RL78/L13

How to Retain Data When Determining Reset Source and the Supply Voltage is Below the LVD Level CC-RL

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Abstract

This document describes how to retain data (values in registers associated with the high-accuracy real-time clock) when determining the RL78/L13 reset source and the supply voltage is below the LVD level.

Products

RL78/L13

When using this application note with other Renesas MCUs, careful evaluation is recommended after making modifications to comply with the alternate MCU.

Contents

1. Specifications

In this application note, RL78/L13 is used to determine if it retains values for registers associated with the high-accuracy real-time clock (RTC) as the reset source when it is reset.

The relationship between the reset source and registers associated with the RTC are as follows;

- When RL78/L13 is reset by the voltage detector (LVD): Values for registers associated with the RTC are retained
- When RL78/L13 is reset by a source other than the LVD: Values for registers associated with the RTC are initialized

Table 1.1 lists the peripheral functions and their applications. Figure 1.1 shows the operation overview of supply voltage shift and data retention.

Table 1.1 Peripheral Functions and Their Applications

Peripheral Function	Application
Reset function	Determines the reset source
LVD	Detects a decrease in supply voltage (V_{DD})
RTC	Counts years, months, days of the week, days, hours, minutes, and seconds
LCD controller/driver (Note)	Controls the LCD panel
12-bit interval timer (IT) (Note)	Generates a 10 ms wait time to prevent switch chattering
External interrupt INTP0 (Note)	Detects input from the UP switch and increments the hours and minutes displayed on the LCD
External interrupt INTP7 (Note)	Detects input from the SET switch and enters hour setting mode or minute setting mode

Note: For more information on these functions, refer to the reference application note.

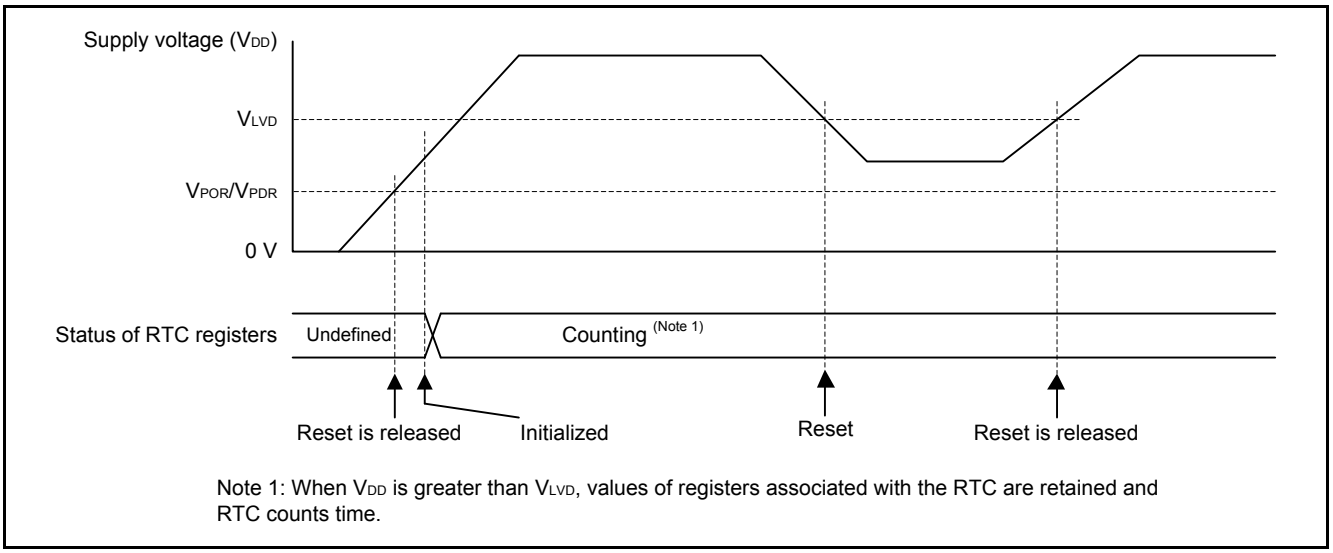


Figure 1.1 Operation Overview of Supply Voltage Shift and Data Retention

2. Operation Confirmation Conditions

The sample code accompanying this application note has been run and confirmed under the conditions below.

Table 2.1 Operation Confirmation Conditions

Item	Contents
MCU used	RL78/L13 (R5F10WMGA)
Operating frequencies	• High-speed on-chip oscillator clock (f_{HOCO}): 24 MHz (typ.) • CPU/peripheral hardware clock (f_{CLK}): 24 MHz • RTC/IT/LCD operating clock (f_{SUB}): 32.768 kHz
Operating voltage	5.0 V (operation possible from 2.9 to 5.5 V) LVD operation (V_{LVD}) in reset mode is 2.81 V at the rising edge or 2.75 V at the falling edge.
Integrated development environment(CS+)	CS+ for CC V3.01.00 from Renesas Electronics Corp.
C compiler(CS+)	CC-RL V1.01.00 from Renesas Electronics Corp.
Integrated development environment(e^2studio)	e^2studio V4.2.0.012 from Renesas Electronics Corp.
C compiler(e^2studio)	CC-RL V1.01.00 from Renesas Electronics Corp.
RL78/L13 code library	RL78/L13 code library V1.03.02.01 from Renesas Electronics Corp.
Board used	Renesas Starter Kit for RL78/L13 CPU board (R0K5010WMC001BR)

3. Reference Application Note

For additional information associated with this document, refer to the following application note.

- RL78/L13 24-Hour Clock Displayed on an LCD (document number: R01AN3135EJ0100)

4. Hardware

For details on hardware configuration and pins used, refer to the reference application note.

