RX231 Group

Serial Transfer Demo using RX real-time OS Package

R01AN3783ES0100
Rev.1.00
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Introduction

This document describes the procedure to produce the Serial Transfer Demo by using the modules of RX real-time OS Package., and demonstrates the following FreeRTOS features:

- Task Management
- Interrupt Management

Target Device

RX231 (Product number: R5F52318ADFP)

Target Board

Renesas Starter Kit (RSK) for RX231 (product number: R0K505231C010BR)

RX real-time OS Package Used

RX231 real-time OS Package v1.00 (R01ANxxxxEJ)

When using this application note with your product, careful evaluation is recommended.

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

Contents

1. Overview

1.1 Contents of Application Note

This document describes the procedure to perform serial transfer using modules from RX231 real-time OS package.

1.2 Operating Environment

This application note operates in the following environment.

Table 1-1 Operating Environment

Microcontroller	RX231 Group
Evaluation board	Renesas Starter Kit+ RX231 https://www.renesas.com/en-sg/products/software-tools/boards-and-kits/renesas-starter-kits/renesas-starter-kit-for-rx231.html
IDE	e^{2}studio, v5.2.0.020 or later
Toolchain	RX Family C/C++ Compiler Package v2.05.00
Emulator	Renesas E1
RX real-time OS Package	RX231_realtime_OS_pkg v1.00 (R01ANxxxxEJ) **(Note 1)**

Notes: **1**. Operation of this application note has been verified when the modules in the RX real-time OS Package mentioned above is incorporated. If any of the modules used in this application note are replaced with a different module, the user must verify the operation.

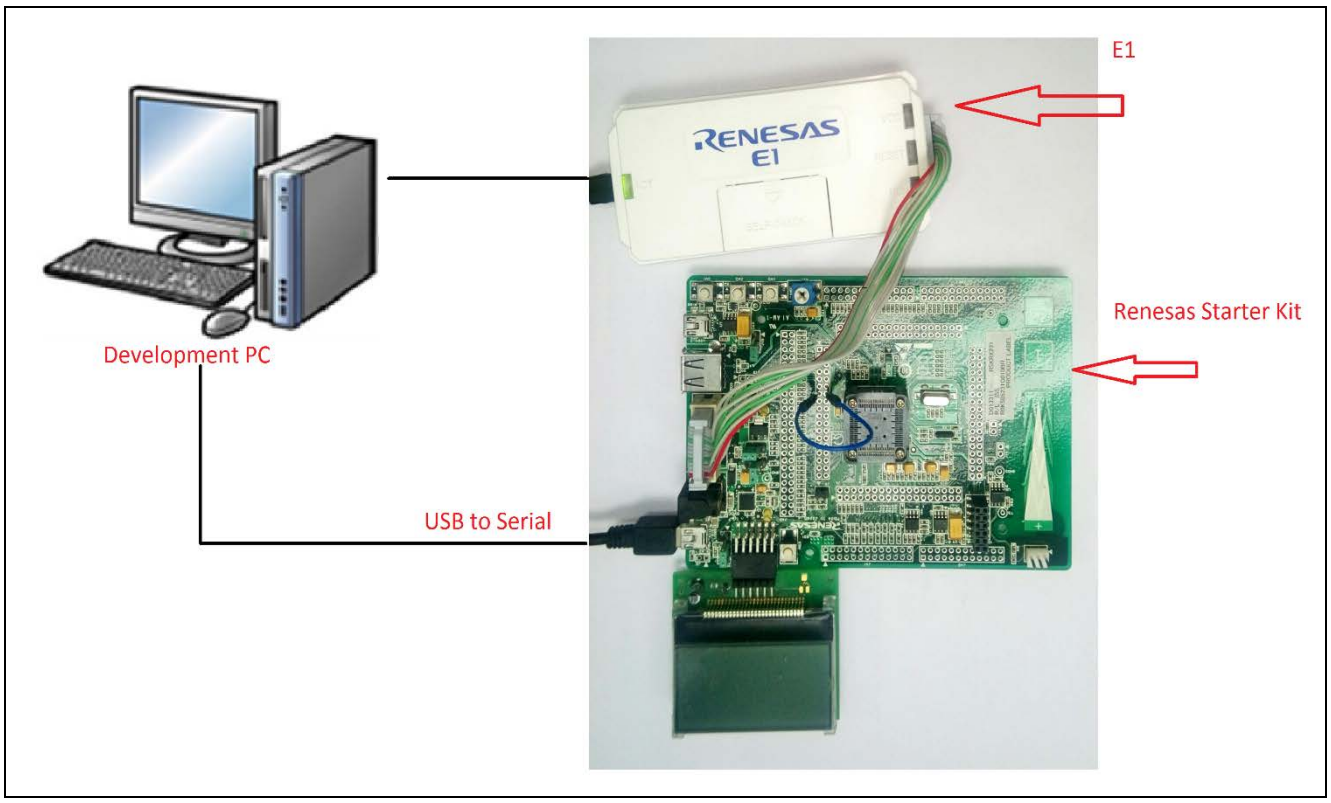

Figure 1-1 Sample Operating Environment

See **4.2** for more information.

1.3 File Structure

This section shows the file structure used in this guideline.

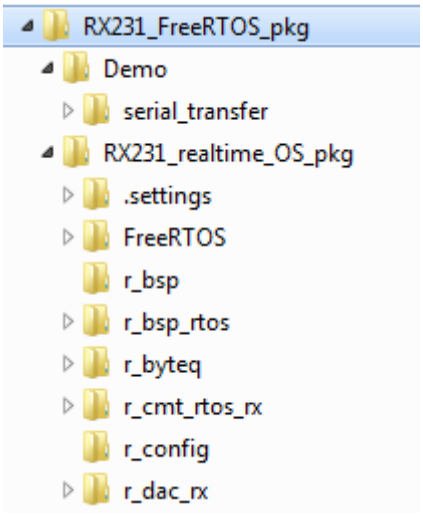

Figure 1-2 File Structure

When the ZIP file provided with this guideline is decompressed, a folder with the same name is created and the various folders and files are created within that folder.

- **Demo/serial_transfer**: the sample workspace (source files for serial transfer + e^{2}studio project files)
- **RX231_realtime_OS_pkg**: store all modules of RX real-time OS Package

To make the completed workspace of serial transfer sample, the required modules must be copied from the RX real-time OS Package to the sample workspace in advance. (See **3.1**)

1.4 Module Structure

This section shows the structure of the modules used by serial transfer sample and a list of those modules.

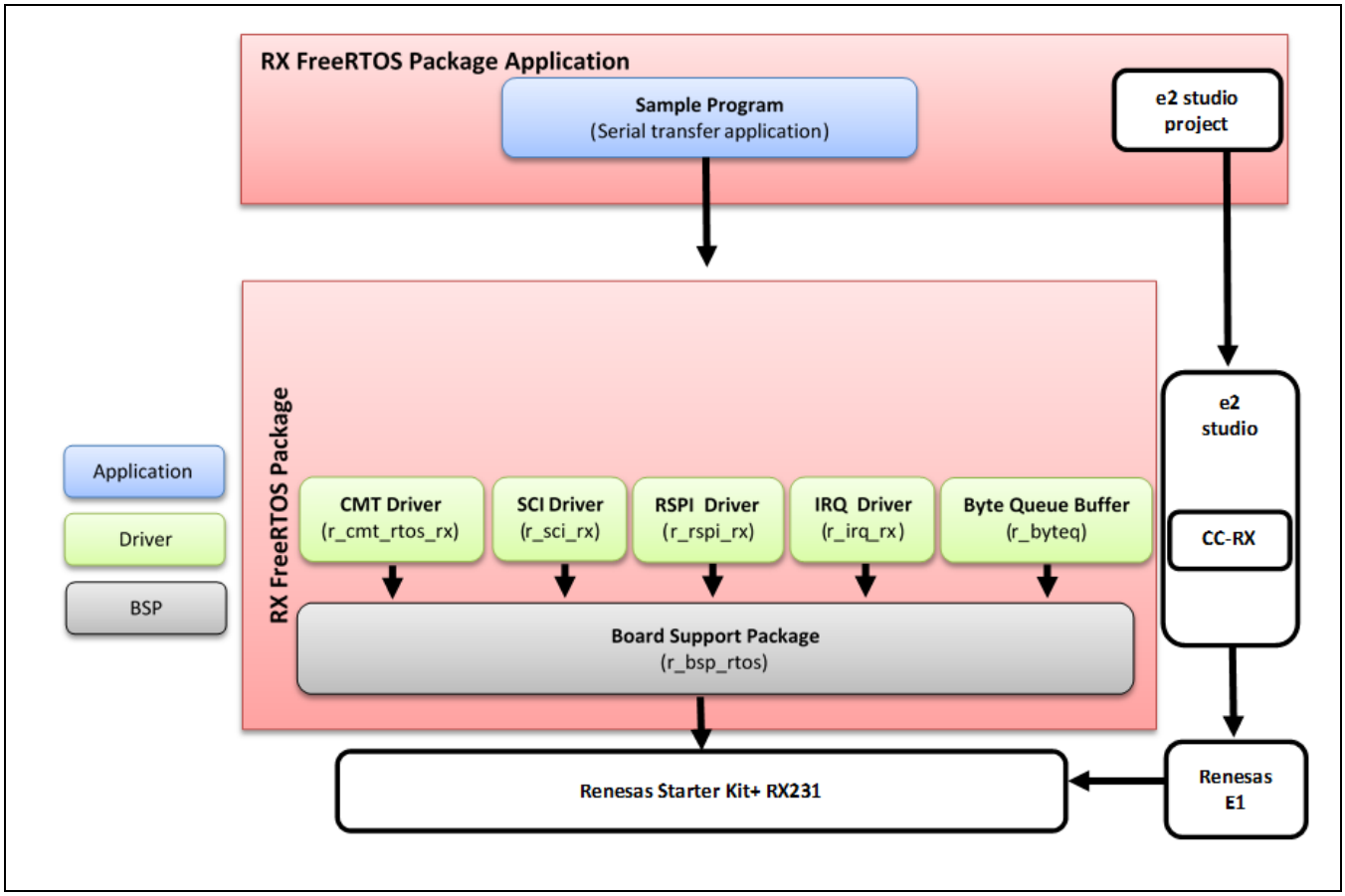

Figure 1-3 Module Structure

Table 1-2 List of modules

Type	Module	Folder name	Version
RTOS	FreeRTOS™	FreeRTOS	9.0.0
BSP	Board Support Package (with FreeRTOS™)	r_bsp_rtos	3.40
Device Driver	Compare Match Timer (with FreeRTOS™)	r_cmt_rtos_rx	3.00
Device Driver	Byte Queue Buffer	r_byteq	1.60
Device Driver	Serial Communications Interface	r_sci_rx	1.80
Device Driver	Serial Peripheral Interface	r_rspi_rx	1.50
Device Driver	Interrupt Controller	r_irq_rx	2.00
Application	Serial Transfer sample	src	1.00

Notes: FreeRTOS is a trademark of Real Time Engineers Ltd.
Please read the FreeRTOS license at: *http://www.freertos.org/a00114.html*

2. Acquiring a Development Environment

2.1 Acquire e2 studio

Access the following URL and download the e^2 studio.

https://www.renesas.com/en-sg/products/software-tools/tools/ide/e2studio.html

This document requires you to use e^2 studio v5.2.0.020 or later. If the version older than v5.2.0.020 is used, some functions of the e^2 studio may not be available. For download, obtain the latest version of the e^2 studio on the website.

2.2 Acquire a Compiler Package

Access the following URL and download the RX Family C/C++ Compiler Package.

https://www.renesas.com/en-sg/products/software-tools/tools/compiler-assembler/compiler-package-for-rx-family.html

This document requires you to use RX Family C/C++ Compiler v2.05.00

3. Creating Serial Transfer Demo on RX real-time OS Package

3.1 Import necessary modules to sample workspace

Open the **serial_transfer** directory and run the **RXFreeRTOSDemo.bat** file

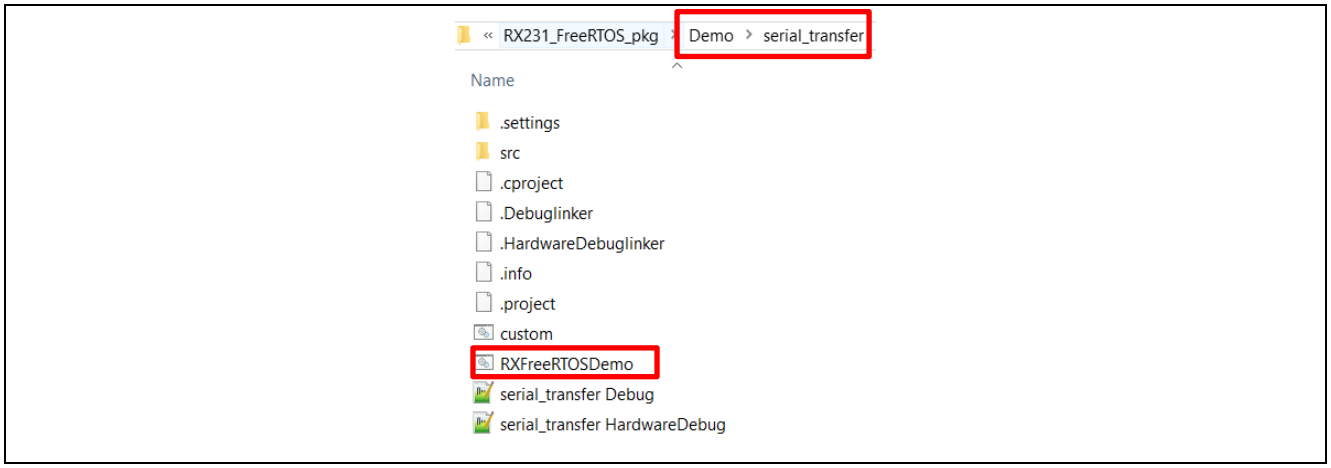

Figure 3-1 Running RXFreeRTOSDemo.bat

The description and usage of this batch file are mentioned inside it (open with notepad to read its code)

```
Prior to import the workspace to e2studio, this file must be executed from
the command line to copy all required modules of RX Driver FreeRTOS
packages to the workspace.

Below is the list of modules will be copied:
1. FreeRTOS
2. r_bsp - Board Support Package (stub directory)
3. r_bsp_rtos - Board Support Package with FreeRTOS
4. r_cmt_rtos_rx - Compare Match Timer with FreeRTOS
5. r_sci_rx - SCI Controller
6. r_rspi_rx - RSPI Controller
7. r_irq_rx - IRQ Controller
8. r_byteq - Functions for using byte queues/circular buffers
9. r_config (copy only necessary files which are used for all modules above)
```

Figure 3-2 Description of RXFreeRTOSDemo.bat

After running is done, all necessary files/folders for the sample application are copied to the workspace and ready to use.

