

# RZ/T1 Group

Renesas Starter Kit+ Tutorial Manual  
For e<sup>2</sup> studio

RENESAS MCU  
RZ Family / RZ/T1 Series

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## General Precautions in the Handling of MPU/MCU Products

The following usage notes are applicable to all MPU/MCU 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.

¾ 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.

¾ 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.

¾ 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.

¾ 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.

¾ The characteristics of an MPU or MCU 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.

## Disclaimer

By using this Renesas Starter Kit+ (RSK+), the user accepts the following terms:

The RSK is not guaranteed to be error free, and the entire risk as to the results and performance of the RSK is assumed by the User. The RSK is provided by Renesas on an "as is" basis without warranty of any kind whether express or implied, including but not limited to the implied warranties of satisfactory quality, fitness for a particular purpose, title and non-infringement of intellectual property rights with regard to the RSK. Renesas expressly disclaims all such warranties. Renesas or its affiliates shall in no event be liable for any loss of profit, loss of data, loss of contract, loss of business, damage to reputation or goodwill, any economic loss, any reprogramming or recall costs (whether the foregoing losses are direct or indirect) nor shall Renesas or its affiliates be liable for any other direct or indirect special, incidental or consequential damages arising out of or in relation to the use of this RSK, even if Renesas or its affiliates have been advised of the possibility of such damages.

## Precautions

The following precautions should be observed when operating any RSK product:

This Renesas Starter Kit is only intended for use in a laboratory environment under ambient temperature and humidity conditions. A safe separation distance should be used between this and any sensitive equipment. Its use outside the laboratory, classroom, study area or similar such area invalidates conformity with the protection requirements of the Electromagnetic Compatibility Directive and could lead to prosecution.

The product generates, uses, and can radiate radio frequency energy and may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment causes harmful interference to radio or television reception, which can be determined by turning the equipment off or on, you are encouraged to try to correct the interference by one or more of the following measures;

- ensure attached cables do not lie across the equipment
- reorient the receiving antenna
- increase the distance between the equipment and the receiver
- connect the equipment into an outlet on a circuit different from that which the receiver is connected
- power down the equipment when not in use
- consult the dealer or an experienced radio/TV technician for help NOTE: It is recommended that wherever possible shielded interface cables are used.

The product is potentially susceptible to certain EMC phenomena. To mitigate against them it is recommended that the following measures be undertaken;

- The user is advised that mobile phones should not be used within 10m of the product when in use.
- The user is advised to take ESD precautions when handling the equipment.

The Renesas Starter Kit does not represent an ideal reference design for an end product and does not fulfil the regulatory standards for an end product.

# How to Use This Manual

## 1. Purpose and Target Readers

This manual is designed to provide the user with an understanding of how to use the e<sup>2</sup> studio IDE to develop and debug software for the RSK platform. It is intended for users designing sample code on the RSK platform, using the many different incorporated peripheral devices.

The manual comprises of step-by-step instructions to load and debug a project in e<sup>2</sup> studio, but does not intend to be a complete guide to software development on the RSK platform. Further details regarding operating the RZT1 microcontroller may be found in the Hardware Manual and within the provided sample code.

Particular attention should be paid to the precautionary notes when using the manual. These notes occur within the body of the text, at the end of each section, and in the Usage Notes section.

The revision history summarizes the locations of revisions and additions. It does not list all revisions. Refer to the text of the manual for details.

The following documents apply to the RZT1 Group. Make sure to refer to the latest versions of these documents. The newest versions of the documents listed may be obtained from the Renesas Electronics Web site.

Document Type	Description	Document Title	Document No.
Quick Start Guide	Provides simple instructions to setup the RSK+ and run the first sample, on a single A4 sheet.	RSK+RZT1 Quick Start Guide	R20UT3244EG
User's Manual	Describes the technical details of the RSK+ hardware.	RSK+RZT1 User's Manual	R20UT3242EG
Tutorial	Provides a guide to setting up RSK+ environment, running sample code and debugging programs.	RSK+RZT1 Tutorial Manual	R20UT3243EG
Schematics	Full detail circuit schematics of the RSK+.	RSK+RZT1 Schematics	R20UT3241EG
Hardware Manual	Provides technical details of the RZT1 microcontroller.	RZT1 Group Hardware Manual	R01UH0483EJ

## 2. List of Abbreviations and Acronyms

Abbreviation	Full Form
ADC	Analog-to-Digital Converter
e <sup>2</sup> studio	Renesas <i>Eclipse Embedded Studio</i> Integrated Debugging Environment
EMC	Electromagnetic Compatibility
ESD	Electrostatic Discharge
GDB	GNU Debugger
J-LINK	On-chip Debugger
LCD	Liquid Crystal Display
LED	Light Emitting Diode
MCU	Micro-controller Unit
RSK	Renesas Starter Kit
RSK+	Renesas Starter Kit + (denotes extra functionality over standard RSK)

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## **1. Overview**

### **1.1 Purpose**

This RSK+ is an evaluation tool for Renesas microcontrollers. This manual describes how to get the RSK+ tutorial started, and basic debugging operations.

