RL78/G10

Window Alarm with Buzzer

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Introduction

This document describes a Renesas microcontroller RL78/G10 application for a window alarm with buzzer.

Target Device

RL78/G10

When applying the sample program covered in this application note to another microcomputer, modify the program according to the specifications for the target microcomputer and conduct an extensive evaluation of the modified program.

Contents

1. Description

1.1 Abstract

In recent years, the cases of breaking window to steal property and hurt people are on the increase. It becomes very necessary to enhance window security. A window alarm with a buzzer is ideal for places where it needs to prevent thieves from entering the room through the window. If the window is vibrated by a criminal, a window alarm with buzzer will sound to discourage crime motivation, and then prevents criminal behavior. Window alarm with buzzer has the characters of low price, easily operating and strong security. Besides ordinary house door and window, window alarm with buzzer can also play a defensive and alarm role for large glass window, glass cabinet and booth. This document provides a window alarm with buzzer solution based on Renesas low cost microcontroller RL78/G10.

1.2 Specifications and Main Technical Parameters

Technical Parameters

- Power supply: 4.5 V (3 AAA batteries)
- Low power consumption current (MCU): 0.56 μA (TYP.)
- Power on delay: 10 s
- Sensing method: Vibration detection
- Alarm sound: > 80 dB
- Alarm lasting time: 20 s

Specifications

- Low power consumption function: After the system is powered on, it operates in low power consumption mode. When an external interrupt or watchdog timer interrupt occurs, system enters normal operation mode.
- Audible and visual alarm function: If the external interrupt happens after vibration is detected, the system will activate an audible and visual alarm. The sound of the alarm is around 80 dB and lasts 20 s.
  LED blinks with a 500 ms cycle.
- Reset standby function: After the ON-OFF switch is activated, the system is powered on and starts initialization.
  10 s later, vibration detection sensor starts to operate.
- LED indication function: Reset standby function: LED blinks with a 50 ms cycle and lasts 10 s.
  Audible and visual alarm function: LED blinks with a 500 ms cycle and lasts 20 s.
  Blink the LED about every 3.28 s to indicate MCU operates normally.
  Other function: LED goes out to reduce the power consumption.
- Operating temperature: -10 °C ~ 60 °C
- Operating humidity: 5 ~ 99% RH (No condensate water)

2. RL78/G10 Microcontroller

2.1 RL78/G10 Block Diagram

Figure 2.1 shows the block diagram of RL78/G10 (10-pin products).

