RL78/L1C

Low Power Mode for e² studio

R01AN2307EG0100
Rev.1.00
Sep 11, 2014

Introduction

The Low Power sample code demonstrates the low power modes HALT, SNOOZE and STOP for reducing current consumption.

Target Device

RL78/L1C

Development environment

IDE: e^2 studio
Compiler: GNURL78 v13.02 -ELF
Hardware: Renesas Starter Kit for RL78/L1C

Contents

1. Installation

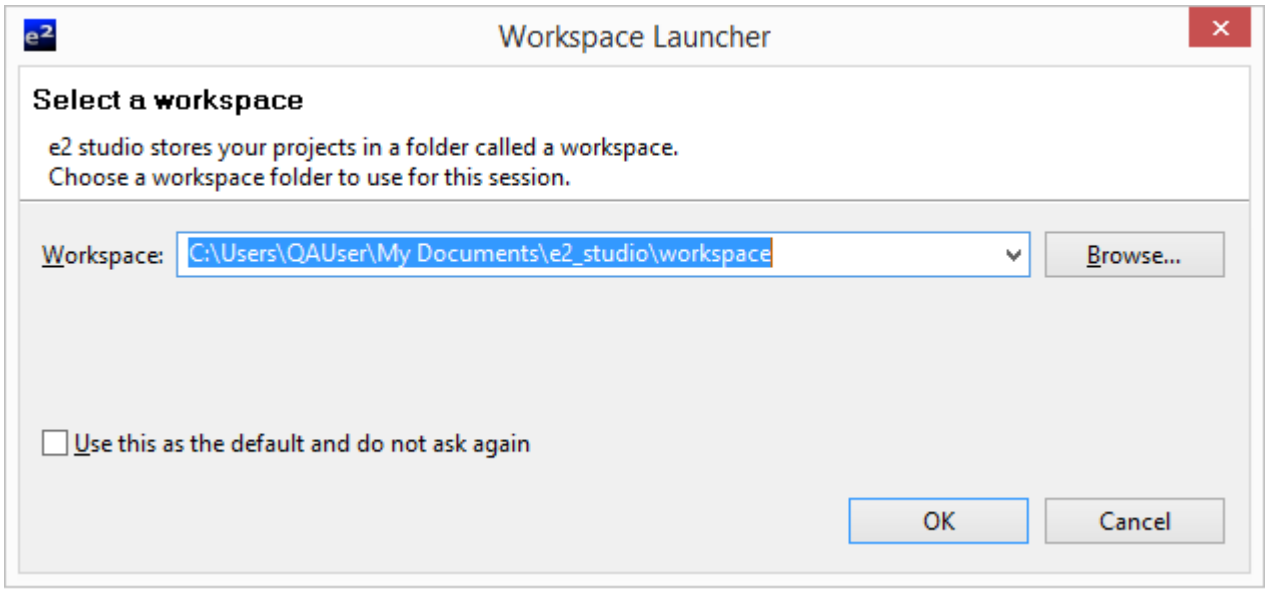
This section assumes e² studio IDE is already installed on the user's personal computer (PC). It is also assumed that the following software and versions are installed:

- Renesas e² studio Version 2.02.00.13 or later
- Application Leading Tool for RL78 Version 1.01.00.02
- GNURL78 Version 13.02-ELF

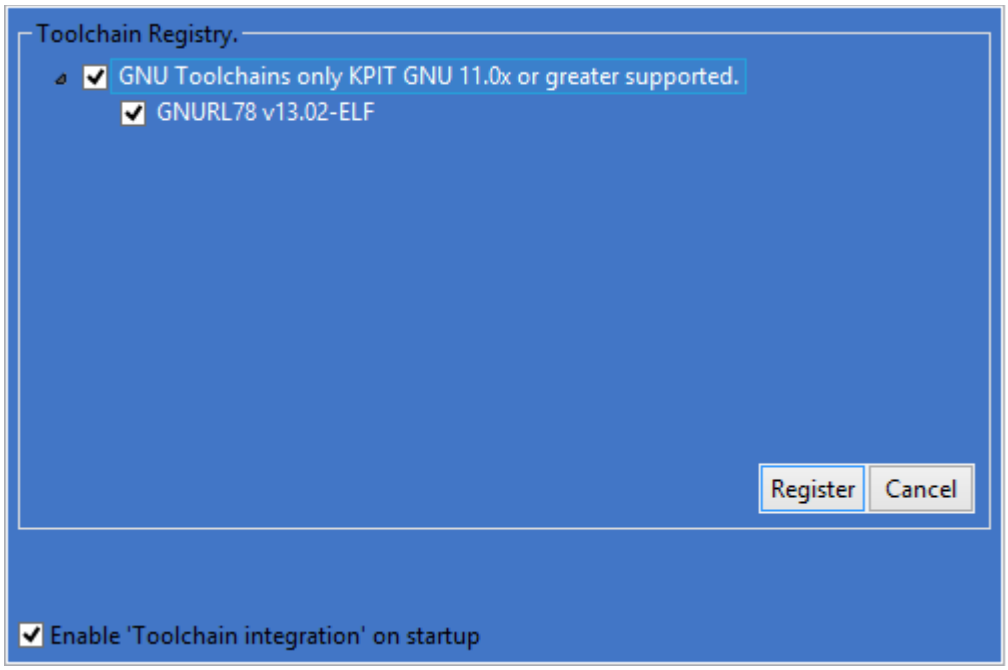
Create a new folder and name it as 'RSKRL78L1C_Workspace'. Copy the zipped file 'an_r01an2125eg0100_rl78l1c_power_save.zip', available in the Application Note package downloaded from the website, to this folder. Extract the 'an_r01an2125eg0100_rl78l1c_power_save.zip' file to the 'RSKRL78L1C_Workspace' folder.

