User's Manual

16

RL78/G1C Group

Renesas Starter Kit Tutorial Manual
For e^{2}studio

RENESAS MCU
RL78 Family / G1X Series

Renesas Electronics
www.renesas.com

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(2012.4)

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^2 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^2 studio, but does not intend to be a complete guide to software development on the RSK platform. Further details regarding operating the RL78/G1C 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 RL78/G1C 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.	RSKRL78G1C User's Manual	R20UT1986EG
Tutorial	Provides a guide to setting up RSK environment, running sample code and debugging programs.	RSKRL78G1C Tutorial Manual	R20UT1987EG
Quick Start Guide	Provides simple instructions to setup the RSK and run the first sample, on a single A4 sheet.	RSKRL78G1C Quick Start Guide	R20UT1988EG
Schematics	Full detail circuit schematics of the RSK.	RSKRL78G1C Schematics	R20UT1981EG
Hardware Manual	Provides technical details of the RL78/G1C microcontroller.	RL78/G1C Group Hardware Manual	R01UH0348EJ

2. List of Abbreviations and Acronyms

Abbreviation	Full Form
ADC	Analog-to-Digital Converter
E1	On-chip Debugger
EMC	Electromagnetic Compatibility
ESD	Electrostatic Discharge
LCD	Liquid Crystal Display
LED	Light Emitting Diode
MCU	Micro-controller Unit
RSK	Renesas Starter Kit

Table of Contents

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.

Some of the illustrative screenshots in this document will show text in the form RL78XXX. These are general screenshots and are applicable across the whole RL78 family. In this case, simply substitute for RL78XXX RL78/G1C.

These tutorials are designed to show you how to use the RSK and are not intended as a comprehensive introduction to the e^{2}studio debugger, compiler toolchains or the E1 emulator. 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.