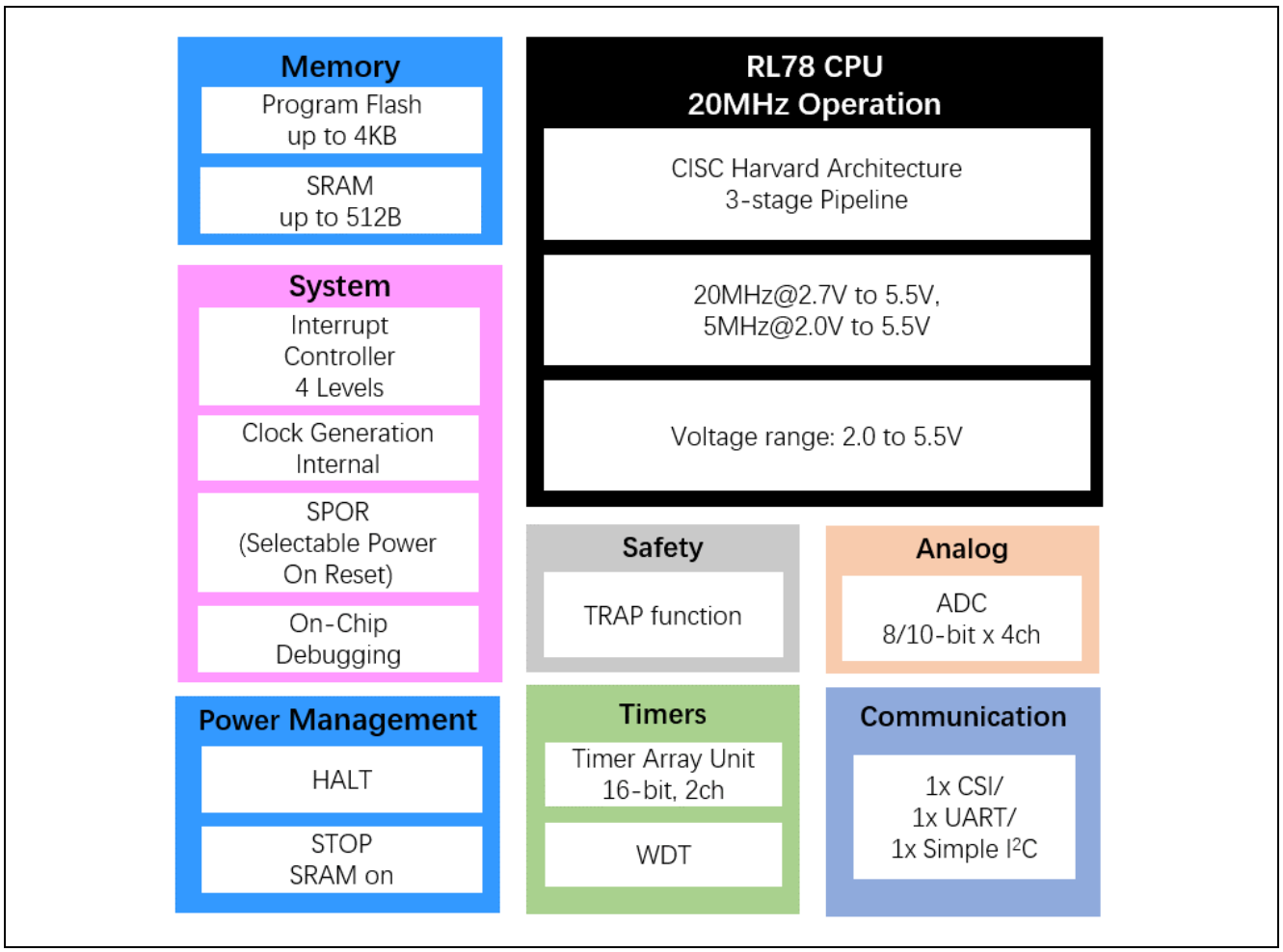

Figure 2.1 RL78/G10 (10-pin products) Block Diagram

2.2 Key Features

- Minimum instruction execution time: Can be changed from high speed (0.05 µs @ 20 MHz operation with high-speed on-chip oscillator) to low speed (1.0 µs @ 1 MHz operation)
- General-purpose registers: 8-bit register × 8
- ROM: 1 to 4 KB, RAM: 128 to 512 bytes
- Selectable high-speed on-chip oscillator clock: 20/10/5/2.5/1.25 MHz (TYP.)
- On-chip debug function
- On-chip selectable power-on-reset (SPOR) circuit
- On-chip watchdog timer (operable with the dedicated low-speed on-chip oscillator)
- On-chip key interrupt function: 6 key interrupt input pins
- On-chip clock output/buzzer output controller
- On-chip BCD (binary-coded decimal) correction circuit
- I/O port: 8
- Timer
  8/16-bit timer: 2 channels
- Serial interface
  CSI: 1 channel
  UART: 1 channel
  Simplified I2C communication: 1 channel
- 8/10-bit resolution A/D converter: 4 channels
- Standby function: HALT or STOP mode
- Power supply voltage: V_{DD} = 2.0 to 5.5 V
- Operating ambient temperature: T_A = -40 to +85 °C

RL78/G10 is widely used in small consumer electronics for industry, office, home appliance, healthcare, security and city application.

2.3 Pin Configuration

Figure 2.2 shows the pin configuration of RL78/G10 (10-pin products).

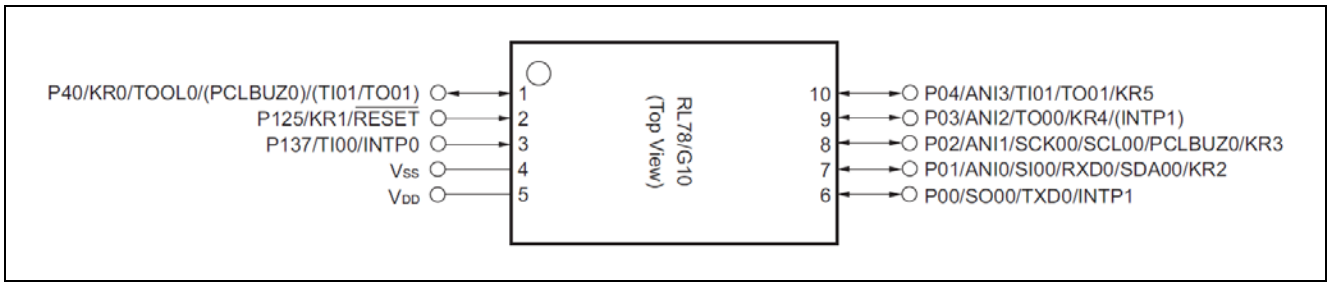

Figure 2.2 RL78/G10 (10-pin products) Pin Configuration

3. System Outline

3.1 Principle Introduction

After system initialization is completed, the LED blinks to indicate the system is running well. After 10 s, the system starts to detect vibration. If no vibration is detected, the LED will steadily blink to indicate that the MCU is operating normally. If any vibration occurs, LED will blink quickly, and in the meanwhile the buzzer sounds and lasts about 20 s. And after 20 s, the system starts to detect vibration again.

Figure 3.1 shows the system block diagram for this document.

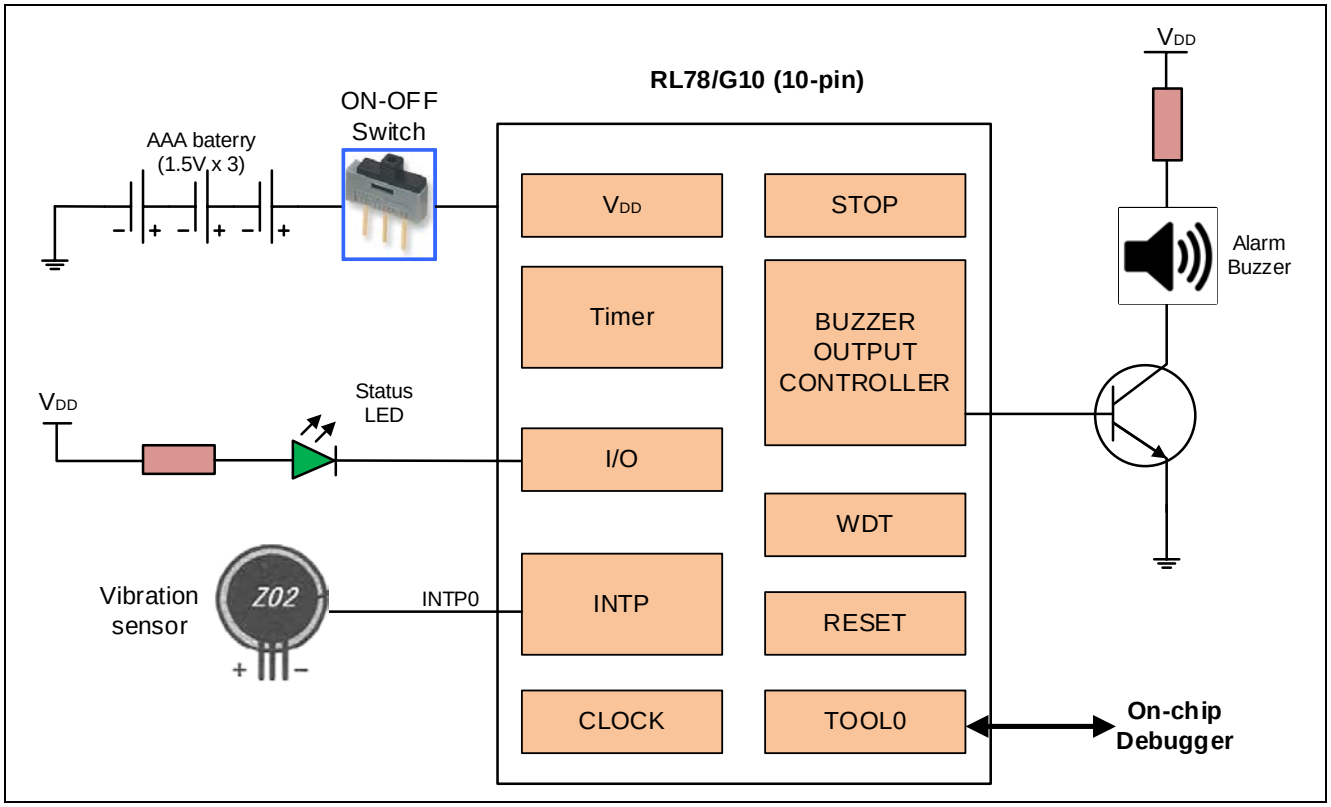

Figure 3.1 System Block Diagram

3.2 Peripheral Functions to be Used

Table 3.1 lists the peripheral functions to be used and their usages.

