This document outlines the target devices, simulation functions and cautions of RL78/G12 simulator.

Contents

Chapter 1. Target Devices and simulation functions ................................................................. 2
Chapter 2. Changes .................................................................................................................. 3
  2.1 Additional functions ........................................................................................................ 3
Chapter 3. Cautions ................................................................................................................ 4
  3.1 Differences between target devices and simulator ......................................................... 4
  3.2 Cautions for using simulation function ......................................................................... 10
Chapter 1. Target Devices and simulation functions

The following target devices are supported by the RL78/G12 simulator.
In addition to CPU instruction simulation, the following simulation functions are available.
(For other RL78 devices, the simulator works as CPU instruction simulation mode alone.)
- The MCU peripheral function simulation
- Virtual target board simulation by using "I/O panel" window
- MCU pin signal waveform by using "Timing chart" window
- Current consumption simulation of MCU

<table>
<thead>
<tr>
<th>Device group</th>
<th>Device name</th>
</tr>
</thead>
<tbody>
<tr>
<td>RL78/G12</td>
<td>R5F10266, R5F10267, R5F10268, R5F10269, R5F1026A, R5F10366, R5F10367, R5F10368, R5F10369, R5F1036A, R5F10277, R5F10278, R5F10279, R5F1027A, R5F10377, R5F10378, R5F10379, R5F1037A, R5F102A7, R5F102A8, R5F102A9, R5F102AA, R5F103A7, R5F103A8, R5F103A9, R5F103AA</td>
</tr>
</tbody>
</table>
Chapter 2. Changes

This chapter describes changes of RL78/G12 simulator from e² studio V5.3.0 to V5.4.0.

2.1 Additional functions

Current consumption simulation function is added. Please refer to “e² studio Current Consumption View” in the e² studio Help for usage.
Chapter 3. Cautions

This section describes cautions for using RL78/G12 simulator. The following two types of cautions are described:

• Differences between target devices and simulator: Behavior differences between simulator and the target devices due to simulator specifications

• Cautions for using simulation functions: Cautions for the usage of simulator (e.g. configurations and GUI operation)

3.1 Differences between target devices and simulator

3.1.1 Unsupported peripheral functions

The simulator does not support the following peripheral functions of the target device (the following functions are not simulated).

- Regulator
- Power-on-reset circuit
- Voltage detector
- Flash self programming function
- Simplified I2C of serial array unit

3.1.2 Peripheral I/O redirection register (PIOR)

If using Peripheral I/O redirection register (PIOR), simulator’s alternate pin functions are switched same as target device. Note that the PIOR register setting for serial interface pins should not be changed, because “Serial” window could not communicate with a serial interface, if the port related to the serial interface pins is switched.

In addition, in case of switching alternate pin function, be sure to select port name on the “Select Pin” dialog. Do not use alternate function pin name.
3.1.3 Oscillation stabilization time of Clock Generator

Since the simulator does not simulate the clock oscillator oscillation stabilization time, the value remains at 0 second. When the oscillation is started, the OSTC register is set to one of the following values without counting-up operations.

<table>
<thead>
<tr>
<th>OSTS Setting Value</th>
<th>OSTC Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>0x0 : (2^8/fx)</td>
<td>0x80</td>
</tr>
<tr>
<td>0x1 : (2^9/fx)</td>
<td>0xc0</td>
</tr>
<tr>
<td>0x2 : (2^{10}/fx)</td>
<td>0xe0</td>
</tr>
<tr>
<td>0x3 : (2^{11}/fx)</td>
<td>0xf0</td>
</tr>
<tr>
<td>0x4 : (2^{13}/fx)</td>
<td>0xf8</td>
</tr>
<tr>
<td>0x5 : (2^{15}/fx)</td>
<td>0xfc</td>
</tr>
<tr>
<td>0x6 : (2^{17}/fx)</td>
<td>0xfe</td>
</tr>
<tr>
<td>0x7 : (2^{18}/fx)</td>
<td>0xfff</td>
</tr>
</tbody>
</table>

The following figure illustrates this operation.

