

RL78/G1G Group

Renesas Starter Kit Tutorial Manual
For e² studio

RENESAS MCU
RL78 Family / RL78/G1X Series

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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 e² 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 e² studio, but does not intend to be a complete guide to software development on the RSK platform. Further details regarding operating the RL78/G1G microcontroller may be found in the RL78/G1G Group 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 RL78/G1G 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. |
|-------------------------|---|---|--------------|
| User's Manual | Describes the technical details of the RSK hardware. | RSK RL78/G1G User's Manual | R20UT3022EG |
| Tutorial | Provides a guide to setting up RSK environment, running sample code and debugging programs. | RSK RL78/G1G Tutorial Manual | R20UT3023EG |
| Code Generator Tutorial | Provides a guide to code generation and importing into the e ² studio IDE. | RSK RL78/G1G Code Generator Tutorial Manual | R20UT3025EG |
| Quick Start Guide | Provides simple instructions to setup the RSK and run the first sample, on a single A4 sheet. | RSK RL78/G1G Quick Start Guide | R20UT3024EG |
| Schematics | Full detail circuit schematics of the RSK . | RSK RL78/G1G Schematics | R20UT3017EG |
| Hardware Manual | Provides technical details of the RL78/G1G microcontroller. | RL78/G1G Group, User's Manual: Hardware | R01UH0499EJ |

2. List of Abbreviations and Acronyms

| Abbreviation | Full Form |
|--------------|---|
| ADC | Analog-to-Digital Converter |
| E1 | On-chip Debugger |
| GDB | GNU Debugger |
| LCD | Liquid Crystal Display |
| LED | Light Emitting Diode |
| MCU | Micro-controller Unit |
| PC | Personal Computer |
| RSK | Renesas Starter Kit |
| USB | Universal Serial Bus |
| UART | Universal Asynchronous Receiver/Transmitter |

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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 project generator 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 e² studio, the compiler toolchains or the E1 emulator. Please refer to the relevant user manuals for more in-depth information.

2.1 Code Generator Plug in

The Code Generator plug in for the RL78/G1G has been used to generate the sample code discussed in this document. Code Generator for e² studio is a plug in tool for generating template 'C' source code and project settings for the RL78/G1G. When using Code Generator, the engineer is able to configure various MCU features and operating parameters using intuitive GUI controls, thereby bypassing the need in most cases to refer to sections of the Hardware Manual.

Once the engineer has configured the project, the 'Generate Code' function is used to generate three code modules for each specific MCU feature selected. These code modules are name 'r_cg_XXX.h', 'r_cg_XXX.c', and 'r_cg_XXX_user.c', where 'XXX' is a three letter acronym for the relevant MCU feature, for example 'adc'. Within these code modules, the engineer is then free to add custom code to meet their specific requirement. Custom code should be added, whenever possible, in between the following comment delimiters:

```
/* Start user code for adding. Do not edit comment generated here */  
/* End user code. Do not edit comment generated here */
```

Code Generator will locate these comment delimiters, and preserve any custom code inside the delimiters on subsequent code generation operations. This is useful if, after adding custom code, the engineer needs to re-visit Code Generator to change any MCU operating parameters.

2.2 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.

