User's Manual

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RZ/A1H Group

Renesas Starter Kit+ Tutorial Manual For DS-5

RENESAS MCU
RZ Family / A1H 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 DS-5 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 DS-5, 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.
User’s Manual	Describes the technical details of the RSK hardware.	RSK+RZA1H User’s Manual	R20UT2587EG
Tutorial	Provides a guide to setting up RSK environment, running sample code and debugging programs.	RSK+RZA1H Tutorial Manual	R20UT2845EG
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	R20UT2588EG
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
DS-5	ARM *Development 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 Programming Interface
RSK	Renesas Starter Kit
RSK+	Renesas Starter Kit + (denotes extra functionality over standard RSK)

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 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 DS-5 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

DS-5 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. DS-5 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.

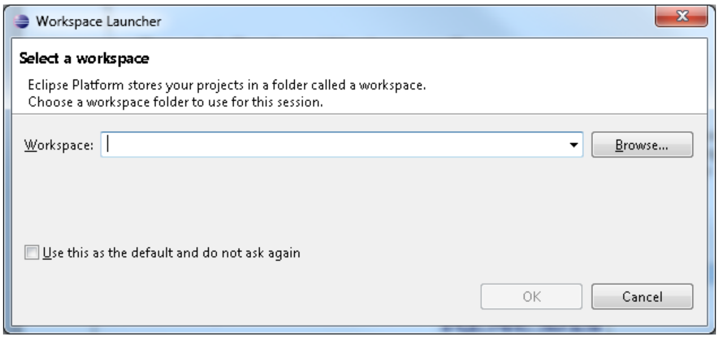
3.2 Jumper and Switch Configuration

Ensure jumpers and switches are in the following positions:

Jumper	Pins	Switch	Position	Switch	Position
JP11	2 - 3	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 DS-5 and Importing Sample Code

- Start Eclipse for DS-5 by selecting it from the Start Menu -> All Programs -> ARM DS-5 -> Eclipse for DS-5. 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’.


Select a workspace

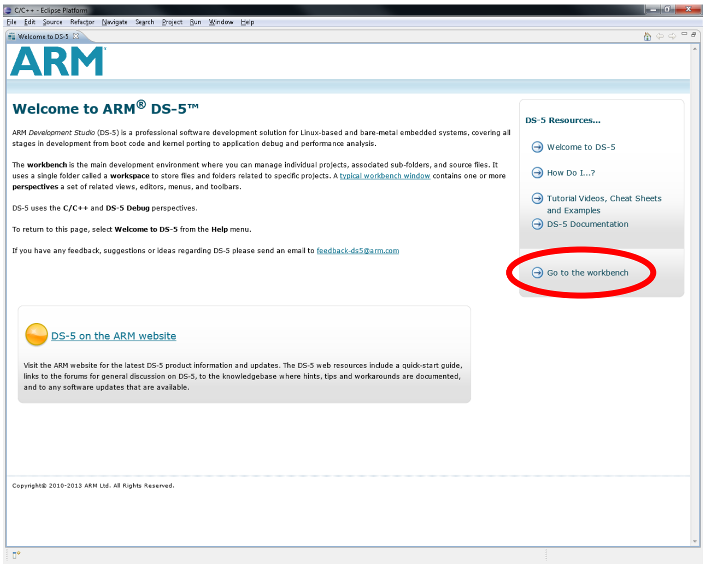
Eclipse Platform stores your projects in a folder called a workspace.
Choose a workspace folder to use for this session.

Workspace:

□ Use this as the default and do not ask again

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.

- The DS-5 welcome splash screen will appear. Click the ‘Go to the workbench’ arrow button on the far right (circled in the screenshot opposite).



Welcome to ARM® DS-5™

ARM *Development Studio* (DS-5) is a professional software development solution for Linux-based and bare-metal embedded systems, covering all stages in development from boot code and kernel porting to application debug and performance analysis.

The **workbench** is the main development environment where you can manage individual projects, associated sub-folders, and source files. It uses a single folder called a **workspace** to store files and folders related to specific projects. A typical workbench window contains one or more **perspectives** a set of related views, editors, menus, and toolbars.

DS-5 uses the **C/C++** and **DS-5 Debug** perspectives.

To return to this page, select **Welcome to DS-5** from the **Help** menu.

If you have any feedback, suggestions or ideas regarding DS-5 please send an email to feedback-ds5@arm.com

DS-5 on the ARM website

Visit the ARM website for the latest DS-5 product information and updates. The DS-5 web resources include a quick-start guide, links to the forums for general discussion on DS-5, to the knowledgebase where hints, tips and workarounds are documented, and to any software updates that are available.

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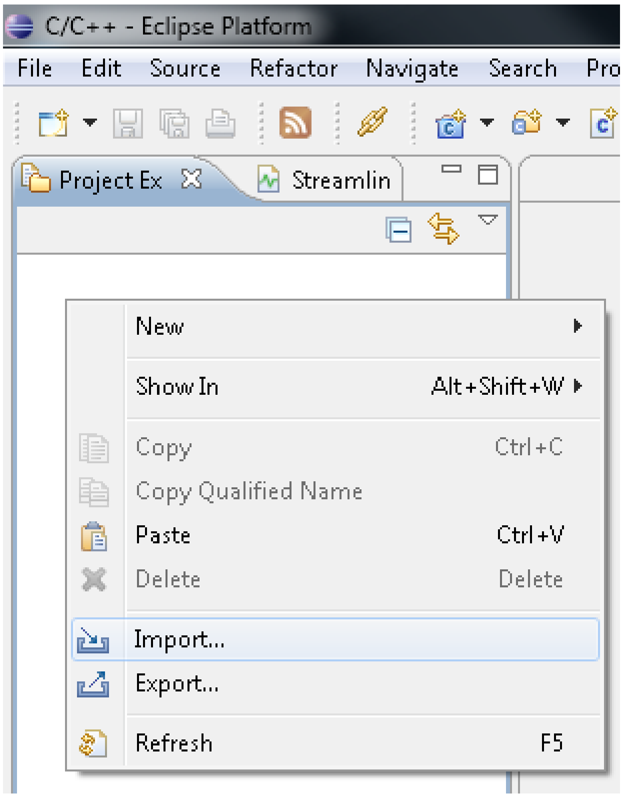
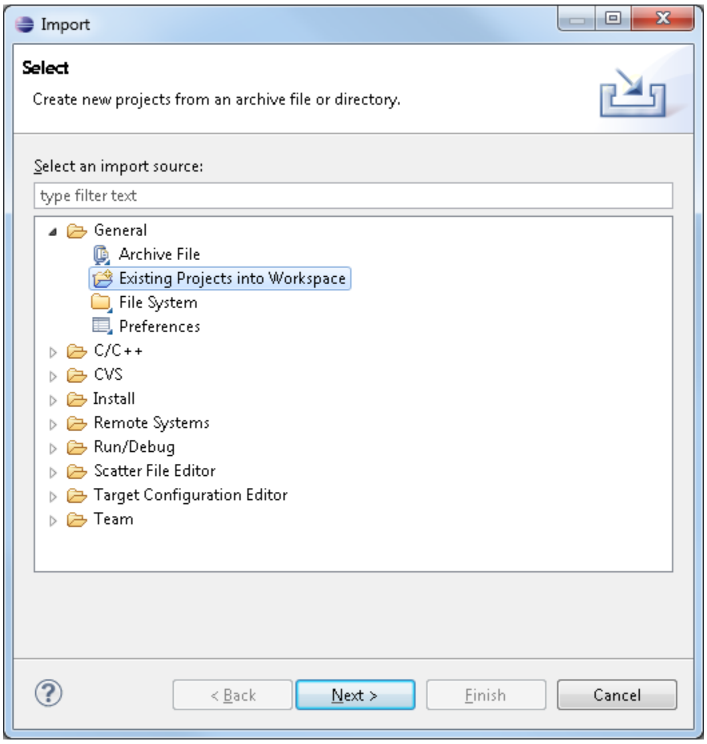
- Once the environment has initialised, right click in the ‘Project Explorer’ window and select ‘Import…’



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



Import

Select

Create new projects from an archive file or directory.

Select an import source:

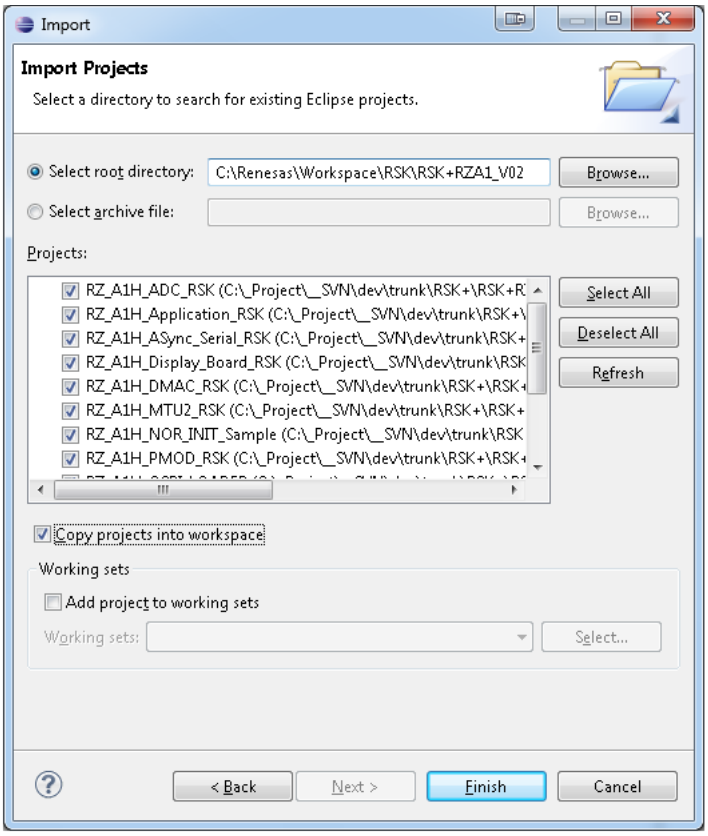
type filter text

- 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_V02

- 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’.



