RL78/G13

R01AN1524EG0100
Rev.1.00
Jun 7, 2013

Voltage Detector (Reset Mode) for GNURL78 v13.01 Toolchain

Introduction

This application note describes the reset mode of the voltage detector (LVD) on the RL78/G13. When the supply voltage (V_{DD}) becomes lower than the LVD detection voltage (V_{LVI}), the voltage detector generates an internal reset. Using LEDs, the internal reset can be distinguished from a power-on-reset (POR).

Target Device

RL78/G13

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.

This application note has been updated for the RSKRL78/G13 hardware platform.

Contents

1. Installation

This application note and associated code has been written to work with GNURL78 v13.01 toolchain.

Create a new folder and name it as 'RSKRL78G13_Workspace'. Copy the zipped file, available in the Application Note package downloaded from the website, to this folder. Extract it to the RSKRL78G13_Workspace folder.

2. Specifications

This application note describes the operation (reset mode) of the voltage detector.

When the supply voltage (V_{DD}) becomes lower than the LVD detection voltage (V_{LVI}), the voltage detector generates an internal reset. The three LEDs permit a visual distinction between this internal reset and a power-on-reset. The indications provided by these LEDs are changed according to the switch SW1 input count.

When $V_{DD} < V_{LVI}$, the voltage detector generates an internal reset. Later, when $V_{DD} \geq V_{LVI}$, this reset is ended. At this time, the system restarts from the state it was in when the LEDs provided the last indications.

When $V_{DD} < V_{PDR}$, an internal reset occurs due to a power-on-reset. Later, when $V_{DD} \geq V_{LVI}$, this internal reset is ended and the system restarts while all the LEDs are off.

Table 2.1 shows the required peripheral functions and their uses. Figure 2.1 presents an overview of the operation (reset mode) of the voltage detector.

Table 2.1 Required Peripheral Functions and Their Uses

Peripheral Function	Use
LVD	Supply voltage (VDD) monitoring
P50/INTP1	Switch SW1 Input
P53, P62, P63	LED lighting control (for LED1 to LED3)

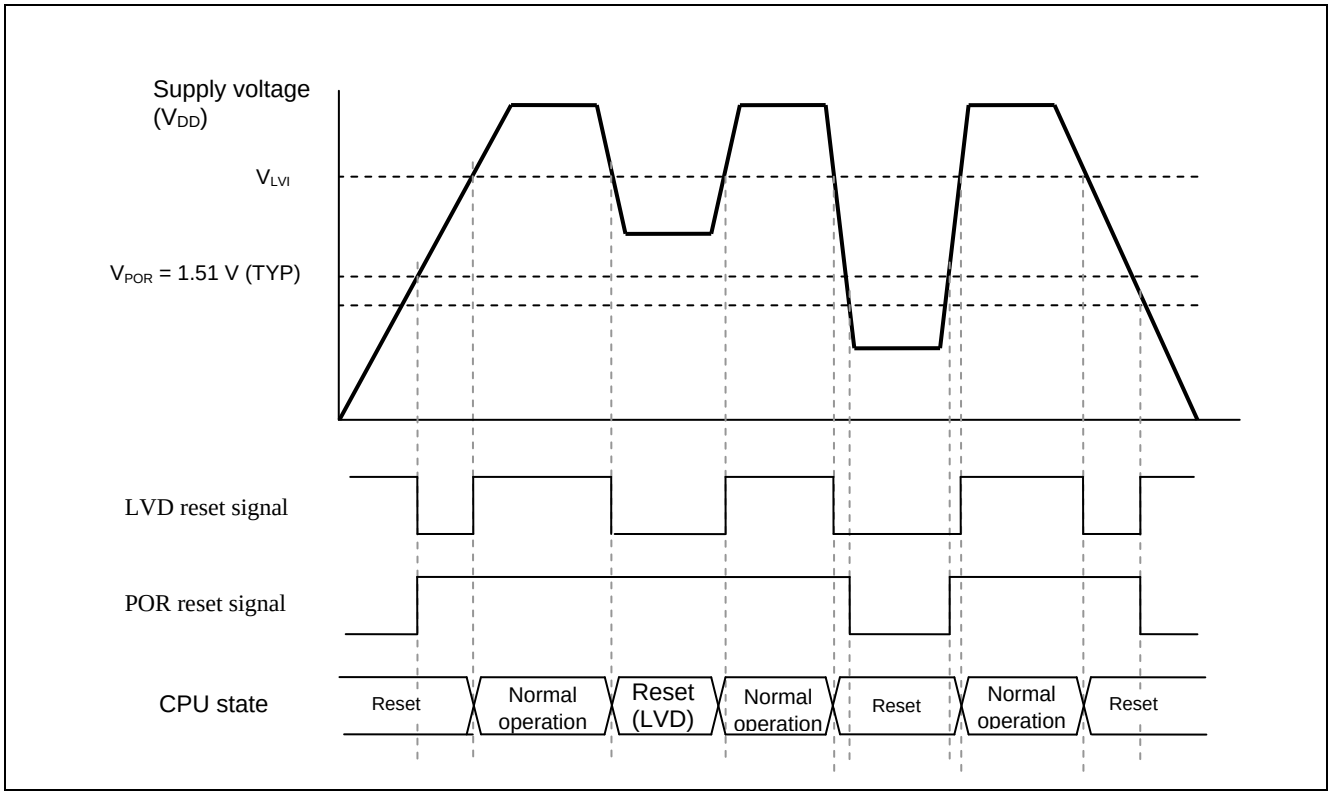


Figure 2.1 Overview of LVD Operation (Reset Mode)

3. Operation Check Conditions

The sample code contained in this application note has been checked under the conditions listed in the table below.

Table 3.1 Operation Check Conditions

Item	Description
Microcontroller used	RL78/G13 (R5F100LEA)
Operating frequency	• High-speed on-chip oscillator (HOCO) clock: 32 MHz • CPU/peripheral hardware clock: 32 MHz
Operating voltage	5.0 V (can run on a voltage range of 2.9 V to 5.5 V.) LVD operation (V_{LVI}): Reset mode • Rising edge voltage: 2.81 V (2.76 V to 2.87 V) • Falling edge voltage: 2.75 V (2.70 V to 2.81V)
Integrated development environments	Renesas Electronics e^2studio 1.1.1.7
C compiler toolchain	GNURL78 v13.01

4. Related Application Notes

The application note related to this application note is listed below for reference.

- RL78/G13 Initialization (R01AN1525EG0100) Application Note

5. Description of the Hardware

5.1 Hardware Configuration Example

Figure 5.1 shows an example of the hardware configuration used for this application note.