In the target device, the X1 clock oscillation starts after the states (1) to (4) have passed. In the simulator, states (1) through (4) are skipped and instantly the X1 clock oscillation starts.

![X1 clock oscillation waveform](image.png)

[In target device (an example of when OSTS is set to 0x07)]

[In simulator (an example of when OSTS is set to 0x07)]

STOP mode release or MSTOP bit = 0 (The OSTC register is set to 0xfff at this moment.)
Therefore, pay attention to the code that waits for oscillation stabilization.

There is no problem if a program is created with the condition that the execution exits the oscillation stabilization wait period when the OSTC register value becomes the maximum value, or when the OSTC register value exceeds the specified value, but if a program is created with the condition that the execution exits the oscillation stabilization wait period when the OSTC register value becomes a value other than the maximum value, the execution enters an infinite loop.

The following shows examples of code that causes/does not cause problems.

(This is an example when OSTS is set to 0x07)

<table>
<thead>
<tr>
<th>Correct program example (1)</th>
<th>Correct program example (2)</th>
<th>Example of program that may cause problems</th>
</tr>
</thead>
<tbody>
<tr>
<td>while(OSTC != 0xff)</td>
<td>while(OSTC &lt;= 0xf0)</td>
<td>while(OSTC != 0xf0)</td>
</tr>
<tr>
<td>{</td>
<td>{</td>
<td>{</td>
</tr>
<tr>
<td>NOP();/* wait */</td>
<td>NOP();/* wait */</td>
<td>NOP();/* wait */</td>
</tr>
<tr>
<td>}</td>
<td>}</td>
<td>}</td>
</tr>
</tbody>
</table>

### 3.1.4 SFR with clock generator (AMPH/HIOTRM)

The following SFRs which belong to the clock generator are not simulated. Although read/write accesses for each register can be performed normally, the operation does not change even if its value is changed.

- Bit 0 (AMPH) of clock operation mode control register (CMC)
- High-speed internal oscillator trimming register (HIOTRM)

### 3.1.5 Operation clock of timer array unit

Do not specify an operation clock that is 233 Hz or lower. If the operation clock of the timer array unit is 233 Hz or lower, then the timer array unit will not work properly (it will behave as if operating via a clock that is faster than the one selected).

### 3.1.6 Noise filter of timer array unit

Although the target device’s timer array unit has a function to turn the noise filter on and off in order to reduce noise from the timer input pin, the simulator does not simulate this function. (There is no difference in behavior whether filtering is on or off.) Since there is no noise in the simulator’s signal, it would be meaningless to simulate this function.
3.1.7 Interval interrupt of watchdog timer

The following differences occur between the target device and simulator when using an interval interrupt of watchdog timer.

[Target device]
An interval interrupt is generated when 75% + 1/2fL of overflow time is reached.

[Simulator]
An interval interrupt is generated when 75% of overflow time is reached.

3.1.8 Operation clock of serial array unit

Do not specify an operation clock that is 233 Hz or lower. If the operation clock of the serial array unit is 233 Hz or lower, then the serial array unit will not operate correctly (it will behave as if operating via a clock that is faster than the one selected).

3.1.9 Noise filter of serial array unit

Although the target device's serial array unit has a function to turn the noise filter on and off in order to reduce noise on the input pin, the simulator does not simulate this function. (There is no difference in behavior whether filtering is on or off.) Since there is no noise in the simulator's signal, it would be meaningless to simulate this function.

3.1.10 SDRmn register of serial array unit

The following differences occur between the target device and simulator when the serial data register (SDRmn) is read during serial operation.

[Target device]
The value is 0.

[Simulator]
The value remains right before starting serial operation.
3.1.11 Serial interface IICA

IICA supports pin waveform generation, current consumption measurement and the communication with “Serial” window. The following functions are not supported.
- Digital filter
- Arbitration
- Detection of transmission errors
- Communication reservation

3.1.12 Reset

The behavior differs as follows if a reset is generated by the RESET pin.

[Target device]
MCU goes into reset status when the RESET pin goes to low level. Reset status is released when it goes to high level.

