To our customers,

Old Company Name in Catalogs and Other Documents

On April 1st, 2010, NEC Electronics Corporation merged with Renesas Technology Corporation, and Renesas Electronics Corporation took over all the business of both companies. Therefore, although the old company name remains in this document, it is a valid Renesas Electronics document. We appreciate your understanding.

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

April 1st, 2010
Renesas Electronics Corporation

Issued by: Renesas Electronics Corporation (http://www.renesas.com)

Send any inquiries to http://www.renesas.com/inquiry.

Notice

1. All information included in this document is current as of the date this document is issued. Such information, however, is subject to change without any prior notice. Before purchasing or using any Renesas Electronics products listed herein, please confirm the latest product information with a Renesas Electronics sales office. Also, please pay regular and careful attention to additional and different information to be disclosed by Renesas Electronics such as that disclosed through our website.
2. 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.
3. You should not alter, modify, copy, or otherwise misappropriate any Renesas Electronics product, whether in whole or in part.
4. 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.
5. When exporting the 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. You should not use Renesas Electronics products or the 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. 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.
6. 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.
7. Renesas Electronics products are classified according to the following three quality grades: "Standard", "High Quality", and "Specific". The recommended applications for each Renesas Electronics product depends on the product's quality grade, as indicated below. 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 categorized as "Specific" without the prior written consent of Renesas Electronics. Further, you may not use any Renesas Electronics product for any application for which it is not intended without the prior written consent of Renesas Electronics. 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 an application categorized as "Specific" or for which the product is not intended where you have failed to obtain the prior written consent of Renesas Electronics. The quality grade of each Renesas Electronics product is "Standard" unless otherwise expressly specified in a Renesas Electronics data sheets or data books, etc.

   "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.

   "High Quality": Transportation equipment (automobiles, trains, ships, etc.); traffic control systems; anti-disaster systems; anti-crime systems; safety equipment; and medical equipment not specifically designed for life support.

   "Specific": Aircraft; aerospace equipment; submersible repeaters; nuclear reactor control systems; medical equipment or systems for life support (e.g. artificial life support devices or systems), surgical implantations, or healthcare intervention (e.g. excision, etc.), and any other applications or purposes that pose a direct threat to human life.
8. 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.
9. 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 system manufactured by you.
10. 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.
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.

H8/300H Super Low Power Series

RAM Emulation Function

Introduction

This document explains emulation of flash memory using RAM of the H8/38099 Group.

Target Device

H8/38099F

Contents

1. Specifications

(1) The RAM emulation function of the H8/38099 Group is used.
(2) The user program active in the RAM emulation mode is transferred to the on-chip RAM area.
(3) The RAM overlay area is loaded with the interrupt vector addresses for the interrupts (RTC second interval interrupts) used in the RAM emulation mode.
(4) After the transfer of the user program is completed, the LED (LED0) connected to the P90 output pin is turned on and off at 0.5 s intervals using the on-chip RTC of the H8/38099 Group.
(5) When the switch (SW1) connected to the $\overline{\text{IRQ0}}$ input pin is pressed, control is transferred to the user program in the RAM to set the flash memory into the module standby mode.
(6) The user program running in the RAM turns on and off the LED (LED1) connected to the P91 output pin at one s intervals using the H8/38099 Group on-chip RTC.
(7) When the switch (SW3) connected to the $\overline{\text{IRQ3}}$ input pin is pressed, the flash memory's module standby mode is canceled. Subsequently, program process is returned to the program in the flash memory, which turns on and off the LED (LED0) connected to the P90 output pin at 0.5 s intervals.
(8) This program runs on the H8/38099 Group RSK (Renesas Starter Kit). Figure 1 shows the block diagram of the hardware that this program uses.

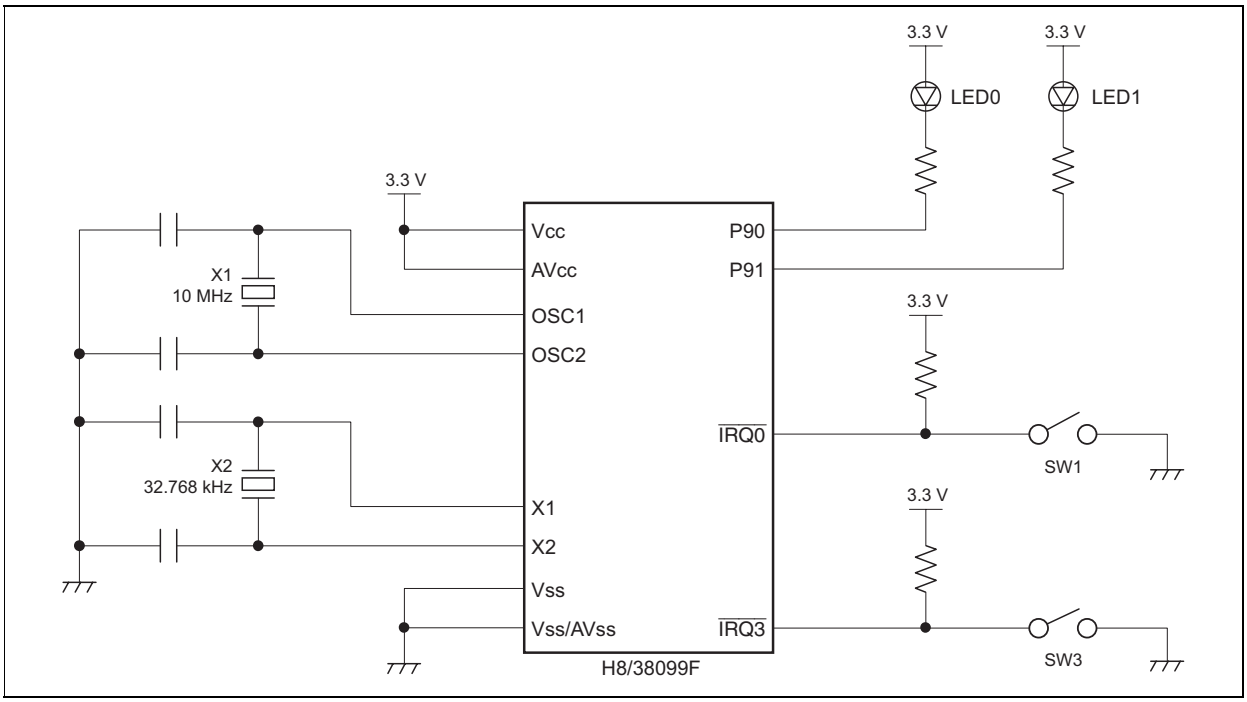

Figure 1 Hardware Block Diagram (Renesas Starter Kit for H8/38099)

2. Applicable Conditions

Table 1 summarizes the H8/38099 Group conditions applied to this task example.