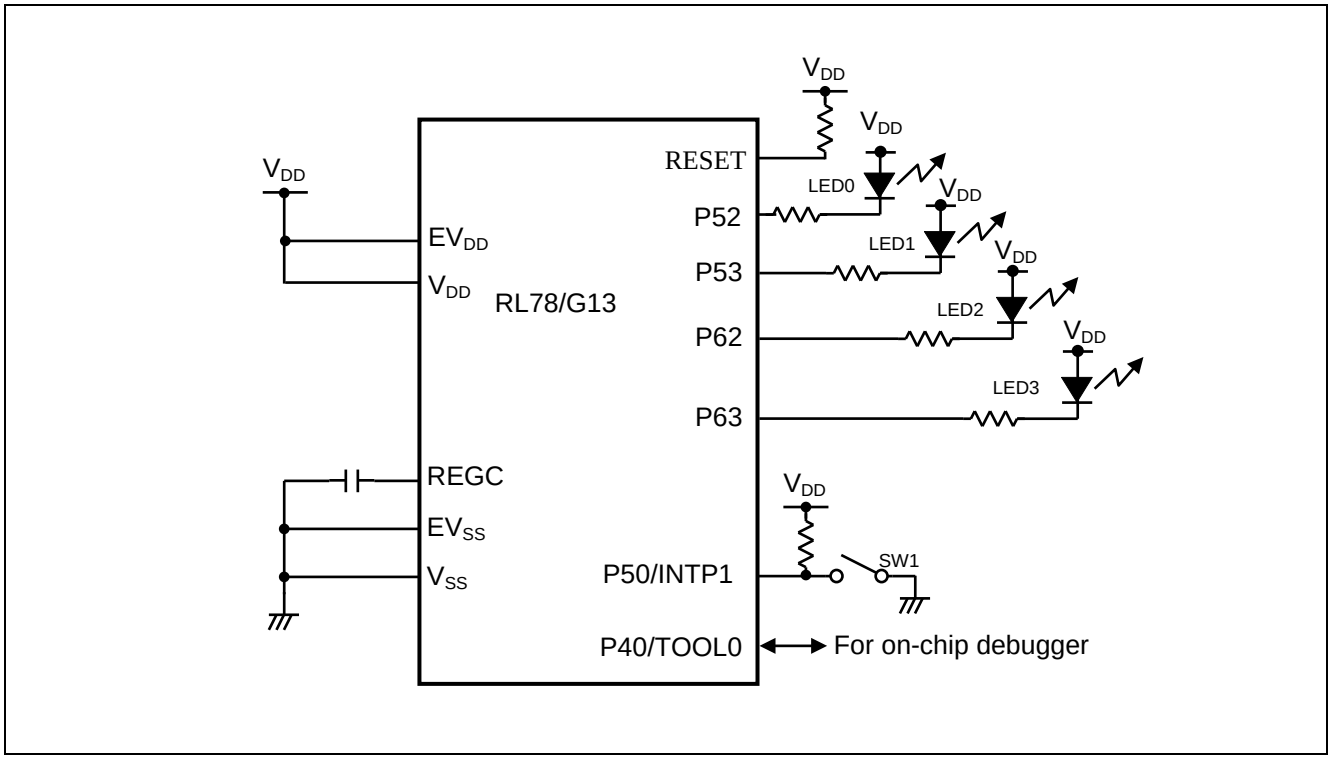


Figure 5.1 Hardware Configuration

Cautions 1. The purpose of this circuit is only to provide the connection outline and the circuit is simplified accordingly. When designing and implementing an actual circuit, provide proper pin treatment and make sure that the hardware's electrical specifications are met (connect the input-only ports separately to V_{DD} or V_{SS} via a resistor).

2. Connect any pins whose name begins with EV_{SS} to V_{SS} and any pins whose name begins with EV_{DD} to V_{DD}, respectively.

5.2 List of Pins Used

Table 5.1 lists the pins to be used and their functions.

Table 5.1 Pins to be Used and Their Functions

Pin Name	I/O	Description
P52	Output	LED on (LED0) control port
P53	Output	LED on (LED1) control port
P62	Output	LED on (LED2) control port
P63	Output	LED on (LED3) control port
P50/INTP1	Input	Switch SW1 input port

6. Description of the Software

6.1 Operation Outline

The sample program described in this application note monitors the supply voltage using the voltage detector (reset mode).

When $V_{DD} < V_{LVI}$, the voltage detector generates an internal reset (LVD reset). At this time, various registers are initialized. If, however, V_{DD} is equal to or greater than the power-on-reset detection voltage (V_{PDR} = 1.50 V ± 0.03 V), the on-chip RAM's state remains unchanged since before the reset generation. Because the on-chip RAM holds the switch input count which was obtained before the reset generation, the system can restart from the state it was in when the LED indications were provided before the reset generation.

The switch input count is initialized when a reset other than the LVD reset occurs.

(1) Initializing the voltage detector

<Conditions for setting>

- When the power is turned on or after the reset is ended, the option byte should be referenced automatically and the voltage detector should be set to reset mode.
- The rising edge detection voltage should be set to 2.81 V. The falling edge detection voltage should be set to 2.75 V.

Caution: When reset mode is selected, the voltage detection level register (LVIS) is write-prohibited. The initial value for the LVIS register is set to 81H (low-voltage detection level: V_{LVI} for reset mode) automatically.

(2) Setting the input and output ports

- LED lighting control (for LED1 to LED3): Configure P52, P62 and P63 as the output ports.
- Switch SW1 input: Configure P50/INTP1 for detecting INTP1 falling edges (via an external pull-up resistor)

(3) LED indications depending on the switch SW1 input count

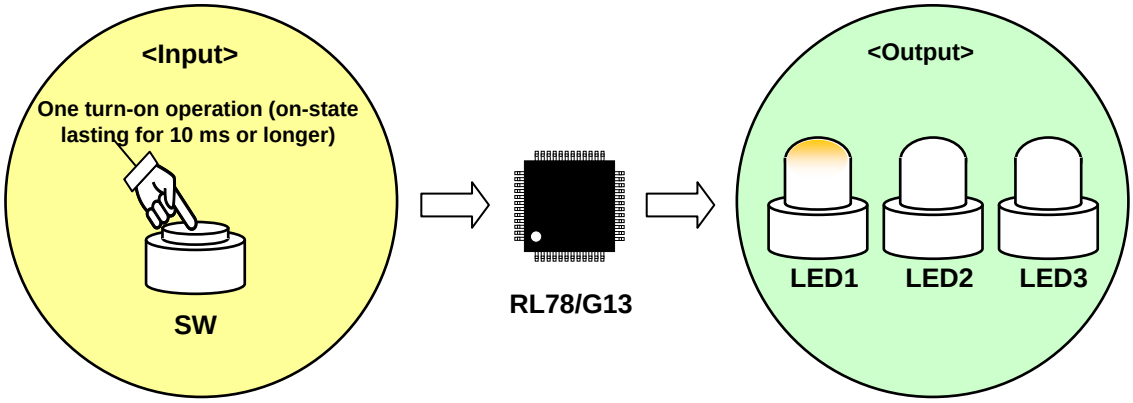
- Interrupt processing is started upon detection of a P50/INTP1 falling edge. Chattering is detected and, if the on state of the input lasts about 10 ms, it is recognized as a switch input and the LED indications are changed. When $V_{DD} < V_{LVI}$, an LVD reset is generated; however the on-chip RAM's state remains unchanged since before the reset generation (see Note).

(4) When $V_{DD} < V_{PDR}$, a POR internal reset occurs, deleting the LED indication data.