2. Creating the Project Workspace

Open e² studio IDE by clicking the Windows Start button, select All Programs > Renesas Electronics e2 studio > Renesas e2 studio.

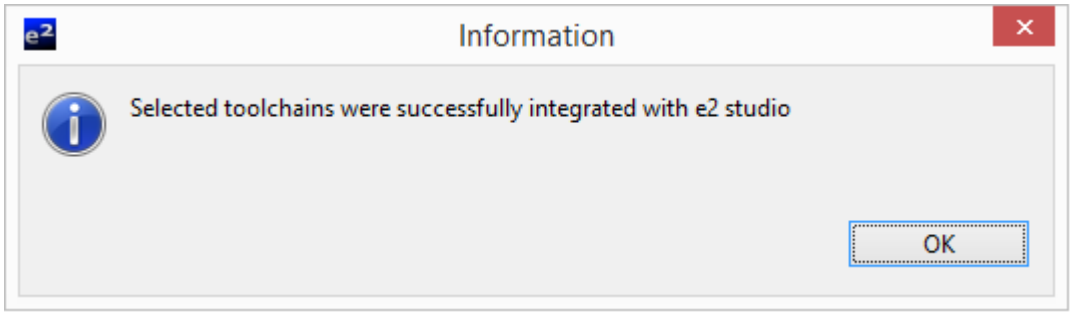


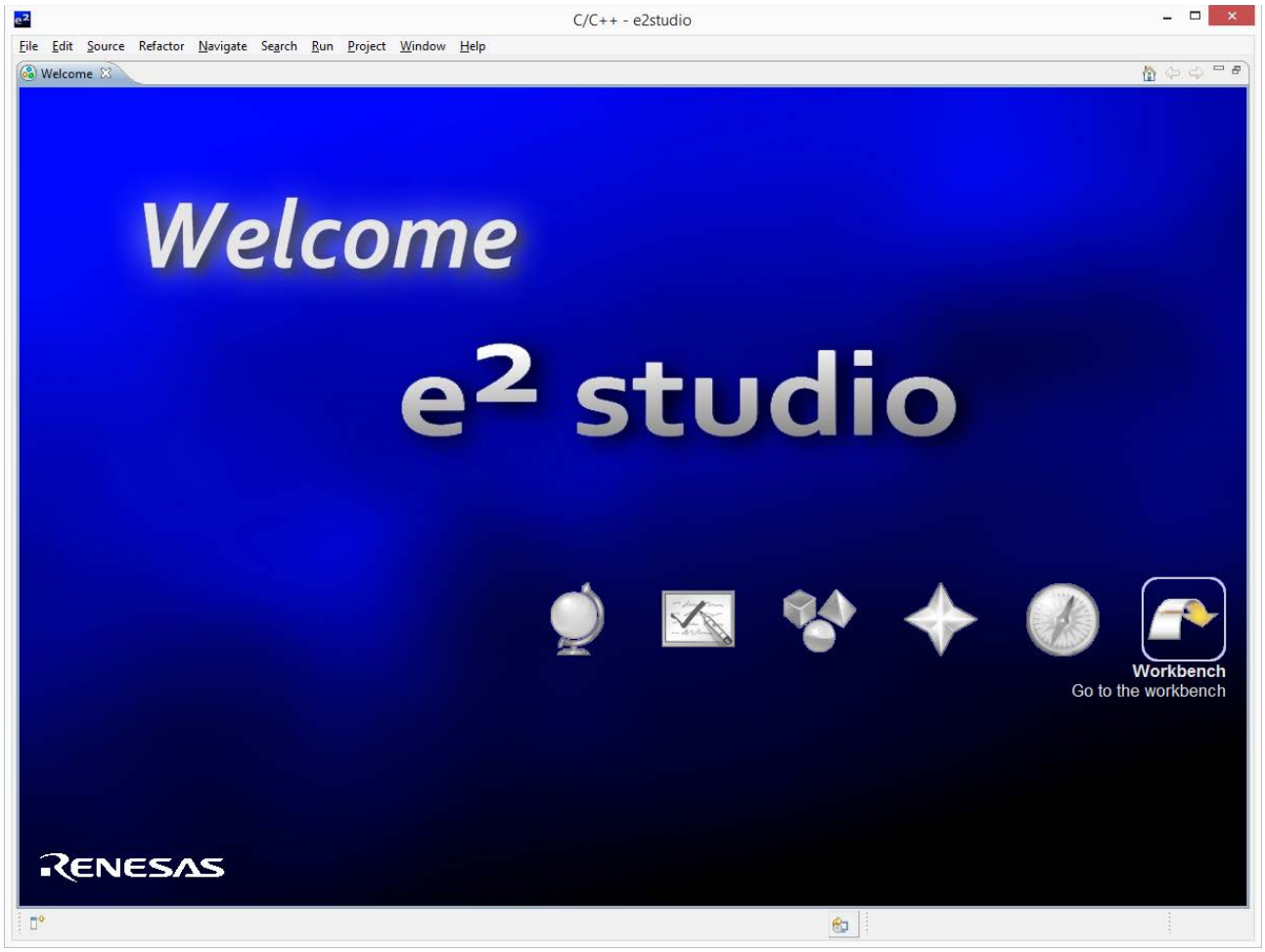
