User's Manual

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# RX630 Group

## Renesas Starter Kit Tutorial Manual
## For e²studio

RENESAS MCU
RX Family / RX600 Series



Renesas Electronics
www.renesas.com

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## 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 is 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 the RSK hardware functionality, and electrical characteristics. It is intended for users designing sample code on the RSK platform, using the many different incorporated peripheral devices.

The manual comprises of an overview of the capabilities of the RSK product, but does not intend to be a guide to embedded programming or hardware design. Further details regarding setting up the RSK and development environment can found in the tutorial manual.

| |
|---|
| 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. |

## 2. List of Abbreviations and Acronyms

| Abbreviation | Full Form |
|---|---|
| ADC | Analogue to Digital Converter |
| API | Application Programming Interface |
| CD | Compact Disk |
| CPU | Central Processing Unit |
| E1 | E1 Emulator |
| E20 | E20 Emulator |
| LCD | Liquid Crystal Display |
| LED | Light Emitting Diode |
| ROM | Read-Only Memory |
| RSK | Renesas Starter Kit |
| USB | Universal Serial Bus |

# 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.

> These tutorials are designed to show you how to use the RSK and are not intended as a comprehensive introduction to e$^2$studio, 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 the line numbers for source code illustrated in this document does not match exactly with that in the actual source files. It is also possible that the source address of instructions illustrated in this manual differs from a user's code compiled from the same source. These differences are minor, and do not effect the functionality of the sample code or the validity of this accompanying manual.

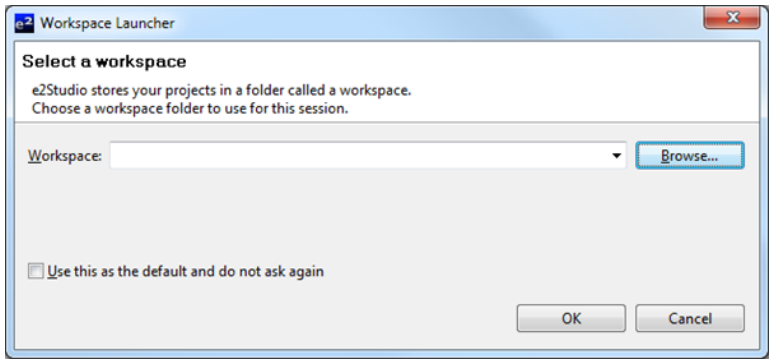
# 3. Project Workspace

## 3.1 Introduction

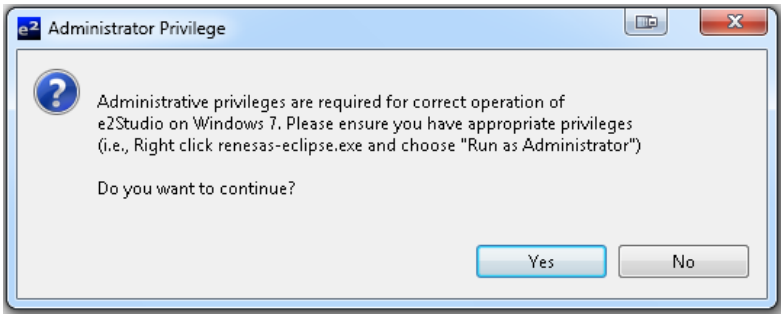
e$^2$studio is a open source integrated development tool that allows the user to write, compile, program and debug a software project on many of the Renesas Microcontrollers.

## 3.2 Starting e$^2$studio and Importing Sample Code

- Start e$^2$studio by selecting it from Start Menu. The first dialog to appear will be the Workspace Launcher.
- Click ‘Browse’ and select a suitable location to store your workspace, using the ‘Make New Folder’ option as necessary. Click ‘OK’.