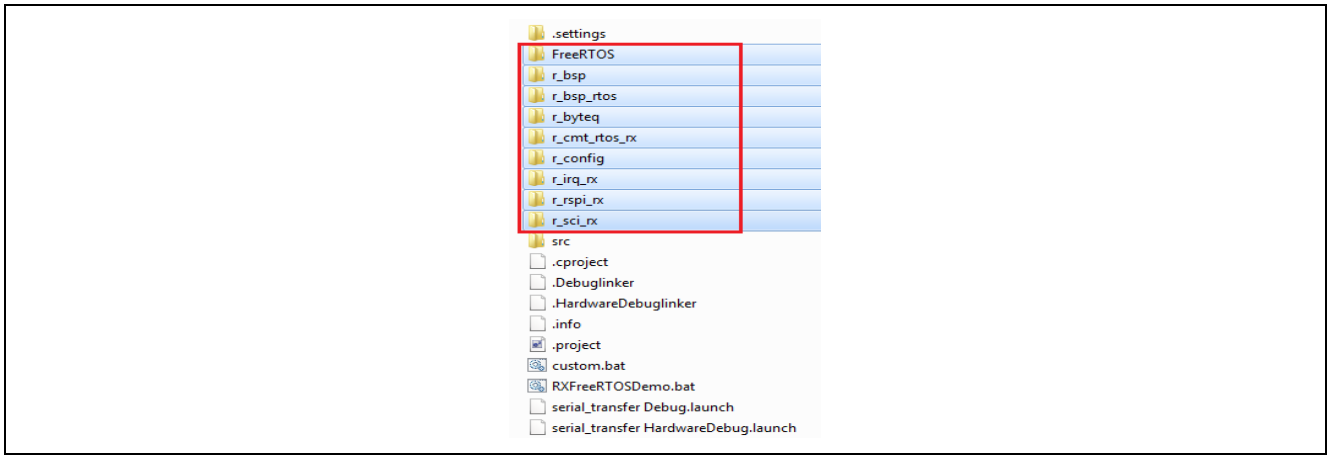

Figure 3-3 File structure after running RXFreeRTOSDemo.bat

3.2 Import workspace to e²studio

This section describes how to import the sample workspace to e²studio.

1. Start the e2studio.
2. Enter an arbitrary workspace folder in the displayed dialog box and click [OK].

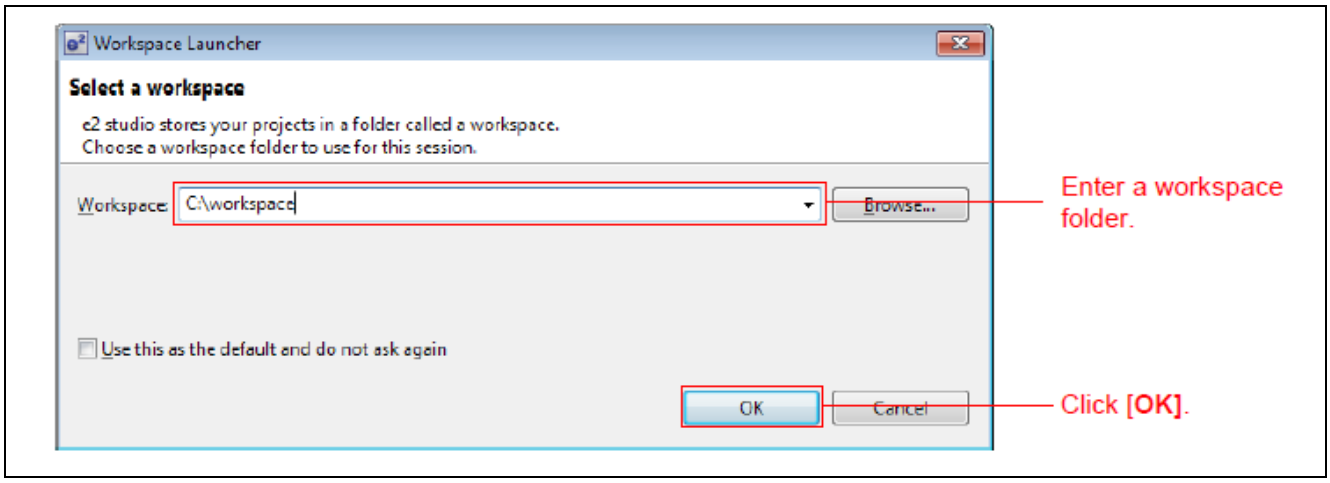

Figure 3-4 Select workspace

3. When the following window is displayed, click [Workbench].

Figure 3-5 Start workbench

4. Click [File]--[Import] to import an existing project.

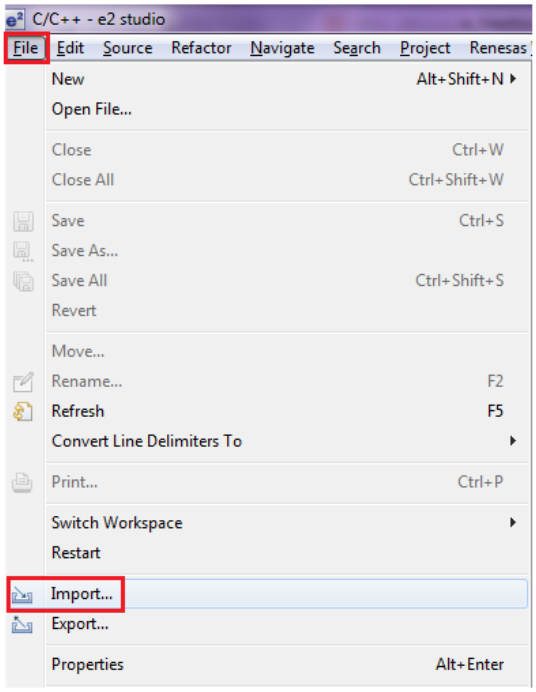

Figure 3-6 Import project

5. In the following window, select [Existing Projects into Workspace], then click [Next].

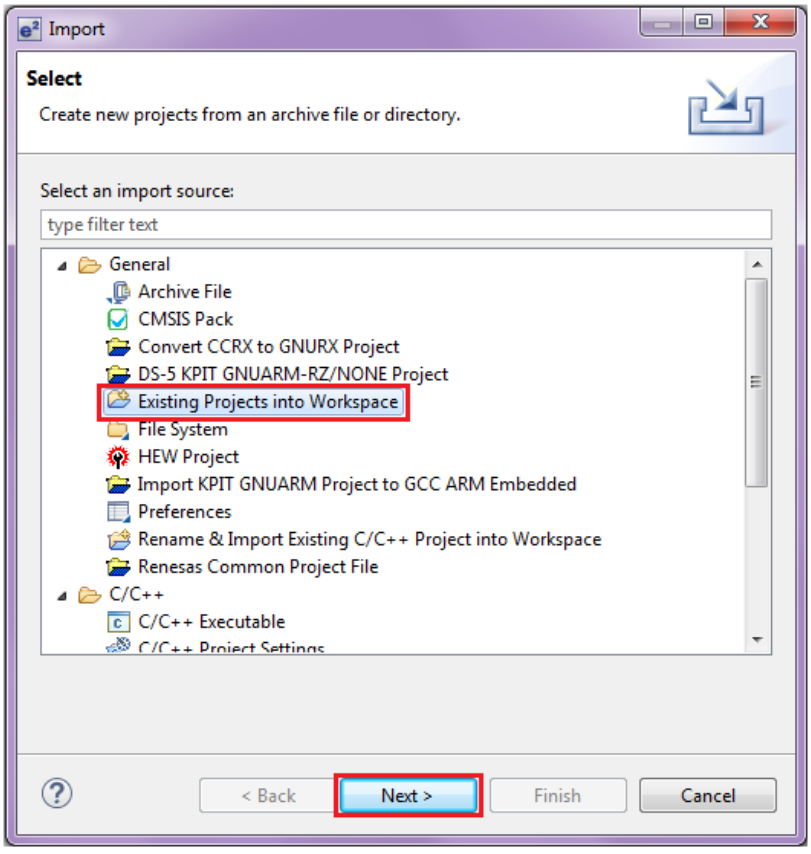

Figure 3-7 Import existing projects into workspace

6. In the next window, choose [Select root directory], then click [Browse…]. When the “Browse For Folder” window appears, select the **./Demo/serial_transfer** folder and click [OK].

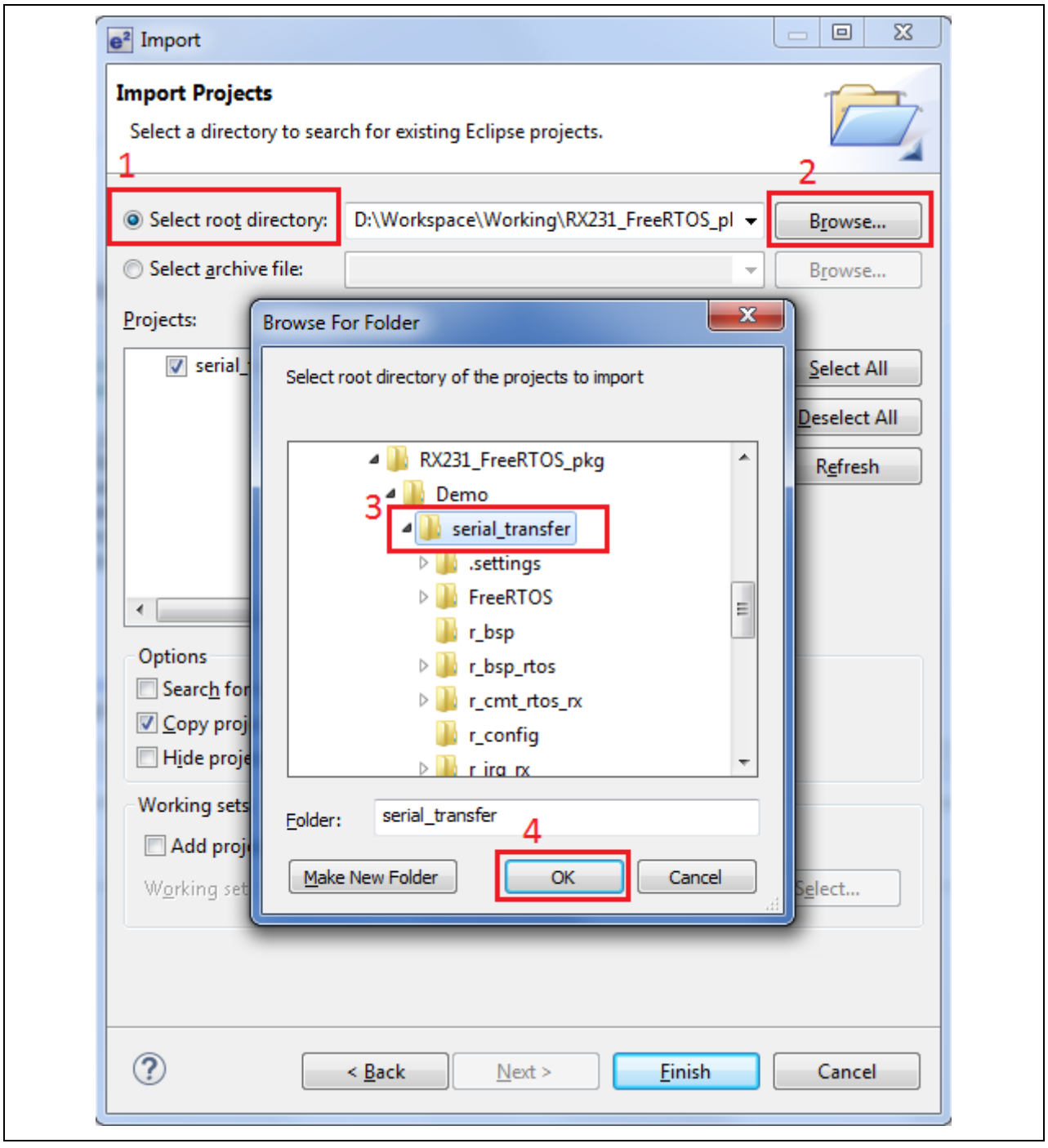

Figure 3-8 Select the serial transfer sample

7. Now, the **serial_transfer** workspace is detected. Click [Finish] to finish the importing.

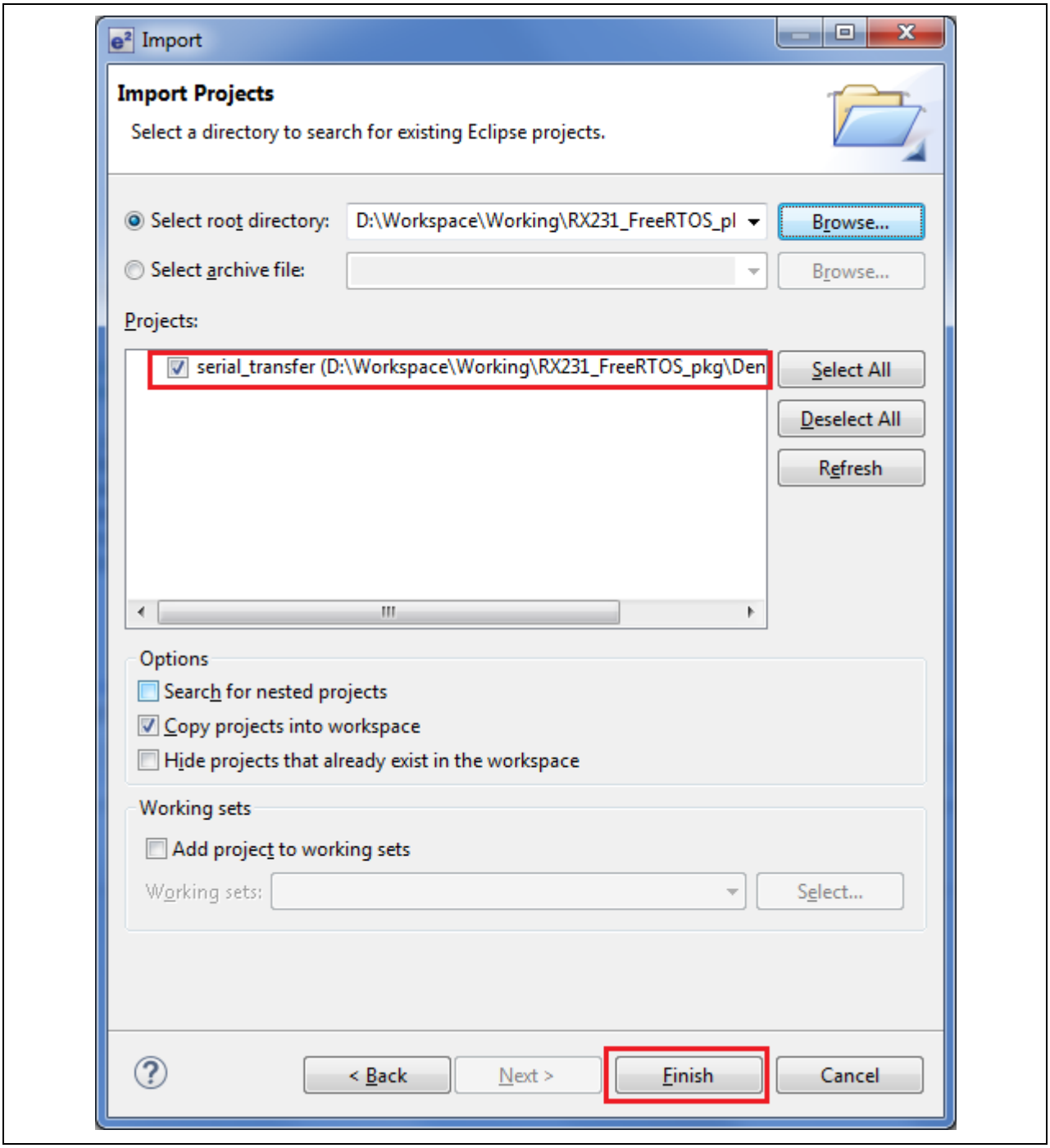

Figure 3-9 Finish importing

8. The project is imported successfully; however, some folders copied in 3.1 (by running the batch file) are currently excluded from build. To include these folders, right-click on them, then click [Exclude from build…].