[Simulator]
MCU does not go into reset status when the RESET pin goes to low level. When it goes to high level, the simulator momentarily goes into reset status, and then the reset status is released immediately.

3.1.13 Reset control flag register (RESF)

The simulator only responses to WDTRF bit of Reset control flag register (RESF). TRAP bit and RPERF bit and IAWRF bit and LVIRF bit remains the initial value.

3.1.14 A/D converter

When VDD, AVREFP signal has no input, the default reference voltage of A/D converter is 5.0V.
For changing the reference voltage, input it to VDD, AVREFP signal by using signal data editor and so on.
The temperature sensor output voltage is always 1.05V.
3.1.15 Clock output/buzzer output controller

When selecting $f_{\text{MAIN}}$ as an output clock, “Timing chart” window does not show the clock waveform of PCLBUZn signal.

When selecting $f_{\text{MAIN}}/2$ or slower as an output clock, “Timing chart” window shows the clock waveform.

3.1.16 Execution of illegal instructions

If an illegal instruction (instruction code: 0xFF) is executed, the target device will be reset, but the simulator will go into an infinite loop (the illegal instruction will be executed repeatedly).

3.1.17 DMA controller

The transfer speeds of the target device and simulator differ as follows when simulating the DMA controller.

[Target device]
- It takes two clock cycles to complete one DMA transfer. The CPU waits during this period.
- Contended with another channel's DMA transfer, then one of the DMA transfers will be placed on hold until the other DMA transfer has been completed.

[Simulator]
- It takes zero clock cycles to complete one DMA transfer. For this reason, the CPU does not wait.
- Even with contentions, all DMA channel's transfers will be performed simultaneously.
3.2 Cautions for using simulation function

3.2.1 Cautions for current consumption simulation

There are 3 cautions about current consumption simulation.
- The current consumption value is estimated from typical current value of the actual device. This value is approximated value as MCU alone. Not including the current values of other parts.
- When using current consumption simulation, open “Current Consumption” view from the menu “Renesas Views” and “Debug”, and turn on the switch of “Current Consumption” view before connecting the simulator.
- The maximum length of the current consumption calculation is 200,000 current changing points. If the changing current points reach the maximum length, the user program execution is stopped.

3.2.2 Cautions for simulation speed

The simulation speed of RL78/G12 simulator depends on the numbers of operating peripheral functions. If many peripheral functions are operating, the simulation speed becomes several times to ten and several times slower than actual devices. Note: Using a few, or even no peripheral functions, the simulation speed becomes faster than actual devices. 
Note: The measurement environment of simulation speed.

CPU: 3.10GHz (Quad-Core), Memory: 4Gbyte, OS: Windows7 32-bit edition

3.2.3 Cautions for terminal waveform of “Timing chart” window

The maximum length of the terminal waveform is 4096 pin changing points. After reached to the maximum length, the data will be overwritten from the oldest one. If the length is not enough, please use the following method.
- Reduce the numbers of registered terminal
- Stop the user program at the place where you want to confirm the waveform by using breakpoint.

3.2.4 Cautions for controlling each window

The following keyboard operations are not available in the simulator windows (“Signal-data editor” window, “I/O panel” window, and “Serial” window).
- Navigation via tab or arrow keys (←, ↑, →, ↓)
- Deletion via the Del or Backspace keys
- Copy & paste and other operations via the Ctrl + C, V, X, A, or Z keys.
Perform the above operations as follows.
- Navigation: Navigate using the mouse.
- Deletion: Right click and perform the action via the context menu.
- Copy & paste, etc.: Right click and perform the action via the context menu.
3.2.5  Cautions for closing “Simulator GUI” window

The “Simulator GUI” window can only be closed by disconnecting from the debugging tool, or by closing e² studio in proper manner. (The X cannot be used.)
Additionally, although it appears that the X button can be pressed if Aero is enabled in Windows, pressing this button will not close the GUI window.

3.2.6  Cautions for disconnecting the debug tool

e² studio may exit if the debugging tool is disconnected while any of the following dialog boxes is open from the “Simulator GUI” window. Please be sure that the following dialog boxes have been closed before disconnecting the simulator.