Select <OK>



Select ‘GNU Toolchains only…’ and ‘GNURL78 v13.02-ELF’ checkboxes. Click ‘Register’. A dialog will appear Click <OK>.

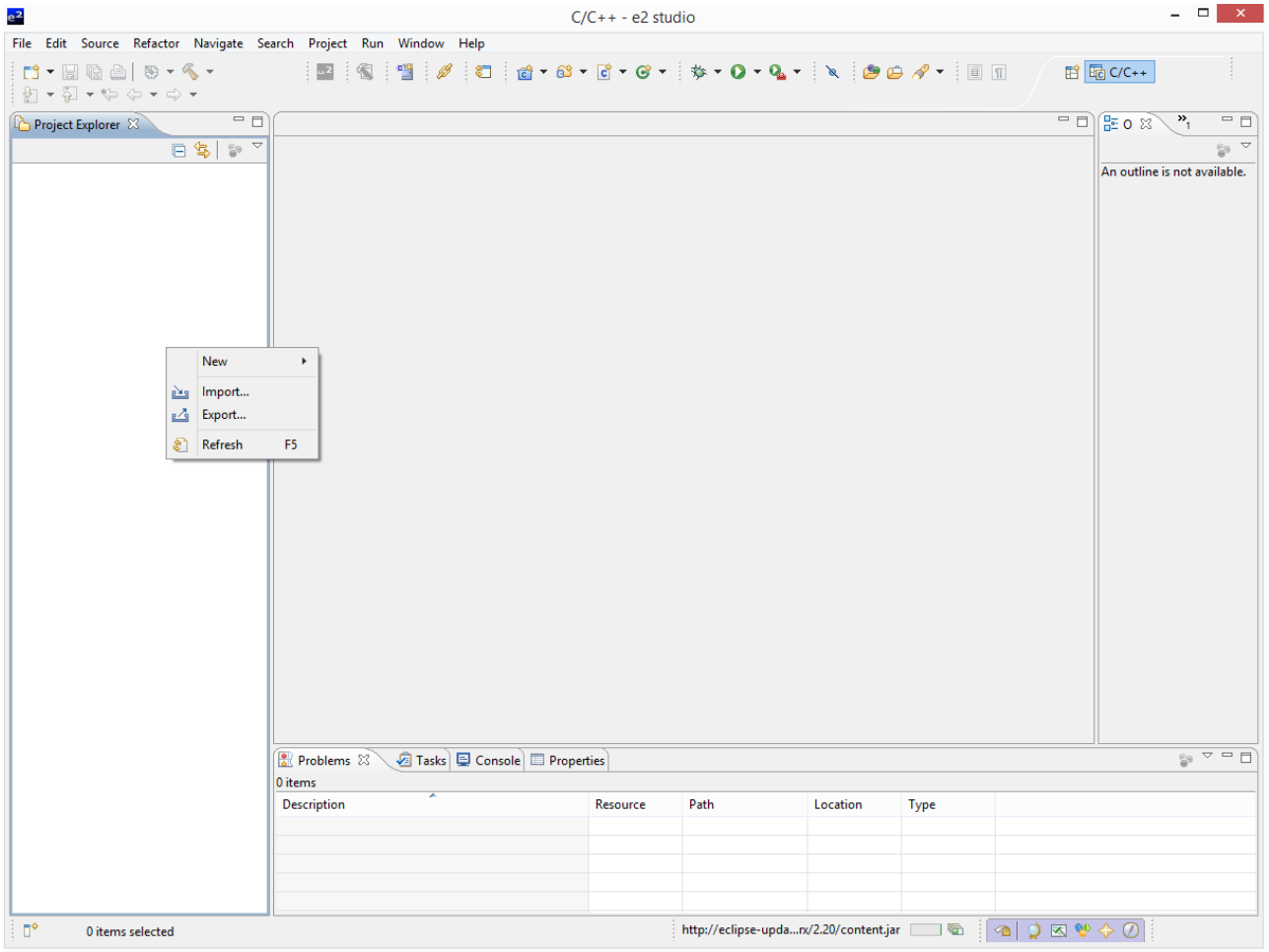
“Selected Toolchains were successfully integrated with e2studio”. Click <OK>.



