RL78 Family

Reality AI Data Acquisition Module (Data Collector / Data Shipper) – Sample Code

Introduction

This application note describes sample software for data acquisition for Reality AI. Acquired data is converted into any files using Reality AI Data Storage Tool on PC.

Target Device

RL78 Family MCUs : G23,G24,G13,G13A,G1D,G1H,G14 (ROM size more than 128KB)

- Operation confirmed MCU: RL78G23

When using this application note with other Renesas MCUs, careful evaluation is recommended after making modifications to comply with the alternate MCU.

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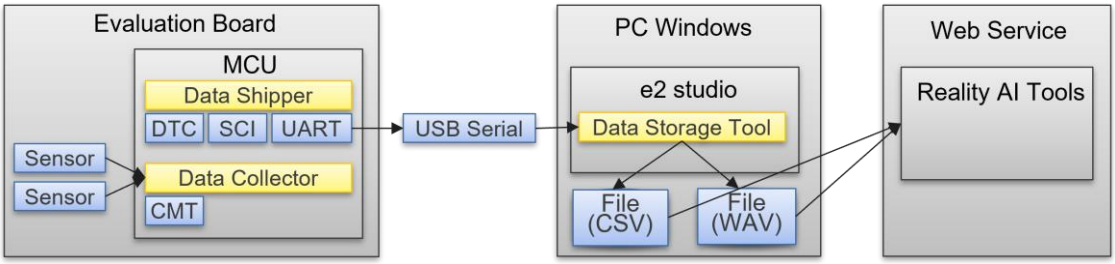
1. Data acquisition for Reality AI

Follow the steps below to collect data for Reality AI.

- Signal data such as sensors are stored in memory by Data Collector.
- The stored data is sent to the PC Data Shipper.
- Data Storage Tool running on a PC converts it into a file and uploads it to Reality AI.

Reality AI analyzes uploaded data and generates source code. Please see the e2 studio documentation for information on how Reality AI and e2 studio work together.

The following diagram is the system structure.



1.1 Overview of Data Collector

Data Collector collects data such as sensors in memory. There are two ways to collect it.

- Snapshot

  Data is collected using a timer provided by the Data Collector.

- Data Feed

  Data is collected using a timer provided by the user.

After collecting a specified number of data, it calls the Data Shipper's API.

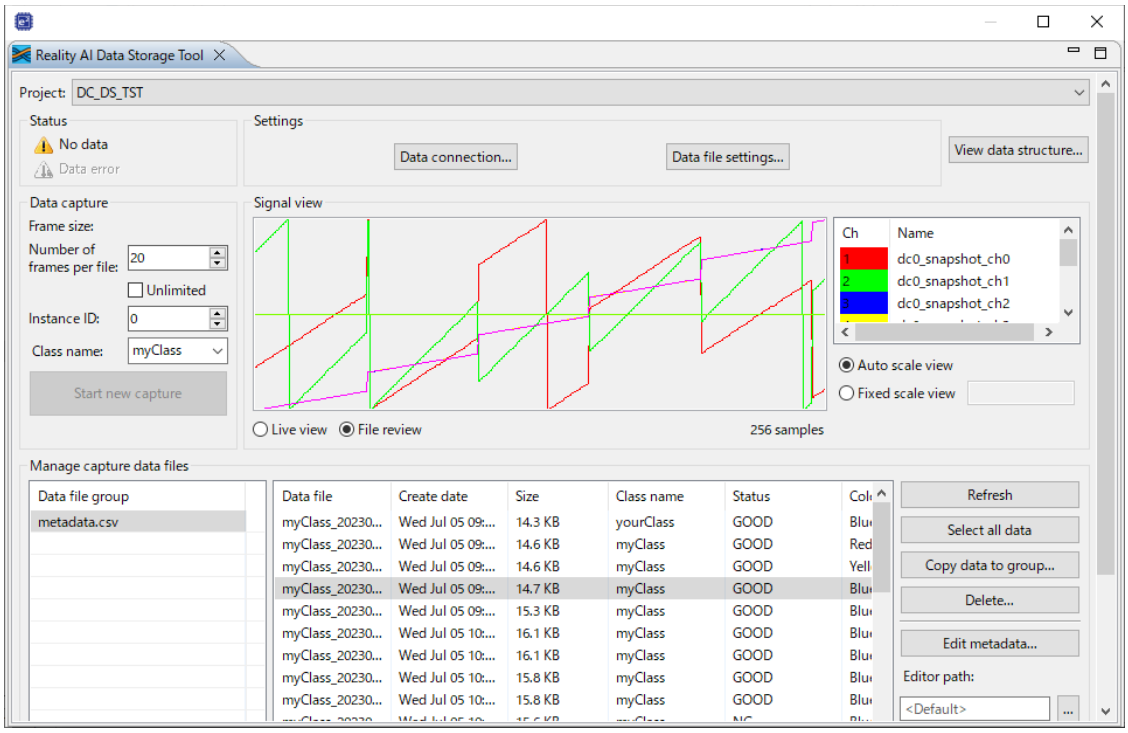
1.2 Overview of Data Shipper

Data Shipper sends data stored in memory by Data Collector to the PC via UART.

UART settings are set in "UART Communication Driver Interface Middleware".

1.3 Overview of Data Storage Tool

Data Storage Tool convert file from sent data by Data Shipper.

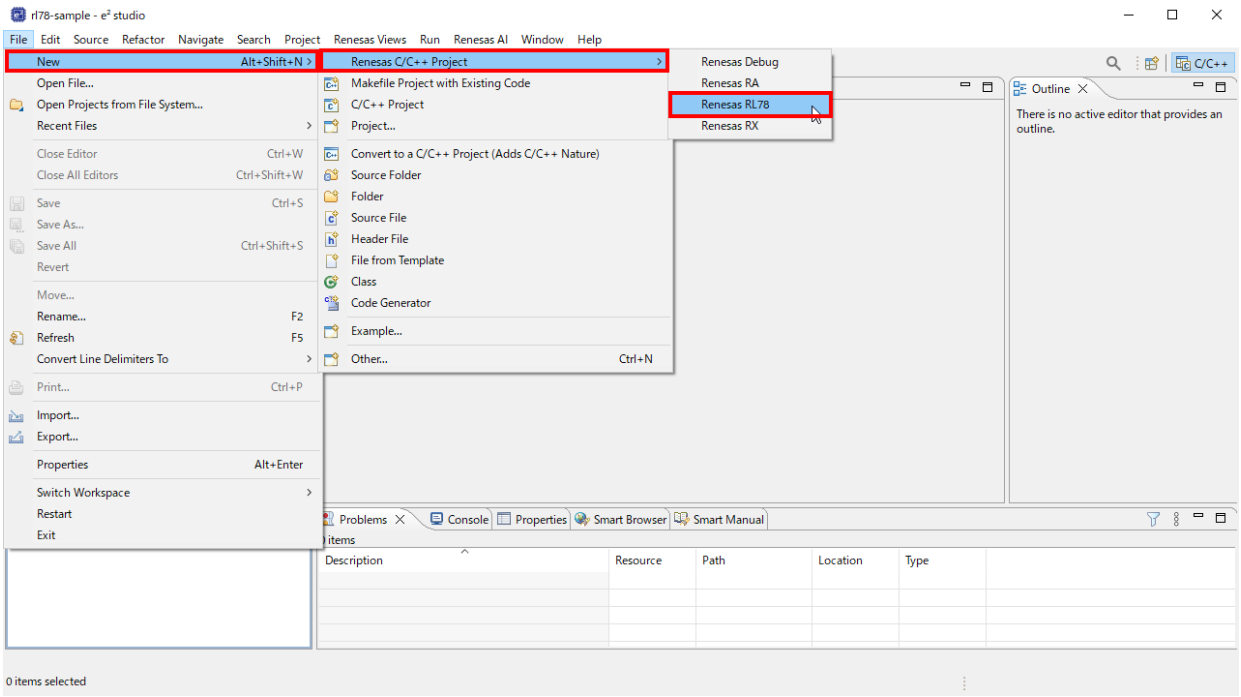


2. How to implement data acquisition [RL78/G23]

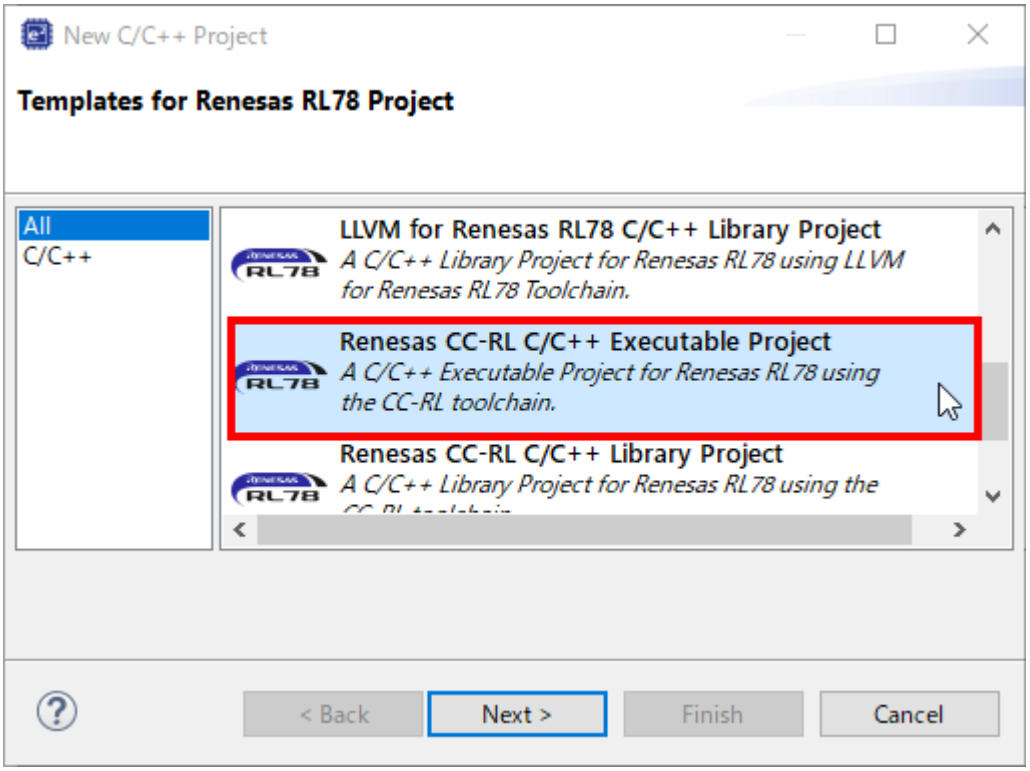
Describes how to implement a data acquisition module using Data Collector and Data Shipper into a program.

2.1 Create New project.

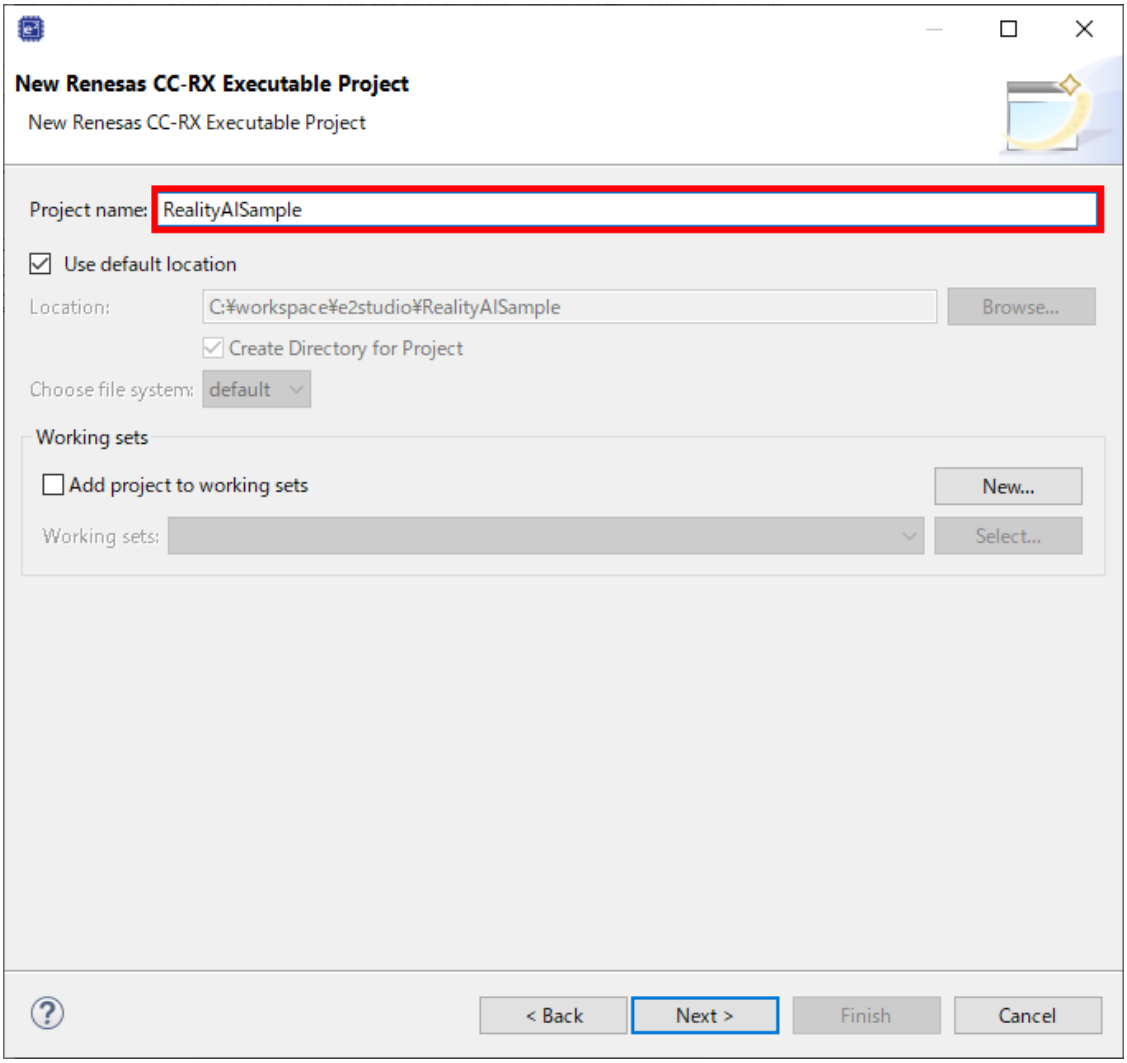
1. Select [File]>[New]>[Renesas C/C++ Project]>[Renesas RL78] menu.



2. Select [Renesas CC-RL C/C++ Executable Project] item.

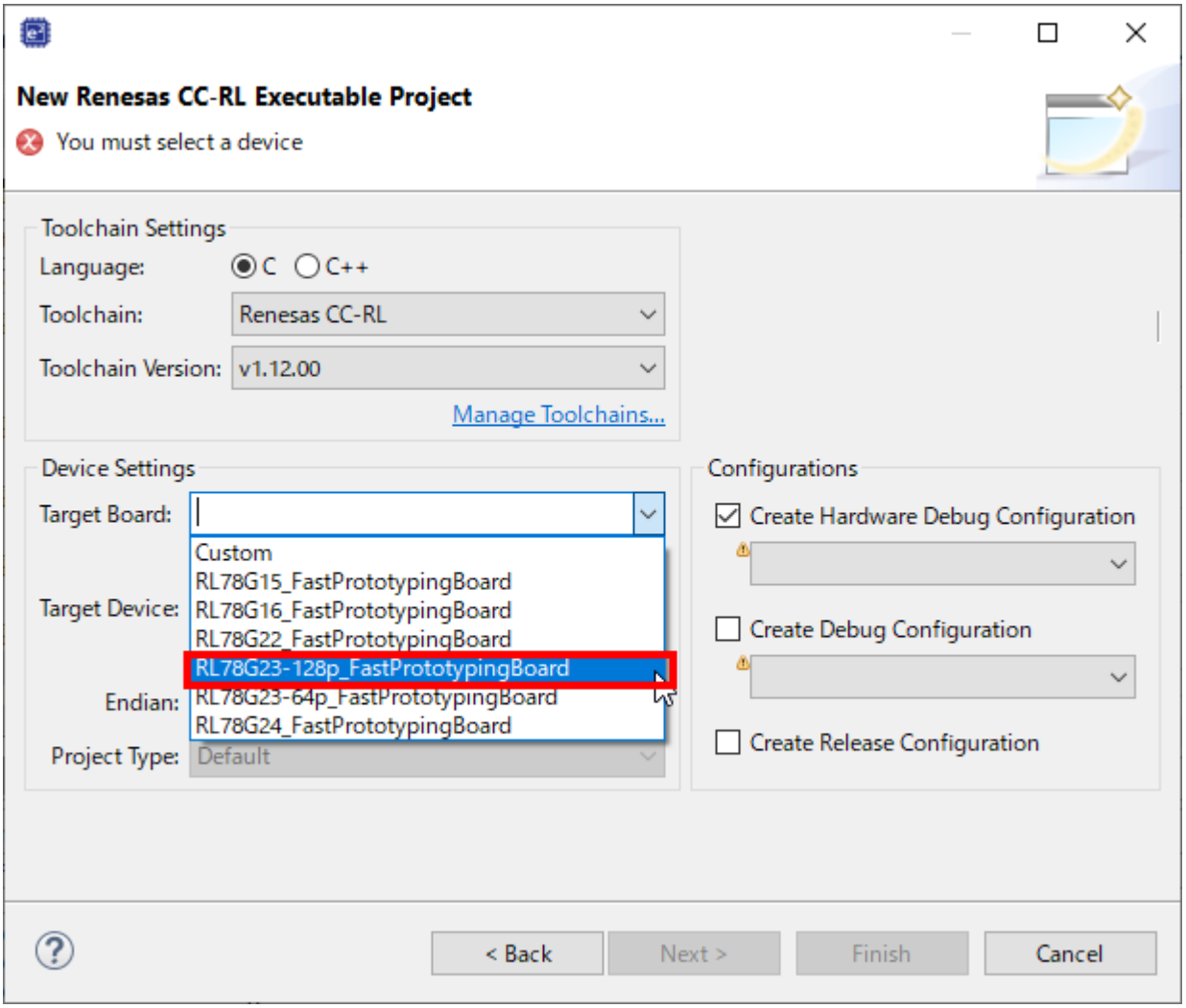


3. Specify Project Name.



Push [Next] button.

4. Select [RL78G23-128p_FastPrototypingBoard] in Target Board.

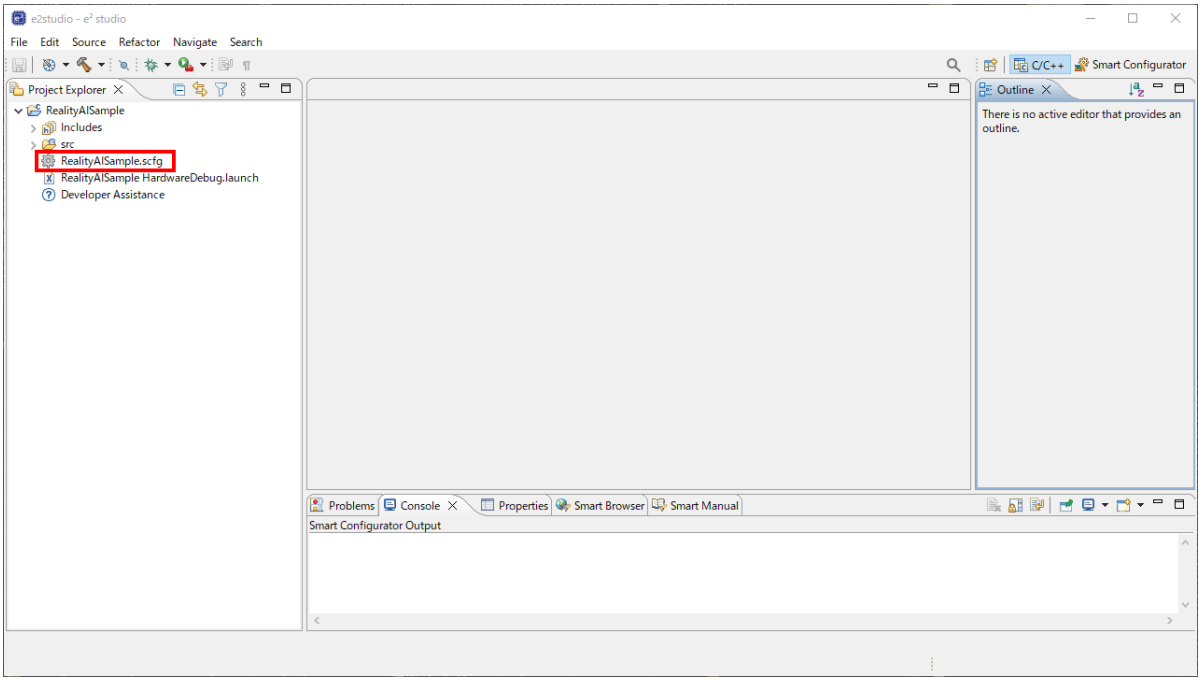


Push [Next] and [Finish] button to create a new project.