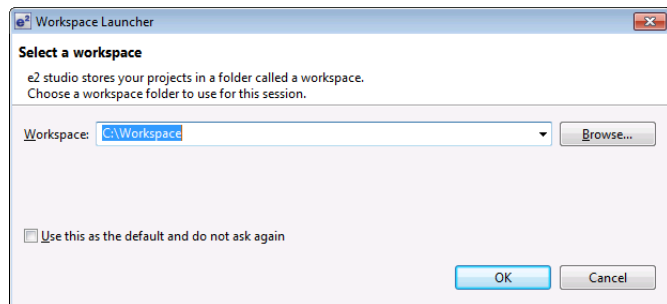
3. Tutorial Project Workspace

3.1 Introduction

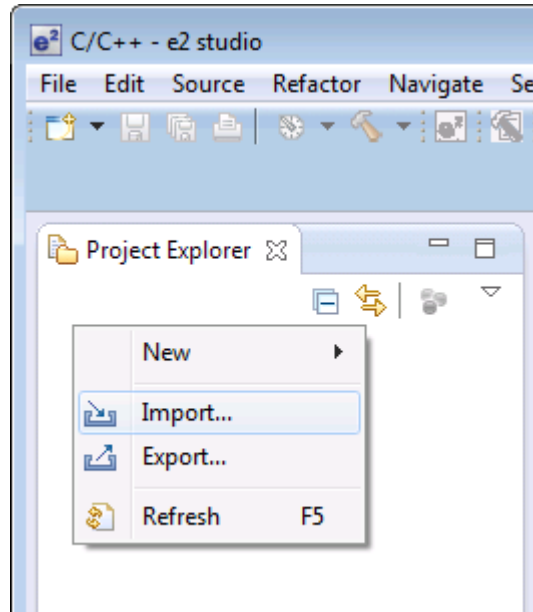
e² studio is an open source integrated development tool that allows the user to write, compile, program and debug a software product on many of the Renesas microcontrollers.

3.2 Starting e² studio and Importing Sample Code

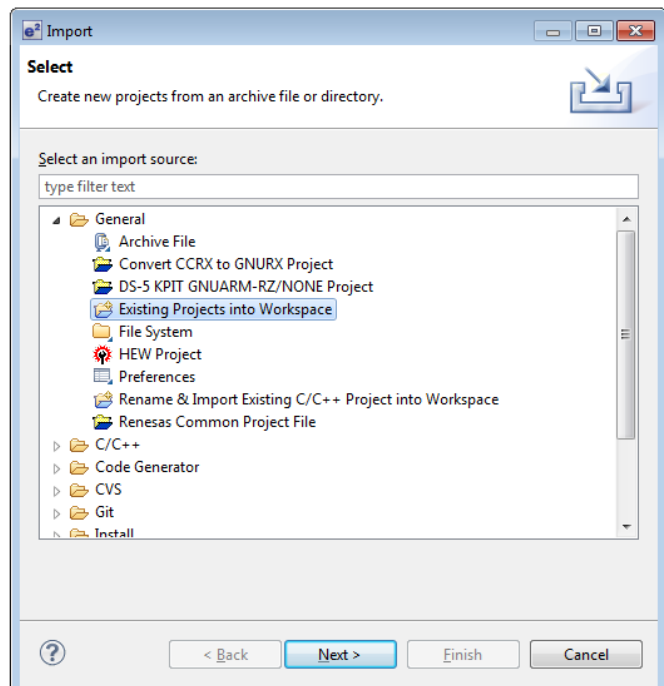
- Start e² studio by selecting it from the Windows™ Start Menu. The first dialog box to appear will be the Workspace Launcher.
- Click 'Browse' and select a suitable location to store your workspace, using the 'Create New Folder' option as necessary. Click 'OK'.
- The e² studio welcome splash screen will appear. Click the 'Go to the workbench' arrow button on the far right (circled in the screenshot opposite).



- Once the environment has initialised, right click in the 'Project Explorer' window and select 'Import...'