Caution: If the standard startup routine is used for programs written in C, data in the on-chip RAM is initialized before the main function is executed. To prevent it from being initialized, a startup routine which has its initialization code commented out is adopted (see reset_program.asm where bss initialisation is skipped by the CLEAR_BSS macro).

Caution: Usage Precautions: For information about the precautions in using the device, refer to RL78/G13 User's Manual: Hardware.

Figure 6.1 presents an overview of the sample code operation.



Switch (SW1) input count	LED indications		
	LED1	LED2	LED3
0	OFF	OFF	OFF
1	ON	OFF	OFF
2	OFF	ON	OFF
3	ON	ON	OFF
4	OFF	OFF	ON
5	ON	OFF	ON
6	OFF	ON	ON
7	ON	ON	ON

Note: For the eighth and subsequent operations, the LED indications above are repeated.

Figure 6.1 Overview of Sample Code Operation

6.2 List of Option Byte Settings

Table 6.1 summarizes the settings of the option bytes.

Table 6.1 **Option Byte Settings**

Address	Value	Description
000C0H/010C0H	01101110B	Disables the watchdog timer. (Stops counting after the release from the reset state.)
000C1H/010C1H	01111111B	LVD reset mode Rising edge voltage: 2.81 V (2.76 V to 2.87 V) Falling edge voltage: 2.75 V (2.70 V to 2.81 V)
000C2H/010C2H	11101000B	HS mode HOCO: 32 MHz
000C3H/010C3H	10000100B	Enables the on-chip debugger.

6.3 List of Variables

Table 6.2 lists the global variables.

Table 6.2 **Global Variables**

Type	Variable Name	Contents	Function Used
uint8_t	g_ResetFactor	RESF register save area	main() R_CGC_Get_ResetSource()
uint8_t	g_SwCount	SW depress count	main() R_INTC1_Interrupt()

6.4 List of Functions

Table 6.3 gives a list of functions that are used by this sample program.

Table 6.3 **Functions**

Function Name	Outline
R_PORT_Create	Initializes the input and output ports.
R_INTC_Create	Initializes the external-interrupt settings.
R_INTC1_Start	Enables INTP1 interrupts.
R_INTC1_Interrupt	Processes INTP1 interrupts.

6.5 Function Specifications

This section describes the specifications for the functions that are used in the sample code.

[Function Name] R_PORT_Create

Synopsis	Initializes the input and output ports.
Header	r_cg_port.h
Declaration	void R_PORT_Create(void)
Explanation	• LED lighting control (for LED 1 to LED3): This function configures P53, P62 and P63 as the output ports.
Arguments	None
Return value	None
Remarks	None

[Function Name] R_INTC_Create

Synopsis	Initializes the external-interrupt settings.
Header	r_cg_intc.h
Declaration	void R_INTC_Create(void)
Explanation	This function initializes the external-interrupt settings. This function clears the interrupt request.
Arguments	None
Return value	None
Remarks	None

[Function Name] R_INTC1_Start

Synopsis	Enables INTP1 interrupts.
Header	r_cg_intc.h
Declaration	void R_INTC1_Start(void)
Explanation	This function clears the interrupt request flag. This function enables INTP1 interrupts and starts taking in the switch input.
Arguments	None
Return value	None
Remarks	None

[Function Name] R_INTC1_Interrupt

Synopsis	Processes INTP1 interrupts.
Header	r_cg_intc.h
Declaration	__interrupt void R_INTC1_Interrupt(void)
Explanation	This function processes the INTP1 interrupt when it occurs. This function waits 10 ms and then scans the P50 (SW1 input pin). When the switch is depressed, this function causes the LED indication counter to count up.
Arguments	None
Return value	None
Remarks	None

6.6 Flowcharts

Figure 6.2 shows the overall flow of the sample program described in this application note.

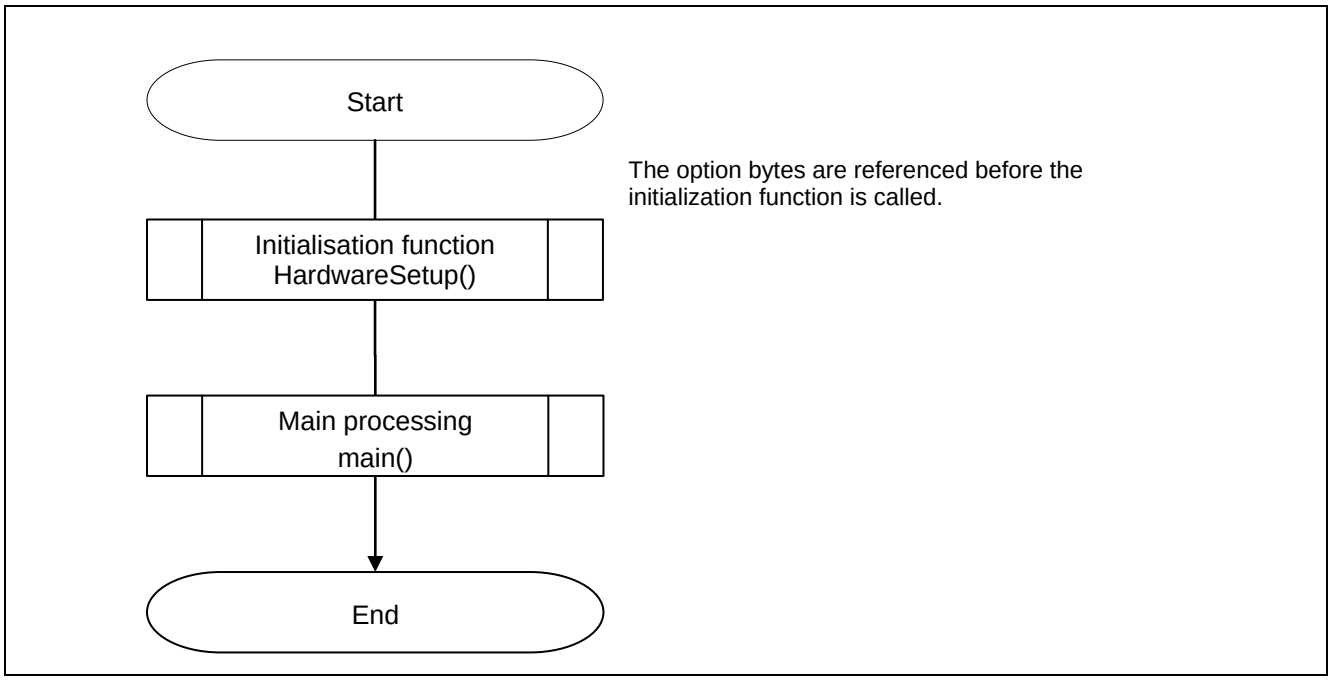


Figure 6.2 Overall Flow

6.6.1 Initialization Function

Figure 6.3 shows the flowchart for the initialization function.