Import

Import Projects

Select a directory to search for existing Eclipse projects.

● Select root directory: C:\Renesas\Workspace\RSK\RSK+RZA1_V02

○ Select archive file:

Projects:

☑ RZ_A1H_ADC_RSK (C:_Project__SVN\dev\trunk\RSK+\RSK+R
☑ RZ_A1H_Application_RSK (C:_Project__SVN\dev\trunk\RSK+\
☑ RZ_A1H_ASync_Serial_RSK (C:_Project__SVN\dev\trunk\RSK+
☑ RZ_A1H_Display_Board_RSK (C:_Project__SVN\dev\trunk\RSK
☑ RZ_A1H_DMAC_RSK (C:_Project__SVN\dev\trunk\RSK+\RSK+
☑ RZ_A1H_MTU2_RSK (C:_Project__SVN\dev\trunk\RSK+\RSK+
☑ RZ_A1H_NOR_INIT_Sample (C:_Project__SVN\dev\trunk\RSK
☑ RZ_A1H_PMOD_RSK (C:_Project__SVN\dev\trunk\RSK+\RSK+

☑ Copy projects into workspace

Working sets

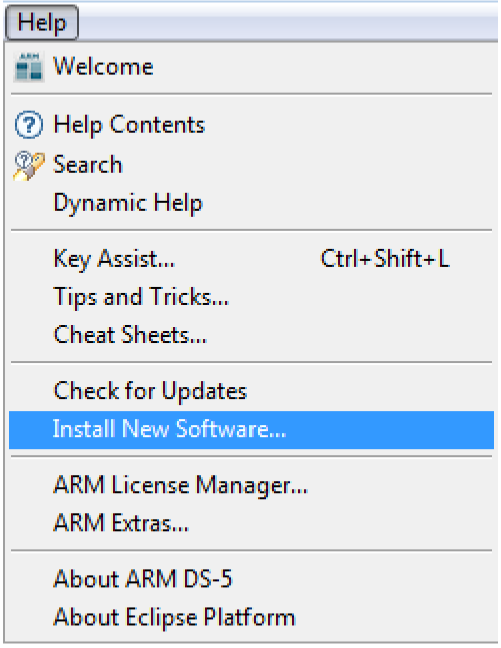
□ Add project to working sets

Working sets:

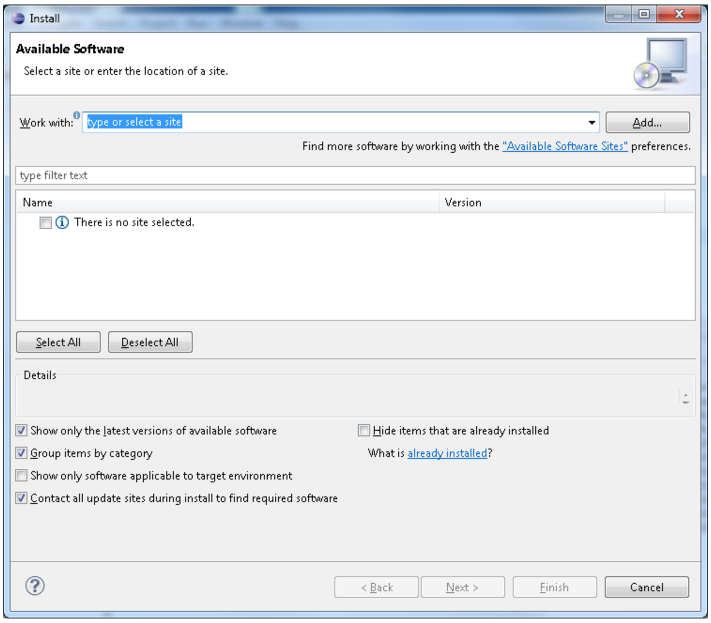
3.4 Adding GNU Toolchain Support for DS-5

After initial installation of the RSK+RZA1H, it is necessary to import the GNU ARM-RZ Toolchain into DS-5. The steps required to import the toolchain are described in this section. Note that these steps only need to be performed once per Windows^{TM} workstation.
This process will require internet access to download the referenced packages.

- From the DS-5 ‘Help’ menu, select ‘Install New Software…’



- From the Install dialog, select ‘Add…’.



Select a site or enter the location of a site.

Work with: type or select a site

Find more software by working with the "Available Software Sites" preferences.

type filter text

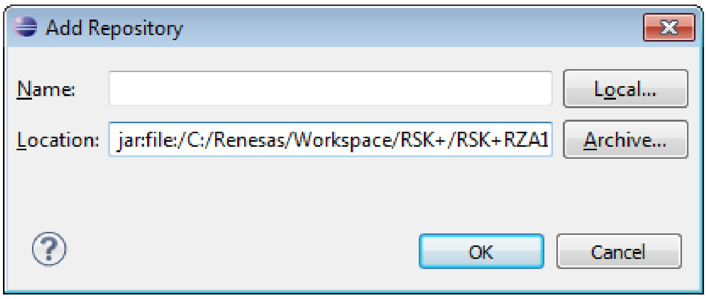
□ There is no site selected.

☑ Show only the latest versions of available software
☑ Group items by category
□ Show only software applicable to target environment
☑ Contact all update sites during install to find required software
□ Hide items that are already installed
What is already installed?

- The Add Repository dialog box will allow you to specify the .zip archive which is supplied with the RSK. Click the ‘Archive..’ button and browse to

C:\Renesas\Workspace\RSK\RSK+RZA1_V02\Renesas_ARM-RZ_Update.zip

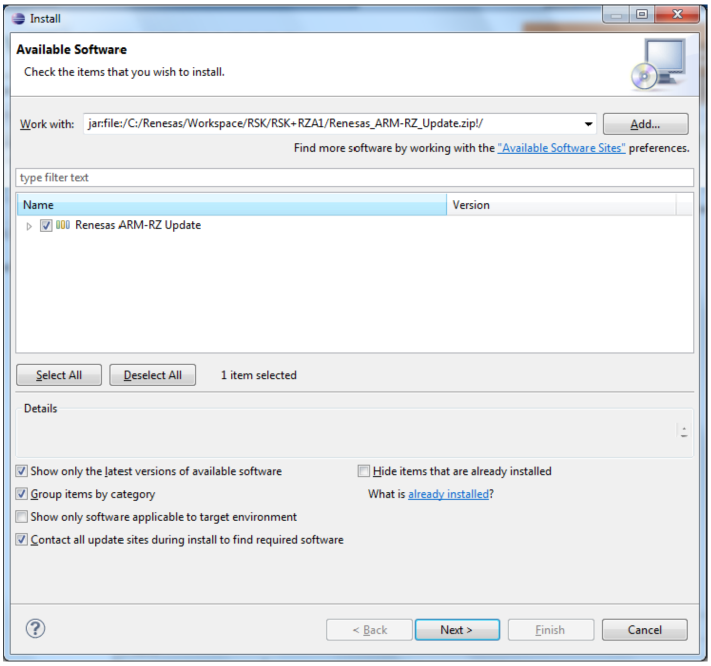
- Click ‘OK’ .



Name:

Location: jar:file:/C:/Renesas/Workspace/RSK+/RSK+RZA1

- Back in the ‘Install’ dialog, ensure that the tick box next to ‘Renesas ARM-RZ Update’ is selected, then click ‘Next >’.



Available Software

Check the items that you wish to install.

Work with: jar:file:/C:/Renesas/Workspace/RSK/RSK+RZA1/Renesas_ARM-RZ_Update.zip!/

Find more software by working with the "Available Software Sites" preferences.

type filter text

Name	Version
☑ Renesas ARM-RZ Update	

1 item selected

Details

☑ Show only the latest versions of available software

□ Hide items that are already installed

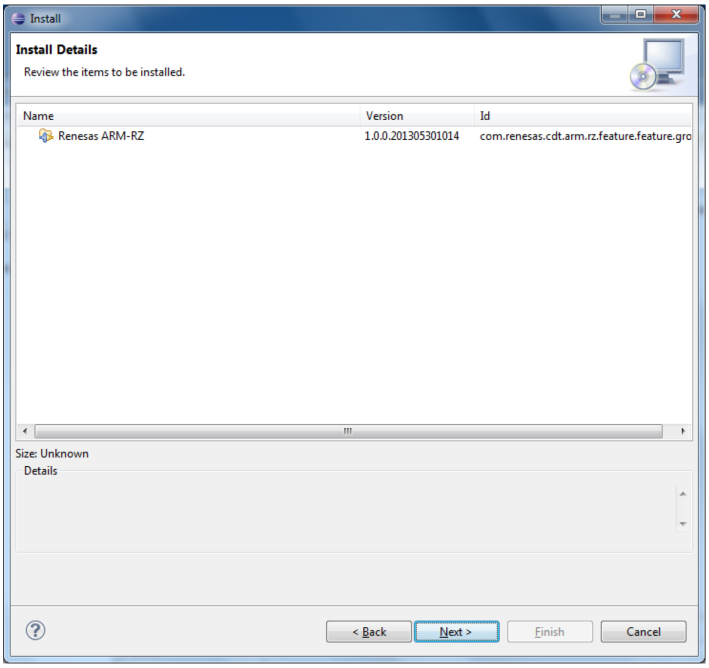
☑ Group items by category

What is already installed?

