

# RZ/T1 Group

Renesas Starter Kit Code Generator Tutorial Manual For e<sup>2</sup> studio

RENESAS MCU RZ Family / RZ/T1 Series

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- · 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.

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- 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.

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### 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 Code Generator for RZ together with the e<sup>2</sup> studio IDE to create a working project 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 generate code and import it into e<sup>2</sup> studio, but does not intend to be a complete guide to software development on the RSK platform. Further details regarding operating the RZT1 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 RZT1 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+RZT1 User's Manual	R20UT3242EG
Tutorial	Provides a guide to setting up RSK environment, running sample code and debugging programs.	RSK+RZT1 Tutorial Manual	R20UT3243EG
Quick Start Guide	Provides simple instructions to setup the RSK and run the first sample.	RSK+RZT1 Quick Start Guide	R20UT3244EG
Code Generator Tutorial	Provides a guide to the standalone code generation tool.	RSK+RZT1 Code Generator Tutorial Manual	R20UT3281EG
Schematics	Full detail circuit schematics of the RSK.	RSK+RZT1 Schematics	R20UT3241EG
Hardware Manual	Provides technical details of the RZ/T1 microcontroller.	RZT1 Group, User's Manual: Hardware	R01UH0483EJ
NOR Boot Loader Application Note	Describes operational details of the NOR Boot Loader Program.	RZT1 NOR Boot Loader Application Note	R01AN2470EG
QSPI Boot Loader Application Note	Describes operational details of the QSPI Boot Loader Program.	RZT1 QSPI Boot Loader Application Note	R01AN2471EG

### 2. List of Abbreviations and Acronyms

Abbreviation	Full Form
ADC	Analog-to-Digital Converter
API	Application Programming Interface
СОМ	COMmunications port referring to PC serial port
CPU	Central Processing Unit
DVD	Digital Versatile Disc
E1	Renesas On-chip Debugger
GUI	Graphical User Interface
IDE	Integrated Development Environment
IRQ	Interrupt Request line
LCD	Liquid Crystal Display
LED	Light Emitting Diode
MCU	Micro-controller Unit
PC	Personal Computer
Pmod <sup>™</sup>	Digilent Pmod <sup>™</sup> Compatible connector. PmodTM is registered to Digilent Inc. Digilent-Pmod_Interface_Specification
PLL	Phase-locked Loop
QSPI	Quad Serial Peripheral Interface
RSK	Renesas Starter Kit
SCI	Serial Communications Interface
SPI	Serial Peripheral Interface

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### Table of Contents

1. O	verview	7
1.1	Purpose	7
1.2	Features	7
2. In	troduction	8
	roject Creation with e <sup>2</sup> studio	
3.1	Introduction	
3.2	Creating the Project	9
4. Us	sing the Code Generator	14
4.1	Introduction	
4.2	Code Generator Tour	14
4.3	Code Generation	
	3.1 Peripheral Function Configuration	
4.3	3.2 Generating the Code	22
5. Ac	dding Code to Generated Files	23
5.1	Excluding Files	
5.2	Adding Code to Generated Files	
5.2	2.1 r_cg_userdefine.h Code Insertion	24
5.2	2.2 r_cg_icu_user.c Code Insertion	24
5.2	2.3 r_cg_icu.h Code Insertion	24
5.2	2.4 r_cg_cmt_user.c Code Insertion	24
5.2	2.5 r_cg_main.c Code Insertion	25
5.3	Additional include paths	26
5.4	Release Build Section Map	27
6. Ex	xternal Linker File	
6.1	Linker File Over-ride	
6.2	Building the Project	
7. E>	xecuting the Project	31
0 11		20
	sage Notes	
8.1 8.2	iodefine.h File RIIC Module	
0.2		
9. Ac	dditional Information	33

## RENESAS

#### RSK+RZT1

1.

**RENESAS STARTER KIT** 

This RSK is an evaluation tool for Renesas microcontrollers. This manual describes how to use the e<sup>2</sup> studio IDE Code Generator plug in to create a working project for the RSK platform.

#### 1.2 Features

This RSK tutorial guides the user through creating a project to evaluate the following features:

- Project creation with  $e^2$  studio,
- · Code Generation using the Code Generator plug in,
- · User circuitry such as switches, LEDs and a potentiometer.

The RSK board contains all the circuitry required for microcontroller operation.



### 2. Introduction

This manual is designed to answer, in tutorial form, how to use the Code Generator plug in for the RZ family together with the e<sup>2</sup> studio IDE to create a working project for the RSK platform. The tutorials help explain the following:

- Project generation using the e<sup>2</sup> studio,
- Detailed use of the Code Generator plug in for e<sup>2</sup> studio,
- · Integration with custom code,
- Building and running the project  $e^2$  studio.

The project generator will create a tutorial project with two selectable build configurations:

- 'HardwareDebug' is a project built with the debugger support included. Optimisation is set to zero.
- 'Release' is a project with optimised compile options, producing code suitable for release in a product.

Some of the illustrative screenshots in this document will show text in the form RZxx. These are general screenshots and are applicable across the whole RZ family. In this case, simply substitute RZxx for RZT1

These tutorials are designed to show you how to use the RSK and are not intended as a comprehensive introduction to the e<sup>2</sup> studio debugger, compiler toolchains or the J-Link emulator. Please refer to the relevant user manuals for more indepth information.



### 3. Project Creation with e<sup>2</sup> studio

#### 3.1 Introduction

In this section the user will be guided through the steps required to create a new 'C' project for the RZT1 microcontroller, ready to generate and add peripheral driver code using Code Generator. This project generation step is necessary to create the MCU-specific source, project and debug files.

#### 3.2 Creating the Project

 Start e<sup>2</sup> studio and select a suitable location for the project workspace. Start e<sup>2</sup> studio and select a suitable location for the project workspace.

e <sup>2</sup> Workspace Launcher	<b>—</b>
Select a workspace	
e2 studio stores your projects in a folder called a workspace. Choose a workspace folder to use for this session.	
Workspace: C:Workspace	▼ <u>B</u> rowse
Use this as the default and do not ask again	OK Cancel

• In the Welcome page, click 'Go to the workbench'.





3. Project Creation with e<sup>2</sup> studio

 Create a new C project by rightclicking in the Project Explorer pane and selecting 'New -> C Project' as shown. Alternatively, use the menu item 'File -> New -> C Project'.

ြာ Project Explorer 🖾 📄 🔁							
		New	×		Project		
1	2	Import		C <sup>2</sup>	C Project		
1	4	Export		C <sup>2</sup>	C++ Project		
	8	Refresh	F5		Other	Ctrl+N	

Enter the project name 'CG\_Tutorial'. In 'Project type:' choose 'Sample Project'. In 'Toolchains' choose 'KPIT GNUARM-NONE-EABI Toolchain'. Click 'Next'.

e <sup>2</sup> C Project	
C Project Create C project of selected type	
Project name: CG_Tutorial Use default location Location: C:\Workspace\CG_Tutorial C:Create Directory for Project	B <u>r</u> owse
Project type: Executable (Renesas) Sample Project Constraint (Renesas) Static Library (Renesas) Sample Project Makefile project	Toolchains: KPIT GNUARM-NONE-EABI Toolchain
Show project types and toolchains only if th	ey are supported on the platform



