RL78 Family

Processing Example when the WDT Window Open Period is set to 75%

R01AN3935EJ0101
Rev.1.01
2021.09.30

Introduction

This application note describes a processing example when the window open period of the internal watchdog timer (here after WDT) is set to 75%.

Target devices

RL78/D1A, RL78/F12, RL78/F13, RL78/F14, RL78/F15

Contents

1. WDT Functionality and User Option Bytes to Use

In case of using WDT on the target device, setting of the user option byte (000C0H/020C0H) Note is mandatory. The interval interrupt function and related user option bytes used in this application note are described below.

Note: RL78/F12 is set by user option byte (000C0H/010C0H).

- **Interval interrupt**

  Interval interrupt can be generated when 75% of the overflow time + 1 / 2 f_{WDT} is reached.
  From the WDTINT bit, user can set the use / non-use of this interval interrupt.

- **Window open period**

  Window open period can be set by WINDOW1 and WINDOW0 bits.

  Caution: WDTSBYON bit is needed to set “1” (enables WDT counter during standby mode) to enable the window open period.

- **Overflow time**

  WDT overflow time which generates WDT reset can be set by WDCS0 to WDCS2 bits.

  Caution: Do not set $2^{13}/f_{WDT}$, $2^{14}/f_{WDT}$ and $2^{16}/f_{WDT}$, if using interval interrupt in RL78/F13, RL78/F14 and RL78/F15.

- **Counter operation during standby mode**

  Conter operation (enabled / stop) during standby mode can be set by WDSTBYON bit.

For detail of the user option byte, refer to the user’s manual: hardware.

2. Processing Example when the WDT Window Open Period is set to 75%

As an example of processing when the window open period is set to 75%, the processing to avoid the window close period and clear the WDT counter in standby mode (intermittent operation) is shown below.

Also, this chapter uses RL78/F13, F14 as examples.

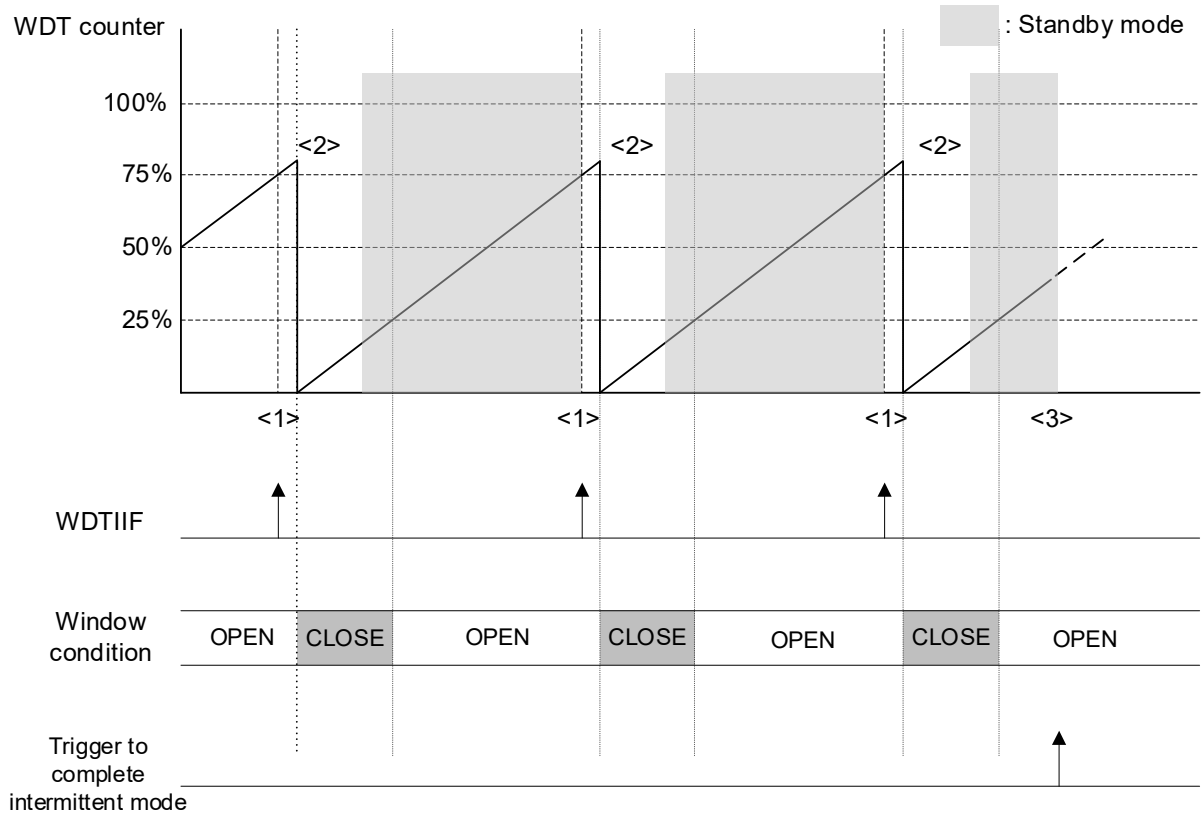
2.1 Processing Example when Using the WDT Function

Figure 2-1 shows a processing example that returning from standby mode to normal mode by the WDT interval interrupt and clears the WDT counter (writes “ACH” to the WDTE register).