5. Software

As the sample code is created by editing the functions generated by the RL78/L13 code library, the code generator property has been modified. Figure 5.1 shows the code generator property setting.

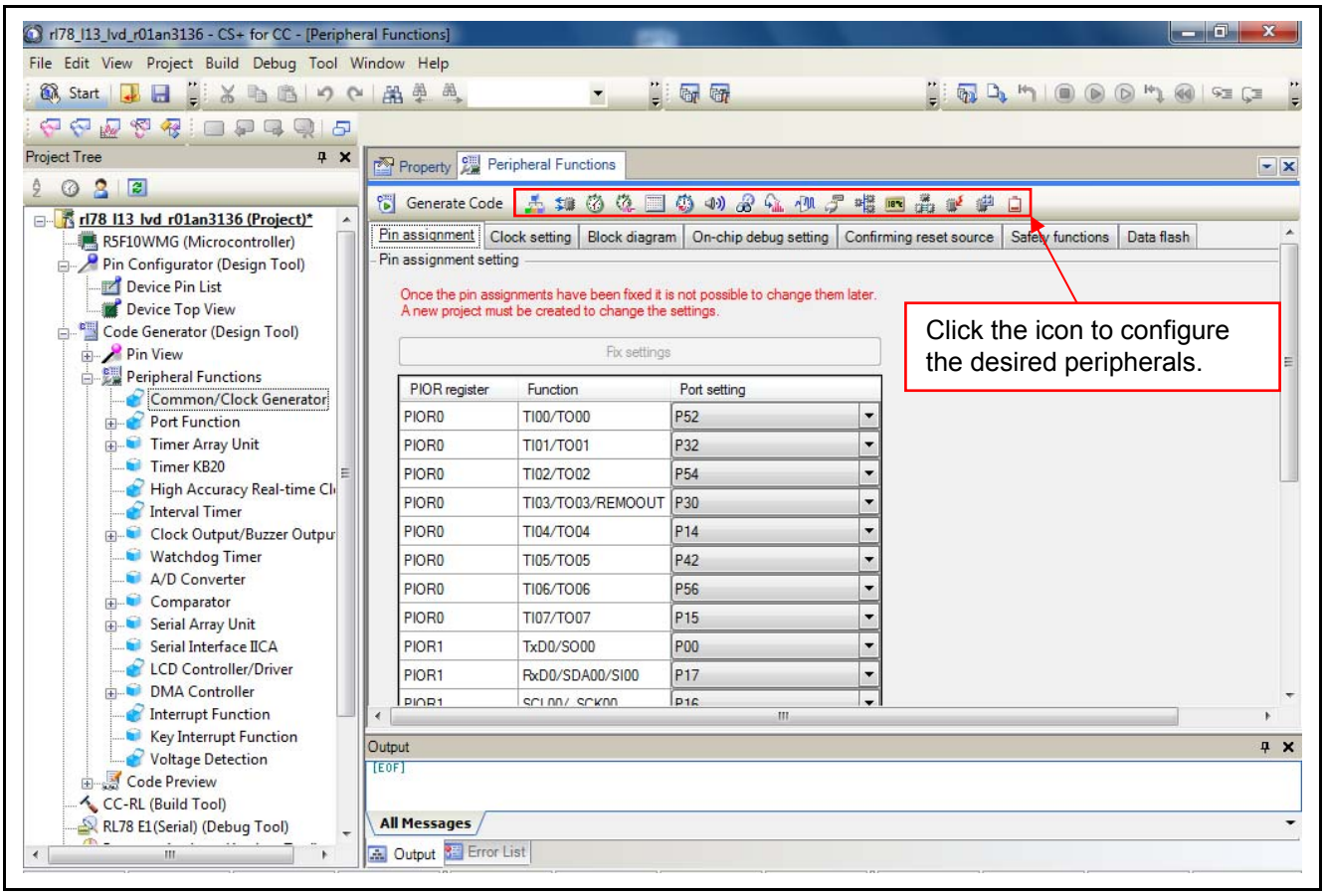


Figure 5.1 Code Generator Property Setting

5.1 Operation Overview

When RL78/L13 is reset, it determines source of the reset, and then determines whether or not to initialize the registers associated with the RTC based on that source. If RL78/L13 determines the source of the reset was the LVD, the register values are not initialized and the value set before the reset is retained; if the source of the reset was something other than the LVD, the RTC registers are initialized.

The LVD generates a reset when it detects the decrease in voltage (V_{DD} is less than V_{LVD}), and releases the reset when it detects the increase in voltage (V_{DD} is greater than or equal to V_{LVD}).

Settings for the peripheral functions are listed below.

LVD

- Set LVD in reset mode
- Set the detection voltage (V_{LVD}) as 2.75 V at the rising edge and 2.81 V at the falling edge

Reset Source

- Determines the internal reset by LVD (LVIRF bit = 1)
- Power-on reset (POR) clears the RESF register.

RTC

- The RTC is operable when RL78/L13 is reset by the LVD (reset other than POR). The table below lists the status of the register value for each reset source.

For details about settings, refer to the reference application note.

Reset Sources	System Registers (Note 1)	Calendar Registers (Note 2)
POR	Reset	Not reset
External reset	Retained	Retained
Watchdog timer	Retained	Retained
Illegal instruction execution	Retained	Retained
LVD	Retained	Retained
Other internal resets	Retained	Retained

Notes: 1. RTCC0, RTCC1, SUBCUD
2. SEC, MIN, HOUR, DAY, WEEK, MONTH, YEAR, ALARMWM, ALARMWH, ALARMWW (counters)

Figure 5.2 shows the supply voltage shift and RTC status.