### **1.2 Features**

This RSK+ provides an evaluation of the following features:

- Renesas microcontroller programming
- User code debugging
- User circuitry such as switches, LEDs and a potentiometer
- Sample application
- Sample peripheral device initialisation code

The RSK+ board contains all the circuitry required for microcontroller operation.



## 2. Introduction

This manual is designed to answer, in tutorial form, the most common questions asked about using a Renesas Starter Kit (RSK+). The tutorials help explain the following:

- How do I compile, link, download and run a simple program on the RSK+?
- How do I build an embedded application?
- How do I use Renesas' tools?

Files referred to in this manual are installed using the import wizard as you work through the tutorials. The tutorial examples in this manual assume that installation procedures described in the RSK+ Quick Start Guide have been completed. Please refer to the Quick Start Guide for details of preparing the configuration.

These tutorials are designed to show you how to use the RSK+ and are not intended as a comprehensive introduction to the e<sup>2</sup> studio environment, compiler toolchains or the J-Link LITE debugger. Please refer to the relevant user manuals for more in-depth information.

### 2.1 Note Regarding Source Code

Due to the project generator, it is possible that line numbers for source code illustrated in this document do not match exactly with that in the actual source files. It is also possible that the source address of instructions illustrated in this manual differ from those in user code compiled from the same source. These differences are minor, and do not affect the functionality of the sample code nor the validity of this manual.

## 3. Tutorial Project Workspace

### 3.1 Introduction

e<sup>2</sup> studio is an integrated development tool that allows the user to write, compile, program and debug a software project on the RZ family of Renesas microcontrollers. e<sup>2</sup> studio will have been installed during the installation of the software support for the Renesas Starter Kit product. This manual will describe the stages required to create and debug the supplied tutorial code.

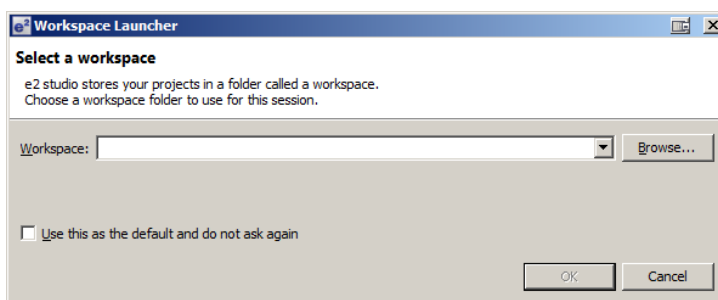
### 3.2 Jumper and Switch Configuration

Ensure jumpers and switches are in the NOR Boot Setting positions:

Jumper	Pins	NOR Boot Setting		QSPI Boot Setting	
		Switch	Position	Switch	Position
JP2	2 - 3	SW4-1	ON	SW4-1	ON
JP7	1 - 2	SW4-2	OFF	SW4-2	ON
--	--	SW4-3	ON	SW4-3	ON
--	--	SW4-4	ON	SW4-4	ON
--	--	SW4-5	ON	SW4-5	ON
--	--	SW4-6	OFF	SW4-6	OFF

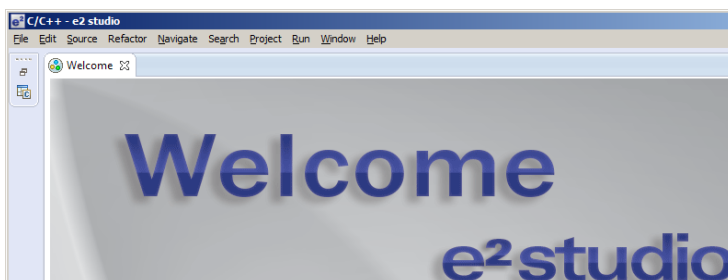
### 3.3 Starting e<sup>2</sup> studio and Importing Sample Code

- Start Eclipse for e<sup>2</sup> studio by selecting it from the Start Menu -> All Programs -> Renesas Electronics e2 studio 3.1 -> Renesas e2 studio. The first dialog box to appear will be the Workspace Launcher.
- Click 'Browse' and select a suitable location to store your workspace, using the 'Create New Folder' option as necessary. Click 'OK'.

