User's Manual

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RZ/A1H Group

Renesas Starter Kit+ Tutorial Manual
For e^2 studio

RENESAS MCU
RZ Family / RZ/A1H 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.
   — The input pins of CMOS products are generally in the high-impedance state. In operation with an unused pin in the open-circuit state, extra electromagnetic noise is induced in the vicinity of LSI, an associated shoot-through current flows internally, and malfunctions occur due to the false recognition of the pin state as an input signal become possible. Unused pins should be handled as described under Handling of Unused Pins in the manual.
2. Processing at Power-on
   The state of the product is undefined at the moment when power is supplied.
   — The states of internal circuits in the LSI are indeterminate and the states of register settings and pins are undefined at the moment when power is supplied.
   In a finished product where the reset signal is applied to the external reset pin, the states of pins are not guaranteed from the moment when power is supplied until the reset process is completed.
   In a similar way, the states of pins in a product that is reset by an on-chip power-on reset function are not guaranteed from the moment when power is supplied until the power reaches the level at which resetting has been specified.
3. Prohibition of Access to Reserved Addresses
   Access to reserved addresses is prohibited.
   — The reserved addresses are provided for the possible future expansion of functions. Do not access these addresses; the correct operation of LSI is not guaranteed if they are accessed.
4. Clock Signals
   After applying a reset, only release the reset line after the operating clock signal has become stable. When switching the clock signal during program execution, wait until the target clock signal has stabilized.
   — When the clock signal is generated with an external resonator (or from an external oscillator) during a reset, ensure that the reset line is only released after full stabilization of the clock signal. Moreover, when switching to a clock signal produced with an external resonator (or by an external oscillator) while program execution is in progress, wait until the target clock signal is stable.
5. Differences between Products
   Before changing from one product to another, i.e. to a product with a different part number, confirm that the change will not lead to problems.
   — The characteristics of 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^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 RZA1H 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 RZA1H 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+RZA1H Quick Start Guide	R20UT3006EG
User's Manual	Describes the technical details of the RSK+ hardware.	RSK+RZA1H User's Manual	R20UT3007EG
Tutorial	Provides a guide to setting up RSK+ environment, running sample code and debugging programs.	RSK+RZA1H Tutorial Manual	R20UT3008EG
Schematics	Full detail circuit schematics of the RSK+.	RSK+RZA1H Schematics	R20UT2586EG
Hardware Manual	Provides technical details of the RZA1H microcontroller.	RZA1H Group Hardware Manual	R01UH0403EJ

2. List of Abbreviations and Acronyms

Abbreviation	Full Form
ADC	Analog-to-Digital Converter
e^2 studio	Renesas *Eclipse Embedded Studio* Integrated Debugging Environment
EMC	Electromagnetic Compatibility
ESD	Electrostatic Discharge
J-LINK	On-chip Debugger
LCD	Liquid Crystal Display
LED	Light Emitting Diode
MCU	Micro-controller Unit
QSPI	Quad Serial Peripheral Interface
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^2 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^2 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^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.

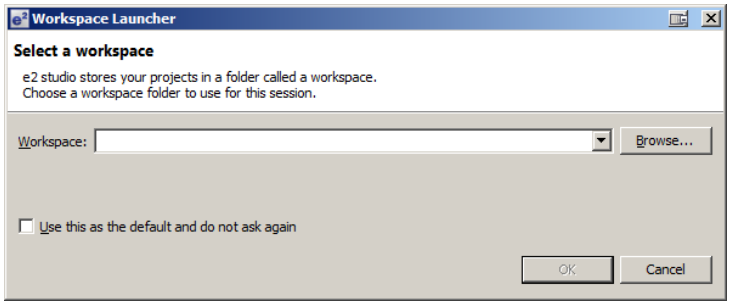
3.2 Jumper and Switch Configuration

Ensure jumpers and switches are in the following positions:

Jumper	Pins	Switch	Position	Switch	Position
JP11	1 - 2	SW4-1	OFF	SW6-1	OFF
JP12	1 - 2	SW4-2	OFF	SW6-2	ON
JP18	1 - 2	SW4-3	OFF	SW6-3	OFF
JP21	1 - 2	SW4-4	OFF	SW6-4	ON
PWR_SEL	2 - 3	SW4-5	OFF	SW6-5	ON
--	--	SW4-6	OFF	SW6-6	ON
--	--	SW4-7	OFF	--	--
--	--	SW4-8	OFF	--	--