Table 3.1 Peripheral Functions to be Used

Peripheral Function	Usage
Channel 1 of TAU0	Operated as a 1 ms counter.
Watchdog timer	Wake up MCU from STOP mode about every 3.28 s.
INTP0	Detect the vibration.
PCLBUZ0	Output a square wave to drive the buzzer.

3.3 Pins to be Used

Table 3.2 lists the pins to be used and their descriptions.

Table 3.2 Pins to be Used

Pin Name	Description
P40/TOOL0	On-chip debug
P125/RESET	Hardware reset
P137/INTP0	Z02 sensor detection
V_{SS}	Ground
V_{DD}	Power supply voltage
P02/PCLBUZ0	Buzzer alarm
P03	Alarm LED

3.4 Operating Instructions

(1) After ON-OFF switch is activated, the system is powered on and LED blinks with a 50 ms cycle for about 10 s.

(2) When LED goes out, it means that the system can start to operate normally. Then the MCU operates in STOP mode to reduce power consumption. The watchdog timer continues counting after MCU enters STOP mode.

(3) When watchdog timer interrupt occurs or the vibration module Z02 detects a vibration signal (external interrupt), the system exits from STOP mode and enters alarm mode.

(4) If watchdog timer interrupt occurs, after system exits from STOP mode, LED blinks to indicate that the MCU operates normally. And then the system enters STOP low consumption mode and waits for the next interrupt.

(5) If the vibration module Z02 detects the vibration signal, after system exits from STOP mode, LED blinks with a 500 ms cycle, buzzer sounds (>80 dB) and lasts about 20 s. 20 s later, system enters STOP low consumption mode and waits for the next interrupt.

4. Hardware

There is a vibration module, alarm buzzer circuit and an LED circuit. Z02 vibration sensor is used to detect whether the vibration has occurred. When a vibration signal is detected, the alarm buzzer gives out a high decibel alarm. After initialization the LED will begin blinking. It will remain in this state as long as normal operation is being executed, regardless of the tripped status of the vibration sensor. What may vary is the frequency of the LED pulses.

Figure 4.1 shows the board picture.

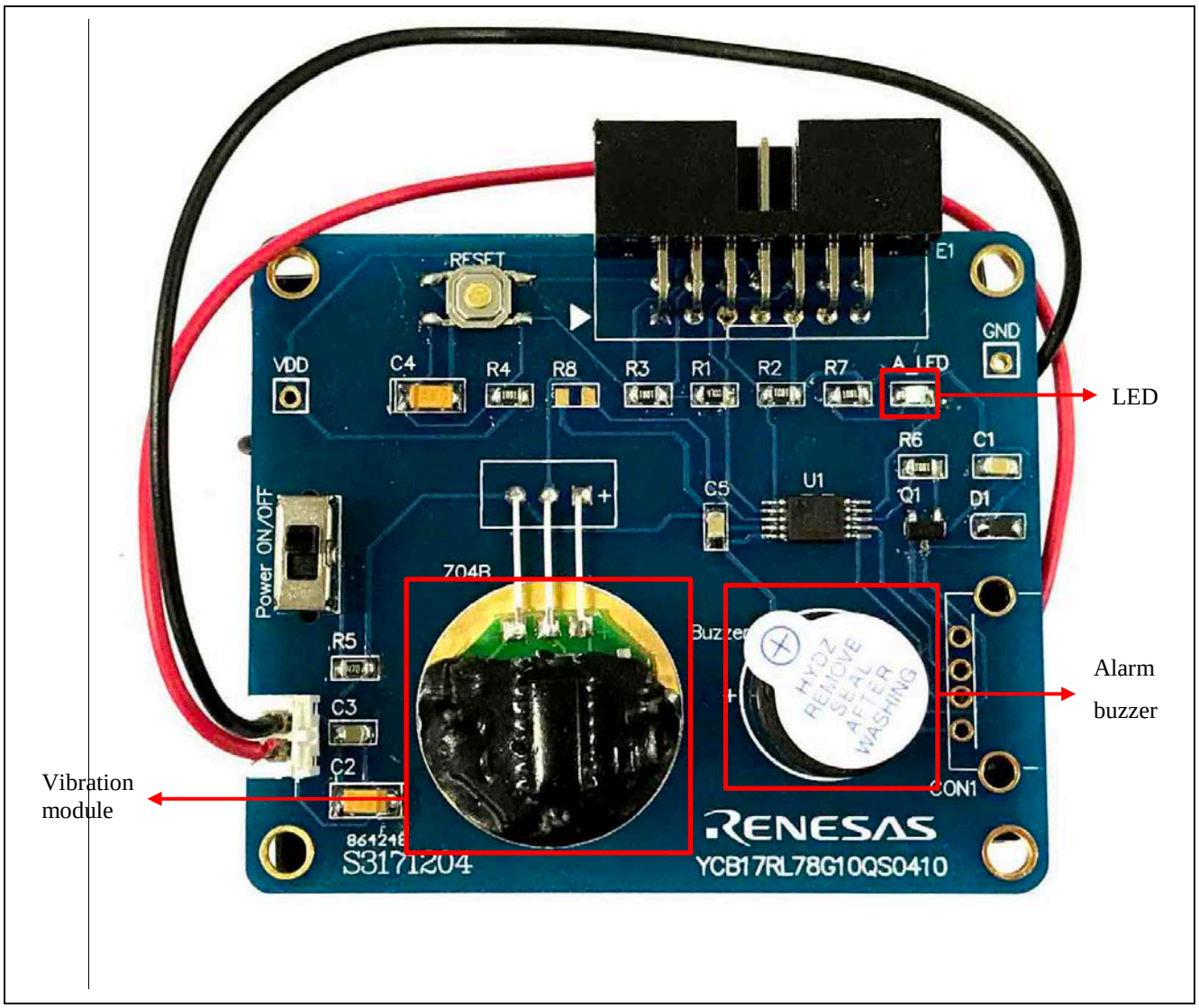

Figure 4.1 Board Picture

4.1 Vibration Detection Circuit

Figure 4.2 shows the schematics of the vibration detection circuit.