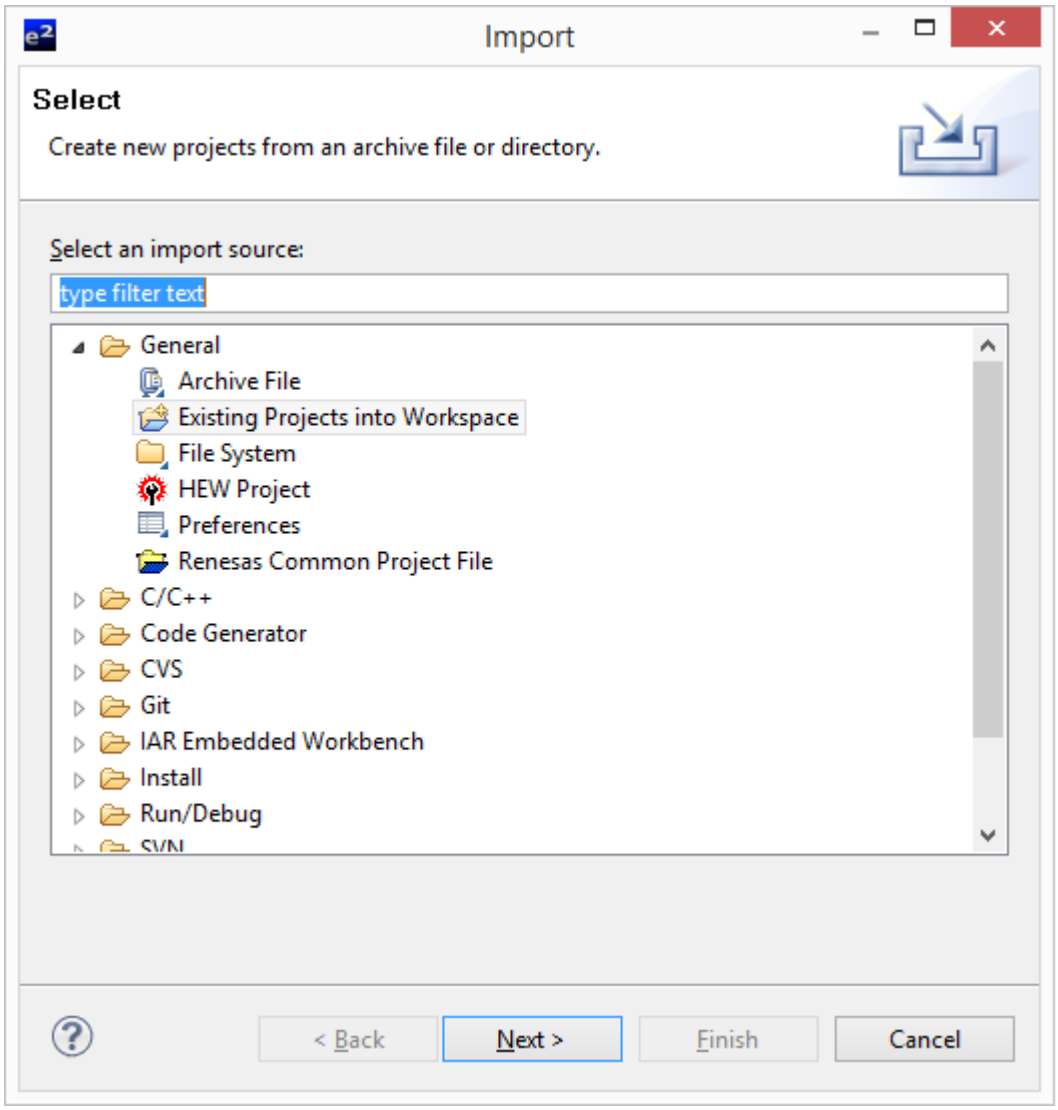

C/C++ - e2studio
File Edit Source Refactor Navigate Search Run Project Window Help
Welcome
Welcome
e² studio
Workbench
Go to the workbench
RENESAS

On the welcome screen, select ‘Go to the Workbench’ icon as shown above.