□ Show only software applicable to target environment

☑ Contact all update sites during install to find required software

- The Install dialog will appear, click ‘Next’.



Install Details

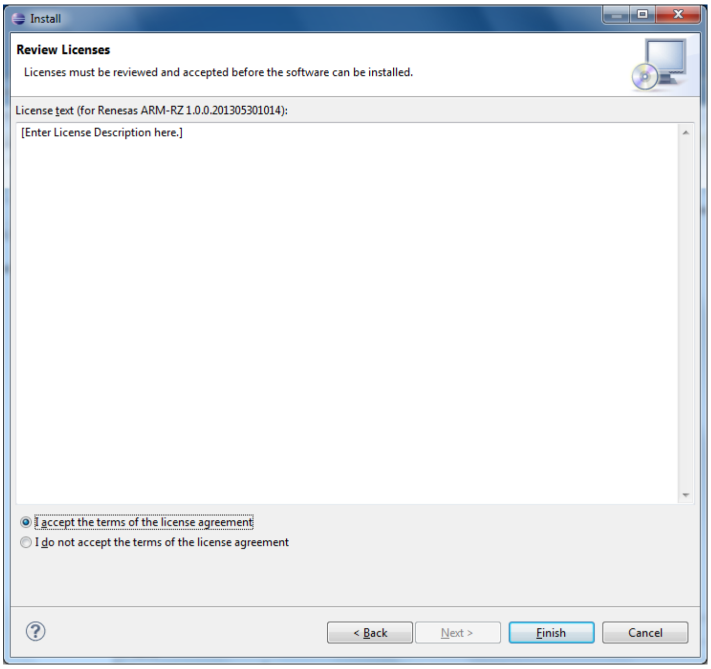
Review the items to be installed.

Name	Version	Id
Renesas ARM-RZ	1.0.0.201305301014	com.renesas.cdt.arm.rz.feature.feature.gro

Size: Unknown

Details

- The Review Licenses dialog will appear, click ‘Finish’.


Install

Review Licenses

Licenses must be reviewed and accepted before the software can be installed.

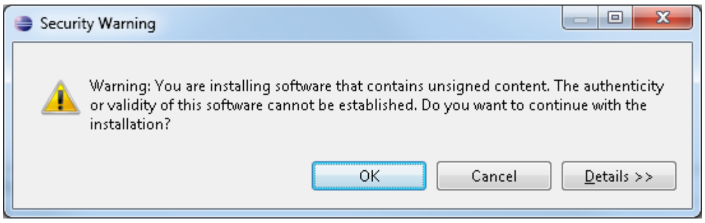
License text (for Renesas ARM-RZ 1.0.0.201305301014):

[Enter License Description here.]

● I accept the terms of the license agreement

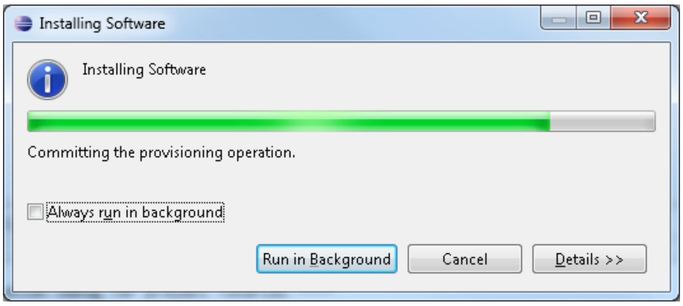
○ I do not accept the terms of the license agreement

- A security dialog will appear. Click ‘OK’.


Security Warning

Warning: You are installing software that contains unsigned content. The authenticity or validity of this software cannot be established. Do you want to continue with the installation?

- The toolchain software will be installed.

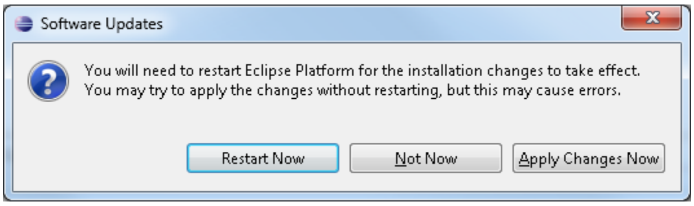

Installing Software

Installing Software

Committing the provisioning operation.

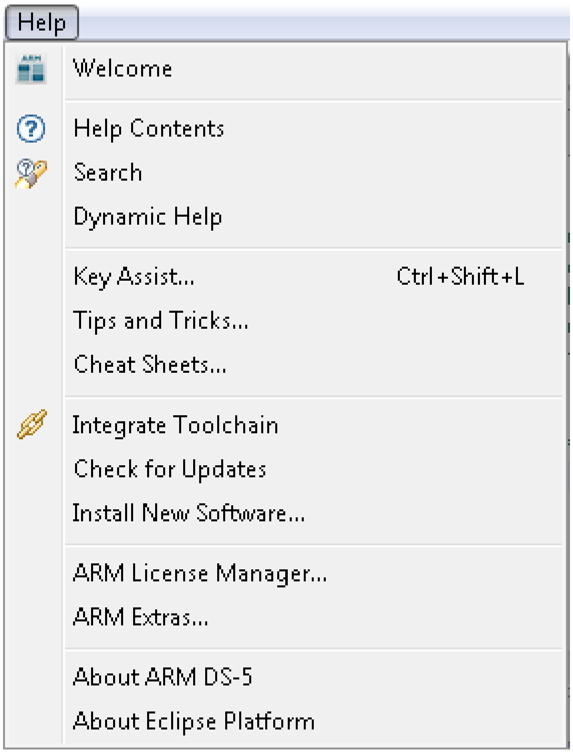
□ Always run in background

- After installation has completed it will be necessary to restart DS-5. Click ‘Restart Now’.

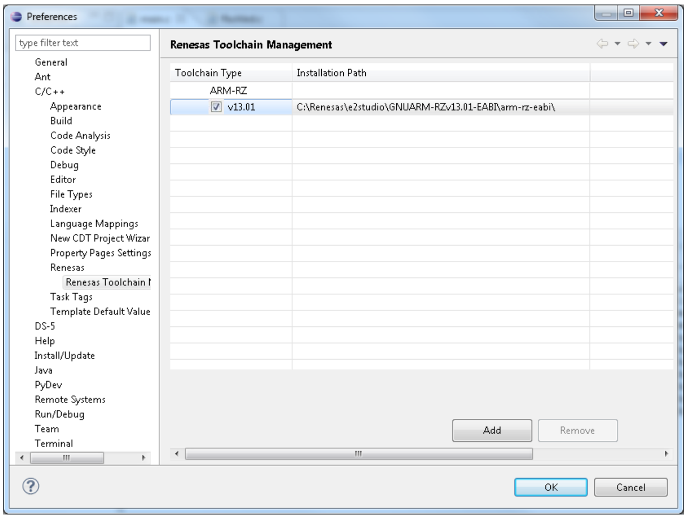

Software Updates

You will need to restart Eclipse Platform for the installation changes to take effect. You may try to apply the changes without restarting, but this may cause errors.

- Once DS-5 has restarted, in the DS-5 ‘Help’ menu, there will now be a new item ‘Integrate Toolchain’. Select this menu item.



- In the ‘Preferences’ dialog, under ‘C/C++ -> Renesas -> Renesas Toolchain Management’, ensure the tick-box is checked as shown opposite, then click ‘OK’.



Renesas Toolchain Management

Toolchain Type	Installation Path
ARM-RZ	
☑ v13.01	C:\Renesas\e2studio\GNUARM-RZv13.01-EABI\arm-rz-eabi\

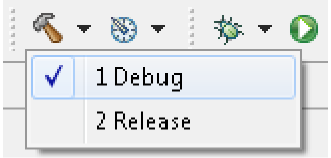
3.5 Build Configurations and Debug Sessions

3.5.1 Build Configuration

The DS-5 workspace will be created with two build configurations: ‘Debug’ and ‘Release’.

Debug
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 ‘Debug’ 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 ‘Debug’ option.

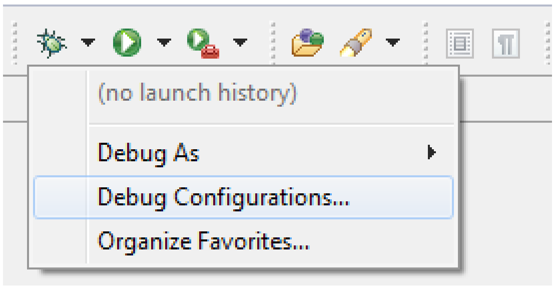


DS-5 will now build the code.