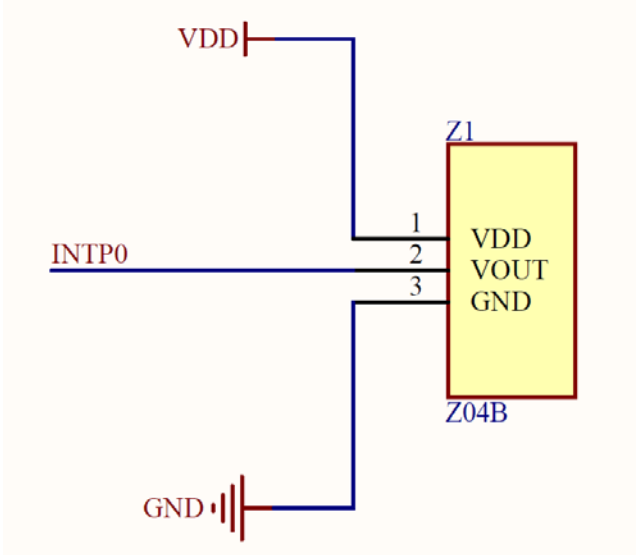

Figure 4.2 Vibration Detection Circuit

In this system, Z02 vibration sensor is used to detect whether the vibration is generated.

Z02 is a Φ20 mm 3.5 mm thick plate-shaped high-sensitive vibration detection module. It can be used as a miniature sensor head of vibration alarm for doors & windows, security alarms and real-time monitoring control circuits.

The brass plate of the module can detect a very tiny vibration wave, and output a transient pulse signal whose amplitude is close to power supply 3~5 s later by internal amplification, filtering, shaping and level shifting. When the vibration stops, output signal returns to 0 level status immediately.

4.2 Buzzer Driver Circuit

Figure 4.3 shows the schematics of the buzzer driver circuit.

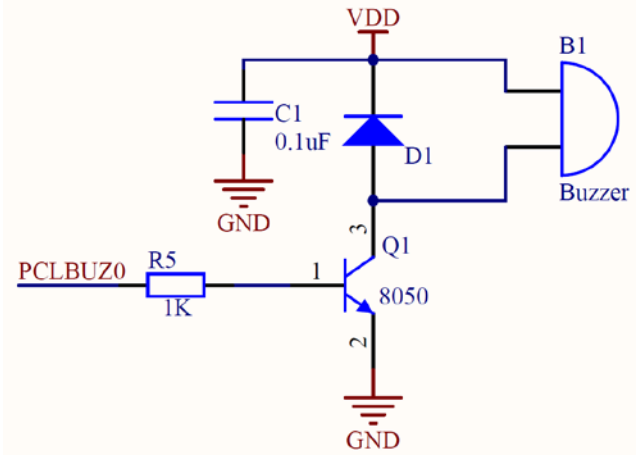

Figure 4.3 Buzzer Driver Circuit

When a vibration signal is detected the buzzer gives out a high decibel alarm. There are two kinds of buzzers. One is driven by direct current, and the other is driven by square wave. This system uses the buzzer driven by square wave. It can output a certain frequency by PCLBUZ0 to compose the alarm sound.

Generally, a buzzer is an inductive component whose current is not transient, so a free wheel diode is needed to provide continuous current. Otherwise, it will generate tens of volts of peak voltage on both ends of the buzzer. It may damage the triode and interfere with the operation of whole circuit system.

The frequency of the alarm sound is 2500 kHz.

4.3 LED Driver Circuit

Figure 4.4 shows the schematics of the LED driver circuit.

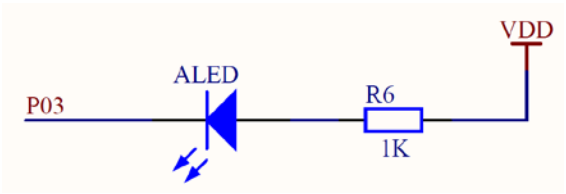

Figure 4.4 LED Driver Circuit

The alarm LED in this system uses LED, its drive current is usually about 5 mA. Because the large current driving capability of the MCU can drive LED directly, low level is used to turn on the LED.

5. Software

5.1 Integrated Development Environment

The sample code described in this chapter has been checked under the conditions listed in the table below.

Table 5.1 Operation Check Conditions

Item	Description
Microcontroller used	RL78/G10 (R5F10Y16)
Operating frequency	High-speed on-chip oscillator (HOCO) clock: 20 MHz CPU/peripheral hardware clock: 20 MHz
Operating voltage	4.5V (can run on a voltage range of 2.7 V to 5.5 V.) SPOR detection voltage When power supply falls: TYP. 2.84V (2.70 V to 2.96 V) When power supply rises: TYP. 2.90V (2.76 V to 3.02 V)
Integrated development environment (CS+)	CS+ V6.00.00 from Renesas Electronics Corp.
C compiler (CS+)	CC-RL V1.05.00 from Renesas Electronics Corp.
Integrated development environment (e2 studio)	e2 studio V6.0.0 from Renesas Electronics Corp.
C compiler (e2 studio)	CC-RL V1.05.00 from Renesas Electronics Corp.

5.2 Option Byte

Table 5.2 summarizes the settings of the option bytes.

Table 5.2 Option Byte Settings

Address	Value	Description
000C0H/010C0H	11111111B	Watchdog timer counter operation enabled (counting started after reset) Interval interrupt time: about 3276.8 ms
000C1H/010C1H	11110111B	SPOR detection voltage When power supply falls: TYP. 2.84V (2.70 V to 2.96 V) When power supply rises: TYP. 2.90V (2.76 V to 3.02 V)
000C2H/010C2H	11111001B	Operating frequency: 20 MHz (2.7 V ~ 5.5 V)
000C3H/010C3H	10000101B	Enables on-chip debugging

5.3 Operation Outline

The tasks of the entire system are listed as below: reset/initialization, standby task, STOP mode, interrupt wake-up task, LED display task and audible and visual alarm task.

Figure 5.1 shows the block diagram for the tasks transition.