2.2 Application Leading Tool (Applilet)

Applilet for RL78/G1C has been used to generate the sample code discussed in this document. Applilet is a Windows GUI tool for generating template 'C' source code and project settings for the RL78/G1C. When using Applilet, 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 */
```

Applilet 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 Applilet to change any MCU operating parameters.

Applilet is not released with this RSK, but will be available in the near future via a web download at:

http://www.renesas.com/applilet_download

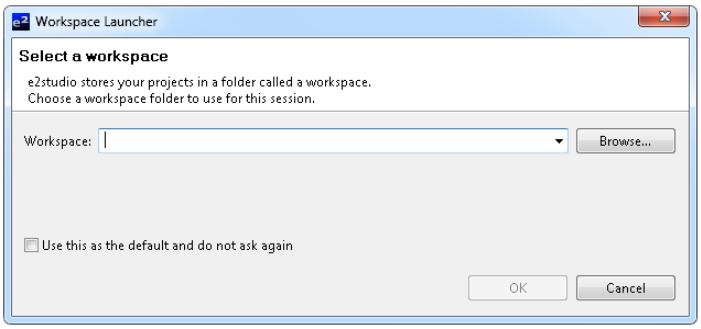
3. Tutorial Project Workspace

3.1 Introduction

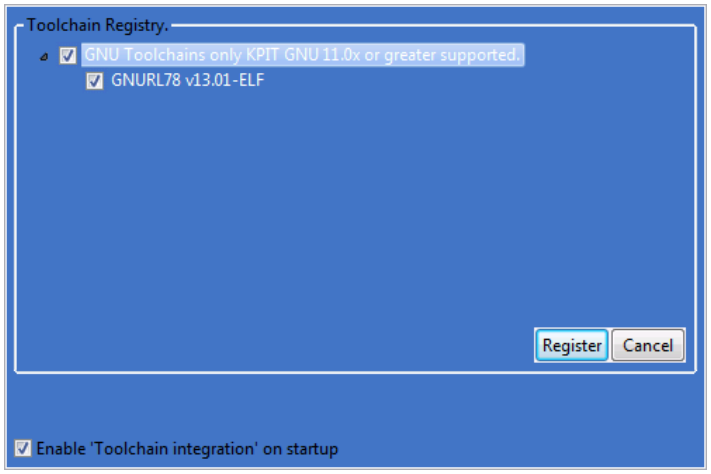
e^{2}studio is an integrated development tool that allows the user to write, compile, program and debug a software project on the RX, 78K, RL and V850 family of Renesas microcontrollers. e^{2}studio will have been installed during the installation of the software support for the Renesas Starter Kit product. This manual will describe the stages required to create and debug the supplied tutorial code.

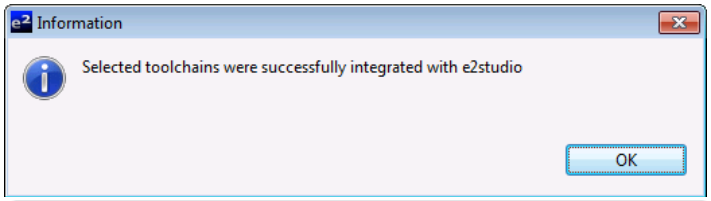
3.2 Starting e^{2}studio and Importing Sample Code

- Start e^{2}studio by selecting it from the 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’.

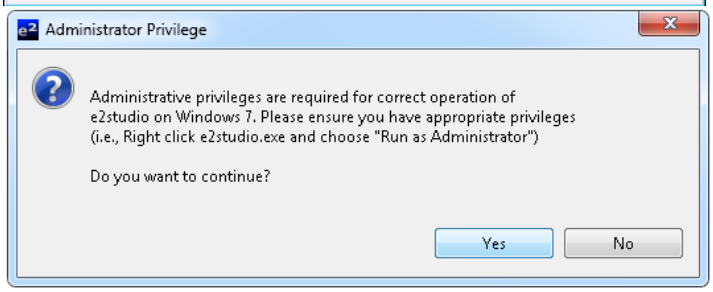