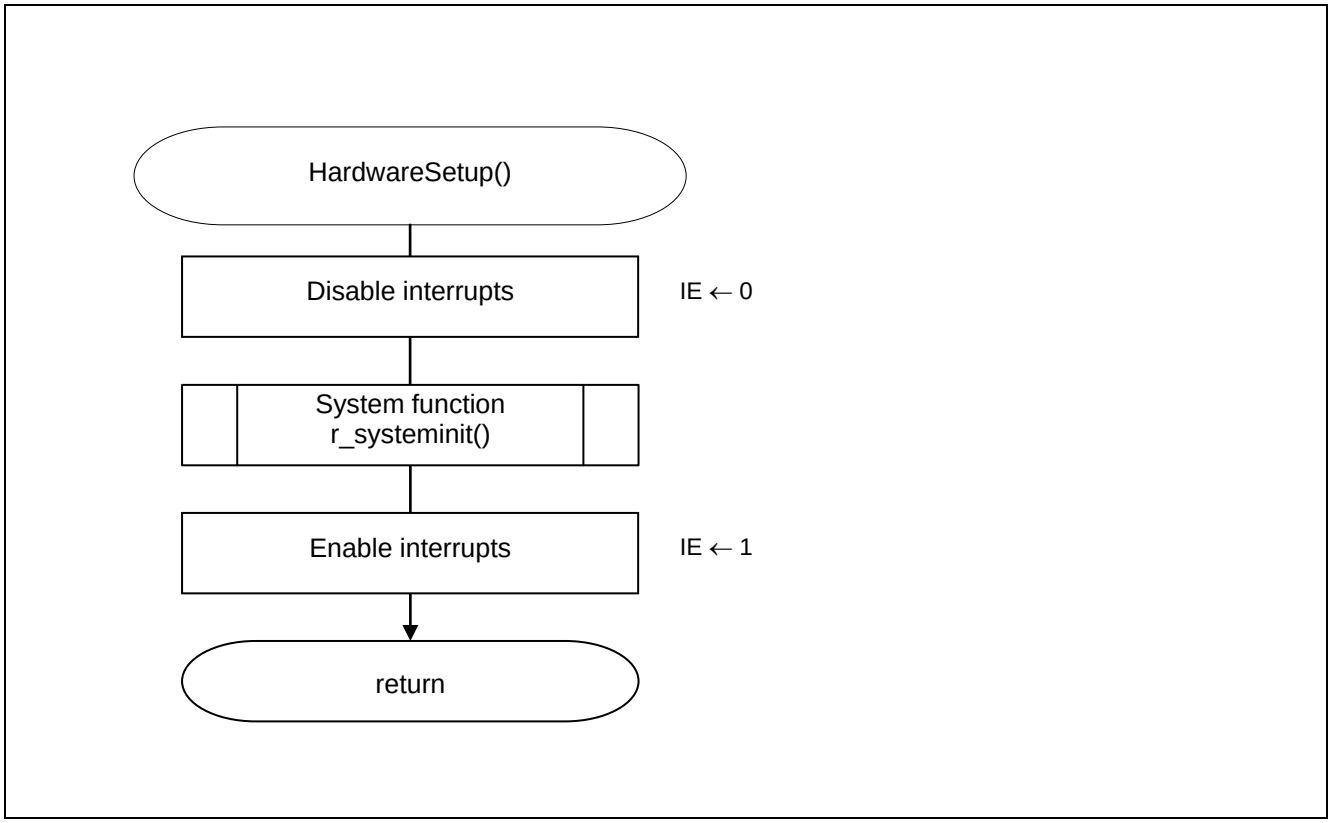


Figure 6.3 Initialization Function

6.6.2 System Function

Figure 6.4 shows the flowchart for the system function.

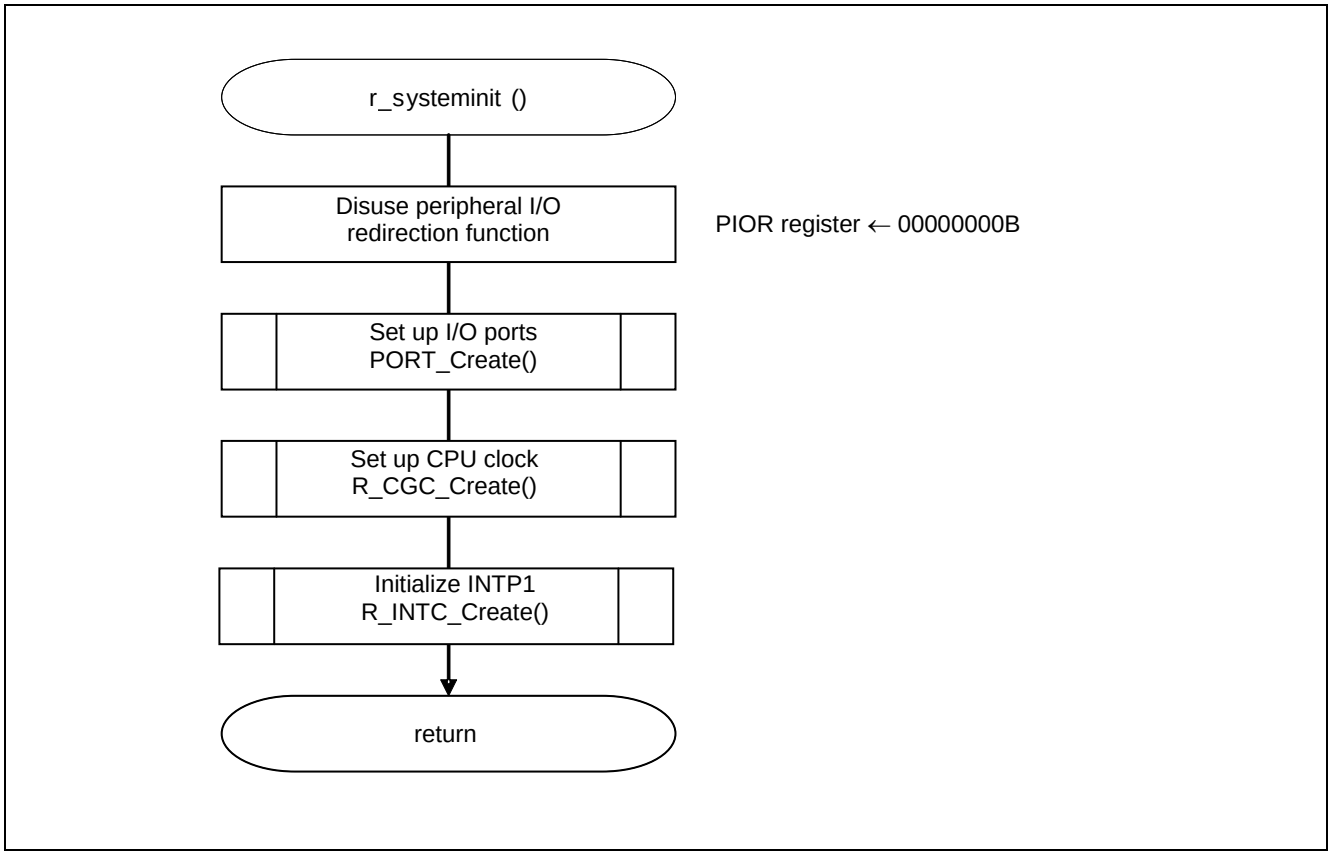


Figure 6.4 System Function

6.6.3 Setting up the I/O Ports

Figure 6.5 shows the flowchart for setting up the I/O ports.