Table 1 Applicable Conditions

Item	Description
System clock frequency	Crystal oscillator frequency: 10 MHz System clock (ϕ): 10 MHz
Subclock frequency	Crystal oscillator frequency: 32.768 kHz Subclock (ϕ_{SUB}): 32.768 kHz
Supply voltage	Vcc = AVcc = 3.3 V

3. Functional Description

3.1 RAM Emulation Function

The RAM emulation function can overlay part of the flash memory (emulation area) with the on-chip RAM.

Figure 2 shows the outline of the memory configuration in which the flash memory's emulation area and RAM overlay.

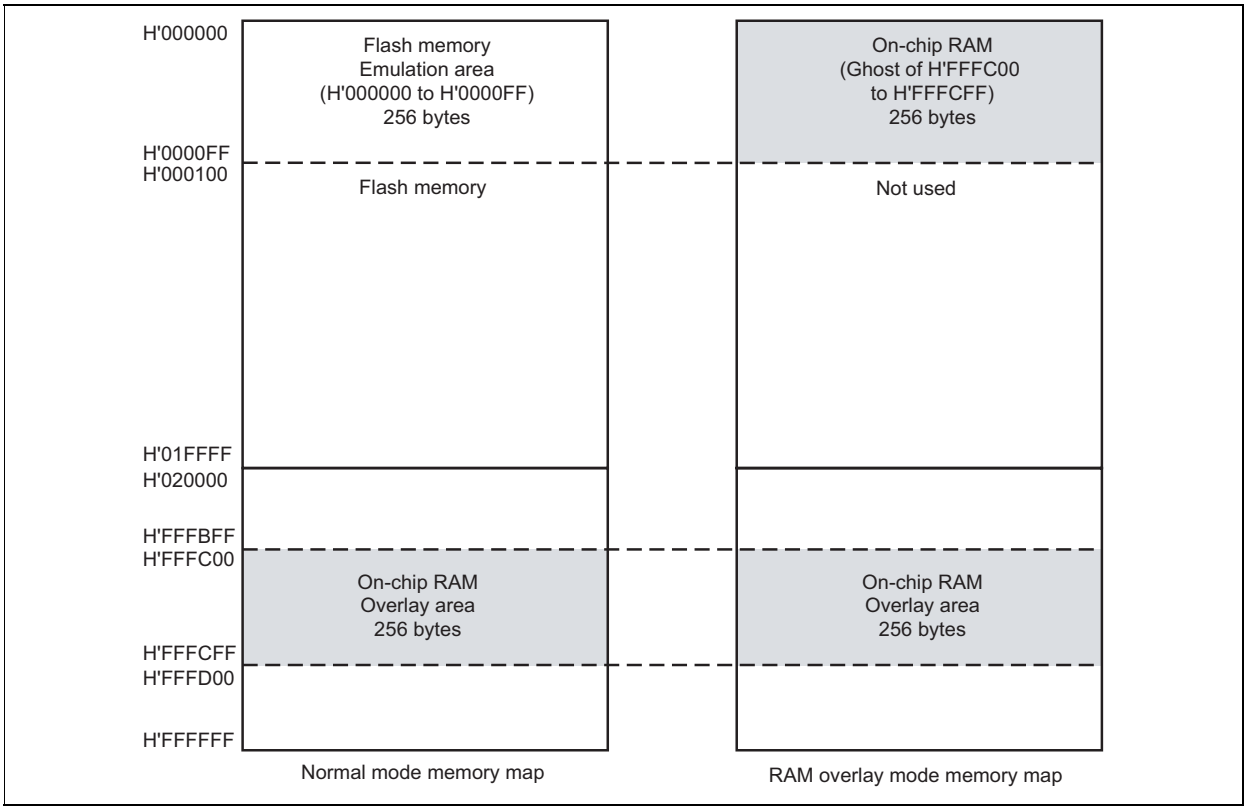

Figure 2 Outline of RAM Overlay Processing

(1) The size of the overlaid RAM area (RAM overlay area) is fixed at 256 bytes from H'FFFC00 to H'FFFCFF.
(2) The size of the overlaid flash memory area (emulation area) is 256 bytes from H'000000 to H'0000FF.
(3) The emulation area is overlaid with the RAM overlay area when the flash memory module standby bit (FROMCKSTP) of the clock stop register 1 (CKSTPR1) is set to 0 to set the flash memory into the standby mode and an access is made to the emulation area.
(4) The RAM overlay area is accessible from both the addresses in the flash memory and in the original RAM. The RAM overlay area needs to be provided with a vector table when RAM emulation is used.
(5) The RAM overlay is cancelled by setting the FROMCKSTP bit of CKSTPR1 to 1 and canceling the flash memory's module standby mode.

3.2 Power-down Operation of Flash Memory

The flash memory will operate in one of the following states in the user mode:

- Normal operating state
  The flash memory can be read at high speed.
- Power-down state
  Part of the power supply circuit for the flash memory can be stopped. This makes it possible to read data from the flash memory with low power consumption.
- Standby state
  All circuitry of the flash memory are stopped.

Table 2 shows the relationship between the LSI's operating modes and flash memory states. In subactive mode, the flash memory can be set into power-down mode using the power-down enable bit (PDWND) of the flash memory power control register (FLPWCR). Some operation stabilization time is required required for the suspended power supply circuit to restore the flash memory from power-down or standby state. Set the standby timer select bits 3-0 (STS3 to STS0) of the system control registers (SYSCR1 andSYSCR3) so that the wait time required to return to normal operating mode, including the case when an external clock is used, is set to 20 µs or longer.

Table 2 Flash Memory Operating States

	Flash Memory State	
LSI Operating Mode	**When PDWND = 0 (initial value)**	**When PDWND = 1**
Active mode	Normal operating state	Normal operating state
Sleep mode	Normal operating state	Normal operating state
Subactive mode	Power-down mode	Normal operating state
Subsleep mode	Standby state	Standby state
Module stand by mode	Standby state	Standby state
Standby mode	Standby state	Standby state

3.3 Notes on the Setting of Module Standby Mode

When the flash memory is set to enter module standby mode, the system clock supply is stopped to the module, the function is stopped, and the state is the same as that in standby mode. Also program operation is stopped in the flash memory. Therefore operation program should be transferred to the RAM and the program should run in the RAM. Then the flash memory should be set to enter module standby mode.