Select

- 3. Project Creation with e<sup>2</sup> studio
- In the 'Target Specific Settings' dialog, e<sup>2</sup> C Project select the options as shown in the e2 studio - Project Generation screenshot opposite. Select Target Specific Settings The R7S910018 MCU is found under RZ/T -> RZ/T1 -> RZ/T1 - 320 pin -> Toolchain Version: v14.02 Ŧ R7S910018. Debug Hardware: J-Link ARM Click 'Next'. • No Image Endian: Little-endian • Available R7S910018 Select Target: .... Select Configuration From List below Hardware Debug : Debug using hardware Debug using Simulator : Debug using simulator Release (no debug) : Project without any debug information Build configurations will be created in the project only for the selected debug mode options, however by default the project will be built for the active configuration i.e., first configuration selected from group. Based on the device selection you made (RZ/T) the debug hardware (J-Link ARM) and debug target (R7S910018), debug configuration will be automatically created for you. ? < Back Next > Finish 'Use Peripheral code e<sup>2</sup> C Project Generator'. e2 studio - Project Generation Click 'Next'. Code Generator Settings Use Peripheral code Generator The e2 studio peripheral code generator automatically generates programs (device drivers) for MCU peripheral functions (clocks, timers, serial interfaces, A/D converters, DMA controllers, etc.) based on settings entered via a graphical user interface (GUI). Functions are provided as application programming interfaces (APIs) and are not limited to initialization of peripheral functions. Automatic generation of peripheral function UART CSI Application under development Timer A/D D/A Port settings Middleware RTOS DMA Clock driver ? < <u>B</u>ack <u>N</u>ext > Finish



Cancel

Cancel

\_\_ 🗆 🕳 X

Software

Microcontroller

- In 'Select Additional CPU Options' leave everything at default values.
- · Click 'Next'.

3. Project Creation with e<sup>2</sup> studio

- 0

•

•

Ŧ

Cancel

e<sup>2</sup> C Project

e2 studio - Project Generation

Select Additional CPU Options :

ARM

vfp

Select Additional CPU Options

Instruction Set

✓ Inter Working Target FPU

Floating Point ABI Soft

- In the 'Library Generator Settings' leave everything at default values.
- Click 'Finish'.

C Project
C Project Generation
Select Library Generator Settings
Select Library Source :

 Optimized
 Newlib
Use these for further code size Optimization.
Select Header Files :
 Ctype.h : Handles and checks characters
 math.h : Performs numerical calculations such as trigonometric funtions
 Stdio.h : Performs input/output handling
 Stdio.h : Performs C program standard processing such as storage area management
 Select Library Type :
 Project-Built
Build the library with user specified options.

 Select Library Type :

 Project-Built



#### 3. Project Creation with e<sup>2</sup> studio

 A summary dialog will appear, click 'OK' to complete the project generation.

Summary	
Project Summary:	
PROJECT GENERAT	ror 🔺
PROJECT NAME :	CG_Tutorial
PROJECT DIRECTORY :	C:\Workspace\CG_Tutorial\CG_
CPU SERIES :	RZ/T
CPU TYPE :	RZ/T1
TOOLCHAIN NAME :	KPIT GNUARM-NONE-EABI Too
TOOLCHAIN VERSION :	√14.02 ≡
GENERATION FILES :	
C:\Workspace\CG_Tutorial Reset Program	\CG_Tutorial\src\reset_program.a
C:\Workspace\CG_Tutorial Main Program	\CG_Tutorial\src\CG_Tutorial.c
C:\Workspace\CG_Tutorial Hardware Initialization	\CG_Tutorial\src\hardware_setup
C:\Workspace\CG_Tutorial	\CG_Tutorial\src\typedefine.h 👻
۰ ا	4
Click OK to generate the pro	ject or Cancel to abort.
	OK Cancel

The generated sample is a fully functional sample that can be built and executed, however, for the purpose of this tutorial, the sample's functionality will not be tested.

Note: the sample toggles LED0 on the RSK+RZT1 board. The toggling rate changes with variations of the potentiometer (RV1). Pressing SW3 enables/disables the LED toggling. This manual does not focus on the functionality of the sample.

Use 'Build Project' from the 'Project' menu or the State button to build the tutorial. The project will build with no errors.



### 4. Using the Code Generator

#### 4.1 Introduction

Code Generator is a GUI tool for generating template 'C' source code. This tool comes in two versions, either as an integrated plugin in e<sup>2</sup> studio or as a standalone application. The Code Generator tool distributed with the RSK+RZT1 is the plugin version. Code Generator enables the user is to configure various MCU features and operating parameters using intuitive GUI controls, bypassing the need, in most cases, to refer to sections of the Hardware Manual.

By following the steps detailed in this tutorial, the user will generate an  $e^2$  studio project called CG\_Tutorial. A fully completed CG\_Tutorial project is contained on the DVD and may be imported into  $e^2$  studio by following the steps in the Quick Start Guide. This tutorial is intended as a learning exercise for users who wish to use the Code Generator to generate their own custom projects for  $e^2$  studio.

Once the user has configured the project, the 'Generate Code' function is used to generate three code modules for each specific MCU feature selected. These code modules are named 'r\_cg\_xxx.h', 'r\_cg\_xxx.c', and 'r\_cg\_xxx\_user.c', where 'xxx' is a three letter acronym for the relevant MCU feature, for example 'scifa'. Within these code modules, the user is free to add custom code to meet their specific requirement. Custom code should be added between the following comment delimiters:

/\* Start user code for adding. Do not edit comment generated here \*/
/\* End user code. Do not edit comment generated here \*/

Code Generator will locate these comment delimiters, and preserve any custom code inside the delimiters on subsequent code generation operations. Any code outside of these comment delimiters will be overwritten on subsequent code generation sessions.

The CG\_Tutorial project uses the ADC module with external trigger, Interrupt Controller Unit (ICU) and Comapare Match Timer (CMT) and an LED (I/O Port). As a demonstration this tutorial performs the following actions:

- Configure an LED to be toggled.
- Configure an A/D channel for setting the toggling period.
- · Configure a timer channel to generate the toggling period.
- · Configure a switch used to enable or disable toggling of the LED.

Following a tour of the key user interface features of Code Generator in Section 4.2, the reader is guided through each of the peripheral function configuration dialogs in Section 4.3.1. In Section 5, the reader is familiarised with the structure of the template code, as well as how to add custom code in the areas provided by the Code Generator and any other changes required to be made in the project generated in Section 3.2.

#### 4.2 Code Generator Tour

This section presents a brief tour of Code Generator. AP4 is the stand-alone version of Code Generator and this manual is applicable to the Code Generator.

From the e<sup>2</sup> studio menus, select 'Window -> Open Perspective -> Other. In the 'Open Perspective' dialog shown in Figure 4-1, select 'Code Generator' and click 'OK'.





Figure 4-1: Changing Perspectives

A Code Generator project file with extension '.cpg' exists in the CG\_Tutorial project's .settings/CodeGenerator directory. Code Generator also creates a folder named 'cg\_src' in the 'src' folder to store generated source and header files. The user is encouraged to add non-CodeGenerator files to the 'src' folder.

The Code Generator's Peripheral View is displayed as illustrated in Figure 4-2.