- In the Toolchain registry dialog. Select Renesas Toolchains. GNURL78 v13.01-ELF. Click on Register. A dialog will appear "Selected Toolchains were successfully integrated with e2studio". Click OK.



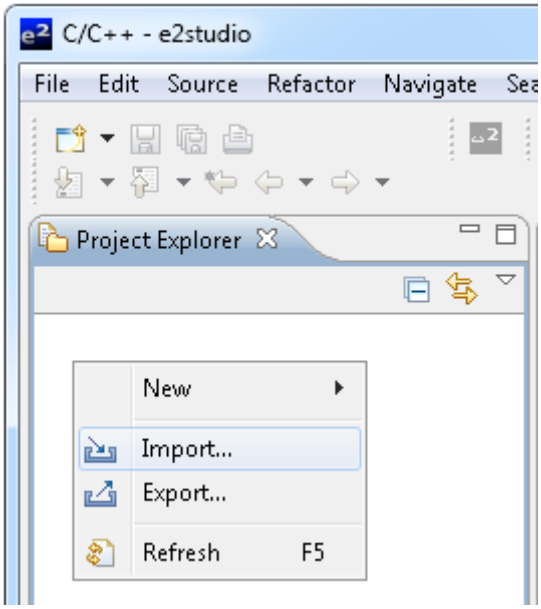


- Click ‘Yes’ when presented with the ‘Administrator Privilege’ dialog box.

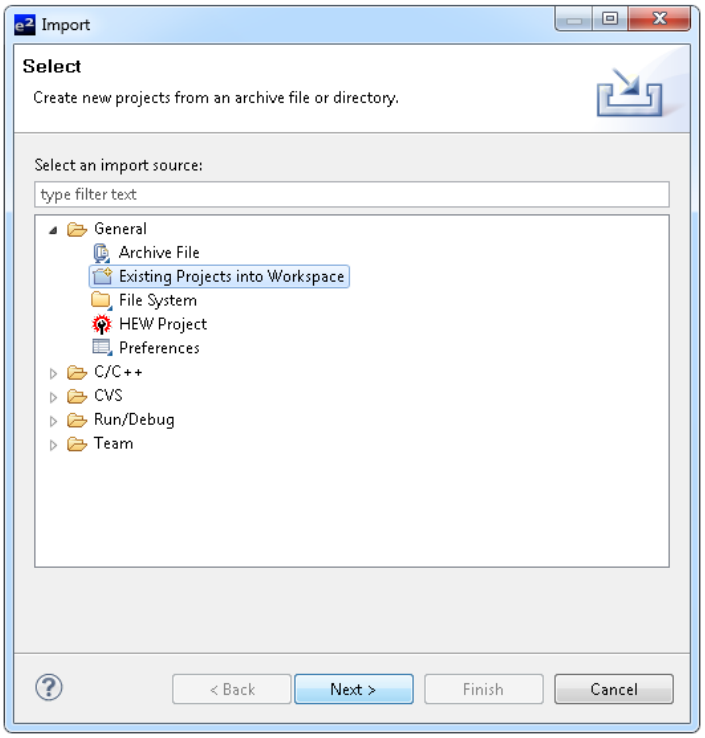


- The e²studio welcome splash screen will appear. Click the 'Go to the workbench' arrow button on the far right (circled in the screenshot opposite).

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



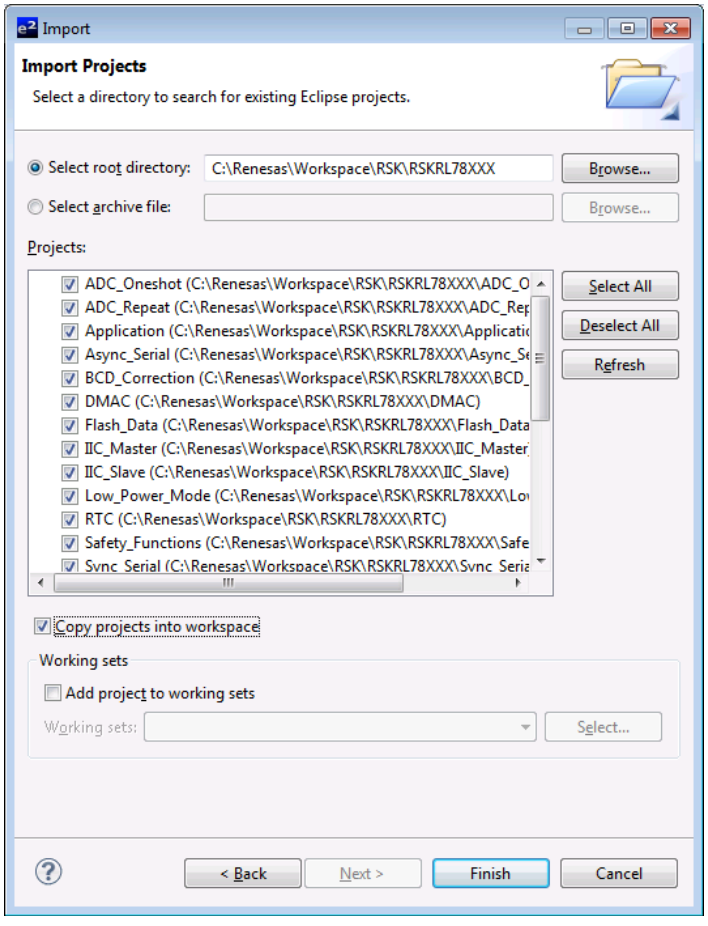
- The Import dialog box will now show. Expand the 'General' folder icon, and select 'Existing Projects into Workspace', then click 'Next'.



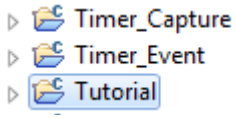
- The Import dialog box will allow you to specify a project to import. Click the 'Browse' button and locate the following directory:

  C:\Renesas\Workspace\RSK\RSKRL78G1C

- 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

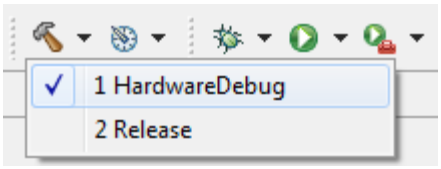
3.3.1 Build Configuration

The e^{2}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 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.

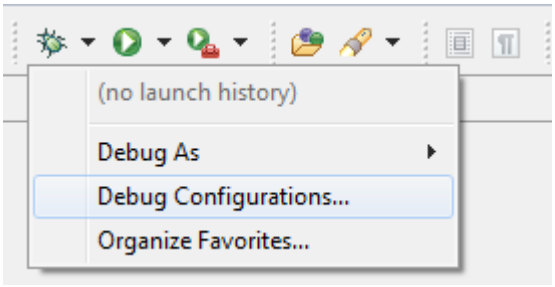
- Click the top level ‘Tutorial’ folder again, and then the arrow next to the build button (hammer icon), and select the ‘HardwareDebug’ option.



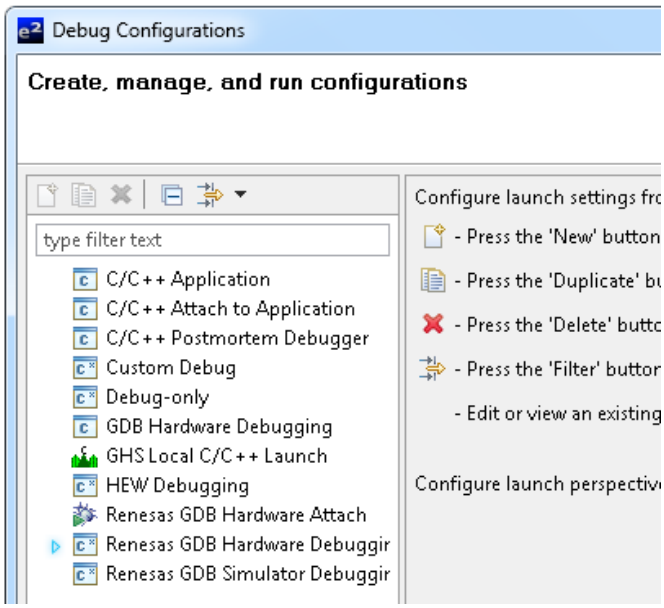