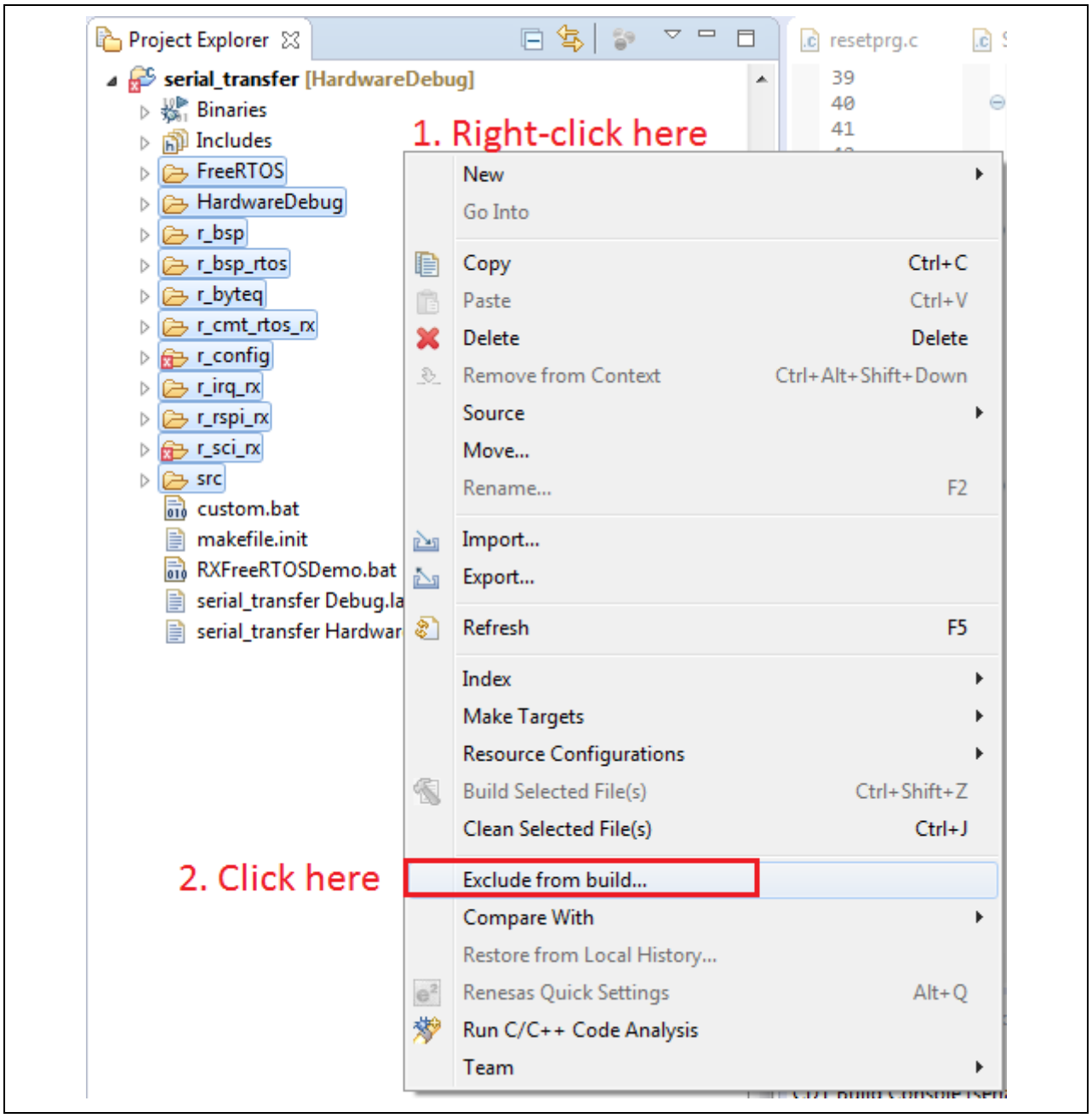

Figure 3-10 Finish importing

9. When the next window appears, click [Deselect All], make sure the [Release] and [HardwareDebug] are unchecked, and then click [OK].

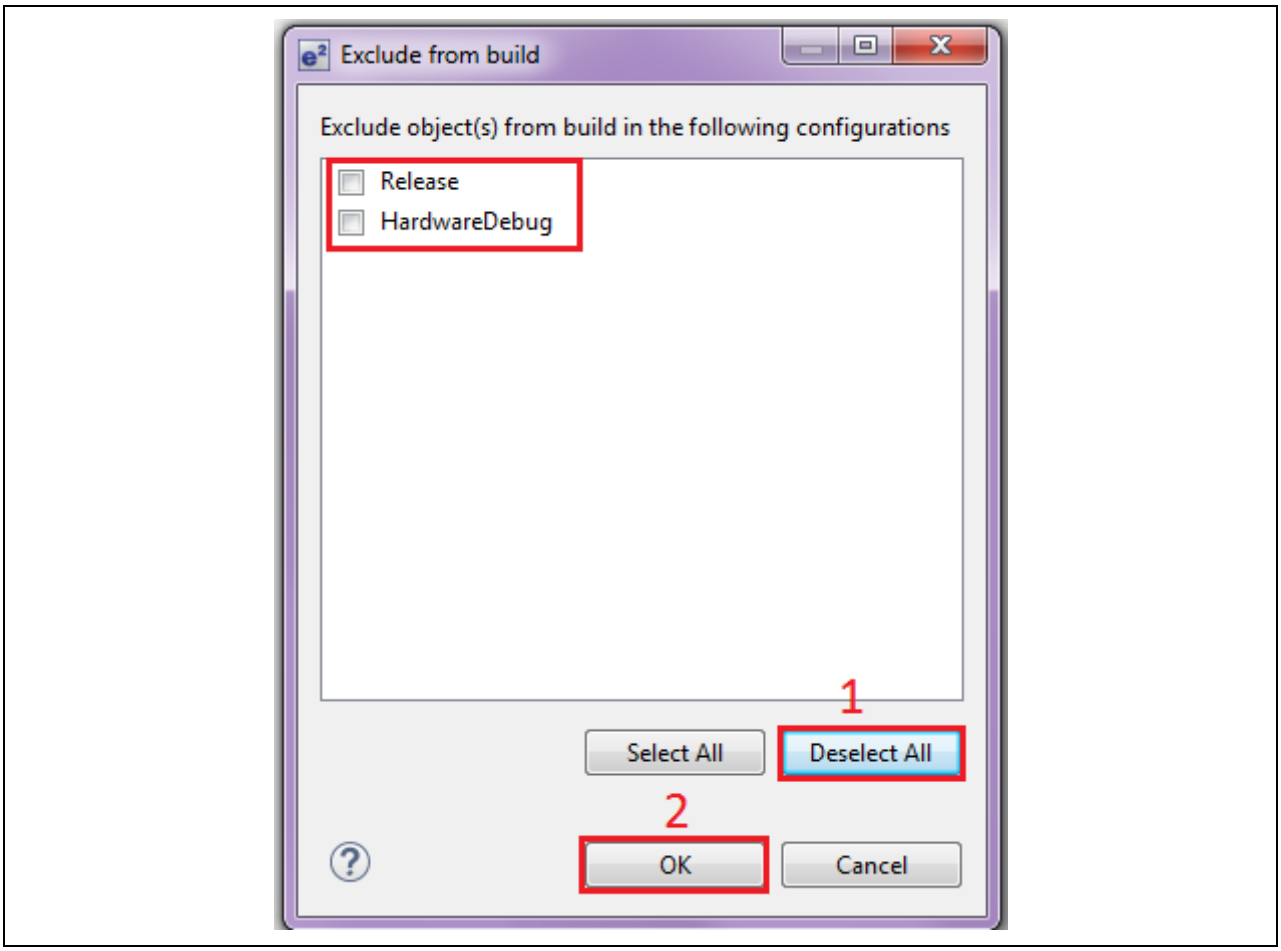

Figure 3-11 Deselect Exclude from Build option

3.3 Modification Configuration

3.3.1 Include paths

This section describes how to add the necessary include paths (the paths to header files and standard libraries) into the project.

1. Right-click on the project, choose [Renesas Tool Settings].

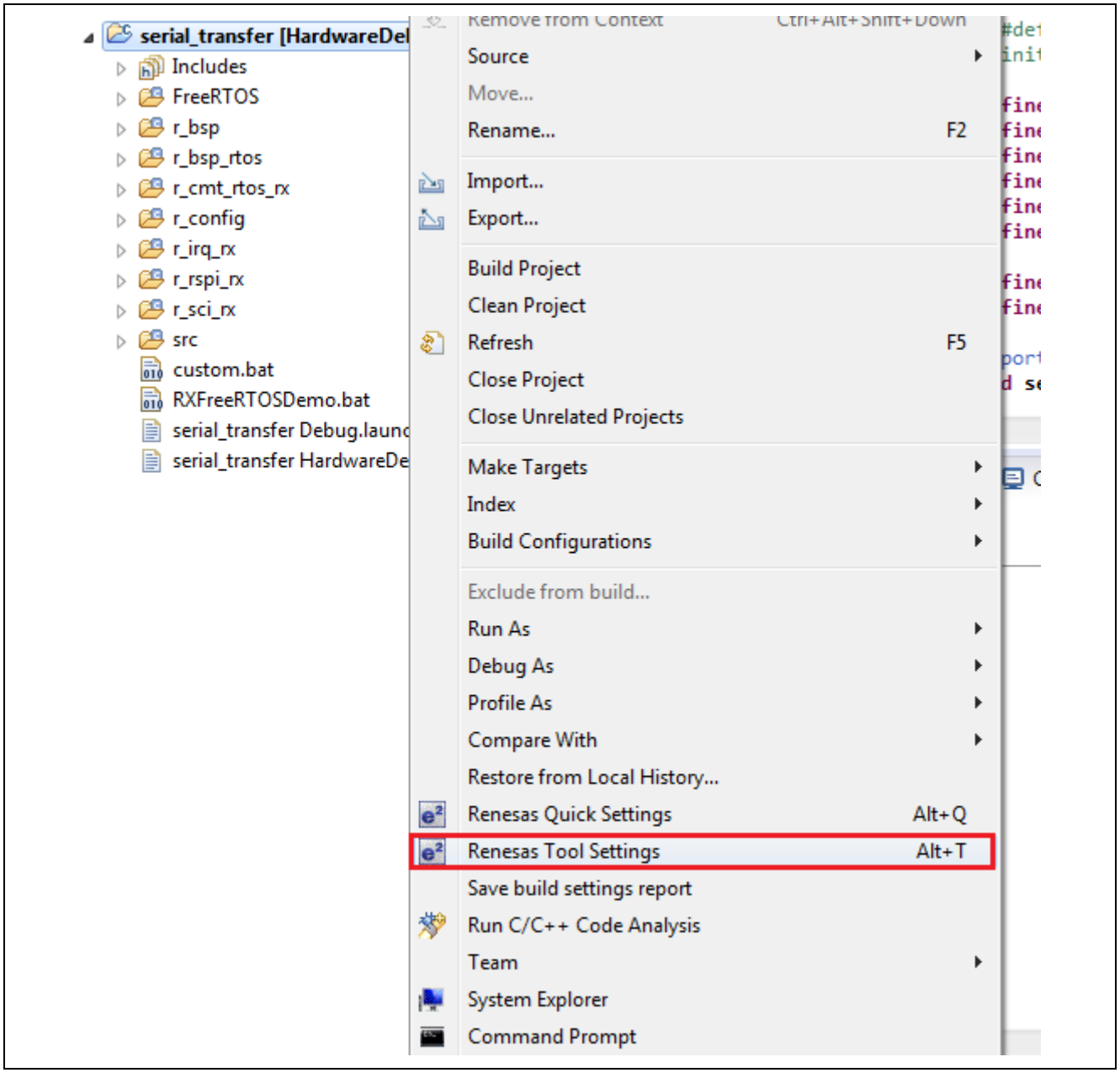

Figure 3-12 Open Renesas Tool Settings

2. In the following window, click [C/C++ Build]--[Settings]--[Tool Settings]--[Compiler]--[Source]--[ ] to include new path to the project.

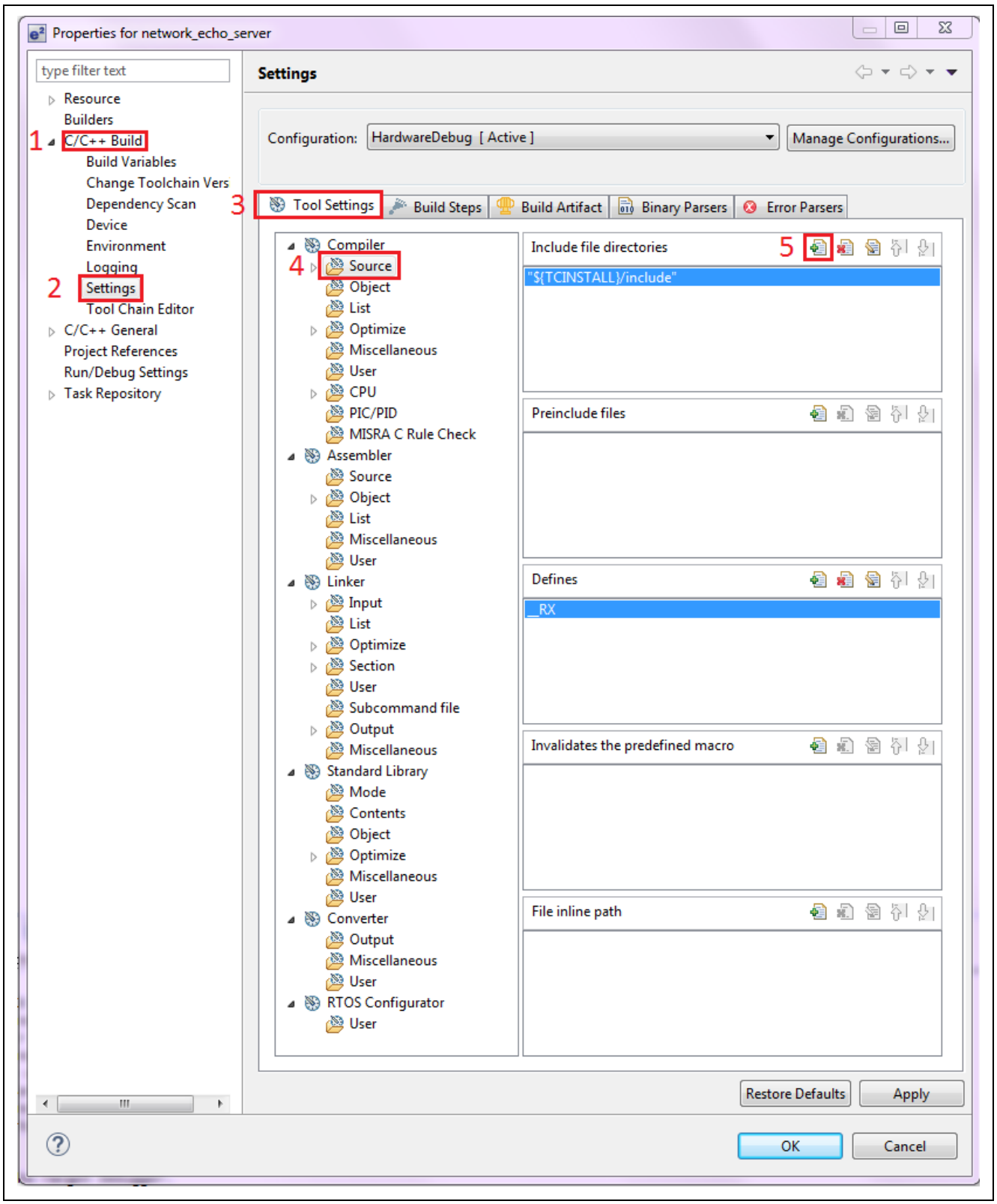

Figure 3-13 Include new path

3. In “Add directory path” window, click [Workspace…]. In “Folder selection” window, select the directory to include, and then click [OK].