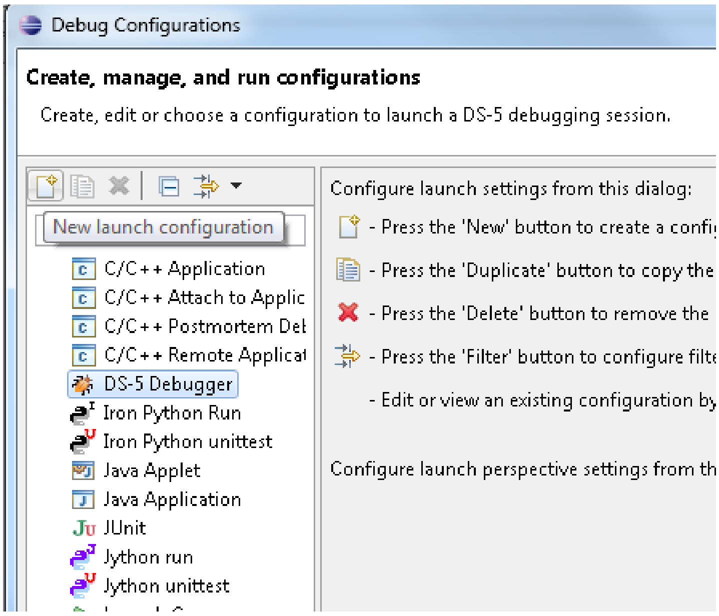
- The output from the build process will be presented in the console window of DS5

3.5.2 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 ‘DS-5 Debugger’ icon.
- Press the ‘New’ button to create a new DS-5 Debugger configuration.


Debug Configurations

Create, manage, and run configurations

Create, edit or choose a configuration to launch a DS-5 debugging session.

Configure launch settings from this dialog:

- Press the 'New' button to create a confi

- Press the 'Duplicate' button to copy the

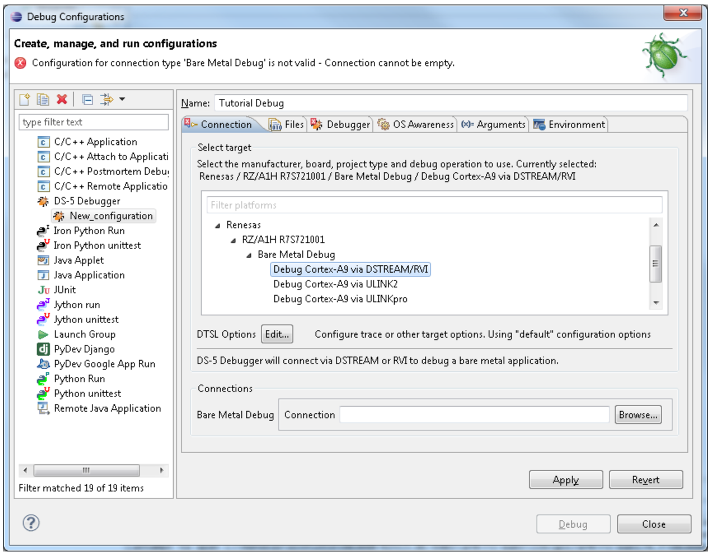
- Press the 'Delete' button to remove the

- Press the 'Filter' button to configure filte

- Edit or view an existing configuration by

Configure launch perspective settings from th

- The debug configurations control page will then be created. In the 'Connection' tab, rename the configuration 'Tutorial Debug'.
- In the 'Select Target' tree control, ensure that 'Renesas -> RZ/A1H R7S721001 -> Bare Metal Debug -> Debug Cortex-A9 via DSTREAM/RVI' is selected.
- In 'Connections', click the 'Browse…' button.


Debug Configurations

Create, manage, and run configurations

Configuration for connection type 'Bare Metal Debug' is not valid - Connection cannot be empty.

Name: Tutorial Debug

Select target

Select the manufacturer, board, project type and debug operation to use. Currently selected:
Renesas / RZ/A1H R7S721001 / Bare Metal Debug / Debug Cortex-A9 via DSTREAM/RVI

DTSL Options Edit... Configure trace or other target options. Using "default" configuration options

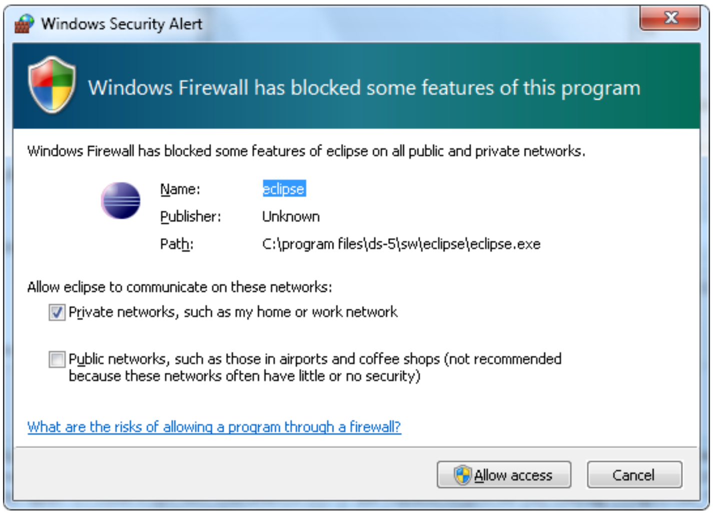
DS-5 Debugger will connect via DSTREAM or RVI to debug a bare metal application.

Connections

Bare Metal Debug Connection

Filter matched 19 of 19 items

- A security dialog may appear indicating that the Windows Firewall has blocked some features of the eclipse platform. Under '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'


Windows Security Alert

Windows Firewall has blocked some features of this program

Windows Firewall has blocked some features of eclipse on all public and private networks.

Name: eclipse

Publisher: Unknown

Path: C:\program files\ds-5\sw\eclipse\eclipse.exe

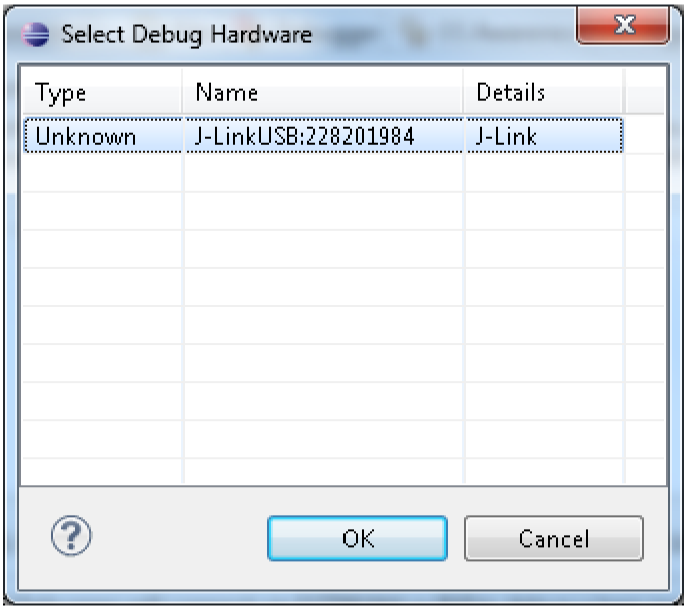
Allow eclipse to communicate on these networks:

☑ Private networks, such as my home or work network

☐ Public networks, such as those in airports and coffee shops (not recommended because these networks often have little or no security)

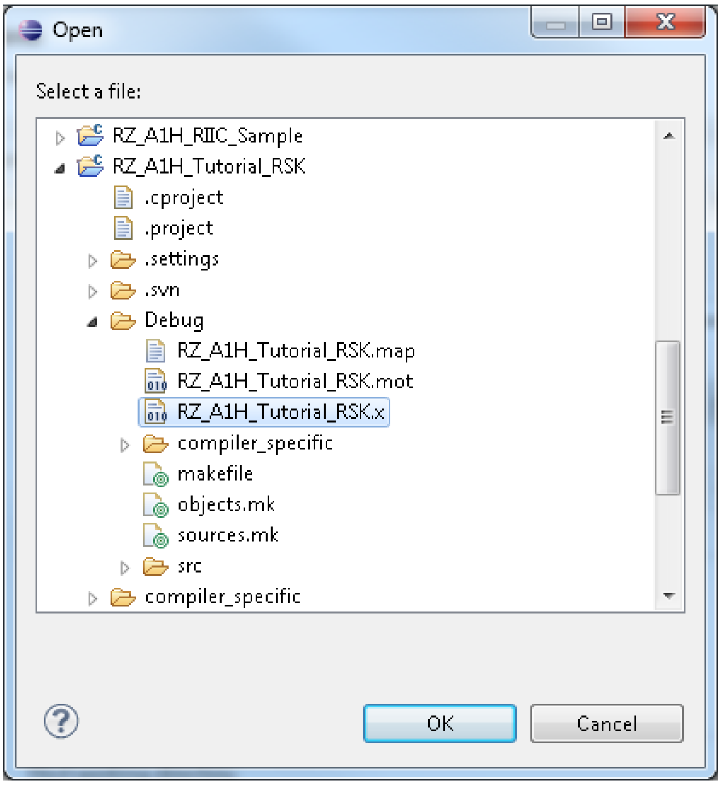
What are the risks of allowing a program through a firewall?
Allow access
Cancel

- In the 'Select Debug Hardware' dialog, select 'J-LinkUSB:xxxxxxxx'. Click OK.
- Append ":device R7S721001_DualSPI" to the connection serial number string, for example "J-LinkUSB:xxxxxxxx:device R7S721001_DualSPI".
- In the 'Connection' tab click 'Apply', then select the 'Files' tab.

