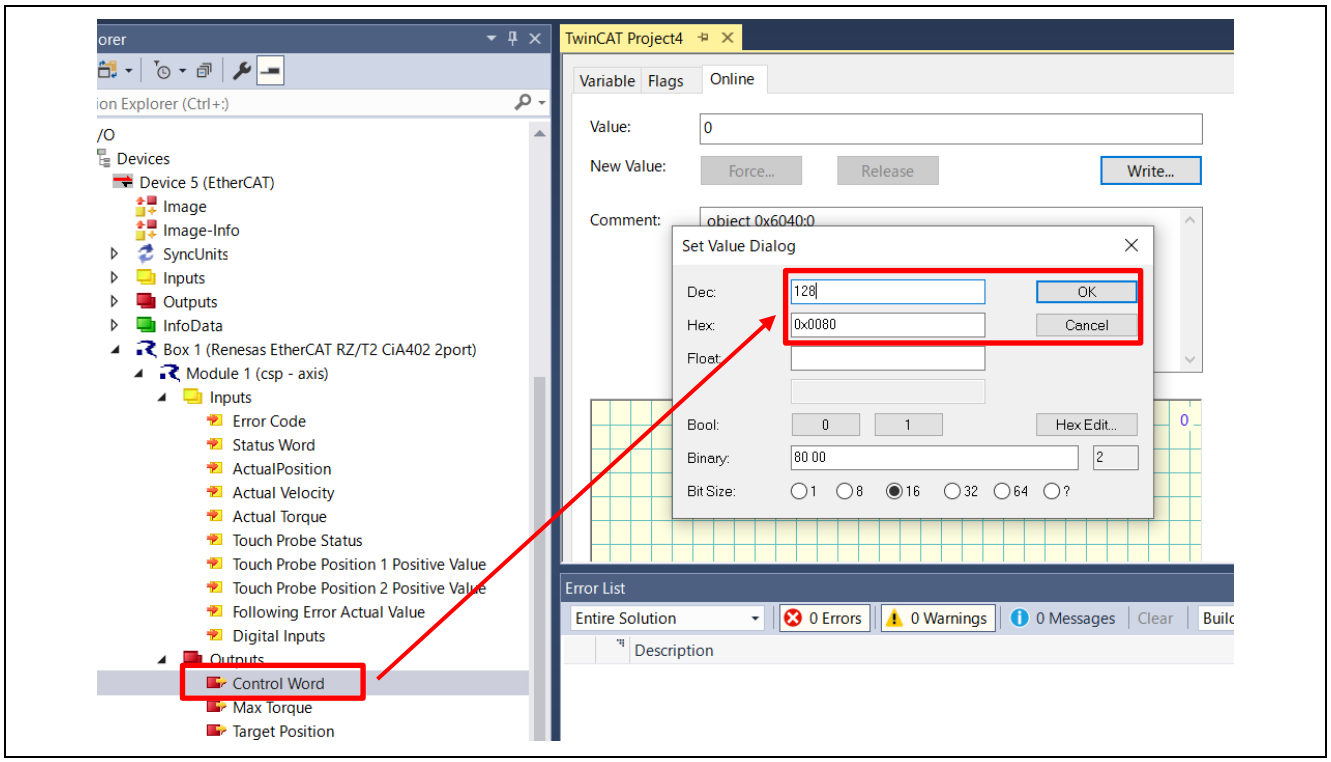
6.3.3 CiA402 State Transition

To check the operation in csp and csv modes, the state must be changed to "Operation Enabled" in both modes.
Change the state by setting a value in the "Control Word" object and check the state by confirming the value of the "Status Word" object.

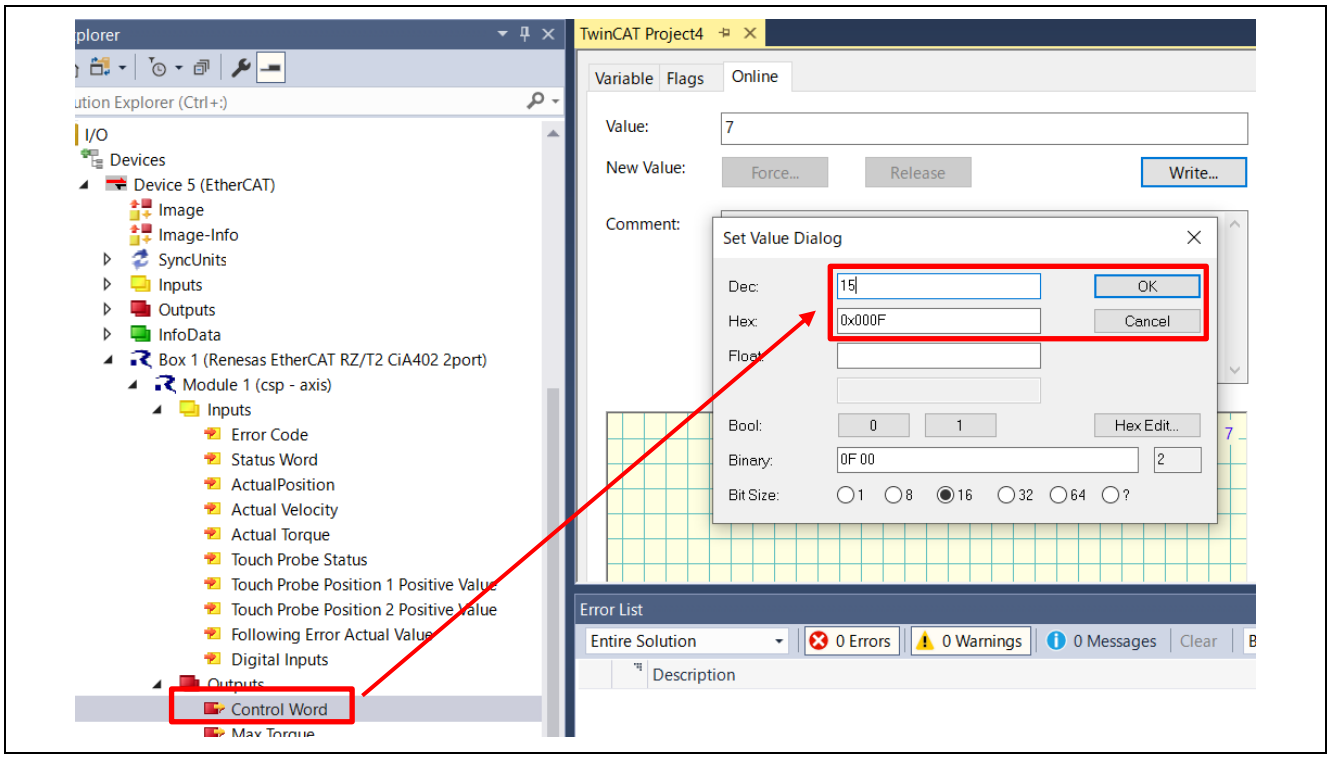
(1) Select "Inputs" → "Status Word" in the Solution Explorer tree and then select the [Flags] tab on the right-side panel. value will then be displayed.
Change the display mode from [Dec] to [Hex]