- e^{2}studio will now build the code.

3.3.2 Debug Configuration

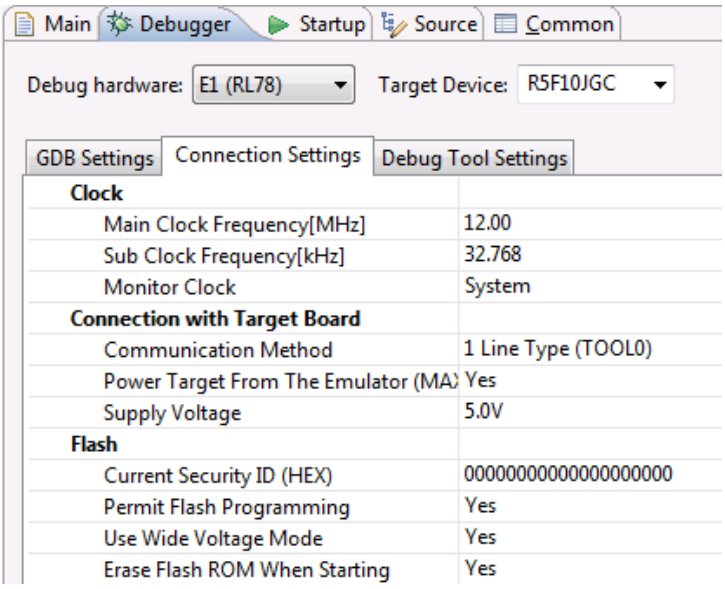
- Click the arrow next to the debug button (bug icon). Select ‘Debug Configurations’.



- 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 project.

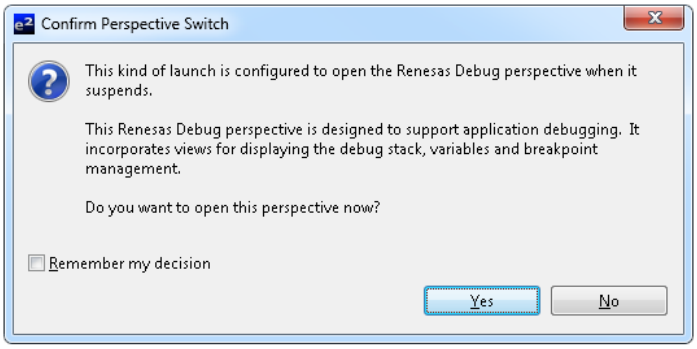


- The debug configurations control page will then show for the tutorial project. Change the main tab to 'Debugger' and then select 'Connection Settings' on the secondary tab bar that appears.
- There is no need to change the debugger settings as they are preconfigured with the tutorial project, however if you intend to use an external power supply, set the 'Power Target From The Emulator' option to No (drop-down menu).
- Refer to the RSKRL78G1C User's Manual for details of power supply configuration.

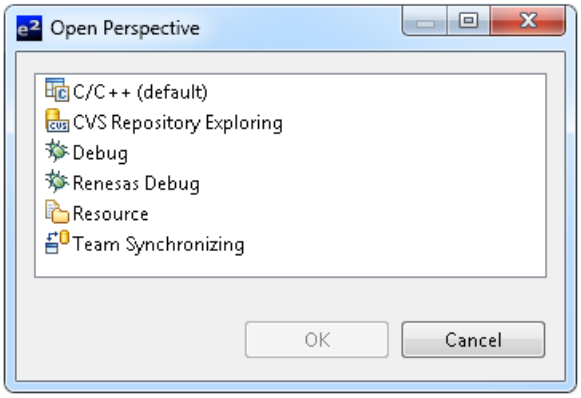


Note: e²studio will display a warning if you attempt to connect with an incorrect power supply setting.

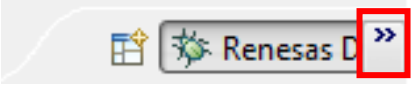
- Click the 'Debug' button to continue. e²studio will now connect to the debugger and download the code to the target.
- After downloading the code a dialog box will appear asking if you would like to switch to the 'Renesas Debug perspective'. Click 'Remember my decision' to prevent this dialog box from appearing in future, then click 'Yes'
- e²studio will load the new perspective, which is optimised for debugging.