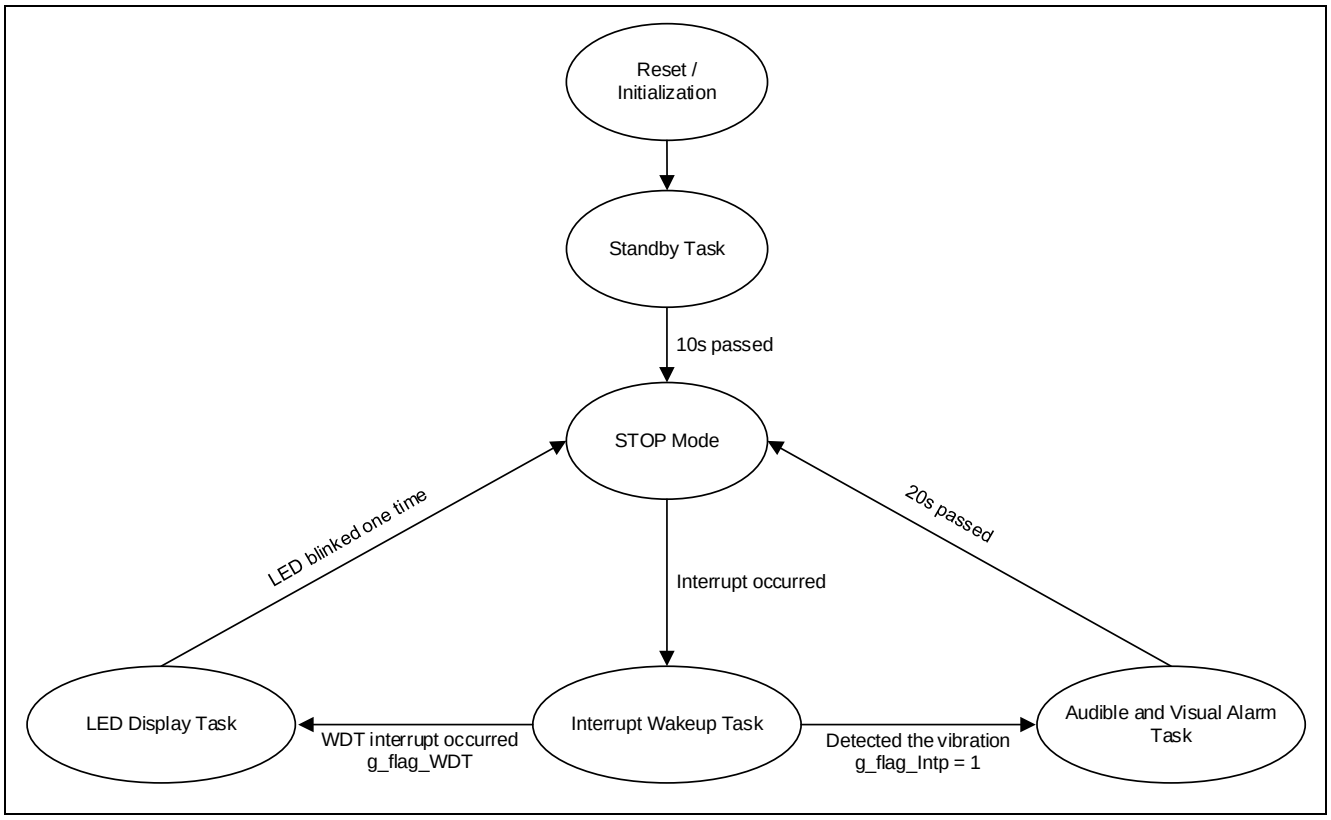

Figure 5.1 Tasks Transition Block Diagram

(1) Reset / Initialization

After ON-OFF switch is activated, the system is powered on and executes initialization routine of each module.

(2) Standby Task

After system initialization, system enters standby mode. In this mode, LED blinks with a 50 ms cycle. About 10 s (standby time) later the LED goes out. It means system standby task is completed and can start to operate normally.

(3) STOP Mode

After exiting from the reset standby task, system enters low power consumption task by executing STOP instruction. At this time all peripheral functions stop operating except the interrupt function.

(4) Interrupt Wake-up Task

When watchdog timer interrupt occurs or vibration module detects external interrupt signal, the system wakes up and exits from STOP mode, and sets alarm flag in interrupt service subroutine.

(5) LED Display Task

When system is woken up by the watchdog timer interrupt signal the LED blinks, then alarm mode releases. The system then enters low power consumption mode again and waits for the next wake-up.

(6) Audible and Visual Alarm Task

When system is woken up by an external interrupt signal generated by the vibration module, it generates an audible and visual alarm signal to make an alert. The system uses square wave output function of TAU to make buzzer give out an 80 dB alarm sound, and makes LED blink with a 500 ms cycle. At this time, the system is not in low power consumption mode. About 20 s later the alarm mode releases and the system enters low power consumption mode again and waits for the next wake-up.

5.4 Flow Chart

5.4.1 Main Processing

Figure 5.2 shows the flowchart for main processing routine.