When the RAM emulation is not in use, if an interrupt is generated in module standby mode, the vector address cannot be fetched. As a result, the program may run away.

Before the flash memory is set to enter module standby mode, the corresponding bit in the interrupt enable register should be cleared to 0 and the I bit in CCR should be set to 1. Then after the flash memory enters module standby mode, NMI and address break interrupt requests should
not be generated.

Figure3 shows a module standby mode setting when the RAM emulation isnot used.

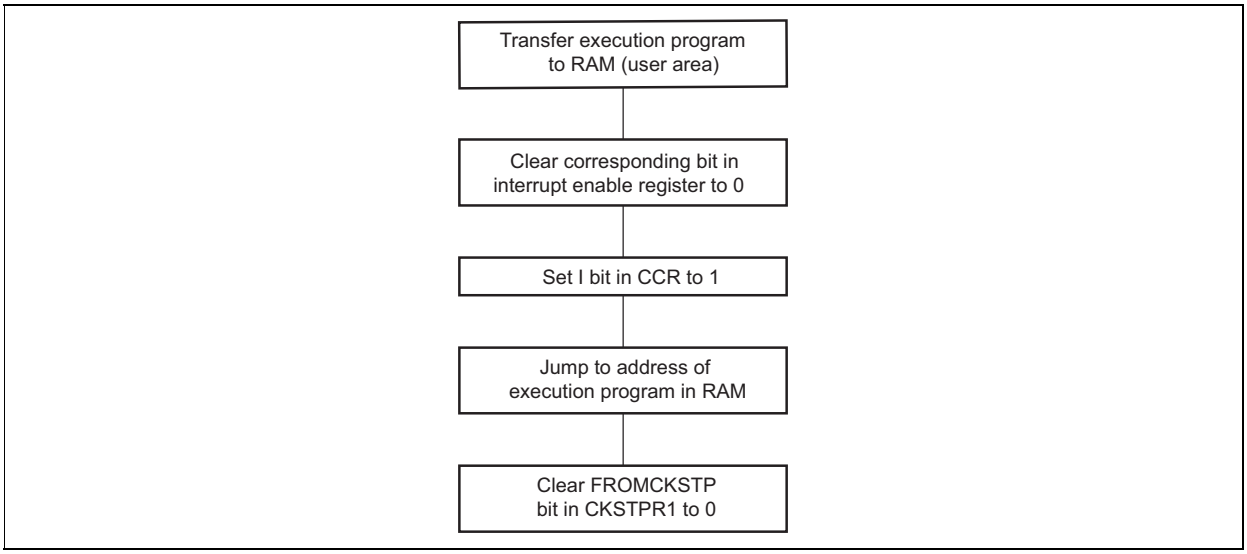

Figure 3 Configuring Module Standby Mode (Without Using the RAM Emulation)

When the RAM emulation is used (an interrupt vector is provided), if an interrupt is generated in module standby mode, the vector address can be set by assigning the interrupt vector to the RAM, and this prevents the program to run away.

4. Principles of Operation

4.1 State Transition Diagram

Figure 4 shows the state transition diagram of this program.

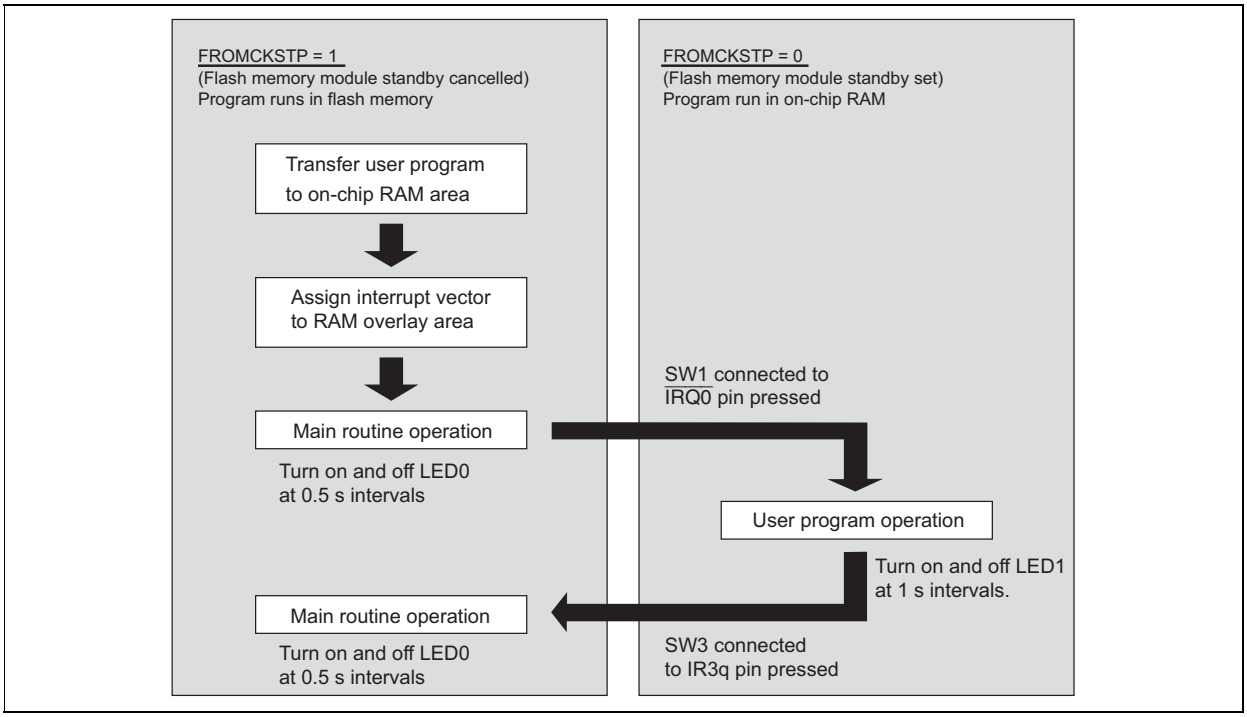

Figure 4 State Transition Diagram

4.2 LED On/Off Operations

Figure 5 illustrates the operations of the main routing running in the flash memory and the user program running in the on-chip RAM.