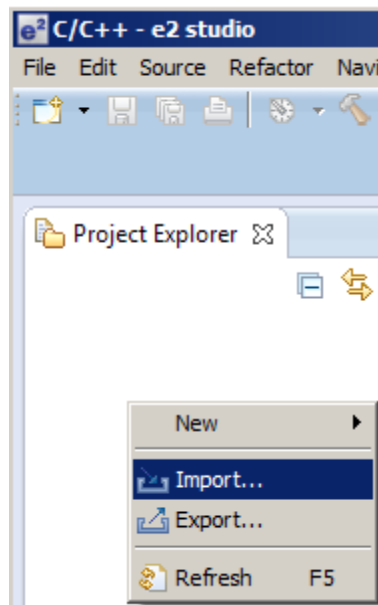


Note: The Workspace location does not have to contain your project files, the workspace contains the configuration of the tool and can group projects together. Projects may be referred to from this location, or the projects may be stored under this directory.

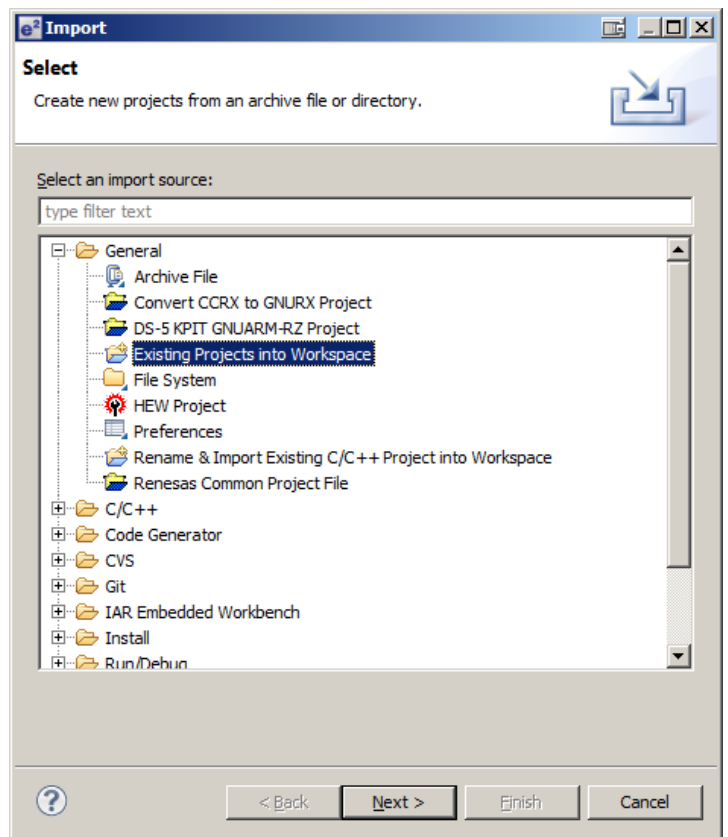
- e<sup>2</sup> studio will open with the 'Welcome...' tab as shown opposite.
- Close the tab by clicking on the cross.



- Right click in the 'Project Explorer' window and select 'Import...'



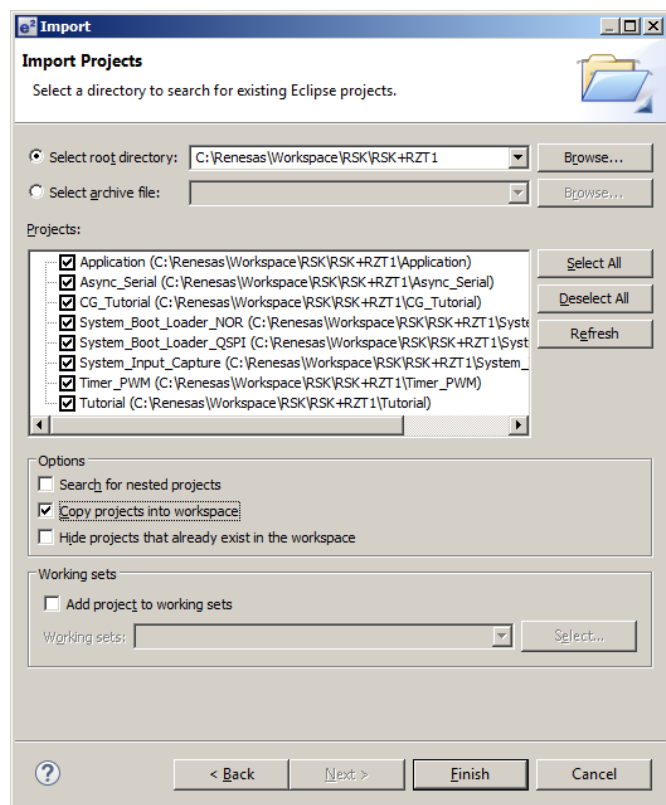
- The Import dialog box will now show. Expand the 'General' folder icon, and select 'Existing Projects into Workspace', then click 'Next'.