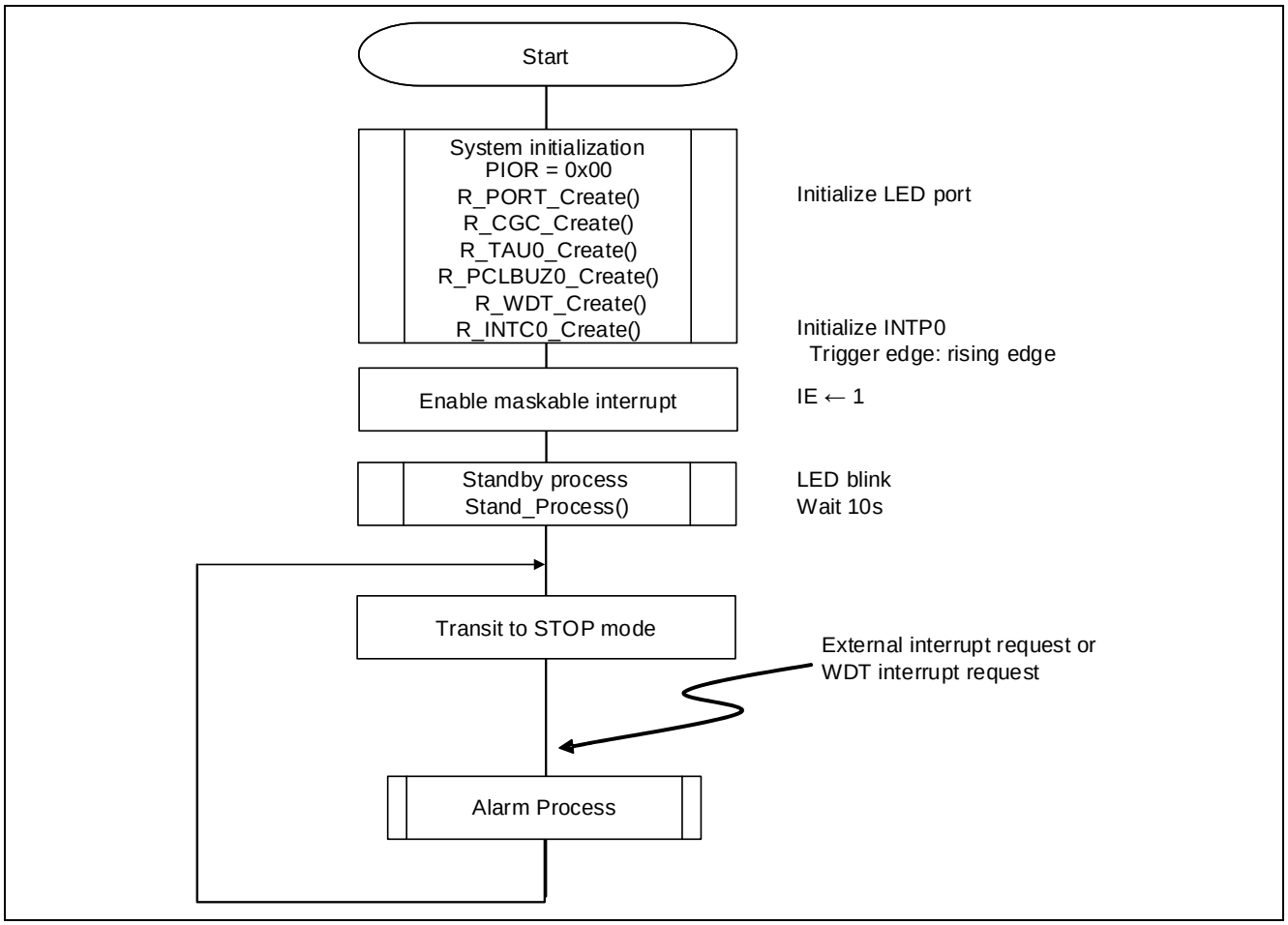

Figure 5.2 Main Processing

5.4.2 Standby Task Processing

After system initialization, system enters standby processing, and the processing will be completed in 10 s.

Figure 5.3 shows the flowchart for standby task processing.

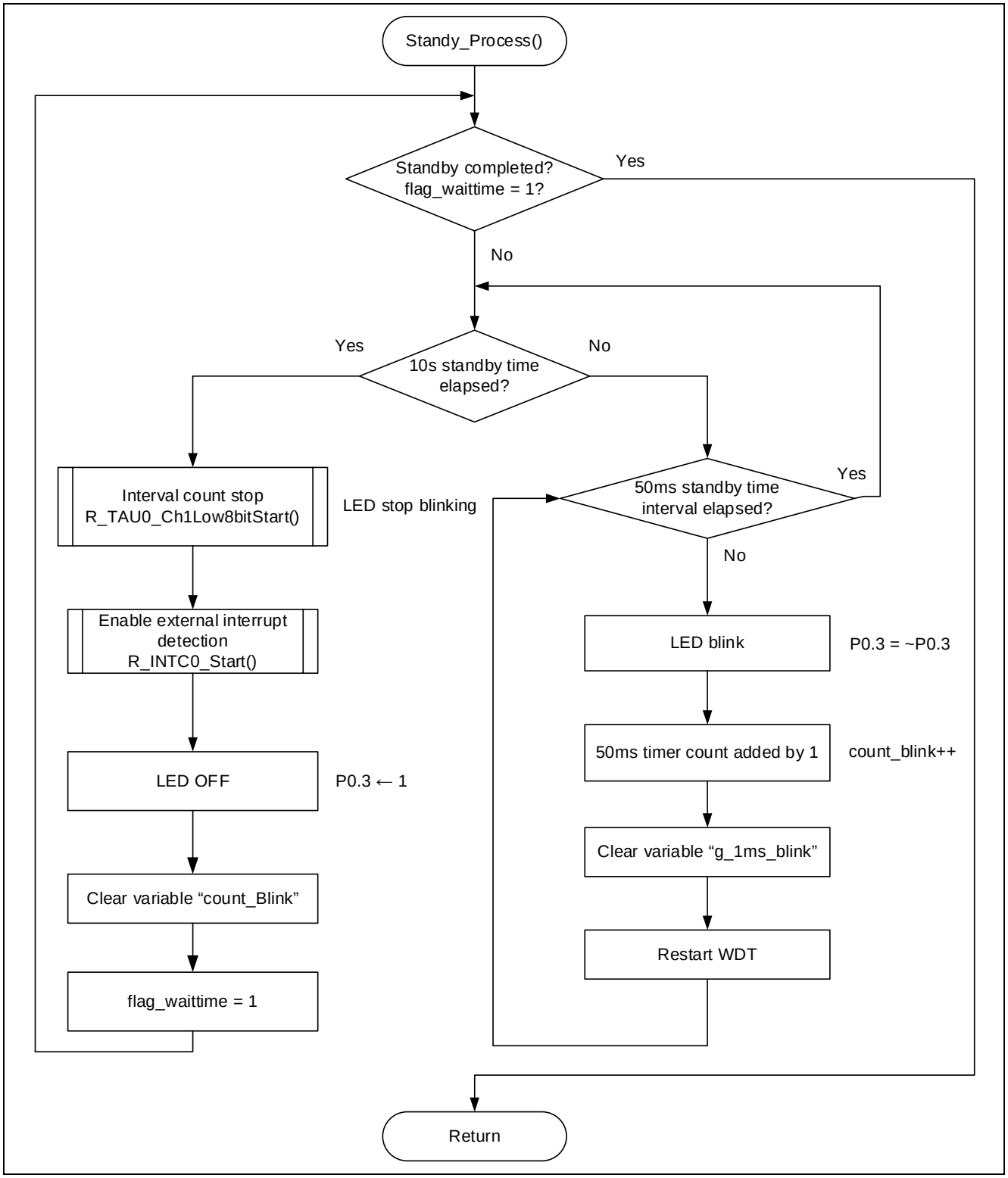

Figure 5.3 Standby Task Processing

5.4.3 Alarm Task Processing

Figure 5.4 ~ Figure 5.6 show the flowchart for the alarm task processing of vibration detection or watchdog timer interrupt.