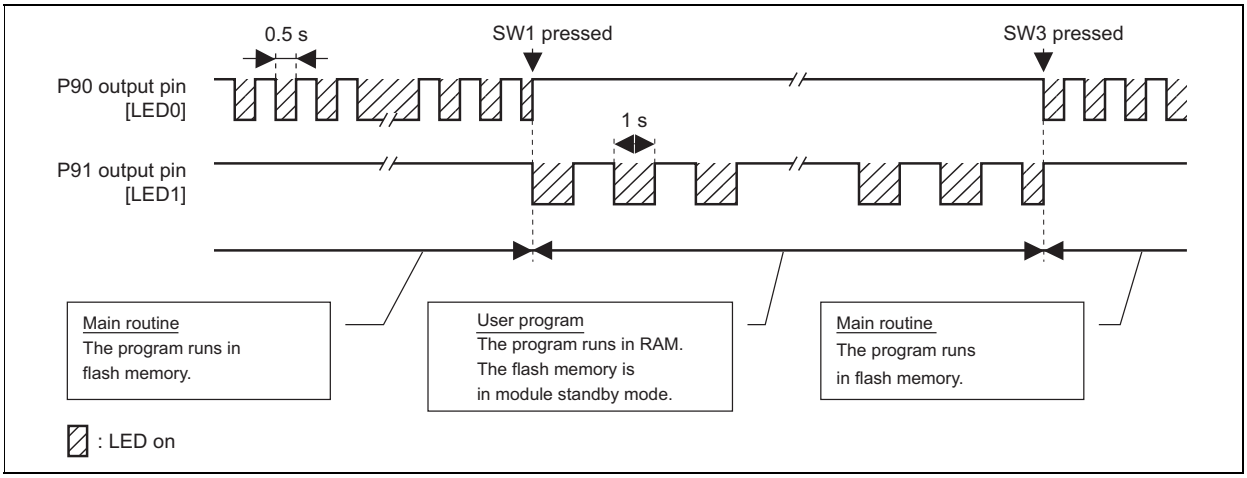

Figure 5 LED On/Off Operations

4.3 Memory Map

Figure 6 shows the H8/38099 Group (flash memory version) memory map for this program.

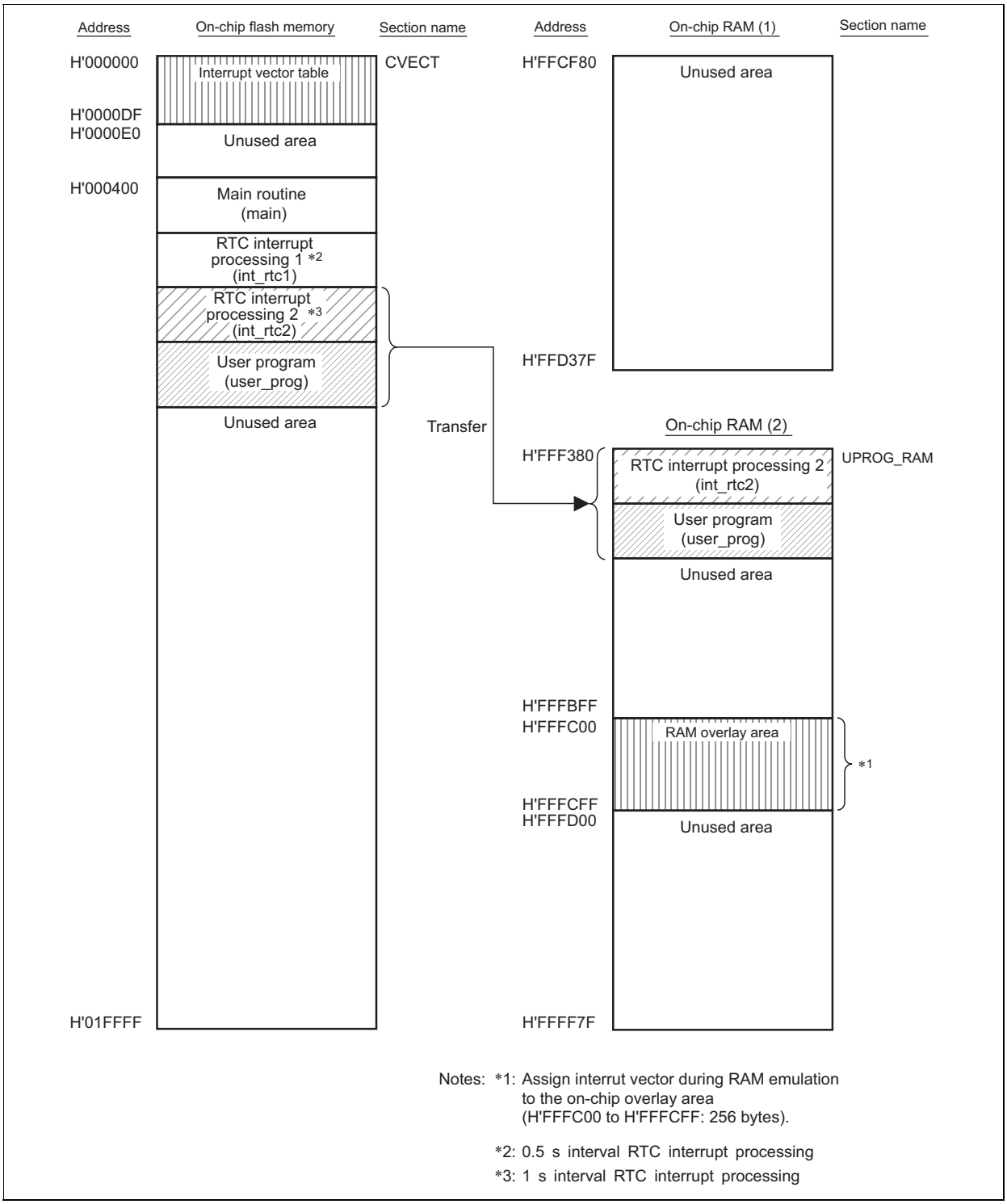

Figure 6 Memory Map

4.4 Program Transfer to RAM

When the H8/38099 Group on-chip flash memory is set in module standby mode, programs operating in the on-chip RAM is tranfered to the on-chip RAM.