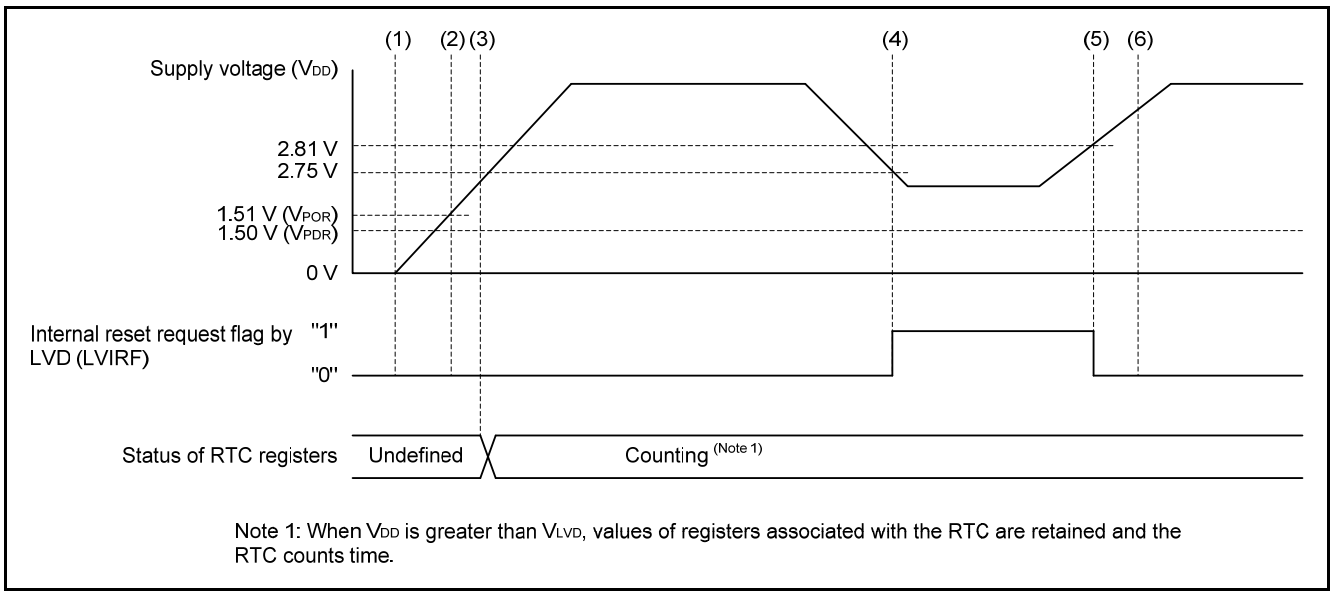


Figure 5.2 Operation Overview of Supply Voltage Shift and RTC Status

(1) Power-on

(2) Reset release

RTC system registers are reset, however, RTC calendar registers are not reset. The LVIRF bit in the RESF register is cleared by POR.

(3) Register initialization

Initializes the registers associated with the peripheral functions used. RTC counter values (HOUR, MIN) are displayed on the LCD.

(4) A reset is generated by a reduction in voltage (V_{DD} is less than V_{LVD}). RTC register value continues to count.

(5) The reset is released by an increase in voltage (V_{DD} is greater than or equal to V_{LVD}).

When voltage increases, reset is released and CPU restarts.

The LVIRF bit is cleared by reading the RESF register. The LVIRF bit status is stored in a variable.

(6) Register initialization

Initializes the registers associated with the peripheral functions used (as the LVIRF bit stored in step 5 is 1, registers associated with the RTC are not initialized). RTC counter values (HOUR, MIN) are displayed on the LCD.

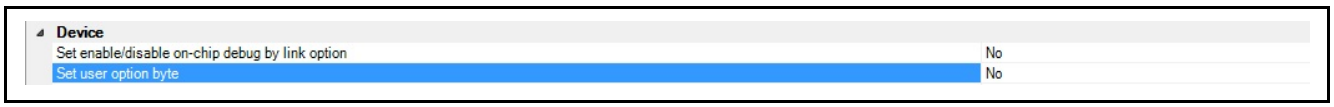
5.2 Option Byte Settings

Table 5.1 lists the option byte settings. Option bytes are set in the opt.asm file.

Table 5.1 Option Byte Settings

Address	Setting Value	Contents
000C0H/010C0H	01101110B	Stops the watchdog timer (counting is stopped when a reset is released)
000C1H/010C1H	01111111B	Sets the LVD in reset mode Detection voltage: 2.81 V at the rising edge, 2.75 V at the falling edge
000C2H/010C2H	11100000B	Sets the high-speed on-chip oscillator clock to 24 MHz in HS (high-speed main) mode
000C3H/010C3H	10000100B	Enables on-chip debugging

User option bytes can also be specified in the [Device] category of the [Link Options] tab. As the link option setting is prior to settings in the program, select [No] in the [Set user option byte] property.



Note: To learn more on how to set Link Options in CS+, refer to the CS+ Tutorial manual.

5.3 Constants

For more information about constants used in the sample program, refer to the reference application note.

5.4 Variable

Table 5.2 lists the global variable. To learn more on other variables, refer to the reference application note.

Table 5.2 Global Variable

Type	Variable Name	Contents	Function Used
uint8_t	lvd_detect	LVD detect information (note)	R_CGC_Get_ResetSource R_RTC_Create

Note: This setting value can only be referred in the R_Systeminit function. As variables are initialized after executing the R_Systeminit function, the setting value cannot be referred.