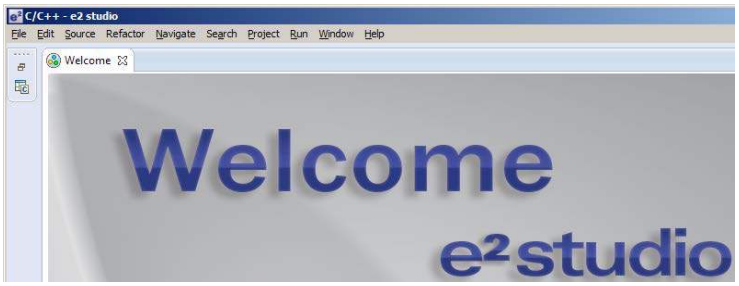
3.3 Starting e^2 studio and Importing Sample Code

- Start Eclipse for e^2 studio by selecting it from the Start Menu -> All Programs -> Renesas Electronics e2 studio -> 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'.

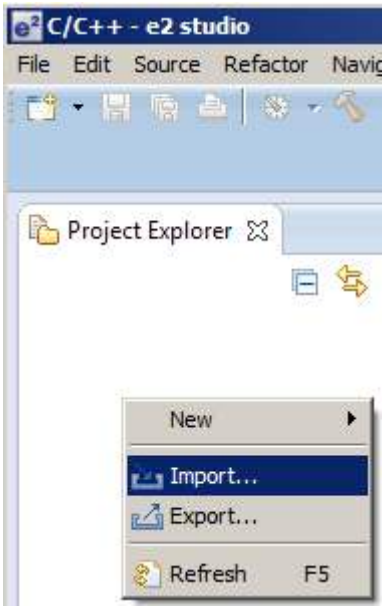


Note: The Workspace location does not have to contain your project files, the workspace contains the configuration of the tool and can group projects together. Projects may be referred to from this location, or the projects may be stored under this directory.

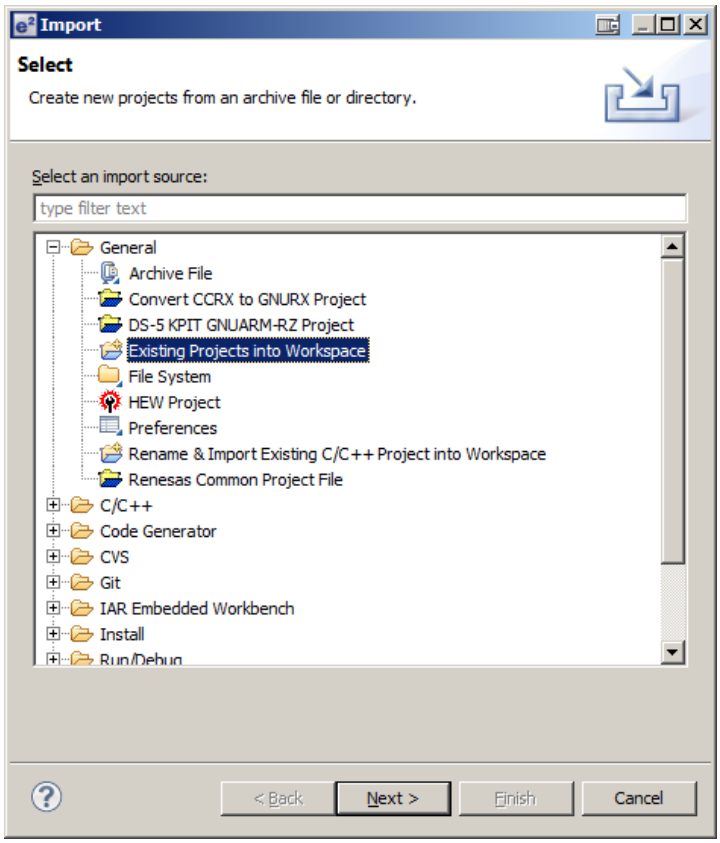
- e^2 studio will open with the 'Welcome…' tab as shown opposite.
- Close the tab by clicking on the cross.