The program (user_prog) that is to run when the on-chip flash memory is set in module standby mode and the RTC second interval interrupt processing routine (int_rtc2) are transferred from the on-chip flash memory with a section name [PUPROG_ROM] to the on-chip RAM with a section name [UPROG_RAM] (address = H'FFF380).

In this case, it is necessary to set the ROM conversion support option of the Optimizing Linkage Editor. The ROM conversion support option reserves the ROM and RAM areas in the initialized data area and the symbols defined in the ROM section are relocated to addresses in the RAM section. Figure 7 shows the ROM conversion option setting for this program.

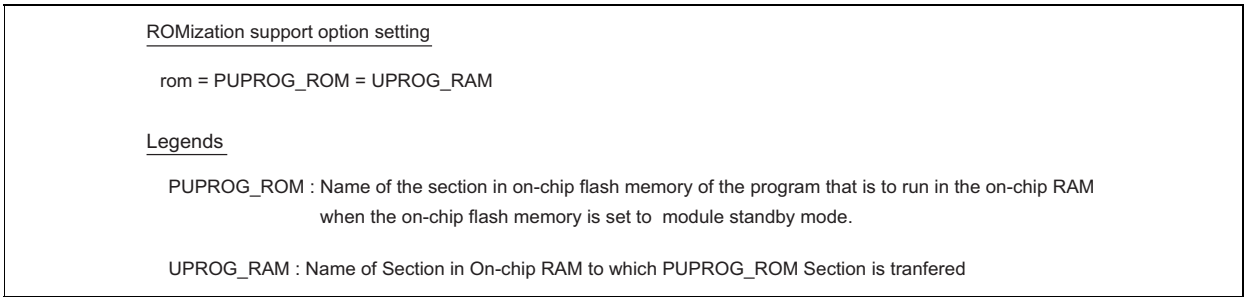

Figure 7 Specifying the Optimized Linkage Editor Option

The function memcpy() in [string.h] is used to transfer the actual program.

4.5 Vector Table in RAM Overlay Area

A vector table needs to be set up in the RAM overlay area (H'FFFC00 to H'FFFCFF) to use the RAM emulation function. In this program, the start address (H'FF380) of the RTC second interval interrupt processing routine (int_rtc2) is written into the address (H'FFFC54) of the RAM overlay area to make use of RTC interrupts (second interval interrupts) during RAM emulation processing. Table 3 lists the vector table in the RAM overlay area.

Table 3 Vector Table in RAM Overlay Area

RAM Overlay Area Address			Vector No.	Interrupt Source	Destination Function (Address)
H'FFFC00	to	H'FFFC03	0	Reset	—
H'FFFC0C	to	H'FFFC0F	3	NMI	—
H'FFFC14	to	H'FFFC17	5	Address break	—
H'FFFC18	to	H'FFFC1B	6	External pin $\overline{\text{IRQ0}}$	—
H'FFFC1C	to	H'FFFC1F	7	External pin $\overline{\text{IRQ1}}$	—
H'FFFC20	to	H'FFFC23	8	External pin $\overline{\text{IRQAEC}}$	—
H'FFFC24	to	H'FFFC27	9	External pin $\overline{\text{IRQ3}}$	—
H'FFFC28	to	H'FFFC2B	10	External pin $\overline{\text{IRQ4}}$	—
H'FFFC2C	to	H'FFFC2F	11	External pin WKP0	—
H'FFFC30	to	H'FFFC33	12	External pin WKP1	—
H'FFFC34	to	H'FFFC37	13	External pin WKP2	—
H'FFFC38	to	H'FFFC3B	14	External pin WKP3	—
H'FFFC3C	to	H'FFFC3F	15	External pin WKP4	—

Table 3 Vector Table in RAM Overlay Area (Continued)

RAM Overlay Area Address			Vector No.	Interrupt Source	Destination Function (Address)
H'FFFC40	to	H'FFFC43	16	External pin WKP5	—
H'FFFC44	to	H'FFFC47	17	External pin WKP6	—
H'FFFC48	to	H'FFFC4B	18	External pin WKP7	—
H'FFFC4C	to	H'FFFC4F	19	RTC 0.25 s overflow	—
H'FFFC50	to	H'FFFC53	20	RTC 0.5 s overflow	—
H'FFFC54	to	H'FFFC57	21	RTC second interval overflow	int_rtc2 (H'FFF380)
H'FFFC58	to	H'FFFC5B	22	RTC minute interval overflow	—
H'FFFC5C	to	H'FFFC5F	23	RTC hour interval overflow	—
H'FFFC60	to	H'FFFC63	24	RTC day interval overflow	—
H'FFFC64	to	H'FFFC67	25	RTC week interval overflow	—
H'FFFC68	to	H'FFFC6B	26	RTC free-running overflow	—
H'FFFC6C	to	H'FFFC6F	27	WDT	—
H'FFFC70	to	H'FFFC73	28	AEC	—
H'FFFC74	to	H'FFFC77	29	TPU_1 TG1A	—
H'FFFC78	to	H'FFFC7B	30	TPU_1 TG1B	—
H'FFFC7C	to	H'FFFC7F	31	TPU_1 TCI1V	—
H'FFFC80	to	H'FFFC83	32	TPU_2 TG2A	—
H'FFFC84	to	H'FFFC87	33	TPU_2 TG2B	—
H'FFFC88	to	H'FFFC8B	34	TPU_2 TCI2V	—
H'FFFC8C	to	H'FFFC8F	35	Timer FL	—
H'FFFC90	to	H'FFFC93	36	Timer FH	—
H'FFFC94	to	H'FFFC97	37	SCI4	—
H'FFFC98	to	H'FFFC9B	38	SCI3_1	—
H'FFFC9C	to	H'FFFC9F	39	SCI3_2	—
H'FFFCA0	to	H'FFFCA3	40	IIC2	—
H'FFFCA8	to	H'FFCAB	42	10-bit A/D converter	—
H'FFFCAC	to	H'FFFCAF	43	Direct transition	—
H'FFFCD4	to	H'FFFCD7	53	Timer C	—
H'FFFCD8	to	H'FFFCDB	54	Timer G	—
H'FFFCDC	to	H'FFFCDF	55	SCI3_3	—

Note: It is presumed that neither NMI nor address break interrupts can occur.