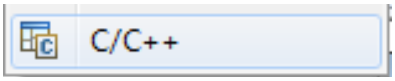


- To change back to the default 'C/C++' perspective, from the menu bar select Window > Open Perspective > Other
- The 'Open Perpsective' dialog box will appear. Click on the desired perspective to select it then 'OK'.



- Alternatively, click on the button with the double arrow in the top right corner of the screen, as shown opposite, and select the 'C/C++' option that appears.





3.4 Running the Tutorial

- Refer to the Description.txt file for instructions on how to configure the RSK and run the sample code.
- Once the code has been downloaded, click ‘Resume’ to run the code to the main function. The main function is set as the program entry point by default. The program counter will stop on the first instruction in the main function.
- Click the ‘Resume’ button in the ‘Renesas Debug’ perspective to run the rest of the code
- It is recommended that you run the entire tutorial demo first, before continuing to debug it

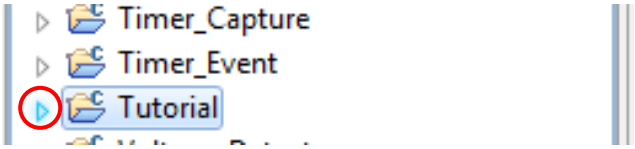
4. Reviewing the Tutorial Program

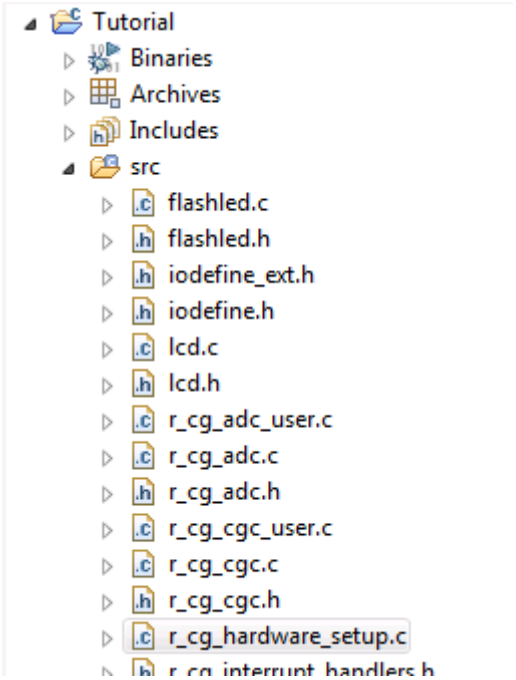
This section will look at each section of the tutorial code and basic debugging functionality in e^{2}studio.

4.1 Program Initialisation

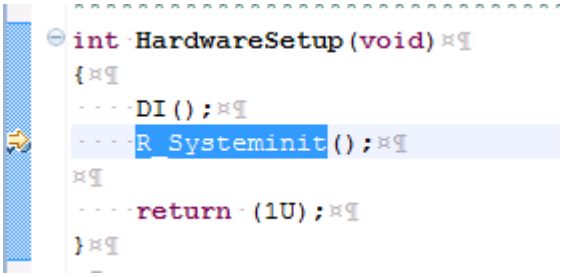
Before the main program can run, the microcontroller must be configured. The following parts of the tutorial program are used exclusively for initialising the RSK device so that the main function can execute correctly. The initialisation code is run every time the device is reset via the reset switch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

- After downloading the code, switch back to the C/C++ perspective and navigate to the Project Explorer window on the left-hand side.
- 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.
- 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.

- Click the ‘Resume’ button in the Renesas 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 Into’ button (or press [F5]), to step into the ‘R_Systeminit’ function.

- The ‘R_Systeminit’ function calls several initialisation functions which configure the MCU for normal operation. 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.

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

    return (1U);
}
```

```
/*****************************************
* Function Name: R_Systeminit
* Description  : This function initial
* Arguments    : None
* Return Value : None
*****************************************
void R_Systeminit(void)
{
    PIOR = 0x00U;
    R_CGC_Get_ResetSource();
    R_PORT_Create();
    R_CGC_Create();
    R_TAU0_Create();
    R_ADC_Create();
    R_INTC_Create();
    R_KEY_Create();
    CRC0CTL = 0x00U;
    IAWCTL = 0x00U;
    PMS = 0x00U;
}
```

