# RL78/G13

Utilising the Timer Array Unit (TAU) (Using GNURL78 v13.01 Toolchain)

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## Introduction

The purpose of this Application Note is to show the user how to add the associated RL78G13 sample code to a new or existing e$^2$studio workspace; as well as give an explanation of what the sample code does.

The sample code provided with this Application Note runs on the RL78G13 RSK and demonstrates usage of the Timer Array Unit (TAU) in various application modes; PWM mode, square wave output, interval timer and event counter.

## Target Device

RL78G13

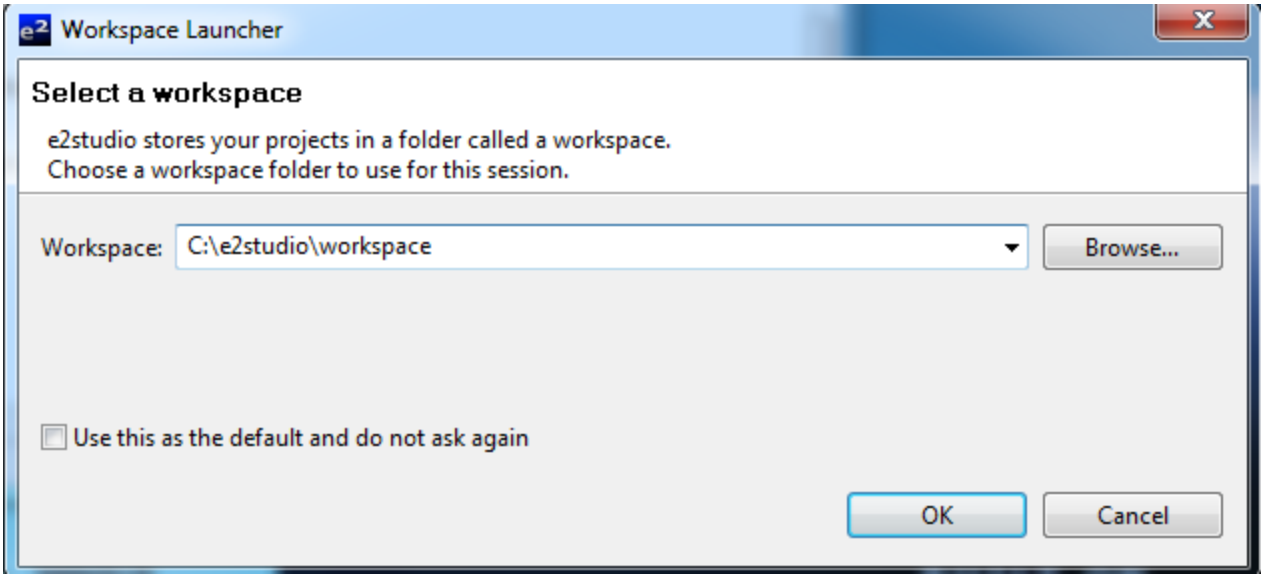
## Contents

## 1. Installation

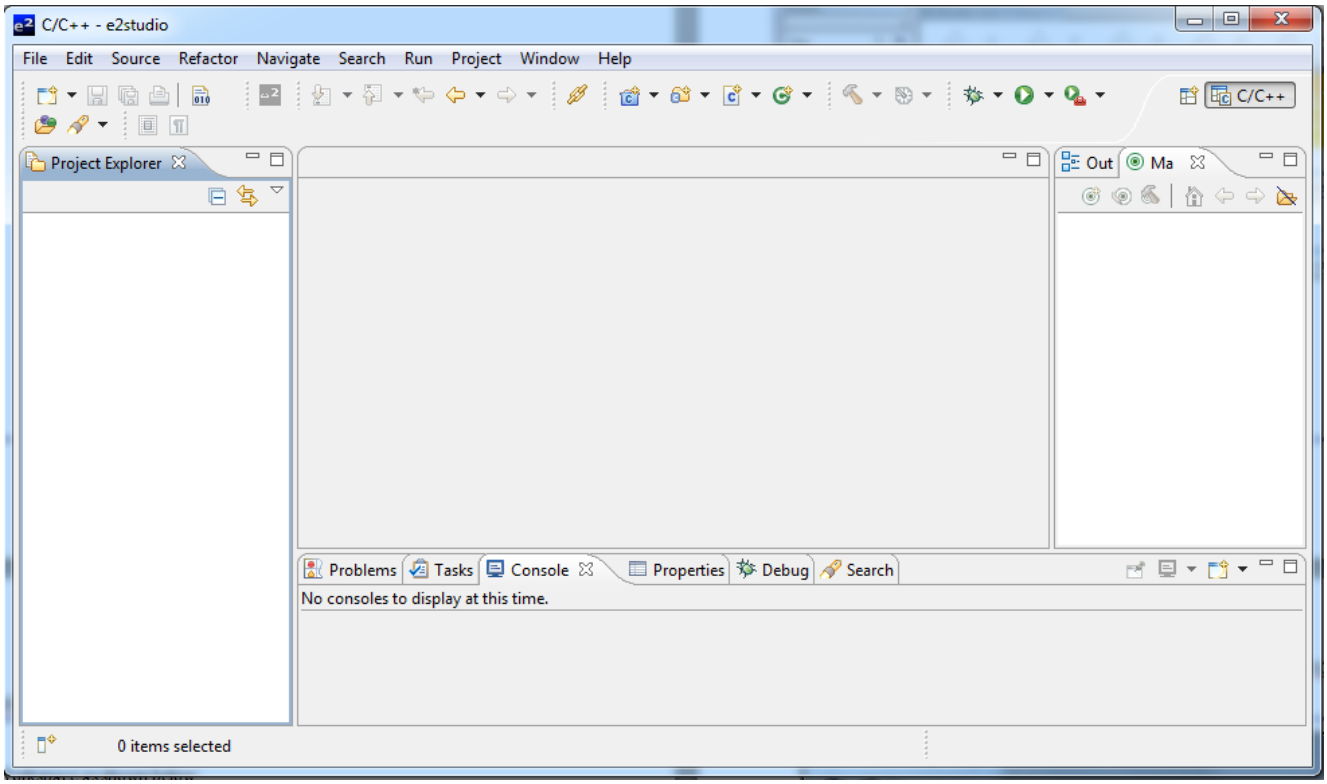
This section assumes e$^2$studio is already installed on the user's personal computer (PC). Create a new folder and name it as 'RSKRL78G13_Workspace'. Copy the zipped file TIMER.zip, available in the Application Note package downloaded from the website, to this folder. Extract the TIMER.zip file to the RSKRL78G13_Workspace folder.