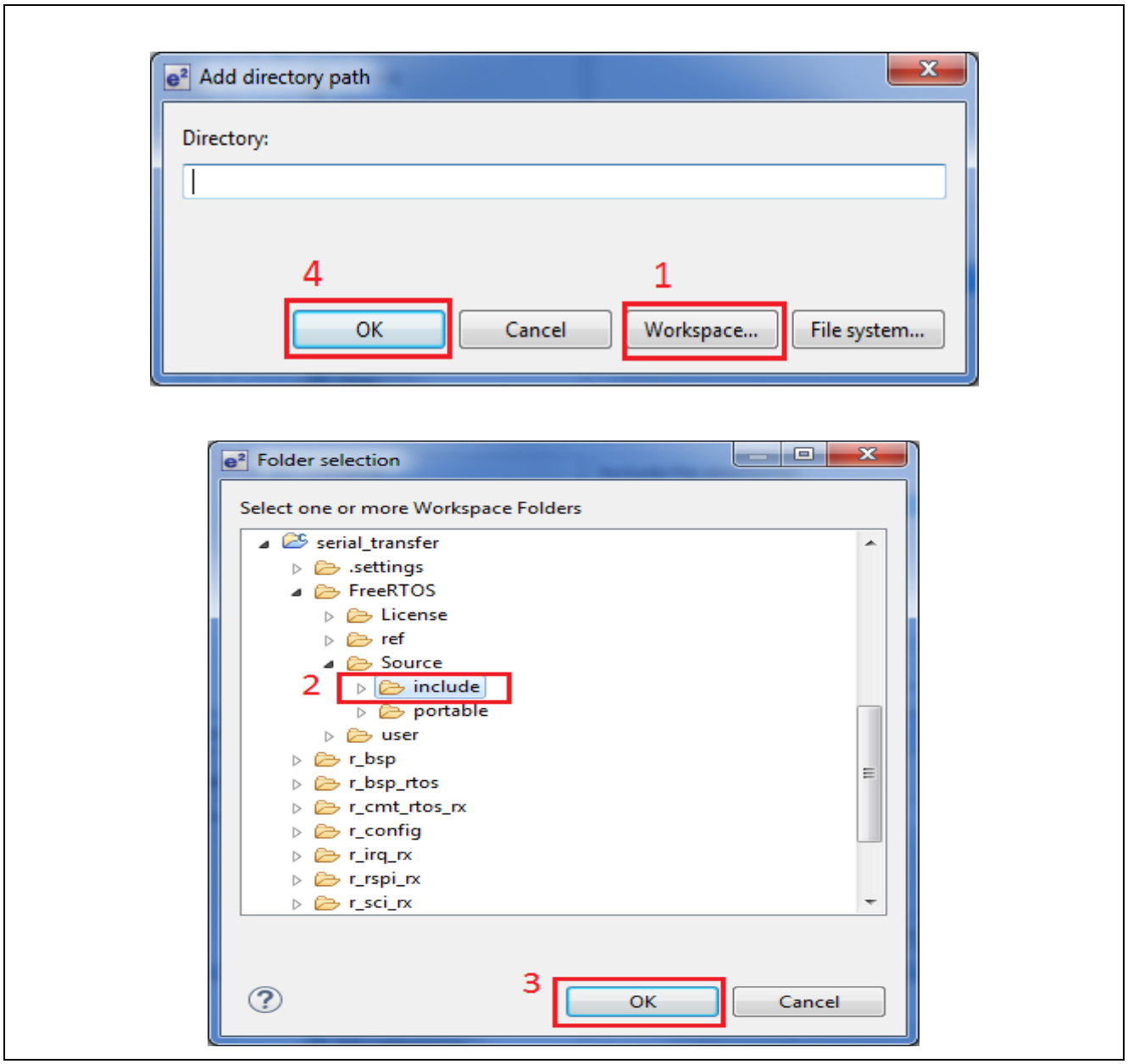

Figure 3-14 Select directory to include

In this application, those folders need to be included into the project:

- FreeRTOS/Source/include
- FreeRTOS/Source/portable/Renesas/RX600v2
- FreeRTOS/user
- r_bsp_rtos
- r_byteq
- r_cmt_rtos_rx
- r_cmt_rtos_rx/src
- r_config
- r_irq_rx
- r_rspi_rx
- r_rspi_rx/src
- r_sci_rx
- r_sci_rx/src
- src

In general, the following paths are required to add for each module:

- r_module/
- r_module/src
- r_module/inc

4. After all necessary folders are included; the result is same with Figure 3-15. Click [Apply] button to make all changes take effect. Then, click [OK].

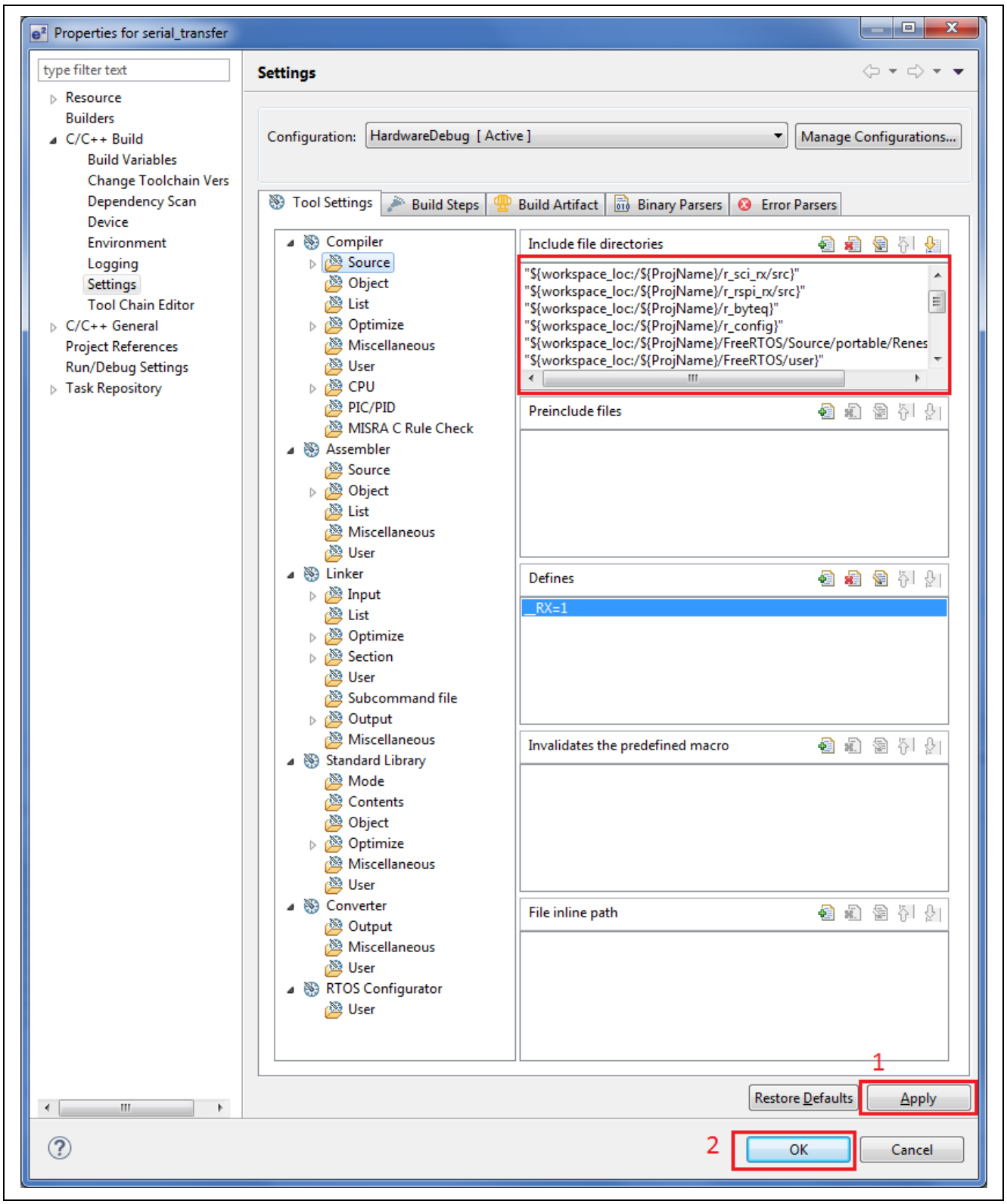

Figure 3-15 Finish including paths

5. In Project Explorer, make sure all necessary folders are included successfully as Figure 3-16.

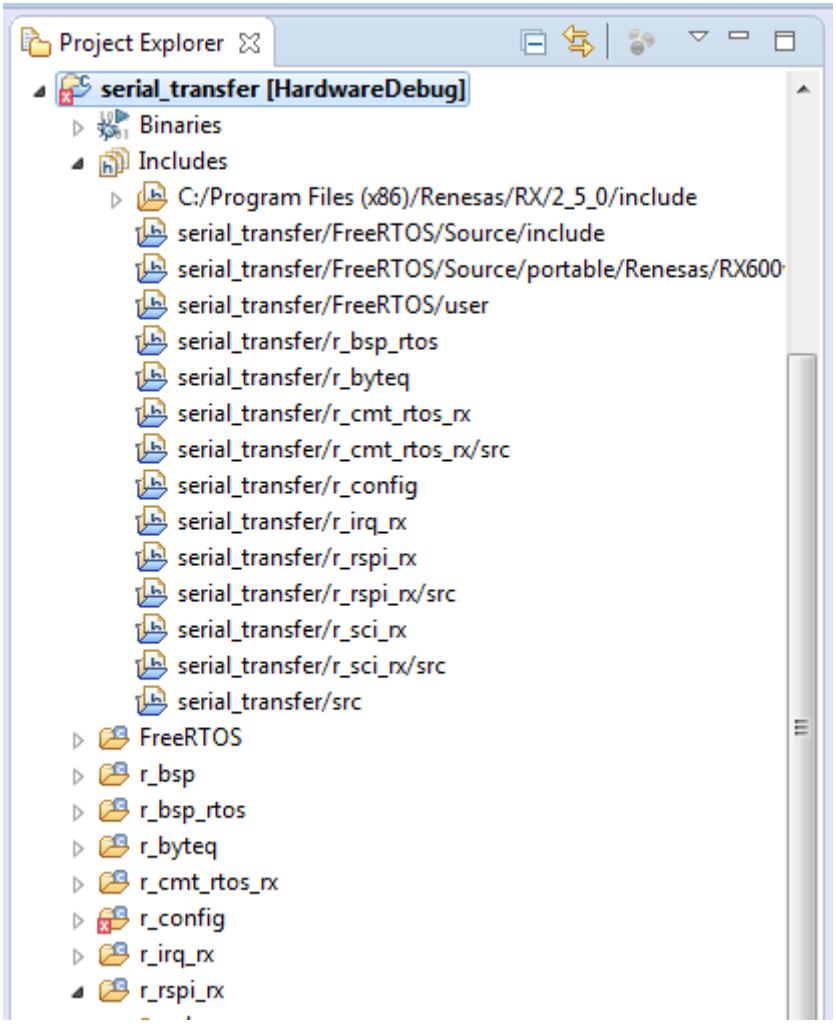

Figure 3-16 Result after including paths

3.4 Modify source code

In **\r_config\r_irq_rx_config.h** do the following modifications:

1. IRQ enabling and port assignments for SW1

```
#define IRQ_CFG_USE_IRQ1    (1)
#if IRQ_CFG_USE_IRQ1 == 1
#define IRQ_PORT_IRQ1     (PORT3)
#define IRQ_PORT_BIT_IRQ1 (IRQ_BIT1)
#endif
```

2. IRQ enabling and port assignments for SW2

```
#define IRQ_CFG_USE_IRQ4    (1)
#if IRQ_CFG_USE_IRQ4 == 1
#define IRQ_PORT_IRQ4     (PORT3)
#define IRQ_PORT_BIT_IRQ4 (IRQ_BIT4)
#endif
```

In **\r_config\ r_sci_rx_config.h** do the following modifications:

1. Enable driver support for channel 5

```
#define SCI_CFG_CH5_INCLUDED    (1)
```

After finish all modifications, the workspace is now completed and ready to build/ debug.