For further details regarding hardware configuration, please refer to the RSKRL78G1C User’s Manual and the RL78/G1C Group Hardware Manual.

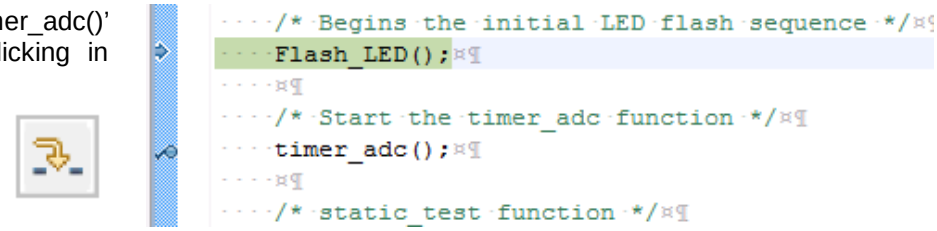
4.2 Main Functions

This section will look at the program code called from with the main() function, and how it works.

- Right click the 'Flash_LED()' function call and select 'Run to Line' to execute the program up to this line. The 'Init_LCD()' function call enables and configures the LCD panel, and 'Display_LCD()' will write "Renesas" on the top line and "RL78/G1C" onto the bottom line.

```
void main(void)
{
    R_MAIN_UserInit();
    /* Start user code. Do not edit comment generated here */

    /* Initialise the debug LCD */
    Init_LCD();

    /* Displays the Renesas splash screen */
    Display_LCD(LCD_LINE1, "Renesas");
    Display_LCD(LCD_LINE2, "RL78/G1C");

    /* Initialise the switch module */
    Switch_Init();

    /* Begins the initial LED flash sequence */
    Flash_LED();
```

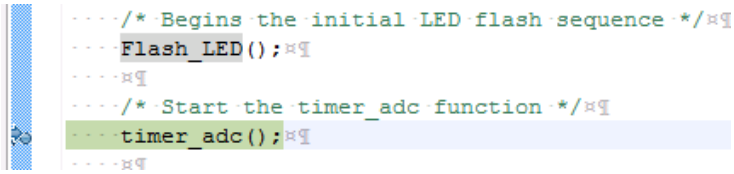
- Set a breakpoint on the 'timer_adc()' function call by double-clicking in the breakpoint column.
- Click the 'Step Into' button to step into the 'Flash_LED()' function.



- Click the 'Resume' button to resume program execution.
- The program will now run the Flash_LED function. This function periodically polls the user switches and flashes all the LEDs 200 times or until a user switch has been pressed.

```
void Flash_LED (void)
{
    /* Variable used to count down the number of LED flashes */
    static uint16_t flash_count = 0xC8;

    /* Declare a delay count variable */
    uint32_t        ulLed_Delay = 0;

    /* Flash the LEDs for 200 times or until a user switch is pressed */
    while ((0 == g_switch_flag ) && (--flash_count > 0))
    {
        for (ulLed_Delay = 0; ulLed_Delay < 60000; ++ulLed_Delay)
        {
            /* delay */
        }

        /* Toggles the LEDs after a specific delay. */
        Toggle_LED();
    }

    /* Reset the g_switch_flag flag variable */
    g_switch_flag = 0;

    /* Disable switch interrupts */
    ControlSwitchInterrupts(0);
}
```

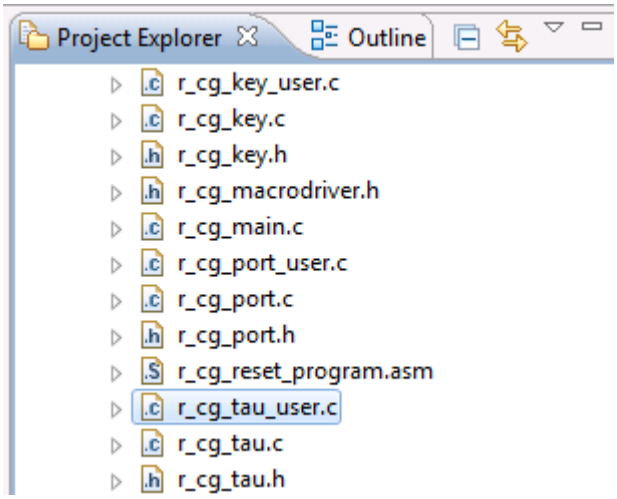
- The program counter should come to a halt at the timer_adc function.
- Step over the function by clicking the 'Step Over' button. Alternatively, press [F6].



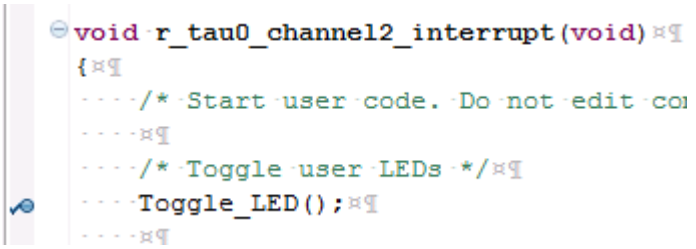
The timer_adc function starts a continuous A/D conversion and a periodic timer whose period is up-dated with the ADC result.

This timer is used to flash the LEDs at a variable rate.