## 2. Creating the Project Workspace

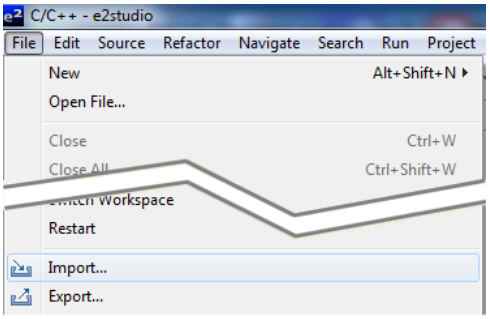
Run e$^2$studio by clicking the Windows Start button, select All Programs > Renesas Electronics e2studio > Renesas e2studio. Choose a workspace folder.




This will automatically open e$^2$studio IDE with an empty workspace.



To add the sample code select from the menu bar File > Import as shown:



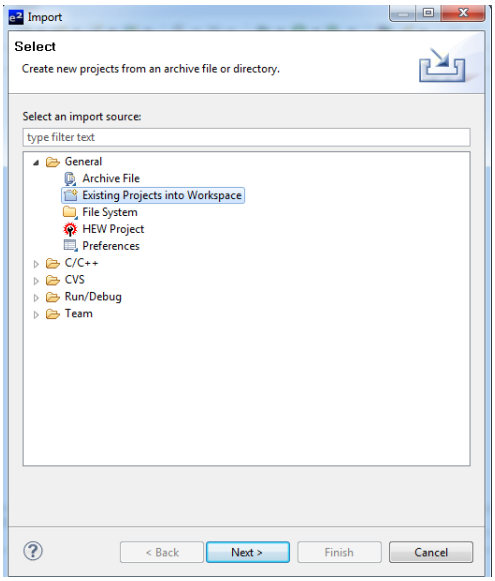

Choose ‘Existing Projects into Workspace’as shown:

Click Next >, a new window will appear. Navigate to the RSKRL78G13_Workspace folder and select the IIC_Master folder.

Make sure that ‘Copy projects into workspace’ is checked.

Single-click the project file to select it.

Click < Finish > to add the project to the workspace.




## 3. Opening Sample Code and Source Files

Once the project has been added, the source code and all dependant files can be opened in the editor by expanding the folders in the Project Explorer window and double clicking the files in the folders. Each source file listed in Workspace window in e$^2$studio can be expanded to reveal its dependant files ; as well as the output files.

In the Project Explorer sidebar, right-click on the project's name and select Build Configurations > Set Active > HardwareDebug. This ensures that the best debug experience will be made available when trying this sample.

## 4. Source Code

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 Applilet. The project will contain a C source file ‘r_main.c’. This source file will include the C function main(). All source files and dependant files whose filenames are prefixed with ‘r_’ were generated using Applilet.