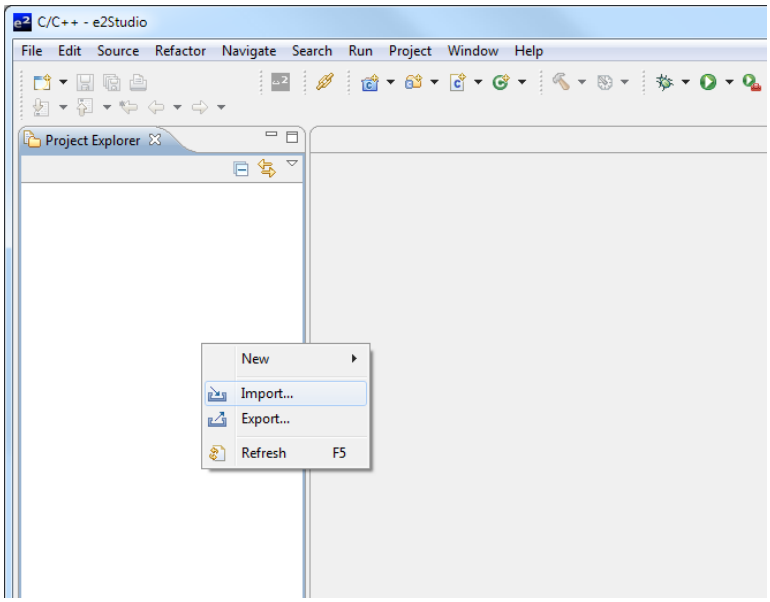



- Click ‘Yes’ when presented with the ‘Administrator Privilege’ dialog.

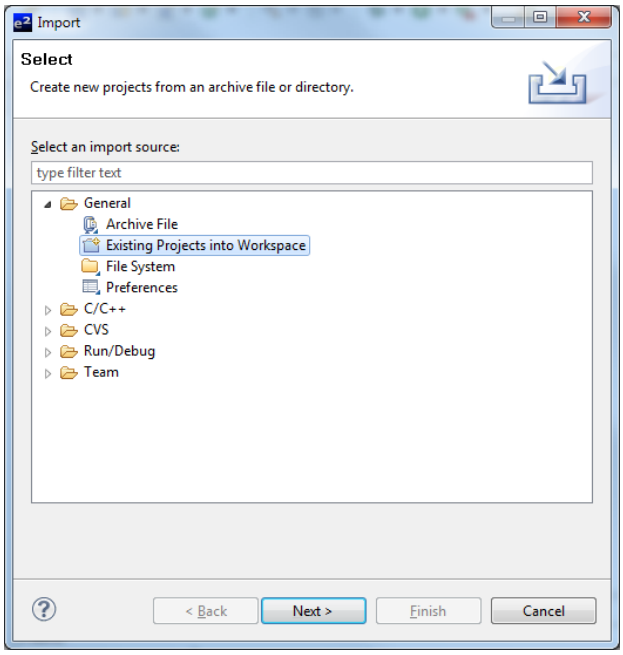



- The e2studio welcome splash screen will appear. Click the ‘Go to the workbench’ arrow button on the far right.

- Once the e$^2$studio environment has initialised, right click in the project explorer window and click ‘Import…’