4. Verify Operation

4.1 Build the Serial Transfer Demo on RX real-time OS Package

1. Select the project, and then click [Project]--[Build Project] (or click [ ] in the menu bar)

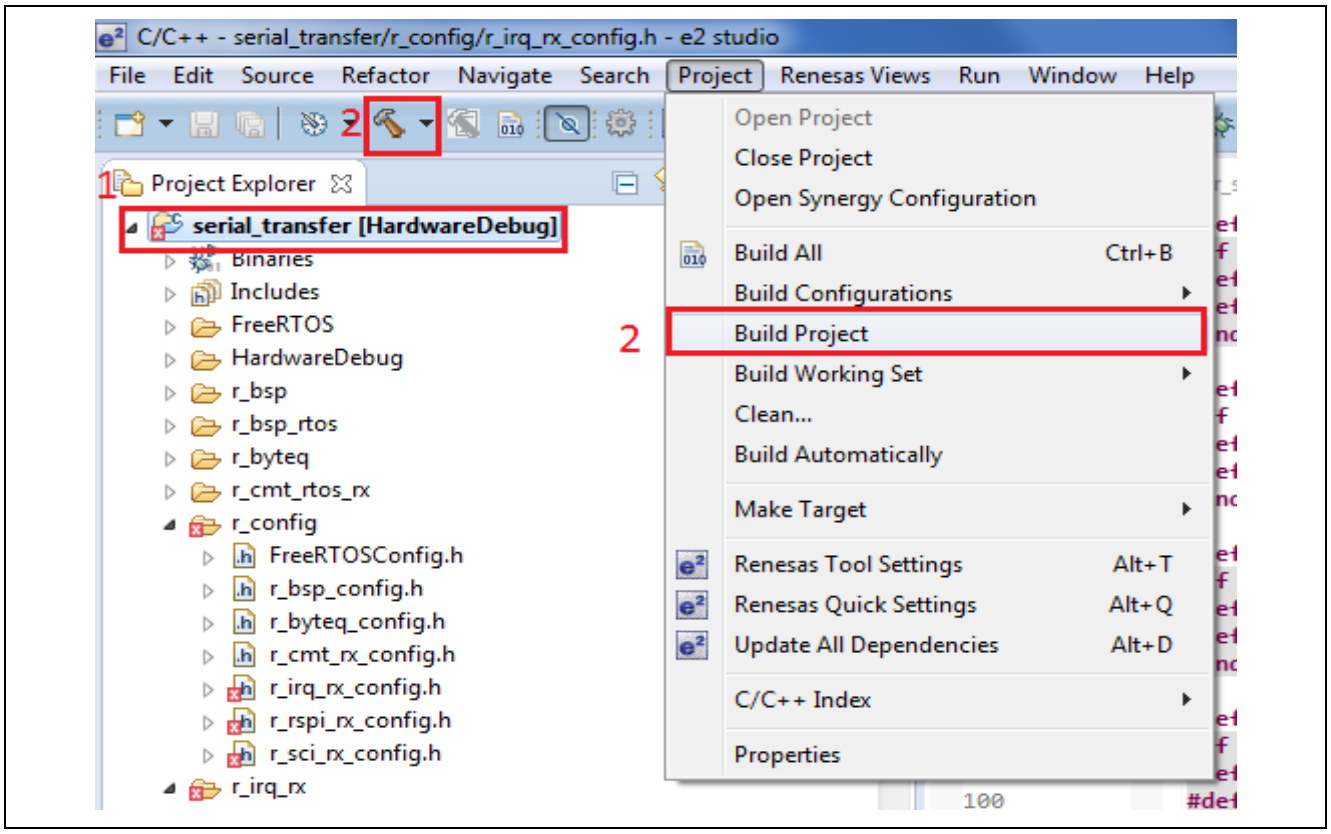

Figure 4-1 Build project

2. Wait until **"Build complete"** is displayed on the **Console panel**, the build will have completed.

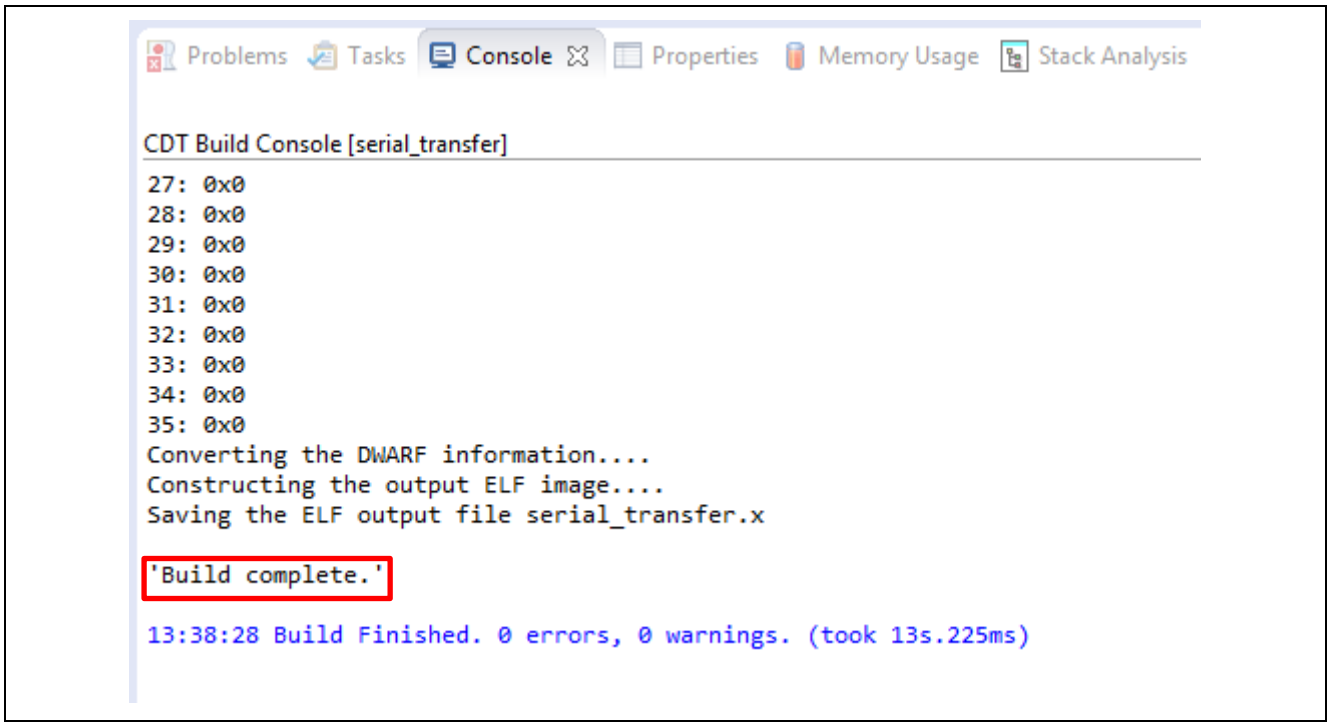

Figure 4-2 Build complete

4.2 Prepare for Debugging

4.2.1 Prepare Environment

The hardware and software requirements are shown in below tables.

Table 4-1 Hardware requirements

No.	Device	Supplementary Information
1	Development PC	PC used to build/download project to board
2	Renesas Starter Kit+ RX231	(See the configuration on 1.2)
3	Renesas E1 Emulator	
4	USB Cable (Type A to mini B)	Connect to USB to Serial port

Table 4-2 Software requirements

No.	Software	Ver.	Homepage	Purpose
1	Tera Term	4.83	ttssh2.osdn.jp/index.html.en	Used for terminal emulation application

The operating environment is set up as below figure.

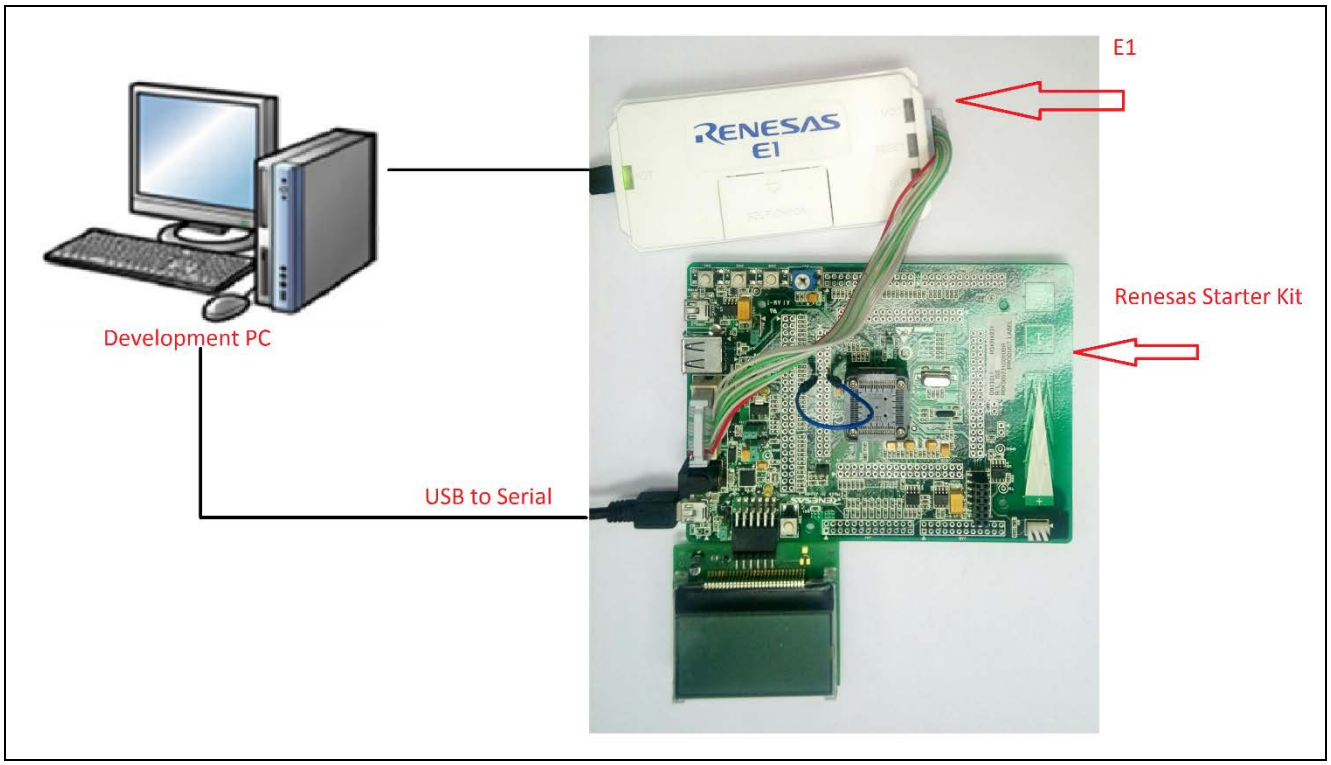

Figure 4-3 Operating Environment

4.2.2 Set Up the Evaluation Board

The setup configuration on RSK+RX231 board to operate this application is shown below:

1. Prepare the board by jumping MOSIA to MISOA depending on the target board (Connect expansion header J3 pin 13 to J3 pin 14).

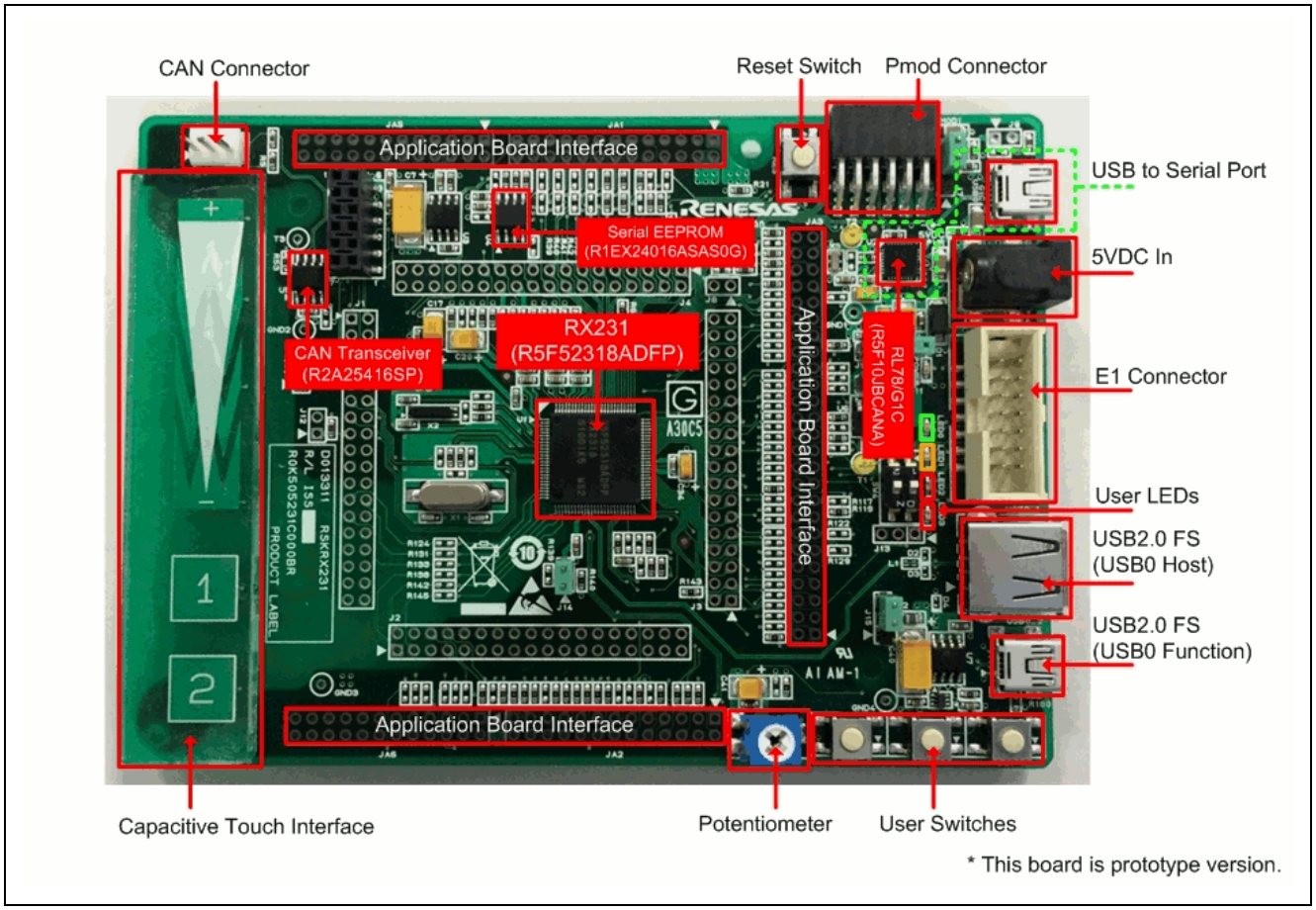

Figure 4-4 RSK+RX231 Board Configuration

4.2.3 Setup PC

For this demo the RSK+RX231 serial to USB Virtual COM Interface is used. A PC running a terminal emulation application, such as "Tera Term", is required for user input and output.

1. Open **Tera term v4.83,** and choose USM to serial port connected to RSK board.

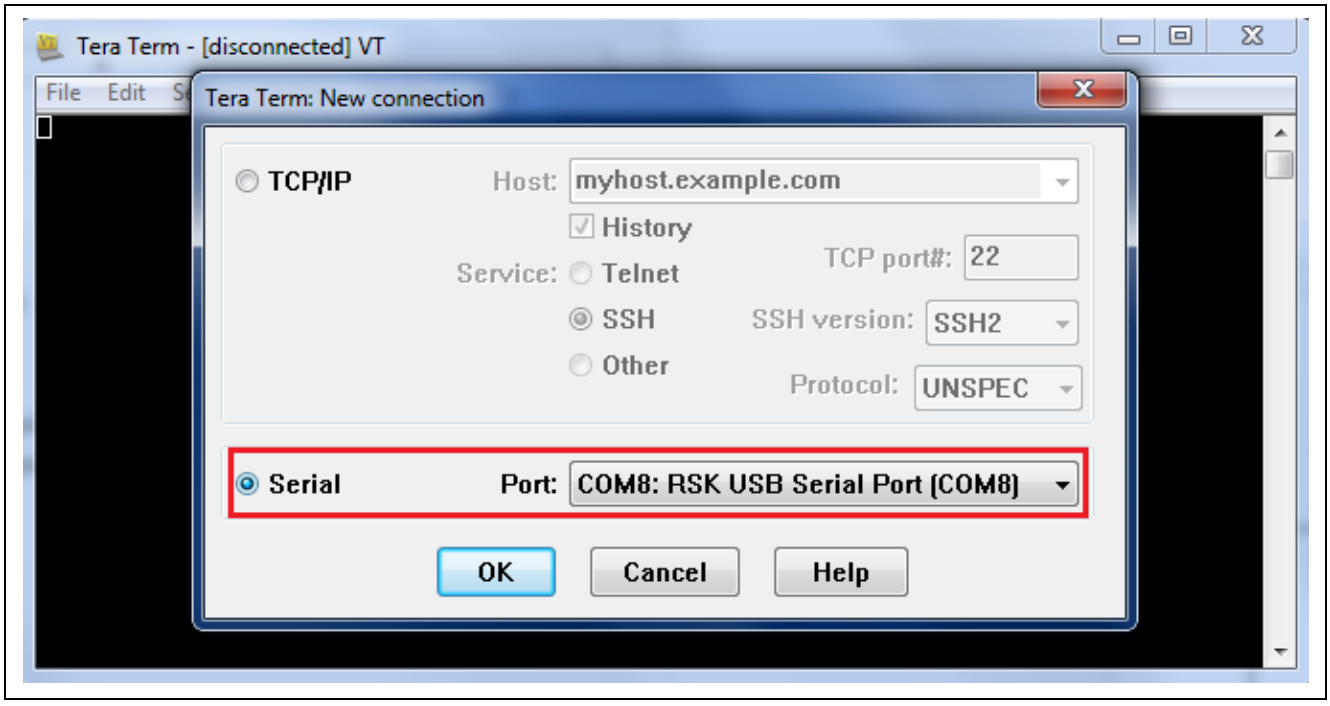

Figure 4-5 Tera Term Serial Port Select

2. Select [Setup]--[Serial port].

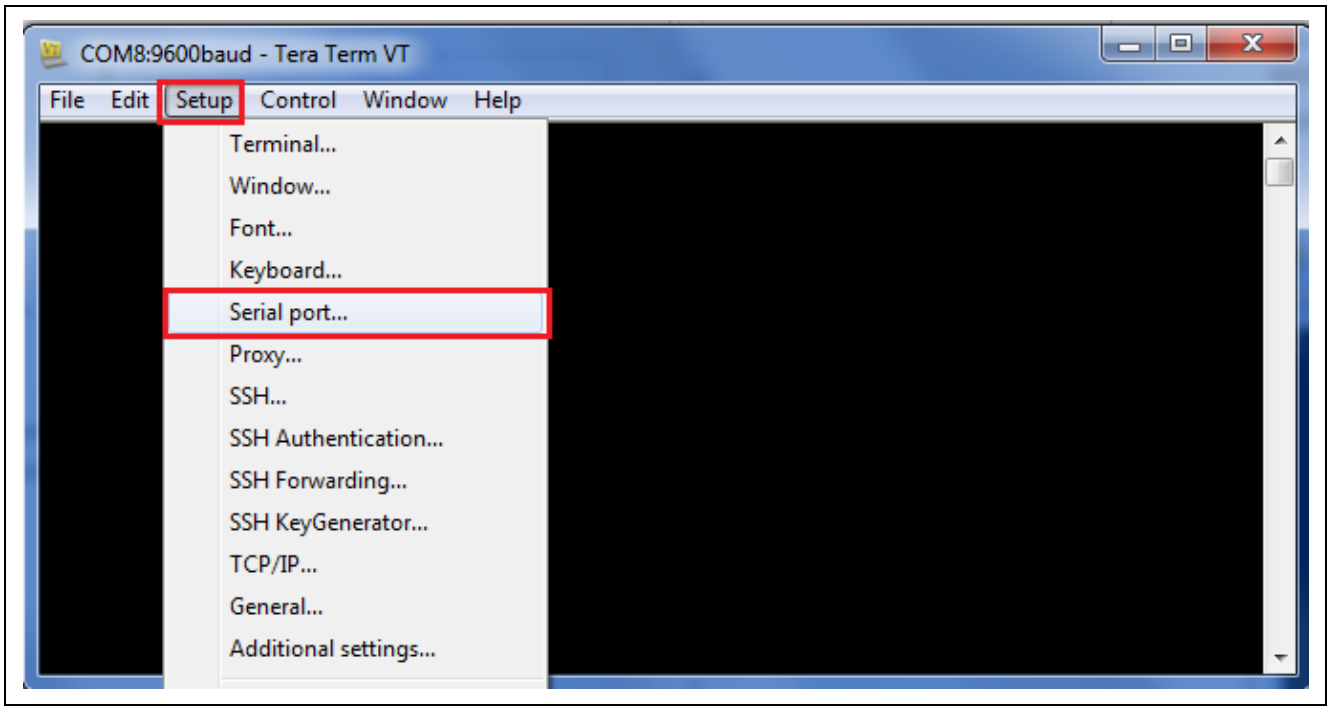

Figure 4-6 Open Serial Port Setting Window

3. Configure the terminal serial settings to match the settings in this sample application:
   - 115 200 baud rate
   - 8 bit data
   - No parity
   - No flow control