1. Once the e^2 studio environment has initialised, right click in the project explorer window and click <Import…>



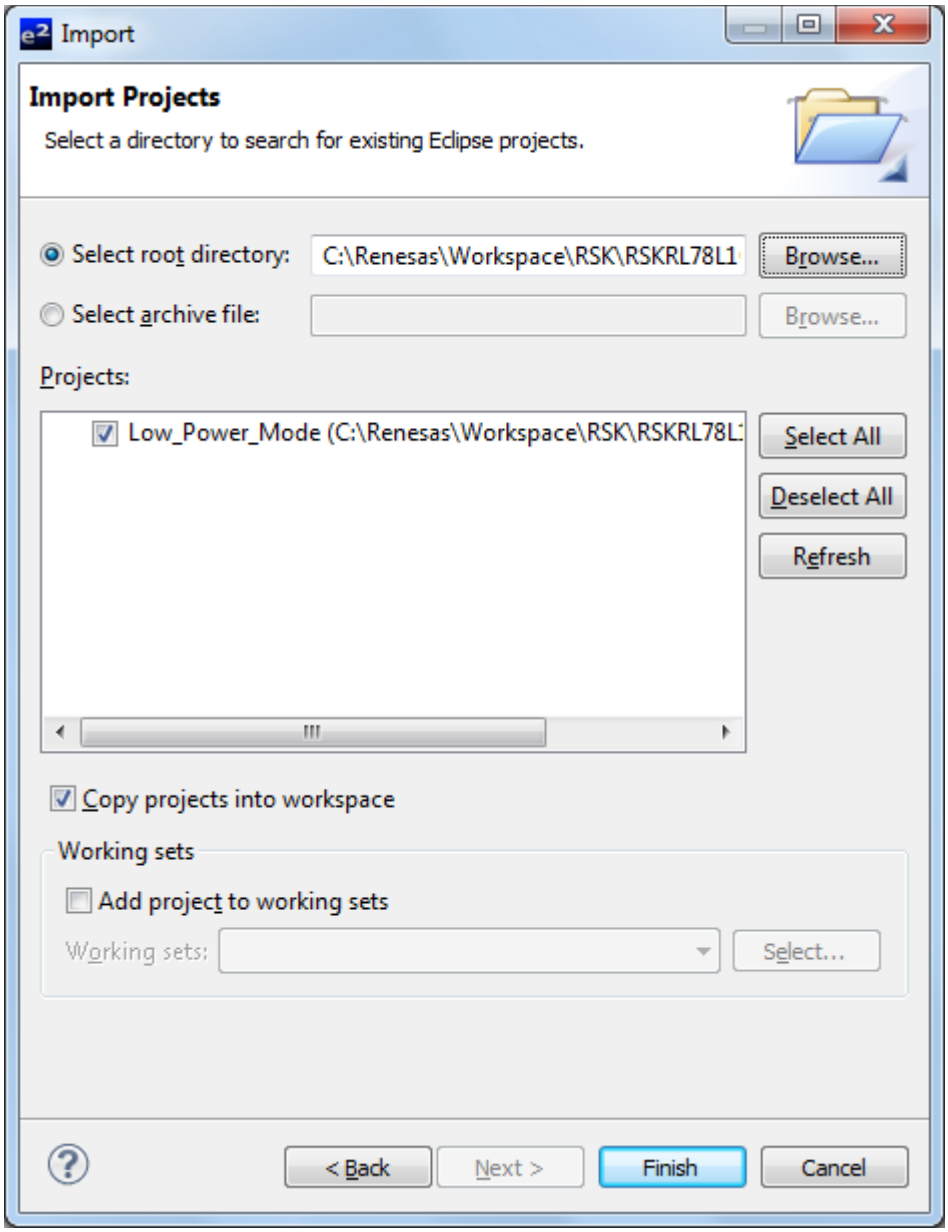
2. The Import dialog will now appear. Expand the “General” folder icon, and select “Existing Projects into Workspace”, then click ‘Next’.



3. The Import Dialog will now appear and specify the project to import. Click the “Browse” button and locate the directory created in section 1: ‘RSKRL78L1C_Workspace’.