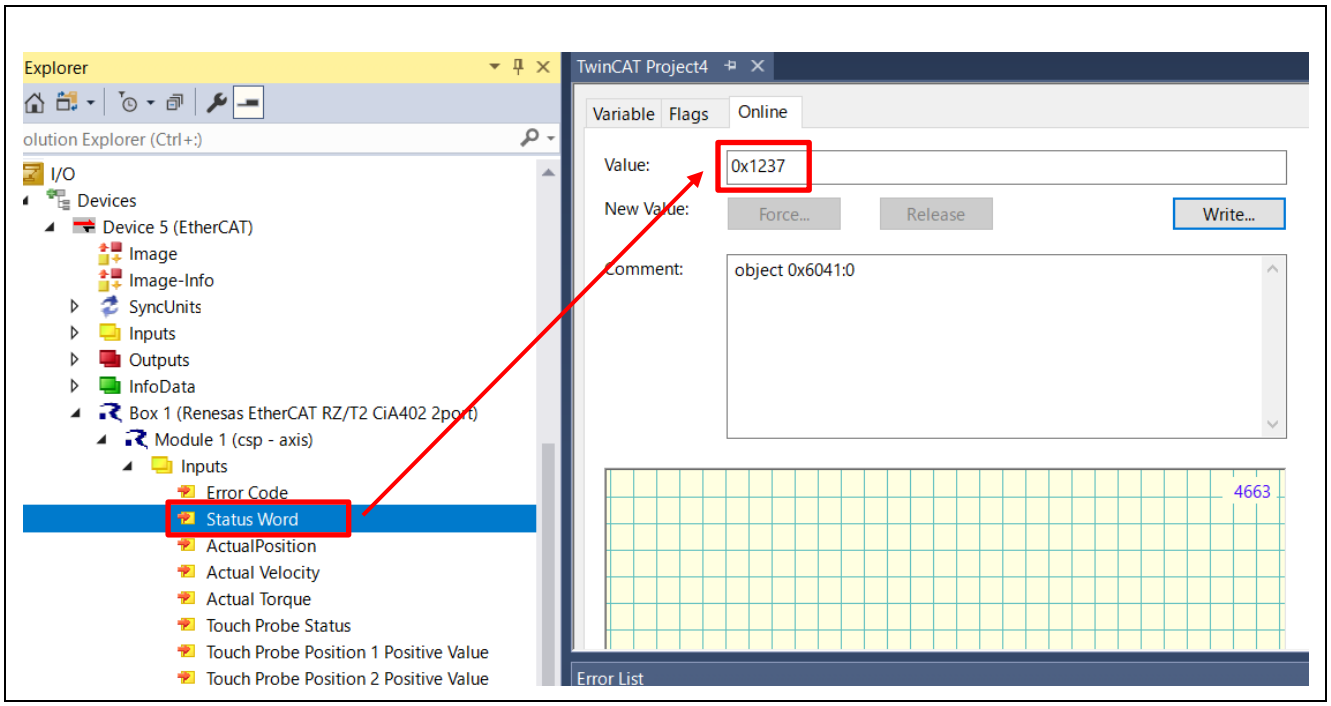
(2) Check the operation of the profile. Initialize the control word by setting it to 128 (Dec).



(3) Select "Outputs" → "Control Word" in the System Manager tree and then select the [Online] tab on the right-side panel. value will then be displayed.
Click on [Write] and set values from [7] to [15] in that order.