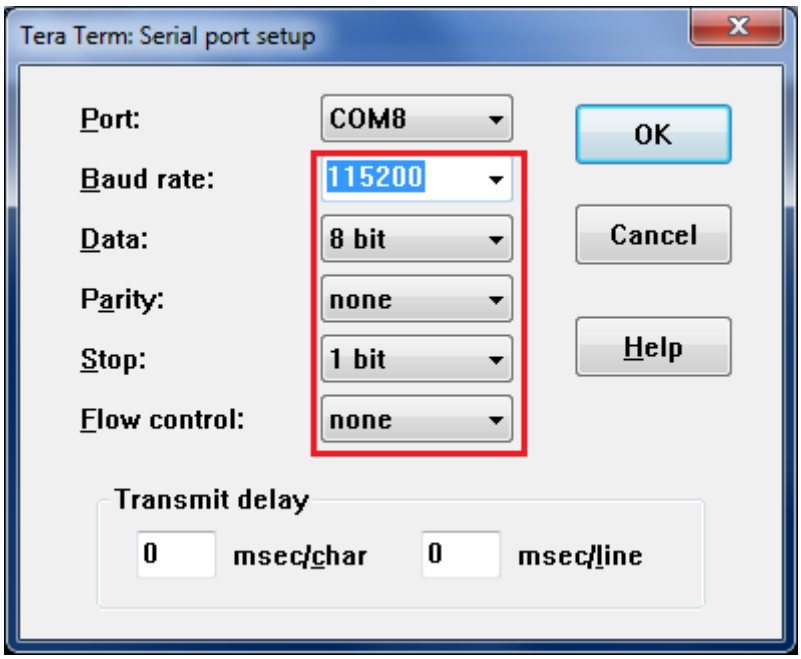

Figure 4-7 Serial Port Settings

4.3 Debug the Project

Use the following procedure to start debugging the project.

1. Connect the development PC to the E1 emulator with a USB cable.
2. Connect the evaluation board to the adapter and turn on the power.
3. Click [Debug Configurations] in the e^2 studio “Run” menu.

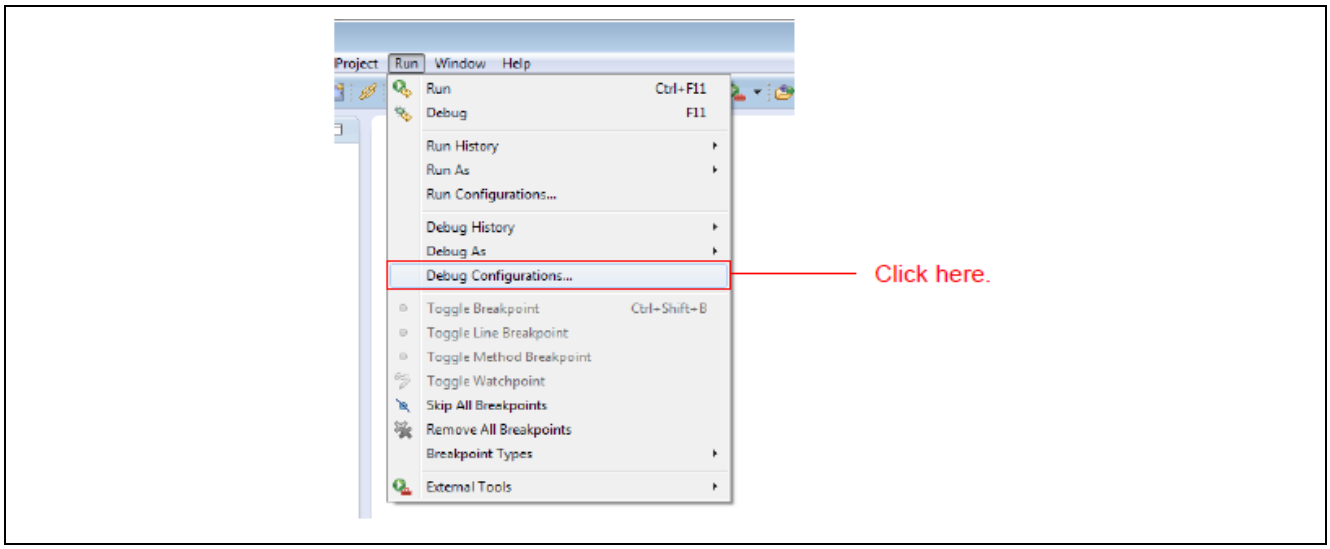

Figure 4-8 Open debug configuration

4. Click in order [Renesas GDB Hardware Debugging]--[serial_transfer HardwareDebug]--[Debugger]--[Connection Setting]. Change [EXTAL frequency] to **8.0000** and [Power target from the emulator] to **No (Note 1)**. Then, click [Apply].

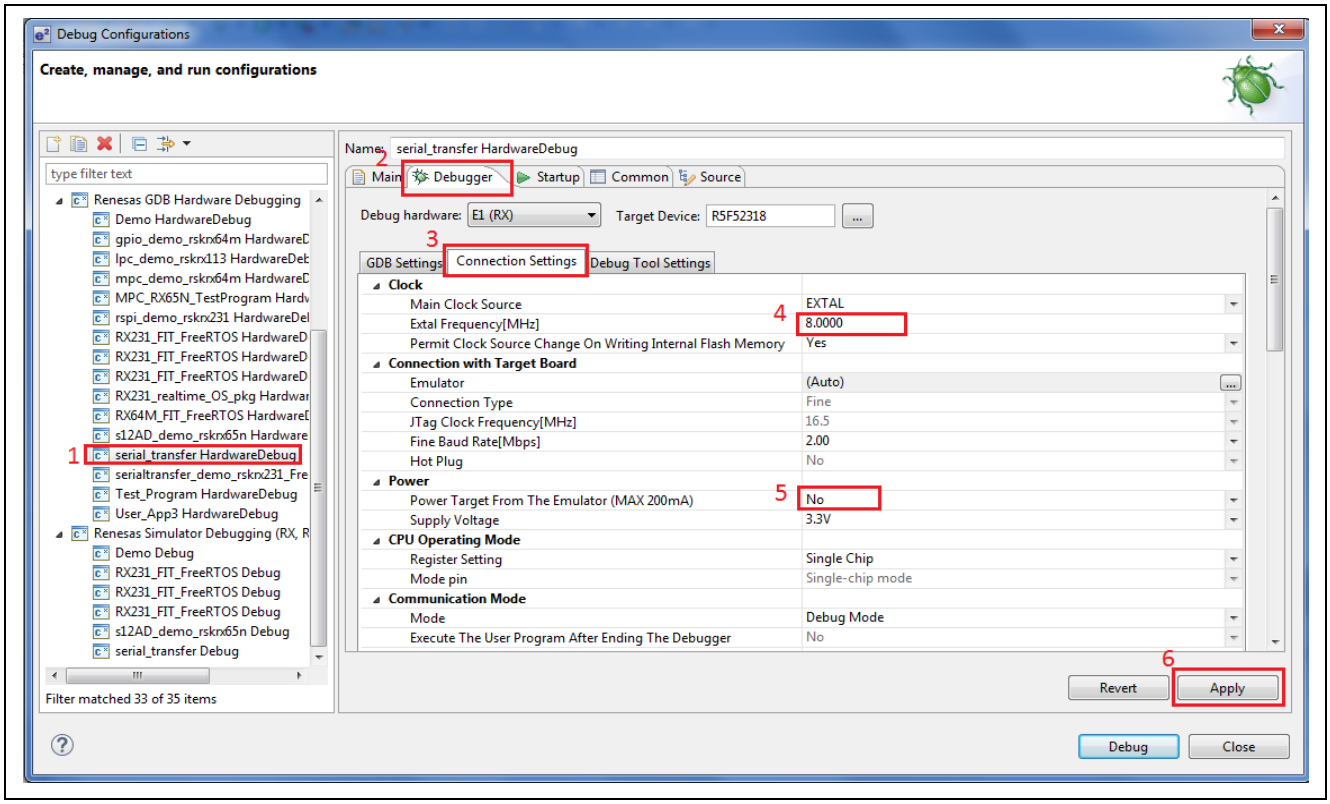

Figure 4-9 Configure Debugger Connection Settings

Note 1: The setting is used in case of using external power supply. Select **Yes** when using power target from the emulator.

5. Click [Startup] and uncheck the option [Set breakpoint at]. Then, click [Apply] and [Debug] to start debugging.

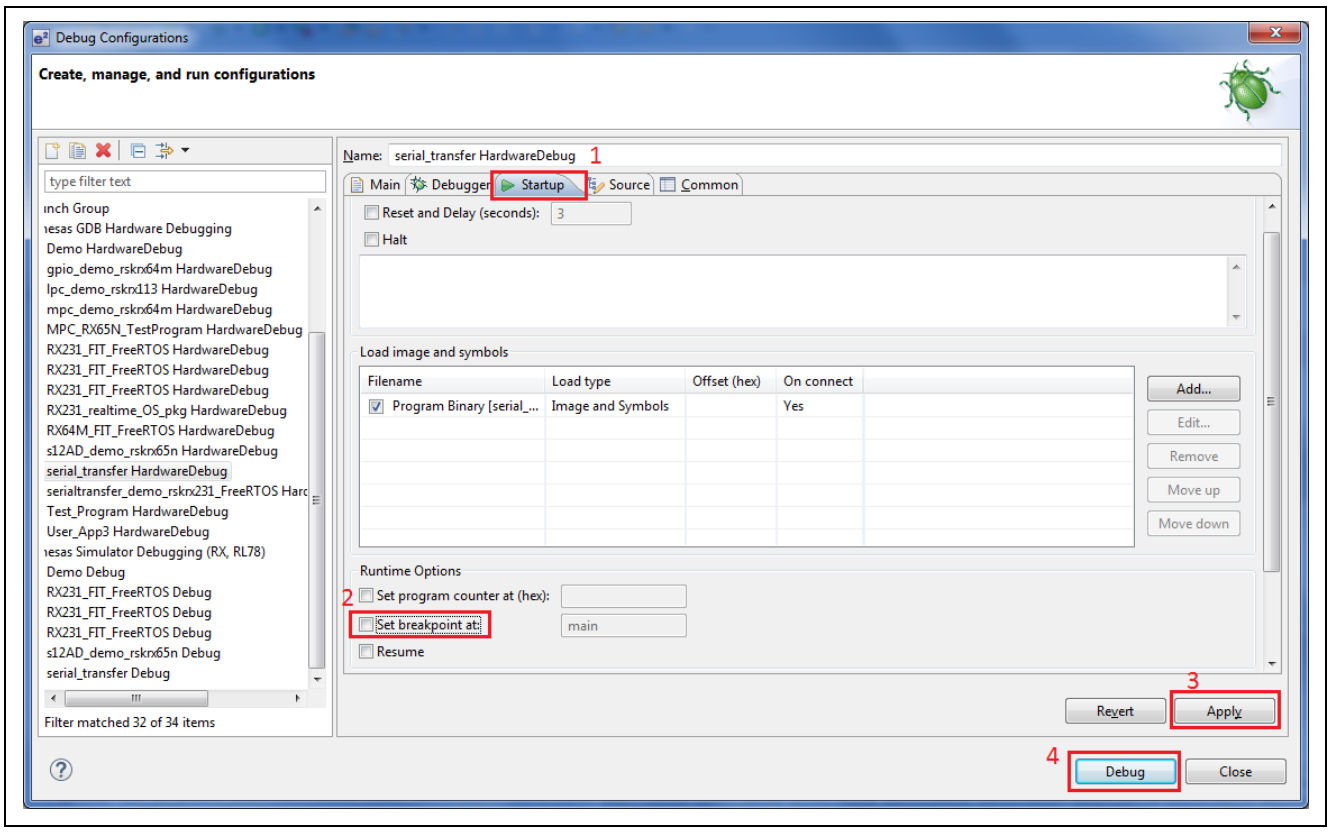

Figure 4-10 Configure Startup and Start Debugging

6. When the load module downloads to board completely, a Debug perspective opens. Click [ ] on the toolbar to run the application.

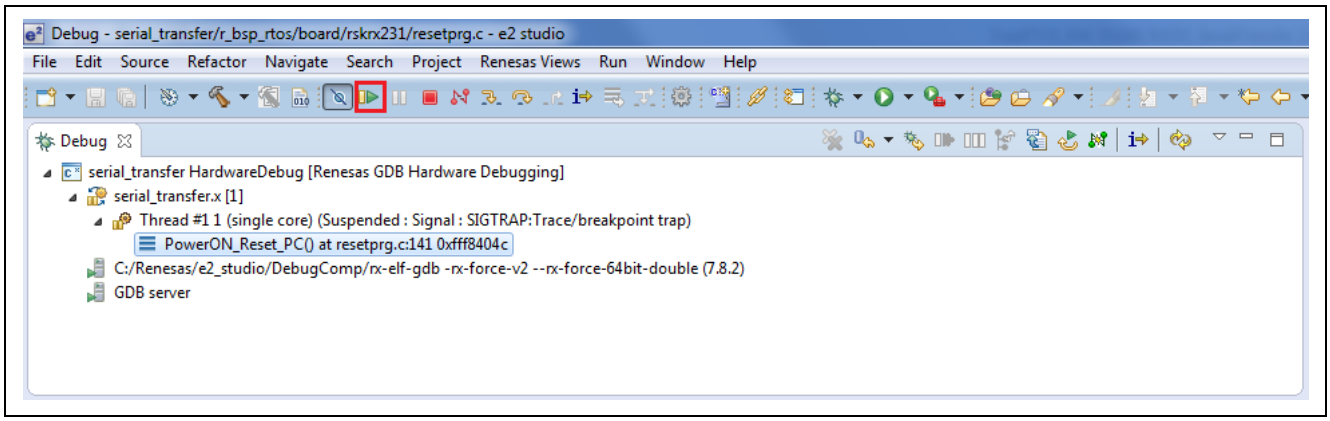

Figure 4-11 Configure Startup and Start Debugging

4.4 Verify Operation of the Serial Transfer

4.4.1 Output String of SCI Version (Task #1)

1. Upon debugging, the device will perform task #1 which is to output the information string of SCI version using SCI driver to PC. The output will be displayed in Tera Term (normal priority).