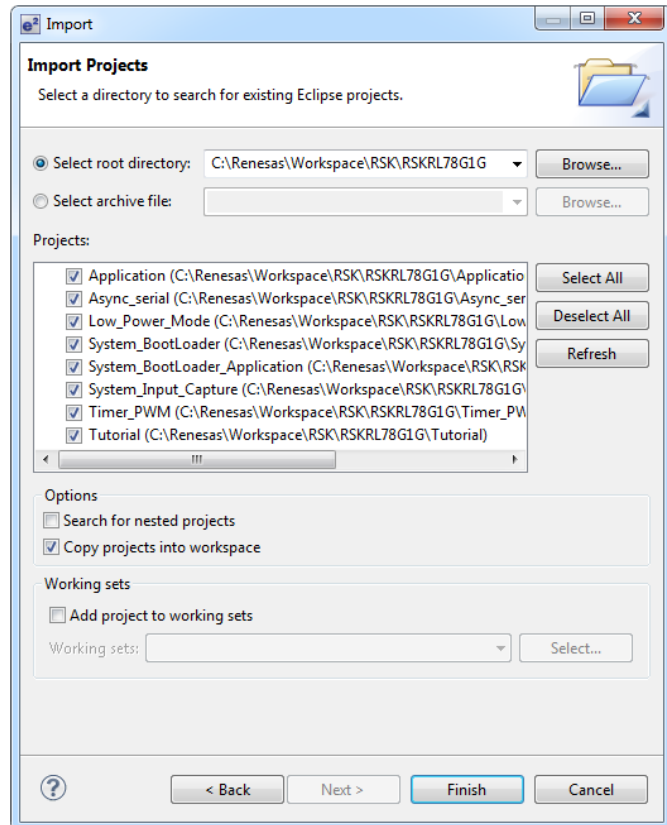
- The Import dialog box will now show. Expand the 'General' folder icon, and select 'Existing Projects into Workspace', then click 'Next'.



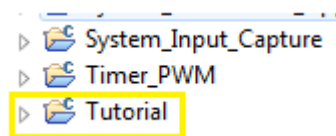
- The Import dialog box will allow you to specify a project to import. Click the 'Browse' button and locate the following directory:

C:\Renesas\Workspace\RSK\RSKRL78G1G

- Ensure that the 'Copy projects into workspace' option is ticked, and then click 'Finish'.



- Click on Tutorial from the list of projects in the 'Project Explorer' on the left-hand side.



3.3 Build Configurations and Debug Sessions

3.3.1 Build Configuration

The e² studio workspace will be created with two build configurations: 'HardwareDebug' and 'Release'.

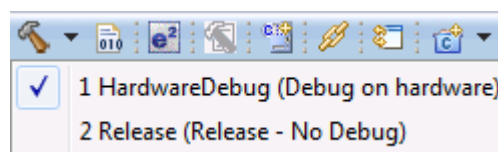
Release

This build mode has optimisation turned on, and provides little debug information. The C code execution may appear to be out of order, due to the way compiler optimises the code. This build configuration is intended for final ROM-programmable code.

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.

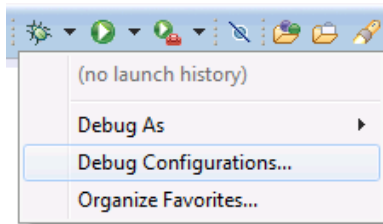
- Click the top level 'Tutorial' folder again, and then the arrow next to the build button (hammer icon), and select the 'HardwareDebug' option.



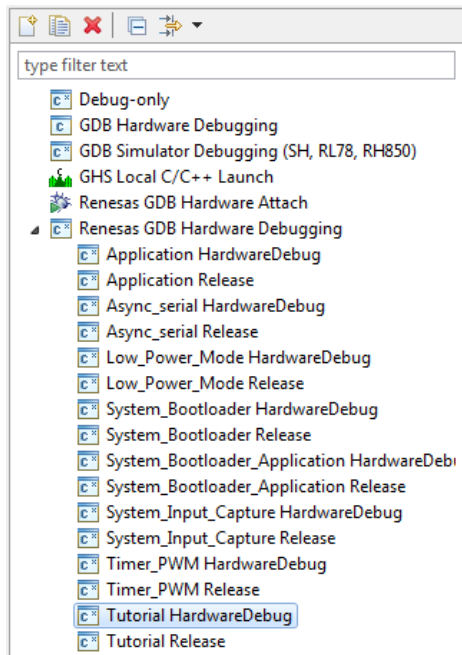
- e² studio will now build the code.