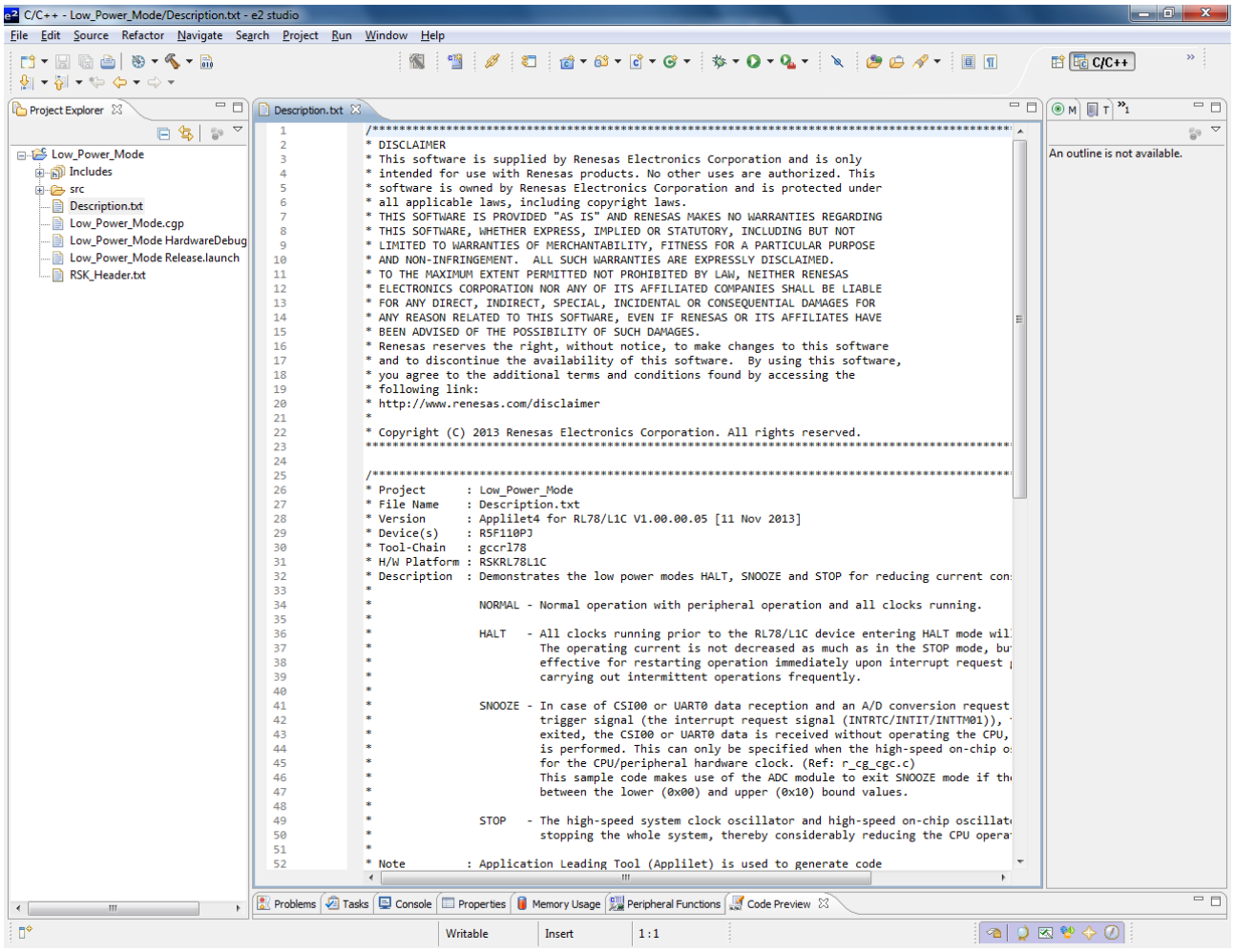
   Also ensure that the ‘Copy projects into workspace’ option is ticked, and then click <Finish>

   The IDE e^2 studio will load the project.


Import
Import Projects
Select a directory to search for existing Eclipse projects.
Select root directory:
C:\Renesas\Workspace\RSK\RSKRL78L1
Browse...
Select archive file:
Browse...
Projects:
Low_Power_Mode (C:\Renesas\Workspace\RSK\RSKRL78L
Select All
Deselect All
Refresh
Copy projects into workspace
Working sets
Add project to working sets
Working sets:
Select...
< Back
Next >
Finish
Cancel

3. Opening Sample Code and Source

Once the project has been opened, the source code and all dependent files can be opened in the editor by expanding the folders in the Project Tree window and double clicking the files listed. All files have been grouped according to their file type.



4. Source Code Functionality

The source code project is specifically written to run on the appropriate RSK. However, this source code can be useful as an example even without the RSK.

The project was written using source files containing API functions generated using Code Generator. The project will contain a C source file ‘r_cg_main.c’. This source file includes the C function main(). All source files and dependent files whose filenames are prefixed with ‘r_cg_’ were generated using Applilet4 (Application Leading Tool). For more information, refer to Description.txt.