2.2 Import and setup for SIS Modules for Reality AI

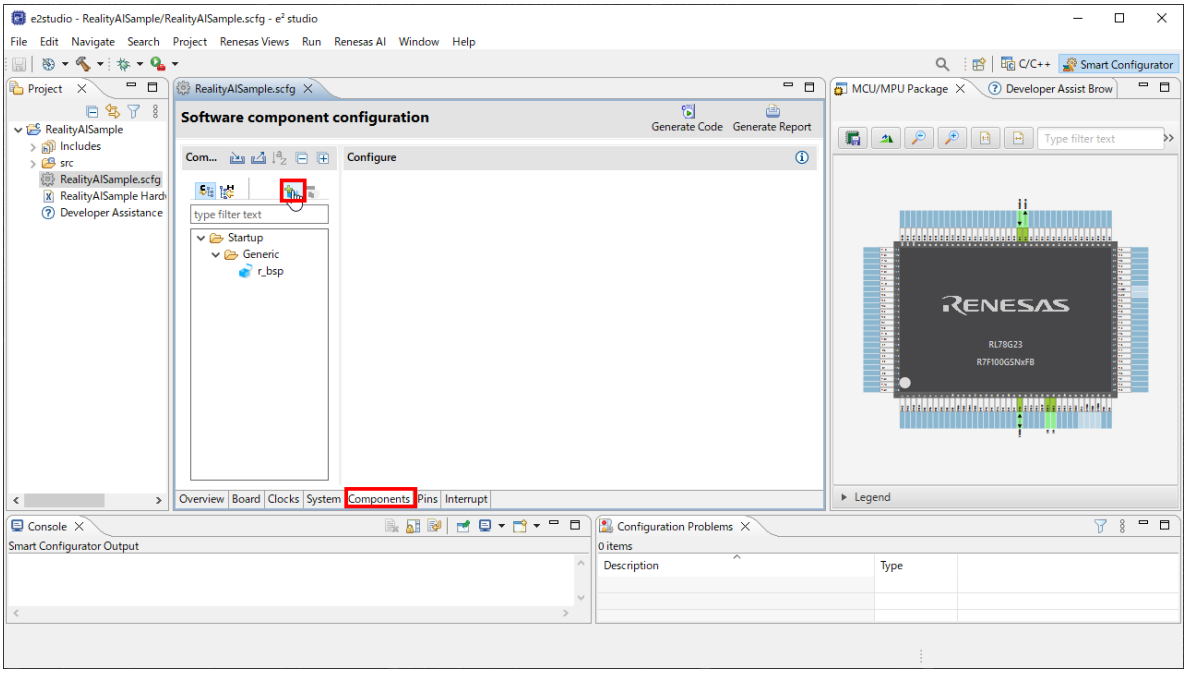
1. Open Smart Configurator.

   Double Click [“projectname”.scfg] in Project Explorer.



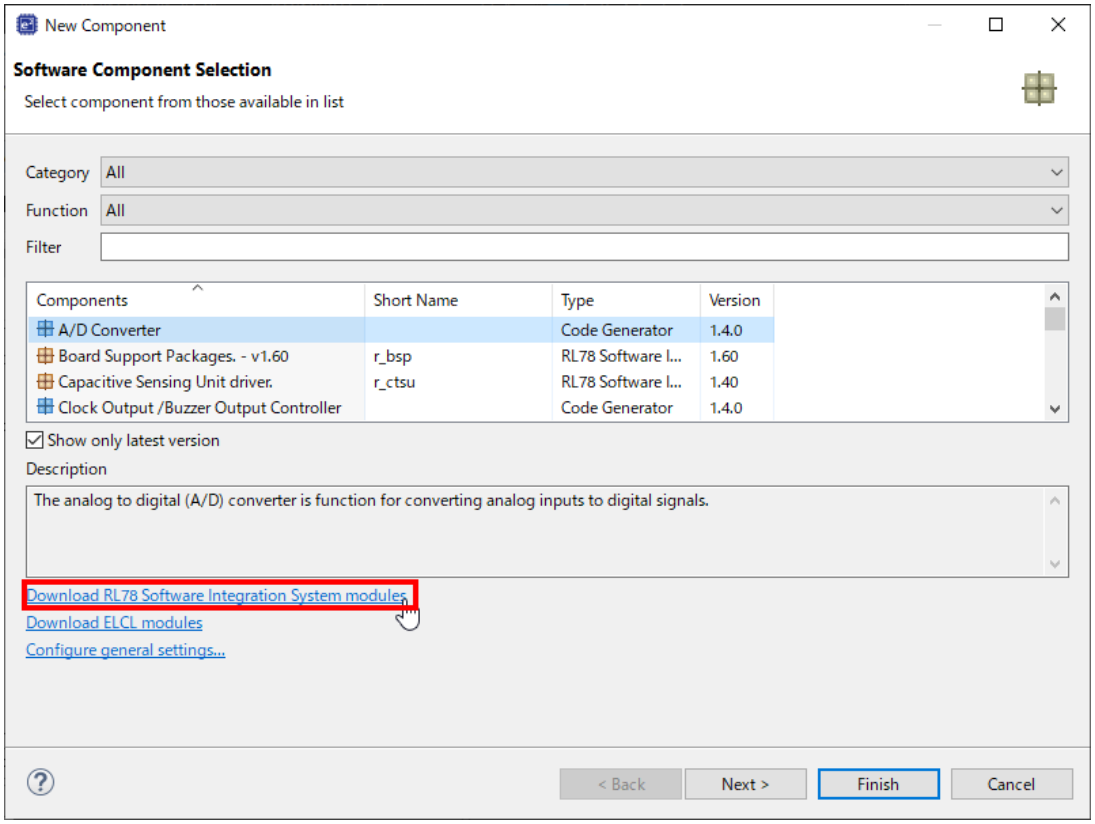
2. Add Components.

Select [Components] tab and Click [Add component] icon.



3. Download FIT modules.

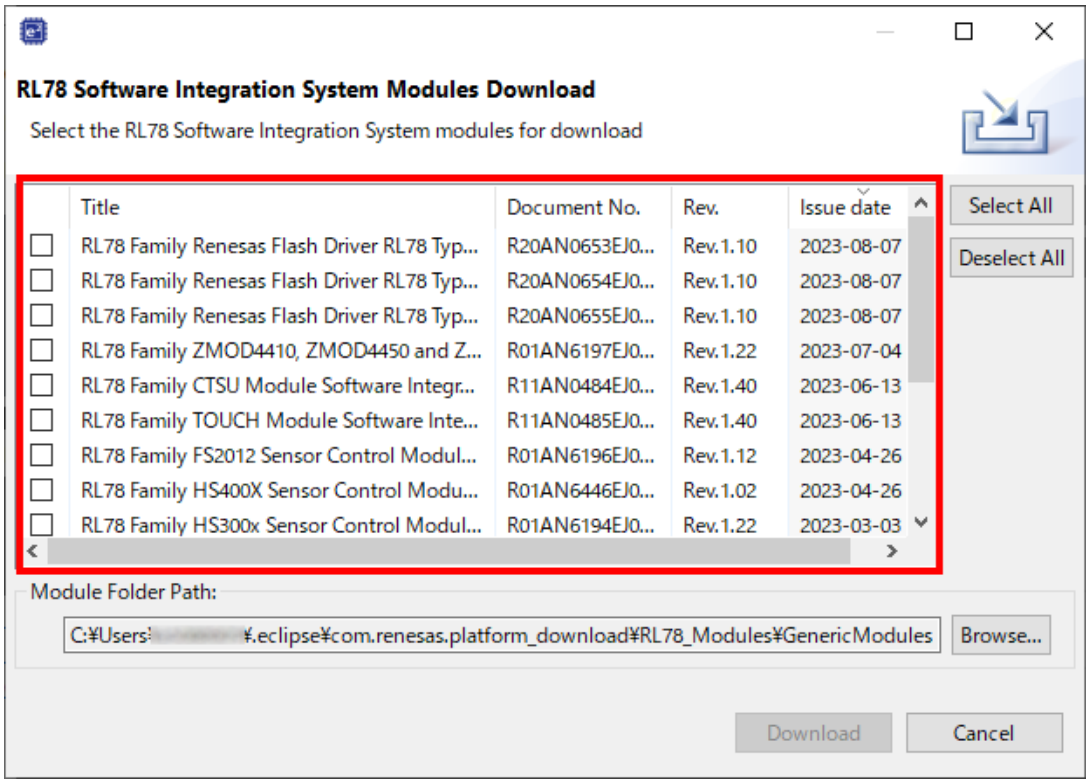
– Select [Download RL78 Software Integration System modules] link.



– Select Region on dialog.

- Check the following SIS modules in list.

  - RAI Data Collector Middleware
  - RAI Data Shipper Middleware
  - UART Communication Driver Interface Middleware

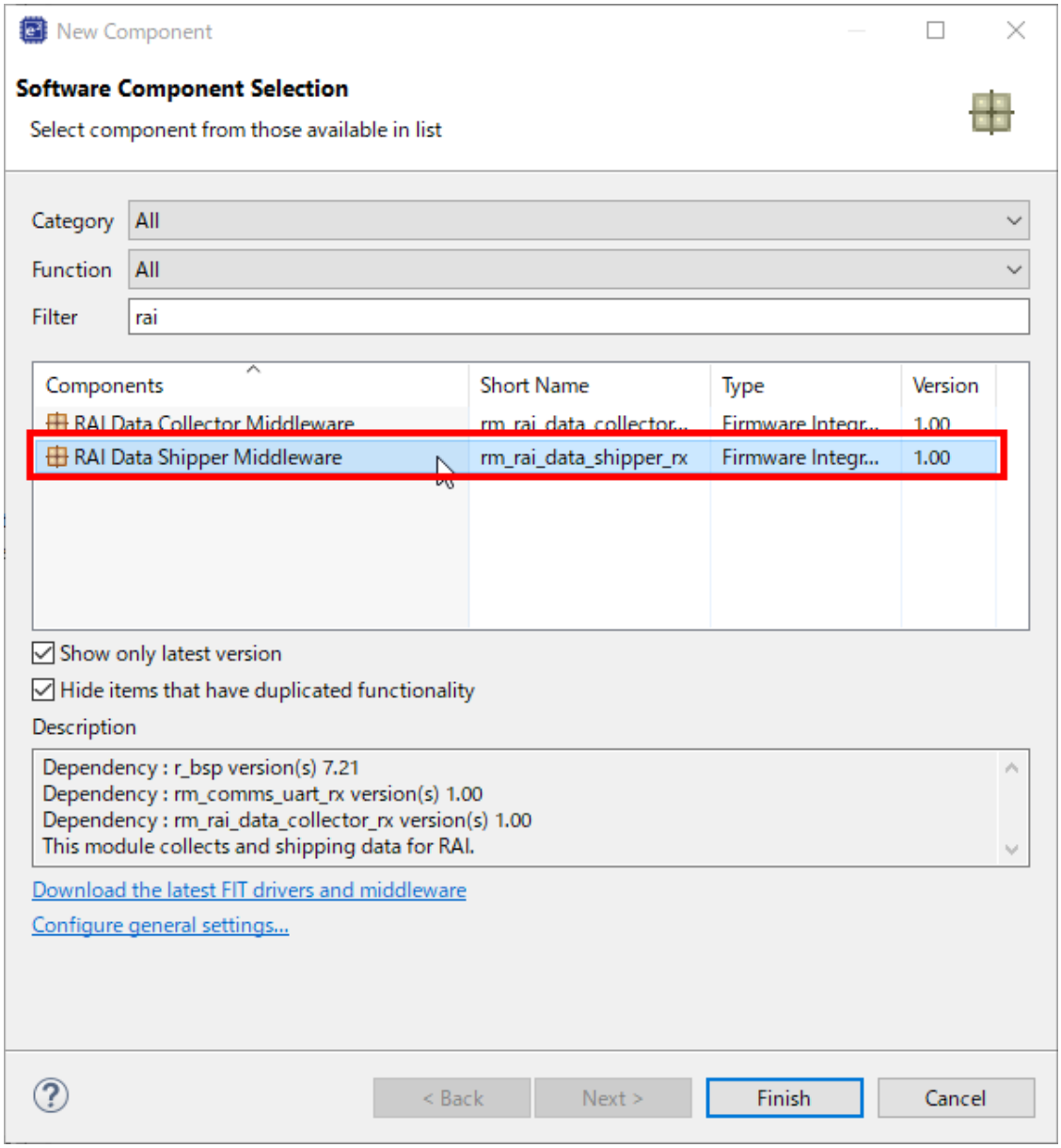


Push [Download] button

Confirm “End User License Agreement (Sample Code)”. If you can agree this license, push [Accept] button.

– Input [rai] in Filter and select [RAI Data Shipper Middleware] item.

When select [RAI Data Shipper Middleware], Smart Configurator will automatically import the required components.



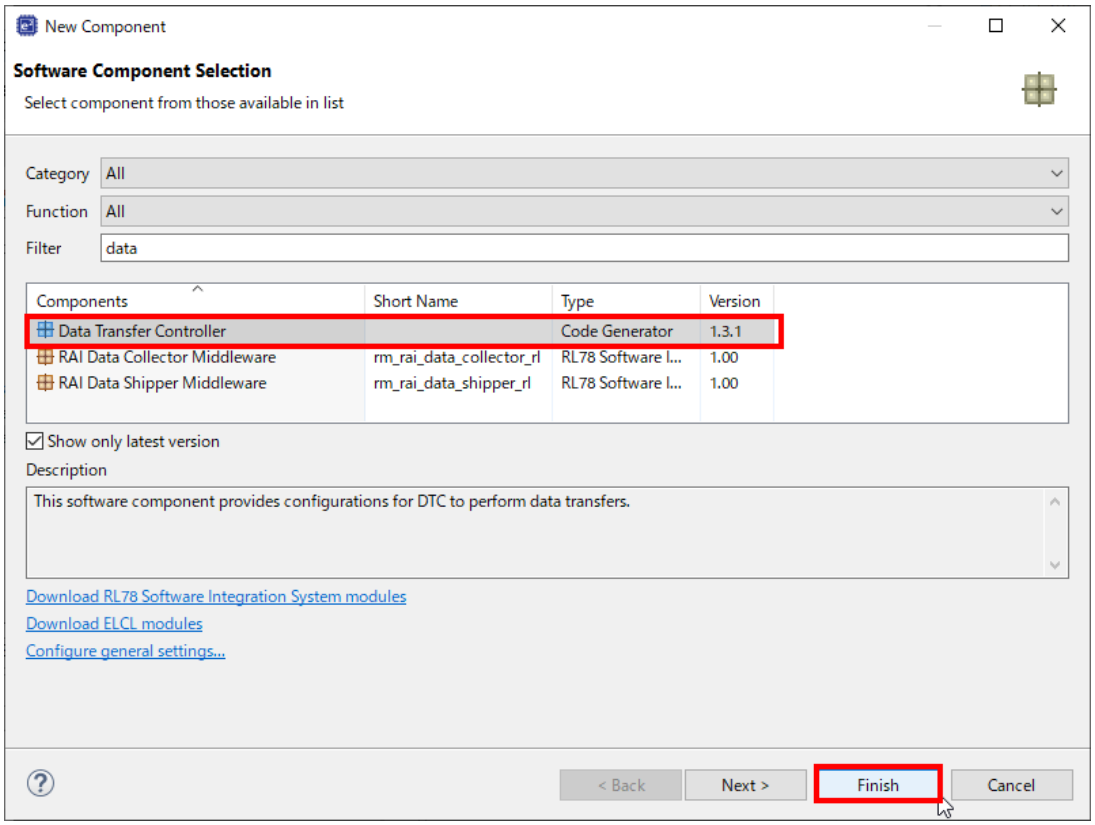
Push [Finish] button in New Component Dialog.

4. Import Data Transfer Controller (DTC) and setup.

   Data Collector use DTC feature. So, import Code Generator module.

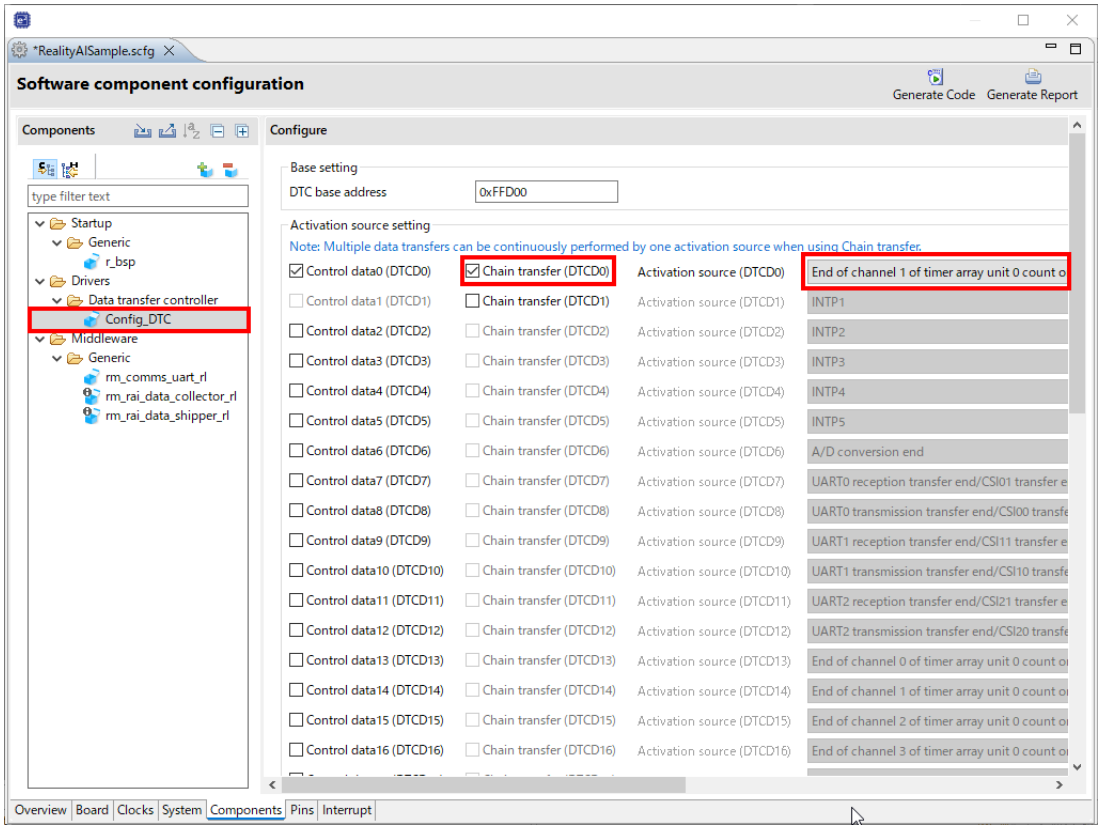
   – Select [Components] tab and Click [Add component] icon in Smart Configurator.

   – Select [Data Transfer Controller] item and push [Finish] button.



– Change the settings of [Config_DTC] as follows:

Items	Value
Chain transfer (DTCD0)	Check
Activation source (DTCD0)	End of channel 1 of timer array unit 0 count or capture

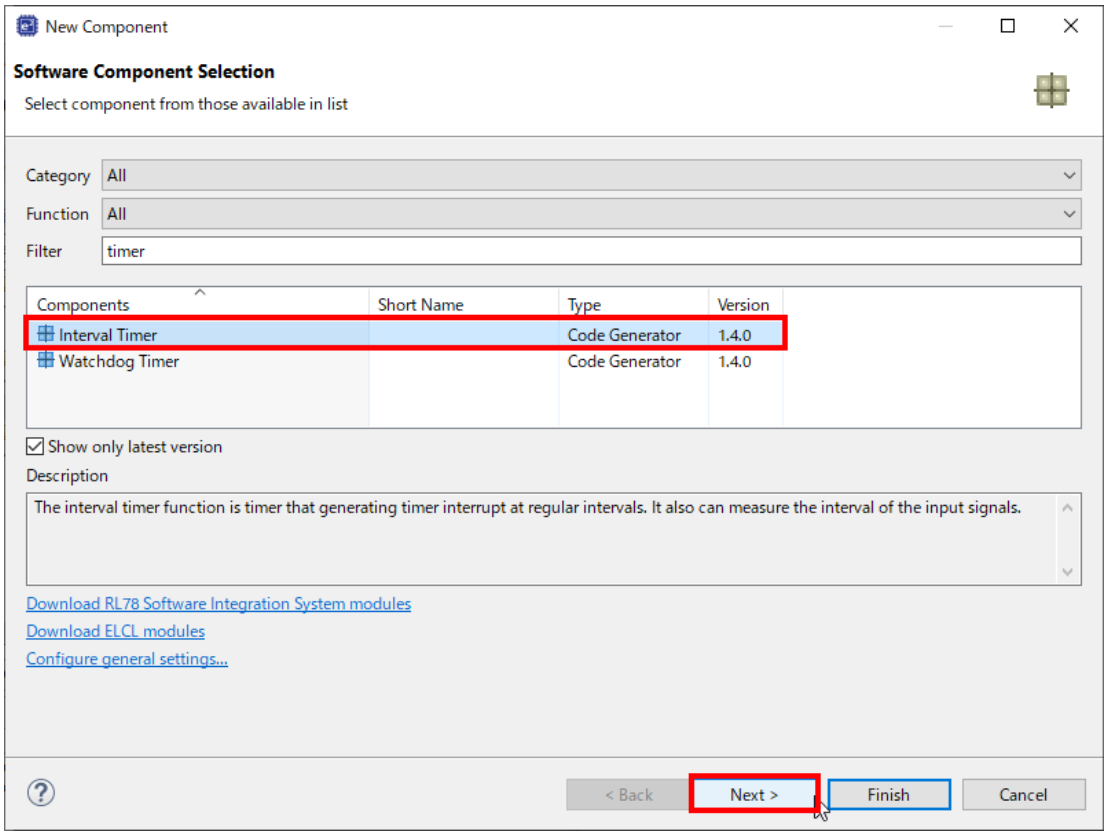


5. Import Interval Timer and setup.

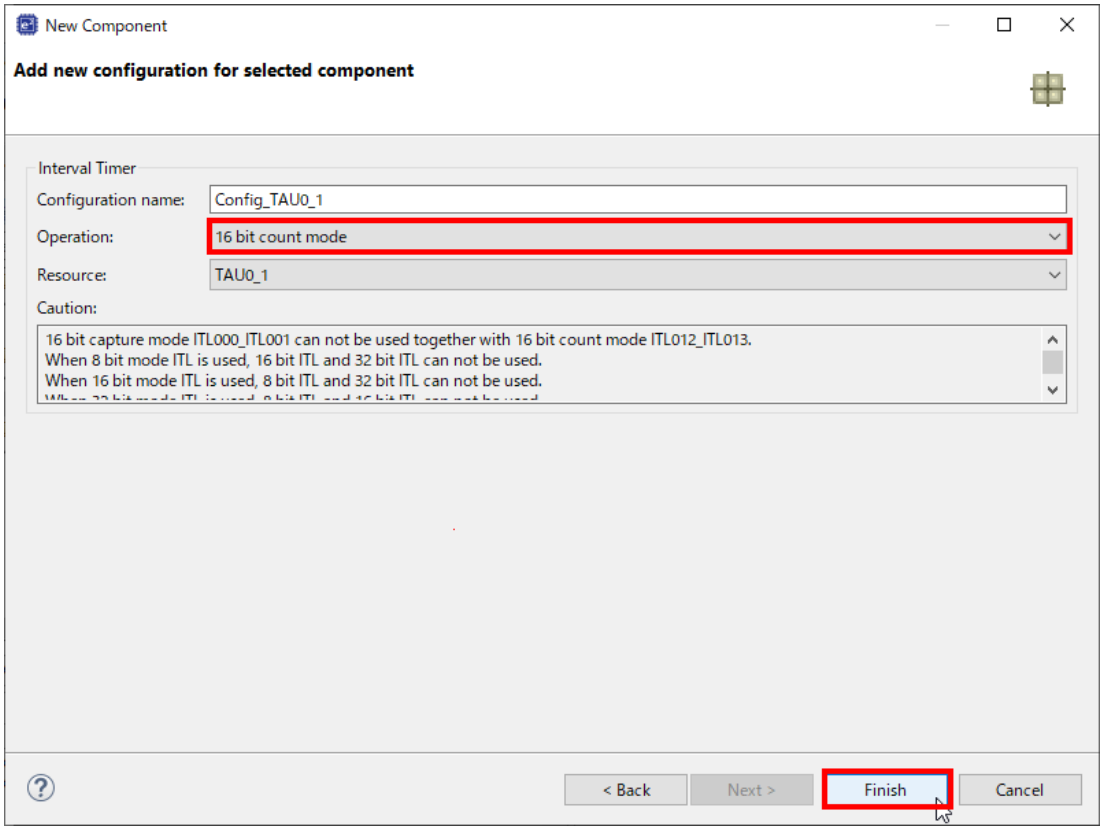
   Data Collector use timer. So, import SIS module and change the settings.