3.3.2 Debug Configuration

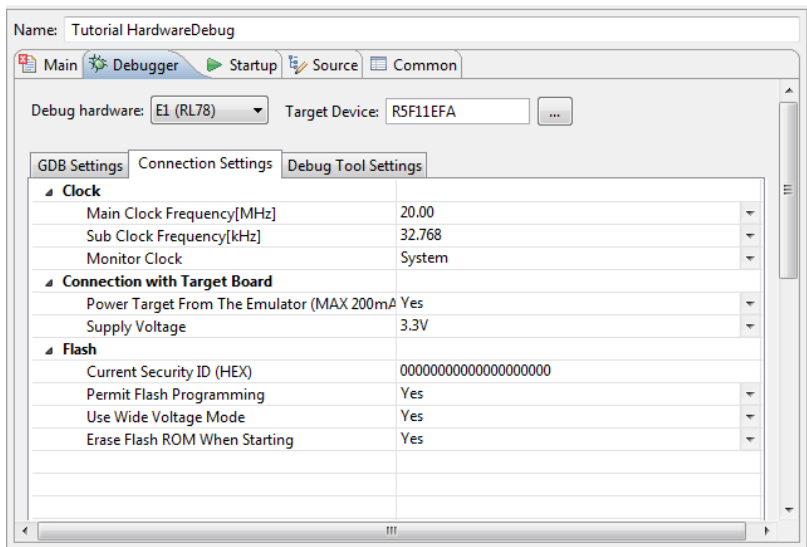
- Click the arrow next to the debug button (bug icon). Select 'Debug Configurations'.



- The 'Debug Configurations' dialog box will appear. Click the small arrow next to the 'Renesas GDB Hardware Debugging' option.
- The debug configurations for each project will appear. Select the entry for the 'Tutorial HardwareDebug'.



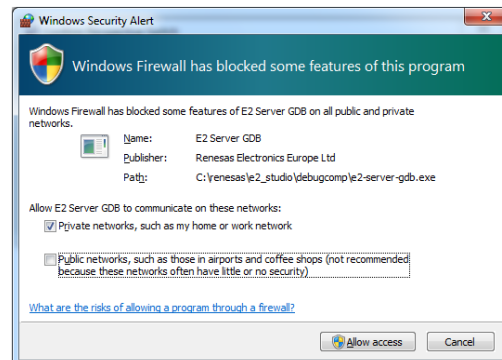
- The debug configurations control page will then show for the Tutorial project. Change the main tab to 'Debugger' and then select 'Connection Settings' on the secondary tab bar that appears.
- There is no need to change the debugger settings as they are preconfigured with the Tutorial project.
- For this tutorial the RSK RL78/G1G will be powered from the E1 Emulator. Refer to the RSK RL78/G1G User's Manual for details of power supply configuration.



Note: e² studio will display a warning if you attempt to connect with an incorrect power supply setting.

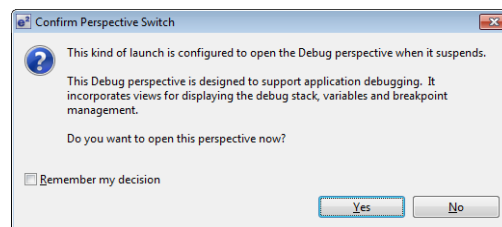
- Click the 'Debug' button to continue. e² studio will now connect to the debugger and download the code to the target.

- A firewall warning may be displayed for 'e2-server-gdb.exe'. Check the 'Private networks, such as my home or work network' box and click 'Allow access'.




- A user account control dialog may be displayed. Enter the administrator password and click <Yes>

- e² studio may display a dialog, asking if you would like to switch to the 'Renesas Debug perspective'. Click 'Yes'.



- The new e² studio perspective layout is optimised for debugging.

3.4 Running the Tutorial

- Once the code has been downloaded, the program counter will stop at the entry vector, usually the '_PowerON_Reset' 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.