- The Import dialog box will allow you to specify a project to import. Click the 'Browse' button and locate the following directory:

C:\Renesas\Workspace\RSK\RSK+RZT1

- Ensure that the 'Copy projects into workspace' option is ticked.
- Caution: Ticking this box will copy the projects from the location where they were installed. It is important to select this option to preserve the projects that were installed so that you can return to them in the future.
- Click 'Finish'.



### 3.4 Build Configurations and Debug Sessions

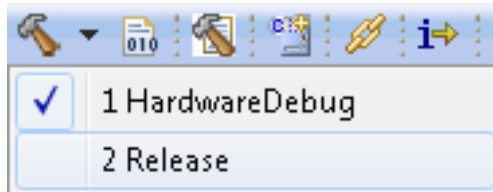
#### 3.4.1 Build Configuration

The e<sup>2</sup> studio workspace will be created with two build configurations: 'HardwareDebug' and 'Release'.

##### HardwareDebug

This default build mode has all optimisation turned off, and provides full debug information. This is the best configuration to use whilst developing code as C code execution will be linear. The 'HardwareDebug' build configuration provided for this Tutorial program is configured to load the code directly into RAM.

- Click the top level 'Tutorial' folder again, and then the arrow next to the build button (hammer icon), and select the 'HardwareDebug' option.

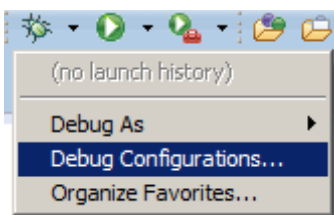


e<sup>2</sup> studio will now build the code.

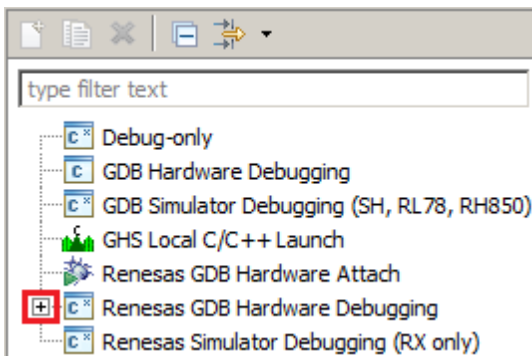
- The output from the build process will be presented in the console window of e<sup>2</sup> studio.

#### 3.4.2 Debug Configuration


- Click the arrow next to the debug button (bug icon). Select 'Debug Configurations'.



- The 'Debug Configurations' dialog box will appear. Click on the button next to 'Renesas GDB Hardware Debugging' to expand the view.
- By default, e<sup>2</sup> studio creates Debug Configurations for each existing build mode. The RSK+RZT1 project have pre-configured debug configurations that are ready to use.

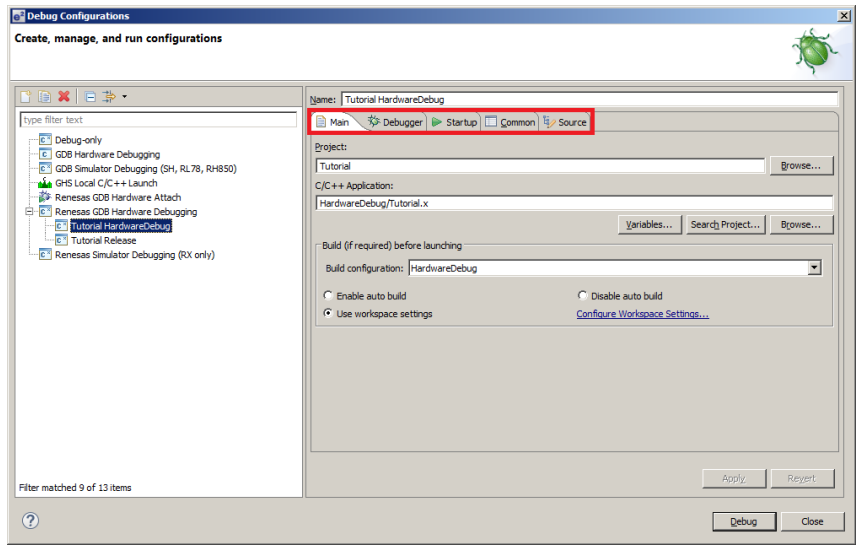


Note:

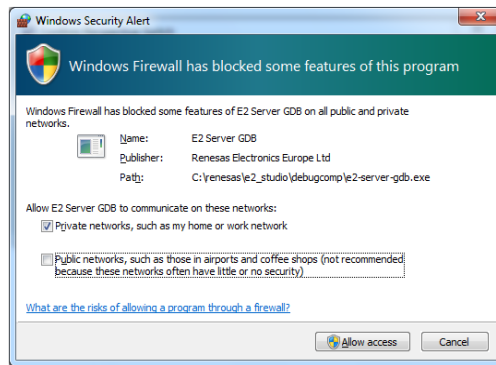
To manually create a new e<sup>2</sup> studio debug configuration, click on 'Renesas GDB Hardware Debugging' then click on the 'New' button .

- The debug configurations control page will open. Observe the settings under each tab.
- Under the 'Debugger' tab, ensure the 'Debugger hardware' option is set to 'J-Link ARM'.
- The 'Target Device' is preset to 'R7S910018'.

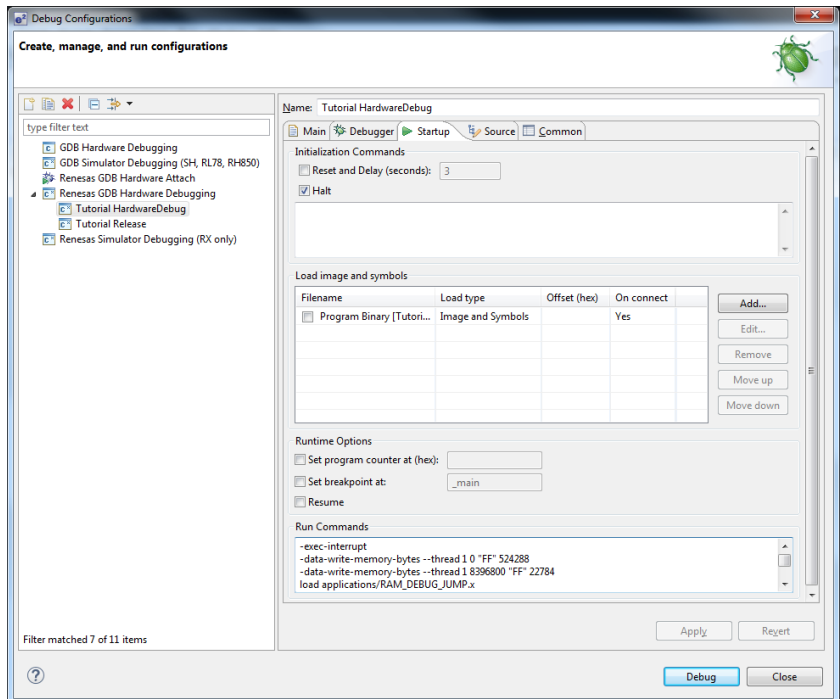
Note:  
Do **not** modify any settings.



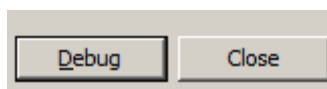
- A security dialog may appear indicating that the Windows Firewall has blocked some features of the eclipse platform.
- Under the text 'Allow eclipse to communicate on these networks', ensure the check box next to 'Private networks, such as my home or work network' is ticked. Click 'Allow access'



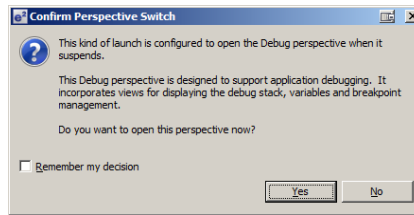
- Select the 'Startup' tab.
- Ensure that 'Halt' is the only tickbox selected.



- Click on 'Debug'.




- Before downloading the code a dialog box will appear asking if you would like to switch to the 'e<sup>2</sup> studio Debug perspective'. If you agree click 'Remember my decision' to prevent this dialog box from appearing in future, then click 'Yes'.
- e<sup>2</sup> studio will load the new perspective, which is optimised for debugging.
- To change back to the default 'C/C++' perspective, from the menu bar select Window > Open Perspective > Other



- The 'Open Perspective' dialog box will appear. Click on the desired perspective to select it then 'OK'.
- Alternatively, click on the button within the top right corner of the screen, as shown opposite, and select the 'C/C++' perspective.