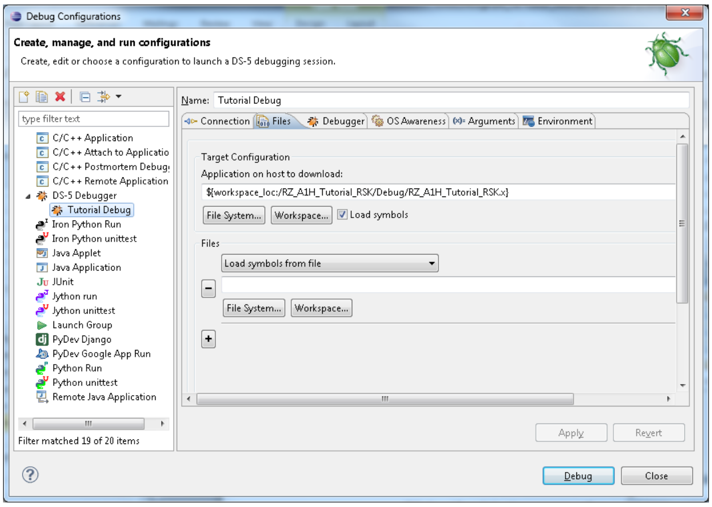

Select Debug Hardware

Type	Name	Details
Unknown	J-LinkUSB:228201984	J-Link

- In the ‘Files’ tab, under ‘Target Configuration -> Application on host to download’, click the ‘Workspace’ button. Browse to ‘Tutorial -> Debug -> RZ_A1H_Tutorial_RSK.x’ and click OK.



- Click ‘Apply’ to save the changes, then select the ‘Debugger’ tab.



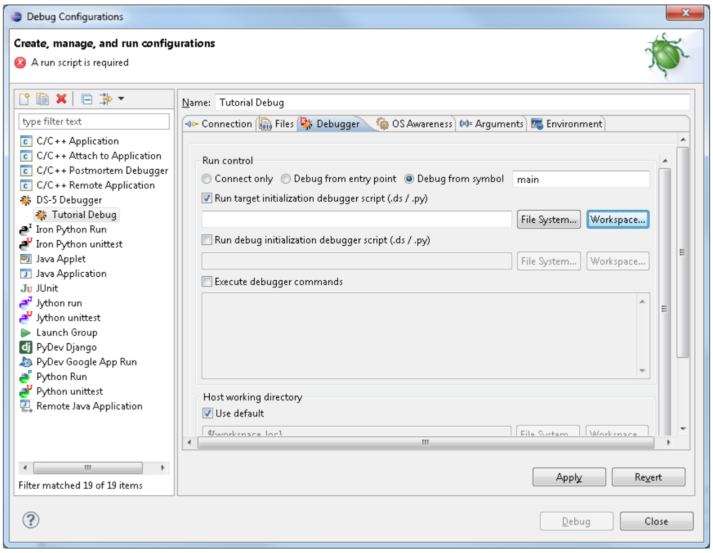
Name: Tutorial Debug

Application on host to download: ${workspace_loc:/RZ_A1H_Tutorial_RSK/Debug/RZ_A1H_Tutorial_RSK.x}

☑ Load symbols

Load symbols from file

- In the ‘Debugger’ tab, under ‘Run control’, ensure that ‘Debug from symbol main’ is selected. Select the ‘Run target initialization debugger script (.ds/ py)’ tick box and click ‘Workspace’.


Debug Configurations

Create, manage, and run configurations

A run script is required

Filter matched 19 of 19 items

Name: Tutorial Debug

Run control

○ Connect only ○ Debug from entry point ● Debug from symbol main

☑ Run target initialization debugger script (.ds / .py)

☐ Run debug initialization debugger script (.ds / .py)

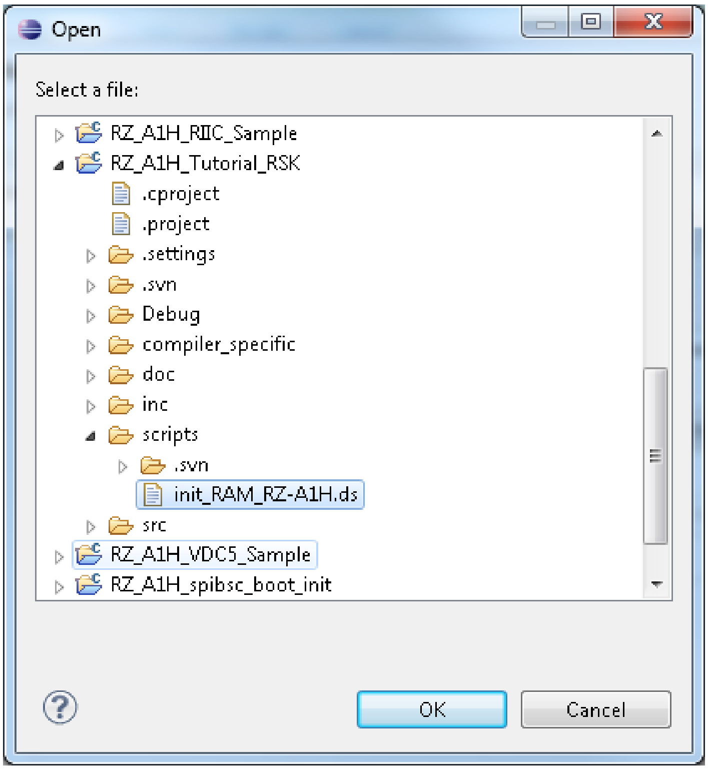
☐ Execute debugger commands

Host working directory

☑ Use default

${workspace_loc}

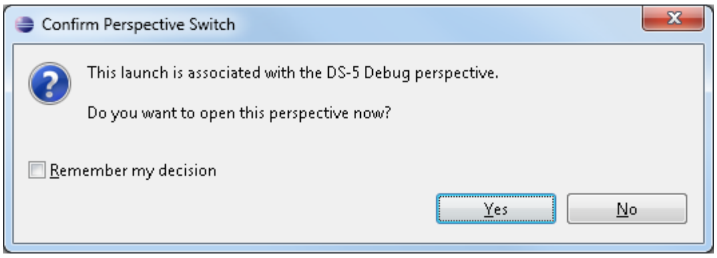
- In the ‘Open’ dialog, browse to ‘Tutorial -> Scripts ->init_RAM_RZ-A1H.ds’ and click OK. In the ‘Debugger’ tab, click ‘Apply’ to save the changes.
- Connect the SEGGER JLink-Lite debugger to a spare USB port on the PC and connect the ribbon cable to CN14 on the RSK+RZA1H.
- **Ensure the PWR_SEL jumper is set to match the power supply. See the RSK+RZA1H User’s manual to locate the PWR_SEL jumper.**
- Connect a PSU to the RSK+RZA1H PWR connector and apply power.
- Click ‘Debug’ to start the new debug session.


Open

Select a file:

```
▷ RZ_A1H_RIIC_Sample
◢ RZ_A1H_Tutorial_RSK
      .cproject
      .project
   ▷ .settings
   ▷ .svn
   ▷ Debug
   ▷ compiler_specific
   ▷ doc
   ▷ inc
   ◢ scripts
      ▷ .svn
         init_RAM_RZ-A1H.ds
   ▷ src
▷ RZ_A1H_VDC5_Sample
▷ RZ_A1H_spibsc_boot_init
```

- Before downloading the code a dialog box will appear asking if you would like to switch to the ‘DS-5 Debug perspective’. If you agree click ‘Remember my decision’ to prevent this dialog box from appearing in future, then click ‘Yes’.
- A dilaog may appear indicating that the J-Link firmware needs to be updated. Click ‘Yes’ to update the J-Link firmware.
- DS-5 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

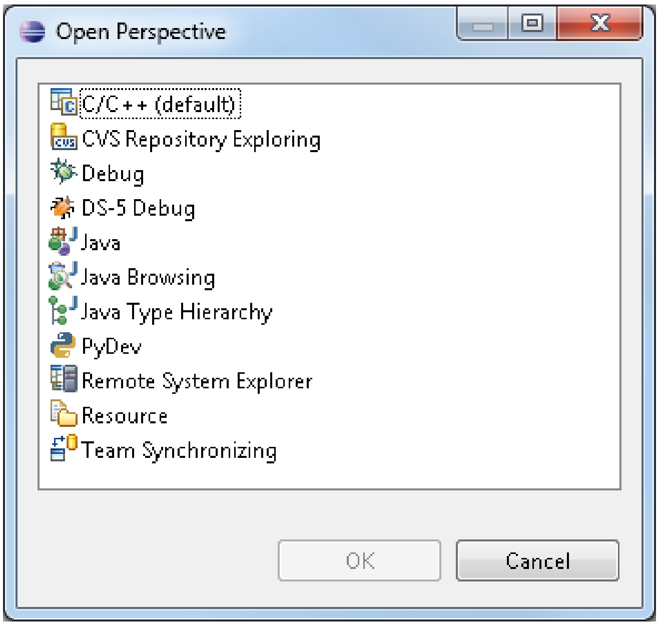

Confirm Perspective Switch

This launch is associated with the DS-5 Debug perspective.