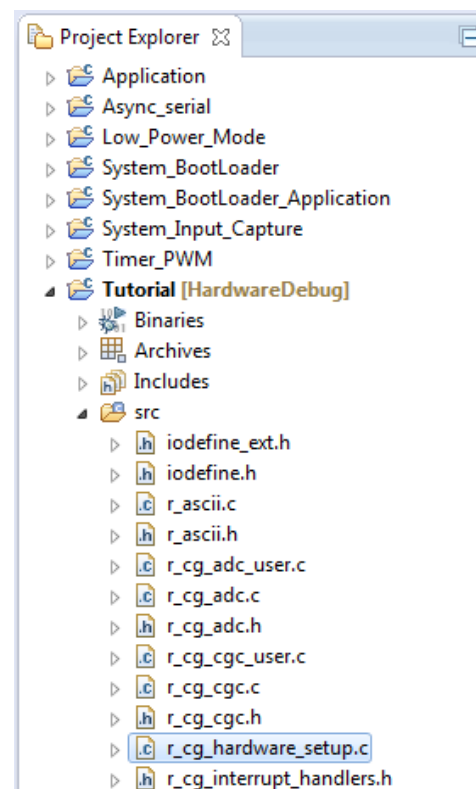
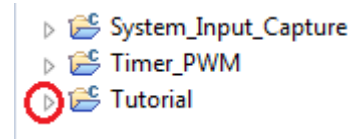
4. Reviewing the Tutorial Program

This section will look at each section of the tutorial code and basic debugging functionality in e² 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 RSK device 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 3.3.
- 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 'src' folder in the same way and double click on 'r_cg_hardware_setup.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 R_Systeminit(), double click next to the vertical line to set a breakpoint.

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

```

80
81 0000040e
82 00000410
83 00000413
84
85 00000417
86 0000041c
87
      int HardwareSetup(void)
      {
          DI();
          R_Systeminit();

          return (1U);
      }

```

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



```

80
81 0000040e
82 00000410
83 00000413
84
85 00000417
86 0000041c

```

```

int HardwareSetup(void)
{
    DI();
    R_Systeminit();

    return (1U);
}

```

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

- Click the 'Step Into' button (or press [F5]), to step into the 'R_Systeminit' function.



```

62
63
64
65 000003dd
66 000003e9
67 000003ed
68 000003f1
69 000003f5
70 000003f9
71 000003fd
72 00000401
73 0000040d

```

```

void R_Systeminit(void)
{
    PIOR1 = 0x00U;
    R_CGC_Get_ResetSource();
    R_PORT_Create();
    R_CGC_Create();
    R_TAU0_Create();
    R_ADC_Create();
    R_SAU0_Create();
    IAWCTL = 0x00U;
}

```

- 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.



For further details regarding hardware configuration, please refer to the RSK RL78/G1G User's Manual and the RL78/G1G Group Hardware Manual.