### 3.4.3 Running the Tutorial

- Once the code has been downloaded, the program counter will stop at the entry vector, the 'start' function.
- Click the 'Resume' button to let the code run. It will keep running up to the 'main' function. Execute the main code function. 
- It is recommended that you execute the entire tutorial demo first, before continuing to debug it. Please refer to the 'description.txt' for details of how to operate this sample.

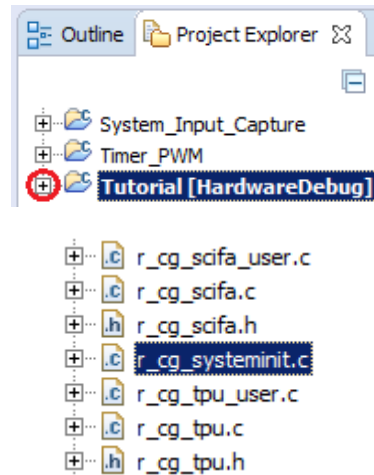
# 4. Reviewing the Tutorial Program

This section will look at each section of the tutorial code and basic debugging functionality in e<sup>2</sup> studio.

## 4.1 Program Initialisation

Before the main program can run, the microcontroller must be configured. The following parts of the tutorial program are used exclusively for initialising the microcontroller so that the main function can execute correctly. The initialisation code is run every time the device is reset via the reset switch or from a power cycle.

- Build and download the code as shown in Section 3.4.
- On the Project Explorer tab expand the 'Tutorial' folder by clicking on the arrow next to the folder icon, as highlighted by the red circle.
- Click the arrow next to the 'src' folder to show the source files.
- Expand the 'cg\_src' folder in the same way and double click on 'r\_cg\_systeminit.c' to open the file.



- Breakpoints can be set by double clicking at the left-hand edge of the source window. On the line with instruction DI(), double click next to the vertical line to set a breakpoint.

```

63  * Function Name: R_Systeminit
68  void R_Systeminit(void)
69  {
70      DI();

```

Note: As an alternative breakpoints may be set in the C/C++ perspective by selecting a line and using Run > Toggle Breakpoint.

```

63  * Function Name: R_Systeminit
68  void R_Systeminit(void)
69  {
70      DI();

```

- Click the 'Resume' button in the Debug perspective (or press [F8]) to run the code up to this breakpoint.



Note: The program counter is indicated by the blue arrow next to the breakpoint.



- Click the 'Step Over' button (or press [F5]), to step over the 'DI' function.



- The 'R\_Systeminit' function calls several initialisation functions which configure the microcontroller for normal operation. For example this includes input/output ports, and system clocks.

- The user can step through all the initialisation code by clicking the 'Step Into' icon and reading the code however for the purpose of this manual, it will be skipped.

- Click the 'Resume' button, to run the code up to the main function.



```

68 void R_Systeminit(void)
69 {
70     DI();
71
72     /* Enable writing to register
73     SYSTEM.PRCR.LONG = 0x0000A50B;
74
75     /* Enable writing to MPC pin
76     MPC.PWPR.BIT.B0WI = 0U;
77     MPC.PWPR.BIT.PFSWE = 1U;
78
79     r_set_exception_handler();
80
81     /* Set peripheral settings */
82     R_CGC_Create();
83     R_ICU_Create();
84     R_PORT_Create();
85     R_TPU_Create();
86     R_CMT4_Create();
87     R_CMT5_Create();
88     R_SCIFA2_Create();
89     R_RSPI1_Create();
90     R_S12AD0_Create();
91     R_MPC_Create();

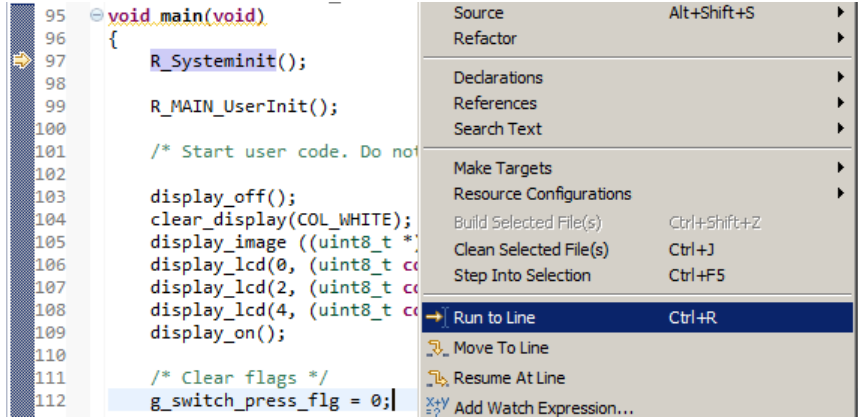
```

For further details regarding hardware configuration, please refer to the RSK+RZT1 User's Manual and the RZT1 Group Hardware Manual.