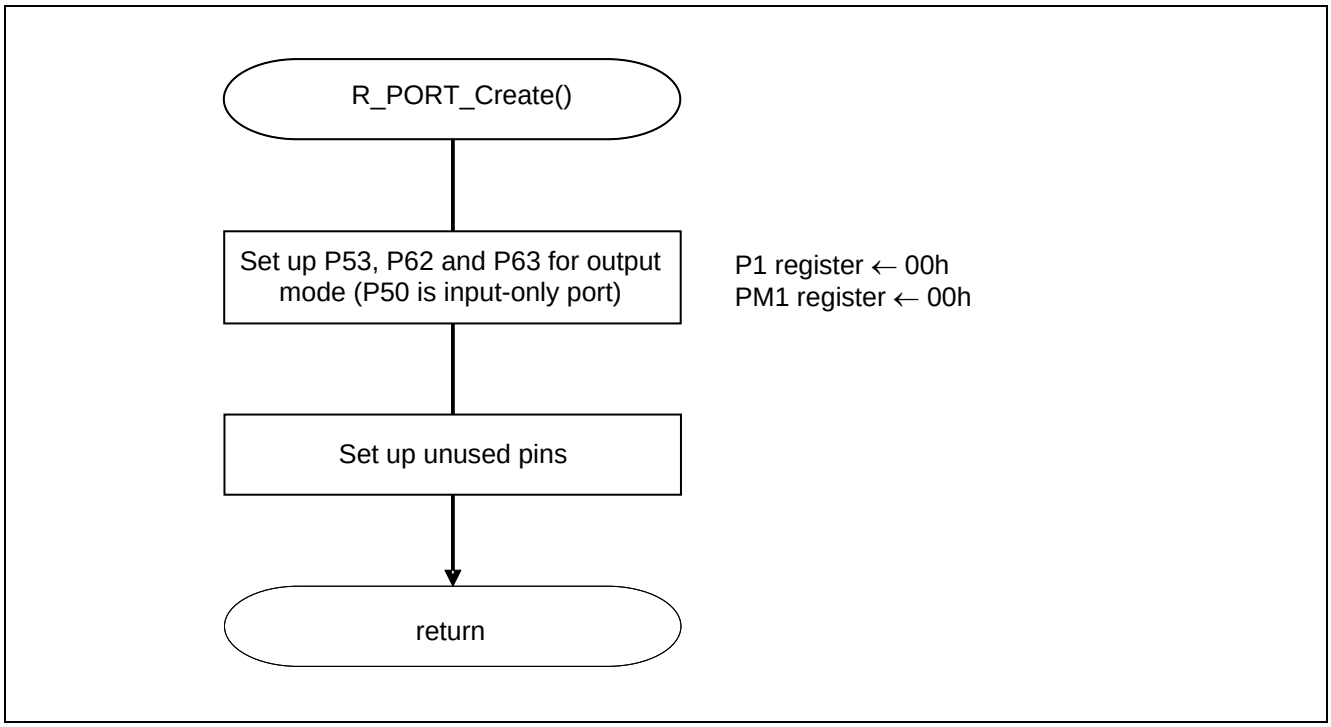


Figure 6.5 I/O Port Setup

Caution: Refer to the section entitled "Flowcharts" in RL78/G13 Initialization Application Note (R01AN1525EG0100) for the configuration of the unused ports.

Caution: Provide proper treatment for unused ports so that their electrical specifications are observed. Connect each of any unused input-only ports to V_{DD} or V_{SS} via a resistor.

6.6.4 CPU Clock Setup

Figure 6.6 shows the flowchart for setting up the CPU clock.

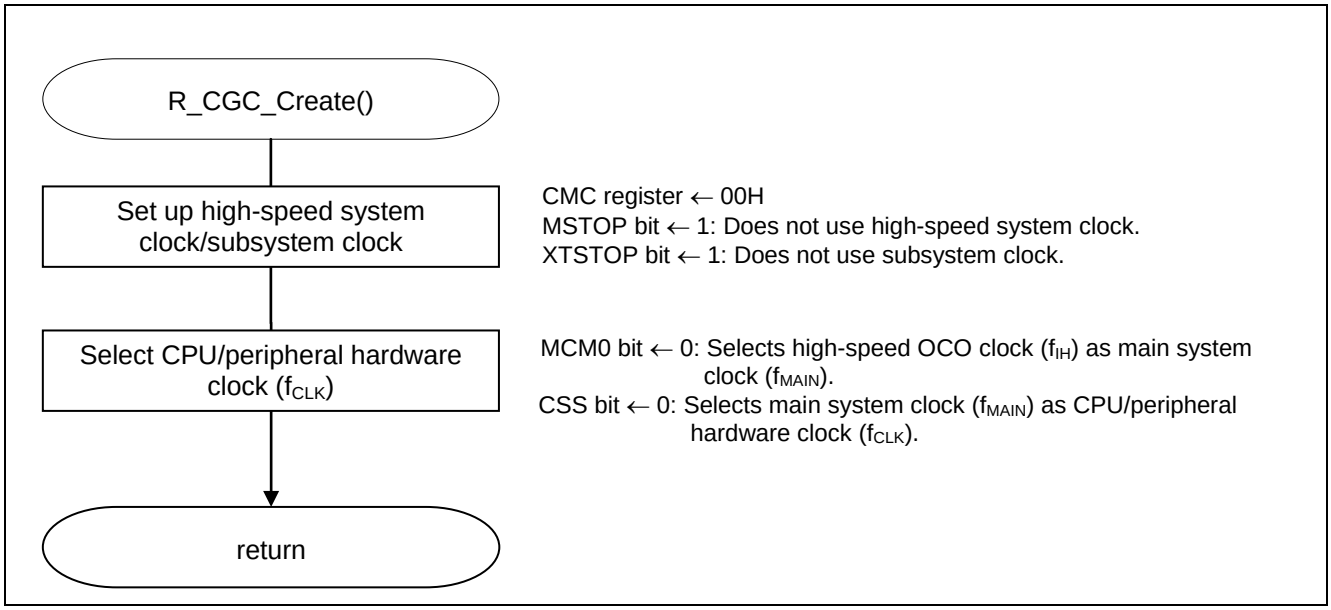


Figure 6.6 CPU Clock Setup

Caution: For details on the procedure for setting up the CPU clock (R_CGC_Create ()), refer to the section entitled "Flowcharts" in RL78/G13 Initialization Application Note (R01AN1525EG0100).

6.6.5 INTP1 Initialization

Figure 6.7 shows the flowchart for INTP1 initialization.