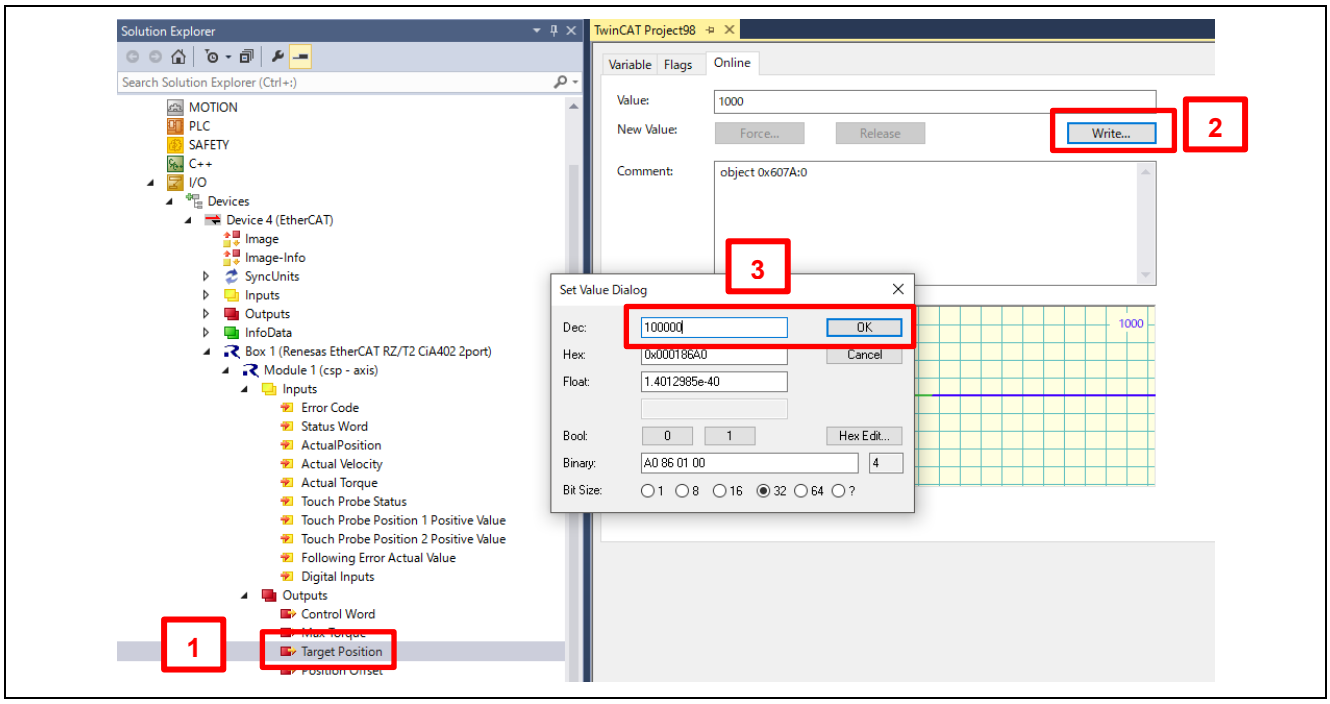
(4) Select "Inputs" → "Status Word" in the System Manager tree and then select the [Online] tab on the right-side panel. value will then be displayed.
If the value is [0x1237], the state is "Operation Enabled". Proceed to the next step.
If the value is [0x1208], the state is "Fault" for some reason. Set "Control Word" to [128] once and return to step (1).



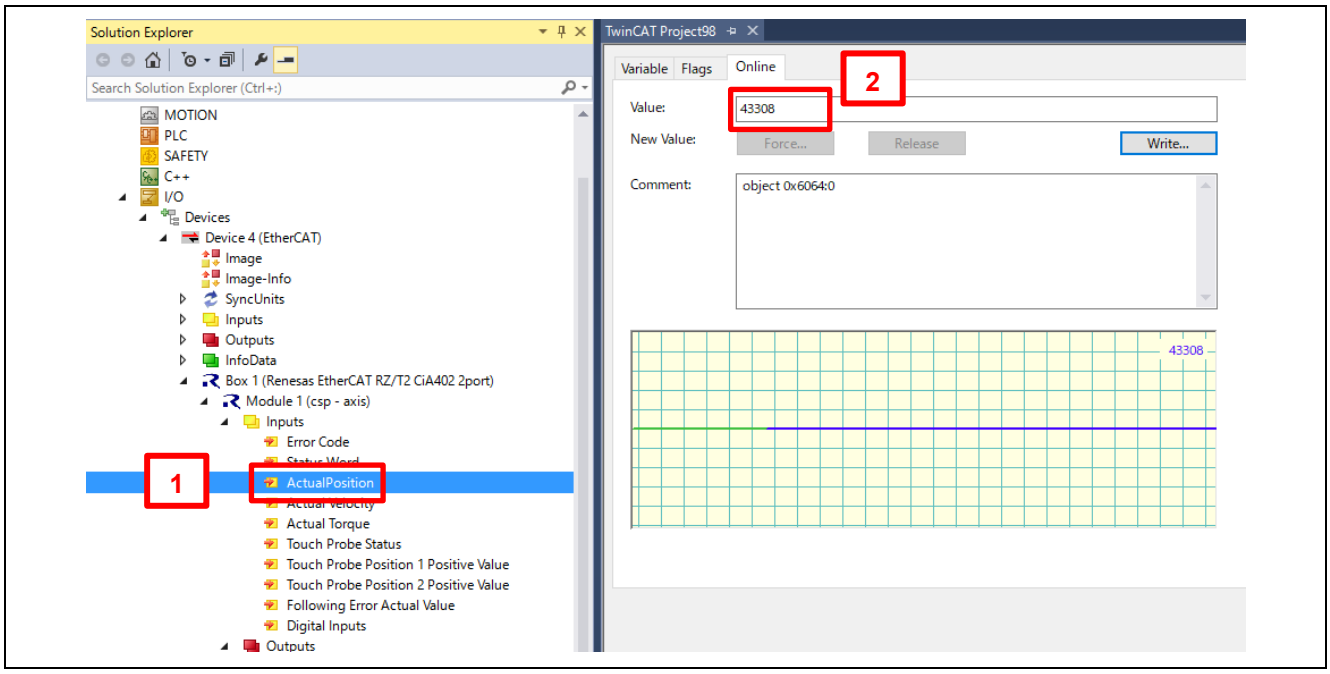
6.3.4 csp Mode

Check that "Module 1" is displayed as "Module 1 (csp-axis)".

(1) Select "Outputs" → "Target Position" in the System Manager tree and then select the [Online] tab on the right-side panel. A value will then be displayed.
Click on [Write] and set a desired value. As an example, set [100000] here.



(2) Select "Inputs" → "Actual Position" in the System Manager tree and then select the [Online] tab on the right-side panel. A value will then be displayed.