4.2 Main Functions

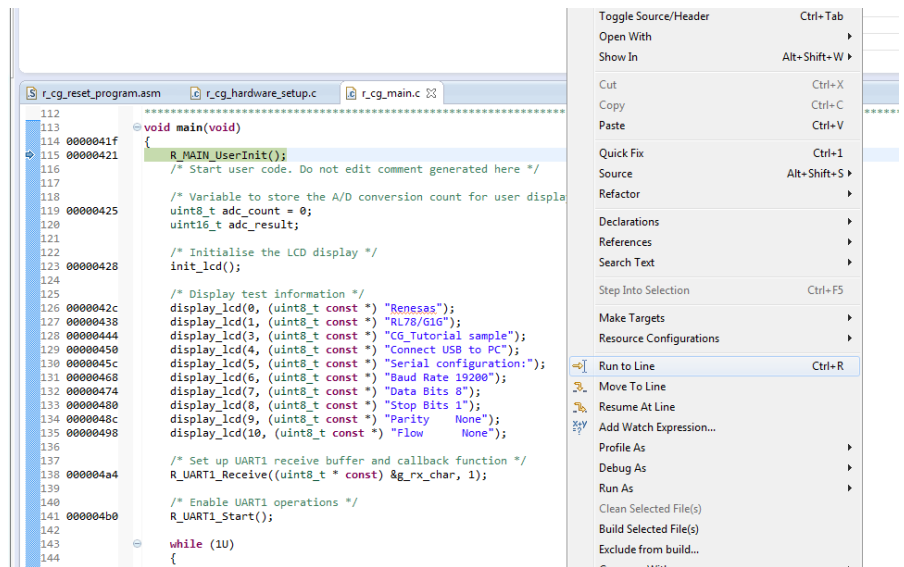
This section will look at the program code called from with the 'main' function, and how it works. It is necessary to connect the RSK RL78G1C-USB connection to a PC USB port and open a terminal emulation program, such as TeraTerm, with the settings 19200, 8, N, 1. For information on installation of the RSK virtual COM port driver, refer to the file 'Description.txt' in the e² studio Tutorial project.

The program code performs the following tasks:

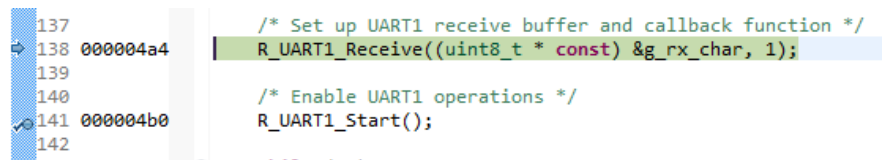
- Initialises the LCD display.
- Writes some information to the display.
- Sets up UART1 to receive data by passing it a location to store received data and the length of the received data.
- Enables UART1 operations.
- Enters an infinite loop, which checks to see if SW3 has been pressed or a 'c' or 'C' character has been received from the PC and if so it will request a new A/D (analog to digital) conversion of the potentiometer value. The ADC value is then displayed on the LCD and on the PC. In addition a modulo 16 counter is maintained that counts the number of requested ADC conversions. The count results are displayed on the PC and they are also represented on LEDs 0 to 3.

Let us now follow this flow by setting some breakpoints in the code.

- Right click the 'R_UART1_Receive' function call and select 'Run to Line' to execute the program up to this line. The 'init_lcd' function call configures the LCD module, and 'display_lcd' will write the text between the double quotes to the display.



- Set a breakpoint on the 'R_UART1_Start()' function call by double-clicking in the breakpoint column.



- Click the 'Step Into' button to step into the 'R_UART1_Receive()' function.



- The program counter should now move into the R_UART1_Receive function definition. This function is an API function provided by the Code Generator. It sets up the UART interrupt handler code to receive a specified number of bytes into a receive buffer. Once the specified number of bytes has been received, the interrupt handler code calls a callback function as shown later on in this section.

```

166
167 00000de0
168 00000de2
169
170 00000de5
171
172 00000df0
173
174
175
176 00000df9
177 00000dfd
178 00000e04
179
180
181 00000e0b
182 00000e13

```

```

MD_STATUS R_UART1_Receive(uint8_t * const rx_buf, uint16_t rx_num)
{
    MD_STATUS status = MD_OK;

    if (rx_num < 1U)
    {
        status = MD_ARGERROR;
    }
    else
    {
        g_uart1_rx_count = 0U;
        g_uart1_rx_length = rx_num;
        gp_uart1_rx_address = rx_buf;
    }

    return (status);
}

```

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

- Click the 'Resume' button to resume program execution.

- The program counter should come to a halt at the R_UART1_Start function.

```

137
138 000004a4
139
140
141 000004b0
142
143

```

```

/* Set up UART1 receive buffer and callback function */
R_UART1_Receive((uint8_t * const) &g_rx_char, 1);

/* Enable UART1 operations */
R_UART1_Start();

while (1U)

```

- Step over the function by clicking the 'Step Over' button. Alternatively, press [F6].