5.5 Functions

Table 5.3 lists the functions. For more information about other functions, refer to the reference application note.

Table 5.3 Functions

Function Name	Outline
hdwinit	Initialization
R_Systeminit	Peripheral function initialization
R_CGC_Get_ResetSource	Reset source retrieval
R_RTC_Create	RTC initialization

5.6 Function Specifications

The following tables list the sample code function specifications. For more information about other function specifications, refer to the reference application note.

hdwinit	
Outline	Initialization
Header	None
Declaration	void hdwinit(void)
Description	Initializes the peripheral functions.
Arguments	None
Return Value	None

R_Systeminit	
Outline	Peripheral function initialization
Header	None
Declaration	void R_Systeminit(void)
Description	Initializes the peripheral functions used in this application note.
Arguments	None
Return Value	None

R_CGC_Get_ResetSource	
Outline	Reset source retrieval
Header	r_cg_cgc.h
Declaration	void R_CGC_Get_ResetSource(void)
Description	Determines if a reset is generated by the LVD or not. When a reset request is generated by the LVD, 1 is set to the variable lvd_detect. 0 is set to the variable when other resets are generated.
Arguments	None
Return Value	None

R_RTC_Create	
Outline	RTC initialization
Header	r_cg_rtc.h
Declaration	void R_RTC_Create(void)
Description	The RTC is configured depending on the value in the variable lvd_detect.
Arguments	None
Return Value	None

5.7 Flowcharts

5.7.1 Overall Flowchart

Figure 5.3 shows the overall flowchart.

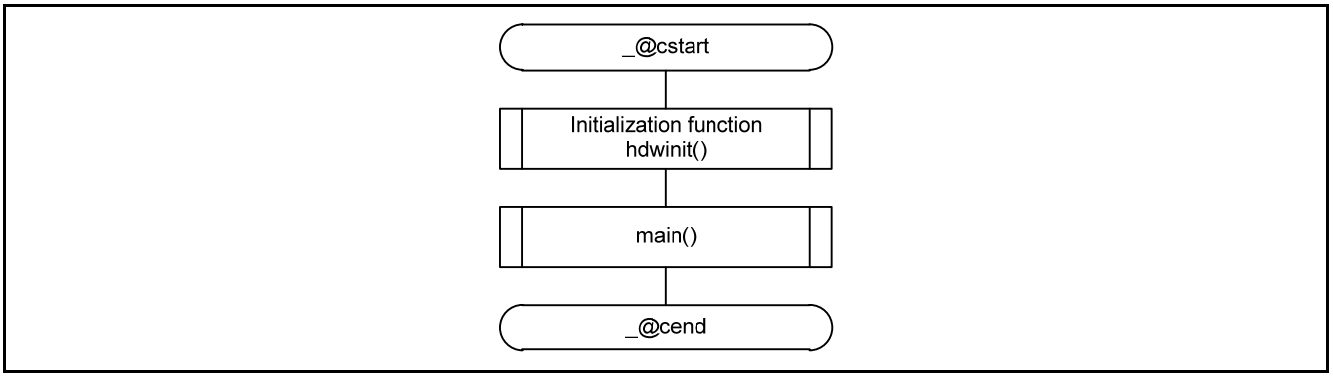


Figure 5.3 Overall Flowchart

5.7.2 Initialization

Figure 5.4 shows the initialization.

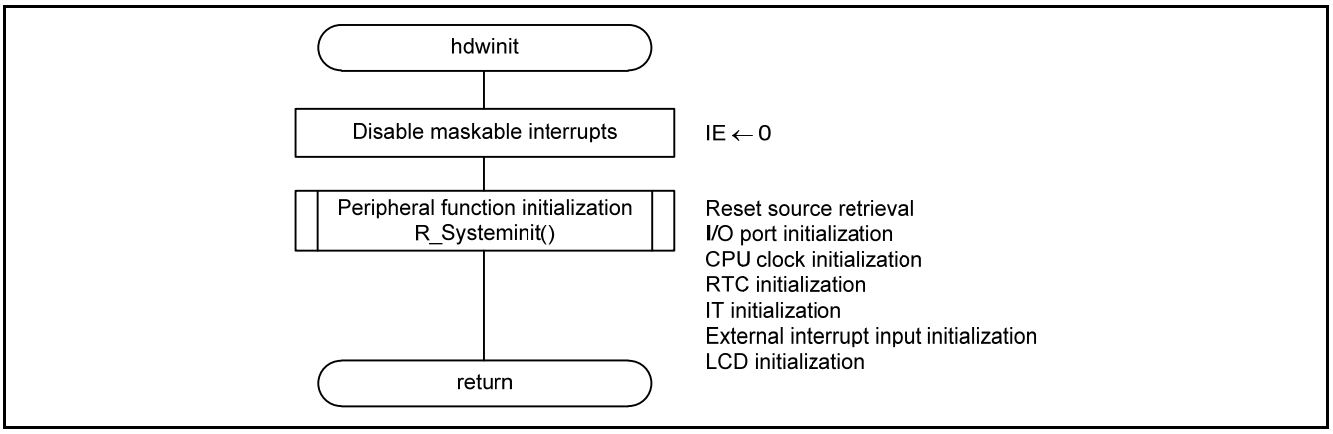


Figure 5.4 Initialization

5.7.3 Peripheral Function Initialization

Figure 5.5 shows the peripheral function initialization.