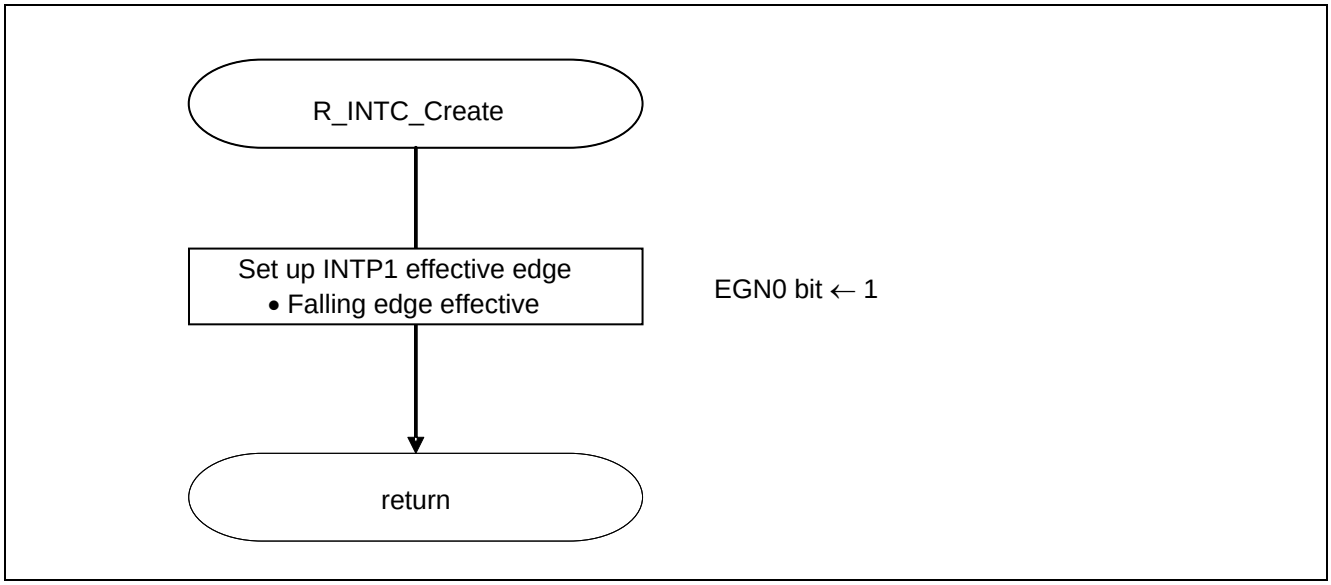


Figure 6.7 INTP1 Initialization

Setup for INTP1 pin edge detection

- External interrupt rising edge enable registers (EGP0, EGP1)
- External interrupt falling edge enable registers (EGN0, EGN1)

These registers are used to set up effective edges for INTP1 to INTP11

Symbol: EGP0

7	6	5	4	3	2	1	0
EGP7	EGP6	EGP5	EGP4	EGP3	EGP2	EGP1	EGP0
x	x	x	x	x	x	x	**0**

Symbol: EGN0

7	6	5	4	3	2	1	0
EGN7	EGN6	EGN5	EGN4	EGN3	EGN2	EGN1	EGN0
x	x	x	x	x	x	x	**1**

Bit 0

EGP0	EGN0	INTP1 pin valid edge selection
0	0	Edge detection disabled
0	**1**	**Falling edge**
1	0	Rising edge
1	1	Both rising and falling edges

Caution: For detailed information about setting the registers, refer to RL78/G13 User's Manual: Hardware.

6.6.6 Main Processing

Figure 6.8 shows the flowchart for main processing.

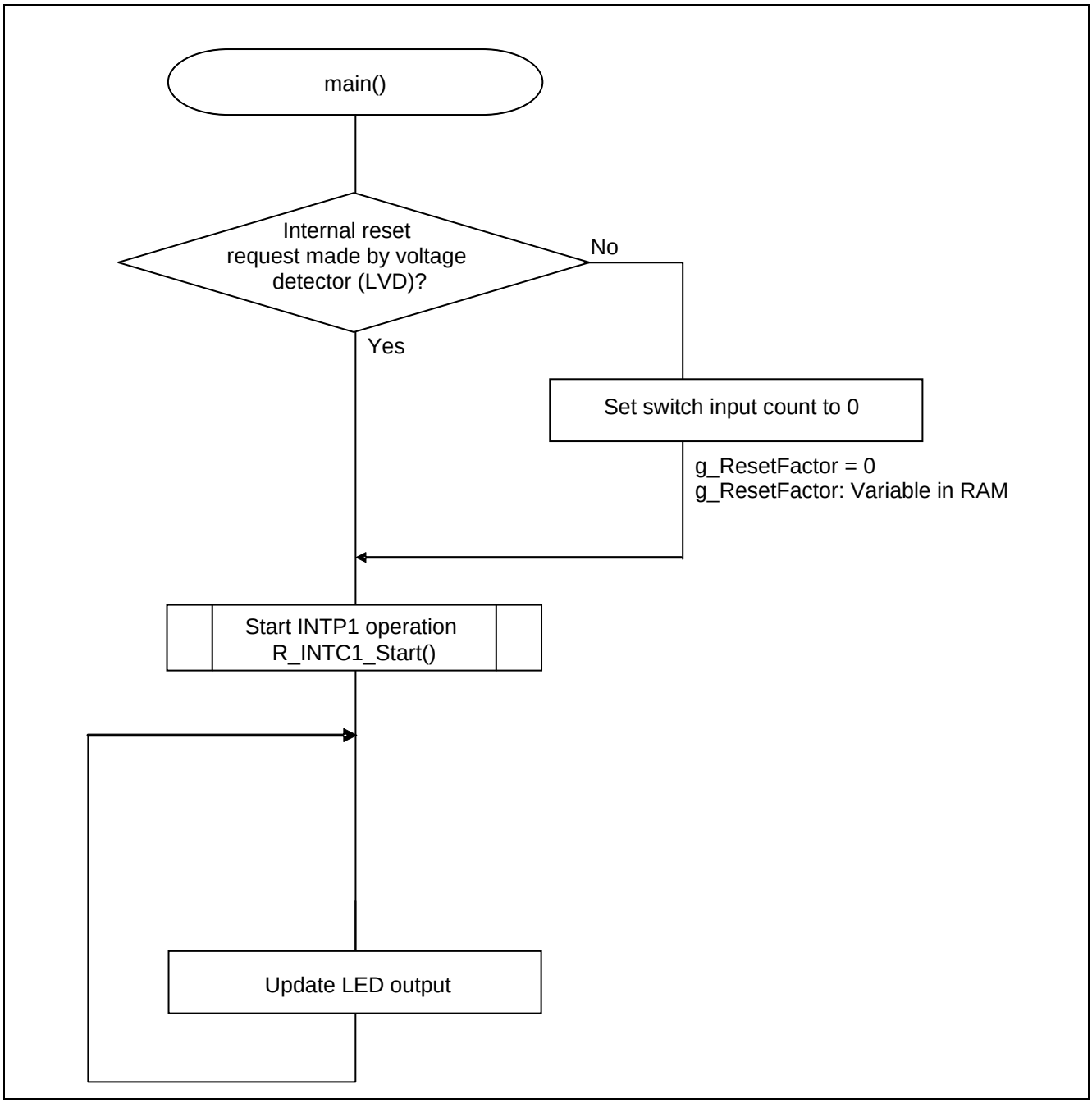


Figure 6.8 Main Processing

6.6.7 INTP1 Operation Start

Figure 6.9 shows the flowchart for starting INTP1 operation.