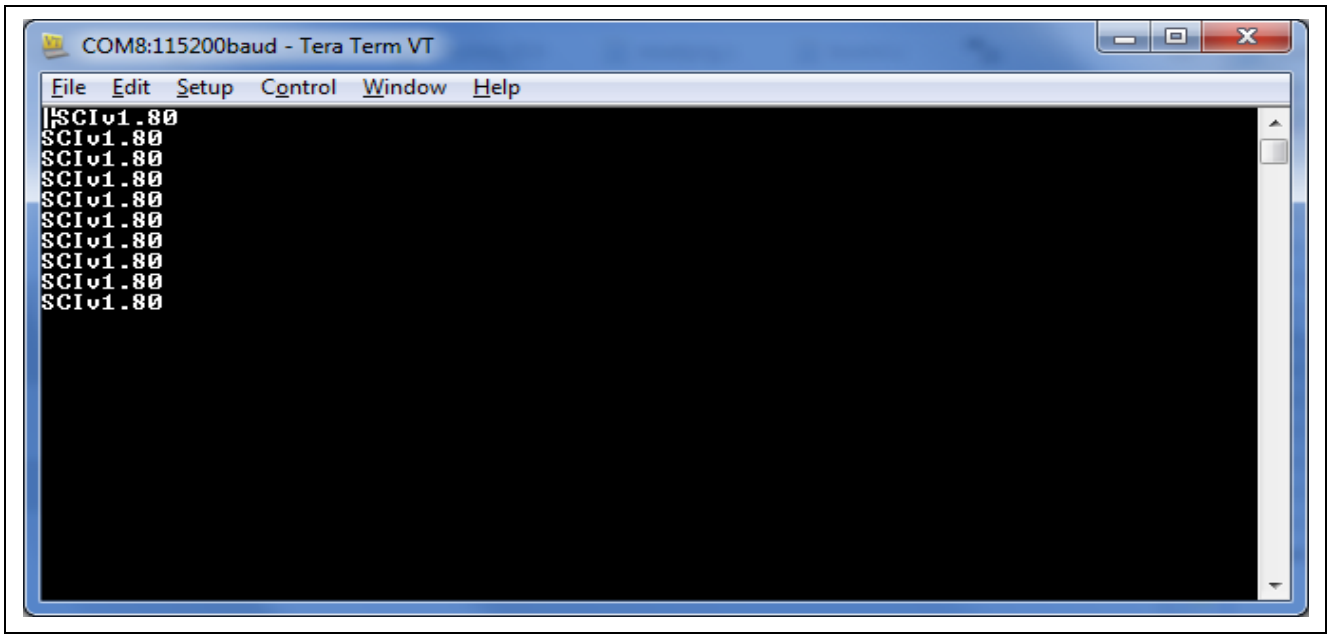

Figure 4-12 Task #1

4.4.2 Output String of RSPI Version (Task #2)

1. Press SW1 in order to activate Task #2 which is to perform task#1 as well as output the information string of RSPI version using SCI driver. The output will be displayed in Tera Term (normal priority).
2. Task #2 can be confirmed with LED1 ON.
3. LED3 will turn ON when jumping MOSIA to MISOA to connect expansion header J3 pin 13 to J3 pin 14.

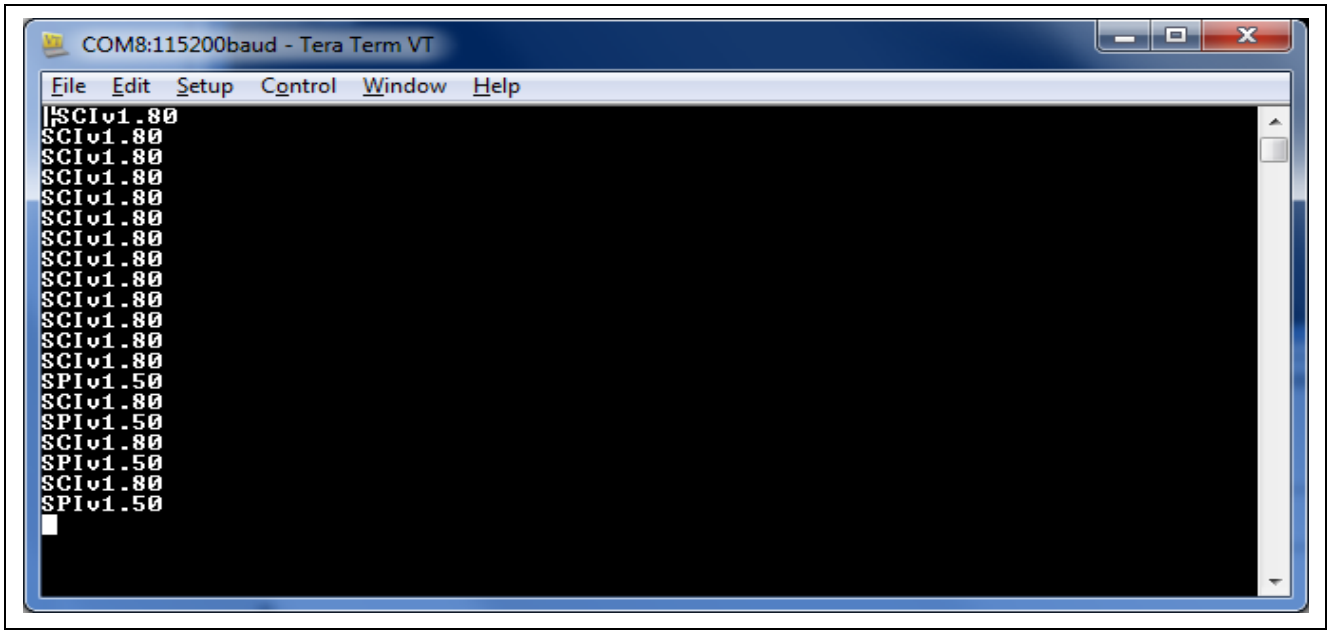

Figure 4-13 Task #2

4.4.3 Retransmission of Character Back to Terminal (Task #3)

1. Press SW2 to switch to Task #3 with higher priority.
2. Any key type on the terminal will be received by the SCI driver, and then this application will retransmit the character back to the terminal. Example: input string “Hello”.
3. Task #3 can be confirmed with LED2 ON.

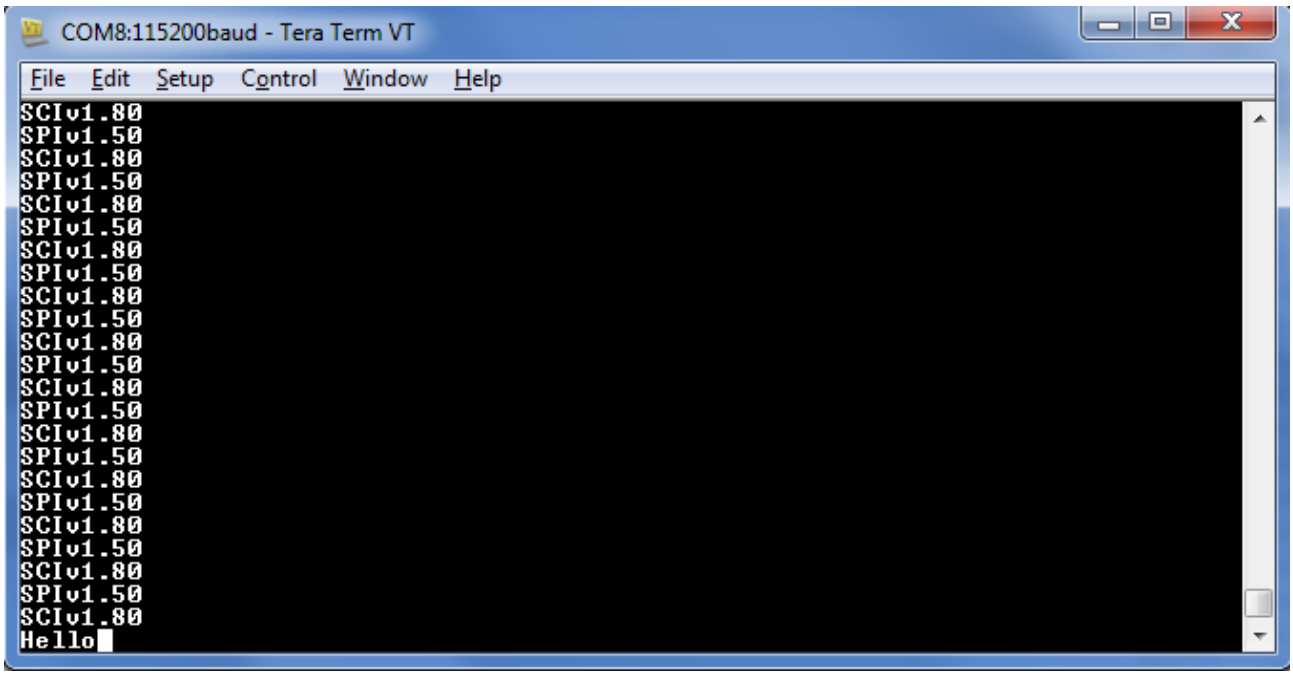

Figure 4-14 Task #3

4.5 Renesas Debug Virtual Console

Renesas Debug Virtual Console function of RX MCUs can input and output arbitrary characters by utilizing the standard I/O functions (printf/scanf) via the on-chip emulator. In this demo, the Renesas debug virtual console is utilized to display which task is currently running. The following steps show the method to open Renesas Debug Virtual Console:

1. On the Debug Perspective, click on [Open Console].
2. Select the Renesas Debug Virtual Console to view which task is running.

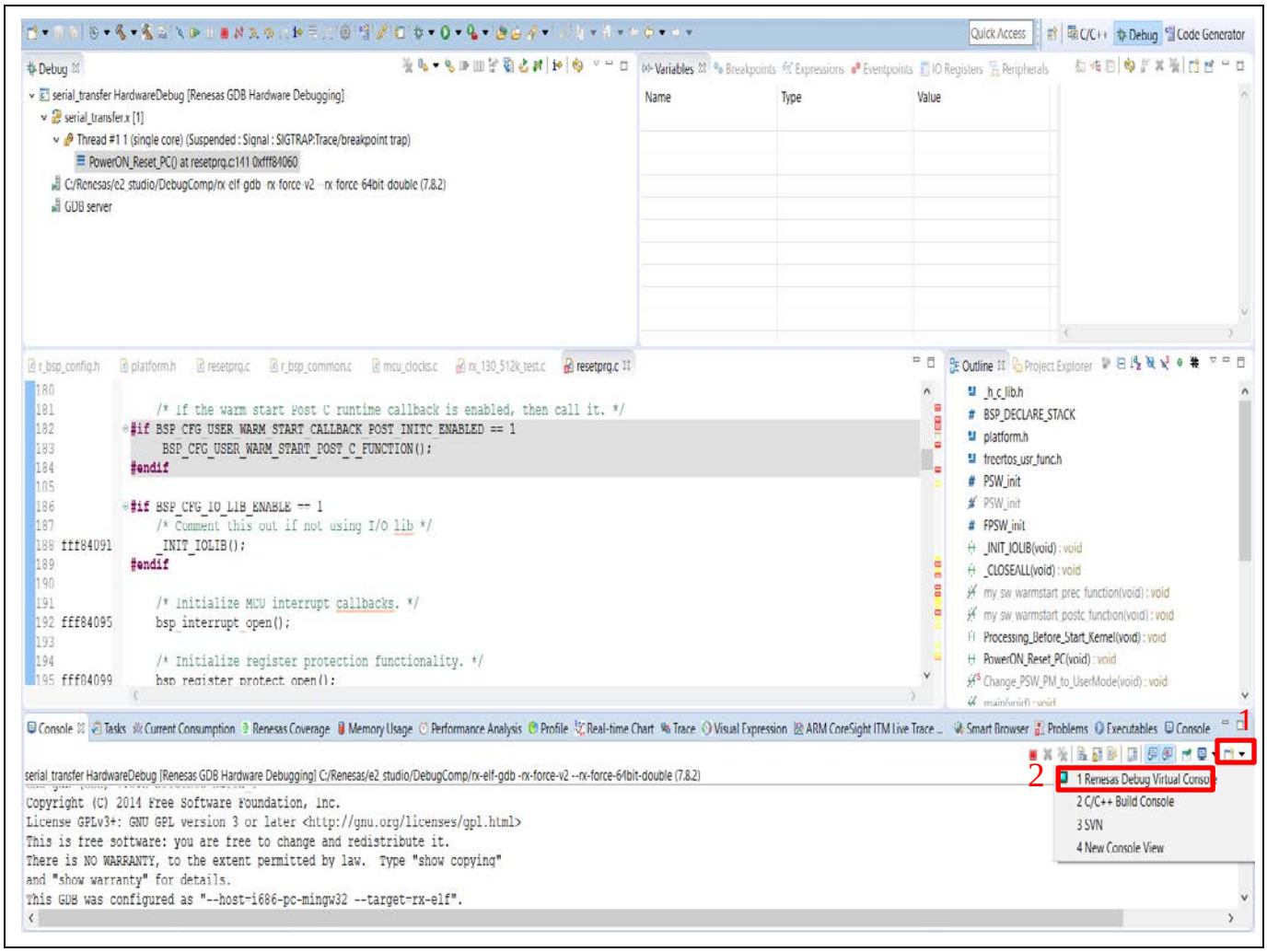

Figure 4-15 Selecting Renesas Debug Virtual Console

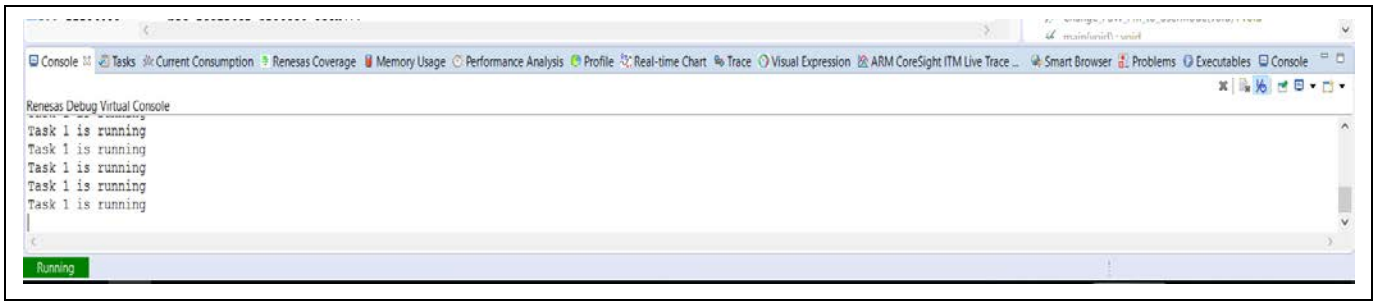

Figure 4-16 Renesas Debug Virtual Console

5. Serial Transfer Specification

5.1 Files

Table 5-1 Main Program Files

Folder Name	File name	Description
src	main.c	Main task
	SerialTransfer_Demo.c	Serial Transfer application
	SerialTransfer_Demo.h	Serial Transfer header file

5.2 Modules

The following table lists the modules in the main program.