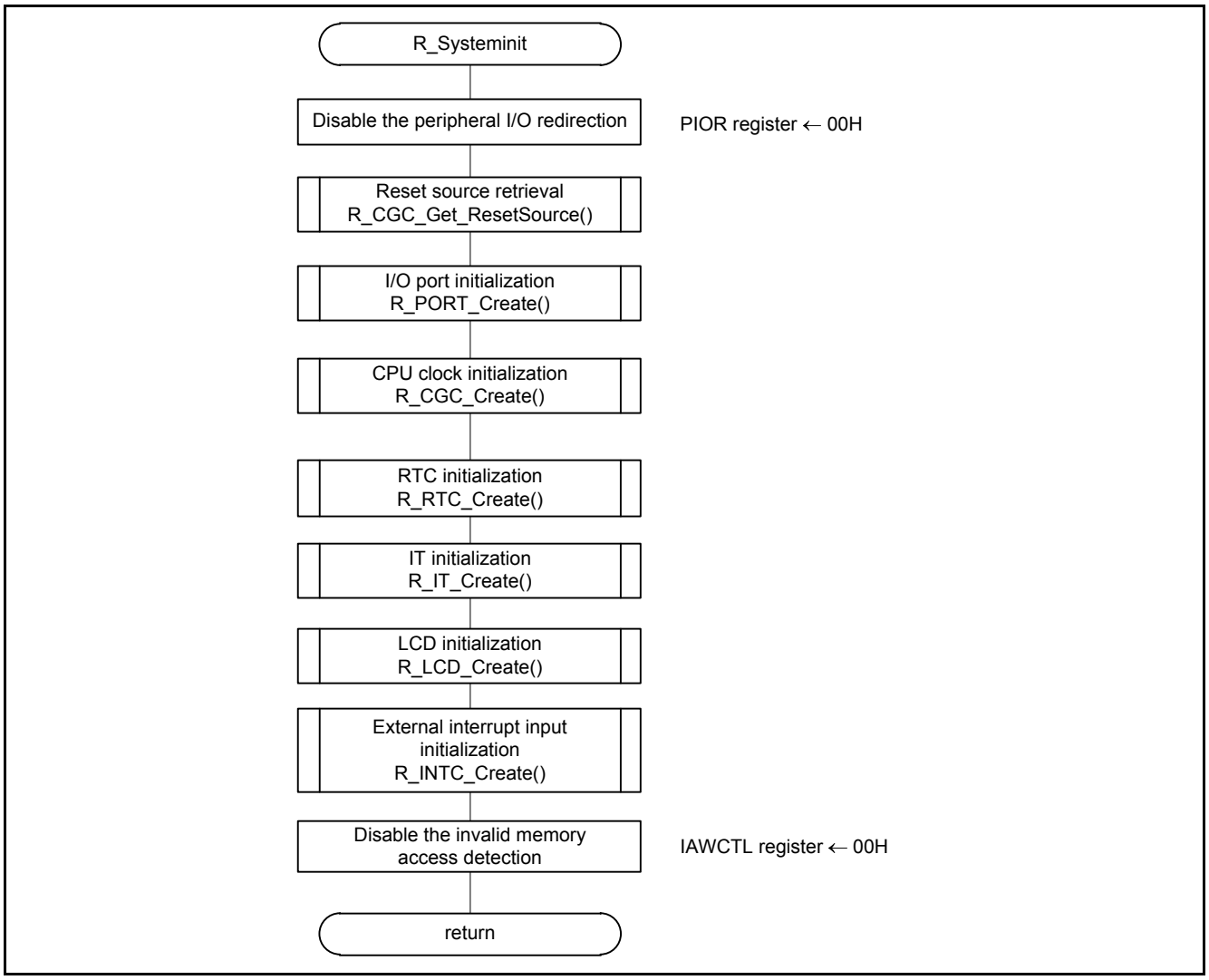


Figure 5.5 Peripheral Function Initialization

5.7.4 Reset Source Retrieval

Figure 5.6 show the reset source retrieval.

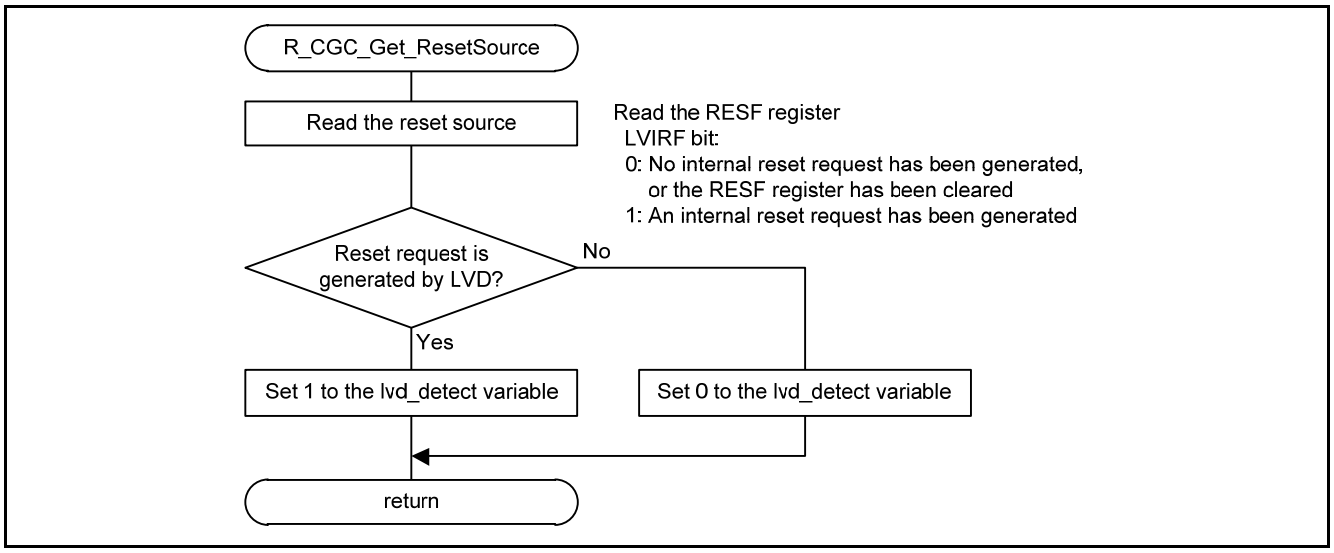


Figure 5.6 Reset Source Retrieval

Reading the Reset Source

- Reset control flag register (RESF)