   – Select [Components] tab and Click [Add component] icon in Smart Configurator.

   – Select [Interval Timer] item and push [Next] button.

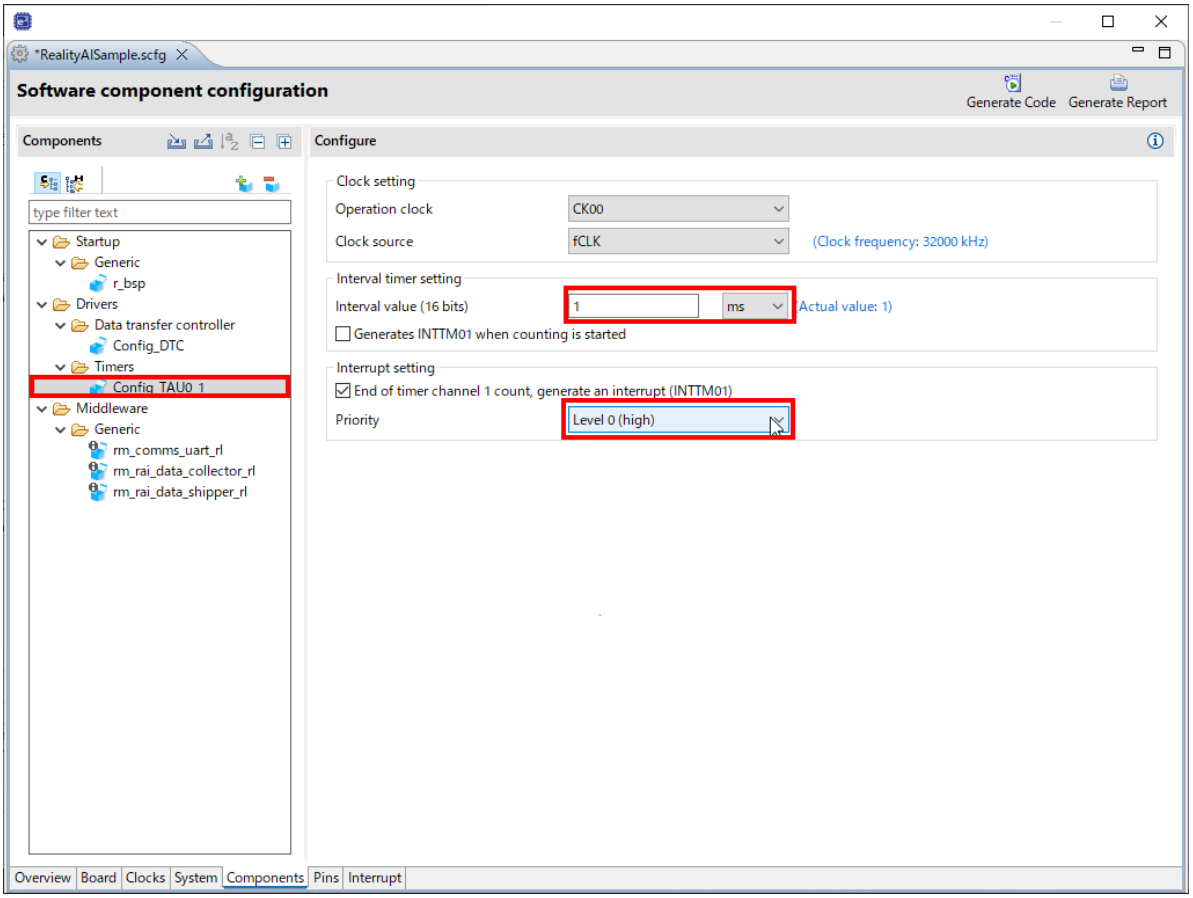


– Change [16bit count mode] of “Operation” and push [Finish] button.



– Change the settings of [Config_TAU0_1] as follows:

Items	Value
Interval value (16 bits)	1 ms
Priority	Level 0 (high)

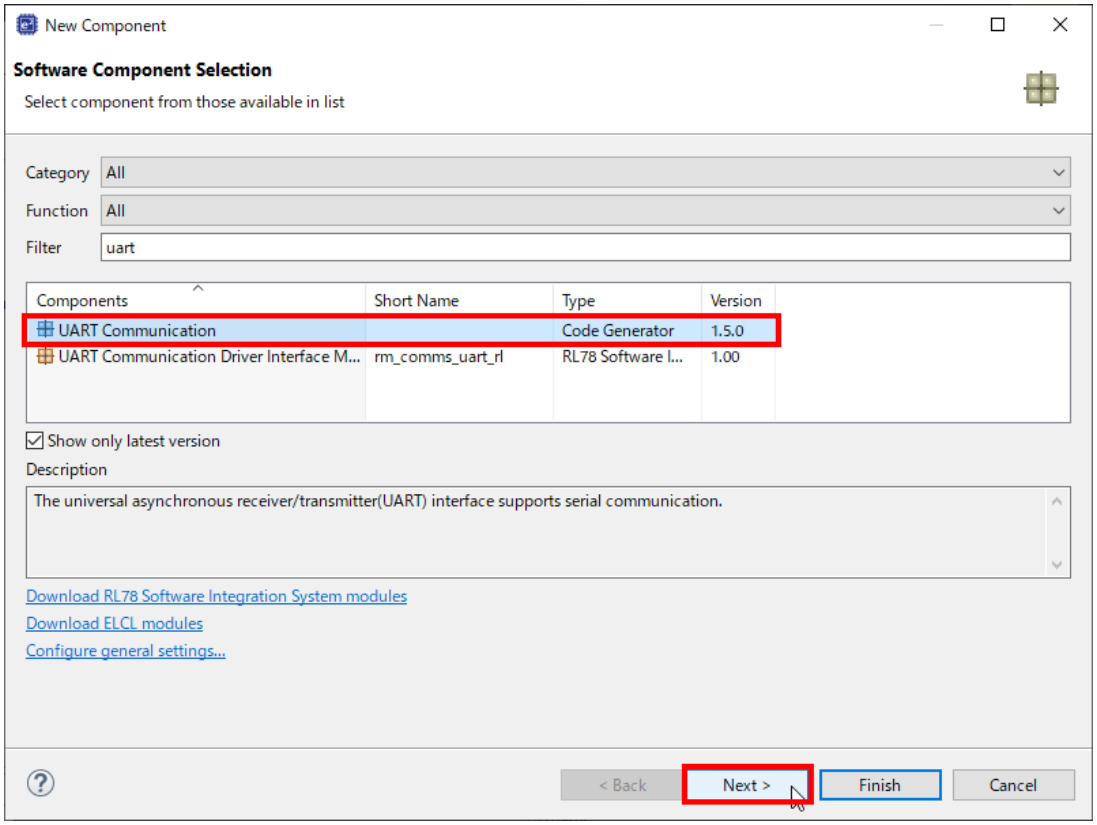


6. Import UART communication and setup.

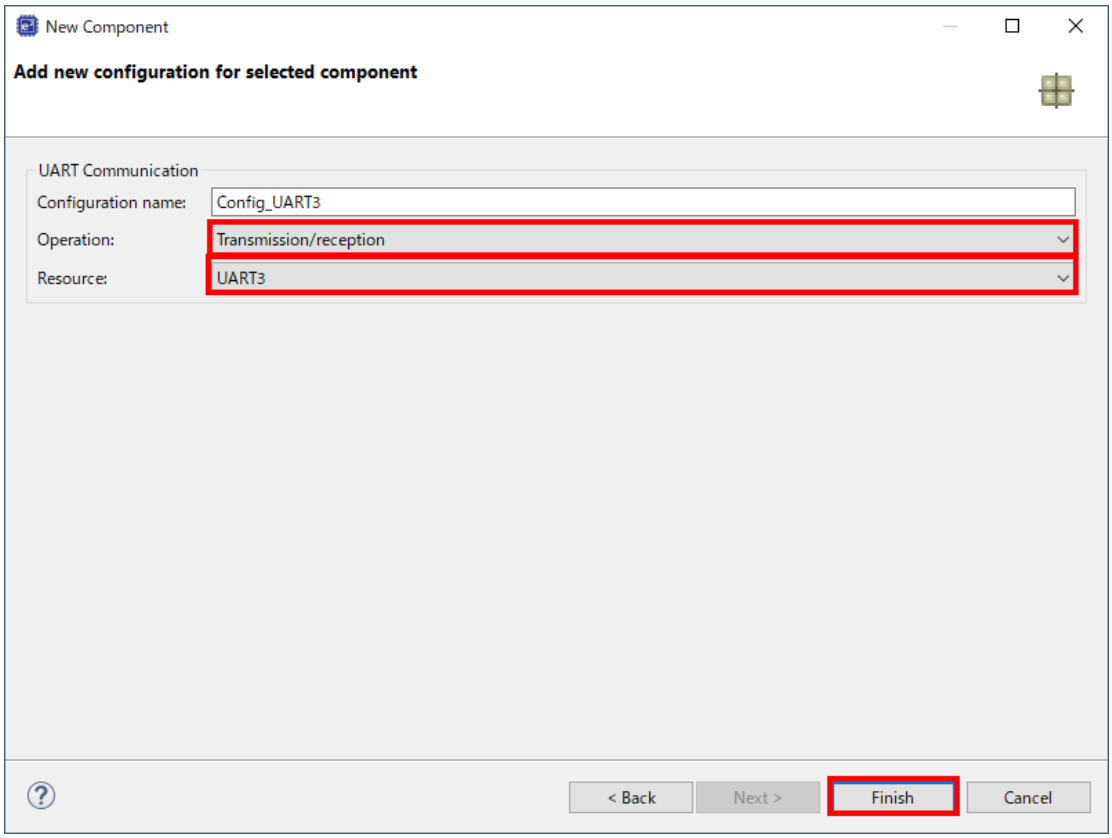
Data Shipper use UART communication. So, import code generator module and change the settings.

– Select [Components] tab and Click [Add component] icon in Smart Configurator.

– Select [UART communication] item and push [Next] button.

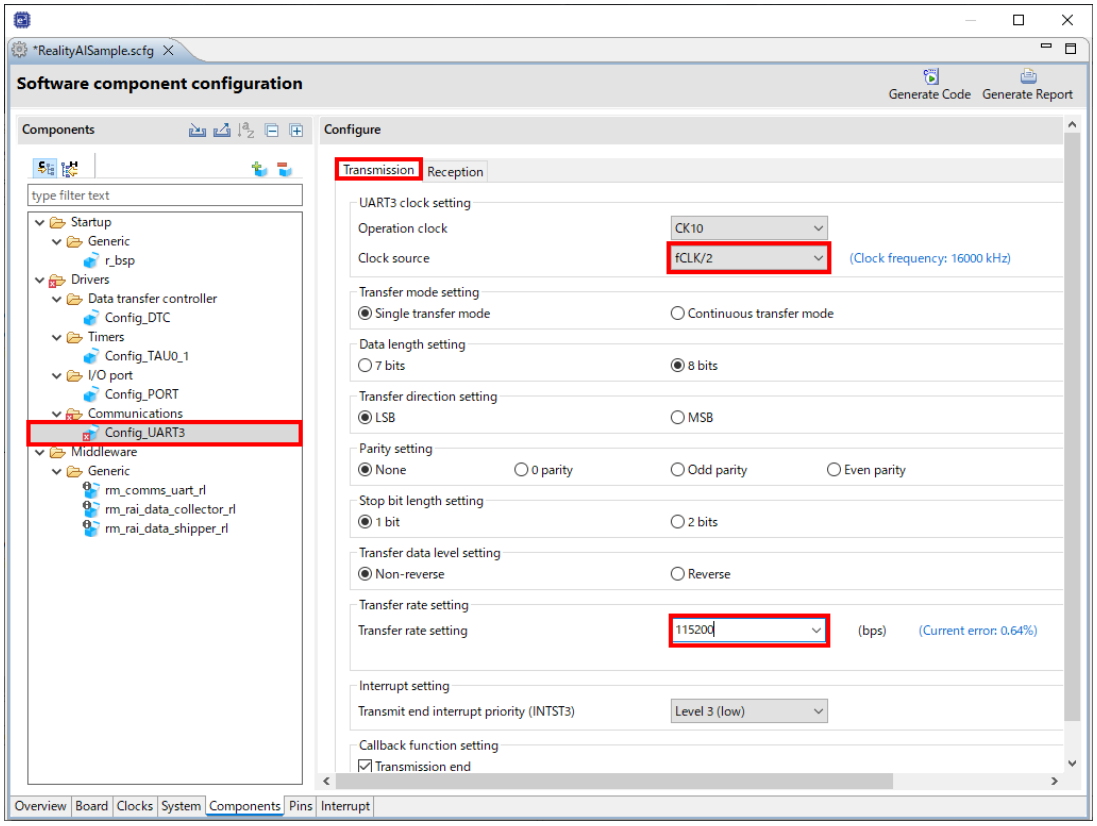


– Select [Transmission/reception] in “Operation” and select [UART3] in “Resource” and push [Finish] button.



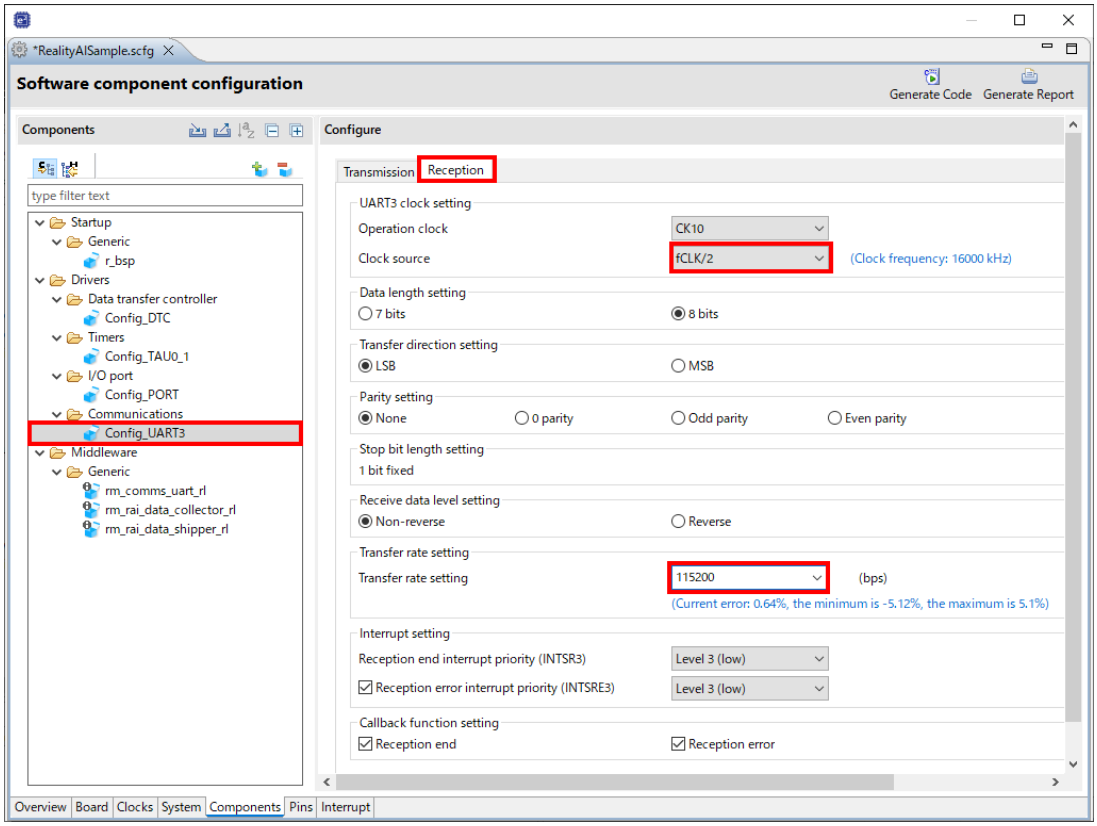
– Change the settings of [Config_UART3] and [Transmission] tab as follows:

Items	Value
Clock source	fCLK/2
Transfer rate setting	115200 (bps)



– Change the settings of [Config_UART3] and [Reception] tab as follows:

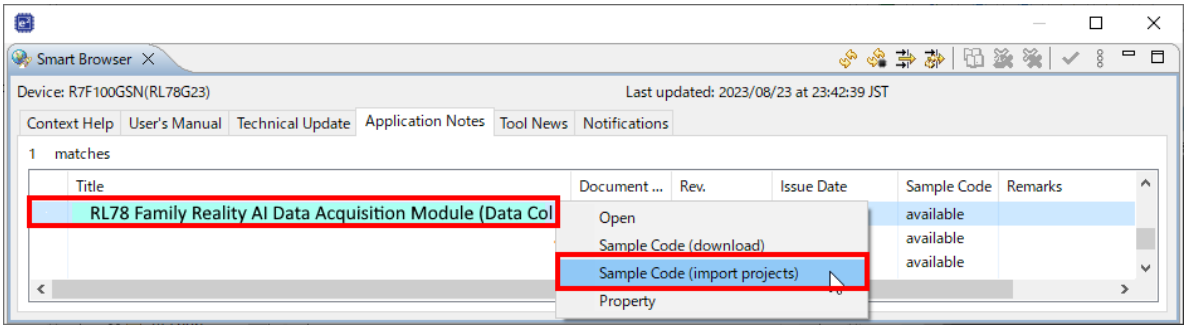
Items	Value
Clock source	fCLK/2
Transfer rate setting	115200 (bps)



2.3 Import sample project for Data Collector and Data Shipper

A sample project created using the steps described in this application note is attached with this application note. Please import by the following steps. Please refer to the imported project as necessary.

- Right-button click [rm_rai_data_shipper_rl] in tree of Smart Configurator and select [Download and import sample projects] menu.
- Launch [Smart Browser] view and right button click [RL78 Family Reality AI Data Acquisition Module (Data Collector / Data Shipper) - Sample Code] list and select [Sample Code(import projects)] menu.