Operating conditions: User option byte (000C0H/020C0H) = 1101xxx1B

- WDTINT: 1 (Interval interrupt is generated when 75% + 1/2 f_{WDT} of the overflow time is reached.)
- WINDOW1 - WINDOW0: 10B (Window open period: 75%)
- WDTON : 1 (Counter operation enabled (counting started after reset))
- WDCS2 - WDCS0: xxxB (Overflow time: any)
- WDSTBYON: 1 (Counter operation enabled in HALT/STOP/SNOOZE mode)

Set the WDT interval interrupt mask flag (WDTIMK) to “0” (interrupt enabled).



	Software operation	Hardware condition
<1>	-	Occurs WDT interval interrupt
<2>	Write “ACH” to WDTE register	Clearing WDT counter
<3>	To normal operation mode process	Return from standby mode to normal operation mode

Figure 2-1 Processing Example when Using the WDT Function

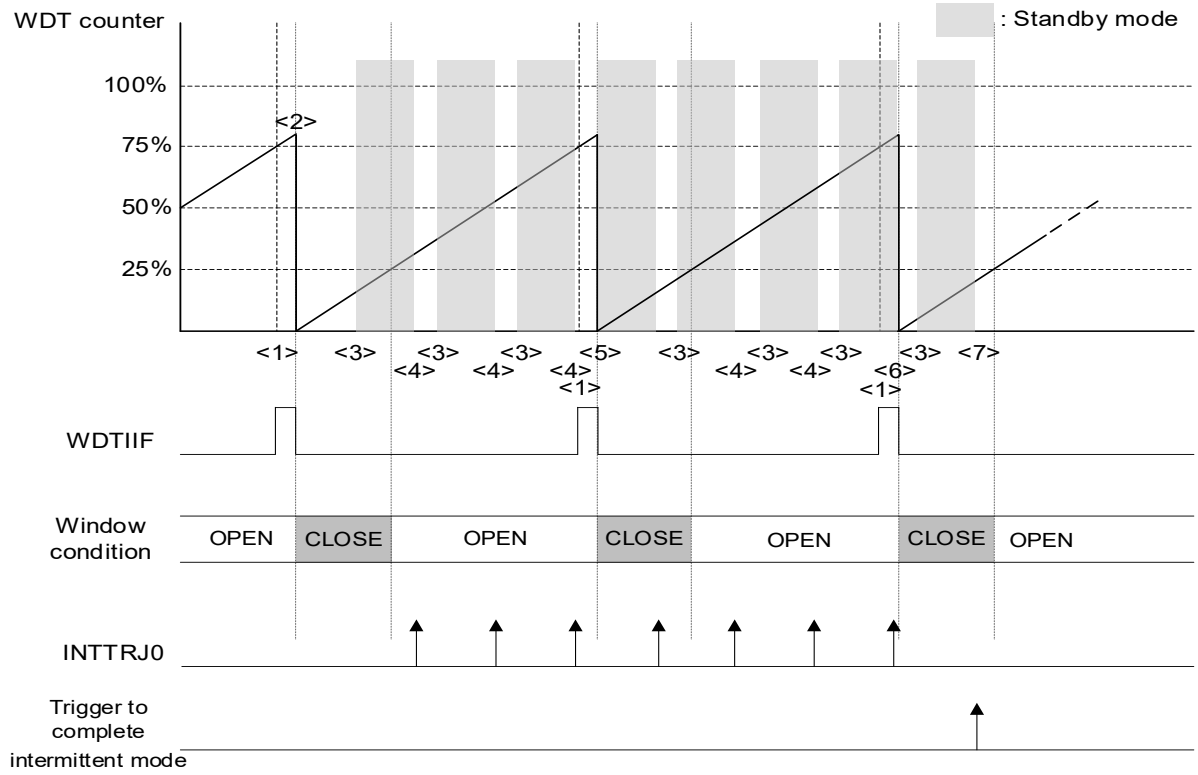
2.2 Processing Example when Using Timer RJ

Figure 2-2 shows an example for a processing example when using Timer RJ. Uses the timer mode of Timer RJ for cyclic wake-up from standby mode. In the standby mode transition processing and return processing, check the WDT interval interrupt request flag (WDTIIF), and if it is “1” (75% of overflow time + 1/2 f_{WDT} reached), the WDT counter is cleared.