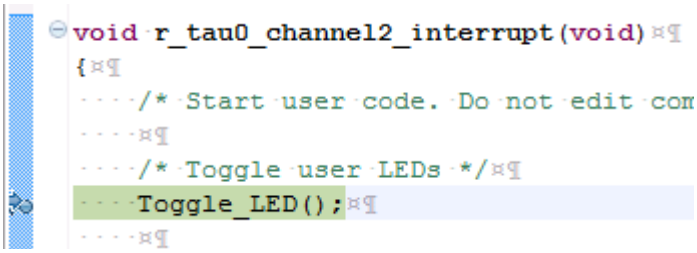
- Open the 'r_cg_tau_user.c' file (using the Project Explorer, on the right-hand side).



- Set a breakpoint on the first line of code inside the 'r_tau0_channel2_interrupt()' interrupt handler.
- Continue to execute the program by clicking the 'Resume' button.



- The program will halt at the breakpoint due to the timer's period elapsing.
- Remove the breakpoint by double-clicking on the breakpoint column.



- Press [F8] to resume program execution.
- Observe the string on the bottom line of the LCD panel change one character at a time from ‘STATIC’ to ‘TESTTEST’ as the ‘static_test’ function is executed.
- After all characters have been changed, the LCD panel’s second line will return to displaying ‘RL78/G1C’.

```
/***********************************************************************************
* Function Name: static_test
* Description  : Static variable test routine. The function replaces the
*                contents of the string ucStr with that of ucReplace, one
*                element at a time. Right-click the variable c_str, and
*                select instant watch - click add in the subsequent dialog.
*                If you step through the function, you can watch the string
*                elements being overwritten with the new data.
* Arguments    : none
* Return value : none
***********************************************************************************/
static void static_test (void)
{
    /* Declare loop count variable */
    uint8_t     ui_count = 0;

    /* Declare string variable to hold the string to be copied */
    char        c_str[] = "STATIC  \0";

    /* Declare variable buffer to store the copied string */
    const char  c_replace[] = "TESTTEST\0";

    /* Declare a delay count variable */
    uint32_t    ul_delay;

    /* Write ucStr variable, "STATIC" to LCD */
    Display_LCD(LCD_LINE2, c_str);

    /* Delay */
    for (ul_delay = 0; ul_delay < 100000; ul_delay++)
    {
        /* Delay */
    }

    /* Begin for loop which writes one letter of ucReplace to the LCD at a time
       The nested while loops generate the delay between each letter change */
    for (ui_count = 0; ui_count < 8; ui_count++)
    {
        /* Replace letter number uiCount of ucStr from ucReplace */
        c_str[ui_count] = c_replace[ui_count];

        /* Display the character on the debug LCD */
        Display_LCD(LCD_LINE2, c_str);

            /* LED Flashing Delay */
        for (ul_delay = 0; ul_delay < 100000; ul_delay++)
        {
            /* Delay */
        }
    }

    /* Clear LCD Display */
    c_str[ui_count] = '\0';

    /* Write MCU nickname to LCD again */
    Display_LCD(LCD_LINE2, NICKNAME);
}
```

- Press the ‘Suspend’ button to halt program execution.
- This is the extent of the tutorial code.

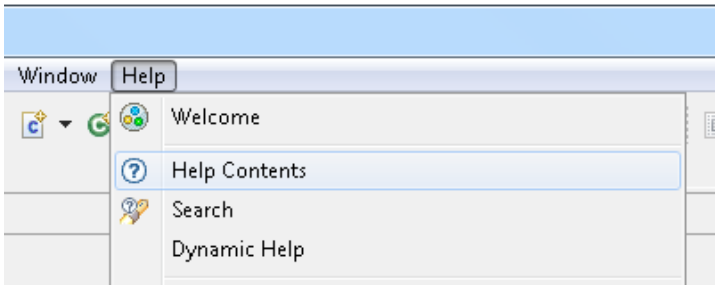
For further details regarding hardware configuration, please refer to the RL78 Series Software Manual and the RL78/G1C Group Hardware Manual.

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 e^{2}studio, refer to the help file by opening e^{2}studio, then selecting Help > Help Contents from the menu bar.



For information about the RL78/G1C series microcontrollers refer to the RL78/G1C Group Hardware Manual.

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 8 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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