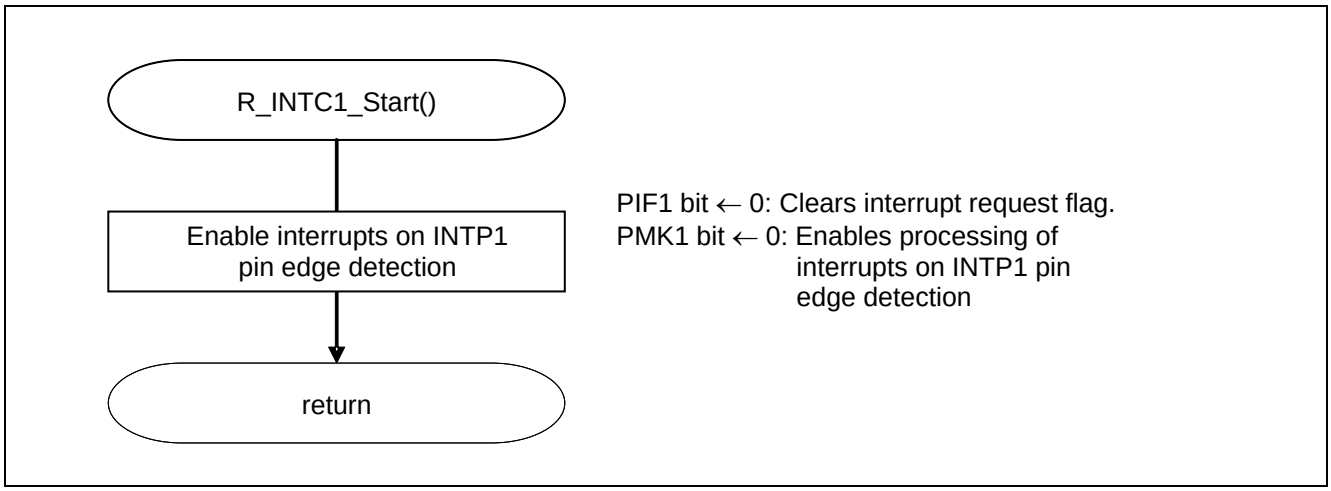


Figure 6.9 INTP1 Operation Start

Setup for INTP1 Interrupts

- Interrupt request flag register (IF1L)
  Clears interrupt request flag.
- Interrupt mask flag register (MK1L)
  Clears interrupt mask.

Symbol: IF0L

7	6	5	4	3	2	1	0
PIF5	PIF4	PIF3	PIF2	PIF1	PIF0	LVIIF	WDTIIF
x	x	x	x	**0**	x	x	x

Bit 2

PIF1	Interrupt request flag
0	**No interrupt request signal is generated**
1	Interrupt request signal is generated, interrupt request status

Symbol: MK0L

7	6	5	4	3	2	1	0
PMK5	PMK4	PMK3	PMK2	PMK1	PMK0	LVIMK	WDTIMK
x	x	x	x	**0**	x	x	x

Bit 2

PMK1	Interrupt processing control
0	**Interrupt processing enabled**
1	Interrupt processing disabled

Caution: For detailed information about setting the registers, see RL78/G13 User's Manual: Hardware.

6.6.8 INTP1 Interrupt Processing

Figure 6.10 shows the flowchart for INTP1 interrupt processing.