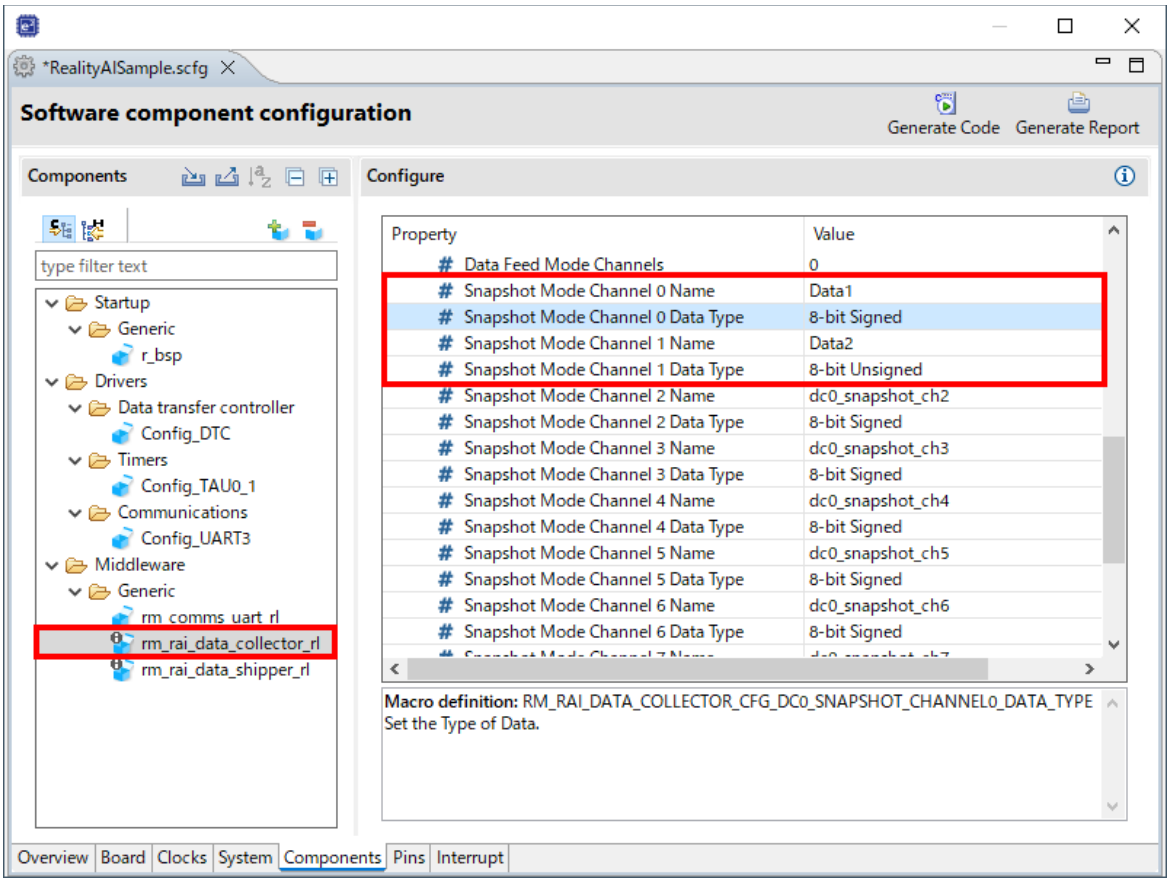


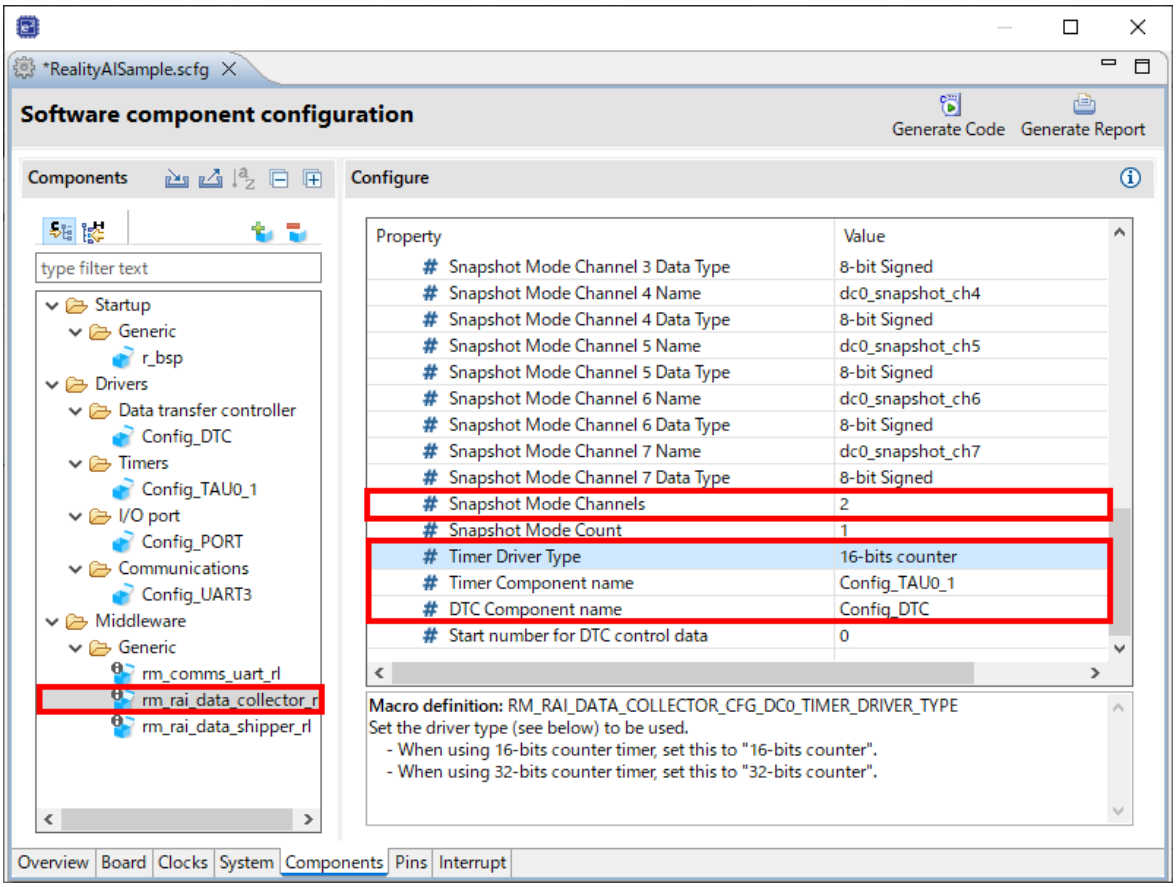
- Select [RealityAI_DataAcquisition_RL78G23_NonOS] item

2.4 Setup Data Collector

- Change the settings of [rm_rai_data_collector_rl] as follows:

Property	Value
Snapshot Mode Channel 0 Name	Data1
Snapshot Mode Channel 0 Data Type	8-bit Signed
Snapshot Mode Channel 1 Name	Data2
Snapshot Mode Channel 1 Data Type	8-bit Unsigned
Snapshot Mode Channels	2
Timer Driver Type	16-bits counter
Timer Component name	Config_TAU0_1
DTC Component name	Config_DTC

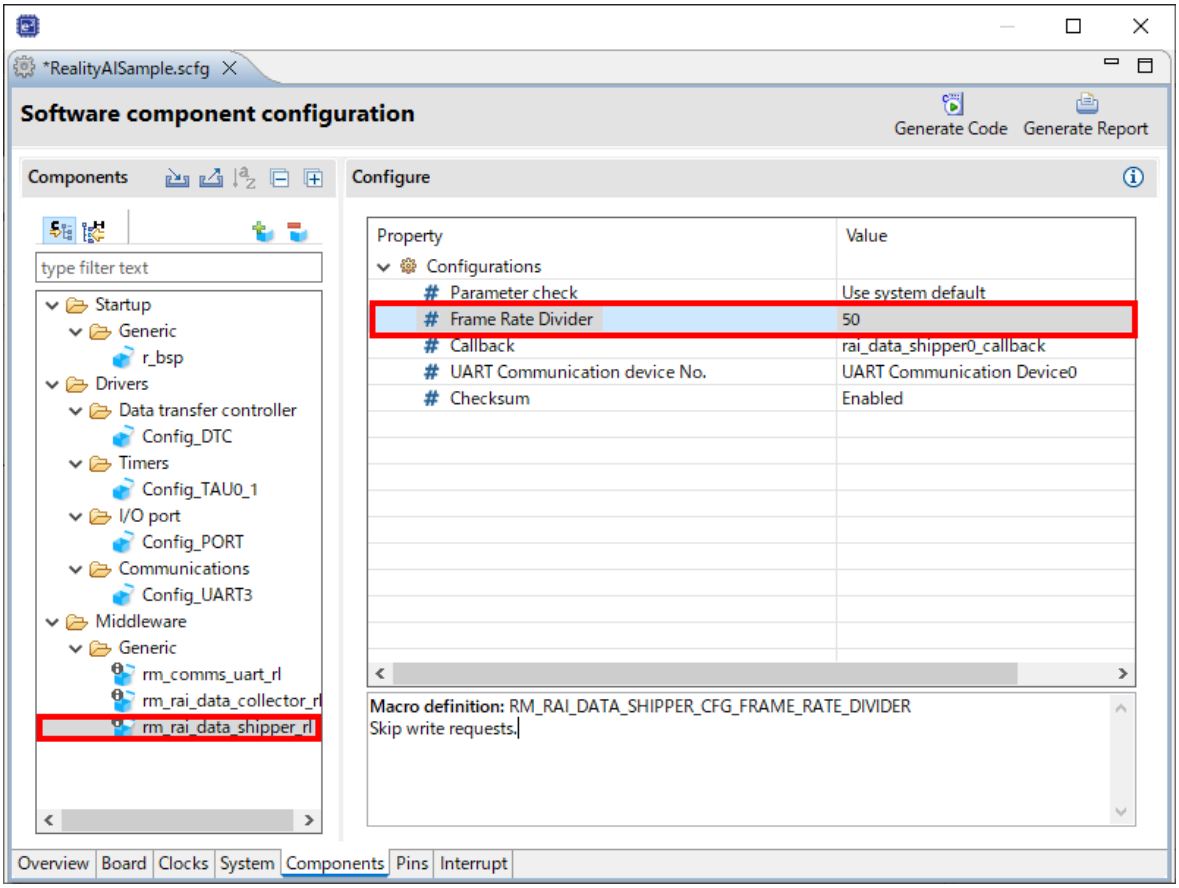

*RealityAISample.scfg
Software component configuration
Generate Code
Generate Report
Components
Configure
type filter text
Startup
Generic
r_bsp
Drivers
Data transfer controller
Config_DTC
Timers
Config_TAU0_1
Communications
Config_UART3
Middleware
Generic
rm_comms_uart_rl
rm_rai_data_collector_rl
rm_rai_data_shipper_rl
Property
Value
Data Feed Mode Channels 0
Snapshot Mode Channel 0 Name Data1
Snapshot Mode Channel 0 Data Type 8-bit Signed
Snapshot Mode Channel 1 Name Data2
Snapshot Mode Channel 1 Data Type 8-bit Unsigned
Snapshot Mode Channel 2 Name dc0_snapshot_ch2
Snapshot Mode Channel 2 Data Type 8-bit Signed
Snapshot Mode Channel 3 Name dc0_snapshot_ch3
Snapshot Mode Channel 3 Data Type 8-bit Signed
Snapshot Mode Channel 4 Name dc0_snapshot_ch4
Snapshot Mode Channel 4 Data Type 8-bit Signed
Snapshot Mode Channel 5 Name dc0_snapshot_ch5
Snapshot Mode Channel 5 Data Type 8-bit Signed
Snapshot Mode Channel 6 Name dc0_snapshot_ch6
Snapshot Mode Channel 6 Data Type 8-bit Signed
Macro definition: RM_RAI_DATA_COLLECTOR_CFG_DC0_SNAPSHOT_CHANNEL0_DATA_TYPE
Set the Type of Data.
Overview
Board
Clocks
System
Components
Pins
Interrupt


*RealityAISample.scfg
Software component configuration
Generate Code
Generate Report
Components
Configure
type filter text
Startup
Generic
r_bsp
Drivers
Data transfer controller
Config_DTC
Timers
Config_TAU0_1
I/O port
Config_PORT
Communications
Config_UART3
Middleware
Generic
rm_comms_uart_rl
rm_rai_data_collector_rl
rm_rai_data_shipper_rl
Property
Value
Snapshot Mode Channel 3 Data Type 8-bit Signed
Snapshot Mode Channel 4 Name dc0_snapshot_ch4
Snapshot Mode Channel 4 Data Type 8-bit Signed
Snapshot Mode Channel 5 Name dc0_snapshot_ch5
Snapshot Mode Channel 5 Data Type 8-bit Signed
Snapshot Mode Channel 6 Name dc0_snapshot_ch6
Snapshot Mode Channel 6 Data Type 8-bit Signed
Snapshot Mode Channel 7 Name dc0_snapshot_ch7
Snapshot Mode Channel 7 Data Type 8-bit Signed
Snapshot Mode Channels 2
Snapshot Mode Count 1
Timer Driver Type 16-bits counter
Timer Component name Config_TAU0_1
DTC Component name Config_DTC
Start number for DTC control data 0
Macro definition: RM_RAI_DATA_COLLECTOR_CFG_DC0_TIMER_DRIVER_TYPE
Set the driver type (see below) to be used.
- When using 16-bits counter timer, set this to "16-bits counter".
- When using 32-bits counter timer, set this to "32-bits counter".
Overview
Board
Clocks
System
Components
Pins
Interrupt

2.5 Setup Data Shipper

- Change the property of [rm_rai_data_shipper_rl] as follows:

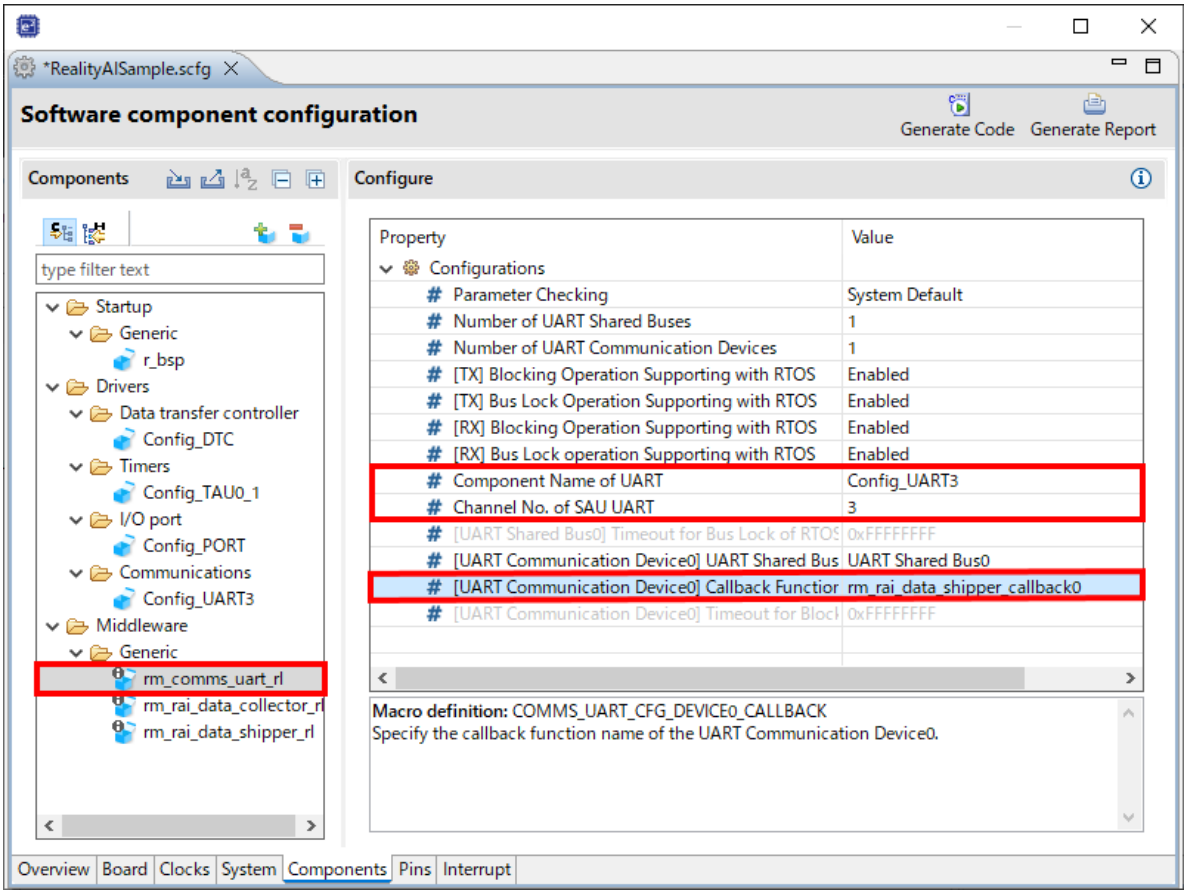
Property	Value
Frame Rate Divider	50



2.5.1 Setup UART for Data Shipper

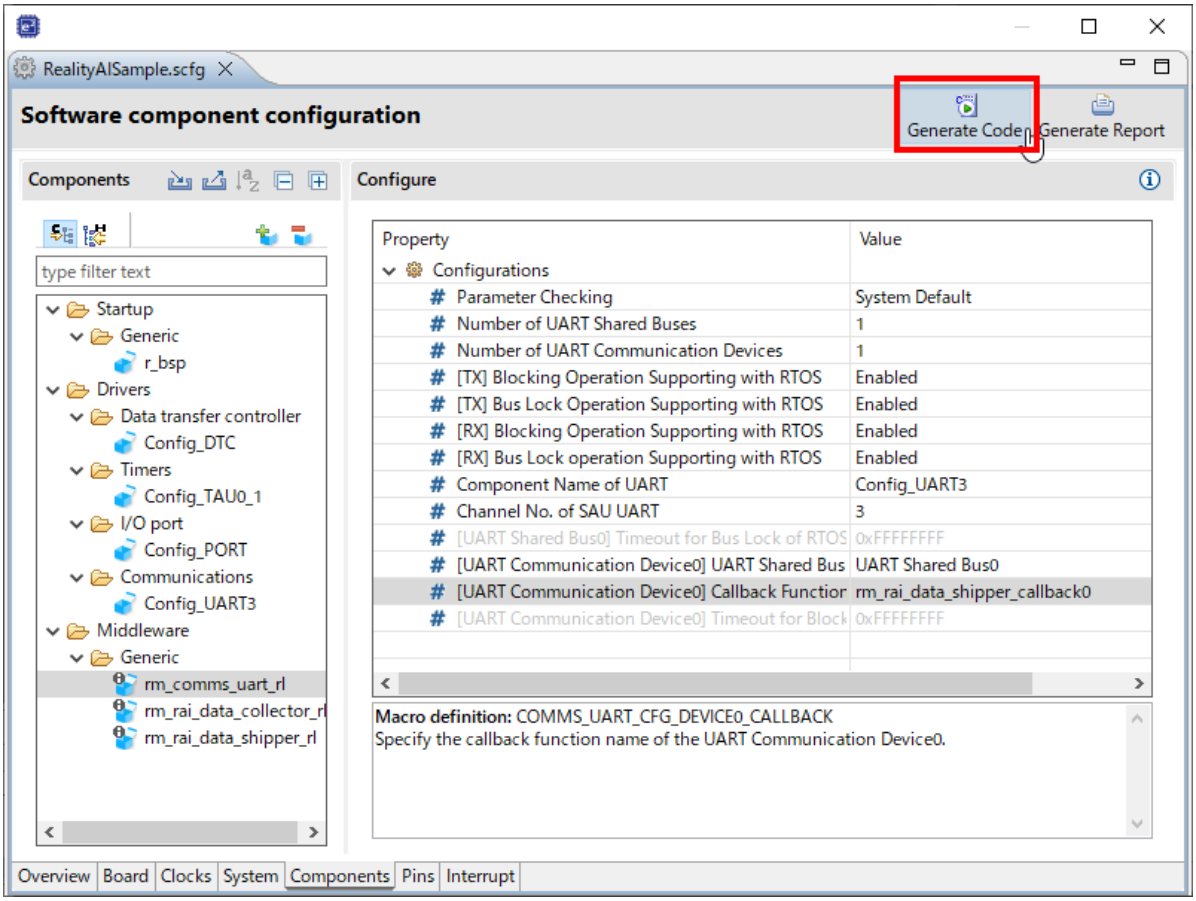
- Change the property of [rm_comms_uart_rl] as follows:

Property	Value
Component name of UART	Config_UART3
Channel No. of SAU UART	3
[UART Communication Device0] Callback Function	rm_rai_data_shipper_callback0



2.6 Generate source code by smart configurator.

- push [Generate Code] button.



2.7 Modify source code.

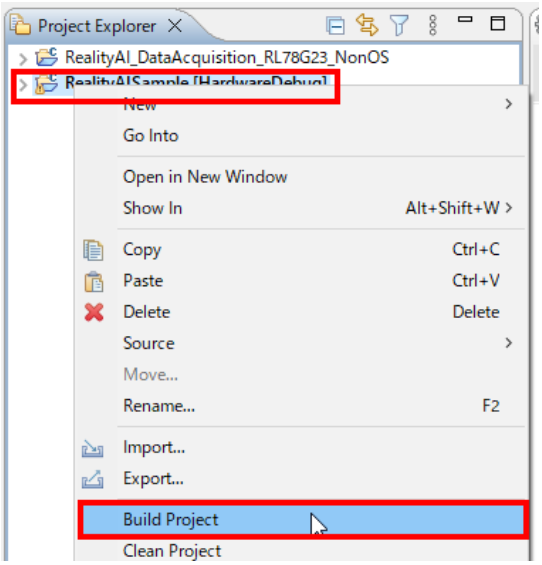
Add process of main function and add callback function to SCI.

- Replace and rename sample source file to src folder.

Replace	File
From	RealityAI_DataAcquisition_RL78G23_NonOS/sample/RealityAISample.c.sample
To	“Project Folder”/src/RealityAISample.c
From	RealityAI_DataAcquisition_RL78G23_NonOS/sample/Config_TAU0_1_user.c.sample
To	“Project Folder”/src/smc_gen/Config_TAU0_1/Config_TAU0_1_user.c
From	RealityAI_DataAcquisition_RL78G23_NonOS/sample/Config_UART3_user.c.sample
To	“Project Folder”/src/smc_gen/Config_UART3/Config_UART3_user.c

2.8 Build project.

- Right-button click “Project Name” in Project Explorer and select [Build Project] menu.