5. Software Description

5.1 Operating Environment

Table 4 Operating Environment

Item	Details
Development tool	High Performance Embeded Wordshop (HEW) Version 4.03.00.001
C/C++ compiler	H8S,H8/300 SERIES C/C++ Compiler V.6.01.02
Compiler options	• -cpu=300HA:24 -object="$(CONFIGDIR)¥$(FILELEAF).obj" -debug • -nolist -chgincpath -nologo
Optimizing Linkage Editor	Optimizing Linkage Editor V.9.02.00
Linkage editor options	• -noprelink -rom=PUPROG_ROM=UPROG_RAM -nomessage • -list="$(CONFIGDIR)¥$(PROJECTNAME).map" -nooptimize • -start=CVECT/00,P,PUPROG_ROM/0400,UPROG_RAM/0FFF380 • -nologo -output="$(CONFIGDIR)¥$(PROJECTNAME).abs" –end • -input="$(CONFIGDIR)¥$(PROJECTNAME).abs" -form=stype • -output="$(CONFIGDIR)¥$(PROJECTNAME).mot" -exit

Table 5 Section Settings

Address	Section Name	Description
H'000000	CVECT	Vector table area (constant area)
H'000400	P	Program area Programs running in on-chip flash memory
	PUPROG_ROM	Program area Program area in on-chip flash memory for programs running in on-chip RAM area
H'FFF380	UPROG_RAM	On-chip RAM area (initialized data area) Destination initialized data area in on-chip RAM to which contents of PURPOG_ROM section in on-chip flash memory are copied

Table 6 Interrupt Exception Processing Vector Table

Source of Exception Processing	Name	Vector No.	Vector Address	Destination Function
RES, WDT	Reset	0	H'000000	main
NMI	NMI	3	H'00000C	main
Address break	Break condition satisfied	5	H'000014	main
External pin	$\overline{\text{IRQ0}}$	6	H'000018	main
	$\overline{\text{IRQ1}}$	7	H'00001C	main
	$\overline{\text{IRQAEC}}$	8	H'000020	main
	$\overline{\text{IRQ3}}$	9	H'000024	main
	$\overline{\text{IRQ4}}$	10	H'000028	main
	WKP0	11	H'00002C	main
	WKP1	12	H'000030	main
	WKP2	13	H'000034	main
	WKP3	14	H'000038	main
	WKP4	15	H'00003C	main
	WKP5	16	H'000040	main
	WKP6	17	H'000044	main
	WKP7	18	H'000048	main

Table 6 Interrupt Exception Processing Vector Table (Continued)

Source of Exception Processing	Name	Vector No.	Vector Address	Destination Function
RTC	0.25 s overflow	19	H'00004C	main
	0.5 s overflow	20	H'000050	int_rtc1
	Second interval overflow	21	H'000054	int_rtc2
	Minute interval overflow	22	H'000058	main
	Hour interval overflow	23	H'00005C	main
	Day interval overflow	24	H'000060	main
	Week interval overflow	25	H'000064	main
	Free-running overflow	26	H'000068	main
WDT	WDT overflow (Interval timer)	27	H'00006C	main
AEC	AEC overflow	28	H'000070	main
TPU_1	TG1A (TG1A input capture/compare match)	29	H'000074	main
	TG1B (TG1B input capture/compare match)	30	H'000078	main
	TCI1V (overflow 1)	31	H'00007C	main
TPU_2	TG2A (TG2A input capture/compare match)	32	H'000080	main
	TG2B (TG2B input capture/compare match)	33	H'000084	main
	TCI2V (overflow 2)	34	H'000088	main
Timer F	Timer FL compare match Timer FL overflow	35	H'00008C	main
	Timer FH compare match Timer FH overflow	36	H'000090	main
SCI4	Receive data full/transmit data empty/ transmit end/receive error	37	H'000094	main
SCI3_1	Transmission completion/transmit data empty/receive data full/overrun error/framing error/parity error	38	H'000098	main
SCI3_2	Transmission completion /transmit data empty/receive data full/overrun error/framing error/parity error	39	H'00009C	main
IIC2	Transmit data empty/transmit end/ receive data full/stop condition detected/NACK detected/arbitration/overrun error	40	H'0000A0	main
10-bit A/D converter	A/D conversion end	42	H'0000A8	main
(SLEEP instruction executed)	Direct transition	43	H'0000AC	main
Timer C	Timer C overflow/underflow	53	H'0000D4	main
Timer G	Timer G input capture Timer G overflow	54	H'0000D8	main
SCI3_3	Transmission completion /transmit data empty/receive data full/overrun error/framing error/parity error	55	H'000DC	main

5.2 Variable Description (in On-chip RAM Area)

This program has no on-chip RAM area that is used to store variables.

5.3 List of Functions

Table 7 Function List

Function Name	Function
main	Main routine Sets up the stack pointer, stops the watchdog timer, sets up the module standby mode, copies the user program to RAM, setups up interrupt vector addresses in RAM overlay area, initializes port 9, RTC, $\overline{\text{IRQ0}}$, and $\overline{\text{IRQ3}}$ interrupt pins, and jump to the user program.
rtc_int1	RTC 0.5 s interval overflow interrupt processing routine Clears the interrupt request flag and controls the P90 pin output.
rtc_int2	RTC second interval interrupt processing routine Clears the interrupt request flag and controls the P91 pin output.
user_prog	User program subroutine Controls the on-chip flash memory module standby mode and interrupts.

5.4 Function Description

5.4.1 main Function (Main Routine)

(1) Function overview

Sets up the stack pointer, stops the watchdog timer, sets up module standby mode, transfers the user program that is to run in RAM emulation mode to on-chip RAM, sets up an interrupt vector table in the RAM overlay area, sets up the P90 and P91 output pins to which the LEDs are connected, sets up RTC, sets up the $\overline{\text{IRQ0}}$ and $\overline{\text{IRQ3}}$ input pins to which switches are connected, enables or disables interrupts, waits until the switch (SW1) connected to the $\overline{\text{IRQ0}}$ input pin is pressed, and jumps to the user program that has been transferred n RAM.

(2) Argument

None

(3) Return value

None

(4) Flowchart

The flowchart of the main function (main routine) is shown in figure 8.