- 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:

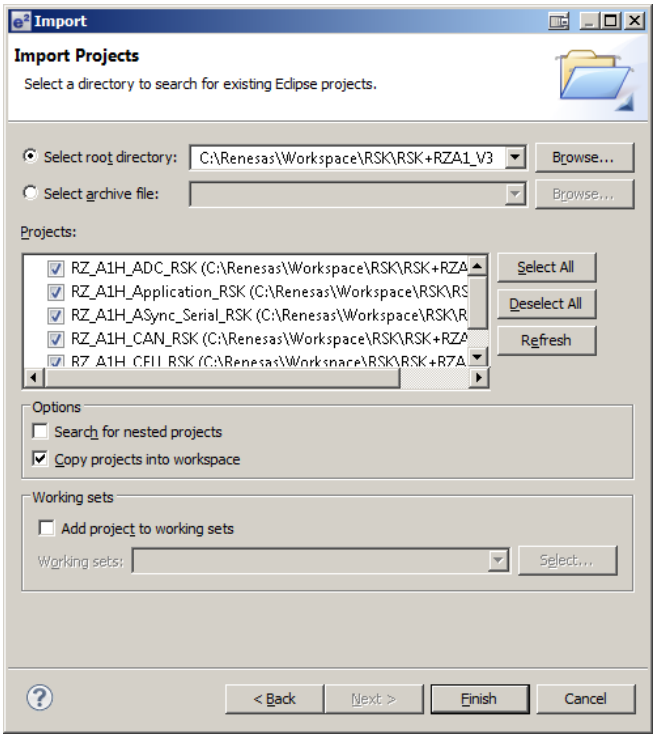
  C:\Renesas\Workspace\RSK\RSK+RZA1_V3

- Press ‘OK’ and select tutorial project [RZ_A1H_Tutorial_RSK]

- 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’.



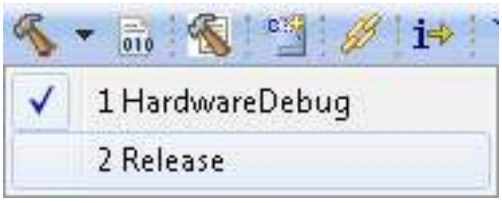
3.4 Build Configurations and Debug Sessions

3.4.1 Build Configuration

The e^2 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.

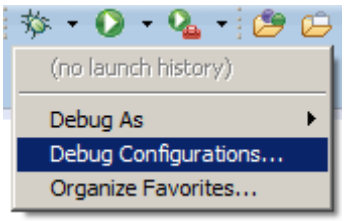
- Click the top level 'Tutorial' folder again, and then the arrow next to the build button (hammer icon), and select the 'HardwareDebug' option.



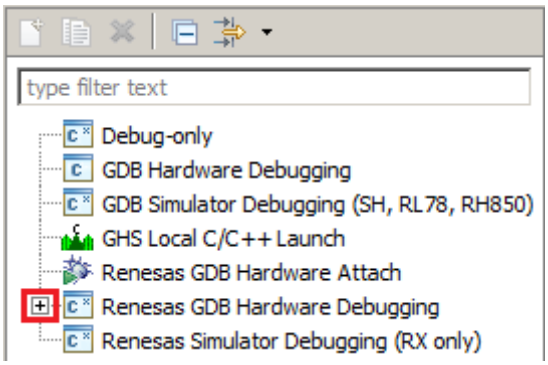
  e^2 studio will now build the code.
- The output from the build process will be presented in the console window of e^2 studio.

3.4.2 Debug Configuration

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



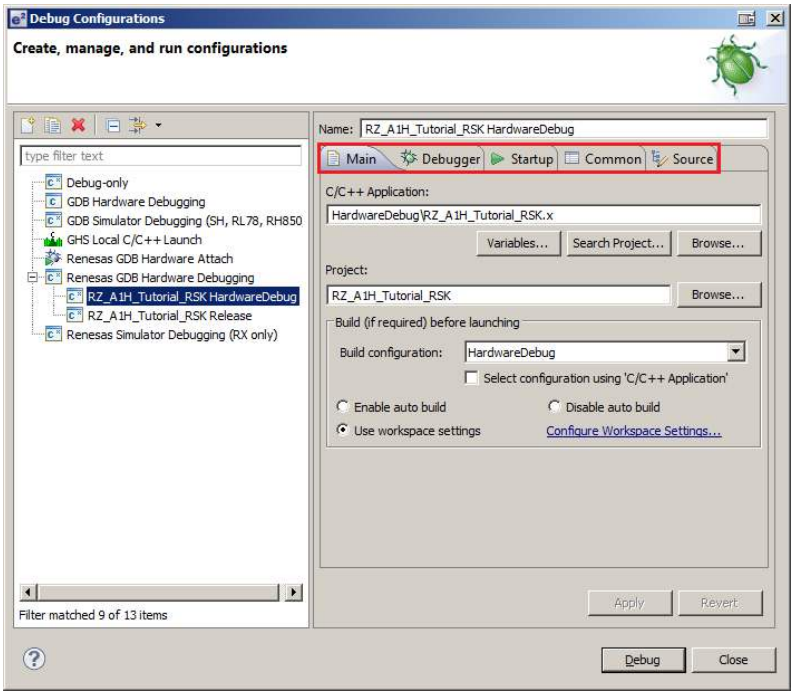
- The 'Debug Configurations' dialog box will appear. Click on the button next to 'Renesas GDB Hardware Debugging' to expand the view.
- By default, e^2 studio creates Debug Configurations for each existing build mode. The RSK+RZA1H project have pre-configured debug configurations that are ready to use.