Symbol	7	6	5	4	3	2	1	0
RESF	TRAP	0	0	WDTRF	0	RPERF	IAWRF	**LVIRF**

- Bit 0

LVIRF bit	Internal reset request by voltage detector (LVD)
0	No internal reset request has been generated, or the RESF register has been cleared.
1	An internal reset request has been generated.

For details on register setting, refer to the RL78/L13 User's Manual: Hardware.

5.7.5 RTC Initialization

Figure 5.7 shows the RTC initialization.

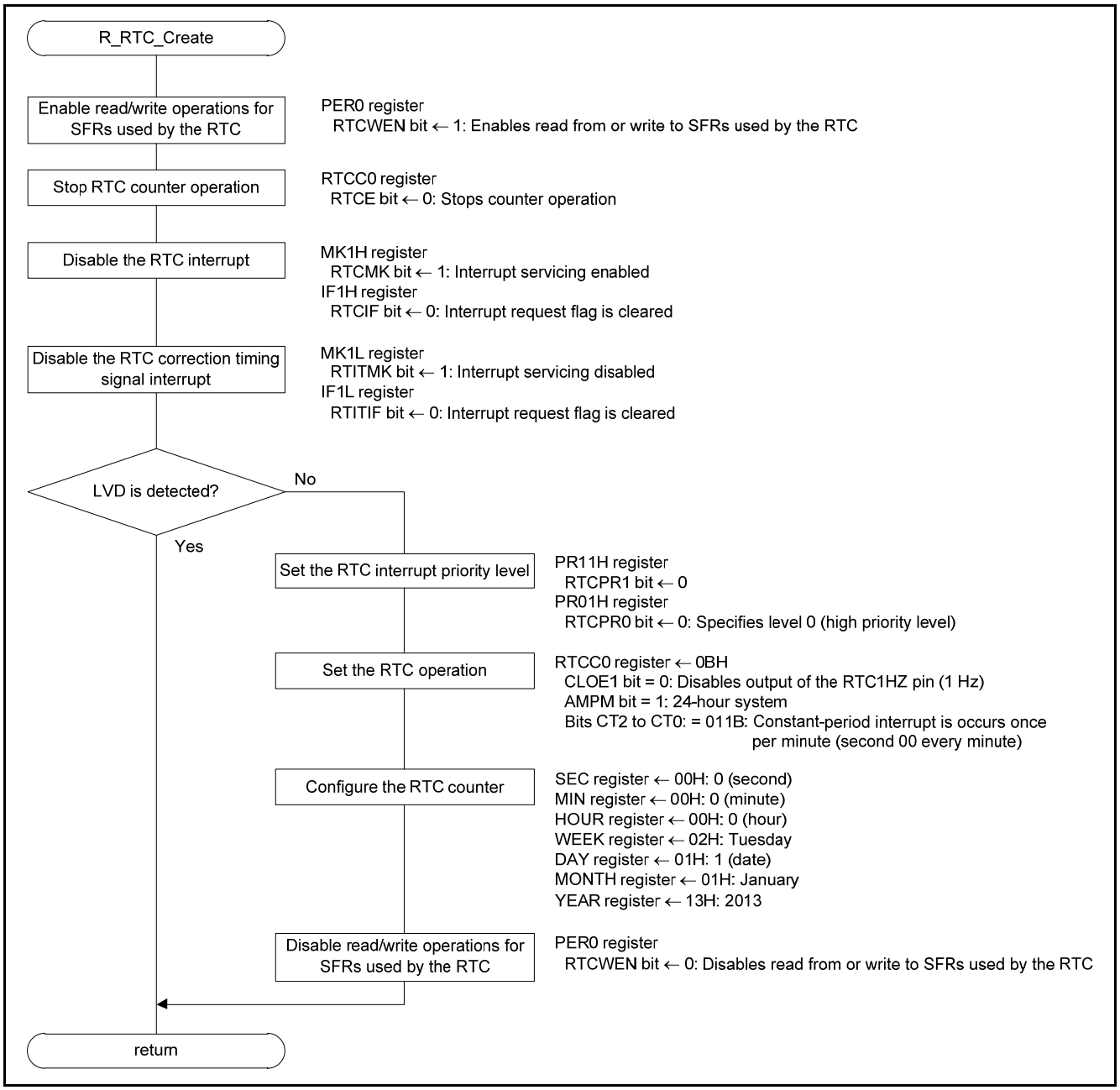


Figure 5.7 RTC Initialization

Enabling read and write operations for SFRs used by the RTC

- Peripheral enable register 0 (PER0)

Symbol	7	6	5	4	3	2	1	0
PER0	**RTCWEN**	0	ADCEN	IICA0EN	SAU1EN	SAU0EN	0	TAU0EN
Value	**1**	–	×	×	×	×	–	×

- Bit 7

RTCWEN bit	Control of input clock supply to high-accuracy real-time clock
0	Stops input clock supply • SFRs used by the high-accuracy real-time clock cannot be written • The high-accuracy real-time clock can operate
1	Enables input clock supply • SFRs used by the high-accuracy real-time clock can be read/written • The high-accuracy real-time clock (RTC) can operate

Stopping RTC counter operation

- Real-time clock control register 0 (RTCC0)

Symbol	7	6	5	4	3	2	1	0
RTCC0	**RTCE**	0	CLOE1	0	AMPM	CT2	CT1	CT0
Value	**0**	–		–				

- Bit 7

RTCE bit	High-accuracy real-time clock operation control
0	Stops counter operation
1	Starts counter operation

For details on register setting, refer to the RL78/L13 User's Manual: Hardware.