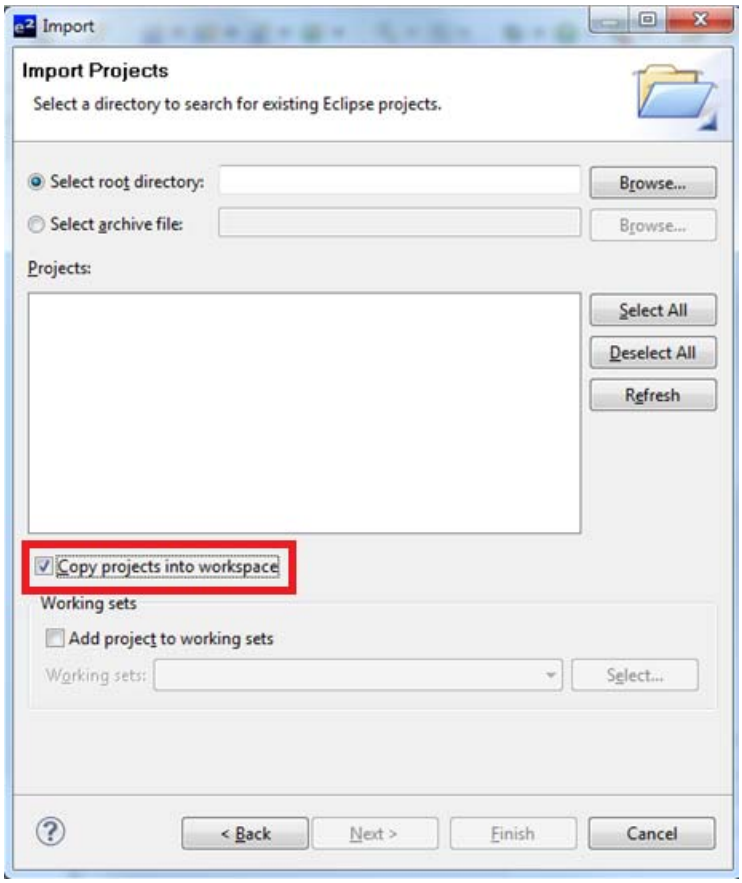

- The Import dialog will now appear. Expand the ‘General’ folder icon, and select “Existing Projects into Workspace”, then click ‘Next’.



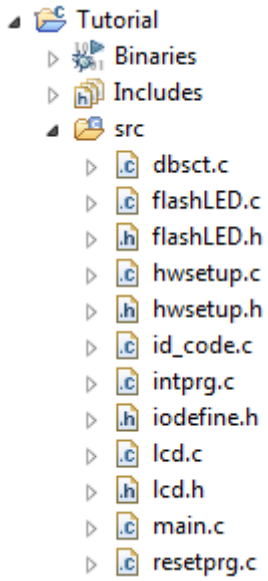
- The import dialog will now allow you to specify the project to import. Click the ‘Browse’ button, and locate the following directory:

  C:\Workspace\RSK\RSKRX630

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




- From the list of projects in the ‘Project Explorer’ on the left hand side, select the ‘Tutorial’ project and click the arrow next to it to expand the folder contents, and click the arrow next to the ‘src’ folder to show the source files.



## 3.3 Build Configurations and Debug Sessions

### 3.3.1 Build Configuration

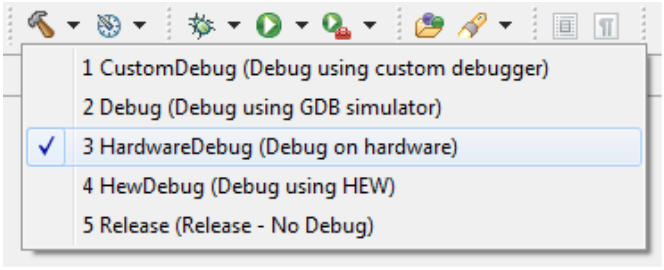
The e$^2$studio workspace will be created with several build configurations – the two we will address in this manual is 'HardwareDebug' and 'Release'.

**Release**
This build mode has optimisation turned on, and provides little debug information. The C code instruction 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. C code instruction execution will be linear.

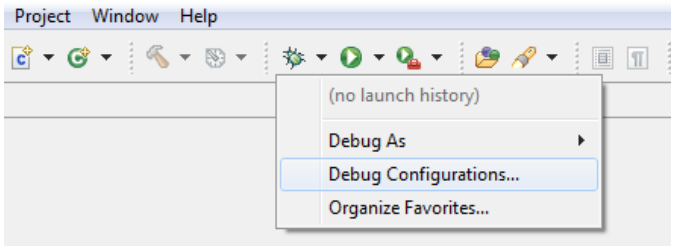
- Click the top level tutorial project folder again, and then the arrow next to the build button (hammer icon), and select the 'HardwareDebug' option.

- e$^2$studio will now build the code.