Operating conditions: User option byte (000C0H/020C0H) = 1101xxx1B

- WDTINT: 1 (Interval interrupt is generated when 75% + 1/2 f_{WDT} of the overflow time is reached.)
- WINDOW1 - WINDOW0: 10B (Window open period: 75%)
- WDTON : 1 (Counter operation enabled (counting started after reset))
- WDCS2 - WDCS0: xxxB (Overflow time: any)
- WDSTBYON: 1 (Counter operation enabled in HALT/STOP/SNOOZE mode)

Set the WDT interval interrupt mask flag (WDTIMK) to “1” (interrupt disabled).



	Software operation	Hardware condition
<1>	-	WDT interval interrupt request is generated (WDTIIF=1)
<2>	Write “ACH” to WDTE register	Clearing WDT counter
<3>	Check WDTIIF value. And if WDTIIF=0, go to standby mode.	• WDT counter operation continue • Go to standby mode
<4>	-	• Occurs Timer RJ interrupt (INTTRJ0) • Release from standby mode • WDT counter operation continue
<5>	Check WDTIIF value. And if WDTIIF=1, write “ACH” to WDTE register, clear WDTIIF and go to standby mode.	• Clearing WDT counter • Go to standby mode
<6>	Check WDTIIF value. And if WDTIIF=1, write “ACH” to WDTE register, clear WDTIIF and go to standby mode.	• Occurs Timer RJ interrupt (INTTRJ0) • Release from standby mode • WDT counter operation continue
<7>	To normal operation mode process	Return from standby mode to normal operation mode

Figure 2-2 Processing Example when Using Timer RJ

3. Precaution when Setting the WDT Window Open Period to 75%

Table 3-1 shows the WDT counter clear prohibition period when the window open period is set to 75%. Do not write “ACH” to the WDTE register during the WDT counter clear prohibition period.

Table 3-1 WDT Counter Clear Prohibition Period

WDCS2	WDCS1	WDCS0	WDT Overflow Time (In case of f_{WDT} = 17.25kHz (MAX.))	WDT Counter Clear Prohibition Period Note
0	0	0	$2^6/f_{WDT}$ (3.71 ms)	1.85 ms to 2.51 ms
0	0	1	$2^7/f_{WDT}$ (7.42 ms)	3.71 ms to 5.02 ms
0	1	0	$2^8/f_{WDT}$ (14.84 ms)	7.42 ms to 10.04 ms
0	1	1	$2^9/f_{WDT}$ (29.68 ms)	14.84 ms to 20.08 ms
1	0	0	$2^{11}/f_{WDT}$ (118.72 ms)	56.36 ms to 80.32 ms
1	0	1	$2^{13}/f_{WDT}$ (474.89 ms)	237.44 ms to 321.26 ms
1	1	0	$2^{14}/f_{WDT}$ (949.79 ms)	474.89 ms to 642.51 ms
1	1	1	$2^{16}/f_{WDT}$ (3799.18 ms)	1899.59 ms to 2570.04 ms

Note: This is the value when 75% is set for the window open period. And the oscillation accuracy of the WDT operating clock (low-speed on-chip oscillator) is included.

4. References

Documents referenced in this application note are shown below. When referring to these documents, make sure to obtain the latest version of each document from Renesas Electronics website.

- RL78/ F12 User's Manual: Hardware Rev. 1.10
- RL78/ F13, F14 User's Manual: Hardware Rev. 2.10
- RL78/ F15 User's Manual: Hardware Rev. 1.00
- RL78/ D1A User's Manual: Hardware Rev. 1.10

Revision History

Rev.	Date	Description	
		Page	Summary
1.01	Sep. 30, 2021	-	First edition issued

General Precautions in the Handling of Microprocessing Unit and Microcontroller Unit Products

The following usage notes are applicable to all Microprocessing unit and Microcontroller unit products from Renesas. For detailed usage notes on the products covered by this document, refer to the relevant sections of the document as well as any technical updates that have been issued for the products.