🎦 Project Explorer 🛛 🗖 🗖				- 🗆 🗄 O 🛛 🔭 – I			
				An outline is not available.			
a 😂 CG_Tutorial							
▷ ﷺ Binaries ▷ 册 Archives	🕐 Problems 🧢 Tasks 🕒 Console 🥅 Prop	erties 🔋 Memory Usage 🛷 Search = Stack A	nalysis 👒 Smart Browser 🕎 Peripheral Functions 🙁	🐻 Generate Code  立 🗢 🛛			
Big Annues     Sub-roberta & Task & Constel Properties in methody usage by Search - Stack Analysis in an constel by Properties in an analysis in an constel by Properties in an analysis in an							
> 😕 src	Bot mode setting						
<ul> <li>HardwareDebug</li> <li>CG Tutorial HardwareDebug.</li> </ul>	-	SPI boot					
CG_Tutorial HardwareDebug.	- Main clock oscillator setting	0					
G_Tutorial Release.jlink	-	Resonator/External clock	(Clock source is set based on the status of OSCTH)				
CG_Tutorial Release.launch custom.bat	Frequency	25	(MHz)				
makefile.init	Oscillation stop detection function	Disabled T					
Code Generator		bisabled ·					
<ul> <li>PinView</li> <li>Peripheral Functions</li> </ul>	- PLL0 circuit setting	[					
Code Preview		1200	(MHz)				
	- PLL1 circuit setting						
	Operation     Frequency	1200	(MHz)				
		1200	(m 12)				
	Low speed on-chip oscillator (LOCO) setting     Operation						
		240	(kHz)				
	- Internal clock setting (Clock source is PLL0 or PL	11)	(N112)				
	Clock source	PLL0 -					
	CPU clock (CPUCLK)	150 🗸	(MHz)				
		150	(MHz)				
	-,						
	High-speed peripheral module clock (PCLKA)		(MHz)				
	High-speed peripheral module clock (PCLKB)		(MHz)				
	External bus clock (CKIO)	50 🗸	(MHz)				

Figure 4-2: Peripheral View

Code Generator provides GUI features for configuration of MCU sub-systems and peripherals. Once the user has configured all required MCU sub-systems and peripherals, the user can click the 'Generate Code' button, resulting in the creation of a number of source and header files in the e<sup>2</sup> studio project's 'src' folder. A few more steps will need to be carried out before the project is fully configured and ready for use.

Navigation to the MCU peripheral configuration screens may be performed by double-clicking the required function in the Code Generator -> Peripheral Function under the Project View pane.

It is also possible to see a preview of the code that will be generated for the current peripheral function settings by double-clicking the required function in the Code Generator -> Code Preview on the left.

#### 4.3 Code Generation

In the following sections, the reader is guided through the steps to configure the MCU peripherals required.

#### Note: Configuration options that are not shown should be left with the default settings.

#### 4.3.1 Peripheral Function Configuration

#### 4.3.1.1 Clock Generator

Figure 4-3 shows a screenshot of Code Generator with the Clock Generator function open.

In this tutorial we are using the 25 MHz crystal resonator for the main clock source with the PLL circuit used as a multiplier. Some peripherals can be configured to use the main clock or PLL circuitry sources to generate their clock.

Double click on the 'Clock Generation Circuit' entry in Code Generator -> Peripheral Functions list in the Project Tree.

Configure the Clock Generation Circuit options under the 'Clock Settings' tab as shown in Figure 4-3.

A block diagram of the Clock Generation Circuit is provided under 'Block Diagram' tab, shown on the next page. This helps to see the different clock configurations available for the system and peripheral clocks.



Clock setting Debug interface setting Block dia Boot mode setting	agram			
16-bit/32-bit bus boot	SPI boot			
Main clock oscillator setting	0 0			
Main clock oscillation source	Resonator/External clock		(Clock source	
Frequency	25	(MHz)		
Oscillation stop detection function	Disabled	•		
PLLO sizevit astring				
PLL0 circuit setting Frequency	1200		(MHz)	
PLL1 circuit setting			(····-)	
✓ Operation				
Frequency	1200		(MHz)	
Low speed on-chip oscillator (LOCO) setting				
Operation	242			
Frequency	240		(kHz)	
Internal clock setting (Clock source is PLL0 or PL Clock source	PLL1			
		•	(1)	
CPU clock (CPUCLK)	600	•	(MHz)	
System clock (ICLK)	150		(MHz)	
High-speed peripheral module clock (PCLKA)	150		(MHz)	
High-speed peripheral module clock (PCLKB)	75		(MHz)	
External bus clock (CKIO)	50	-	(MHz)	
Trace interface clock (TCLK)	150	-	(MHz)	
Internal clock setting (Clock source is PLL0) ——				
High-speed peripheral module clock (PCLKC)	150		(MHz)	
Low-speed peripheral module clock (PCLKD)			(MHz)	
Low-speed peripheral module clock (PCLKE)	75	•	(MHz)	
Low-speed peripheral module clock (PCLKF)	60	-	(MHz)	
Low-speed peripheral module clock (PCLKG)	60	•	(MHz)	
Low-speed peripheral module clock (PCLKH)	60		(MHz)	
High-speed serial clock (SERICLK)	150	•	(MHz)	
IWDT clock setting				
IWDT clock (IWDTCLK)	120		(kHz)	
ECM clock setting				
ECM clock (ECMCLK)	240		(kHz)	
Ethernet clock setting				
Ethernet clock D (ETCLKD)	12.5	-	(MHz)	
Ethernet clock E (ETCLKE)	25	-	(MHz)	
Delta-sigma clock setting				
Delta-sigma interface clock 0 clock source	PLLO	-		
Delta-sigma interface clock 0 supply channel	Clocks input to MCLK0~2 pins	-		
Delta-sigma interface clock 0 (DSCLK0)	25	-	(MHz)	
DSCLK0 output polarity	Not inverted	•		
Delta-sigma interface clock 1 clock source	PLL0	-		
Delta-sigma interface clock 1 (DSCLK1)	25	•	(MHz)	

Figure 4-3: Clock setting tab

#### 4.3.1.2 I/O Ports

This peripheral will be configured to assign output pins for user LEDs. The CG\_Tutorial only makes use of LED0. User LED connectivity port pins on the schematic are as shown in Table 4-1: I/O Ports Connectivity.

Function	MCU Pin	I/O Port	Note
LED0	A5	PF7	
LED1	E3	P56	Not used
LED2	K16	P77	Not used
LED3	J18	PA0	Not used

 Table 4-1: I/O Ports Connectivity

Please refer to the RSK schematic for full details of the connectivity.

Double click on the 'I/O Ports' entry in Project Tree -> Peripheral Functions -> I/O Ports. Expand the list. Configuration is required for the port pins listed in Table 4-1: I/O Ports Connectivity.

Configure the port as shown in Figure 4-4: LED Port Pin Configuration.

	Port1	Port2	Port3	Port4	Port5	Port6	Port7	Port8	Port9	PortA
	PortD	PortE	PortF	PortG	PortH	PortJ	PortK	PortL	PortM	PortN
-	- PF5									
	Oliver Unus Unus	ed 🔘 Ir	n © 0	ut C	isables input p	oull-up and pu	ll-down resist	ors 🔻	🗌 Out	put 1
-	O Unus     PF7	ed 🔘 Ir	n © 0	ut C	isables input p	oull-up and pu	ll-down resist	ors 🔻	🗌 Out	put 1
	O Unus	ed 🔘 Ir	n © 0	ut C	isables input p	oull-up and pu	ll-down resist	ors 🔻	🔲 Out	put 1

Figure 4-4: LED Port Pin Configuration

#### 4.3.1.3 Compare Match Timer (CMT)

This peripheral is configured to generate regular intervals used to flash LED0.

Double click on the 'Compare Match Timer' entry in Project Explorer -> CG\_Tutorial -> Code Generator -> Peripheral Functions.