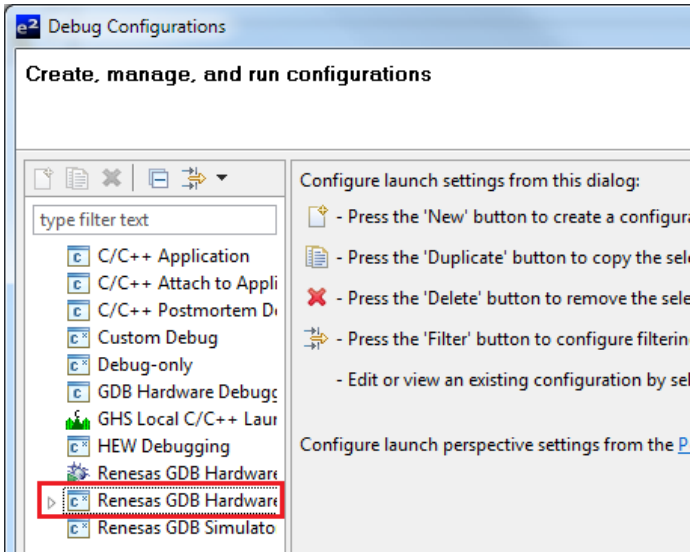


### 3.3.2 Debug Configuration

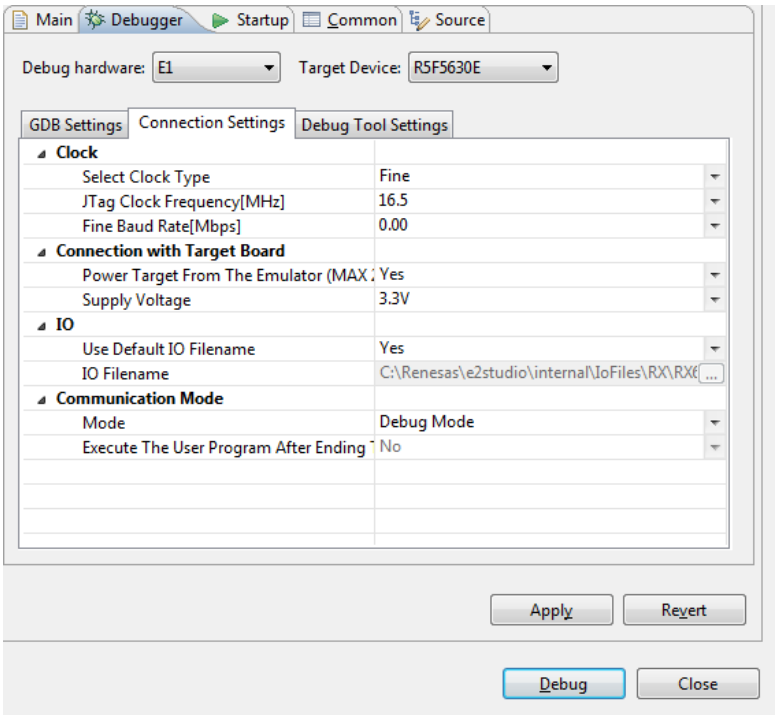
- Click the arrow next to the debug button (bug icon). Select ‘Debug Configurations’.




- The ‘Debug Configuration’ dialog will appear. Click the small arrow next to ‘Renesas GDB Hardware Debugging’ option.
- The build configurations for each project will appear. Select the entry for the tutorial project.

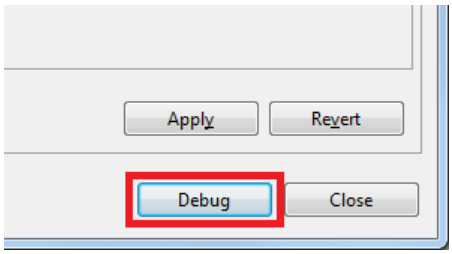



- The debug configurations control page will then show for the tutorial project. Change the main tab to ‘Debugger’, and then secondary tab to ‘Connection Settings’. Check through the debugger settings. If you intend to use an external power supply, set the ‘Power Target From The Emulator’ option to No (drop down menu).
- Refer to the RSK’s User Manual for details of power supply configurations.