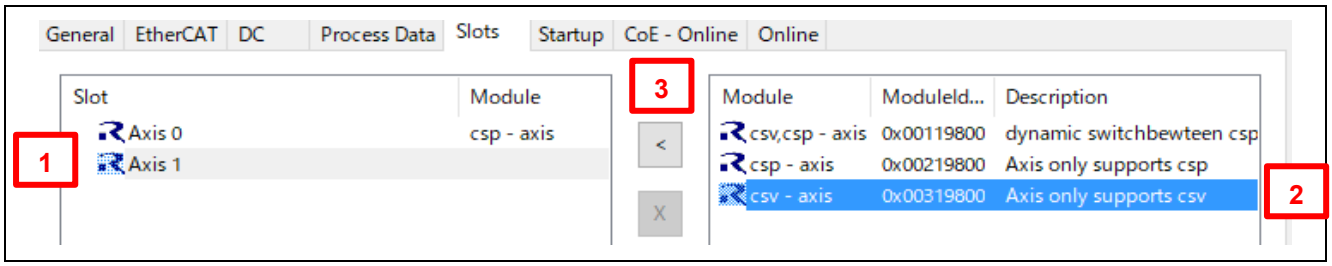


6.3.5 csv Mode

Change the operation mode

(1) In the System Manager tree, select "Box 1 (RZ/N2 EtherCAT CiA402)" and then select the [Slots] tab on the right-side panel.

(2) If select "Axis 1" under "Slot" in the left frame of the tabbed page, modules which can be added will be displayed in the right frame of the page, so add "csv-axis".

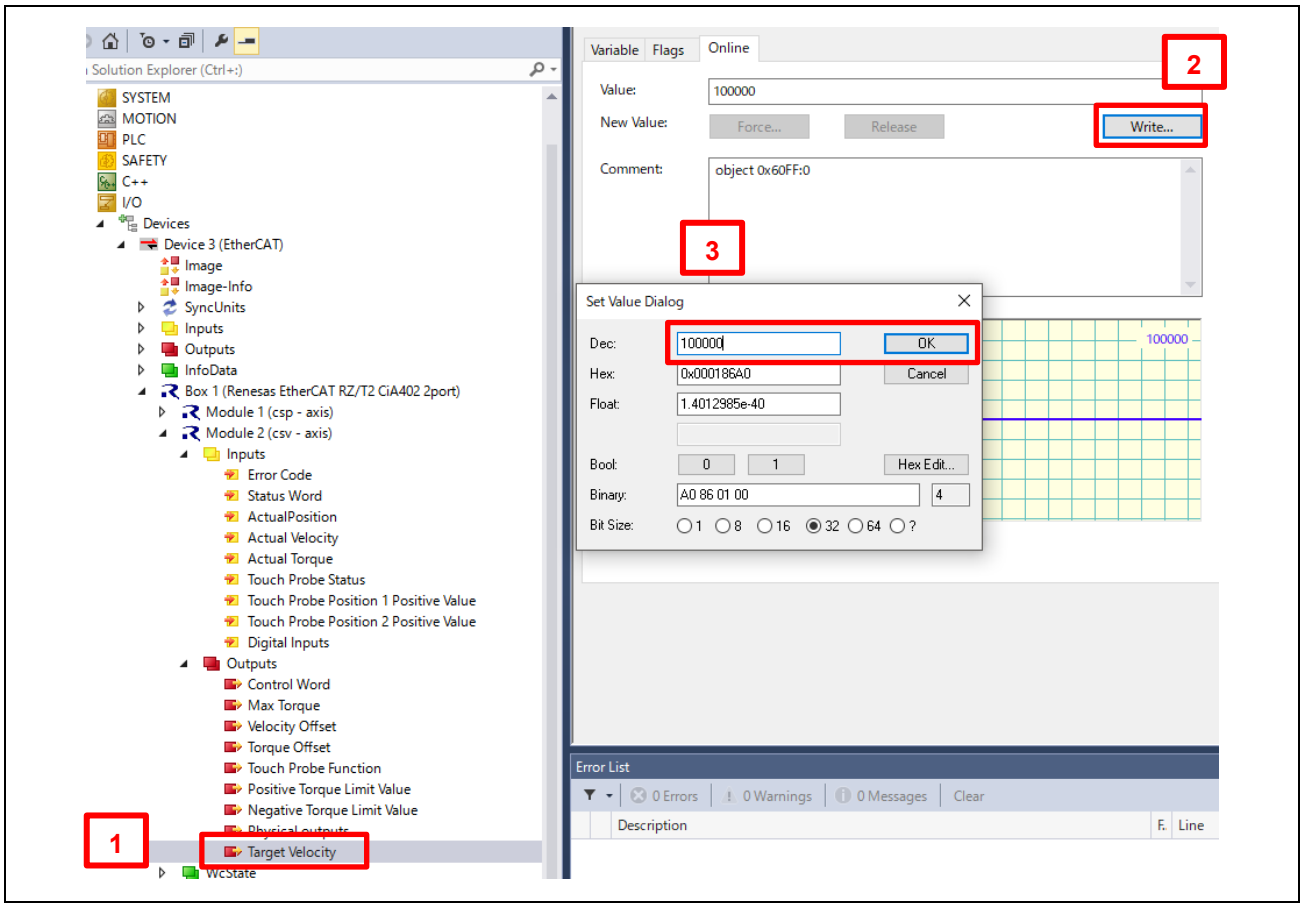


(3) Check that "Module 2 (csv-axis)" has been added in the System Manager tree.