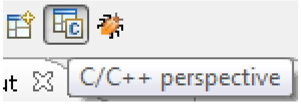
Do you want to open this perspective now?

☐ Remember my decision

- 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.



3.6 Running the Tutorial

- Once the code has been downloaded the program counter will stop on the first instruction in the main function.
- Click the ‘Continue button in the ‘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.

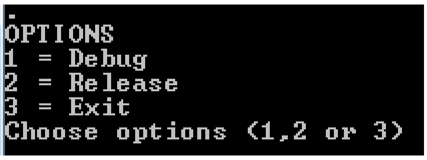
3.7 Running the code from the QSPI Flash ROM

3.7.1 Debug Build – executing in RAM.

It is possible to run the above code from QSPI on start-up. For this to function, the boot loader should be present in the QSPI. The board is shipped with pre-installed boot loader, but if this is changed in anyway, then please re-install it using QSPI_LOADER sample.

On start-up, the boot loader will check the presence of the Tutorial code and then execute it. If the code is not present, it will flash the LED1 continuously. The code can be loaded as follows:

- Disconnect the debug session using the disconnect icon.
- Open the **Windows Explorer** and select the Tutorial project directory.
- Execute the file LoadTutorialToQSPI.bat.
- Select Option 1 – Debug. This will now load the Tutorial code into QSPI.

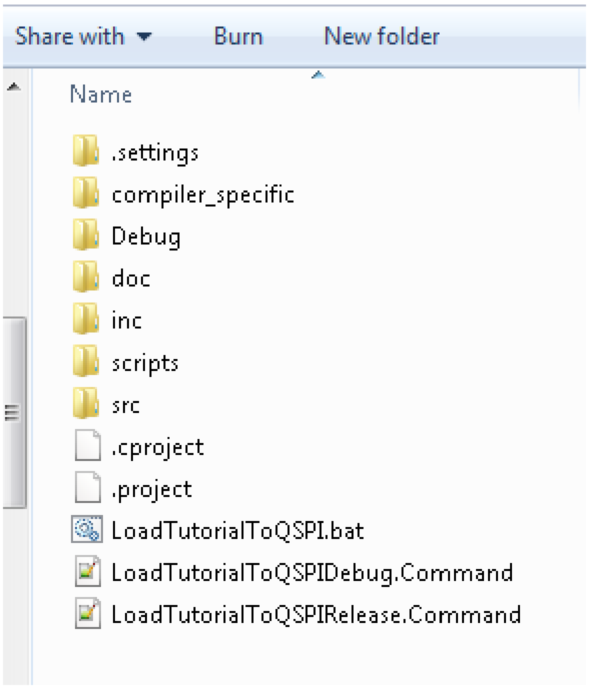


```
.
OPTIONS
1 = Debug
2 = Release
3 = Exit
Choose options (1,2 or 3)
```

- Restart the board by disconnecting and reconnecting the power supply and the Tutorial code will run by iteself.

Note:

Please refer to section 5.3 for information on generating binary files.

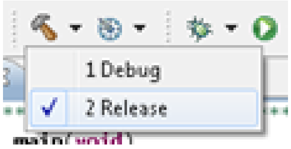


3.7.2 Release Build – executing from QSPI

The release build code will run directly from QSPI instead of transferring into RAM. It is possible to run the above code from QSPI on start-up. For this to function, the boot loader should be present in the QSPI. The board is shipped with pre-installed boot loader, but if this is changed in anyway, then please re-install it using QSPI_LOADER sample.

On start-up, the boot loader will check the presence of the above code, and then transfer it into RAM and execute it. If the code is not present, it will flash the LED1 continuously. The code can be loaded as follows:

- Start the Tutorial project in DS5 as described above.
- Select the arrow next to hammer icon, and select 'Release'.
- Open the Windows Expolrer and select the Tutorial project directory.
- Execute the file LoadTutorialToQSPI.bat.
- Select Option 2 – Release. This will now load the Tutorial code into QSPI.
- Restart the board and the Tutorial code will run by iteself.



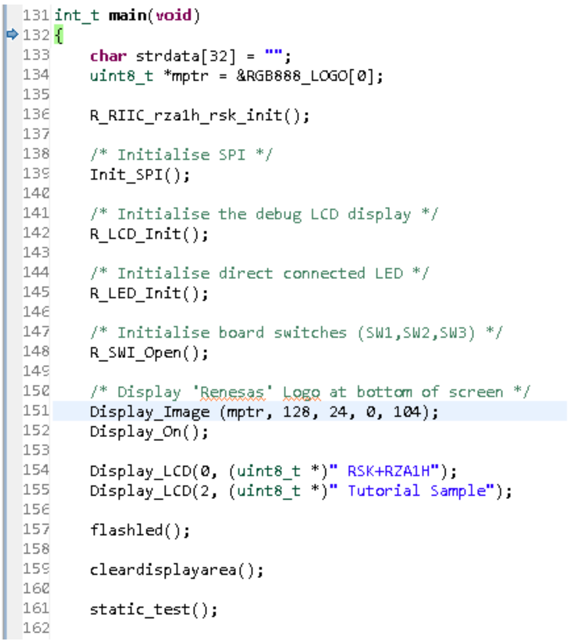
4. Reviewing the Tutorial Program

This section will look at each section of the tutorial code and basic debugging functionality in DS-5.

4.1 Main Functions

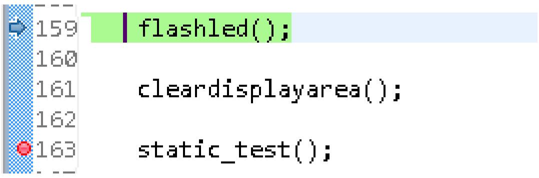
This section will look at the program code called from with the main() function, and how it works.

- 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 Selection' 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.



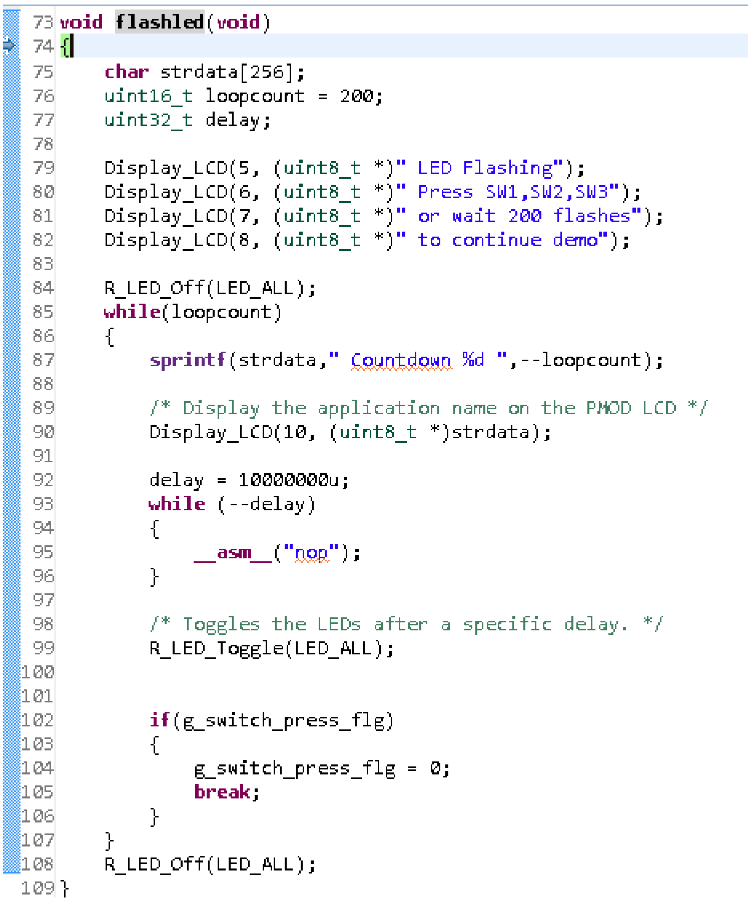
```
int_t main(void)
{
    char strdata[32] = "";
    uint8_t *mptr = &RGB888_LOGO[0];

    R_RIIC_rza1h_rsk_init();

    /* Initialise SPI */
    Init_SPI();

    /* Initialise the debug LCD display */
    R_LCD_Init();

    /* Initialise direct connected LED */
    R_LED_Init();

    /* Initialise board switches (SW1,SW2,SW3) */
    R_SWI_Open();

    /* Display 'Renesas' Logo at bottom of screen */
    Display_Image (mptr, 128, 24, 0, 104);
    Display_On();

    Display_LCD(0, (uint8_t *)" RSK+RZA1H");
    Display_LCD(2, (uint8_t *)" Tutorial Sample");

    flashled();

    cleardisplayarea();

    static_test();

```

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



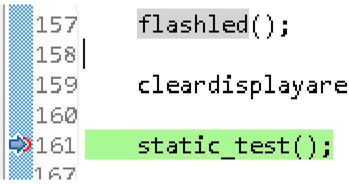
```
    flashled();

    cleardisplayarea();

    static_test();
```

- Click the ‘Continue’ ▶ 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 or until a user switch has been pressed.