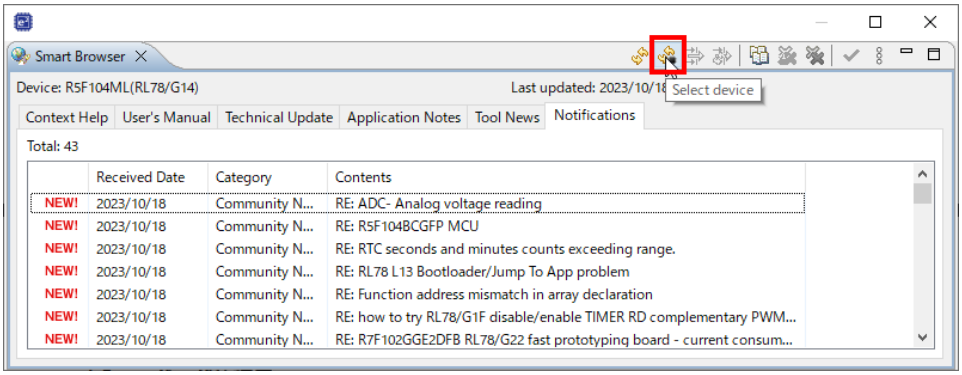
3. How to implement data acquisition [RL78/G14]

For RL78 devices that do no support SIS modules (like as RL78/G14). Please refer the sample project as a guide to implement data acquisition module for Reality AI.

3.1 Import sample project for Data Collector and Data Shipper

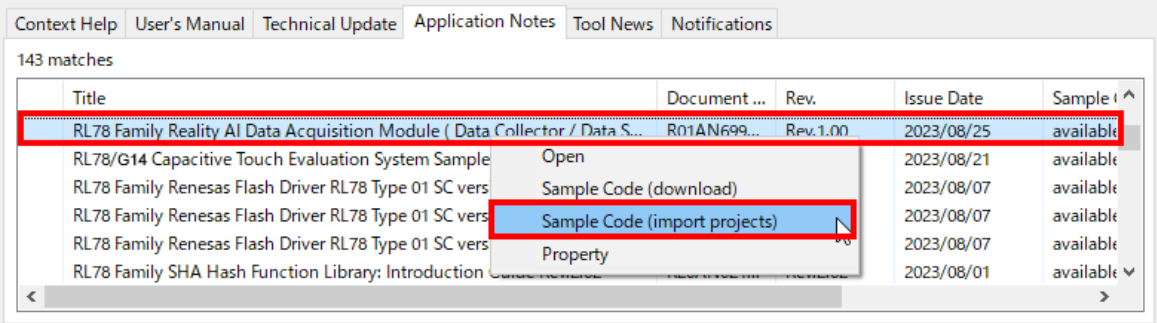
A sample project attached this application note. Please import by the following steps.

1. Select [Renesas Views] [Solution Toolkit] [Smart Browser] menu.
2. Select [Select device] icon.

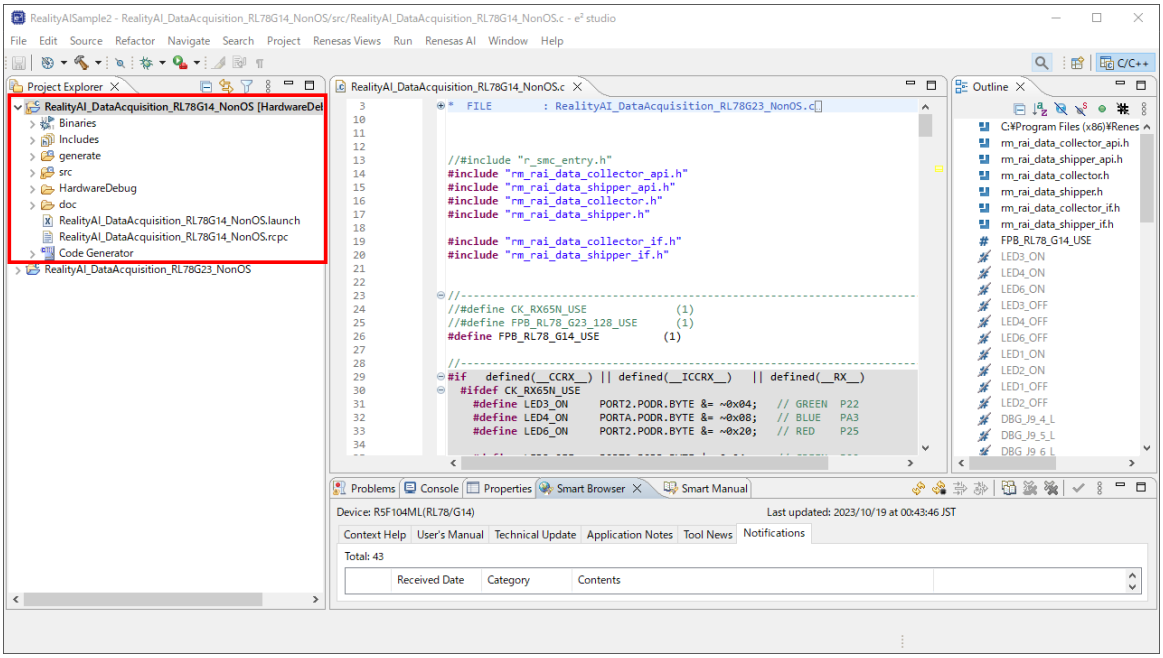


3. Select [RL78] [G14] [R5F104ML] tree and [OK] button.
4. Select [Application Notes] tab.

5. Select [RL78 Family Reality AI Data Acquisition Module (Data Collector / Data Shipper) Sample Code] and Click right-button [Sample Code (import projects)] item.



After importing the sample project, display it in Project Explorer.



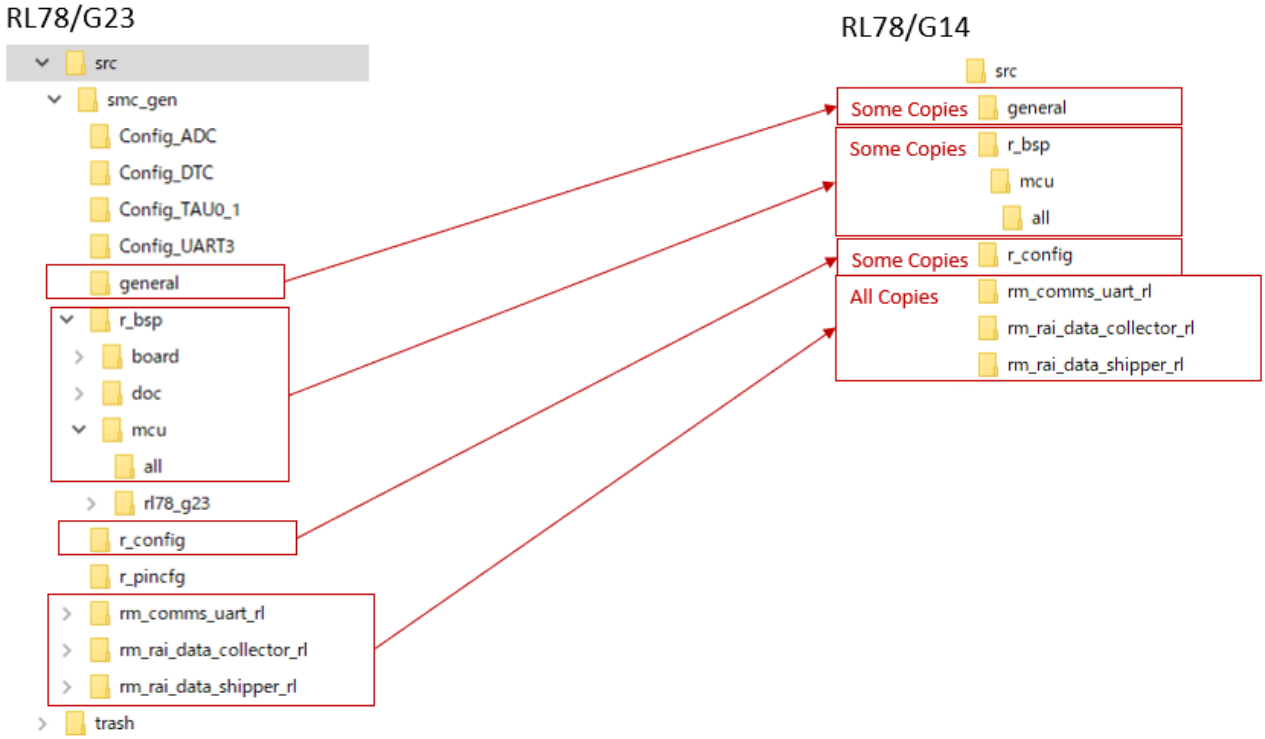
3.2 Information sample project for Data Collector and Data Shipper

RL78/G14 sample project copies and modifies the necessary source code from RL78/G23 sample project. Therefore, we recommend importing RL78/G23 sample project and compare source code.

How to import sample project for RL78/G23, please refer Import sample project for Data Collector and Data Shipper.

3.2.1 Copy source code from RL78/G23 sample project.

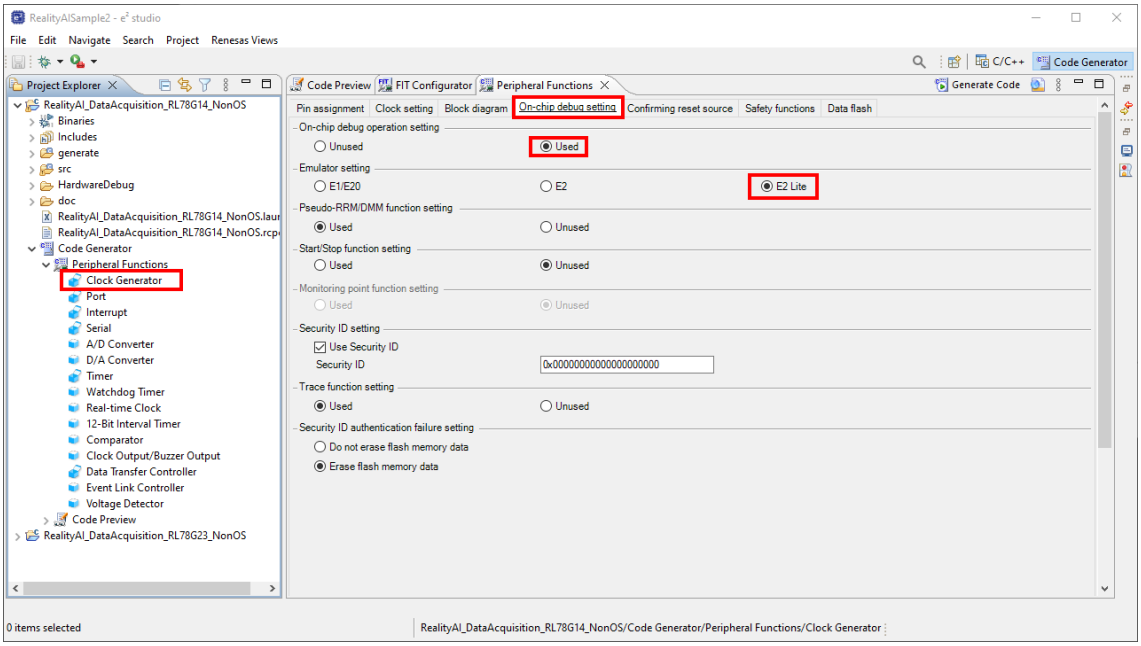
Copy and modify the following source code for RL78/G23 sample project.



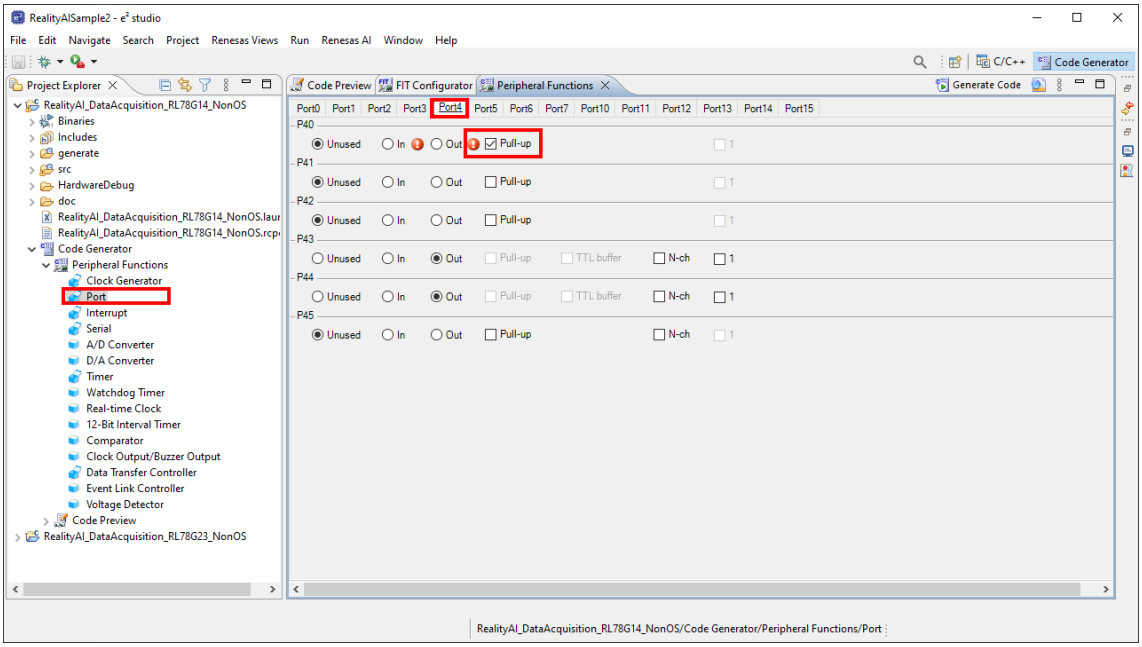
Folder	Description
general	copy only r_smc_entry.h and modify it.
r_bsp\mcu\all	don't copy cstart.asm. don't copy r_rtos.h.
r_bsp	copy platform.h and modify it.
r_config	don't copy r_bsp_config.inc
rm_comms_uart_rl	copy all files
rm_rai_data_collector_rl	copy all files
rm_rai_data_shipper_rl	copy all files

3.2.2 Modify settings of Code Generator

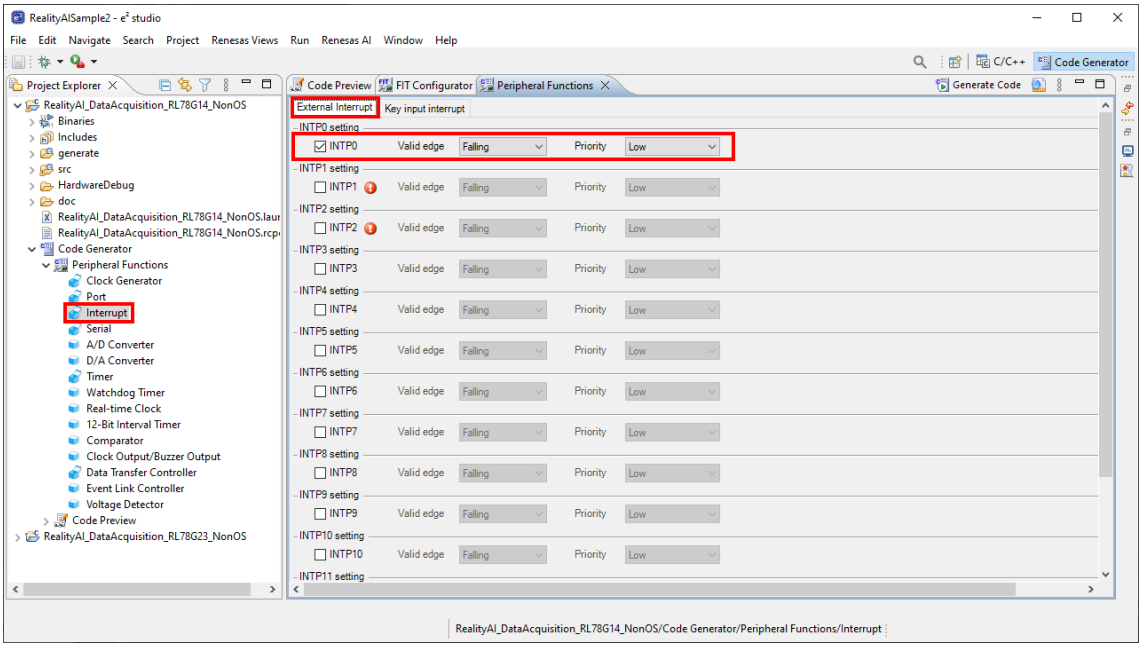
1. Select [Clock Generator] tree and [On-chip debug setting] tab.
   Change the settings as shown in the following figure.



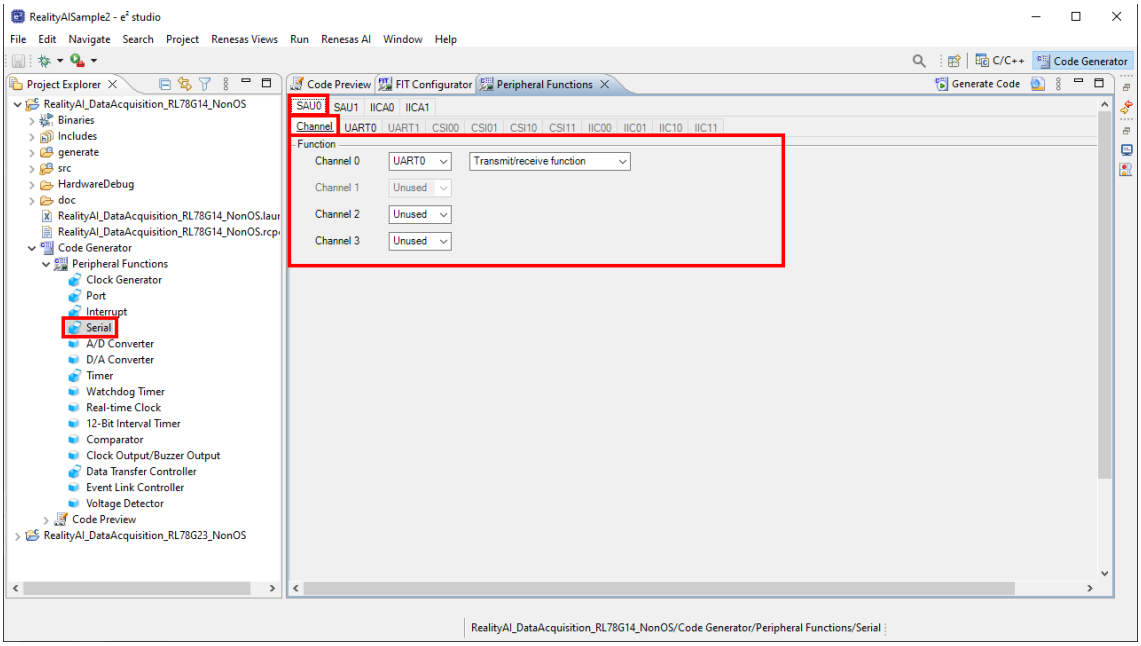
2. Select [Port] tree and [Port4] tab.
   Change the settings as shown in the following figure.



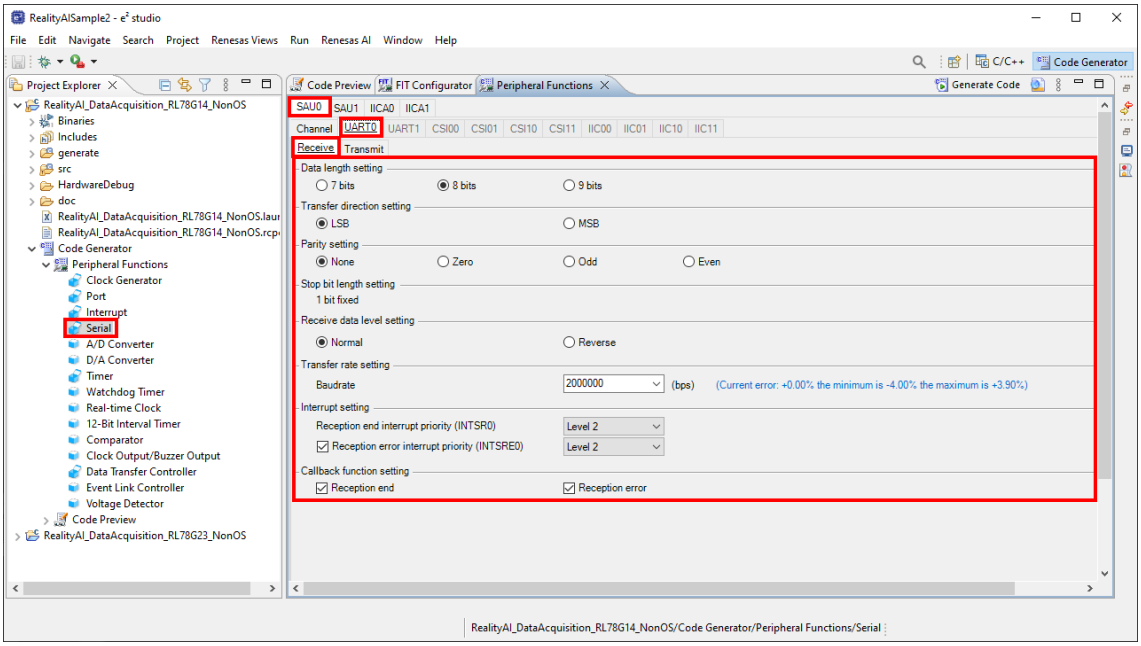
3. Select [Interrupt] tree and [External Interrupt] tab.
   Change the settings as shown in the following figure.