## 5. Code Execution

Only one application can be executed at a time after each code build and download. A list of application modes can be found in the r_cg_userdefine.h header file. An application can be selected by specifying a value for the macro "#define __Current_TMR_APP" that matches the value defined next to each macro definition in the applications list. The list of applications include:

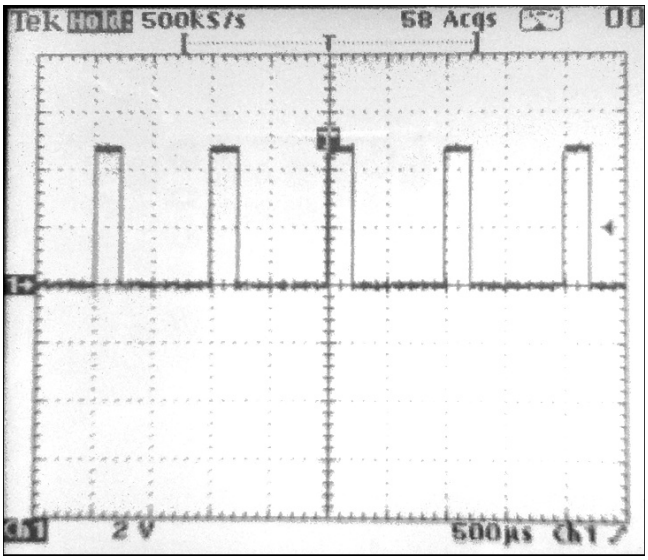
```
/* List of timer applications */
#define __TMR_PWM           1
#define __TMR_SqOut         2
#define __TMR_Interval      3
#define __TMR_EventCount    4
/* Change definition value to that of the desired timer application */
#define __Current_TMR_APP   1
```

The PWM application is configured as the default project.

### 5.1 PWM Application

1. Select the desired application to be executed.

2. Compile the sample code by clicking on the 'Build Project' button on the debug toolbar. Click the ‘Debug’ button to switch to the debug perspective. Click ‘Resume’ button to start the program execution.




Oscilloscope output waveform

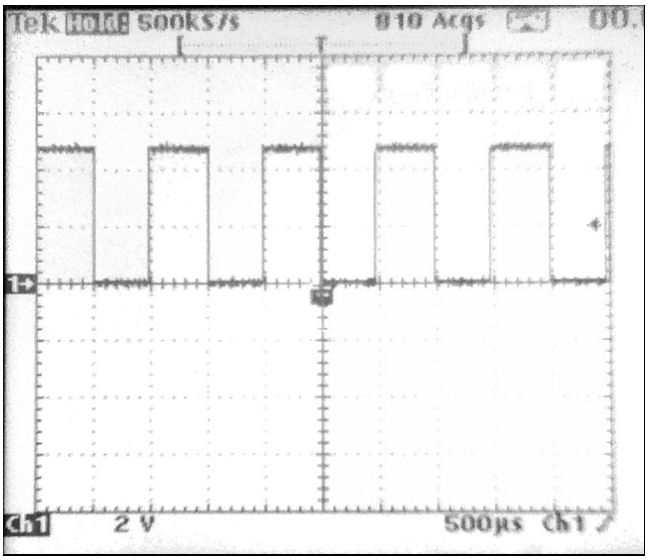
— The PWM application outputs a 1KHz square wave whose duty cycle is varied from 0% to 90%. The duty cycle variation can be stopped by pressing switch SW2. Pressing SW2 results in the display of the duty cycle being shown on the debug LCD as a percentage. The duty cycle variation can be restarted by pressing SW1; which also clears the displayed duty cycle percentage. Connect an oscilloscope to JA5—9 to observe the PWM waveform.

### 5.2 Square-wave Output Application

1. Select the desired application to be executed.

2. Compile the sample code by clicking on the ‘Build Project’ button on the debug toolbar. Click the ‘Debug’ button to switch to the debug perspective. Click ‘Resume’ button to start the program execution.

— The Squarewave Output application outputs a 1 KHz square wave with 50% duty cycle. Connect an oscilloscope to JA2-20 to observe the waveform.




Oscilloscope output waveform

## 5.3 Interval Measurement Application

1. Select the desired application to be executed.

2. Compile the sample code by clicking on the ‘Build Project’ button on the debug toolbar. Click the ‘Debug’ button to switch to the debug perspective. Click ‘Resume’ button to start the program execution.

— The Interval Measurement application measures the interval between pressing and releasing switch SW1. The interval is displayed on the debug LCD as long as it is less than 10 seconds. If the interval exceeds 10 seconds, the debug LCD displays “ > 10s”. Further measurements can be made, simply by pressing and releasing SW1.

## 5.4 Event Count Application

1. Select the desired application to be executed.

2. Compile the sample code by clicking on the 'Build Project' button on the debug toolbar. Click the ‘Debug’ button to switch to the debug perspective. Click ‘Resume’ button to start the program execution.

— The Event Count application configures a timer channel to be clocked from an external falling edge signal. The falling edge signal of switch SW3 is used as the clock signal which is also the event.

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## Revision Record

| | | Description | |
|---|---|---|---|
| **Rev.** | **Date** | **Page** | **Summary** |
| 1.00 | Jun 7, 2013 | — | Original document updated for e²studio IDE and GNURL78 v13.01 toolchain |

## 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 manual, refer to the relevant sections of the manual. If the descriptions under General Precautions in the Handling of MPU/MCU Products and in the body of the manual differ from each other, the description in the body of the manual takes precedence.

1. Handling of Unused Pins
   Handle unused pins in accord 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 one with a different type number, confirm that the change will not lead to problems.
   — The characteristics of MPU/MCU in the same group but having different type numbers may differ because of the differences in internal memory capacity and layout pattern. When changing to products of different type numbers, implement a system-evaluation test for each of the products.

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