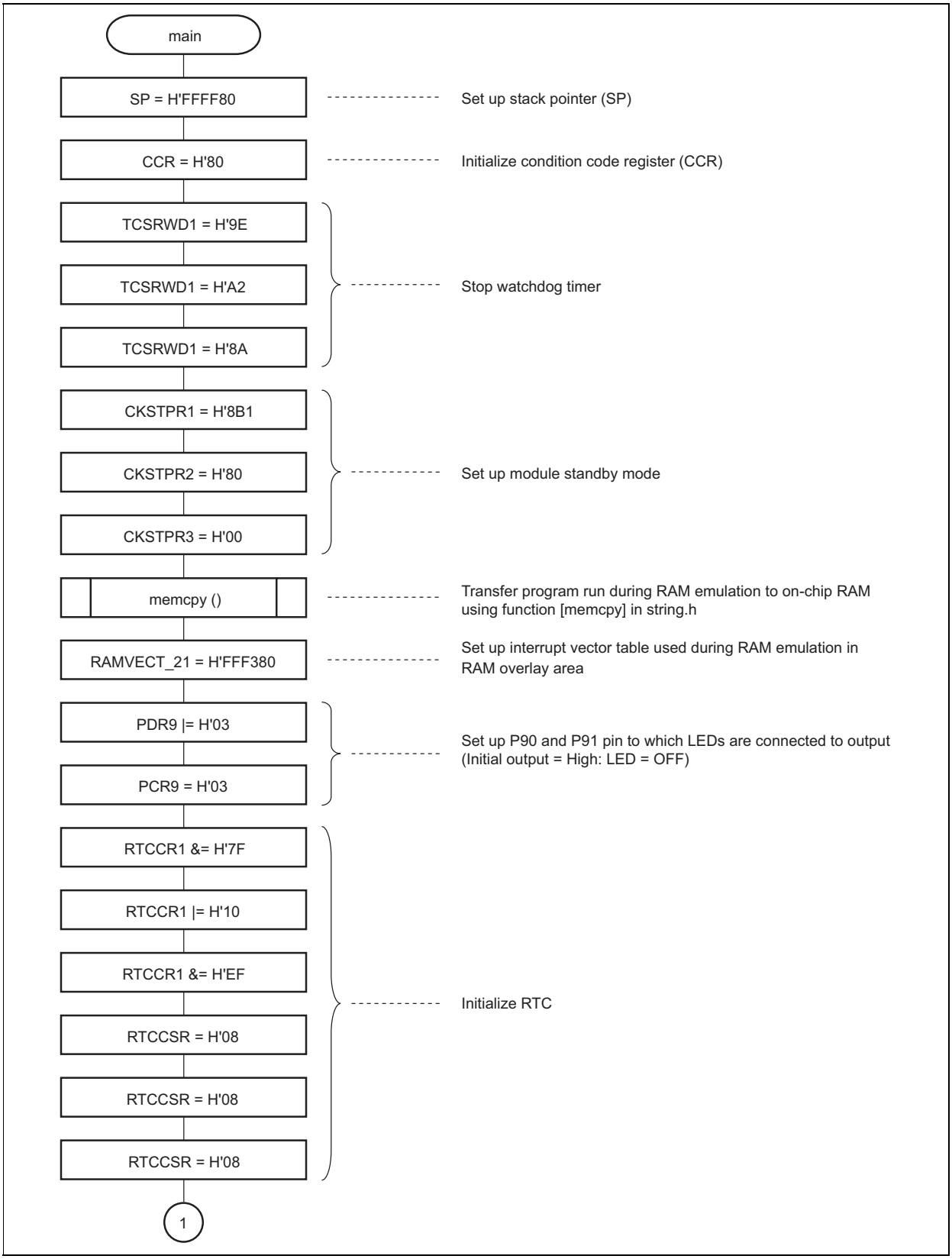

Figure 8 main Function (Main Routine) Flowchart

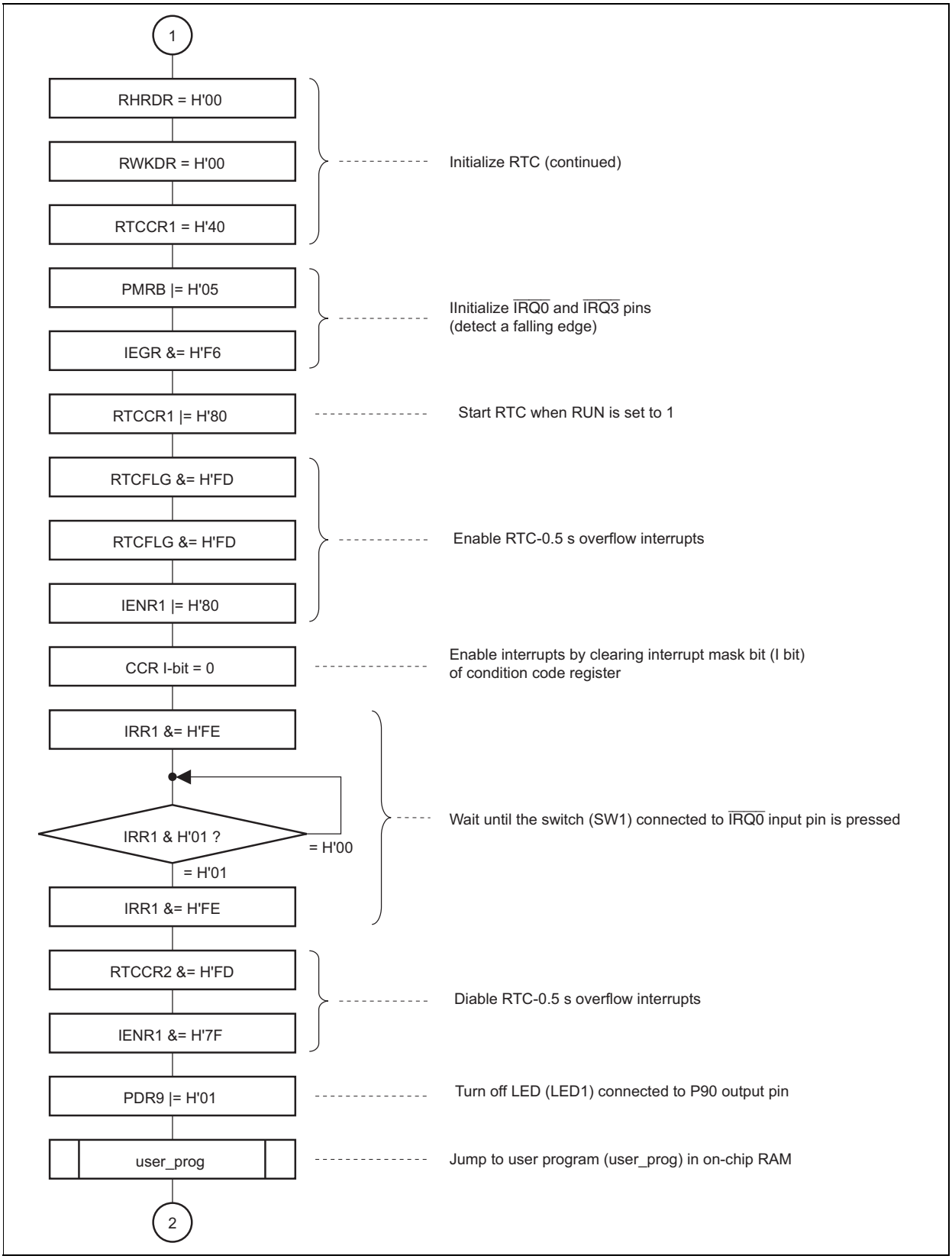

Figure 8 main Function (Main Routine) Flowchart (Continued)