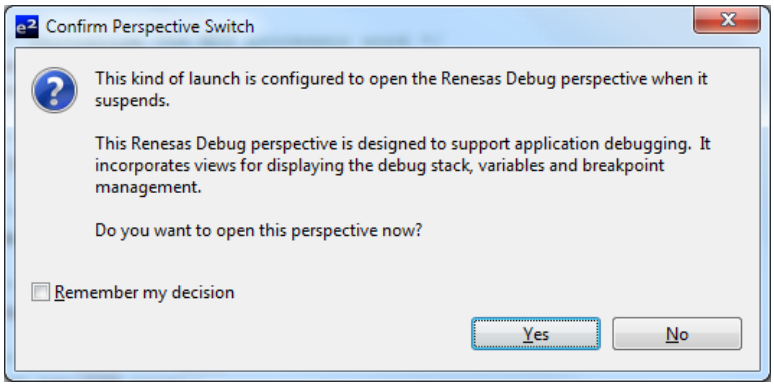



**Note**: e²studio will display a warning dialog if you attempted to connect with an incorrect power supply setting.

- Click the debug button to continue. e$^2$studio will now connect to the debugger, and download the code to the target.




- e$^2$studio may display a dialog, asking if you would like to switch to the ‘Renesas Debug perspective’. Click ‘Yes’.
- The new e$^2$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 ‘Power On’ 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.

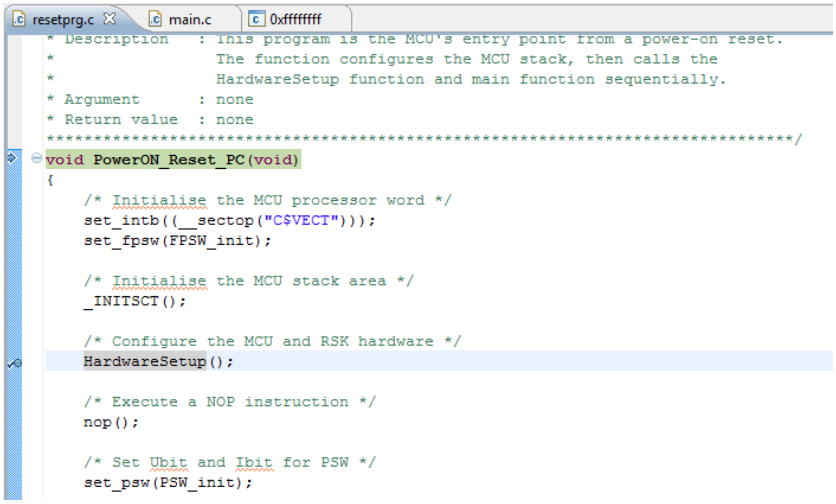
# 4. Basic Debugging of the Tutorial Program

This section will look at basic debugging functionality in e$^2$studio.

## 4.1 Program Initialisation

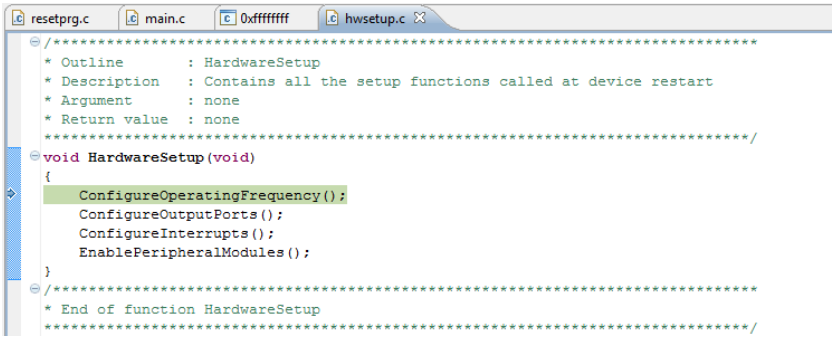
Before the main program can run, the microcontroller must be configured. The following parts of the tutorial program are used exclusively for initialising the RSK device so that the main function can execute correctly. The initialisation code is run every time the device is reset via the reset switch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

- After downloading the code. The File window will open the Tutorial code at the entry point. The program counter position will be highlighted
- Double click the blue section to the left of the code in line with the 'HardwareSetup();' line. This will add a software breakpoint, indicated by a blue tick and a dot.
- Click the 'Resume' button to run the code up to this breakpoint.