Configure the CMT channel as shown in Figure 4-5.

CMT0 CMT1 CMT2 CMT3 CMT4 CMT5		
- Compare match timer operation setting		
🔘 Unused	Used	
- Count clock setting		
PCLKD/8	PCLKD/128	O PCLKD/512
- Interval value setting		
Interval value	447	ms <ul> <li>(Actual value: 447.003307)</li> </ul>
Interrupt option		
- Interrupt setting		
Enable compare match interrupt (CMI1)		
Priority	Level 3	•
	Elevena A.F.	CMT Cotting Tab



#### 4.3.1.4 A/D Converter

This peripheral is configured to sample the analogue output value of the RV1 potentiometer. The A/D Converter is set to perform a sample when the user presses SW3, which is connected to the **AN007** pin of the microcontroller.

Double click on the 'S12AD0' entry in Project Tree -> Peripheral Functions -> 12-Bit A/D Converter.

Configure the 'Setting 1' sub-tab as shown in the following figures:

Cotting 1 Court C				
Setting 1 Setting 2				
S12AD0 operation setting				
Our Unused		Used		
Operation mode setting -				
<ul> <li>Single scan mode</li> </ul>		Group scan m	node	Continuous scan mode
Double trigger mode settir	na			© continuous countinuous
bouble algger mode sear		ure 4-6: A/D Conv	erter Setting tab	
nalog input channel setting —				
alog input channel setting -	Convert (Group A)	Convert (Group B)	Add/Average AD value	Dedicated sample and hold
AN000				
AN001				
AN002				
AN003				
AN004				
AN004 AN005				
AN005 AN006				
AN008 AN007				
Temperature sensor output				
onversion start trigger setting Conversion start trigger (Grou				
Software trigger				<b>▼</b>
Conversion start trigger (Grou	up B)			
Compare match with or inp	put capture to MTUU.TO	JKA		<b>*</b>
ata registers setting —				
AD converted value addition	a count	1-time conversion		_
AD converted value addition	n count	1-time conversion		<b>.</b>
Data placement	n count	Right-alignment	•	<b>*</b>
	n count	Right-alignment Disable automatic clearing		▼
Data placement		Right-alignment Disable automatic clearing 12-bit accuracy	•	▼
Data placement Automatic clearing		Right-alignment Disable automatic clearing	•	~ ~
Data placement Automatic clearing Data accuracy	Figur	Right-alignment Disable automatic clearing 12-bit accuracy	•	<ul> <li>▼</li> </ul>
Data placement Automatic clearing Data accuracy	Figur	Right-alignment Disable automatic clearing 12-bit accuracy	•	<ul> <li>▼</li> </ul>
Data placement Automatic clearing Data accuracy	Figur	Right-alignment Disable automatic clearing 12-bit accuracy	• ter Setting tab (2	(Actual value: 0.367)
Data placement Automatic clearing Data accuracy N007 conversion time set Input sampling time	Figur	Right-alignment Disable automatic clearing 12-bit accuracy re 4-7: A/D Conver	• ter Setting tab (2	-
Data placement Automatic clearing Data accuracy N007 conversion time set Input sampling time	Figur	Right-alignment Disable automatic clearing 12-bit accuracy re 4-7: A/D Conver	ter Setting tab (2 (μs)	(Actual value: 0.367)
Data placement Automatic clearing Data accuracy N007 conversion time set Input sampling time emperature sensor output Input sampling time	Figur	Right-alignment Disable automatic clearing 12-bit accuracy re 4-7: A/D Conver	ter Setting tab (2 (μs)	-
Data placement Automatic clearing Data accuracy N007 conversion time set Input sampling time emperature sensor output Input sampling time conversion time setting —	Figur	Right-alignment Disable automatic clearing 12-bit accuracy re 4-7: A/D Conver 0.3667 etting 0.3667	ter Setting tab (2 (μs)	(Actual value: 0.367)
Data placement Automatic clearing Data accuracy N007 conversion time set Input sampling time emperature sensor output Input sampling time	Figur	Right-alignment Disable automatic clearing 12-bit accuracy re 4-7: A/D Conver	ter Setting tab (2 (μs)	(Actual value: 0.367)
Data placement Automatic clearing Data accuracy N007 conversion time set Input sampling time emperature sensor output Input sampling time Conversion time setting —	Figur tting t conversion time se (Group A)	Right-alignment Disable automatic clearing 12-bit accuracy re 4-7: A/D Conver 0.3667 etting 0.3667	ter Setting tab (2 (μs)	(Actual value: 0.367)
Data placement Automatic clearing Data accuracy N007 conversion time set Input sampling time emperature sensor output Input sampling time conversion time setting — Total conversion time (	Figur tting t conversion time se (Group A)	Right-alignment Disable automatic clearing 12-bit accuracy re 4-7: A/D Conver 0.3667 etting 0.3667	ter Setting tab (2 (μs) (μs)	(Actual value: 0.367)
Data placement Automatic clearing Data accuracy N007 conversion time set Input sampling time remperature sensor output Input sampling time Conversion time setting — Total conversion time ( Total conversion time (	Figur tting t conversion time se (Group A) (Group B)	Right-alignment Disable automatic clearing 12-bit accuracy re 4-7: A/D Conver 0.3667 0.3667 0.717	ter Setting tab (2 (μs) (μs)	(Actual value: 0.367)
Data placement Automatic clearing Data accuracy N007 conversion time set Input sampling time emperature sensor output Input sampling time conversion time setting — Total conversion time ( Total conversion time ( interrupt setting —	Figur tting t conversion time se (Group A) (Group B)	Right-alignment Disable automatic clearing 12-bit accuracy re 4-7: A/D Conver 0.3667 0.3667 0.717 2ADI0)	ter Setting tab (2 (μs) (μs) (μs) (μs) (μs)	(Actual value: 0.367)
Data placement Automatic clearing Data accuracy N007 conversion time set Input sampling time remperature sensor output Input sampling time Conversion time setting — Total conversion time ( Total conversion time ( Total conversion time ( Total conversion time (	Figur tting t conversion time se (Group A) (Group B) ion end interrupt (S1	Right-alignment Disable automatic clearing 12-bit accuracy re 4-7: A/D Conver 0.3667 0.3667 0.717 2ADI0) Level 0 (highest)	ter Setting tab (2 (μs) (μs) (μs) (μs) (μs)	(Actual value: 0.367)
Data placement Automatic clearing Data accuracy N007 conversion time set Input sampling time remperature sensor output Input sampling time Conversion time setting — Total conversion time ( Total conversion time ( nterrupt setting —	Figur tting t conversion time se (Group A) (Group B) ion end interrupt (S1	Right-alignment Disable automatic clearing 12-bit accuracy re 4-7: A/D Conver 0.3667 0.3667 0.717 2ADI0) Level 0 (highest)	ter Setting tab (2 (μs) (μs) (μs) (μs) (μs)	(Actual value: 0.367)
Data placement Automatic clearing Data accuracy N007 conversion time set Input sampling time remperature sensor output Input sampling time Conversion time setting — Total conversion time ( Total conversion time ( Total conversion time ( Total conversion time (	Figur tting t conversion time se (Group A) (Group B) ion end interrupt (S1	Right-alignment Disable automatic clearing 12-bit accuracy re 4-7: A/D Conver 0.3667 0.3667 0.717 2ADI0) Level 0 (highest)	ter Setting tab (2 (μs) (μs) (μs) (μs) (μs) (μs) (μs) (μs)	(Actual value: 0.367)
Data placement Automatic clearing Data accuracy N007 conversion time set Input sampling time emperature sensor output Input sampling time conversion time setting — Total conversion time ( Total conv	Figur tting t conversion time se (Group A) (Group B) ion end interrupt (S1 ion end interrupt for	Right-alignment Disable automatic clearing 12-bit accuracy re 4-7: A/D Conver 0.3667 0.3667 0.717 2ADI0) Level 0 (highest) group B (S12GBADI0)	ter Setting tab (2 (μs) (μs) (μs) (μs) (μs) (μs) (μs) (μs)	(Actual value: 0.367)