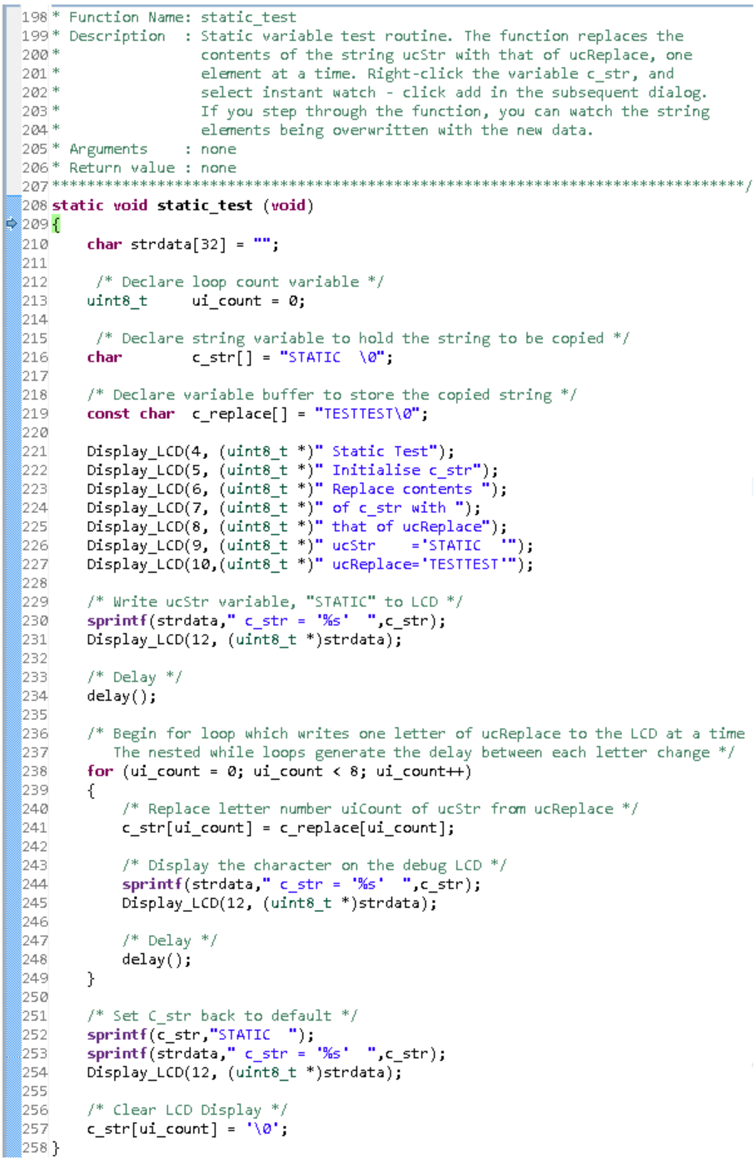
```
void flashled(void)
{
    char strdata[256];
    uint16_t loopcount = 200;
    uint32_t delay;

    Display_LCD(5, (uint8_t *)" LED Flashing");
    Display_LCD(6, (uint8_t *)" Press SW1,SW2,SW3");
    Display_LCD(7, (uint8_t *)" or wait 200 flashes");
    Display_LCD(8, (uint8_t *)" to continue demo");

    R_LED_Off(LED_ALL);
    while(loopcount)
    {
        sprintf(strdata," Countdown %d ",--loopcount);

        /* Display the application name on the PMOD LCD */
        Display_LCD(10, (uint8_t *)strdata);

        delay = 10000000u;
        while (--delay)
        {
            __asm__("nop");
        }

        /* Toggles the LEDs after a specific delay. */
        R_LED_Toggle(LED_ALL);


        if(g_switch_press_flg)
        {
            g_switch_press_flg = 0;
            break;
        }
    }
    R_LED_Off(LED_ALL);
}
```

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



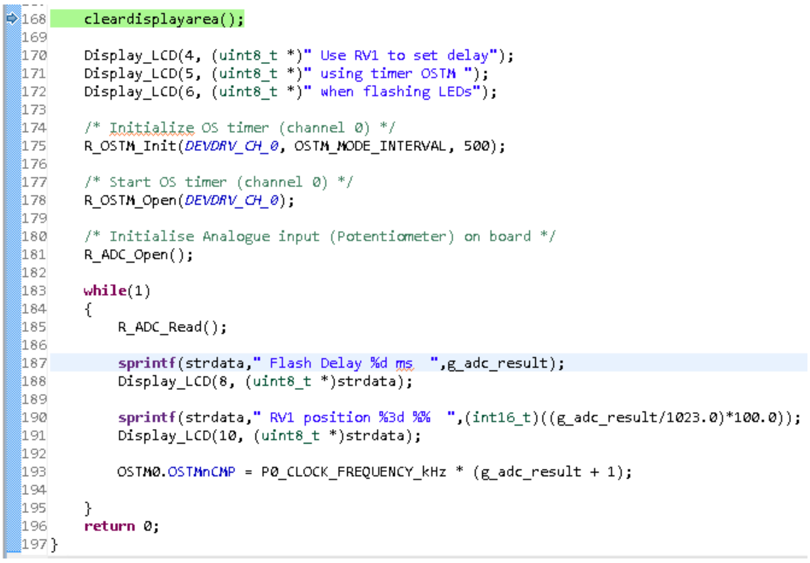
```
    flashled();

    cleardisplayarea();

    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'.



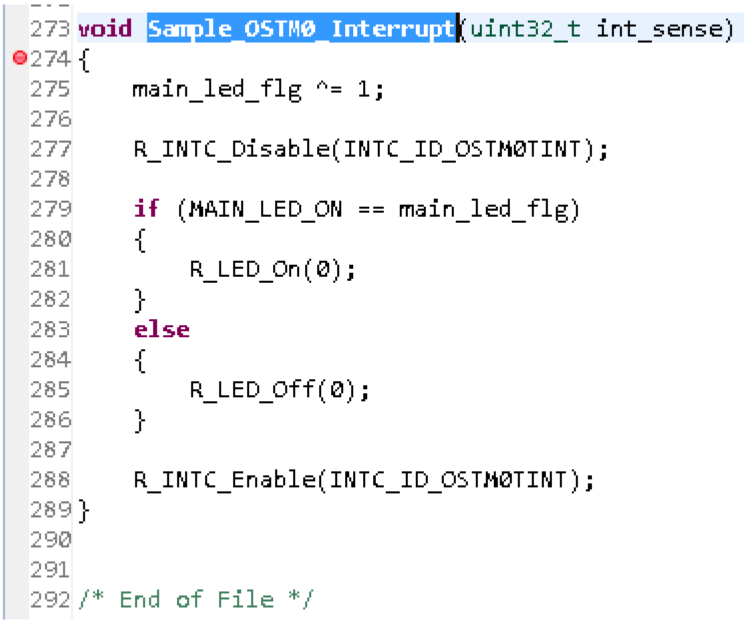
```
* Function Name: static_test
* Description  : Static variable test routine. The function replaces the
*                contents of the string ucStr with that of ucReplace, one
*                element at a time. Right-click the variable c_str, and
*                select instant watch - click add 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)
{
    char strdata[32] = "";

     /* 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";

    Display_LCD(4, (uint8_t *)" Static Test");
    Display_LCD(5, (uint8_t *)" Initialise c_str");
    Display_LCD(6, (uint8_t *)" Replace contents ");
    Display_LCD(7, (uint8_t *)" of c_str with ");
    Display_LCD(8, (uint8_t *)" that of ucReplace");
    Display_LCD(9, (uint8_t *)" ucStr    ='STATIC  '");
    Display_LCD(10,(uint8_t *)" ucReplace='TESTTEST'");

    /* Write ucStr variable, "STATIC" to LCD */
    sprintf(strdata," c_str = '%s'  ",c_str);
    Display_LCD(12, (uint8_t *)strdata);

    /* 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 */
        sprintf(strdata," c_str = '%s'  ",c_str);
        Display_LCD(12, (uint8_t *)strdata);

        /* Delay */
        delay();
    }

    /* Set C_str back to default */
    sprintf(c_str,"STATIC  ");
    sprintf(strdata," c_str = '%s'  ",c_str);
    Display_LCD(12, (uint8_t *)strdata);

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

- The debugger will stop the program at the cleardisplayarea() function. Press F6 or click 'Step Over' to execute this function and clear the display.
- The next portion of code sets up a timer to flash LEDs at a variable rate in an interrupt handler. The timer is set up by calls to R_OSTM_Init() and R_OSTM_Open().
- The timer variable rate is controlled by reading the ADC in a while loop and setting the timer expiration value accordingly.



```
    cleardisplayarea();

    Display_LCD(4, (uint8_t *)" Use RV1 to set delay");
    Display_LCD(5, (uint8_t *)" using timer OSTM ");
    Display_LCD(6, (uint8_t *)" when flashing LEDs");

    /* Initialize OS timer (channel 0) */
    R_OSTM_Init(DEVDRV_CH_0, OSTM_MODE_INTERVAL, 500);

    /* Start OS timer (channel 0) */
    R_OSTM_Open(DEVDRV_CH_0);

    /* Initialise Analogue input (Potentiometer) on board */
    R_ADC_Open();

    while(1)
    {
        R_ADC_Read();

        sprintf(strdata," Flash Delay %d ms  ",g_adc_result);
        Display_LCD(8, (uint8_t *)strdata);

        sprintf(strdata," RV1 position %3d %%  ",(int16_t)((g_adc_result/1023.0)*100.0));
        Display_LCD(10, (uint8_t *)strdata);

        OSTM0.OSTMnCMP = P0_CLOCK_FREQUENCY_kHz * (g_adc_result + 1);

    }
    return 0;
}
```