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

- The 'HardwareSetup' 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 and comments. For this guide, we will skip past it.
- Click the 'Resume' button, to run the code up to the main function.

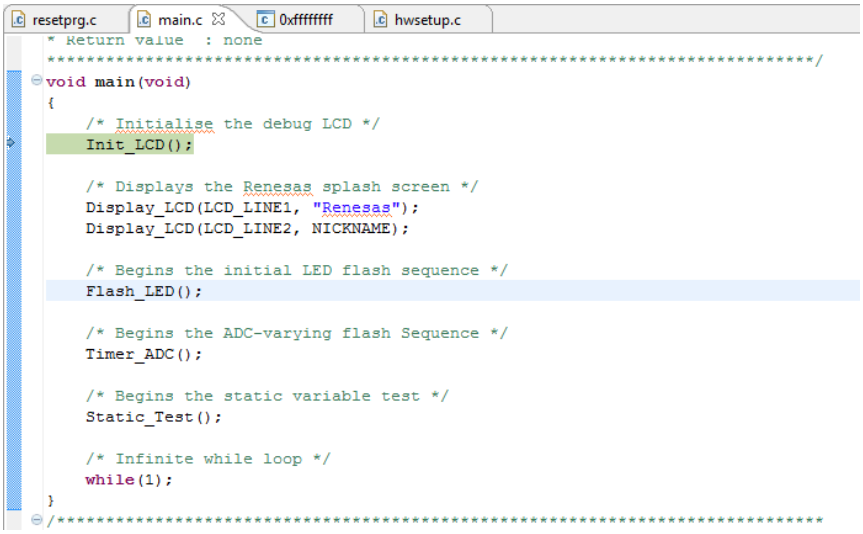



For further details regarding hardware configuration, please refer to the RSKRX630 User's Manual and the RX630 Hardware Manual.

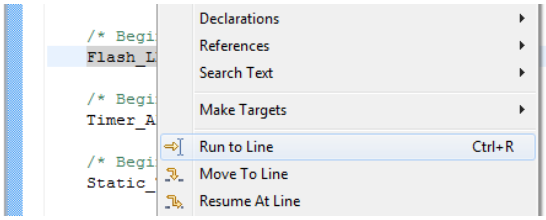
## 4.2 Main Functions

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

- The main function first initialises the debug LCD, and then displays 'Renesas' and the RSK name on the screen.
- Support for the LCD display is included in the tutorial code. We do not need to be concerned about the details of the LCD interface – except that the interface is write-only and so is not affected if the LCD display is attached or not.