Note:
To manually create a new e^2 studio debug configuration, click on 'Renesas GDB Hardware Debugging' then click on the 'New' button .

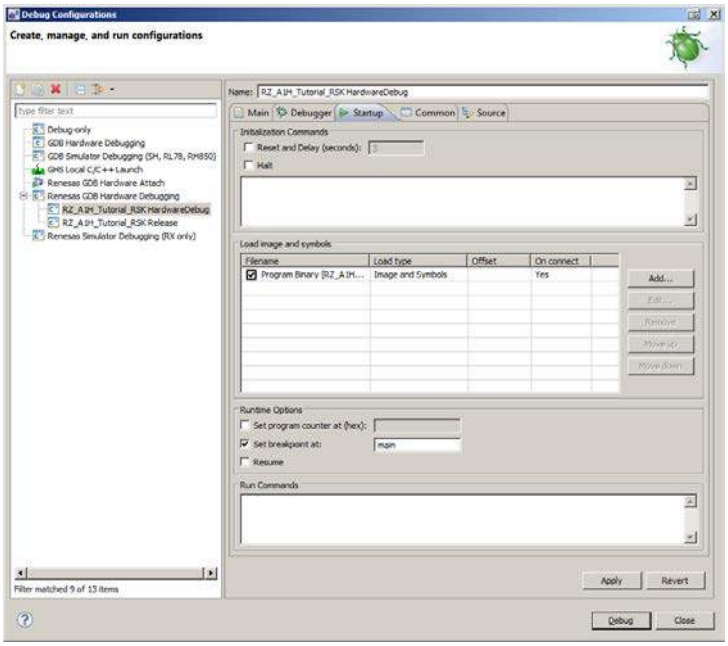
- The debug configurations control page will open. Observe the settings under each tab.
- Under the ‘Debugger’ tab, ensure the ‘Debugger hardware’ option is set to ‘J-Link ARM’.
- The ‘Target Device’ is preset to ‘R7S72100’.

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

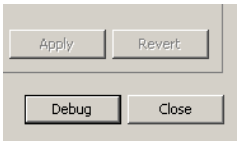


- A security dialog may appear indicating that the Windows Firewall has blocked some features of the eclipse platform.
- Under the text ‘Allow eclipse to communicate on these networks’, ensure the check box next to ‘Private networks, such as my home or work network’ is ticked. Click ‘Allow access’

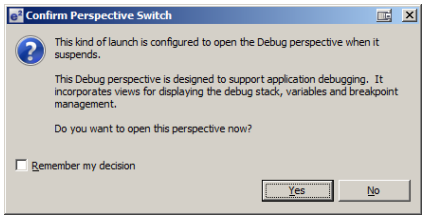
- Select the ‘Startup’ tab.
- Ensure the ‘Runtime Option’ ‘Set breakpoint at:’ is specified as ‘main’.



- Click on ‘Debug’.



- Before downloading the code a dialog box will appear asking if you would like to switch to the ‘e^2 studio Debug perspective’. If you agree click ‘Remember my decision’ to prevent this dialog box from appearing in future, then click ‘Yes’.
- e^2 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 Perpsective’ 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.