1. Precaution against Electrostatic Discharge (ESD)

   A strong electrical field, when exposed to a CMOS device, can cause destruction of the gate oxide and ultimately degrade the device operation. Steps must be taken to stop the generation of static electricity as much as possible, and quickly dissipate it when it occurs. Environmental control must be adequate. When it is dry, a humidifier should be used. This is recommended to avoid using insulators that can easily build up static electricity. Semiconductor devices must be stored and transported in an anti-static container, static shielding bag or conductive material. All test and measurement tools including work benches and floors must be grounded. The operator must also be grounded using a wrist strap. Semiconductor devices must not be touched with bare hands. Similar precautions must be taken for printed circuit boards with mounted semiconductor devices.
2. Processing at power-on

   The state of the product is undefined at the time 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 time 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 time 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 time when power is supplied until the power reaches the level at which resetting is specified.
3. Input of signal during power-off state

   Do not input signals or an I/O pull-up power supply while the device is powered off. The current injection that results from input of such a signal or I/O pull-up power supply may cause malfunction and the abnormal current that passes in the device at this time may cause degradation of internal elements. Follow the guideline for input signal during power-off state as described in your product documentation.
4. Handling of unused pins

   Handle unused pins in accordance with the directions given under handling of unused pins in the manual. The input pins of CMOS products are generally in the high-impedance state. In operation with an unused pin in the open-circuit state, extra electromagnetic noise is induced in the vicinity of the 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.
5. Clock signals

   After applying a reset, only release the reset line after the operating clock signal becomes stable. When switching the clock signal during program execution, wait until the target clock signal is 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. Additionally, 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.
6. Voltage application waveform at input pin

   Waveform distortion due to input noise or a reflected wave may cause malfunction. If the input of the CMOS device stays in the area between V_{IL} (Max.) and V_{IH} (Min.) due to noise, for example, the device may malfunction. Take care to prevent chattering noise from entering the device when the input level is fixed, and also in the transition period when the input level passes through the area between V_{IL} (Max.) and V_{IH} (Min.).
7. Prohibition of access to reserved addresses

   Access to reserved addresses is prohibited. The reserved addresses are provided for possible future expansion of functions. Do not access these addresses as the correct operation of the LSI is not guaranteed.
8. Differences between products

   Before changing from one product to another, for example to a product with a different part number, confirm that the change will not lead to problems. The characteristics of a microprocessing unit or microcontroller unit products in the same group but having a different part number might differ in terms of internal memory capacity, layout pattern, and other factors, which can affect the ranges of electrical characteristics, such as characteristic values, operating margins, immunity to noise, and amount of radiated noise. When changing to a product with a different part number, implement a system-evaluation test for the given product.

Notice

1. Descriptions of circuits, software and other related information in this document are provided only to illustrate the operation of semiconductor products and application examples. You are fully responsible for the incorporation 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 claims 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, drawings, charts, programs, algorithms, and 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 reverse engineer 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, copying or reverse engineering.
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; 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.

   Unless expressly designated as a high reliability product or a product for harsh environments in a Renesas Electronics data sheet or other Renesas Electronics document, Renesas Electronics products are not intended or 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 damage (space system; 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 any third parties arising from the use of any Renesas Electronics product that is inconsistent with any Renesas Electronics data sheet, user’s manual or other Renesas Electronics document.
6. When using Renesas Electronics products, refer to the latest product information (data sheets, 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 dissipation characteristics, installation, etc. Renesas Electronics disclaims any and all liability for any malfunctions, failure or accident arising out of the use of Renesas Electronics products outside of 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 use conditions. Unless designated as a high reliability product or a product for harsh environments in a Renesas Electronics data sheet or other Renesas Electronics document, Renesas Electronics products are not subject to radiation resistance design. You are responsible for implementing safety measures to guard against the possibility of bodily injury, injury or damage caused by fire, and/or danger to the public in the event of a 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. Because the evaluation of microcomputer software alone is very difficult and impractical, you are responsible for evaluating 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. You are responsible for carefully and sufficiently investigating applicable laws and regulations that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive, and using Renesas Electronics products in compliance with all these applicable laws and regulations. Renesas Electronics disclaims any and all liability for damages or losses occurring as a result of your noncompliance with applicable laws and regulations.
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 comply with any applicable export control laws and regulations promulgated and administered by the governments of any countries asserting jurisdiction over the parties or transactions.
10. It is the responsibility of the buyer or distributor of Renesas Electronics products, or any other party who distributes, disposes of, or otherwise sells or transfers the product to a third party, to notify such third party in advance of the contents and conditions set forth in this document.
11. This document shall not be reprinted, 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.

(Note1) “Renesas Electronics” as used in this document means Renesas Electronics Corporation and also includes its directly or indirectly controlled subsidiaries.

(Note2) “Renesas Electronics product(s)” means any product developed or manufactured by or for Renesas Electronics.

(Rev.5.0-1 November 2020)

Corporate Headquarters

TOYOSU FORESIA, 3-2-24 Toyosu,
Koto-ku, Tokyo 135-0061, Japan
www.renesas.com

Trademarks

Renesas and the Renesas logo are trademarks of Renesas Electronics Corporation. All trademarks and registered trademarks are the property of their respective owners.

Contact information

For further information on a product, technology, the most up-to-date version of a document, or your nearest sales office, please visit:
www.renesas.com/contact/.