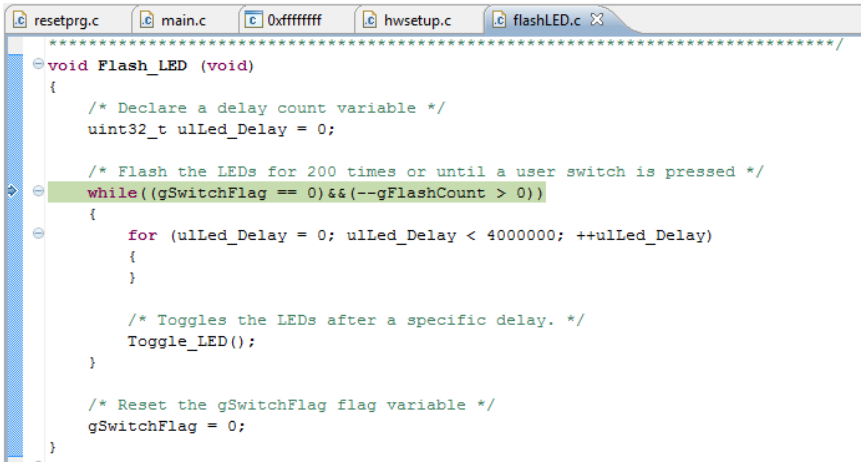



- Left click line with the function call 'Flash_LED()' to select it, then right click it and select the option 'Run to Line'.
- This will cause the target to execute all code before this line. This can be observed by the text displayed on the debug LCD.

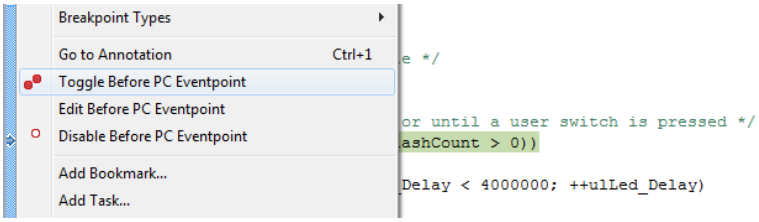



- Click the 'Step Into' button to step into the Flash_LED function.

- The program counter will now move to the Flash_LED function. The while loop iterates through and toggles the user LEDs. This loop will continue until it has flashed the LEDs 200 times or a user switch is pressed.




- Left click the line 'gSwitchFlag = 0', and right click in the blue section to the right and select 'Toggle Before PC Eventpoint'.
- This will insert a hardware event point at this code line.



- Click the resume button, and the RSK will run through the iteration loop. Press one of the user switches to proceed past the loop. The program counter will stop at the hardware eventpoint.
- Click the 'Step Return' button to exit the 'Flash_LED' function and return to main.

```
resetprg.c | main.c | 0xffffffff | hwsetup.c | flashLED.c
 * Return value  : none
 ***********************************************************************************/
void Flash_LED (void)
{
    /* Declare a delay count variable */
    uint32_t ulLed_Delay = 0;

    /* Flash the LEDs for 200 times or until a user switch is pressed */
    while((gSwitchFlag == 0)&&(--gFlashCount > 0))
    {
        for (ulLed_Delay = 0; ulLed_Delay < 4000000; ++ulLed_Delay)
        {
        }

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

    /* Reset the gSwitchFlag flag variable */
    gSwitchFlag = 0;
}
/***********************************************************************************
 * End of function Flash_LED
 ***********************************************************************************/
```

- The 'Timer_ADC' function initialises the ADC and timer unit, so that a periodic interrupt toggles the user LEDs. The period of the periodic interrupt is varied by the value of the potentiometer.

```
resetprg.c | main.c | 0xffffffff | hwsetup.c | flashLED.c | timeradc.c
 * Return value  : none
 ***********************************************************************************/
void main(void)
{
    /* Initialise the debug LCD */
    Init_LCD();

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

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

    /* Begins the ADC-varying flash Sequence */
    Timer_ADC();

    /* Begins the static variable test */
    Static_Test();

    /* Infinite while loop */
    while(1);
}
/***********************************************************************************
```

- Click the 'Step Over' button (or press F6) to step the program counter onto the next function, 'Static_Test'.
- Click 'Step Into' to enter the 'Static_Test' function.

- In the *for* loop, the contents of the string 'ucStr' are replaced with the contents of 'ucReplace', one element at a time.
- While this happens, the code is regularly interrupted by the Timer ADC code, allowing both to appear to run simultaneously.

```
resetprg.c | 0xffffffff | hwsetup.c | flashLED.c | timeradc.c | lcd.c | main.c
 ***********************************************************************************/
void Static_Test(void)
{
    /* Declare loop count variable */
    uint8_t uicount = 0;

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

    /* 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 (uicount=0; uicount<8; uicount++)
    {
        /* Start a one-shot timer to create a delay between each loop
           iteration */
        Timer_Delay(40, mS);

        /* Replace letter number 'uiCount' of 'ucStr' from 'ucReplace' */
        ucStr[uicount] = ucReplace[uicount];
        Display_LCD(LCD_LINE2,ucStr);
    }

    /* Clear LCD Display */
    ucStr[uicount] = '\0';
```

- Click the resume button to run the code through.