4. Reviewing the Tutorial Program

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

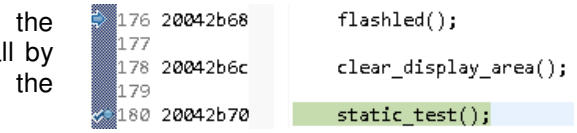
4.1 Main Functions

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

- Start a debug session for the Tutorial program as described in the previous section. The debugger should connect and the program will be stopped on the first line of the main() function as shown in the screenshot opposite.
- Click on the line containing the 'flashled()' function call in 'main()' to position the cursor. Right-click and select 'Run to Line' to execute the program up to this line. The 'R_LCD_Init()' function call enables and configures the LCD, and 'Display_LCD()' will write "RSK+RZA1H" on the top line and "Tutorial Sample" below.

```
150             int_t main(void)
151 20042a9c    {
152 20042aa8        char strdata[32] = "";
153 20042b08        uint8_t * pmptr = &g_rgb888_logo[0];
154
155 20042b14        R_RIIC_rza1h_rsk_init();
156
157                 /* Initialise SPI */
158 20042b18        R_SPI_Init();
159
160                 /* Initialise the PMod Colour LCD display */
161 20042b1c        R_LCD_Init();
162
163                 /* Initialise direct connected LED */
164 20042b20        R_LED_Init();
165
166                 /* Initialise board switches (SW1,SW2,SW3) */
167 20042b24        init_switches();
168
169                 /* Display 'Renesas' Logo at bottom of screen */
170 20042b28        display_image (pmptr, 128, 24, 0, 104);
171 20042b44        display_on();
172
173 20042b48        display_lcd(0, (uint8_t *)" RSK+RZA1H");
174 20042b58        display_lcd(2, (uint8_t *)" Tutorial Sample");
175
176 20042b68        flashled();
177
178 20042b6c        clear_display_area();
179
180 20042b70        static_test();
```

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



- Click the 'Resume' button to resume program execution.
- The program will now run the flashled() function. This function periodically polls the user switches and flashes the LEDs 200 times (as specified in the loopcount variable) or until a user switch has been pressed.

```
78                  void flashled(void)
79  20040668        {
80                      char strdata[256];
81  20040674            uint16_t loopcount = 200;
82                      uint32_t delay;
83
84  2004067c            display_lcd(5, (uint8_t *)" LED Flashing");
85  2004068c            display_lcd(6, (uint8_t *)" Press SW1,SW2,SW3");
86  2004069c            display_lcd(7, (uint8_t *)" or wait 200 flashes");
87  200406ac            display_lcd(8, (uint8_t *)" to continue demo");
88
89  200406bc            R_LED_Off(LED_ALL);
90
91  200406c4            while(loopcount)
92                      {
93  200406c8                sprintf(strdata," Countdown %d ",--loopcount);
94
95                          /* Display the application name on the PMOD LCD */
96  200406f0                display_lcd(10, (uint8_t *)strdata);
97
98  20040700                delay = 10000000u;
99  2004070c                while (--delay)
100                         {
101 20040710                    __asm__("nop");
102                         }
103
104                         /* Toggles the LEDs after a specific delay. */
105 2004072c                R_LED_Toggle(LED_ALL);
106
107
108 20040734                if(g_switch_press_flg)
109                         {
110 20040748                    g_switch_press_flg = 0;
111 20040758                    loopcount = 0;
112                         }
113                     }
114
115 2004076c            R_LED_Off(LED_ALL);
116 20040774       }
```

- The program counter should come to a halt at the static_test() function.
- Step into the function by clicking the 'Step Into' button. Alternatively, press [F5].

```
176 20042b68        flashled();
177
178 20042b6c        clear_display_area();
179
180 20042b70        static_test();
```

- Press [F7] or 'Step Out' to execute the static_test() function.
- Observe the string on the bottom line of the LCD 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 bottom line will return to displaying 'STATIC'.

```
234             static void static_test (void)
235 20042d20    {
236 20042d2c        char strdata[32] = "";
237
238                 /* Declare loop count variable */
239 20042d8c        uint8_t     ui_count = 0;
240
241                 /* Declare string variable to hold the string to be copied */
242 20042d94        char        c_str[] = "STATIC  \0";
243
244                 /* Declare variable buffer to store the copied string */
245 20042dac        const char  c_replace[] = "TESTTEST\0";
246
247 20042dc4        display_lcd(4, (uint8_t *)" Static Test");
248 20042dd4        display_lcd(5, (uint8_t *)" Initialise c_str");
249 20042de4        display_lcd(6, (uint8_t *)" Replace contents ");
250 20042df4        display_lcd(7, (uint8_t *)" of c_str with ");
251 20042e04        display_lcd(8, (uint8_t *)" that of ucReplace");
252 20042e14        display_lcd(9, (uint8_t *)" ucStr    ='STATIC  '");
253 20042e24        display_lcd(10,(uint8_t *)" ucReplace='TESTTEST'");
254
255                 /* Write ucStr variable, "STATIC" to LCD */
256 20042e34        sprintf(strdata," c_str = '%s'  ",c_str);
257 20042e50        display_lcd(12, (uint8_t *)strdata);
258
259                 /* Delay */
260 20042e60        delay();
261
262                 /* Begin for loop which writes one letter of ucReplace to the LCD at a time
263                    The nested while loops generate the delay between each letter change */
264 20042e64        for (ui_count = 0; ui_count < 8; ui_count++)
```