5. Appendix

Example of comment block with code functionality.

```
/***********************************************************************************************
* Project      : Low_Power_Mode
* File Name    : Description.txt
* Version      : Applilet4 for RL78/L1C V1.00.00.05 [11 Nov 2013]
* Device(s)    : R5F110PJ
* Tool-Chain   : gccrl78
* H/W Platform : RSKRL78L1C
* Description  : Demonstrates the low power modes HALT, SNOOZE and STOP for reducing current consumption.
*
*           NORMAL - Normal operation with peripheral operation and all clocks running.
*
*           HALT   - All clocks running prior to the RL78/L1C device entering HALT mode will continue to run.
*                    The operating current is not decreased as much as in the STOP mode, but the HALT mode is
*                    effective for restarting operation immediately upon interrupt request generation and
*                    carrying out intermittent operations frequently.
*
*           SNOOZE - In case of CSI00 or UART0 data reception and an A/D conversion request by the timer
*                    trigger signal (the interrupt request signal (INTRTC/INTIT/INTTM01)), the STOP mode is
*                    exited, the CSI00 or UART0 data is received without operating the CPU, and A/D conversion
*                    is performed. This can only be specified when the high-speed on-chip oscillator is selected
*                    for the CPU/peripheral hardware clock. (Ref: r_cg_cgc.c)
*                    This sample code makes use of the ADC module to exit SNOOZE mode if the conversion result is
*                    between the lower (0x00) and upper (0x10) bound values.
*
*           STOP   - The high-speed system clock oscillator and high-speed on-chip oscillator stop,
*                    stopping the whole system, thereby considerably reducing the CPU operating current.
*
* Note         : Application Leading Tool (Applilet) is used to generate code
*           for this sample program.  The name Applilet is used hereafter.
*           The Applilet details and version number are given in the file
*           header for each relevant module.
* Modifications:
*           External Device/Component
*           -------------------------
*           Remove R125 and connect an ammeter across J5, configure the ammeter for current measurement.
*
*
```

```
* Operation    : Fit J6, pins 2-3 and J7 pins 2-3.
*              Power the RSK from a +5V centre positive PSU via the PWR connector.
*
* Instructions :
*          1. Compile the sample code and download to the RSK. Click the 'Resume'
*             button to start program execution. Click again if the program stops at main().
*             Press 'Stop' and disconnect the debugger from the RSK.
*
*          2. A real time clock will be displayed in the format:
*             HH:MM
*             The : will flash every second; the seconds will be displayed in the main display.
*             The clock is updated when the device is in normal operating mode.
*
*          3. Turn the potentiometer (RV1) fully clockwise. This sets the ADC input
*             to the highest value.
*
*          4. The sample code will cycle through the four different operating modes on each
*             switch press starting with NORMAL, HALT, SNOOZE then STOP.
*
*          5. Press SW1 to prepare for HALT mode, HALT will be displayed on the LCD.
*             Press SW1 again to enter HALT mode and observe the current for HALT mode.
*
*          6. Press SW1 to wake the MCU and prepare for SNOOZE mode. SNZ will be displayed on the LCD.
*             Press SW1 again to enter SNOOZE mode and observe the current. Note that the LCD display will be
*             turned off in this mode.  For SNOOZE mode the MCU is configured to apply the high speed
*             system clock to the ADC at 1 minute intervals and perform an A/D conversion.  If the result of this
*             conversion is in the range 0x00 to 0x10, then SNOOZE mode is exited, otherwise the MCU stays
*             in SNOOZE mode and wakes after another 1 minute interval to perform the next A/D conversion.
*
*          7. Turn the potentiometer (RV1) fully anti-clockwise to wake the MCU and to prepare for STOP mode.
*             Note that this may not cause an immediate wake up of the MCU as the RTC is configured to perform
*             an A/D conversion at one minute intervals. Once the MCU is awake STOP will be displayed on the LCD.
*             Press SW1 again to enter STOP mode and observe the current. Note that the LCD display will be turned
*             off in this mode.

*          8. Press SW1 to exit STOP mode and go to step 2 to repeat the test.
*
*******************************************************************************************************/
```

Website and Support

Renesas Electronics Website
http://www.renesas.com/

Inquiries
http://www.renesas.com/contact/

Support
http://www.renesas.com/rskrl78l1c

Revision History

		Description	
Rev.	**Date**	**Page**	**Summary**
1.0	Sep 11, 2014	-	First edition issued

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.