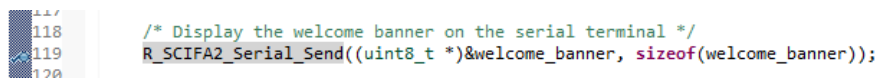
### 4.2 Main Functions

This section will look at the program code called from with the main() function, and how it works. It is necessary to connect the RSK+'s+RL78G1C-USB connection to a PC USB port and open a terminal emulation program, such as HyperTerminal, with the settings 19200, 8, N, 1. For information on installation of the RSK++ virtual COM port driver, refer to the file 'description.txt' in the e<sup>2</sup> studio Tutorial project.

- Open the 'r\_cg\_main.c'. Right click the 'g\_switch\_press\_flg = 0' instruction call and select 'Run to Line' to execute the program up to this line. The Pmod<sup>TM</sup>LCD will display text and an image of the Renesas logo.



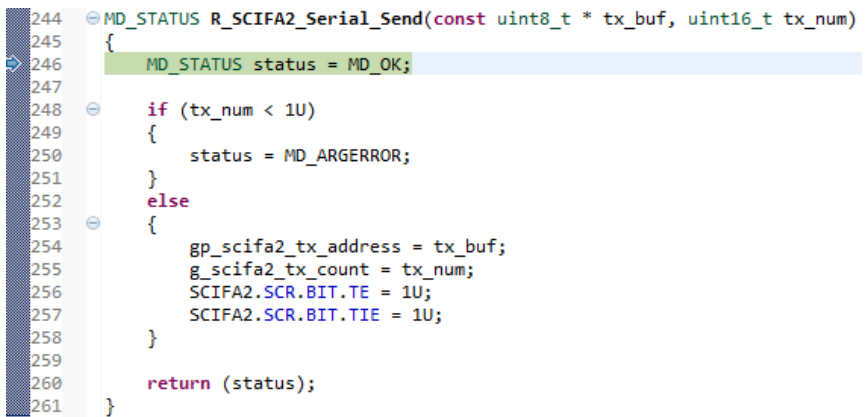
- Set a breakpoint on the 'R\_SCIFA2\_Serial\_Send' function call by double-clicking in the breakpoint column.



- Click the 'Step Into' button to step into the 'R\_SCIFA2\_Serial\_Send' function.



- The program counter will now move into the 'R\_SCIFA2\_Serial\_Send' function definition. This function is an API function provided by the Code Generator. It sets up the SCI interrupt handler code to transmit a specified number of bytes to the serial port.



- For full details on how to configure a project using Code Generator refer to the Code Generator Tutorial Manual.

- Click the 'Step Return' button to execute all the instructions within the 'R\_SCIFA2\_Serial\_Send' function and exit the function.



- The program counter should come to a halt at the [ if ((g\_terminal\_request) || (g\_switch\_press\_flg & SW3\_PRESS\_FLG)) ] instruction inside the main while loop. This conditional statement checks for a SCI or SW3 input.

```
while (1U)
{
    /* Check for a valid request from the switch or serial terminal */
    if ((g_terminal_request) || (g_switch_press_flg & SW3_PRESS_FLG))
    {
        /* Initiate an A/D conversion */
        R_S12AD0_Start();

        /* Wait for completion of A/D conversion */
        while (1U == S12ADC0.ADCSR.BIT.ADST)
        {
            nop();
        }

        /* Read the conversion result */
        R_S12AD0_Get_ValueResult(7, (uint16_t *) &adc_result);
    }
}
```

- Set a breakpoint on the 'R\_S12AD0\_Get\_ValueResult' function call by double-clicking in the breakpoint column.
- Click the 'Resume' button, to run the code.
- In the terminal emulation window, press the 'c' button on the keyboard.
- Code execution will halt at the last breakpoint.
- Step over the instruction by clicking the 'Step Over' button. Alternatively, press [F6].



```
136
137 /* Read the conversion result */
R_S12AD0_Get_ValueResult(7, (uint16_t *) &adc_result);
```

- The 'R\_S12AD0\_Get\_ValueResult' function reads the result of the A/D conversion of ADC channel input 7 and stores it into the 'adc\_result' buffer.
- Remove the breakpoint by double-clicking on the breakpoint column. Continue to execute the program by clicking the 'Resume' button.
- The program proceeds to display the result of the A/D conversion on the LCD and in the terminal window. In addition, the running count of A/D conversions performed is displayed in binary form using LED2 and LED3 on the RSK+.
- In the Project Explorer pane, locate the file 'r\_cg\_icu\_user.c' and double-click to open the source file. Scroll down to the function 'r\_icu\_irq12\_interrupt'.

```
93 void r_icu_irq12_interrupt(void)
94 {
95     VIC.PIC0.LONG = 0x00010000UL;
```