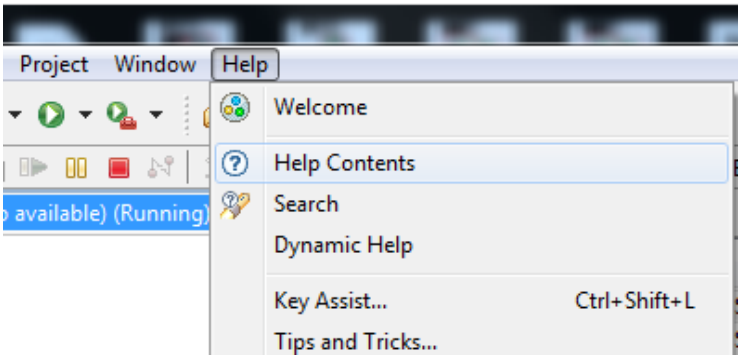
- You can observe the user LED flash rate vary as you adjust the potentiometer, at the same time as the debug LCD string change character by character from ‘STATIC’ to ‘TEST-TEST’.

- This is the extent of the tutorial code.

# 5. Additional Information

**Technical Support**

For details on how to use e$^2$studio, refer to the help file by opening e$^2$studio and clicking 'Help' and selecting 'Help Contents'




For information about the RX630 series microcontrollers refer to the RX630 Group hardware manual.

For information about the RX630 assembly language, refer to the RX600 Series Software Manual.

Online technical support and information is available at: http://www.renesas.com/rskrx630

**Technical Contact Details**

America: techsupport.america@renesas.com
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|---|---|---|---|
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2880 Scott Boulevard Santa Clara, CA 95050-2554, U.S.A.
Tel: +1-408-588-6000, Fax: +1-408-588-6130
**Renesas Electronics Canada Limited**
1101 Nicholson Road, Newmarket, Ontario L3Y 9C3, Canada
Tel: +1-905-898-5441, Fax: +1-905-898-3220
**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: +49-211-65030, Fax: +49-211-6503-1327
**Renesas Electronics (China) Co., Ltd.**
7th Floor, Quantum Plaza, No.27 ZhiChunLu Haidian District, Beijing 100083, P.R.China
Tel: +86-10-8235-1155, Fax: +86-10-8235-7679
**Renesas Electronics (Shanghai) Co., Ltd.**
Unit 204, 205, AZIA Center, No.1233 Lujiazui Ring Rd., Pudong District, Shanghai 200120, China
Tel: +86-21-5877-1818, Fax: +86-21-6887-7858 / -7898
**Renesas Electronics Hong Kong Limited**
Unit 1601-1613, 16/F., Tower 2, Grand Century Place, 193 Prince Edward Road West, Mongkok, Kowloon, Hong Kong
Tel: +852-2886-9318, Fax: +852 2886-9022/9044
**Renesas Electronics Taiwan Co., Ltd.**
7F, No. 363 Fu Shing North Road Taipei, Taiwan
Tel: +886-2-8175-9600, Fax: +886 2-8175-9670
**Renesas Electronics Singapore Pte. Ltd.**
1 harbourFront Avenue, #06-10, keppel Bay Tower, Singapore 098632
Tel: +65-6213-0200, Fax: +65-6278-8001
**Renesas Electronics Malaysia Sdn.Bhd.**
Unit 906, 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 Korea Co., Ltd.**
11F., Samik Lavied' or Bldg., 720-2 Yeoksam-Dong, Kangnam-Ku, Seoul 135-080, Korea
Tel: +82-2-558-3737, Fax: +82-2-558-5141



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