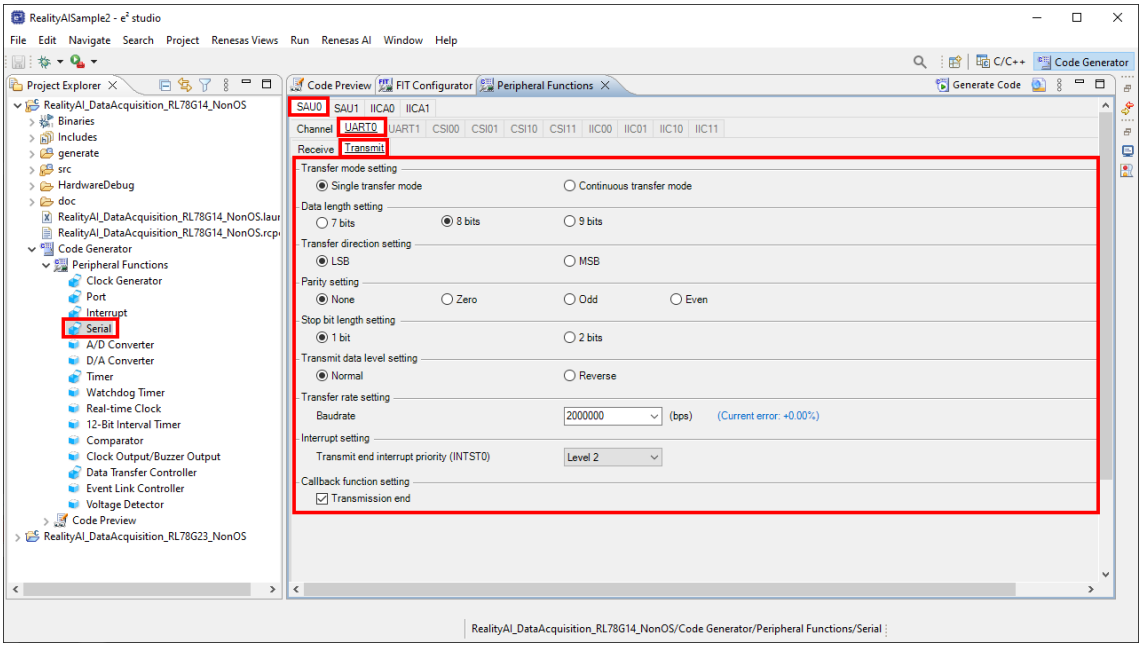
4. Select [Serial] tree and [SAU0] [Channel] tab.
   Change the settings as shown in the following figure.



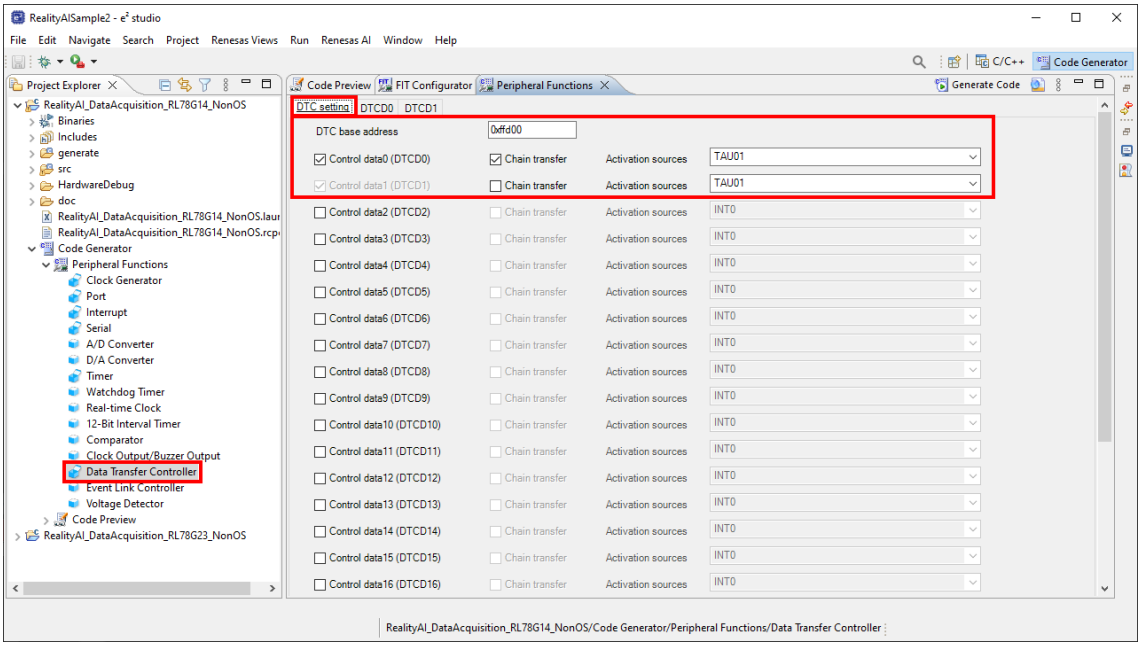
5. Select [Serial] tree and [SAU0] [UART0] [Receive] tab.
   Change the settings as shown in the following figure.



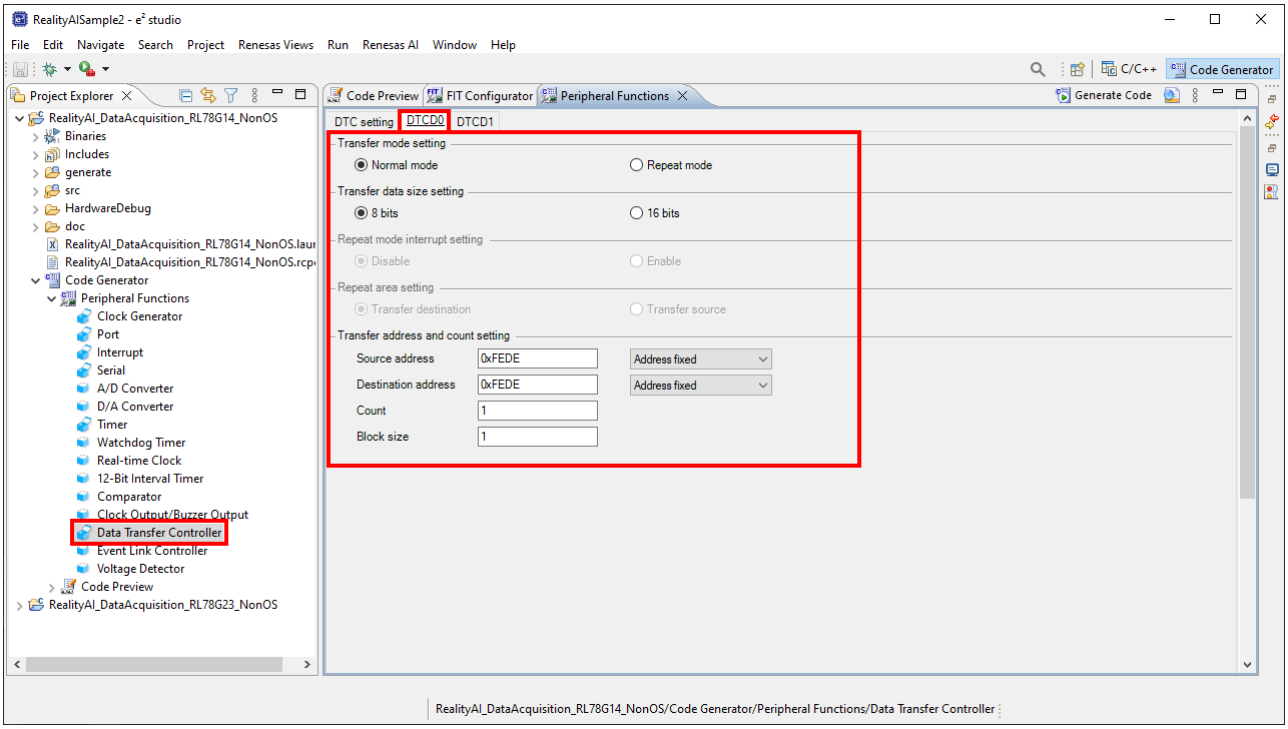
6. Select [Serial] tree and [SAU0] [UART0] [Transmit] tab.
   Change the settings as shown in the following figure.



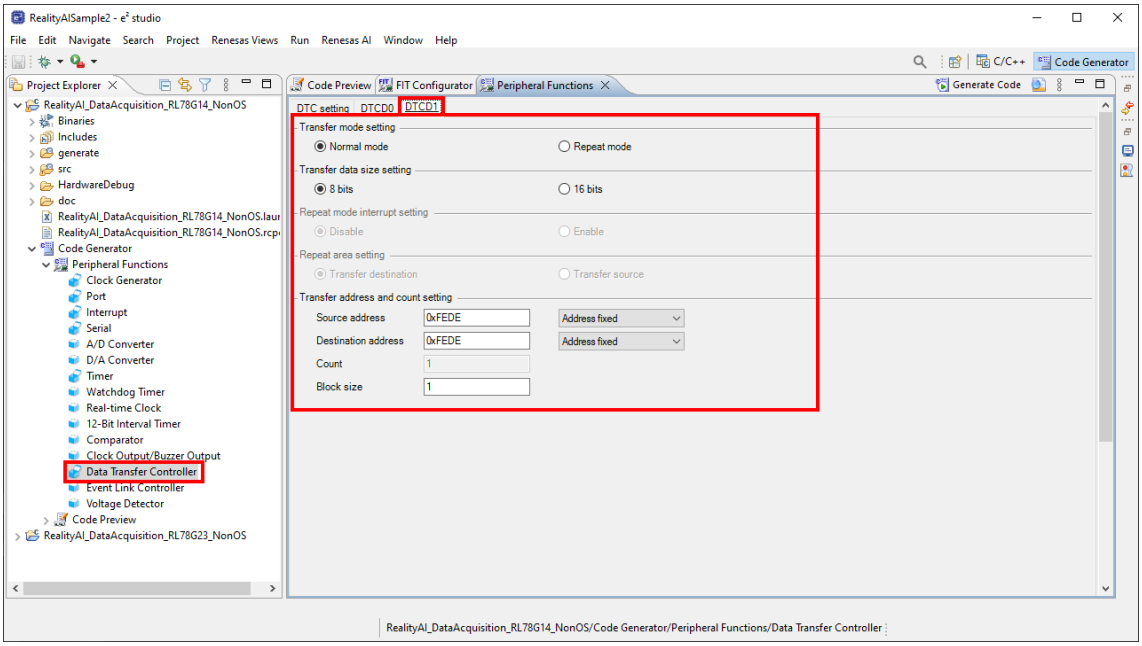
7. Select [Data Transfer Controller] tree and [DTC setting] tab.
Change the settings as shown in the following figure.



8. Select [Data Transfer Controller] tree and [DTC0] tab.
Change the settings as shown in the following figure.

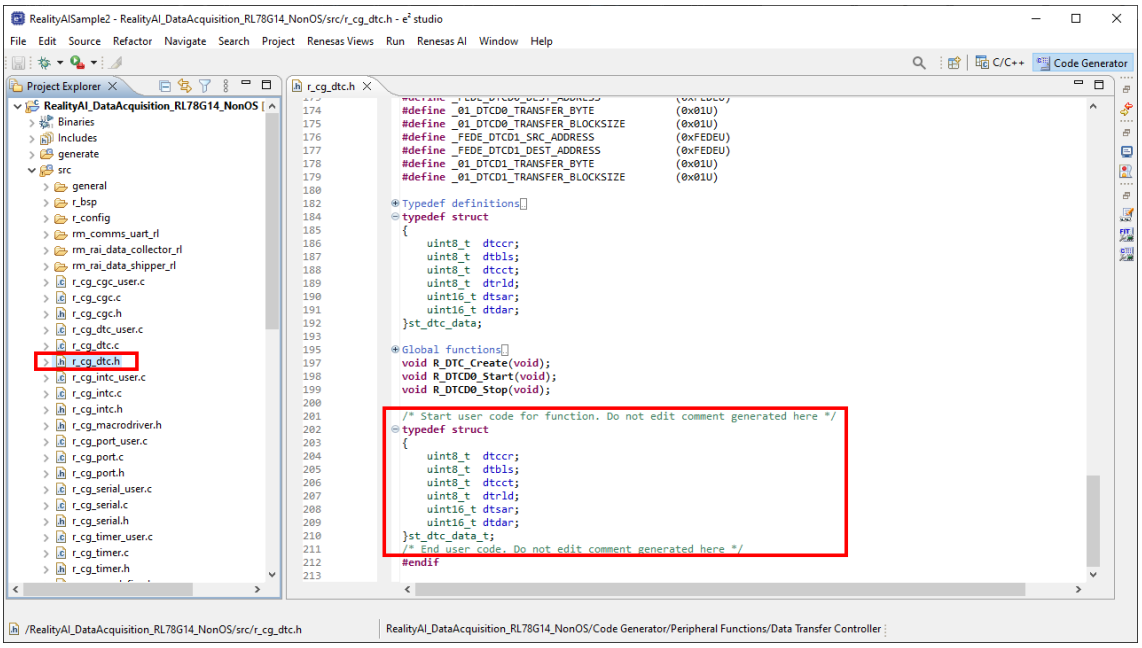


9. Select [Data Transfer Controller] tree and [DTC setting] tab.
   Change the settings as shown in the following figure.

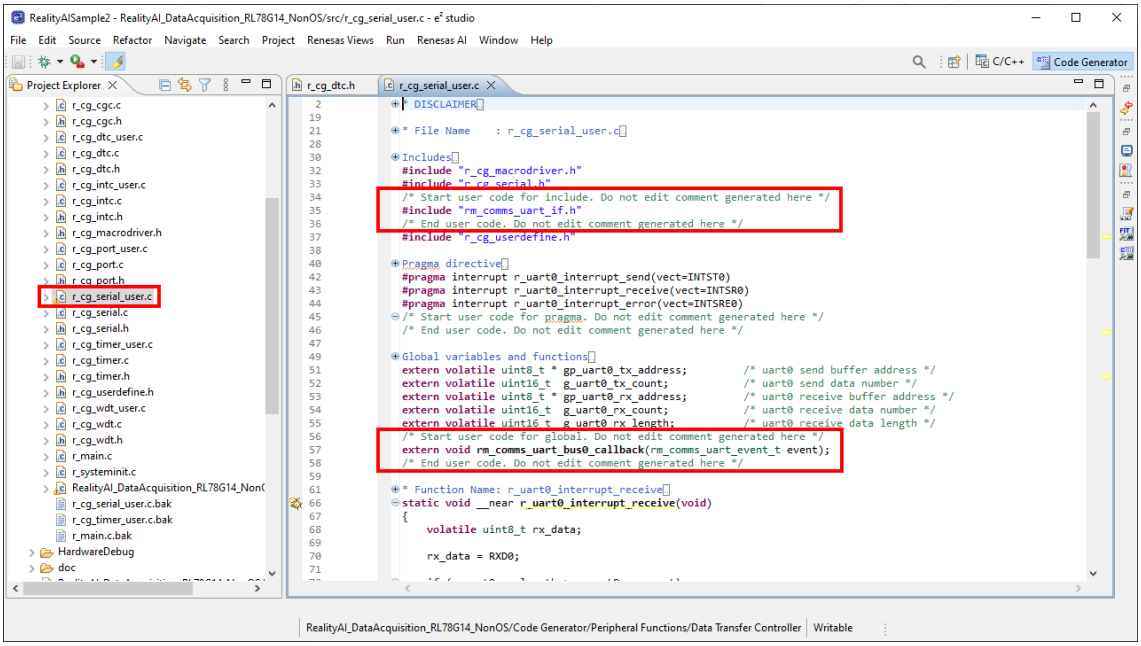


3.2.3 Modify source code.

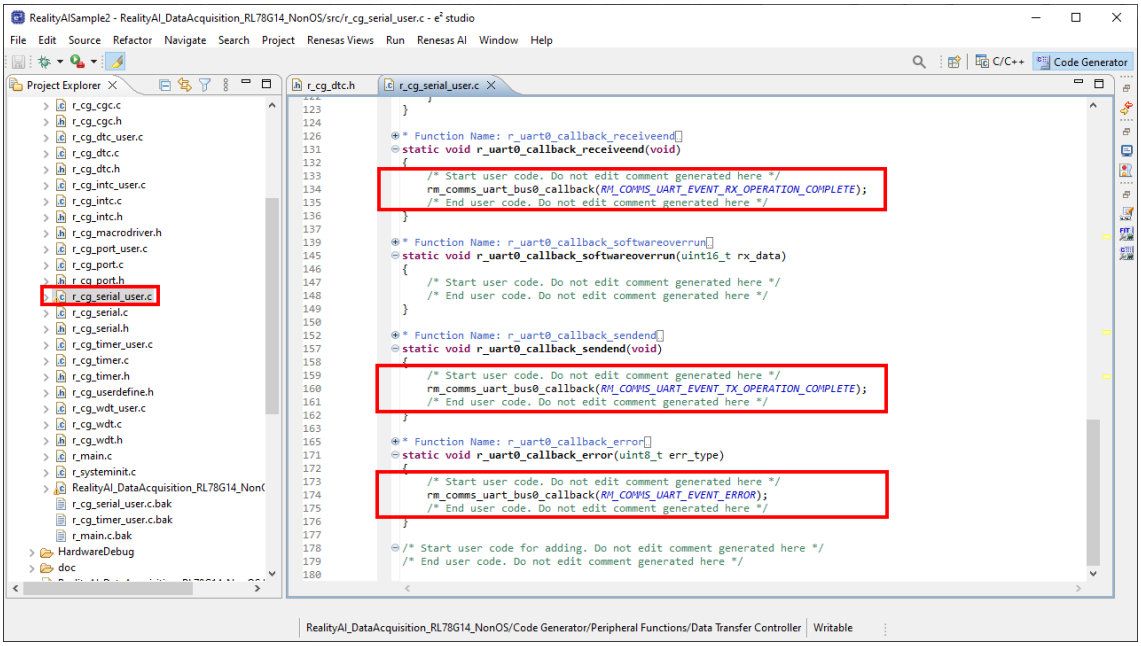
1. Select [r_cg_dtc.h] tree.
   Modify source code as shown in the following figure.



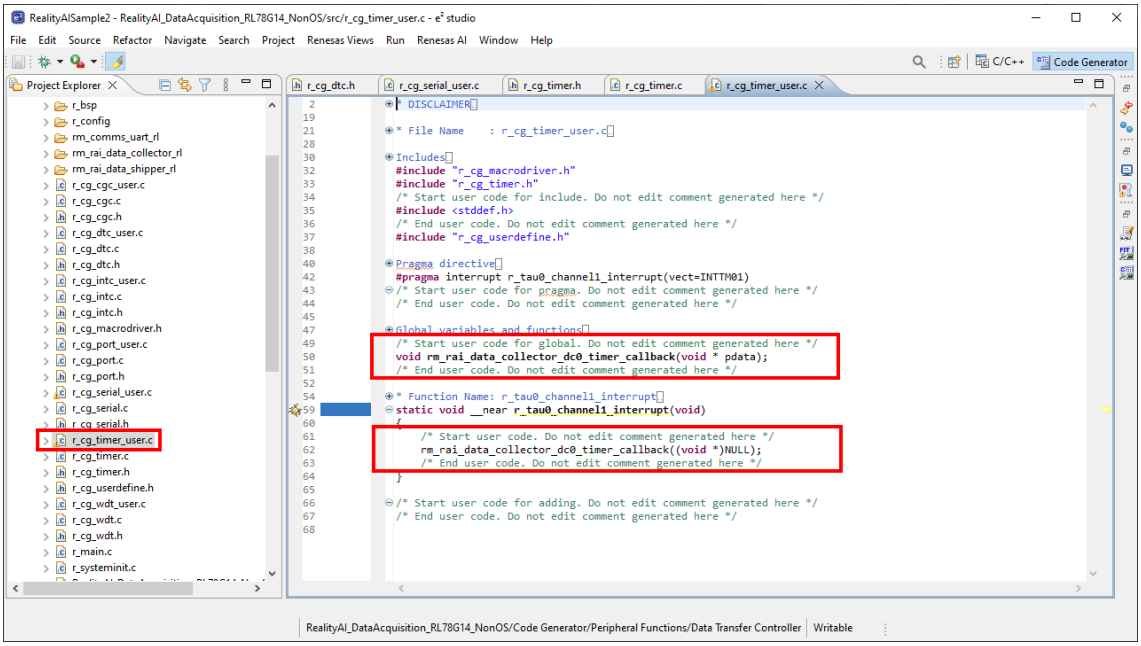
2. Select [r_cg_serial_user.c] tree.
Modify source code as shown in the following figure.