Figure 4-8 A/D Converter Setting tab (3)



S12AD0 S12AD1	
Setting 1 Setting 2	
-Window function setting	
Oisable	⊘ Enable
- Reference data setting	
Initial reference data 0 for comparison	0
Initial reference data 1 for comparison	0
Figure 4-	9 A/D Converter Setting tab (4)

- Interrupt setting	
Enable AD conversion conversion	ompare interrupt (S12CMPI0)
Priority	Level 0 (highest)
	Figure 4.10, A/D Convertor Setting tob (5)

Figure 4-10: A/D Converter Setting tab (5)

#### 4.3.1.5 Interrupt Controller Unit (ICU)

This peripheral is used to configure external interrupts input pins connected to user switches. The CG\_Tutorial only makes use of switch SW3. User switch connectivity on the schematic are shown in Table 4-2: ICU Connectivity

Function	MCU Pin	I/O Port	Note
NMI	H3	P35	Not used.
IRQ5	W3	PN5	Not used.
IRQ12	W15	P44	SW3

Table 4-2: ICU Connectivity

Please refer to the RSK schematic for full details of the connectivity.

Double click on the 'Interrupt Controller' entry under the Project Tree -> Peripheral Functions list.

This is to configure switch SW3 to trigger IRQ12 interrupts.

-IRQ12 setting							
IRQ12	Detection type	Falling edge	-	Digital noise filter	PCLKB/64	▼ 1.172	(MHz)
	Priority	Level 3	•				

#### Figure 4-11: ICU Setting tab

#### 4.3.1.6 Multi-Function Pin Controller (MPC)

This peripheral is used to select and map port/peripheral functionalities of the MCU pins. By default, mapping of functionalities to pins is done during peripheral configuration as shown in the setup of the I/O Ports, A/D and ICU modules. The Multi-Function Controller is used to re-assign the default functionalities mapping if required.

Double click on the 'Device List View' entry under the Project Tree -> Pin View.

Please ensure to verify the port pin functions for each configured peripheral by viewing the 'Pin Number' and 'Pin Function' tabs as shown in Figure 4-12: Pin Number Device List View tab and Figure 4-13: Pin Function Device List View tab



Pin Number	Pin Name	Selected Function	Pin Direction	Pin Remarks
A1	VSS	VSS	-	E
A2	PC2/ ETH0_TXC/ ETH1_RXD2/ CATI2CDATA/ SDA0	Not assigned	-	
A3	PJ3/ IRQ11/ ETH0_TXD0/ ADTRG0	Not assigned	-	
A4	PJ1/ ETH0_TXD2/ CATLEDSTER/ RSPCK3	Not assigned	-	
A5	PF7/ IRQ7/ A25/ ETH0_TXER/ RTS3#/ SSL30	PF7	Out	
A6	PB4/ A24/ ETH1_COL/ ETH0_RXER/ CATSYNC0/ CATL	Not assigned	-	
A7	PB0/ ETH1_RXDV/ MTCLKB/ TCLKD/ TIC3	Not assigned	-	
A8	PC0/ WAIT#/ ETH1_RXD2/ GTETRG/ SCL1/ MDAT3	Not assigned	-	
A9	PF6/ ETH1_RXD0/ MTIOC3D/ GTIOC0B/ TOC2	Not assigned	-	
A10	VCCQ33	VCCQ33	-	
A11	P54/ CLKOUT25M1/ MOSI2	Not assigned	-	
A12	VSS	VSS	-	
A13	AN007	AN007	In	
A14	AN005	Not assigned	-	
A15	AN002	Not assigned	-	
A16	AVCC0	Not assigned	-	
A17	AVCC1	Not assigned	-	
A18	VREFH1	Not assigned	-	
A19	P17/CS5#/ETH1_TXER/PHYRESETOUT#/ADTRG0	Not assigned	-	
A20	VSS	VSS	-	
B1	PJ5/ ETH0_RXD1/ TIOCD0/ RXD3	Not assigned	-	
B2	PJ4/ ETH0_RXD0/ TXD3	Not assigned	-	
B3	PC3/ ETH0_RXC/ ETH0_RXDV/ CATI2CCLK/ RXD4/ SC	Not assigned	-	
Pin Number	Pin Function /			

#### Figure 4-12: Pin Number Device List View tab

Clock Generation Circuit	Pin Name	Pin Assignment	Pin Number	Pin Direction	Pin Rer
Interrupt Controller	NMI	Not assigned	Not assigned	In	
Bus state controller DMA Controller	IRQ0	Not assigned	Not assigned	In	
I/O Ports	IRQ1	Not assigned	Not assigned	In	
Multi-Function Timer Pulse	IRQ2	Not assigned	Not assigned	In	
Port Output Enable 3 General PWM Timer	IRQ3	Not assigned	Not assigned	In	
16-Bit Timer Pulse Unit	IRQ4	Not assigned	Not assigned	In	
Programmable Pulse Gener	IRQ5	Not assigned	Not assigned	In	
Compare Match Timer W	IRQ6	Not assigned	Not assigned	In	
Serial Communications Inter I2C Bus Interface	IRQ7	Not assigned	Not assigned	In	
Serial Peripheral Interface	IRQ8	Not assigned	Not assigned	In	
SPI Multi I/O Bus Controller	IRQ9	Not assigned	Not assigned	In	
ΔΣ Interface Error Control Module	IRQ10	Not assigned	Not assigned	In	
12-Bit A/D Converter	IRQ11	Not assigned	Not assigned	In	
Gigabit Ethemet MAC	IRQ12	PN4/ IRQ12/ MTIOC6C/ TIOCC6/ SSL11	V4	In	
EtherCAT Slave Controller	IRQ13	Not assigned	Not assigned	In	
USB 2.0 HS Host/Function CAN Interface	IRQ14	Not assigned	Not assigned	In	
Serial Sound Interface	IRQ15	Not assigned	Not assigned	In	
Others	ETH0_INT	Not assigned	Not assigned	In	
	ETH1_INT	Not assigned	Not assigned	In	
	ETH2_INT	Not assigned	Not assigned	In	
Pin Number \ Pin Function	•				•

Figure 4-13: Pin Function Device List View tab

Figure 4-13 shows IRQ12 (Pin Name) function assigned to MCU pin number V4 but on the RSK+RZT1 schematic, V4 is connected to I/O port pin P44. The IRQ12 function needs to be re-assigned to P44 (MCU pin number W15).

To assign/re-assign a pin, click on the pin to reveal a drop-down menu button. Click on the button to reveal a list of available pins, then select W15 as shown in Figure 4-14.