Legend symbol:

×: Unused bit; blank cell: unchanged bit; –: reserved bit or unallocated bit

Disabling the RTC interrupt

- Interrupt mask flag register (MK1H)

Symbol	7	6	5	4	3	2	1	0
MK1H	SRMK3	STMK3	KRMK	TMKAMK	**RTCMK**	ADMK	TMMK03	TMMK02
Value	×	×	×	×	**1**	×	×	×

- Bit 3

RTCMK bit	Interrupt servicing control
0	Interrupt servicing enabled
1	Interrupt servicing disabled

- Interrupt request flag register (IF1H)

Symbol	7	6	5	4	3	2	1	0
IF1H	SRIF3	STIF3	KRIF	TMKAIF	**RTCIF**	ADIF	TMIF03	TMIF02
Value	×	×	×	×	**0**	×	×	×

- Bit 3

RTCIF bit	Interrupt request flag
0	No interrupt request signal is generated
1	Interrupt request signal is generated, interrupt request status

For details on register setting, refer to the RL78/L13 User's Manual: Hardware.

Legend symbol:

×: Unused bit; blank cell: unchanged bit; –: reserved bit or unallocated bit

Disabling the RTC correction timing signal interrupt

- Interrupt mask flag register (MK1L)

Symbol	7	6	5	4	3	2	1	0
MK1L	TMMK01	1	**RTITMK**	IICAMK0	SREMK1 TMMK03H	SRMK1	STMK1 CSIMK10 IICMK10	SREMK0 TMMK01H
Value	×	–	**1**	×	×	×	×	×

- Bit 5

RTITMK bit	Interrupt servicing control
0	Interrupt servicing enabled
1	Interrupt servicing disabled

- Interrupt request flag register (IF1L)

Symbol	7	6	5	4	3	2	1	0
IF1L	TMIF01	0	**RTITIF**	IICAIF0	SREIF1 TMIF03H	SRIF1	STIF1 CSIIF10 IICIF10	SREIF0 TMIF01H
Value	×	–	**0**	×	×	×	×	×

- Bit 5

RTITIF bit	Interrupt request flag
0	No interrupt request signal is generated
1	Interrupt request signal is generated, interrupt request status

For details on register setting, refer to the RL78/L13 User's Manual: Hardware.

Legend symbol:

×: Unused bit; blank cell: unchanged bit; –: reserved bit or unallocated bit

Setting the RTC interrupt priority level

- Priority specification flag registers (PR11H, PR01H)

Symbol	7	6	5	4	3	2	1	0
PR11H	SRPR13	STPR13	KRPR1	TMKAPR1	**RTCPR1**	ADPR1	TMPR103	TMPR102
Value	×	×	×	×	**0**	×	×	×

Symbol	7	6	5	4	3	2	1	0
PR01H	SRPR03	STPR03	KRPR0	TMKAPR0	**RTCPR0**	ADPR0	TMPR003	TMPR002
Value	×	×	×	×	**0**	×	×	×

- Bit 3

RTCPR1 bit	RTCPR0 bit	Priority level selection
0	0	Specifies level 0 (high priority)
0	1	Specifies level 1
1	0	Specifies level 2
1	1	Specifies level 3 (low priority)

Setting the RTC operation

- Real-time clock control register 0 (RTCC0)
  - Output signals from the RTC1HZ pin: Disabled
  - 12-hour or 24-hour system: 24-hour system
  - Constant-period interrupt function: Once per minute (second 00 every minute)

Symbol	7	6	5	4	3	2	1	0
RTCC0	RTCE	0	**CLOE1**	0	**AMPM**	**CT2**	**CT1**	**CT0**
Value		–	**0**	–	**1**	**0**	**0**	**0**

- Bit 5

CLOE1 bit	RTC1HZ pin output control
0	Disables output of the RTC1HZ pin (1 Hz)
1	Enables output of the RTC1HZ pin (1 Hz)

- Bit 3

AMPM bit	12-/24-hour system select
0	12-hour system (a.m. and p.m. are displayed)
1	24-hour system

For details on register setting, refer to the RL78/L13 User's Manual: Hardware.

Legend symbol:

×: Unused bit; blank cell: unchanged bit; –: reserved bit or unallocated bit

- Bits 2 to 0

CT2 bit	CT1 bit	CT0 bit	Constant-period interrupt (INTRTC) selection
0	0	0	Does not use constant-period interrupt function
0	0	1	Once per 0.5 seconds (synchronized with counting up seconds)
0	1	0	Once per second (same time as counting up seconds)
0	1	1	Once per minute (second 00 every minute)
1	0	0	Once per hour (minute 00 and second 00 every hour)
1	0	1	Once per day (hour 00, minute 00, and second 00 every day)
1	1	×	Once per month (date 1, hour 00 a.m., minute 00, and second 00 every month)

Configuring the RTC counter

- Second count register (SEC)
  Sets the seconds to 0.