- Save As
- Open
- New
- Color
- Font
- Customize
- Loop
- Select Pin
- Search Data
- Format (UART)
- Format (CSI)
- Format (IIC)
- Message (e.g. Error)
- Parts Button Properties
- Analog Button Properties
- Parts Key Properties
- Parts Level Gauge Properties
- Parts Led Properties
- Parts Segment LED Properties
- Parts Matrix Led Properties
- Parts Buzzer Properties
- Pull up / Pull down
- Entry Bitmap
- Object Properties

3.2.7  Cautions for setting the Host Machine’s language and region

If a Japanese OS is installed on your Host Machine, then if the language or region is set to other than Japanese/Japan, the menus and dialog-box names of the “Simulator GUI” window will be shown in English.
Similarly, if a non-Japanese OS is installed on your Host Machine, then if the language or region is set to Japanese/Japan, the menus and dialog-box names of the “Simulator GUI” window will be shown in Japanese.

3.2.8  Cautions for “Serial” window

When using “Serial” window as the data receiver of IICA, only ACK signal can be generated after receiving the data.
NACK signal cannot be generated.
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 or any other use of the circuits, software, and information in the design of your product or system. Renesas Electronics disclaims any and all liability for any losses and damages incurred by you or third parties arising from the use of these circuits, software, or information.
2. Renesas Electronics hereby expressly disclaims any warranties against and liability for infringement or any other disputes involving 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, including but not limited to, the product data, drawing, chart, program, algorithm, application examples.
3. 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 shall not alter, modify, copy, or otherwise misappropriate any Renesas Electronics product, whether in whole or in part. Renesas Electronics disclaims any and all liability for any losses or damages incurred by you or third parties arising from such alteration, modification, copy or otherwise misappropriation of Renesas Electronics products.
5. Renesas Electronics products are classified according to the following two quality grades “Standard” and “High Quality.” The intended 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 (traffic lights); large-scale communication equipment; key financial terminal systems; safety control 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 (space and undersea repeaters; nuclear power control systems; aircraft control systems; key plant systems; military equipment, etc.). Renesas Electronics disclaims any and all liability 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. When using the Renesas Electronics products, refer to the latest product information data (sheet data, user’s manuals, application notes, “General Notes for Handling and Using Semiconductor Devices” in the reliability handbook, etc.), and ensure that usage conditions are within the ranges specified by Renesas Electronics with respect to maximum ratings, operating power supply voltage range, heat radiation characteristics, installation, etc. Renesas Electronics disclaims any and all liability for any malfunctions or failure or accident 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 Renesas Electronics products, semiconductor products have specific characteristics such as the occurrence of failure at a certain rate and malfunctions under certain further conditions. Further, Renesas Electronics products are not subject to radiation resistance design. Please ensure to implement safety measures to guard them against the possibility of bodily injury, injury or damage caused by fire, and social damage in the event of failure or malfunction of Renesas Electronics products, 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 by your own responsibility as warranty for your products/system. Because the evaluation of microcomputer software alone is very difficult and not practical, 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 investigate applicable laws and regulations that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive carefully and sufficiently and use Renesas Electronics products in compliance with all these applicable laws and regulations. Renesas Electronics products are neither intended nor authorized for use in products or systems whose manufacture, use, or sale is prohibited under any applicable domestic or foreign laws or regulations. You shall not use Renesas Electronics products or technologies for (1) any purpose relating to the development, design, manufacture, use, stockpiling, etc. of weapons of mass destruction, such as nuclear weapons, chemical weapons, or biological weapons, or missiles (including unmanned aerial vehicles (UAVs)) for delivering such weapons, (2) any purpose relating to the development, design, manufacture, or use of conventional weapons, or (3) any other purpose of disturbing international peace and security, and you shall not sell, export, lease, transfer, or release Renesas Electronics products or technologies to any third party whether directly or indirectly with knowledge or reason to know that the third party or any other party will engage in the activities described above. When exporting, selling, transferring, etc. Renesas Electronics products or technologies, you shall comply with any applicable export control laws and regulations promulgated and administered by the governments of the countries asserting jurisdiction over the parties or transactions.
9. Renesas Electronics products and technologies shall 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 shall not use Renesas Electronics products or technologies for (1) any purpose relating to the development, design, manufacture, use, stockpiling, etc. of weapons of mass destruction, such as nuclear weapons, chemical weapons, or biological weapons, or missiles (including unmanned aerial vehicles (UAVs)) for delivering such weapons, (2) any purpose relating to the development, design, manufacture, or use of conventional weapons, or (3) any other purpose of disturbing international peace and security, and you shall not sell, export, lease, transfer, or release Renesas Electronics products or technologies to any third party whether directly or indirectly with knowledge or reason to know that the third party or any other party will engage in the activities described above. When exporting, selling, transferring, etc. Renesas Electronics products or technologies, you shall comply with any applicable export control laws and regulations promulgated and administered by the governments of the countries asserting jurisdiction over the parties or transactions.
10. Please acknowledge and agree that you shall bear all the losses and damages which are incurred from the misuse or violation of the terms and conditions described in this document, including this notice, and hold Renesas Electronics harmless, if such misuse or violation results from your misuse or violation Renesas Electronics products available any third party.
11. This document shall not be repaired, 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.