IRQ11	Not assigned	Not assigned	In
IRQ12	PN4/ IRQ12/ MTIOC6C/ TIOCC6/ SSL11	V4 -	In
IRQ13	Not assigned	Not assigned V4	In
IRQ14	Not assigned	W13	In
IRQ15	Not assigned	W15	In

Figure 4-14: Pin Function Assignment/Re-assignement

The MPC assigns pins in the order in which the peripherals were configured. Once a pin has been assigned to a function, configuring another peripheral that uses the same function will result in the assignment of that function to an alternate pin. In addition, the MPC does not automatically map functions to pins based on the connectivity on the RSK+RZT1. This is why it is important to verify the pin functions in the Device List View.

A pin name will be shown in red if configuration clashes exist.

A remark will be shown on the Pin Remark column of the Device List View if a pin function is assigned without configuring the peripheral that uses the function.

#### 4.3.2 Generating the Code

Peripheral function configuration is now complete. Click 'Generate Code' button located at the top right of the Peripheral Function tab. The Output pane should report 'The operation of generating file was successful', as shown Figure 4-15 below.

M0409001:The following files were generated:
M0409004: <u>src\cg src\r cg main.c</u> was overwritten.
M0409004: <u>src\cg src\r cg mpc.c</u> was overwritten.
M0409004: <u>src\cg src\r cg mpc.h</u> was overwritten.
M0409004:src\cg src\r cg interrupthandlers.h was overwritten.
M0409004: <u>src\cg src\r cg intprg.c</u> was overwritten.
M0409004:src\cg src\r cg systeminit.c was overwritten.
M0409004: <u>src\cg src\r cg macrodriver.h</u> was overwritten.
M0409004: <u>src\cg src\r cg userdefine.h</u> was overwritten.
M0409004: <u>src\cg src\r cg cgc.c</u> was overwritten.
M0409004: <u>src\cg src\r cg cgc user.c</u> was overwritten.
M0409004: <u>src\cg src\r cg cgc.h</u> was overwritten.
M0409004: <u>src\cg src\r cg icu.c</u> was overwritten.
M0409004: <u>src\cg src\r cg icu user.c</u> was overwritten.
M0409004: <u>src\cg src\r cg icu.h</u> was overwritten.
M0409004: <u>src\cg src\r cg port.c</u> was overwritten.
M0409004: <u>src\cg src\r cg port user.c</u> was overwritten.
M0409004: <u>src\cg src\r cg port.h</u> was overwritten.
M0409004: <u>src\cg src\r cg cmt.c</u> was overwritten.
M0409004: <u>src\cg src\r cg cmt user.c</u> was overwritten.
M0409004: <u>src\cg src\r cg cmt.h</u> was overwritten.
M0409004: <u>src\cg src\r cg s12ad.c</u> was overwritten.
M0409004: <u>src\cg src\r cg s12ad user.c</u> was overwritten.
M0409004: <u>src\cg src\r cg s12ad.h</u> was overwritten.
M0409003:The operation of generating file was successful.

#### Figure 4-15: Code Generator's Output pane

### 5. Adding Code to Generated Files

At this stage of a typical project development the user would expand on the generated code to create the application required.

When inserting code in Code Generator created files, it must be placed in the areas delimited by comments as follows:

/\* Start user code for \_xxxxx\_. Do not edit comment generated here \*/
/\* End user code. Do not edit comment generated here \*/

Where \_xxxx\_ depends on the particular area of code, i.e. 'function' for insertion of user functions and prototypes, 'global' for insertion of user global variable declarations, or 'include' for insertion of pre-processor include directives. User code inserted inside these comment delimiters is protected from being overwritten by Code Generator, if the user regenerates the Code Generator code.

#### 5.1 Excluding Files

All sample code can only have one main file. The init\_main.c file generated in Section 3.2 and the r\_cg\_main.c file generated by Code Generator both include a main function. The init\_main.c file is automatically excluded following code generation. To exclude a file from the project following these steps:

- 1. Locate the source file in the 'Project Explorer' view.
- 2. Right click on the file and select 'Exclude from build...'.
- 3. Click on 'Select All' to make change on all available build configurations.
- 4. Click 'OK'.

e <sup>2</sup> Exclude from build	
Exclude object(s) from	build in the following configurations
Release	
HardwareDebug	
	Select All
?	OK Cancel

Figure 5-1: Excluding files from the project

Multiple files can be excluded in on step by selecting the desired files during step 1. Exclude the following files:

loader\_param.c r\_ecm.c r\_icu\_init.c r\_icu\_init.h r\_system.h typdefine.h

To re-include a file, repeat the above steps and click on 'Deselect All' then click 'OK'.



#### 5.2 Adding Code to Generated Files

This section covers inserting code in to the newly created Code Generator files.

Each subsection is a Code Generator generated source file that needs to be opened by double clicking on the file name in e<sup>2</sup> studio's Project Tree window under the 'src' folder.

The code from each section should be copied from this document and pasted in to the relevant file at the location indicated.

#### 5.2.1 r\_cg\_userdefine.h Code Insertion

Open this file by double clicking on the file name in e<sup>2</sup> studio's Project Tree window.

Insert the following at the end of the file between the user code delimiter comments as shown below.

 $/\, \star$  Start user code for function. Do not edit comment generated here  $\, \star /$ 

**#define** LEDO (PORTF. PODR. BIT. B7)

/\* End user code. Do not edit comment generated here \*/

#### 5.2.2 r\_cg\_icu\_user.c Code Insertion

Open this file by double clicking on the file name in e<sup>2</sup> studio's Project Tree window.

Insert the followings between the specific user code insertion delimiter comments as shown below.

/\* Start user code for global. Do not edit comment generated here \*/

volatile uint8\_t g\_switch\_press = 0;

/\* End user code. Do not edit comment generated here \*/

/\* Start user code. Do not edit comment generated here \*/

/\* Invert the flag \*/
g\_switch\_press = (~g\_switch\_press);

```
/* End user code. Do not edit comment generated here */
```

#### 5.2.3 r\_cg\_icu.h Code Insertion

Open this file by double clicking on the file name in e<sup>2</sup> studio's Project Tree window.

Insert the following at the end of the file between the user code delimiter comments as shown below.

/\* Start user code for function. Do not edit comment generated here \*/

extern volatile uint8\_t g\_switch\_press;

/\* End user code. Do not edit comment generated here \*/

#### 5.2.4 r\_cg\_cmt\_user.c Code Insertion

Open this file by double clicking on the file name in e<sup>2</sup> studio's Project Tree window.

Insert the following between the user code delimiter comments as shown below in the file section designated Global variables and functions:

```
/* Start user code for include. Do not edit comment generated here */
#include "r_cg_icu.h"
#include "r_cg_cmt.h"
#include "r_cg_sl2ad.h"
/* End user code. Do not edit comment generated here */
```



/\* Start user code for global. Do not edit comment generated here \*/

/\* Function prototype for scaling a value \*/
static uint32\_t scale\_value (const uint32\_t value, const uint32\_t in\_max, const uint32\_t out\_max);

/\* End user code. Do not edit comment generated here \*/

Insert the following in to the function **void r\_cmt\_cmi1\_interrupt(void)** 

```
/* Start user code. Do not edit comment generated here */
/* Update the period based on the flag set in the switch handler interrupt */
if (0 == g_switch_press)
{
    /* scale the ADC value. ADC range: 0-4095, CMT range: 0 - 65478 */
    CMT1.CMCOR = scale_value ((uint32_t)(S12ADC0.ADDR7), 4095, 65478);
}
else
{
    /* Do not update the CMT period */
}
LED0 = (~LED0);
/* End user code. Do not edit comment generated here */
```

Insert the following between the user code delimiter comments at the end of the file:

 $/\ast$  Start user code for adding. Do not edit comment generated here  $\ast/$ 

```
Function Name: scale_value
 {\tt Description}~ : This function is CMI1 interrupt service routine.
             The formula used
             output = 1 + (value - 0) * (out_max - 0) / (in_max - 0)
             Note - The actual and desired ranges' minimum value is assumed to be 0.
           : uint32_t value
                         - value to scale
 Arguments
                          uint32_t in_max - maximum range of value to scale
                         uint32_t out_max - maximum range of desired scale
 Return Value : None
                    static uint32_t scale_value (const uint32_t value, const uint32_t in_max, const uint32_t out_max)
{
      uint32_t output;
      output = (out_max - 0) / (in_max - 0);
output = (value - 0) * output;
      output = (1 + output);
      return output;
}
                     *******
* End of function scale value
                      /* End user code. Do not edit comment generated here */
        r_cg_main.c Code Insertion
 5.2.5
Insert the following in to the function void main (void).
```

/\* Start user code. Do not edit comment generated here \*/
/\* The rest of the code is executed in interrupt handlers \*/
while (1U)
{
 asm("nop");
}
/\* End user code. Do not edit comment generated here \*/

RENESAS

```
Insert the following in to the function void R_MAIN_UserInit (void):
    /* Start user code. Do not edit comment generated here
    uint32_t delay = 0x3FFFF;
    /* Clear the switches' interrupt flags before enabling the interrupts */
   VIC. PICO.LONG = 0x00000200UL;
   VIC. PICO.LONG = 0x00010000UL;
    /* Enable the switch interrupts */
   R_ICU_IRQ12_Start();
    /* Enabling interrupts can cause generation of an interrupt which should
      be ignored. Allow some delay to catch the interrupt should it occur. */
    while ((0 == g_switch_press) && (delay--))
    {
        asm("nop");
   }
    /* Ensure the switch pressed flag is cleared to enable timer period updates */
   g_switch_press = 0;
    /* Enable continuous A/D conversions */
   R_S12AD0_Start();
    /* Enable the timer's count */
   R_CMIT1_Start();
    /* End user code. Do not edit comment generated here */
```

#### 5.3 Additional include paths

Before the project can be built the compiler needs some additional include paths added. Select the CG\_Tutorial project in the Project Explorer pane. Use the e button in the toolbar to open the project settings. Navigate to 'C/C++ Build -> Settings ->Compiler -> Source and click the e button as shown in below in Figure 5-2.



Figure 5-2: Adding additional search paths



In the 'Add directory path' dialog, click the 'Workspace' button and in the 'Folder selection' dialog browse to the 'CG\_Tutorial/src' folder and click 'OK'. e<sup>2</sup> studio formats the path as shown in Figure 5-3 below.

ne}/src}		
Cancel	Workspace	File system
1	me}/src}	

Figure 5-3 Adding workspace search path

Repeat the above steps to add the workspace search paths and press OK to exit the Properties dialog.

Select 'Build Project' from the 'Project' menu, or use the button. e<sup>2</sup> studio will build the project with no errors. The project may now be run using the debugger as described in §7.

#### 5.4 Release Build Section Map

Code Generator makes changes to Linker Section addresses while generating code. These changes are only performed on the build configuration currently selected.

The steps followed above will create a working 'HardwareDebug' build configuration. Follow the steps below to create a working 'Release' build configuration. For details of the differences in these build configurations please see Section 2.

Select the 'Release' Build configuration by clicking:

Project > Build Configurations > Set Active > Release (Release – No Debug).

In the Project Explorer tree, right click the entry 'Code Generator' and select 'Generate Code'. This will run an update for the generated code and make the required changes to Linker Section addresses.

Open the Release configuration from:

Debug Configurations > Renesas GDB Hardware Debugging . CG\_Tutorial Release

Select the 'Startup' tab. Ensure the 'Set breakpoint at:' option is unticked.

Note: Section 6 will need to be done for both



### 6. External Linker File

e<sup>2</sup> studio allows specifying a different linker file to be used by the linker. The default linker map declaration can be found in:

Project properties > C/C++ Build > Settings > Linker > Sections

The CG\_Tutorial code does not make use of the default linker mapping declaration. The loader\_init.asm file includes variables declared in the default linker map. These variables are used for storing specific addresses in the linker file. Open the loader\_init.asm and change #if 1 to #if 0

#### 6.1 Linker File Over-ride

The following steps are used to create a new linker file, define the linker sections of the RZ/T1 device and set the GNU Linker to use the file created.

- · Create a new file in the project
- · Right click on the 'src' source folder.
- Select New > File
- Specify the name as: linker\_file.ld
- · Open the file by double-clicking on it.
- · Copy and paste the following text:

```
OUTPUT_FORMAT("elf32-littlearm", "elf32-bigarm", "elf32-littlearm")
OUTPUT_ARCH(arm)
ENTRY(_PowerON_Reset)
```

#### MEMORY

{

/\* Internal RAM address range H'2000\_0000 to H'2001\_FFFF is configured as data retention RAM \*/ /\* Write access to this address range has to be enabled by writing to registers SYSCR1 and SYSCR2 \*/ ATCM (rwx) : ORIGIN = 0x00000000, LENGTH = 0x00080000 /\* (512KB) H'00000000 to H'0007FFFF \*/ BTCM (rwx) : ORIGIN = 0x00800000, LENGTH = 0x00800000 /\* (32KB) H'00800000 to H'00807FFF \*/ BUFFER\_RAM (rwx) : ORIGIN = 0x08000000, LENGTH = 0x10000000 /\* (128MB) H'08000000 to H'10000000 \*/ DATA\_RAM (rwx) : ORIGIN = 0x20000000, LENGTH = 0x00080000 /\* (512KB) H'20000000 to H'2007FFFF \*/

/\* Mapped memory type \*/ : ORIGIN = 0x30000000, LENGTH = 0x04000000 SPI\_ROM (rw) CS0\_ROM : ORIGIN = 0x40000000, LENGTH = 0x04000000 (rw) CS1\_ROM (rw) : ORIGIN = 0x44000000, LENGTH = 0x04000000 SDRAM0\_EXT (rw) : ORIGIN = 0x48000000, LENGTH = 0x04000000 SDRAM1\_EXT (rw) : ORIGIN = 0x4C000000, LENGTH = 0x04000000 } SYS\_STACK\_SIZE = 0x200;/\* Application stack size \*/ /\* SVC mode stack \*/ SVC\_STACK\_SIZE = 0x200;IRQ\_STACK\_SIZE = 0x100;/\* IRQ mode stack FIQ\_STACK\_SIZE = 0x100;/\* FRQ mode stack UND\_STACK\_SIZE ABT\_STACK\_SIZE /\* SVC mode stack  $= 0 \times 100$ : = 0x100;/\* ABT mode stack HEAP\_STACK\_SIZE = 0x1000; /\* Heap stack size = 0x0000000; /\* User application located here ATCM\_BASE \*/

```
BTCM_BASE= 0x00800000; /* BTCM base address*/USER_EXEC_BASE= 0x000000000; /* Application loads and runs from here*/USER_RAM= 0x20000000; /* Application's RAM base*/STACK_BASE= 0x00807800; /* Stacks located in BTCM*/
```

```
SECTIONS
```