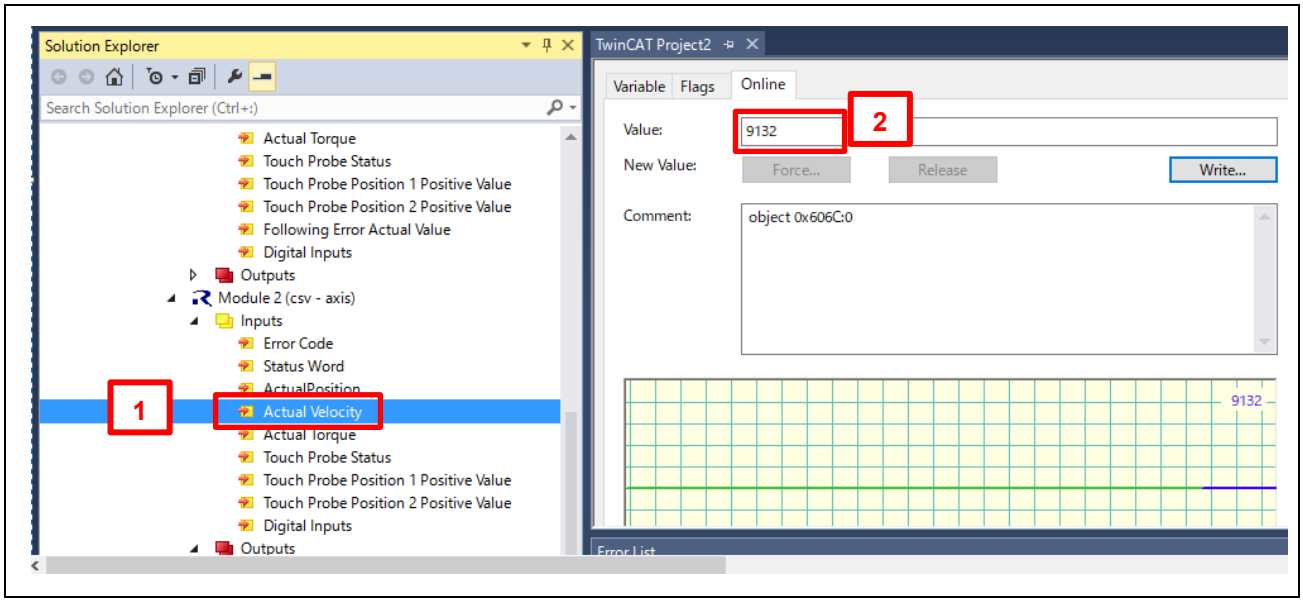
(4) Execute “Reload Devices” to reflect the configuration.

(5) Follow the procedure described in section 4.7 to change the state to "Operation Enabled".

(6) Select "Outputs" → "Target Velocity" in the System Manager tree and then select the [Online] tab on the right-side panel. A value will then be displayed.
Click on [Write] and set a desired value. As an example, set [100000] here.



(7) Select "Inputs" → "Actual Velocity" in the System Manager tree and then select the [Online] tab on the right-side panel. A value will then be displayed.
Check that the value set in "Target Velocity" allows incrementation up to [100000].



7. CiA402 Drive Profile

The CiA402 drive profile is a device profile for driving motors and motion control and mainly defines functional operations for servo drives, sine-wave inverters and stepping motor controllers. In this profile, the multiple operation modes and corresponding parameters are defined as an object dictionary. Also, Finite State Automaton (FSA) to define the internal and external behavior in every state is included. When changing the state, the result after transition is reflected in the status word object that shows the current state by specifying the state through the control word object. The control word and various command values (such as speed) are assigned to RxPDO, and the status word and various real values (such as position) are assigned to TxPDO. Please see the contents of the CiA402 standard for more details.

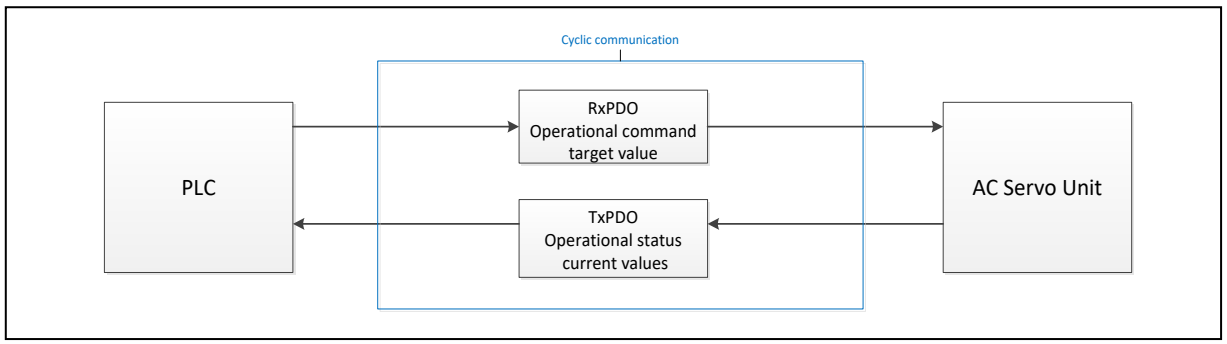


Figure 7-1 CiA402 Communication Flow

7.1 Operation Modes

In the application note, the following modes are supported from among the operation modes defined in the CiA402 standard.

Table 7-1 List of Supported Operation Modes

Operation Mode	Support
Profile position mode	No
Velocity mode (frequency converter)	No
Profile velocity mode	No
Profile torque mode	No
Homing mode	No
Interpolated position mode	No
Cyclic synchronous position mode	Yes
Cyclic synchronous velocity mode	Yes
Cyclic synchronous torque mode	No
Cyclic synchronous torque mode with commutation angle	No
Manufacturer specific mode	No

7.2 State Transition

In this application note, the following is supported as FSA defined in the CiA402 standard.