- Set a breakpoint on the line of code inside the `r_icu_irq12_interrupt` function as shown opposite.
- Continue to execute the program by clicking the 'Resume' button.

```

93 void r_icu_irq12_interrupt(void)
94 {
95     VIC.PIC0.LONG = 0x00010000UL;
96     /* Start user code. Do not edit comment generated here */
97
98     /* Set global switch flag to indicate SW3 is pressed */
99     g_switch_press_flg |= SW3_PRESS_FLG;
100
101     /* End user code. Do not edit comment generated here */
102     VIC.HVA0.LONG = 0x00000000UL;
103 }

```

- Press switch SW3 on the RSK+.
- The program will halt at the breakpoint in the `r_icu_irq12_interrupt` function as shown opposite. Remove the breakpoint by double-clicking on the breakpoint column.
- Continue to execute the program by clicking the 'Resume' button.
- The program proceeds to update the result of the A/D conversion on the Pmod™ LCD and in the terminal window. In addition, the running count of A/D conversions is also updated and displayed in binary form using LED2 and LED3 on the RSK+.
- The program will continue to run until normally.

```

98     /* Set global switch flag to indicate SW3 is pressed */
99     g_switch_press_flg |= SW3_PRESS_FLG;

```

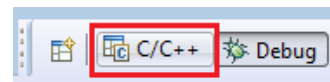
The program proceeds to display the result of the A/D conversion on the Pmod™ LCD and in the terminal window. In addition, the running count of A/D conversions performed is displayed in binary form using LED2 and LED3 on the RSK+. Adjust the potentiometer (RV1) and press SW3 on the RSK+ and an additional A/D conversion will be performed.

- Press the 'Suspend' button to halt program execution.



- To change back to the default 'C/C++' perspective, from the menu bar select Window > Open Perspective > 'C/C++'

- Alternatively, click on the 'C/C++' button in the top right corner of the screen, as shown opposite.



- This is the extent of the tutorial code.

For further details regarding hardware configuration, please refer to the RSK+RZT1 User's Manual and the RZT1 Group Hardware Manual.

## 5. Troubleshoot

### 5.1 Debugging in RAM (TCM)

The RZ/T1 expects the user to preload the loader parameters and a boot loader application into the NOR (U3) and QSPI flash devices for correct operation of the device. Failure to do this will result in problems during debug user applications in the ATCM and BTCM.

RSK+RZT1 boards are programmed with a boot loader binary into the QSPI and NOR flash devices during production. These binaries, include the boot loader parameters required by the RZ/T1's boot loader program during boot. Should the user erase the QSPI or NOR flash, reprogramming of the boot loader binary is required to ensure debugging from RAM will not be affected. To program the boot loader to the relevant flash device:

1. Locate the System\_Boot\_Loader\_NOR or System\_Boot\_Loader\_QSPI sample project from C:\Renesas\Workspace\RSK\RSK+RZT1.
2. Build the Release build configuration.
3. Ensure to configure switch bank SW4 according to the boot mode. See Section 3.2.
4. Connect the Segger J-Link debugger and 5V power supply.
5. Run the Program\_QSPI\_Loader.bat or Program\_NOR\_Loader.bat batch file from the sample project's root folder.
6. Select Option 3 to only program the boot loader binary.

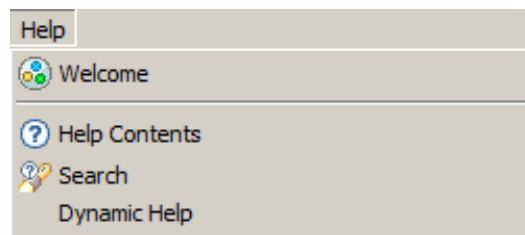
An alternative method to program the QSPI boot loader is to build and run the Release build of one of the following samples:

Application  
Async\_Serial  
System Input Capture  
Timer PWM  
Tutorial

## 6. Additional Information

### Technical Support

For details on how to use e<sup>2</sup> studio, refer to the help file by opening e<sup>2</sup> studio, then selecting Help > Help Contents from the menu bar.



For information about the RZT1 series microcontrollers refer to the RZT1 Group Hardware Manual.

### Technical Contact Details

***Please refer to the contact details listed in section 11 of the “Quick Start Guide”***

General information on Renesas microcontrollers can be found on the Renesas website at:  
<http://www.renesas.com/>

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RZT1 Group