- 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.



```
void Sample_OSTM0_Interrupt(uint32_t int_sense)
{
    main_led_flg ^= 1;

    R_INTC_Disable(INTC_ID_OSTM0TINT);

    if (MAIN_LED_ON == main_led_flg)
    {
        R_LED_On(0);
    }
    else
    {
        R_LED_Off(0);
    }

    R_INTC_Enable(INTC_ID_OSTM0TINT);
}


/* End of File */
```

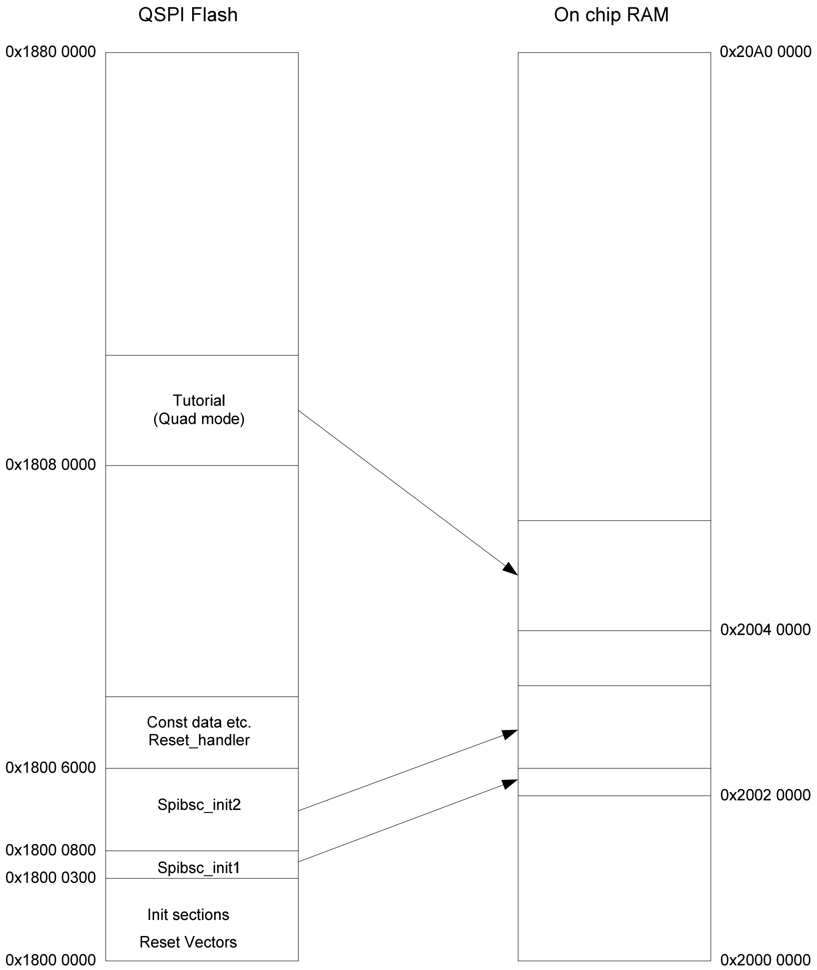
For further details regarding hardware configuration, please refer to the RSK+RZA1H User’s Manual and the RZA1H Group Hardware Manual.

5. QSPI Boot Loader

5.1 Loading Process

When the configuration switch SW6 is set to OFF, ON, OFF, ON, ON, ON, the RZ/A1H processor configures the QSPI bus controller in external address space read mode to boot and execute from location 0x1800000 (QSPI channel 0 bus area). It sets the QSPI in single device, one bit mode at the lowest speed. The boot loader is only located in the first device (IC26) connected to QSPI channel 0's Port 0. The following actions takes place:

- The boot loader will transfer a small section (section 1: Spibsc_init1) of the code into RAM and execute it. This code will speed up the QSPI access before returning back to boot loader code, as the speed cannot be altered whilst the code is running from QSPI.
- The boot loader then transfers the next section (section 2: Spibsc_init2) of the code into RAM and executes it. This code will change the QSPI mode of operation to dual QSPI in quad mode, enabling data transfer of 8 bits at a time. It then checks if a user application is present in the QSPI starting from location 0x18080000. The check is performed by reading a signature at offset 0x2C.
- Offset 0x20 contains the start address of the code, offset 0x24 contains the end address, and 0x28 contains the execution start address.
- It uses the above information to determine if the code has to be transferred into RAM (if the start address is in RAM), or execute in QSPI.
- It transfers the code if necessary and then jumps to the execution start address.



Transfer of QSPI device data to the RZ/A1H On-chip RAM

The QSPI Flash device is shown mapped to the RZ/A1H's QSPI bus area.

5.2 Boot Loader Sections

The boot loader code is arranged in four sections, separate from the user application code (Tutorial). The memory map from the previous page is explained below:

Section 1: 0x18000000 to 0x180002FF

This section contains the reset vectors and initialisation code.

Section 2: 0x18000300 to 0x180007FF

This section contains code to speed up the QSPI and set I/O ports (rza_io_regrw.c). This code is executed in RAM as it cannot change the QSPI access speed when executing from it.

Section 3: 0x18000800 to 0x18005FFF

This section contains code to set QSPI into quad bit mode, using both the devices. This code is executed in RAM as it cannot configure the QSPI when running executing from it. It then checks if there is an application in the start location (0x18080000). If there is, it checks if this application should be executed from QSPI or from RAM. For QSPI, it jumps to the start location; if not, it copies the code into RAM at location 0x20040000 and then jumps to it. Note: This section uses I/O functions from section 2, so they must not overlap.

Section 4: 0x18006000

This section contains the reset_handler and constant data. The reset vector in section 1 calls the reset_handler.

Note:

The boot loader can be installed by first building the Release configuration of the RZ_A1H_QSPI_LOADER sample project, and then executing the Program_QSPI_Loader.bat file located in the project directory. The board is shipped with the boot loader pre-installed.

5.3 Generating a Binary File

Programming a user application requires the program file to be in binary format (.bin). By default the Debug build is configured to generate ELF files with extensions .x and .mot while the Release build is configured to generate an ELF file with extension .x and a binary file with extension .bin.

To generate a Debug build .bin file instead of a .mot file follow these steps:

1. In DS-5, click on the desired project under the ‘Project Explorer’ view.
2. From the menu bar select ‘File > Properties’.
3. In the Properties dialog select ‘C/C++ Build > Settings’
4. Change the ‘Configuration’ to debug, if it is not already selected.
5. Select the ‘Build Steps’ tab.
6. Change the ‘Post-build steps’ to:
   arm-rz-eabi-objcopy -O binary ${ProjName}.x RZ_A1H_PTC_FIRST.bin&
7. Click ‘Apply’.
8. Click ‘OK’.
9. Rebuild the Debug configuration to generate the binary file.

5.4 Programming a User Application Program

Build the desired configuration of your application code or one of the provided sample code using the correct QSPI load file (provided in the RZ_A1H_Tutorial_RSK sample code). Copy the following files from the RZ_A1H_Tutorial_RSK folder to the root folder of your application:

LoadTutorialToQSPI.bat
LoadTutorialToQSPIDebug.Command
LoadTutorialToQSPIRelease.Command

Make the following changes, taking care not to add or remove spaces, to the line numbers in the LoadTutorialToQSPI.bat file:

Line 4: Replace the word Tutorial with the name of your user application.
Line 32: Replace RZ_A1H_Tutorial_RSK with the name of your user application.
Line 52: Replace RZ_A1H_Tutorial_RSK with the name of your user application.
Line 73: Replace RZ_A1H_Tutorial_RSK with the name of your user application.

Lines 41-44 and 61-64 describes the operation of the Tutorial sample code, this can be changed to match the user application’s operation.

Make the following changes, taking care not to add or remove spaces, to the line numbers in the LoadTutorialToQSPIDebug.command and LoadTutorialToQSPIDebug.command files:

Line 10 and 11: Replace RZ_A1H_Tutorial_RSK with the name of your user application.

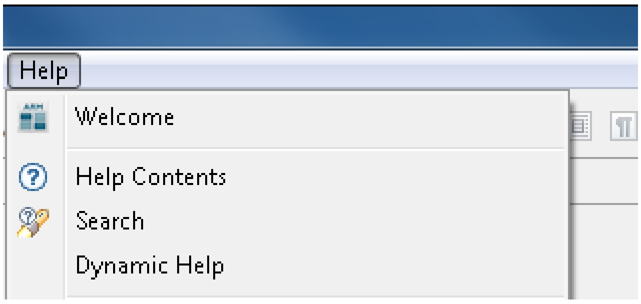
Run the LoadTutorialToQSPI.bat batch file.

The 'exec SetSkipProgOnCRCMatch=0' instruction in the command files checks if the boot loader program to be loaded matches the existing boot loader code in the QSPI device. The 'loadbin' instruction will skip programming if they match. A power cycle to the RSK+RZA1H may be required following a successful loading of the user application.

6. Additional Information

Technical Support

For details on how to use DS-5, refer to the help file by opening DS-5, 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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