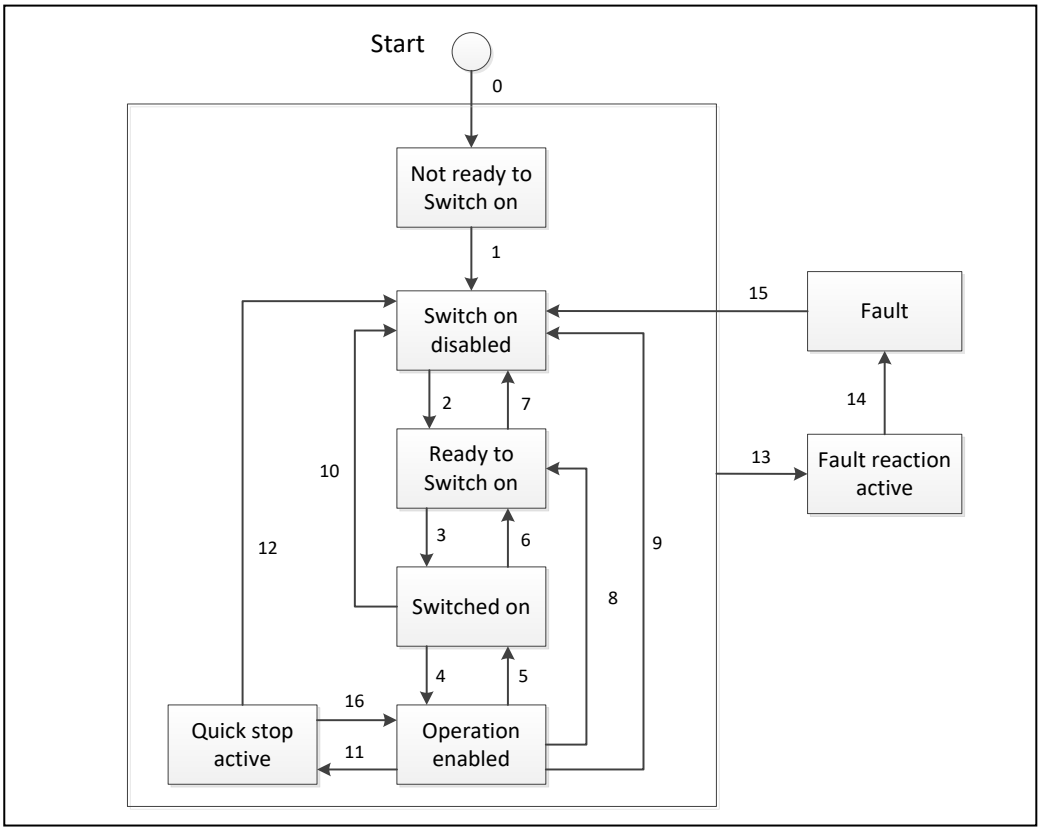


Figure 7-2 CiA402 State Transition Diagram

7.3 Object Dictionary

The following is the list of the object dictionaries supported in this application note.

Table 7-2 List of Supported Object Dictionaries

Operation Mode	OBJECT Name	INDEX	Category	Access	Data Type	PDO Mapping
Cyclic synchronous position mode + Cyclic synchronous velocity mode	Position actual value	0x6064	Mandatory	ro	INT32	Yes
	Following error window	0x6065	Optional	rw	UINT32	No
	Velocity actual value	0x606C	Conditional	ro	INT32	Yes
	Max torque	0x6072	Optional	rw	UINT16	Yes
	Torque actual value	0x6077	Conditional	ro	INT16	Yes
	Target position	0x607A	Optional	rw	INT32	Yes
	Software position limit	0x607D	Optional	c,rw	INT32	No
	Position offset	0x60B0	Optional	rw	INT32	Yes
	Velocity offset	0x60B1	Optional	rw	INT32	Yes
	Torque offset	0x60B2	Optional	rw	INT16	Yes
	Following error actual value	0x60F4	Optional	ro	INT32	Yes
	Target velocity	0x60FF	Conditional	rw	INT32	Yes

Function Group	OBJECT Name	INDEX	Category	Access	Data Type	PDO Mapping
Torque Limiting	Positive torque limit value	0x60E0	Conditional	rw	UINT16	Yes
	Negative torque limit value	0x60E1	Conditional	rw	UINT16	Yes
Homing	Home Offset	0x607C	Optional	rw	INT32	No
	Homing speeds	0x6099	Conditional	c,rw	UINT32	No
Touch Probe	Touch probe function	0x60B8	Optional	rw	UINT16	Yes
	Touch probe status	0x60B9	Optional	ro	UINT16	Yes
	Touch probe pos 1 pos value	0x60BA	Optional	ro	INT32	Yes
	Touch probe pos 2 pos value	0x60BC	Optional	ro	INT32	Yes
Gear ratio	Gear ratio	0x6091	Optional	c,rw	UINT32	No
Other object	**OBJECT Name**	**INDEX**	**Category**	**Access**	**Data Type**	**PDO Mapping**
Controlling the power drive system	Error code	0x603F	Optional	ro	UINT16	Yes
	Controlword	0x6040	Mandatory	rw	UINT16	Yes
	Statusword	0x6041	Mandatory	ro	UINT16	Yes
	Quick stop option code	0x605A	Optional	rw	INT16	No
	Shutdown option code	0x605B	Optional	rw	INT16	No
	Disable operation option code	0x605C	Optional	rw	INT16	No
	Halt option code	0x605D	Optional	rw	INT16	No
	Fault reaction option code	0x605E	Optional	rw	INT16	No
	Modes of operation	0x6060	Optional	rw	INT8	Yes
	Modes of operation disp	0x6061	Optional	ro	INT8	Yes
	Supported drive modes	0x6502	Mandatory	ro	INT32	No
General object	Motor type	0x6402	Optional	rw	INT16	No
Position control function	Position demand value	0x6062	Optional	ro	INT32	No
	Position actual internal value	0x6063	Optional	ro	INT32	No
	Position window	0x6067	Optional	rw	UINT32	No
Optional application FE	Digital inputs	0x60FD	Optional	ro	UINT32	Yes
	Digital outputs	0x60FE	Optional	c,rw	UINT32	No,Yes

7.4 Implementing the Motor Control Program

According to the CiA402 standard from the list of CiA402 protocol stack I/F functions in Table 7-3, implement the motor control application. Each function links the number of each state transition of CiA402 FSA shown in Figure 7-2 and the corresponding function is called in case of state transition. In each function, describe the processing that calls the motor control program or the relevant processing of the main CPU.