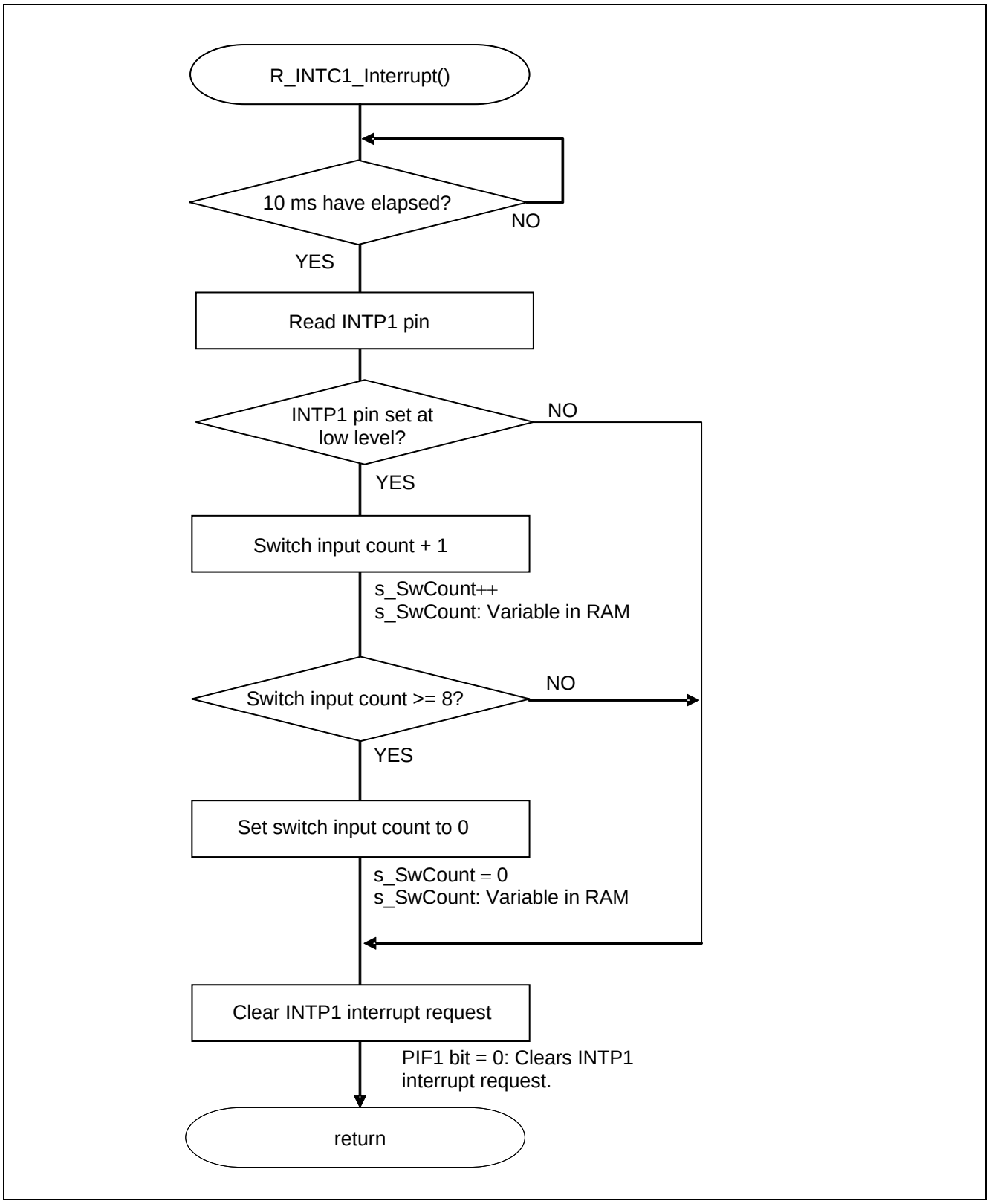


Figure 6.10 INTP1 Interrupt Processing

7. Sample 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.

8. Code Execution

1. Connect a 5.0V regulated variable power supply to the RSK.
2. Set the voltage level to 5.0V. Turn on the power supply.
3. Open the file 'vector_table.c' and check the option byte for rising/falling edge detection is set. LVD reset mode option byte should be set to 0x7F hex value at address 000C1H / 010C1H to configure V_{LVI} (see **Table 6.1** Option Byte Settings).
4. Build and download the sample code to the RSK.
   From the debug perspective, click the ‘Resume’ button to start program execution.
5. Press SW1 repeatedly and observe the LEDs counting in binary from 0 to 7.
6. When the power supply falls below V_{LVI} (approx. 2.8V), the internal reset is generated and after reset is ended the LEDs should indicate the same state as before reset.
7. When the power supply falls below V_{POR} (approx. 1.7V), the power-on-reset is generated and after reset is ended all LEDs should be off.

9. Documents for Reference

RL78/G13 User's Manual: Hardware Rev.1.00 (R01UH0146EJ0100)

RL78 Family User's Manual: Software Rev.1.00 (R01US0015EJ0100)

RL78/G13 Renesas Starter Kit User’s Manual Rev.1.00 (R20UT0459EG0100)

Technical Updates/Technical Brochures

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

Website, Inquiries and Support

Renesas Electronics Website
http://www.renesas.com/

Inquiries
http://www.renesas.com/contact/

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. 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.

—

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

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 of these circuits, software, and information in the design of your equipment. Renesas Electronics assumes no responsibility for any losses incurred by you or third parties arising from the use of these circuits, software, or information.
2. Renesas Electronics has used reasonable care in preparing the information included in this document, but Renesas Electronics does not warrant that such information is error free. Renesas Electronics assumes no liability whatsoever for any damages incurred by you resulting from errors in or omissions from the information included herein.
3. Renesas Electronics does not assume any liability for infringement of 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. 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 should not alter, modify, copy, or otherwise misappropriate any Renesas Electronics product, whether in whole or in part. Renesas Electronics assumes no responsibility for any losses incurred by you or third parties arising from such alteration, modification, copy or otherwise misappropriation of Renesas Electronics product.
5. Renesas Electronics products are classified according to the following two quality grades: "Standard" and "High Quality". The recommended 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 systems; anti-disaster systems; anti-crime systems; and safety 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 (nuclear reactor control systems, military equipment etc.). You must check the quality grade of each Renesas Electronics product before using it in a particular application. You may not use any Renesas Electronics product for any application for which it is not intended. Renesas Electronics shall not be in any way liable 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. You should use the Renesas Electronics products described in this document within the range specified by Renesas Electronics, especially with respect to the maximum rating, operating supply voltage range, movement power voltage range, heat radiation characteristics, installation and other product characteristics. Renesas Electronics shall have no liability for malfunctions or damages 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 its products, semiconductor products have specific characteristics such as the occurrence of failure at a certain rate and malfunctions under certain use conditions. Further, Renesas Electronics products are not subject to radiation resistance design. Please be sure to implement safety measures to guard them against the possibility of physical injury, and injury or damage caused by fire in the event of the failure of a Renesas Electronics product, 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, 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 use Renesas Electronics products in compliance with all applicable laws and regulations that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive. Renesas Electronics assumes no liability for damages or losses occurring as a result of your noncompliance with applicable laws and regulations.
9. Renesas Electronics products and technology may 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 should not use Renesas Electronics products or technology described in this document for any purpose relating to military applications or use by the military, including but not limited to the development of weapons of mass destruction. When exporting the Renesas Electronics products or technology described in this document, you should comply with the applicable export control laws and regulations and follow the procedures required by such laws and regulations.
10. It is the responsibility of the buyer or distributor of Renesas Electronics products, who distributes, disposes of, or otherwise places the product with a third party, to notify such third party in advance of the contents and conditions set forth in this document, Renesas Electronics assumes no responsibility for any losses incurred by you or third parties as a result of unauthorized use of Renesas Electronics products.
11. This document may not be 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, or if you have any other inquiries.

(Note 1) "Renesas Electronics" as used in this document means Renesas Electronics Corporation and also includes its majority-owned subsidiaries.

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

RENESAS

SALES OFFICES

Renesas Electronics Corporation

http://www.renesas.com

Refer to "http://www.renesas.com/" for the latest and detailed information.

Renesas Electronics America Inc.
2880 Scott Boulevard Santa Clara, CA 95050-2554, U.S.A.
Tel: +1-408-588-6000, Fax: +1-408-588-6130

Renesas Electronics Canada Limited
1101 Nicholson Road, Newmarket, Ontario L3Y 9C3, Canada
Tel: +1-905-898-5441, Fax: +1-905-898-3220

Renesas Electronics Europe Limited
Dukes Meadow, Millboard Road, Bourne End, Buckinghamshire, SL8 5FH, U.K
Tel: +44-1628-651-700, Fax: +44-1628-651-804

Renesas Electronics Europe GmbH
Arcadiastrasse 10, 40472 Düsseldorf, Germany
Tel: +49-211-65030, Fax: +49-211-6503-1327

Renesas Electronics (China) Co., Ltd.
7th Floor, Quantum Plaza, No.27 ZhiChunLu Haidian District, Beijing 100083, P.R.China
Tel: +86-10-8235-1155, Fax: +86-10-8235-7679

Renesas Electronics (Shanghai) Co., Ltd.
Unit 204, 205, AZIA Center, No.1233 Lujiazui Ring Rd., Pudong District, Shanghai 200120, China
Tel: +86-21-5877-1818, Fax: +86-21-6887-7858 / -7898

Renesas Electronics Hong Kong Limited
Unit 1601-1613, 16/F., Tower 2, Grand Century Place, 193 Prince Edward Road West, Mongkok, Kowloon, Hong Kong
Tel: +852-2886-9318, Fax: +852 2886-9022/9044

Renesas Electronics Taiwan Co., Ltd.
13F, No. 363, Fu Shing North Road, Taipei, Taiwan
Tel: +886-2-8175-9600, Fax: +886 2-8175-9670

Renesas Electronics Singapore Pte. Ltd.
80 Bendemeer Road, Unit #06-02 Hyflux Innovation Centre Singapore 339949
Tel: +65-6213-0200, Fax: +65-6213-0300

Renesas Electronics Malaysia Sdn.Bhd.
Unit 906, Block B, Menara Amcorp, Amcorp Trade Centre, No. 18, Jln Persiaran Barat, 46050 Petaling Jaya, Selangor Darul Ehsan, Malaysia
Tel: +60-3-7955-9390, Fax: +60-3-7955-9510

Renesas Electronics Korea Co., Ltd.
11F., Samik Lavied' or Bldg., 720-2 Yeoksam-Dong, Kangnam-Ku, Seoul 135-080, Korea
Tel: +82-2-558-3737, Fax: +82-2-558-5141

Colophon 2.2