The R_UART1_Start() function enables the UART interrupts.

The program then proceeds to the main while() loop. The code inside the loop waits for user input from either the UART or RSK switch SW3, and then performs an A/D conversion.

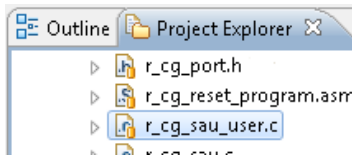
- Locate the function call to 'display_lcd' inside the while loop.

```

145
146 000004b4  /* Read SW3. */
147          read_switch(g_sw3, SW3_VALUE);
148
149 000004ec  /* If a new press of SW3 then request a new A/D conversion. */
150          if (TRUE == g_sw3.switch_new_press)
151          {
152              g_sw3.switch_new_press = FALSE;
153
154              /* set the flag indicating a user requested A/D conversion is required */
155              g_adc_trigger = TRUE;
156          }
157
158 00000500  /* Wait for user requested A/D conversion flag to be set */
159          if (TRUE == g_adc_trigger)
160          {
161              /* Call the function to perform an A/D conversion */
162              adc_result = get_adc();
163
164              /* Display the result on the LCD */
165              uint16_to_string lcd_buf, (uint8_t) 0, adc_result);
166              display_lcd(12, (uint8_t const *) lcd_buf);
167
168
169
170

```

- In the Project Explorer pane, locate the file 'r_cg_sau_user.c' and double-click to open the source file. Scroll down to where r_uart1_callback_receive_end is defined (not where it is being called from).



- Set a breakpoint on the line of code inside the r_uart1_callback_receive_end function as shown opposite.
- Continue to execute the program by clicking the 'Resume' button.

```

136
137 00001380  static void r_uart1_callback_receive_end(void)
138          {
139              /* Start user code. Do not edit comment generated here */
140
141              /* Check the character received from the PC */
142              if (('c' == g_rx_char) || ('C' == g_rx_char))
143              {
144                  g_adc_trigger = TRUE;
145              }

```

- In the terminal emulation window, press the 'c' button on the keyboard.

```

140
141 00001382  /* Check the character received from the PC */
142          if (('c' == g_rx_char) || ('C' == g_rx_char))
143          {
144              g_adc_trigger = TRUE;
145          }

```

- The program will halt at the breakpoint in the r_uart1_callback_receive_end function as shown opposite. Remove the breakpoint by double-clicking on the breakpoint column.

```

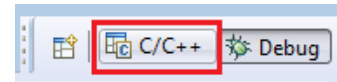
163
164 00000516  /* Display the result on the LCD */
165          uint16_to_string lcd_buf, (uint8_t) 0, adc_result);
166          display_lcd(12, (uint8_t const *) lcd_buf);
167
168          /* Increment the adc_count and display using the LEDs */
169          if (16 == (++adc_count))
170          {
171              adc_count = 0;

```

- Continue to execute the program by clicking the 'Resume' button.
- The program will halt at the breakpoint in the main while loop.
- 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 (modulo 16) of A/D conversions performed is displayed in binary form using LEDs 0-3 on the RSK and also in the terminal window. Adjust the potentiometer 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.



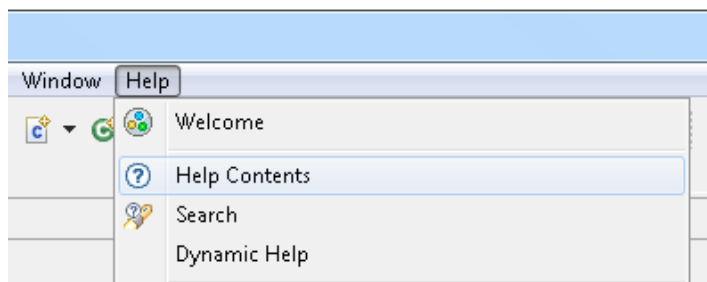
For further details regarding hardware configuration, please refer to the RL78 Series Software Manual and the RL78/G1G Group Hardware Manual.