Symbol	7	6	5	4	3	2	1	0
SEC	0	SEC40	SEC20	SEC10	SEC8	SEC4	SEC2	SEC1
Value	–	0	0	0	0	0	0	0

	Function
Bits 6 to 0	Specify a decimal value of 00 to 59 in BCD code

- Minute count register (MIN)
  Sets the minutes to 0.

Symbol	7	6	5	4	3	2	1	0
MIN	0	MIN40	MIN20	MIN10	MIN8	MIN4	MIN2	MIN1
Value	–	0	0	0	0	0	0	0

	Function
Bits 6 to 0	Specify a decimal value of 00 to 59 in BCD code

- Hour count register (HOUR)
  Sets the hours to 0.

Symbol	7	6	5	4	3	2	1	0
HOUR	0	0	HOUR20	HOUR10	HOUR8	HOUR4	HOUR2	HOUR1
Value	–	–	0	0	0	0	0	0

	Function
Bits 5 to 0	Specify a decimal value of 00 to 23, or 01 to 12 or 21 to 32 in BCD code

For details on register setting, refer to the RL78/L13 User's Manual: Hardware.

Legend symbol:

×: Unused bit; blank cell: unchanged bit; –: reserved bit or unallocated bit

- Day count register (DAY)
  Sets the date to 1.

Symbol	7	6	5	4	3	2	1	0
DAY	0	0	**DAY20**	**DAY10**	**DAY8**	**DAY4**	**DAY2**	**DAY1**
Value	–	–	**0**	**0**	**0**	**0**	**0**	**1**

	Function
Bits 5 to 0	Specify a decimal value of 01 to 31 in BCD code

- Week count register (WEEK)
  Sets the day of the week to Tuesday.

Symbol	7	6	5	4	3	2	1	0
WEEK	0	0	0	0	0	**WEEK4**	**WEEK2**	**WEEK1**
Value	–	–	–	–	–	**0**	**1**	**0**

	Function
Bits 2 to 0	Specify a decimal value of 00 to 06 in BCD code

- Month count register (MONTH)
  Sets the month to January.

Symbol	7	6	5	4	3	2	1	0
MONTH	0	0	0	**MONTH10**	**MONTH8**	**MONTH4**	**MONTH2**	**MONTH1**
Value	–	–	–	**0**	**0**	**0**	**0**	**1**

	Function
Bits 4 to 0	Specify a decimal value of 01 to 12 in BCD code

- Year count register (YEAR)
  Sets the year to 2013.

Symbol	7	6	5	4	3	2	1	0
YEAR	**YEAR80**	**YEAR40**	**YEAR20**	**YEAR10**	**YEAR8**	**YEAR4**	**YEAR2**	**YEAR1**
Value	**0**	**0**	**0**	**1**	**0**	**0**	**1**	**1**

	Function
Bits 7 to 0	Specify a decimal value of 00 to 99 in BCD code

For details on register setting, refer to the RL78/L13 User's Manual: Hardware.

Legend symbol:

×: Unused bit; blank cell: unchanged bit; –: reserved bit or unallocated bit

Disabling read and write operations for SFRs used by the RTC

- Peripheral enable register 0 (PER0)

Symbol	7	6	5	4	3	2	1	0
PER0	**RTCWEN**	0	ADCEN	IICA0EN	SAU1EN	SAU0EN	0	TAU0EN
Value	**0**	–	×	×	×	×	–	×

- Bit 7

RTCWEN bit	Control of input clock supply to high-accuracy real-time clock
0	Stops input clock supply • SFRs used by the high-accuracy real-time clock cannot be written • The high-accuracy real-time clock can operate
1	Enables input clock supply • SFRs used by the high-accuracy real-time clock can be read/written • The high-accuracy real-time clock can operate

For details on register setting, refer to the RL78/L13 User's Manual: Hardware.

Legend symbol:

×: Unused bit; blank cell: unchanged bit; –: reserved bit or unallocated bit

6. Sample Code

Sample code can be downloaded from the Renesas Electronics website.

7. Reference Documents

User's Manual: Hardware

RL78/L13 User's Manual: Hardware

RL78 Family User's Manual: Software

The latest versions can be downloaded from the Renesas Electronics website.

Technical Update/Technical News

The latest information can be downloaded from the Renesas Electronics website.

Website and Support

Renesas Electronics website

http://www.renesas.com

Inquiries

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

REVISION HISTORY	RL78/L13 How to Retain Data When Determining Reset Source and the Supply Voltage is Below the LVD Level CC-RL

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		Page	Summary
1.00	Feb. 19, 2016	—	First edition issued

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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. Handling of Unused Pins

   Handle unused pins in accordance with the directions given under Handling of Unused Pins in the manual.

   ¾ 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.

   ¾ 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.

   ¾ 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.

   ¾ 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 a product with a different part number, confirm that the change will not lead to problems.

   ¾ The characteristics of Microprocessing unit or Microcontroller unit products in the same group but having a different part number may differ in terms of the 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

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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
9251 Yonge Street, Suite 8309 Richmond Hill, Ontario Canada L4C 9T3
Tel: +1-905-237-2004

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

Renesas Electronics Europe GmbH
Arcadiastrasse 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 ZhiChunLu Haidian District, Beijing 100191, P.R.China
Tel: +86-10-8235-1155, Fax: +86-10-8235-7679

Renesas Electronics (Shanghai) Co., Ltd.
Unit 301, Tower A, Central Towers, 555 Langao Road, Putuo District, Shanghai, P. R. China 200333
Tel: +86-21-2226-0888, 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 2-8175-9670

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 1207, 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 India Pvt. Ltd.
No.777C, 100 Feet Road, HALII Stage, Indiranagar, Bangalore, India
Tel: +91-80-67208700, Fax: +91-80-67208777

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

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