- The debugger will stop the program at the clear_display_area() function. Press F6 or click 'Step Over' to execute this function and clear the display.

```
181
182 20042b74    clear_display_area();
183
184 20042b78    display_lcd(4, (uint8_t *)" Use RV1 to set delay");
185 20042b88    display_lcd(5, (uint8_t *)" using timer OSTM ");
186 20042b98    display_lcd(6, (uint8_t *)" when flashing LEDs");
187
188             /* Initialise OS timer (channel 0) */
189 20042ba8    R_OSTM_Init(DEVDRV_CH_0, OSTM_MODE_INTERVAL, 500);
190
191             /* Start OS timer (channel 0) */
192 20042bb8    R_OSTM_Open(DEVDRV_CH_0);
193
194             /* Initialise Analogue input (Potentiometer) on board */
195 20042bc0    R_ADC_Open();
196
197             while(1)
198             {
199 20042bc4        R_ADC_Read();
200
201 20042bc8        sprintf(strdata," Flash Delay %d ms  ",(uint16_t)g_adc_result);
202 20042bf0        display_lcd(8, (uint8_t *)strdata);
203
204 20042c00        sprintf(strdata," RV1 position %3d %%  ",(int16_t)((g_adc_result/1023.0)*100.0));
205 20042c8c        display_lcd(10, (uint8_t *)strdata);
206
207             /* Set the minimum flash rate if the ADC value is less than the minimum */
208 20042c9c        if (g_adc_result < MIN_FLASH_RATE)
209             {
210 20042cb0            g_adc_result = MIN_FLASH_RATE;
211             }
212
213 20042cc0        OSTM0.OSTMnCMP = (uint32_t)(P0_CLOCK_FREQUENCY_kHz * (g_adc_result + 1));
214
215 20042d1c    }
216             return (0);
217 }
```

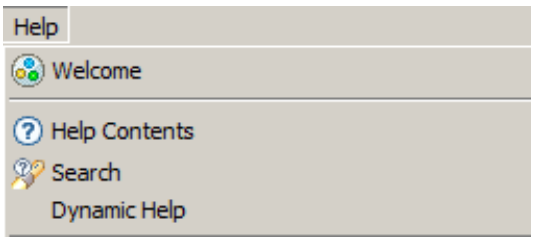
- Scroll to the bottom of main.c to the Sample_OSTM0_Interrupt() function.
- Set a breakpoint on the first line of code inside the Sample_OSTM0_Interrupt() interrupt handler.
- Continue to execute the program by clicking the 'Continue' button.
- The program will halt at the breakpoint due to the timer's period elapsing.
- Remove the breakpoint by double-clicking on the breakpoint column. Continue to execute the program by clicking the 'Continue' button.

```
300             void Sample_OSTM0_Interrupt (uint32_t int_sense)
301 20042f38    {
302 20042f48        R_INTC_Disable(INTC_ID_OSTM0TINT);
303
304 20042f50        R_LED_Toggle(LED0);
305
306 20042f58        R_INTC_Enable(INTC_ID_OSTM0TINT);
307 20042f60    }
```

For further details regarding hardware configuration, please refer to the RSK+RZA1H User's Manual and the RZA1H Group Hardware 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 RZA1H series microcontrollers refer to the RZA1H Group Hardware Manual.

Technical Contact Details

Please refer to the contact details listed in section 10 of the "*Quick Start Guide*"

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

A real time operating system demonstration for the Renesas RZ microcontrollers (ARM Cortex-A9) is provided free of charge by FreeRTOS. This can be found on the FreeRTOS website at:

http://www.freertos.org/Renesas_RZ_Cortex-A9-RTOS.html

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