.loader\_text USER\_EXEC\_BASE :
{
 reset\_start = .;
 \*(.loader\_text);
 . = ALIGN(0x4);
 reset\_end = .;
} > ATCM

```
R20UT3281EG0100 Rev. 1.00
Mar 21, 2015
```



```
.text :
{
  text_start = .;
   *(.text)
   *(.text.startup)
  text_end = .;
} > ATCM
.rodata :
{
  rodata_start = .;
   _start_data_ROM = .;
   *(.rodata)
   *(.rodata.*)
   = ALIGN(0x8);
   *(.data)
   *(.data.*)
   _end_data_ROM = .;
   *(.got.plt)
   *(.got)
   \dot{=} ALIGN(0x8);
  rodata_end = .;
  PROVIDE(end = .);
} > ATCM
_ram_data_size = (_end_data_ROM - _start_data_ROM);
.data USER_RAM :
{
    _start_data_RAM = .;
  data_start = .;
start_data_RAM = .;
   . += _ram_data_size;
  data_end = .;
}
.bss data_end :
{
   bss_start = .;
   PROVIDE(__bss_start__ = .);
   *(.bss)
*(.bss.**)
   *(COMMON)
    = ALIGN(0x4);
   PROVIDE(__bss_end__ = .);
   ebss_end = .;
    _end = .
   PROVIDE(end = .);
}
.heap :
{
  heap_start = .;
  : = ALIGN(0x8);
*(.heap_stack)
. += HEAP_STACK_SIZE;
  heap\_end = .;
} > ATCM
.sys_stack 0x807800 : AT (0x807800)
{
  sys_stack_start = .;
     = ALIGN(0x8);
  . = A∟i⊂. (
*(.sys_stack)
   . += SYS_STACK_SIZE;
  sys_stack_end = .;
   _sys_stack = .;
} > BTCM
.svc_stack 0x807A00 : AT (0x807A00)
{
  svc_stack_start = .;
   = ALIGN(0x8);
   *(.svc_stack)
   . += SVC_STACK_SIZE;
  svc_stack_end = .;
```



```
svc stack = .:
} > BTCM
.irq_stack 0x807C00 : AT (0x807C00)
{
  irq_stack_start = .;
  . = ALIGN(0x8);
  *(.irg stack)
  . += IRQ_STACK_SIZE;
  irq_stack_end = .;
   _irq_stack = .;
} > BTCM
.fig_stack 0x807D00 : AT (0x807D00)
{
  fiq_stack_start = .;
    = ALIGN(0x8);
  *(.fiq_stack)
  . += FIQ_STACK_SIZE;
  fiq_stack_end = .;
   _fiq_stack = .;
} > BTCM
.und_stack 0x807E00 : AT (0x807E00)
{
  und_stack_start = .;
    = ALIGN(0x8);
  *(.und_stack)
  . += UND_STACK_SIZE;
  und_stack_end = .;
  _und_stack = .;
} > BTCM
.abt_stack 0x807F00 : AT (0x807F00)
{
  abt_stack_start = .;
  . = ALIGN(0x8);
  *(.abt_stack)
   += ABT_STACK_SIZE;
  abt_stack_end = .;
   abt_stack = .;
} > BTCM
```

Click File > Save

}

- · Open Project properties > C/C++ Build > Settings > Linker Other
- · Change the 'Command file overide' option to 'External Linker script(-T)'.
- Add the following to the 'File' entry (including the speech marks):
- "\${workspace\_loc:/\${ProjName}/src/linker\_file.ld}"
- · Click 'Apply'.
- Navigate to Project properties > C/C++ Build > Settings > Linker Other > Miscellaneous
- Ensure to untick the 'Enable garbage collection of unused input sections(-gc-sections) if it is ticked.
- Click 'OK'.

The above 7 steps needs to be done for the HardwareDebug and Release configurations.

#### 6.2 Building the Project

The project template created by Code Generator can now be built. In the Project Explorer pane expand the 'src' folder.

Use 'Build Project' from the 'Project' menu or the State button to build the CG\_Tutorial project. The project will build with no errors.



### 7. Executing the Project

In the Project Explorer pane, ensure that the 'CG\_Tutorial' project is selected. To debug the project, click the button. The dialog shown in Figure 7-1 will be displayed.



Figure 7-1: Perspective Switch Dialog

Click 'OK' to confirm that the debug window perspective will be used.

The debugger will start up and the e<sup>2</sup> studio will show the Code Generator function 'PowerOn\_Reset'.

Click the 'Resume' lime button. The debugger will stop again at the beginning of the main() function. Press lime again to run the code.

The program will toggle LED0 at a rate set by the position of RV1. Slowly rotate RV1 fully clockwise then counter-clockwise and observe the change in the rate at which the LED toggles. Press SW3 to keep the rate at the position of RV1 when the SW3 was pressed. Rotating RV1 will not change the toggling rate. Press SW3 to re-enable the variations to the toggling.

For more information on the  $e^2$  studio debugger refer to the Tutorial manual.



### 8. Usage Notes

#### 8.1 iodefine.h File

Location of the iodefine.h file.

By default, the r\_cg\_macrodriver.h header file which includes the iodefine.h file expects the iodefine.h file to be located in the 'src' folder.

#### 8.2 RIIC Module

The RIIC peripheral contains an error in one of its interrupt handler functions. In the r\_cg\_riic\_user.c file, in the function void r\_riic0\_error\_interrupt(void), replace the existing else if condition and the encapsulated lines of code with the following:

```
else if (_IIC_MASTER_RECEIVE == g_riic0_mode_flag)
ł
    if ((_IIC_MASTER_SENDS_ADR_7_R == g_riicO_state) || (_IIC_MASTER_SENDS_ADR_10A_W == g_riicO_state))
    {
         RIICO. ICSR2. BIT. START = OU;
         RIICO. ICIER. BIT. STIE = OU;
         RIICO.ICIER.BIT.SPIE = 1U; /* Enable stop condition detection to prepare for the next receive */
         /* Enable the TXIO interrupt */
         VIC. IEN3. LONG \mid = 0 \times 08000000 UL;
         /* Enable the RXIO interrupt */
         VIC. IEN3. LONG |= 0x0400000UL;
    }
    else if (_IIC_MASTER_RECEIVES_RESTART == g_riic0_state)
         RIICO. ICSR2. BIT. START = OU;
         RIICO. ICIER. BIT. STIE = OU;
         g_riicO_state = _IIC_MASTER_SENDS_ADR_10A_R;
    else if (_IIC_MASTER_RECEIVES_STOP == g_riicO_state)
    ł
         RIICO. ICMR3. BIT. RDRFS = OU;
         RIICO. ICMR3. BIT. ACKWP = 1U;
         RIICO. ICMR3. BIT. ACKBT = OU;
         RIICO. ICSR2. BIT. NACKF = OU;
         RIICO. ICSR2. <u>BIT</u>. STOP = OU;
RIICO. ICIER. BIT. SPIE = OU;
         RIICO. ICIER. BIT. STIE = 1U;
                                        /* Enable start condition detection to prepare for the next receive */
        /* Clear TXI0 interrupt flag */
VIC.PIC3.LONG = 0x08000000UL;
         /* Disable TXI0 interrupt
         VIC. IEC3. LONG = 0x0800000UL;
         /* Clear RXIO interrupt flag */
         VIC. PIC3. LONG = 0x04000000UL:
          * Disable RXIO interrupt *
         VIC. IEC3. LONG = 0x0400000UL;
         r_riic0_callback_receiveend();
    }
}
```



### 9. 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 RZ/T1 group microcontroller refer to the RZ/T1 Group Hardware Manual.

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

#### **Technical Contact Details**

#### Please refer to the contact details listed in section 11 of the "Quick Start Guide"

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

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