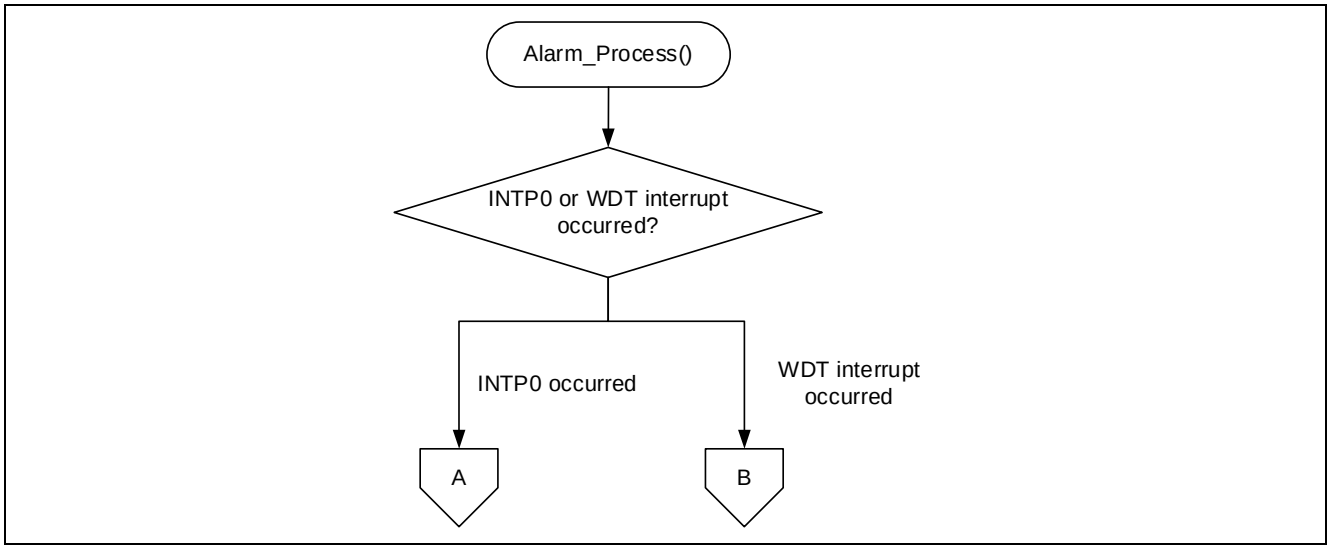

Figure 5.4 Alarm Task Processing (1/3)

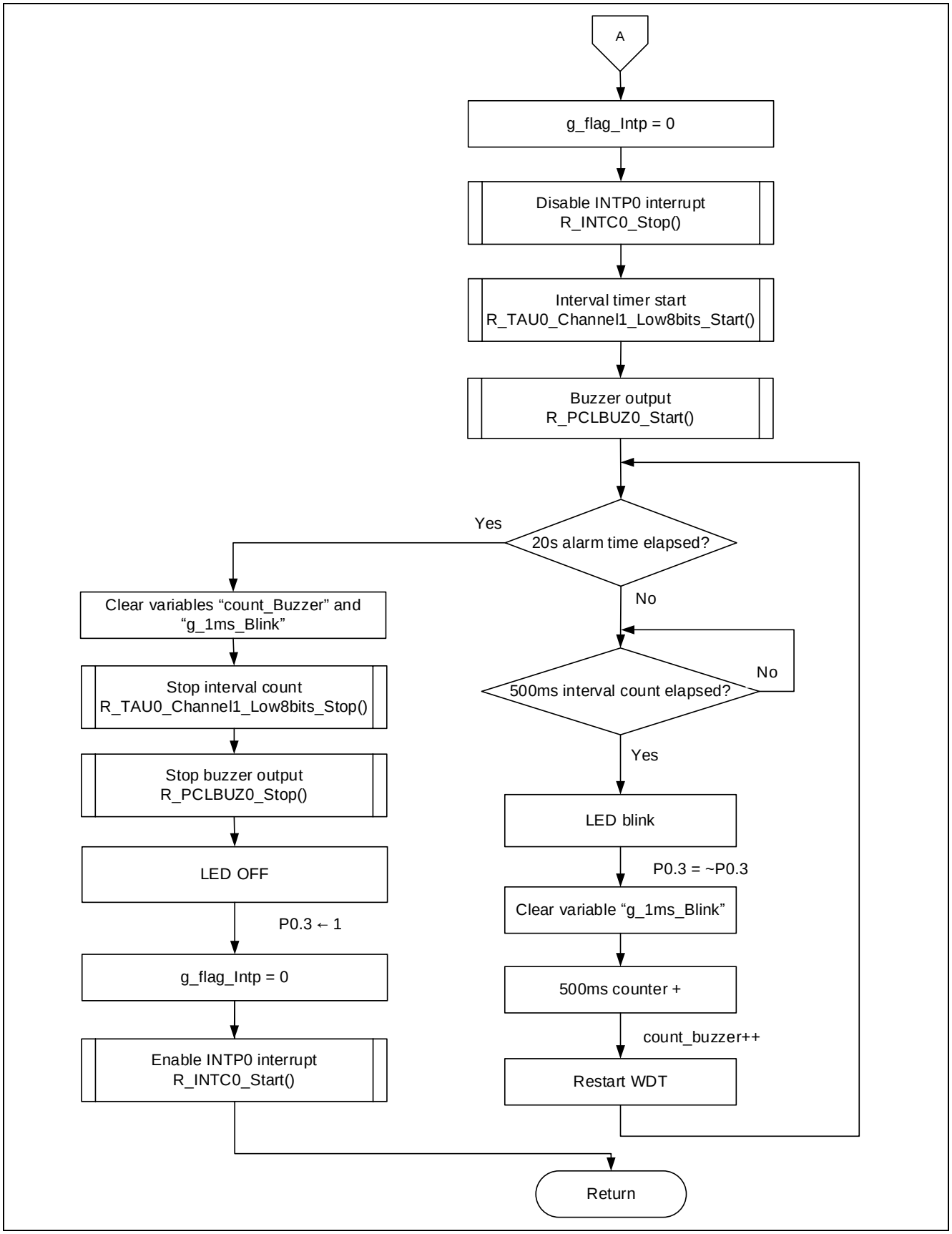

Figure 5.5 Alarm Task Processing (2/3)