Table 7-3 List of CiA402 Protocol Stack I/F Functions

CiA402_StateTransition1	
	Description This function is used when state transition 1 has occurred. Describe the operation in the case of the state transition.
	Usage #include "cia402appl.h"
	Parameters TCiA402Axis *pCiA402Axis
	Return Value 0 Normal end 1 Error
	Remark Remark In the case of error occurrence during processing, exit the function by setting the appropriate values for each object in accordance with the CiA402 standard. If 1 is set to return value, state transition does not occur.
CiA402_StateTransition2	
	Description This function is used when state transition 2 has occurred. Describe the operation in the case of the state transition.
	Usage #include "cia402appl.h"
	Parameters TCiA402Axis *pCiA402Axis
	Return Value 0 Normal end 1 Error
	Remark In the case of error occurrence during processing, exit the function by setting the appropriate values for each object in accordance with the CiA402 standard. If 1 is set to return value, state transition does not occur.

CiA402_StateTransition3	
	Description This function is used when state transition 3 has occurred. Describe the operation in the case of the state transition.
	Usage #include "cia402appl.h"
	Parameters TCiA402Axis *pCiA402Axis
	Return Value 0 Normal end 1 Error
	Remark In the case of error occurrence during processing, exit the function by setting the appropriate values for each object in accordance with the CiA402 standard. If 1 is set to return value, state transition does not occur.
CiA402_StateTransition4	
	Description This function is used when state transition 4 has occurred. Describe the operation in the case of the state transition.
	Usage #include "cia402appl.h"
	Parameters TCiA402Axis *pCiA402Axis
	Return Value 0 Normal end 1 Error
	Remark In the case of error occurrence during processing, exit the function by setting the appropriate values for each object in accordance with the CiA402 standard. If 1 is set to return value, state transition does not occur.
CiA402_StateTransition5	
	Description This function is used when state transition 5 has occurred. Describe the operation in the case of the state transition.
	Usage #include "cia402appl.h"
	Parameters TCiA402Axis *pCiA402Axis
	Return Value 0 Normal end 1 Error
	Remark In the case of error occurrence during processing, exit the function by setting the appropriate values for each object in accordance with the CiA402 standard. If 1 is set to return value, state transition does not occur.

CiA402_StateTransition6	
	Description This function is used when state transition 6 has occurred. Describe the operation in the case of the state transition.
	Usage #include "cia402appl.h"
	Parameters TCiA402Axis *pCiA402Axis
	Return Value 0 Normal end 1 Error
	Remark In the case of error occurrence during processing, exit the function by setting the appropriate values for each object in accordance with the CiA402 standard. If 1 is set to return value, state transition does not occur.
CiA402_StateTransition7	
	Description This function is used when state transition 7 has occurred. Describe the operation in the case of the state transition.
	Usage #include "cia402appl.h"
	Parameters TCiA402Axis *pCiA402Axis
	Return Value 0 Normal end 1 Error
	Remark In the case of error occurrence during processing, exit the function by setting the appropriate values for each object in accordance with the CiA402 standard. If 1 is set to return value, state transition does not occur.
CiA402_StateTransition8	
	Description This function is used when state transition 8 has occurred. Describe the operation in the case of the state transition.
	Usage #include "cia402appl.h"
	Parameters TCiA402Axis *pCiA402Axis
	Return Value 0 Normal end 1 Error
	Remark In the case of error occurrence during processing, exit the function by setting the appropriate values for each object in accordance with the CiA402 standard. If 1 is set to return value, state transition does not occur.

CiA402_StateTransition9	
	Description This function is used when state transition 9 has occurred. Describe the operation in the case of the state transition.
	Usage #include "cia402appl.h"
	Parameters TCiA402Axis *pCiA402Axis
	Return Value 0 Normal end 1 Error
	Remark In the case of error occurrence during processing, exit the function by setting the appropriate values for each object in accordance with the CiA402 standard. If 1 is set to return value, state transition does not occur.
CiA402_StateTransition10	
	Description This function is used when state transition 10 has occurred. Describe the operation in the case of the state transition.
	Usage #include "cia402appl.h"
	Parameters TCiA402Axis *pCiA402Axis
	Return Value 0 Normal end 1 Error
	Remark In the case of error occurrence during processing, exit the function by setting the appropriate values for each object in accordance with the CiA402 standard. If 1 is set to return value, state transition does not occur.
CiA402_StateTransition11	
	Description This function is used when state transition 11 has occurred. Describe the operation in the case of the state transition.
	Usage #include "cia402appl.h"
	Parameters TCiA402Axis *pCiA402Axis
	Return Value 0 Normal end 1 Error
	Remark In the case of error occurrence during processing, exit the function by setting the appropriate values for each object in accordance with the CiA402 standard. If 1 is set to return value, state transition does not occur.

CiA402_StateTransition12	
	Description This function is used when state transition 12 has occurred. Describe the operation in the case of the state transition.
	Usage #include "cia402appl.h"
	Parameters TCiA402Axis *pCiA402Axis
	Return Value 0 Normal end 1 Error
	Remark In the case of error occurrence during processing, exit the function by setting the appropriate values for each object in accordance with the CiA402 standard. If 1 is set to return value, state transition does not occur.
CiA402_LocalError	
	Description This function is used when state transition 13 has occurred. Describe the operation in the case of the state transition.
	Usage #include "cia402appl.h"
	Parameters UINT16 ErrorCode
	Return Value None
	Remark If the error corresponding to state transition 13 occurs, call this function after processing required and saving data at error location.
CiA402_StateTransition14	
	Description This function is used when state transition 14 has occurred. Describe the operation in the case of the state transition.
	Usage #include "cia402appl.h"
	Parameters TCiA402Axis *pCiA402Axis
	Return Value 0 Normal end 1 Error
	Remark In the case of error occurrence during processing, exit the function by setting the appropriate values for each object in accordance with the CiA402 standard. If 1 is set to return value, state transition does not occur.