The E1 emulator features advanced logic-based event point trigger system, and full instruction on its use is outside the scope of this tutorial. For further details, please refer to the E1 Emulator User's Manual

5. Additional Information

Technical Support

For details on how to use e² studio, refer to the help file by opening e² studio, then selecting Help > Help Contents from the menu bar.



Parts of the sample code provided with the RSK RL78/G1G can be reproduced using the Code Generator tool. Code Generator is included as a plug in with e² studio.

Source files and functions generated by Code Generator are prefixed with 'r_cg' and 'R_', respectively.

For information about the RL78/G1G series microcontrollers refer to the RL78/G1G Group, User's Manual: Hardware.

For information about the RL78 assembly language, refer to the RL78 Series Software Manual.

Technical Contact Details

Please refer to the contact details listed in section 9 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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SALES OFFICES

Refer to "<http://www.renesas.com/>" for the latest and detailed information.

Renesas Electronics America Inc.

2801 Scott Boulevard Santa Clara, CA 95050-2549, U.S.A.

Tel: +1-408-588-6000, Fax: +1-408-588-6130

Renesas Electronics Canada Limited

9251 Yonge Street, Suite 8309 Richmond Hill, Ontario Canada L4C 9T3

Tel: +1-905-237-2004

Renesas Electronics Europe Limited

Dukes Meadow, Millboard Road, Bourne End, Buckinghamshire, SL8 5FH, U.K

Tel: +44-1628-585-100, Fax: +44-1628-585-900

Renesas Electronics Europe GmbH

Arcadiastrasse 10, 40472 Düsseldorf, Germany

Tel: +49-211-6503-0, Fax: +49-211-6503-1327

Renesas Electronics (China) Co., Ltd.

Room 1709, Quantum Plaza, No.27 ZhiChunLu Haidian District, Beijing 100191, P.R.China

Tel: +86-10-8235-1155, Fax: +86-10-8235-7679

Renesas Electronics (Shanghai) Co., Ltd.

Unit 301, Tower A, Central Towers, 555 Langao Road, Putuo District, Shanghai, P. R. China 200333

Tel: +86-21-2226-0888, Fax: +86-21-2226-0999

Renesas Electronics Hong Kong Limited

Unit 1601-1611, 16/F., Tower 2, Grand Century Place, 193 Prince Edward Road West, Mongkok, Kowloon, Hong Kong

Tel: +852-2265-6688, Fax: +852 2886-9022

Renesas Electronics Taiwan Co., Ltd.

13F, No. 363, Fu Shing North Road, Taipei 10543, Taiwan

Tel: +886-2-8175-9600, Fax: +886 2-8175-9670

Renesas Electronics Singapore Pte. Ltd.

80 Bendemeer Road, Unit #06-02 Hyflux Innovation Centre, Singapore 339949

Tel: +65-6213-0200, Fax: +65-6213-0300

Renesas Electronics Malaysia Sdn.Bhd.

Unit 1207, Block B, Menara Amcorp, Amcorp Trade Centre, No. 18, Jln Persiaran Barat, 46050 Petaling Jaya, Selangor Darul Ehsan, Malaysia

Tel: +60-3-7955-9390, Fax: +60-3-7955-9510

Renesas Electronics India Pvt. Ltd.

No.777C, 100 Feet Road, HALII Stage, Indiranagar, Bangalore, India

Tel: +91-80-67208700, Fax: +91-80-67208777

Renesas Electronics Korea Co., Ltd.

12F., 234 Teheran-ro, Gangnam-Gu, Seoul, 135-080, Korea

Tel: +82-2-558-3737, Fax: +82-2-558-5141

RL78/G1G Group