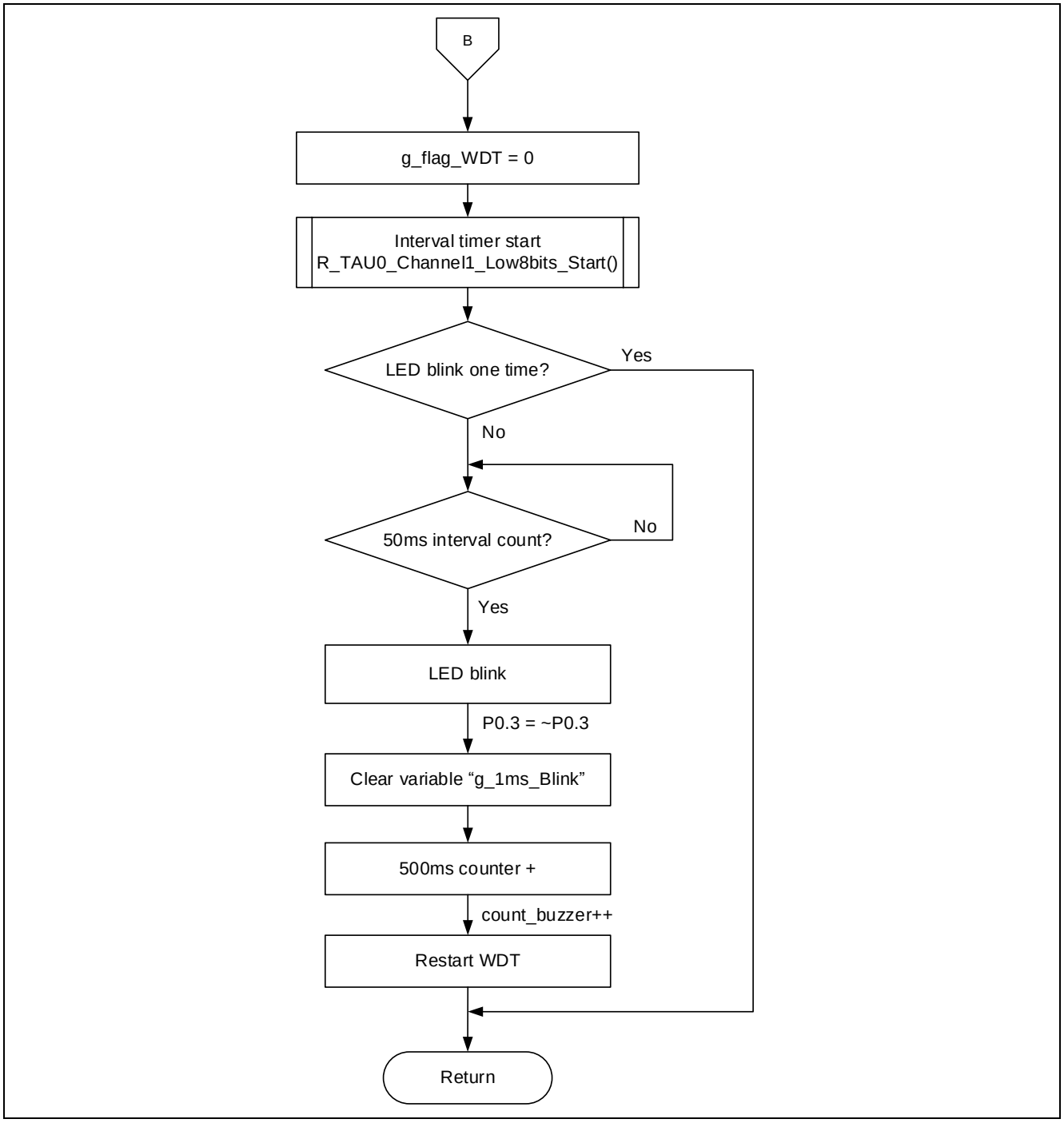

Figure 5.6 Alarm Task Processing (3/3)

5.4.4 Interrupt Task Processing

Figure 5.7 shows the flowchart for interrupt task processing.

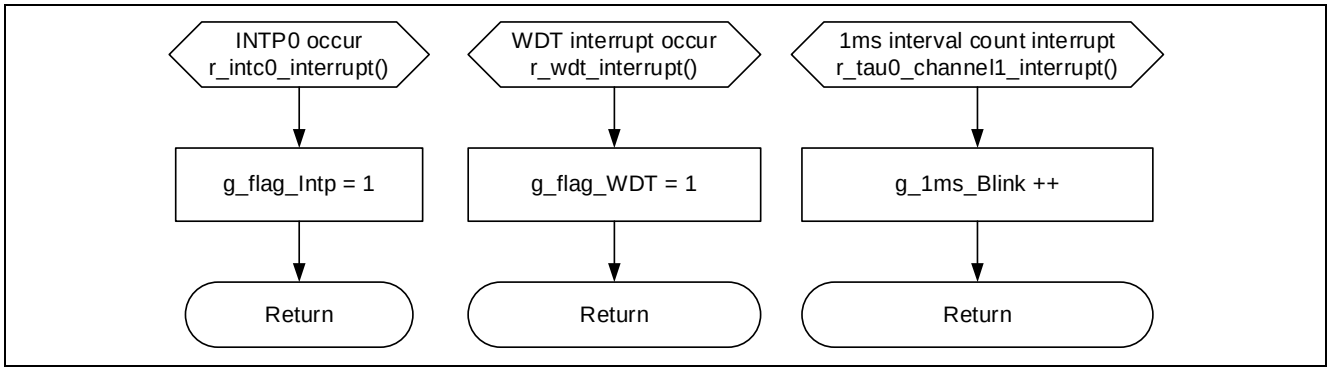

Figure 5.7 Interrupt Task Processing

6. Sample Code

The sample code is available on the Renesas Electronics Website.

7. Reference Documents

RL78/G10 User's Manual: Hardware (R01UH0384)

RL78 Family User's Manual: Software (R01US0015)

(The latest versions of the documents are available on the Renesas Electronics Website.)

Technical Updates/Technical News

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Revision History

		Description	
Rev.	**Date**	**Page**	**Summary**
1.00	Dec. 31, 2017	—	First edition issued

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   — 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.
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   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.

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(Rev.3.0-1 November 2016)

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