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

Please acknowledge and agree that you shall bear all the losses and damages which are incurred from the misuse or violation of the terms and conditions described in this document, including this notice, and hold Renesas Electronics harmless, if such misuse or violation results from your misuse or violation Renesas Electronics products available any third party.

© 2017 Renesas Electronics Corporation. All rights reserved.

Renesas Electronics Corporation

http://www.renesas.com

SALES OFFICES

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
925 Yonge Street, Suite 8309 Richmond Hill, Ontario Canada L4C 9T3
Tel: +1-905-237-2004

Renesas Electronics Europe Limited
Dulkes Meadow, Millboard Road, Bourne End, Buckinghamshire, SL8 5FH, U.K.
Tel: +44-1628-585-100, Fax: +44-1628-585-900

Renesas Electronics Europe GmbH
Arcadiasiede 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 ZhChunLu Haidian District, Beijing 100191, P.R.China
Tel: +86-10-6235-1155, Fax: +86-10-6235-7679

Renesas Electronics (Shanghai) Co., Ltd.
Unit 301, Tower A, Central Tower, 555 Längang Road, Pudong District, Shanghai, P. R. China 200333
Tel: +86-21-2226-0868, Fax: +86-21-2226-0999

Renesas Electronics Hong Kong Limited
Unit 1601-1611, 16/F., Tower 2, Grand Century Place, 193 Prince Edward Road West, Mongkok, Kowloon, Hong Kong
Tel: +852-2265-6688, Fax: +852 2886-9022

Renesas Electronics Taiwan Co., Ltd.
13F, No. 363, Fu Shing North Road, Taipei 10543, Taiwan
Tel: +886-2-8175-9600, Fax: +886-2-8175-9760

Renesas Electronics Singapore Pte. Ltd.
89 Bendemeer Road, Unit 806-02 Hyflux Innovation Centre, Singapore 339949
Tel: +65-6213-0250, Fax: +65-6213-0300

Renesas Electronics Malaysia Sdn.Bhd.
Unit 1207, Block B, Menara Amcorp, Amcorp Trade Centre, No. 18, Jln Periaran Barat, 46050 Petaling Jaya, Selangor Darul Ehsan, Malaysia
Tel: +60-3-7955-9390, Fax: +60-3-7955-9510

Renesas Electronics India Pvt. Ltd.
No. 777C, 100 Feet Road, HAL II Stage, Indiranagar, Bangalore, India
Tel: +91-80-67208700, Fax: +91-80-67208777

Renesas Electronics Korea Co., Ltd.
12F, 234 Teheran-Gaengnamgu, Seoul, 135-080, Korea
Tel: +82-2-558-3737, Fax: +82-2-558-5141

© 2017 Renesas Electronics Corporation. All rights reserved.

Colophon 6.0