CiA402_StateTransition15	
	Description This function is used when state transition 15 has occurred. Describe the operation in the case of the state transition.
	Usage #include "cia402appl.h"
	Parameters TCiA402Axis *pCiA402Axis
	Return Value 0 Normal end 1 Error
	Remark In the case of error occurrence during processing, exit the function by setting the appropriate values for each object in accordance with the CiA402 standard. If 1 is set to return value, state transition does not occur.
CiA402_StateTransition16	
	Description This function is used when state transition 16 has occurred. Describe the operation in the case of the state transition.
	Usage #include "cia402appl.h"
	Parameters TCiA402Axis *pCiA402Axis
	Return Value 0 Normal end 1 Error
	Remark In the case of error occurrence during processing, exit the function by setting the appropriate values for each object in accordance with the CiA402 standard. If 1 is set to return value, state transition does not occur.
APPL_MOTOR_MotionControl_Main	
	Description Implement the motion control code when the state of CiA402 FSA is "Operation enabled". Describe the process for each mode of operation.
	Usage #include "cia402appl.h"
	Parameters TCiA402Axis *pCiA402Axis
	Return Value 0 Normal end 1 Error
	Remark At the initial state, this function is described in "main.c" and calls "CiA402_DummyMotionControl" function for reference.

8. Appendix: FSP Configuration for VSC8531

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.

(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_CiA402\e2studio
- When using EWARM, \project\rzn2l_som\ecat_CiA402\ewarm

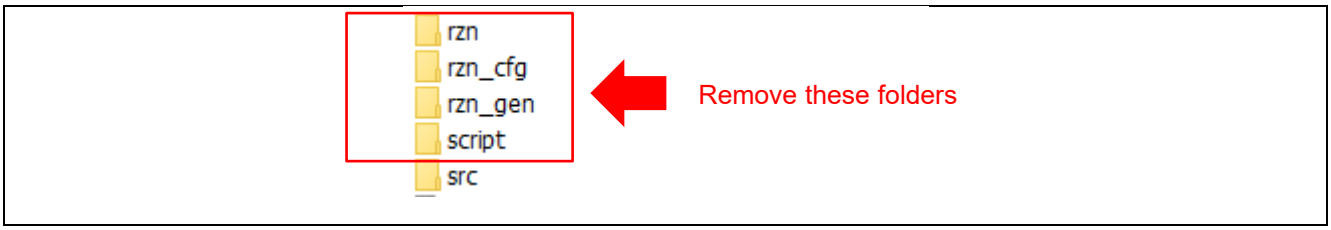


Figure 8-1 Remove folder generated by FSP

(2) Change ethernet driver configuration for VSC8531

Configure g_ether_phy0 Ethernet Driver on r_ether_phy for VSC8531 as shown in Figure 8-2.
Configuration value for VSC8531 shows in Table 8-1.

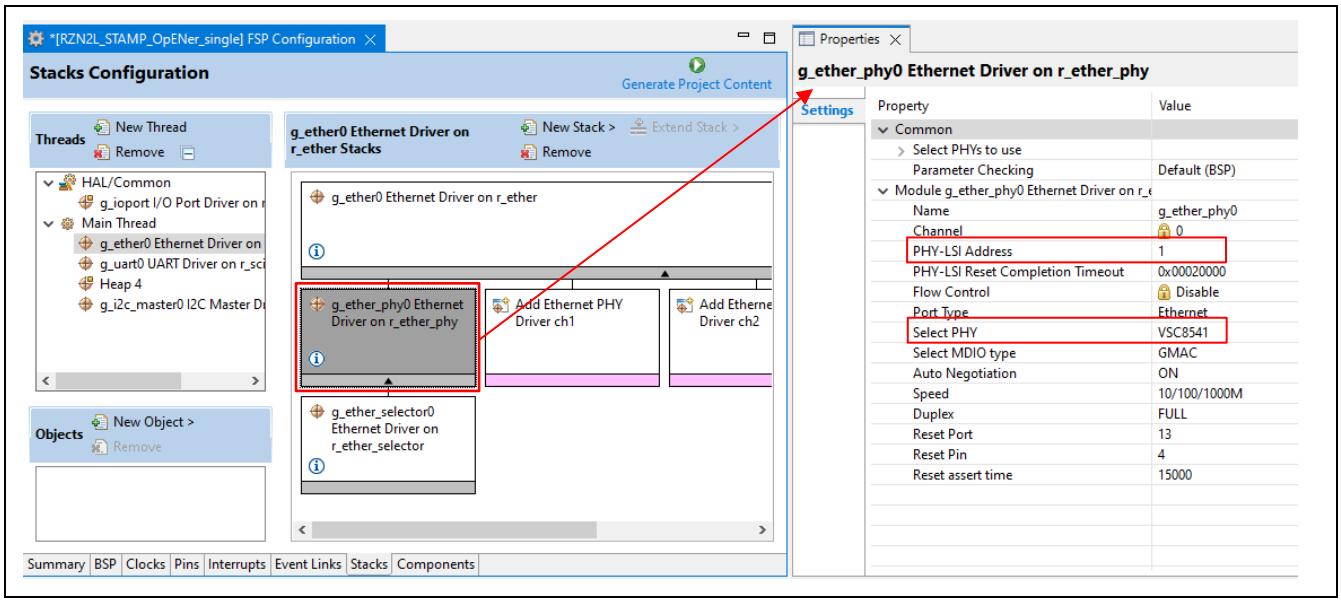


Figure 8-2 Ethernet Driver Configuration for VSC8531 (e.g. ETH0)

Table 8-1 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	Feb 6, 2023	-	First edition issued
1.10	Aug 7.2023	–	Support RZ/N2L FSP v1.2.0

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.).
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