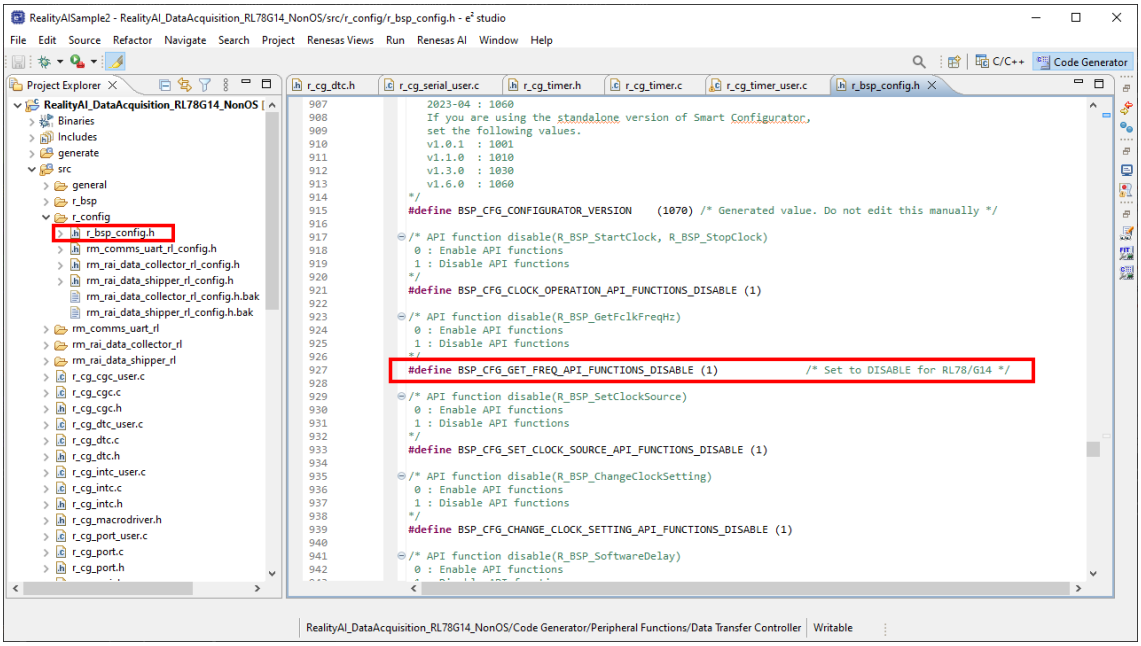
3. Select [r_cg_serial_user.c] tree.
Modify source code as shown in the following figure.



4. Select [r_cg_timer_user.c] tree.
   Modify source code as shown in the following figure.



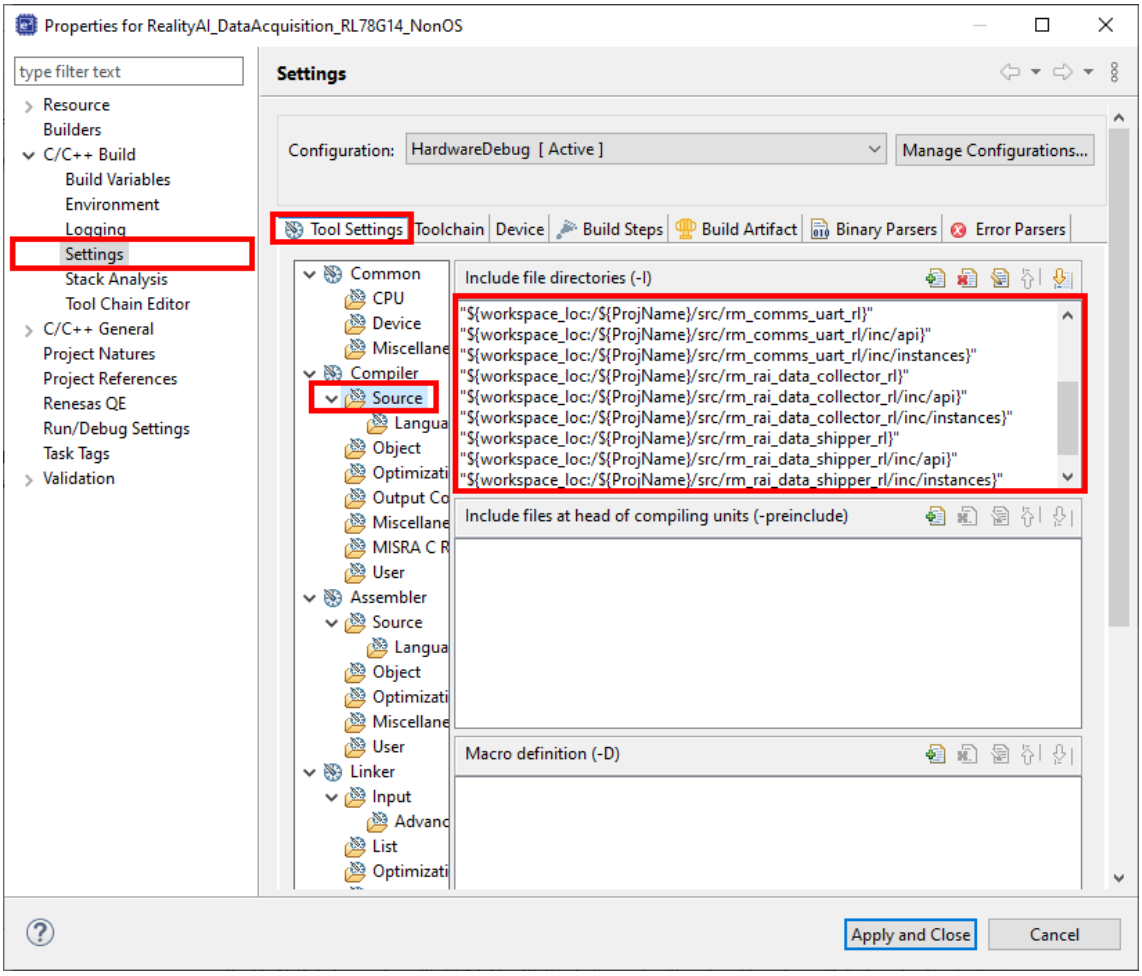
5. Select [r_bsp_config.h] tree.
   Modify source code as shown in the following figure.



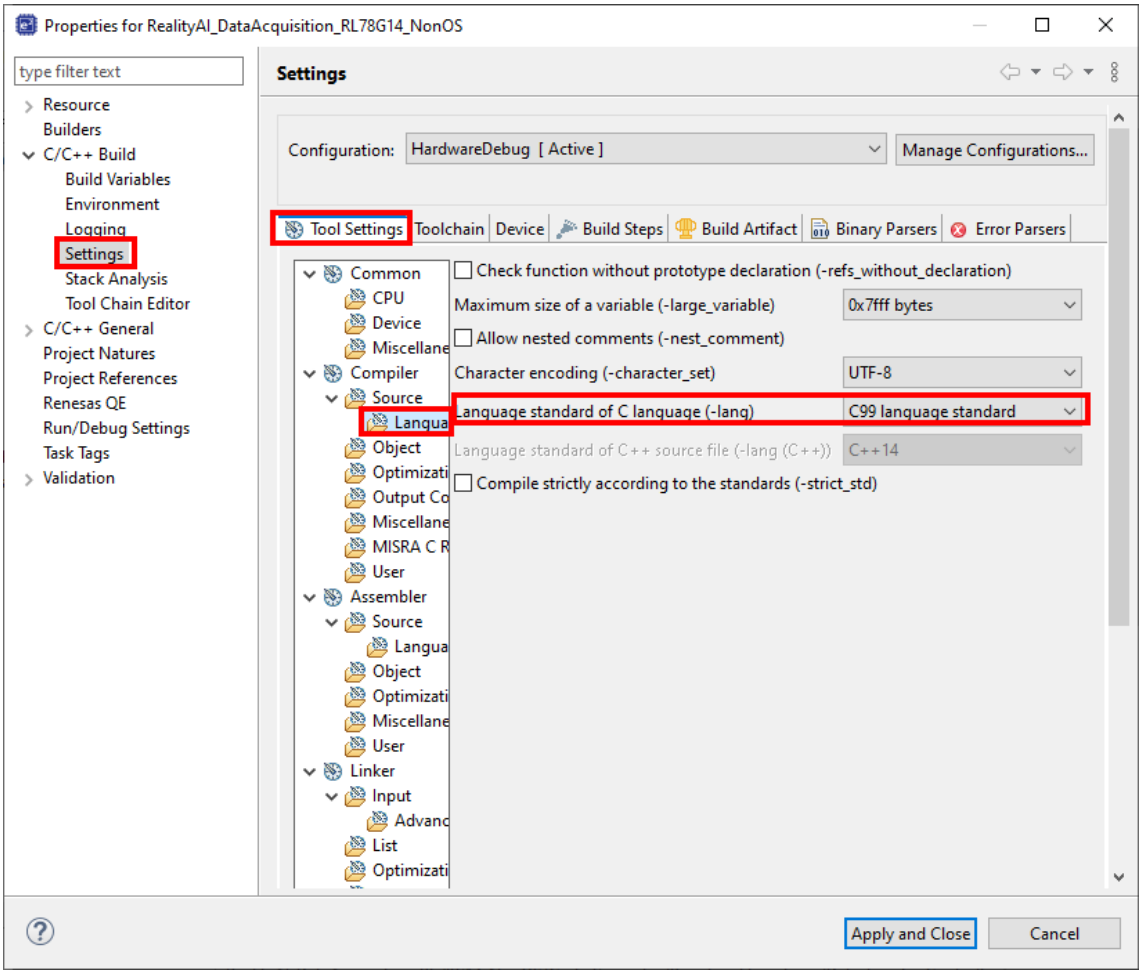
3.2.4 Change build settings.

Right-button click “Project Name” in Project Explorer and select [Properties] menu.

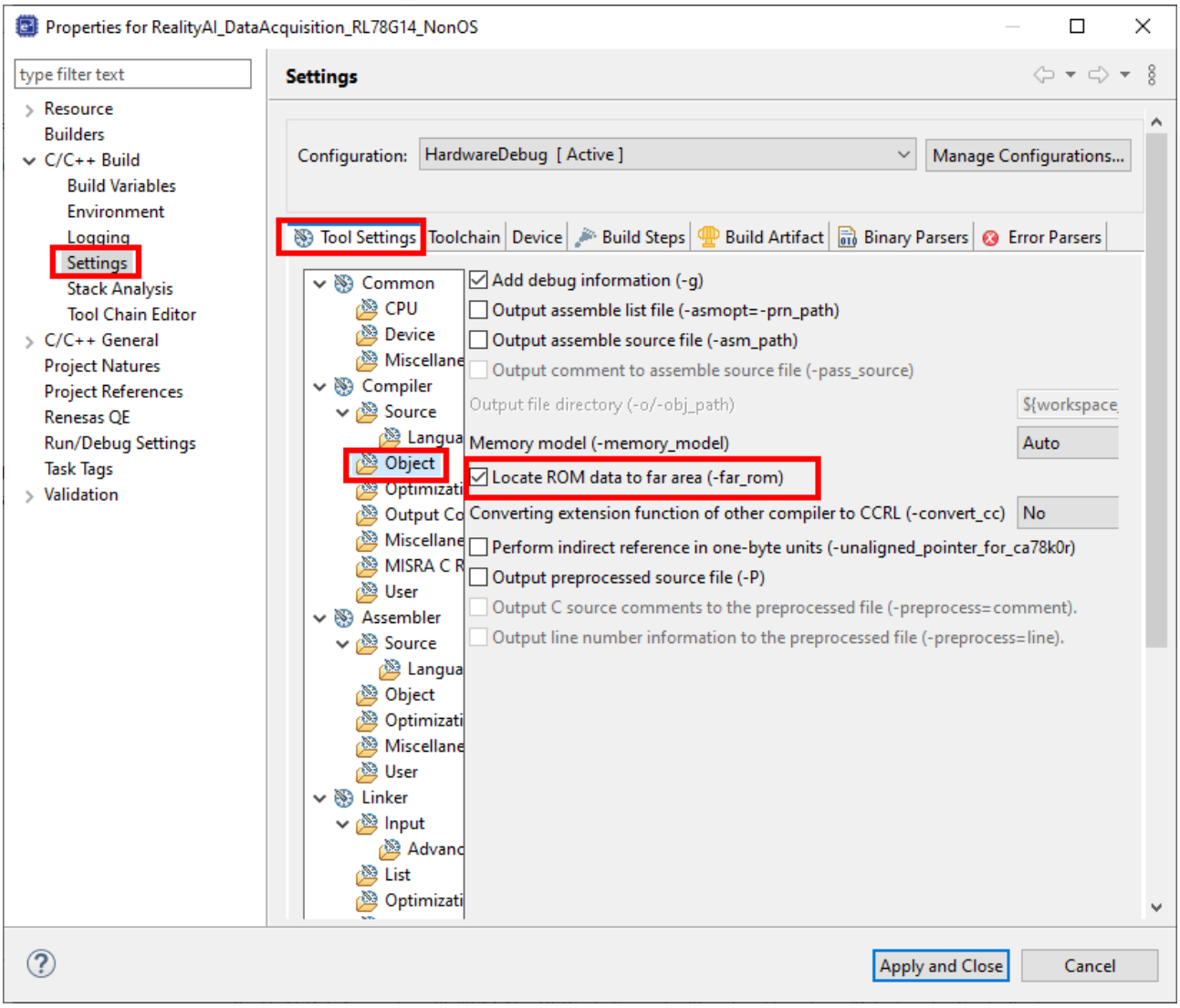
1. Select [C/C++ Build] [Settings] tree and [Tool Settings] tab and [Source] tree.
   Change build setting as shown in the following figure.



2. Select [C/C++ Build] [Settings] tree and [Tool Settings] tab and [Language] tree.
Change build setting as shown in the following figure.



3. Select [C/C++ Build] [Settings] tree and [Tool Settings] tab and [Object] tree.
Change build setting as shown in the following figure.
In this sample project, turned [-far_rom] option on, but change it to suit your system.



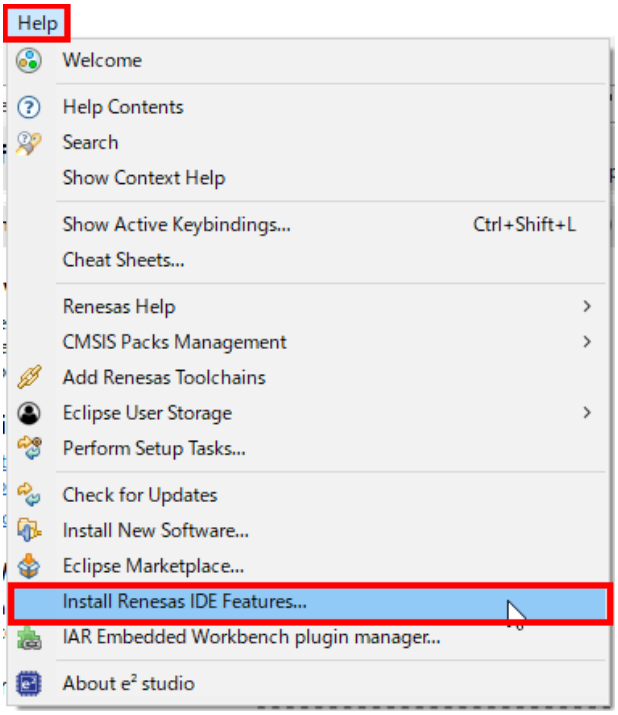
3.2.5 Delete source file.

Delete source file (generate\hdwinit.asm).

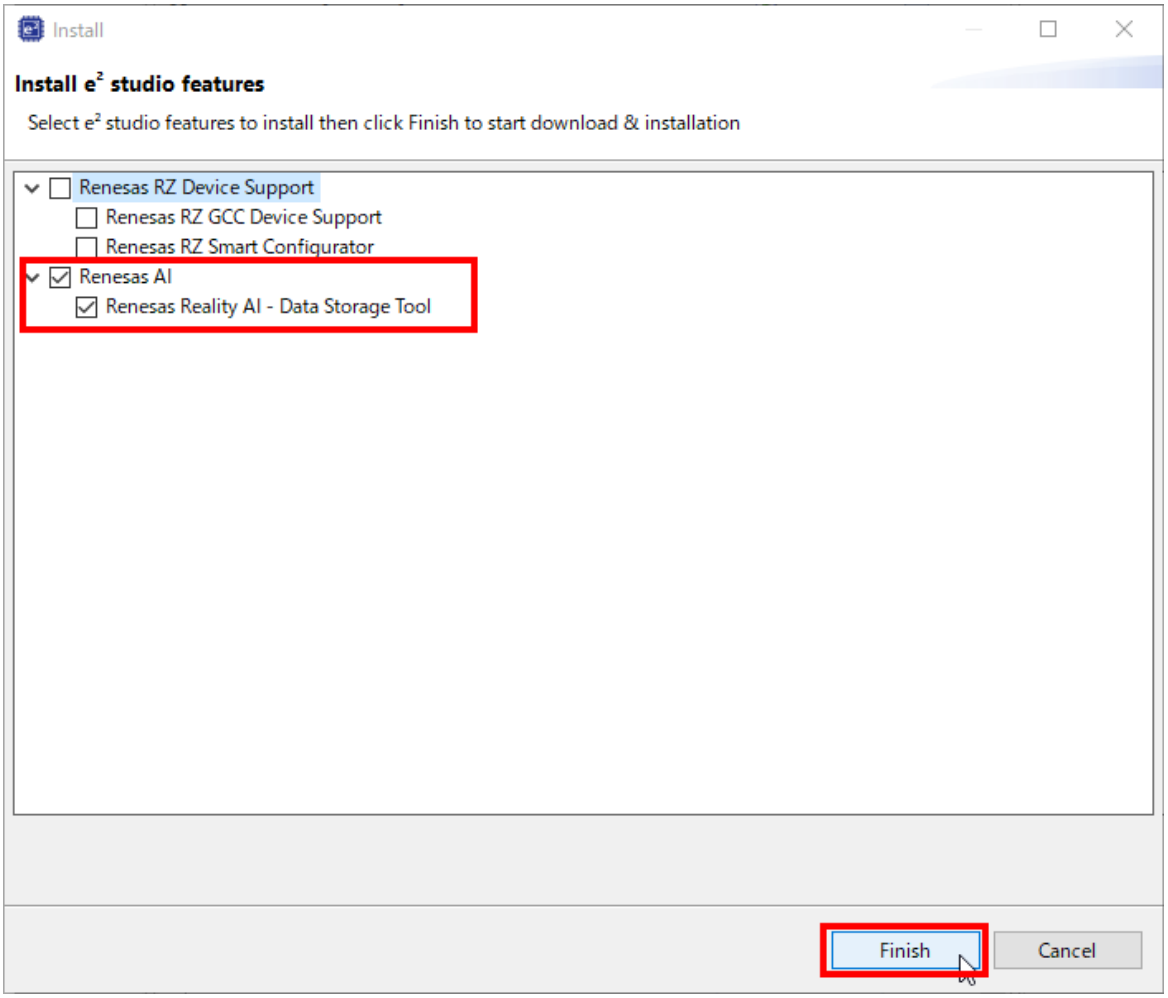
4. How to get sensor data from evaluation board

4.1 Setup Reality AI Data Storage Tool

1. Install Reality AI Data Storage Tool.
   - Select [Help]>[Install Renesas IDE Features] in e2 studio.

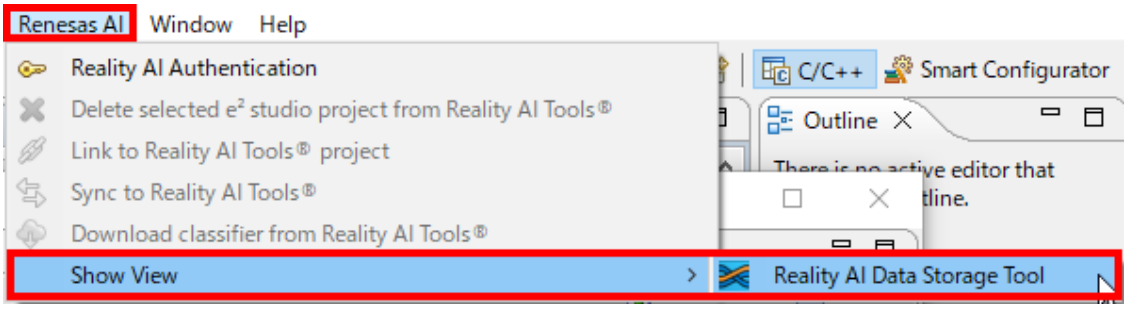


- Check [Renesas Reality AI – Data Storage Tool] and push [Finish] button.



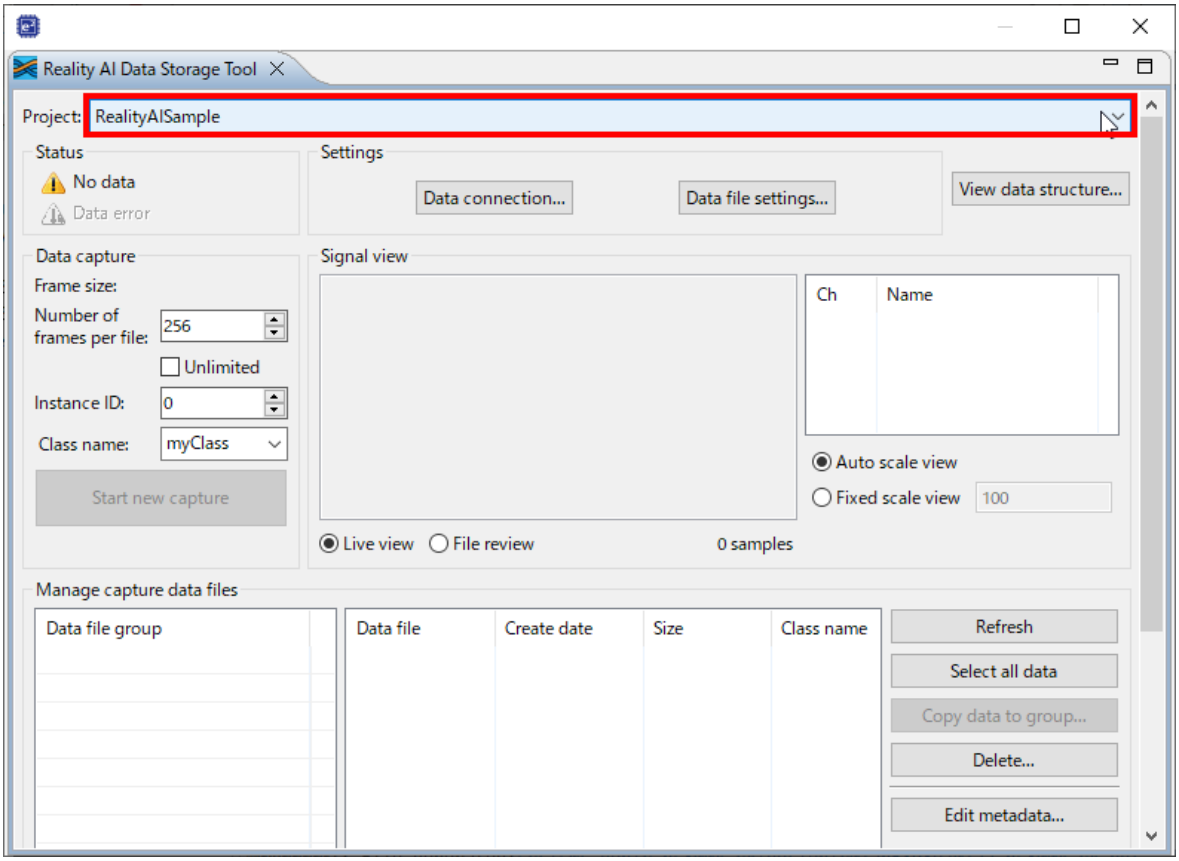
2. Launch Reality AI Data Storage Tool

- Select [Renesas AI]>[Show View]>[Reality AI Data Storage Tool] menu.