Table 5-2 Main Program Modules

File Name	Module name	Description
main.c	main	Main processing for the main program. Initializes the FIT modules; create task#1 of Serial Transfer
SerialTransfer_Demo.c	serial_demo_task1	Normal priority, output the information string of SCI version using SCI driver.
	serial_demo_task2	Same priority of task#1, simulates a full-duplex transfer (simultaneous transmit and receive) by routing the Master output data to the Master input data with a jumper wire. Data received is tested to confirm that it matches the data sent. Output the information string of RSPI version using SCI driver.
	serial_demo_task3	Higher priority than other tasks, support echo mode; any key typed on the terminal will be received by the SCI driver, and then this application will retransmit the character back to the terminal.

5.3 Flowcharts

This section shows the flowcharts for the modules in main program.

5.3.1 main

This is the main task and is created in the “Processing_Before_Start_Kernel” routine of “freertos_usr_func.c”.
It initializes the drivers and create task#1 of Serial Transfer.

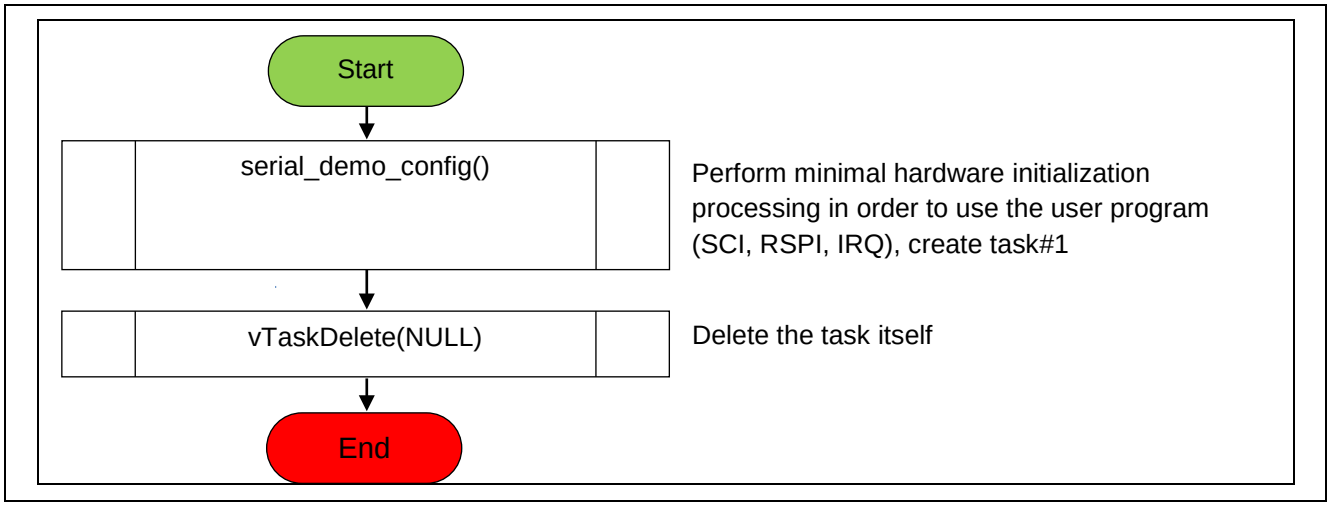

Figure 5-1 Flowchart of main

5.3.2 serial_demo_task1

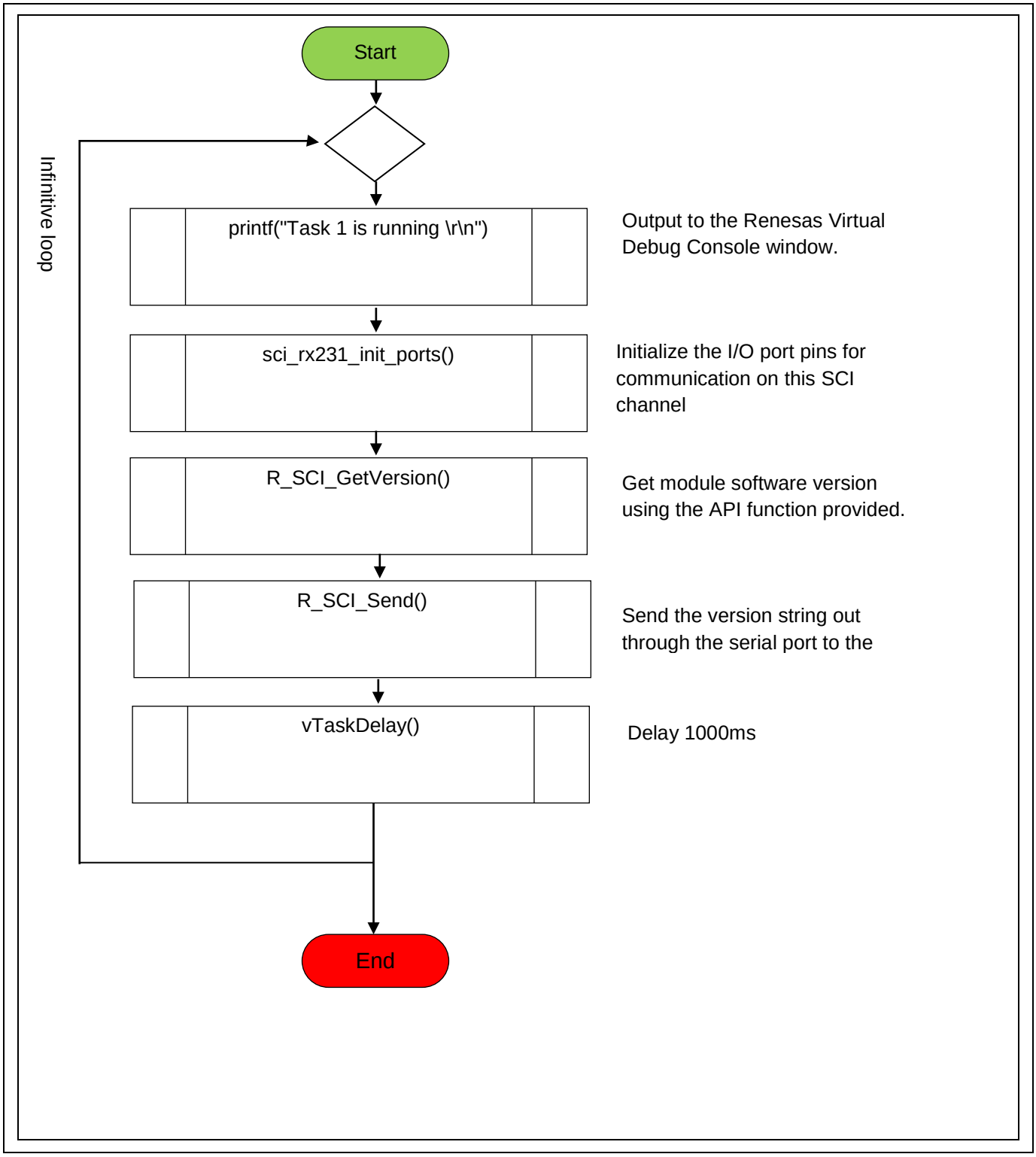

Figure 5-2 Flowchart of serial_demo_task1

5.3.3 serial_demo_task2

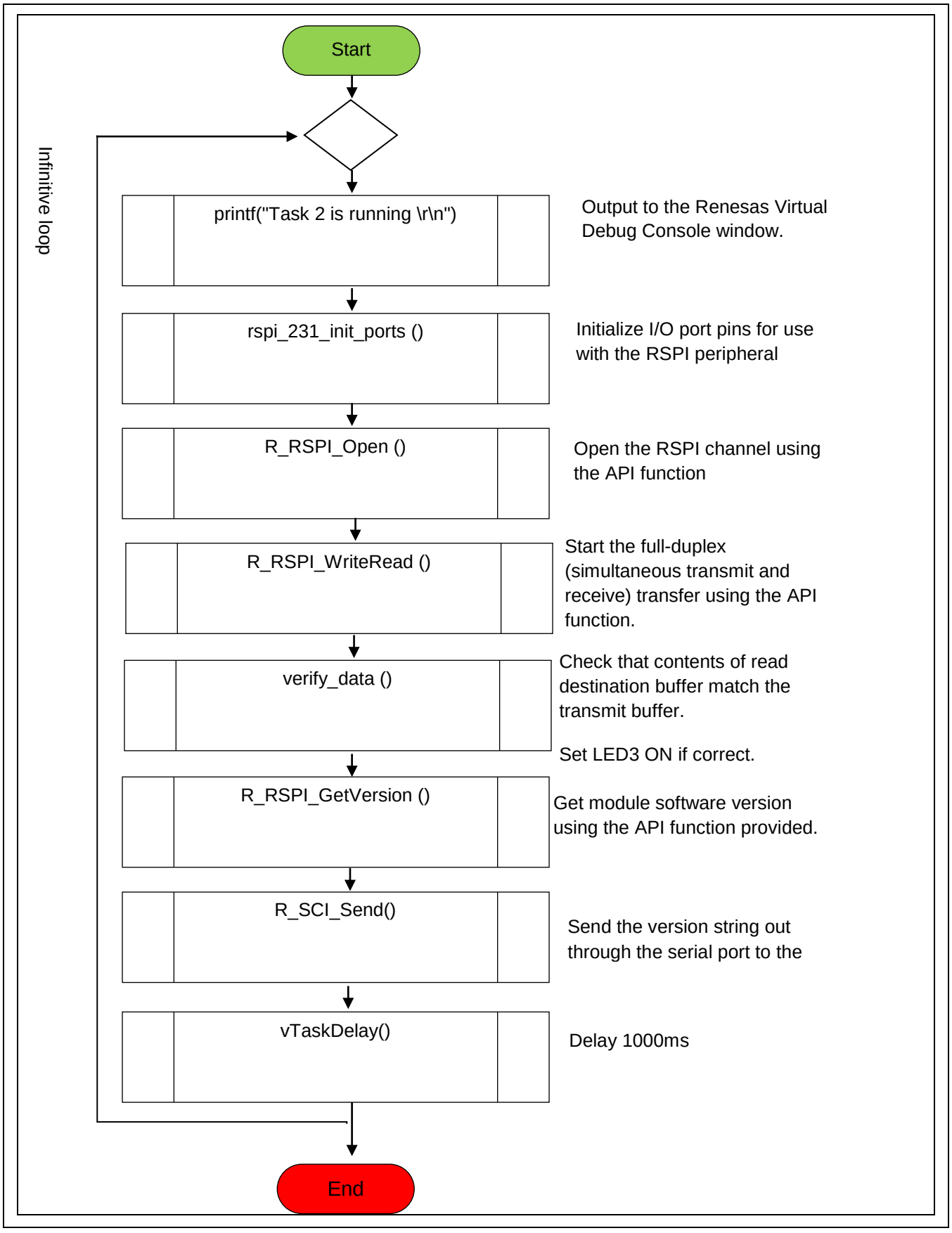

Figure 5-3 Flowchart of serial_demo_task2

5.3.4 serial_demo_task3

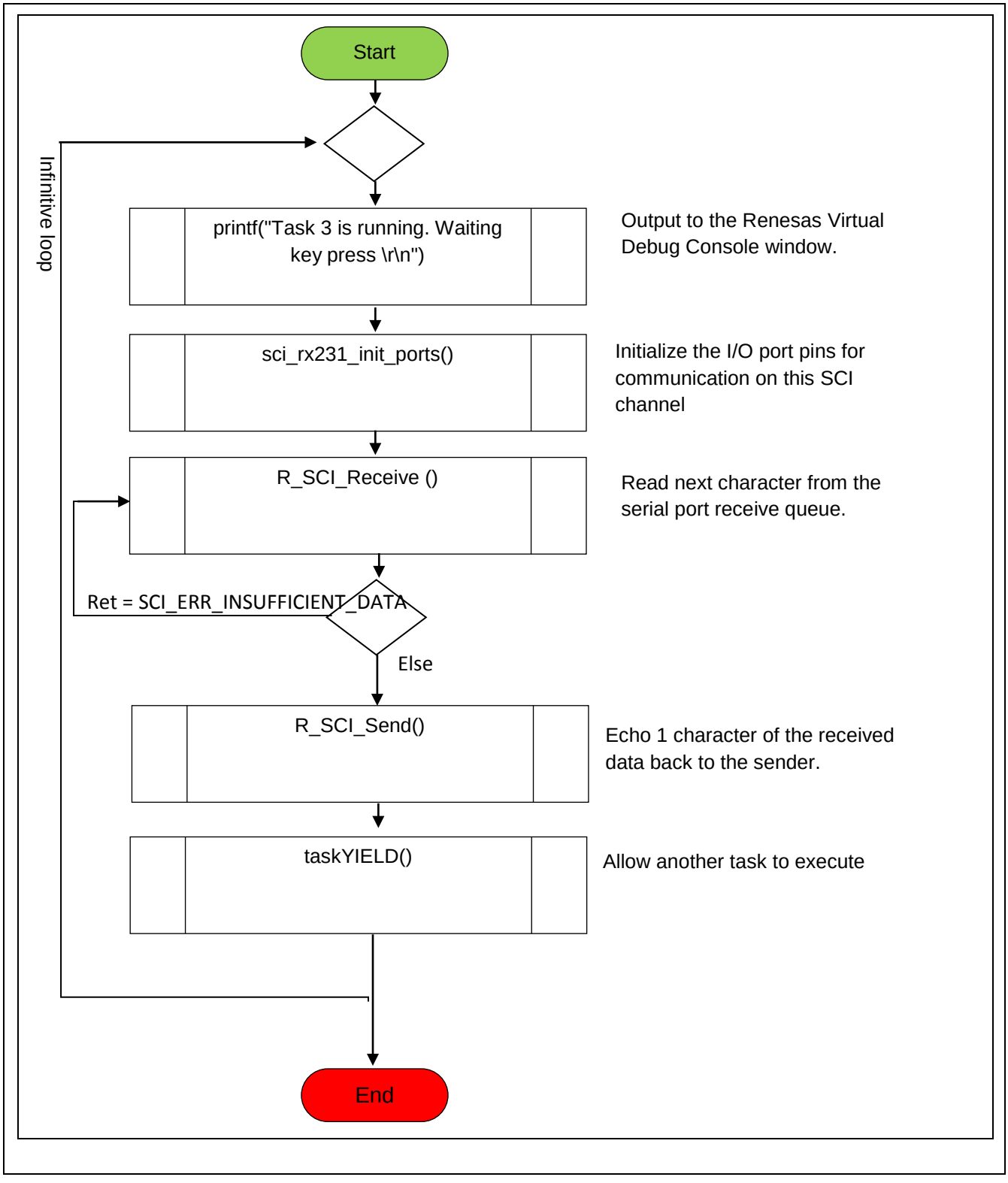

Figure 5-4 Flowchart of serial_demo_task3

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Revision History

		Description	
Rev.	**Date**	**Page**	**Summary**
1.00	Mar.31.2017	-	First edition issued

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. 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 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. Unused pins should be handled as described under Handling of Unused Pins in the manual.

2. Processing at Power-on

   The state of the product is undefined at the moment 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 moment 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 moment 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 moment when power is supplied until the power reaches the level at which resetting has been specified.

3. Prohibition of Access to Reserved Addresses

   Access to reserved addresses is prohibited.

   — The reserved addresses are provided for the possible future expansion of functions. Do not access these addresses; the correct operation of LSI is not guaranteed if they are accessed.

4. Clock Signals

   After applying a reset, only release the reset line after the operating clock signal has become stable. When switching the clock signal during program execution, wait until the target clock signal has 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. Moreover, 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.

5. Differences between Products

   Before changing from one product to another, i.e. to a product with a different part number, confirm that the change will not lead to problems.

   — The characteristics of Microprocessing unit or Microcontroller unit products in the same group but having a different part number may differ in terms of the 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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