Notice

1. Descriptions of circuits, software and other related information in this document are provided only to illustrate the operation of semiconductor products and application examples. You are fully responsible for the incorporation of these circuits, software, and information in the design of your equipment. Renesas Electronics assumes no responsibility for any losses incurred by you or third parties arising from the use of these circuits, software, or information.
2. Renesas Electronics has used reasonable care in preparing the information included in this document, but Renesas Electronics does not warrant that such information is error free. Renesas Electronics assumes no liability whatsoever for any damages incurred by you resulting from errors in or omissions from the information included herein.
3. Renesas Electronics does not assume any liability for infringement of patents, copyrights, or other intellectual property rights of third parties by or arising from the use of Renesas Electronics products or technical information described in this document. No license, express, implied or otherwise, is granted hereby under any patents, copyrights or other intellectual property rights of Renesas Electronics or others.
4. You should not alter, modify, copy, or otherwise misappropriate any Renesas Electronics product, whether in whole or in part. Renesas Electronics assumes no responsibility for any losses incurred by you or third parties arising from such alteration, modification, copy or otherwise misappropriation of Renesas Electronics product.
5. Renesas Electronics products are classified according to the following two quality grades: "Standard" and "High Quality". The recommended applications for each Renesas Electronics product depends on the product's quality grade, as indicated below.
   "Standard": Computers; office equipment; communications equipment; test and measurement equipment; audio and visual equipment; home electronic appliances; machine tools; personal electronic equipment; and industrial robots etc.
   "High Quality": Transportation equipment (automobiles, trains, ships, etc.); traffic control systems; anti-disaster systems; anti-crime systems; and safety equipment etc.
   Renesas Electronics products are neither intended nor authorized for use in products or systems that may pose a direct threat to human life or bodily injury (artificial life support devices or systems, surgical implantations etc.), or may cause serious property damages (nuclear reactor control systems, military equipment etc.). You must check the quality grade of each Renesas Electronics product before using it in a particular application. You may not use any Renesas Electronics product for any application for which it is not intended. Renesas Electronics shall not be in any way liable for any damages or losses incurred by you or third parties arising from the use of any Renesas Electronics product for which the product is not intended by Renesas Electronics.
6. You should use the Renesas Electronics products described in this document within the range specified by Renesas Electronics, especially with respect to the maximum rating, operating supply voltage range, movement power voltage range, heat radiation characteristics, installation and other product characteristics. Renesas Electronics shall have no liability for malfunctions or damages arising out of the use of Renesas Electronics products beyond such specified ranges.
7. Although Renesas Electronics endeavors to improve the quality and reliability of its products, semiconductor products have specific characteristics such as the occurrence of failure at a certain rate and malfunctions under certain use conditions. Further, Renesas Electronics products are not subject to radiation resistance design. Please be sure to implement safety measures to guard them against the possibility of physical injury, and injury or damage caused by fire in the event of the failure of a Renesas Electronics product, such as safety design for hardware and software including but not limited to redundancy, fire control and malfunction prevention, appropriate treatment for aging degradation or any other appropriate measures. Because the evaluation of microcomputer software alone is very difficult, please evaluate the safety of the final products or systems manufactured by you.
8. Please contact a Renesas Electronics sales office for details as to environmental matters such as the environmental compatibility of each Renesas Electronics product. Please use Renesas Electronics products in compliance with all applicable laws and regulations that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive. Renesas Electronics assumes no liability for damages or losses occurring as a result of your noncompliance with applicable laws and regulations.
9. Renesas Electronics products and technology may not be used for or incorporated into any products or systems whose manufacture, use, or sale is prohibited under any applicable domestic or foreign laws or regulations. You should not use Renesas Electronics products or technology described in this document for any purpose relating to military applications or use by the military, including but not limited to the development of weapons of mass destruction. When exporting the Renesas Electronics products or technology described in this document, you should comply with the applicable export control laws and regulations and follow the procedures required by such laws and regulations.
10. It is the responsibility of the buyer or distributor of Renesas Electronics products, who distributes, disposes of, or otherwise places the product with a third party, to notify such third party in advance of the contents and conditions set forth in this document, Renesas Electronics assumes no responsibility for any losses incurred by you or third parties as a result of unauthorized use of Renesas Electronics products.
11. This document may not be reproduced or duplicated in any form, in whole or in part, without prior written consent of Renesas Electronics.
12. Please contact a Renesas Electronics sales office if you have any questions regarding the information contained in this document or Renesas Electronics products, or if you have any other inquiries.

(Note 1) "Renesas Electronics" as used in this document means Renesas Electronics Corporation and also includes its majority-owned subsidiaries.

(Note 2) "Renesas Electronics product(s)" means any product developed or manufactured by or for Renesas Electronics.

SALES OFFICES Renesas Electronics Corporation http://www.renesas.com

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

Renesas Electronics America Inc.
2801 Scott Boulevard Santa Clara, CA 95050-2549, U.S.A.
Tel: +1-408-588-6000, Fax: +1-408-588-6130

Renesas Electronics Canada Limited
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: +49-211-6503-0, Fax: +49-211-6503-1327

Renesas Electronics (China) Co., Ltd.
Room 1709, Quantum Plaza, No.27 ZhiChunLu Haidian District, Beijing 100191, P.R.China
Tel: +86-10-8235-1155, Fax: +86-10-8235-7679

Renesas Electronics (Shanghai) Co., Ltd.
Unit 301, Tower A, Central Towers, 555 Langao Road, Putuo District, Shanghai, P. R. China 200333
Tel: +86-21-2226-0888, Fax: +86-21-2226-0999

Renesas Electronics Hong Kong Limited
Unit 1601-1613, 16/F., Tower 2, Grand Century Place, 193 Prince Edward Road West, Mongkok, Kowloon, Hong Kong
Tel: +852-2265-6688, Fax: +852 2886-9022/9044

Renesas Electronics Taiwan Co., Ltd.
13F, No. 363, Fu Shing North Road, Taipei 10543, Taiwan
Tel: +886-2-8175-9600, Fax: +886 2-8175-9670

Renesas Electronics Singapore Pte. Ltd.
80 Bendemeer Road, Unit #06-02 Hyflux Innovation Centre, Singapore 339949
Tel: +65-6213-0200, Fax: +65-6213-0300

Renesas Electronics Malaysia Sdn.Bhd.
Unit 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.
12F., 234 Teheran-ro, Gangnam-Ku, Seoul, 135-920, Korea
Tel: +82-2-558-3737, Fax: +82-2-558-5141

Colophon 4.0