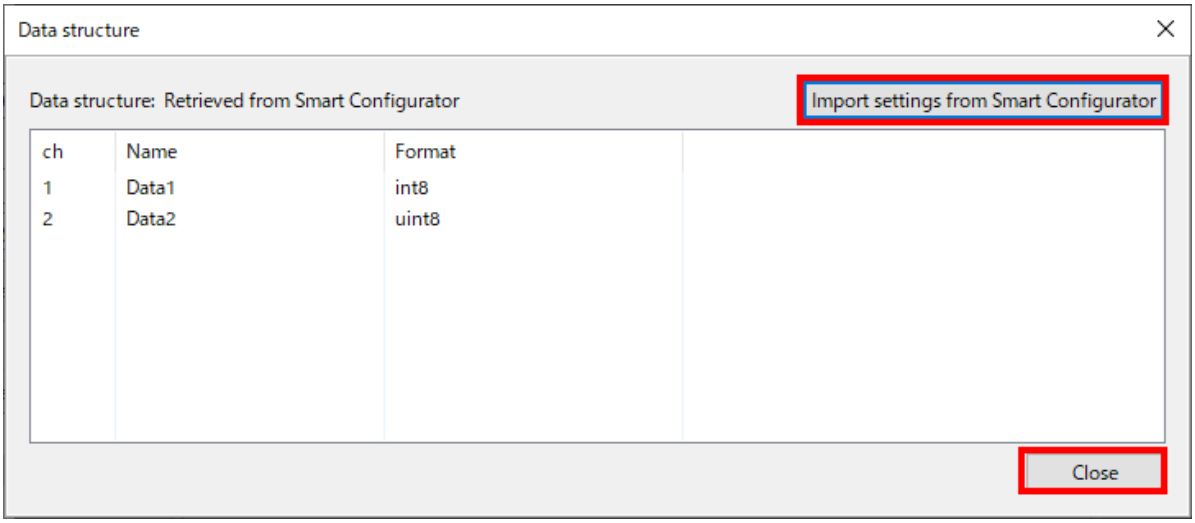
3. Select Project

- Select [“Project Name”] combo box.



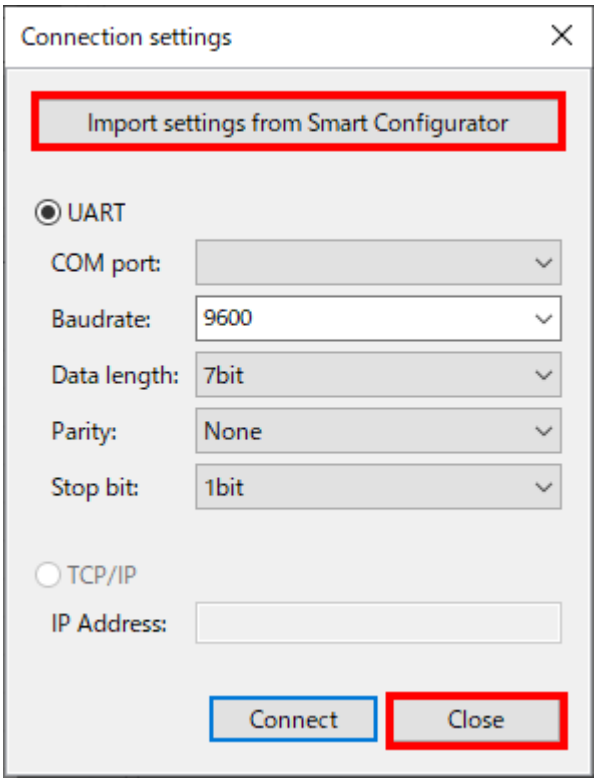
4. Get data structure information from Smart Configurator

- Push [View data structure] button in Reality AI Data Storage Tool.
- Push [Import settings from Smart Configurator] button and push [Close] button.



4. Get connection settings from Smart Configurator

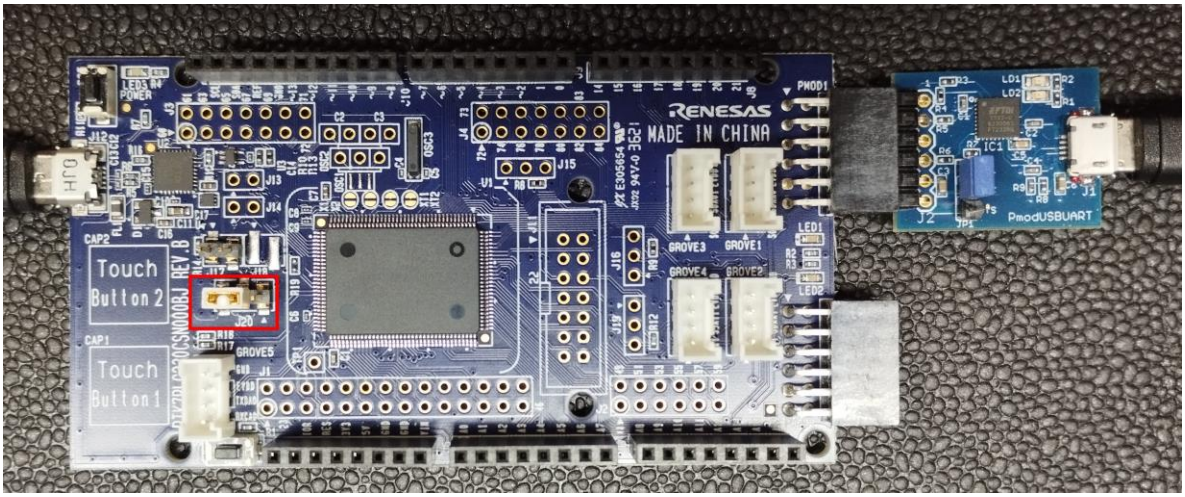
- Push [Data connection] button in Reality AI Data Storage Tool.
- Push [Import settings from Smart Configurator] button and Select [COM port] and push [Close] button.



Limitation: “Renesas Reality AI Data Storage Tool” V1.0.0 can not get information from Smart Configurator. So please change the settings manually.

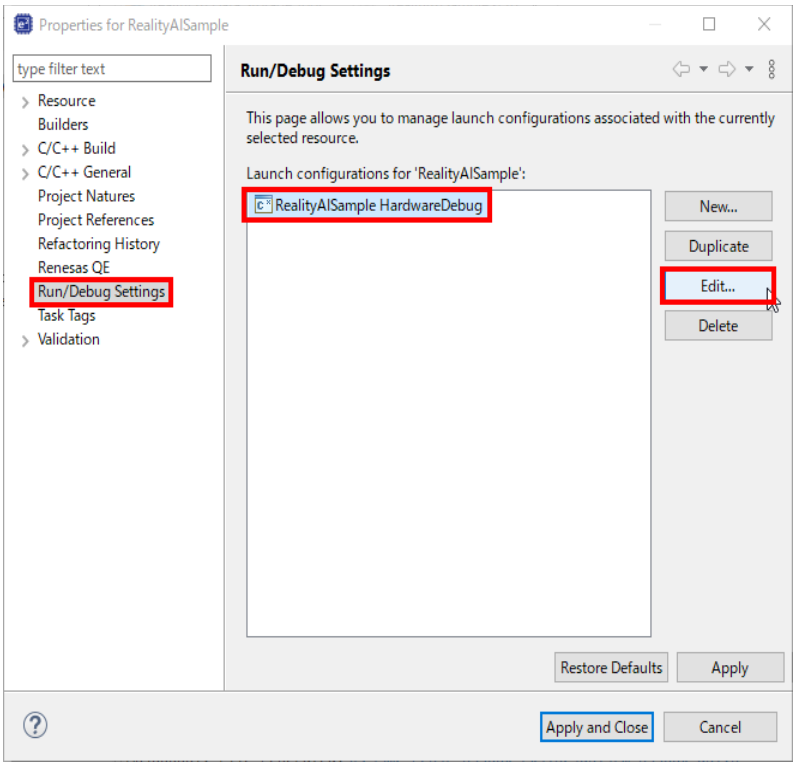
4.2 Connect Evaluation Board and PC

- Short 2-3 in J20
- Connect PMOD (USB-UART) module to evaluation board and connect PMOD module and PC via USB.
- Connect evaluation board and PC via USB.
- For Connection details, please refer “RL78/G23-128p Fast Prototyping Board” manual. The Manual is available on Renesas Web.

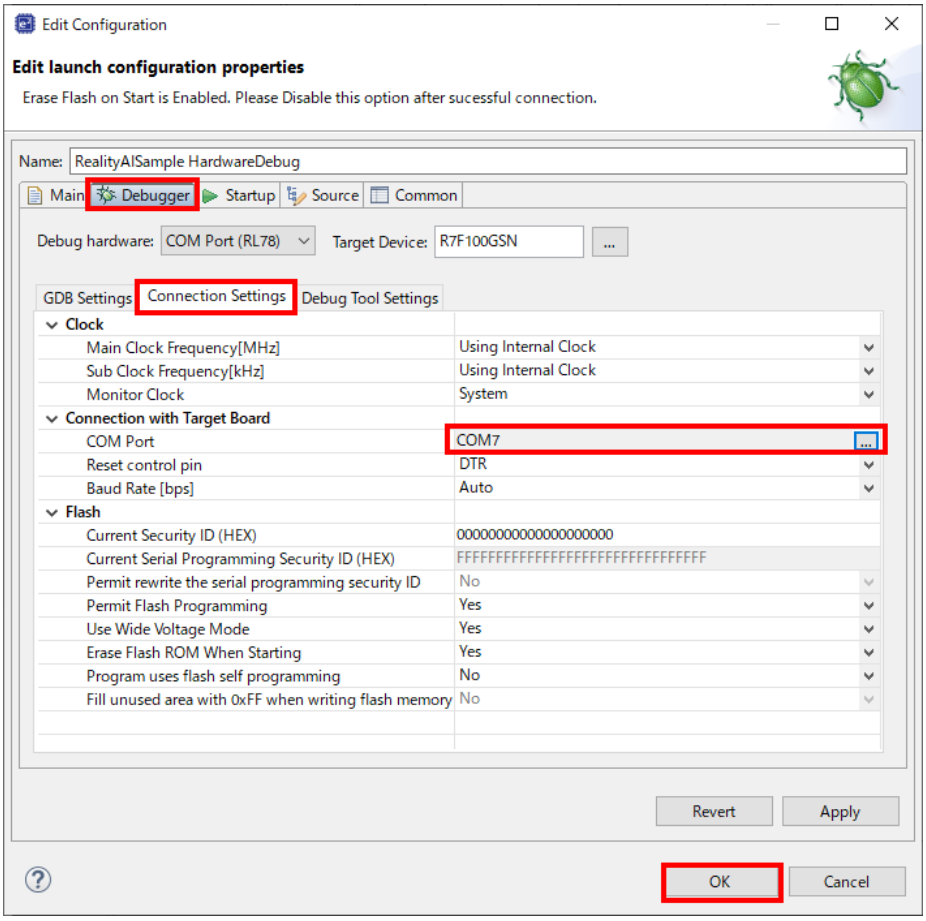


4.3 Modify debugger settings.

- Right-button click “Project Name” in Project Explorer and select [Properties] menu.
- Select [Run/Debug Settings] tree and select [RealityAISample HardwareDebug] item and push [Edit] button.

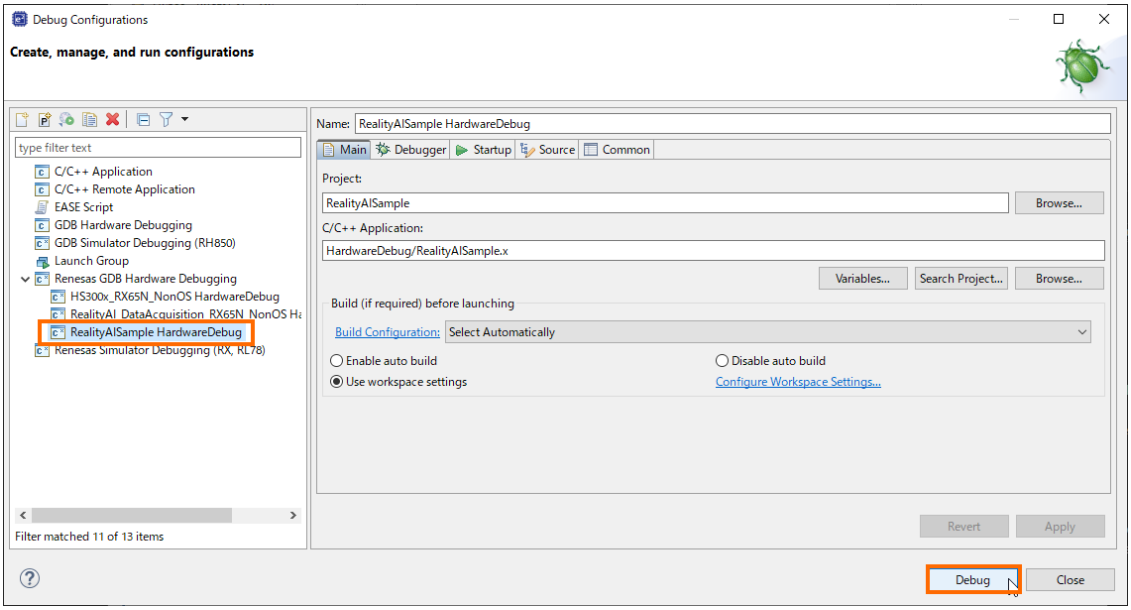

Properties for RealityAISample
type filter text
Resource
Builders
C/C++ Build
C/C++ General
Project Natures
Project References
Refactoring History
Renesas QE
Run/Debug Settings
Task Tags
Validation
Run/Debug Settings
This page allows you to manage launch configurations associated with the currently selected resource.
Launch configurations for 'RealityAISample':
RealityAISample HardwareDebug
New...
Duplicate
Edit...
Delete
Restore Defaults
Apply
Apply and Close
Cancel

- Select [Debugger] tab and Select [Connection Settings] tab and Change “COM Port” to [COMX]. (X is the COM port number connecting your PC and the evaluation board.)

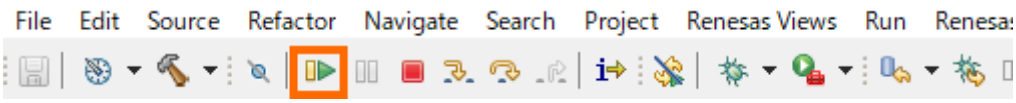


4.4 Execute program.

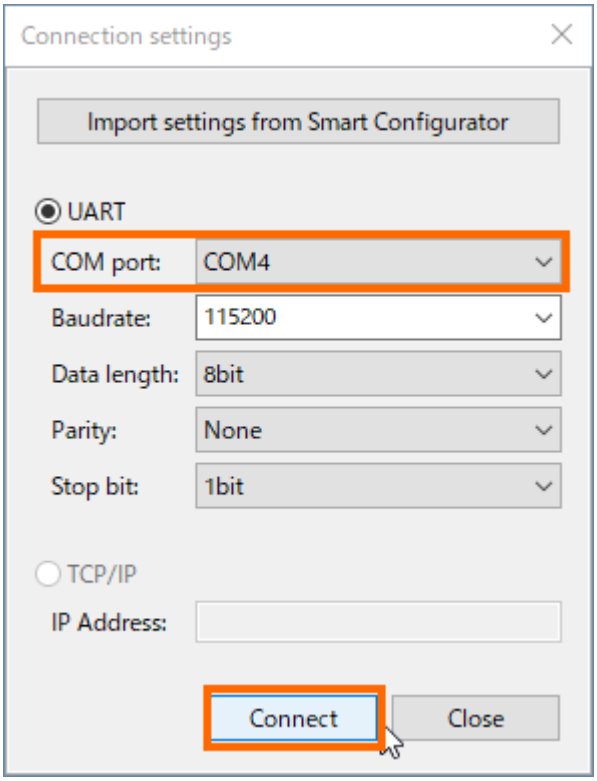
- Right-button click “Project Name” in Project Explorer.
- Select [Debug As]>[Debug Configuration] menu.
- Select [“Project Name” HardwareDebug] tree and push [Debug] button.



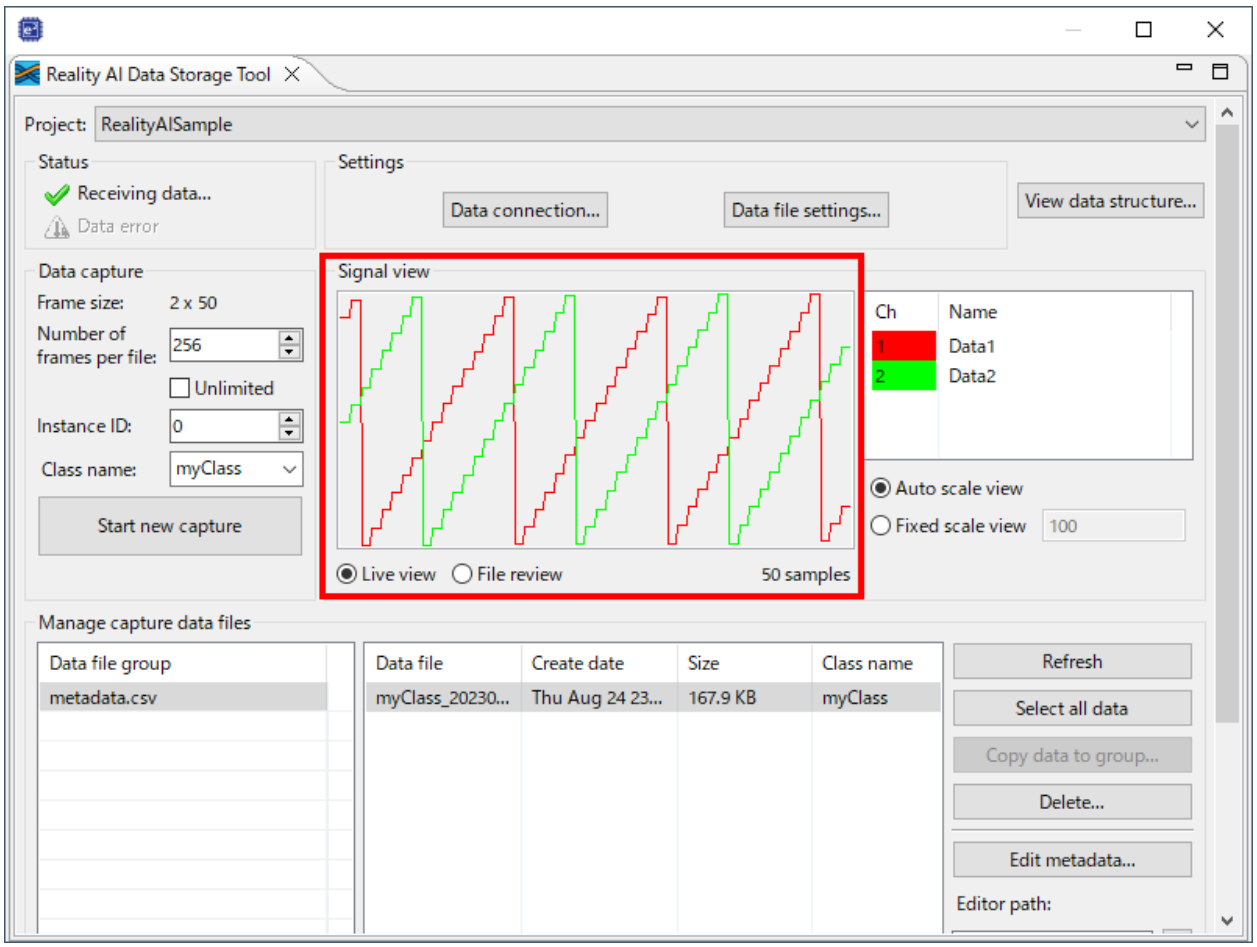
- Push [Resume] icon on toolbar.



4.5 Get sensor data.

- Push [Data connection] button in Reality AI Data Storage Tool.
- Select [COM port] connecting “PMOD (USB-UART) module ” and PC and push [Connect] button.
- 

When sensor data is acquired, a signal appears on the Reality AI Data Storage Tool view. For the operation of Reality AI Data Storage Tool, refer to the help.



Revision History

Rev.	Date	Description	
		Page	Summary
1.0.0	20 Oct, 2023	-	First Release

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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