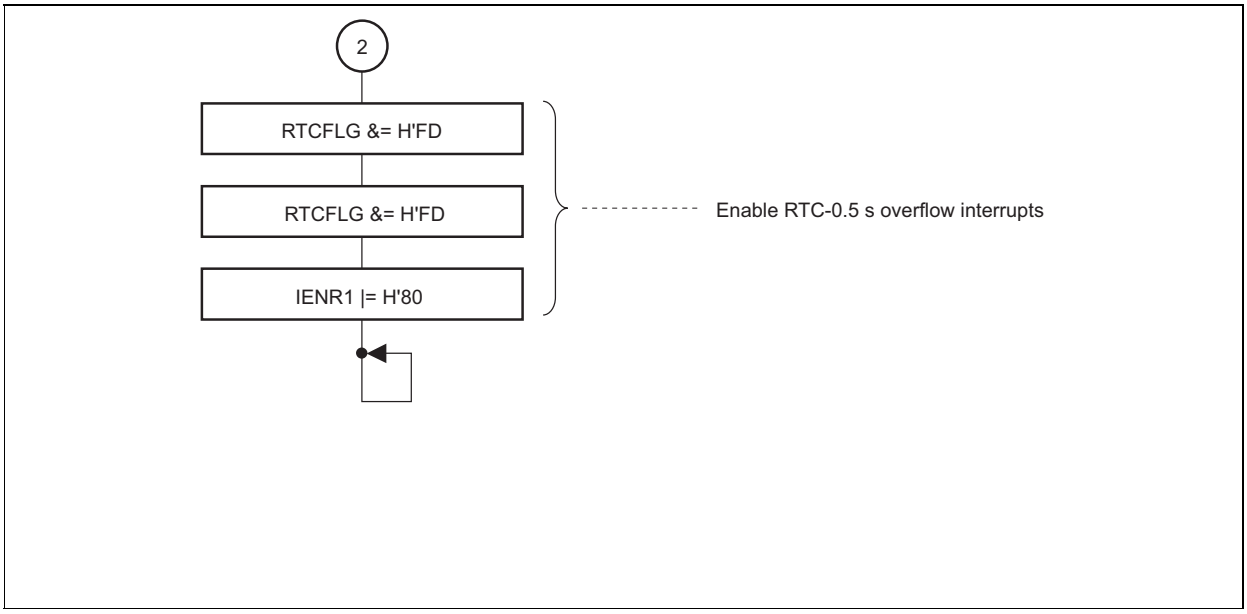

Figure 8 main Function (Main Routine) Flowchart (Continued)

5.4.2 int_rtc1 Function (RTC 0.5 s Overflow Interrupt Processing Routine)

(1) Function overview

Clears the interrupt request flag and inverts the output at the P90 pin.

(2) Argument

None

(3) Return value

None

(4) Flowchart

The flowchart of the int_rtc1 function (RTC 0.5 s overflow interrupt processing routine) is shown in figure 9.

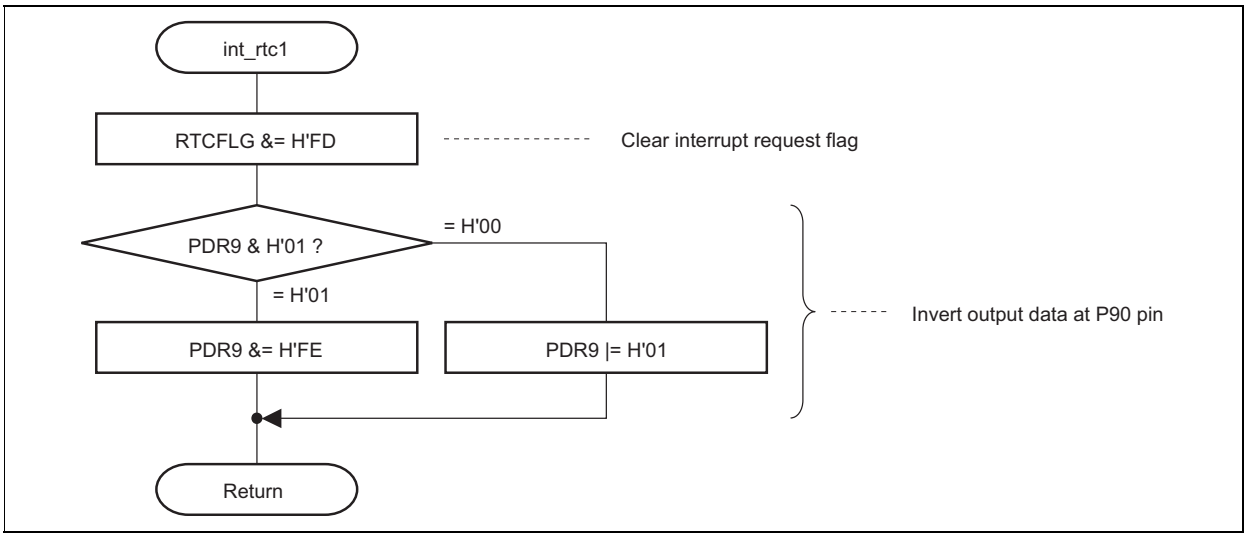

Figure 9 int_rtc1 Function (RTC 0.5 s Overflow Interrupt Processing Routine) Flowchart

5.4.3 int_rtc2 Function (RTC Second Interval Interrupt Processing Routine)

(1) Function overview

Clears the interrupt request flag and inverts the output at the P91 pin.

(2) Argument

None

(3) Return value

None

(4) Flowchart

The flowchart of the int_rtc2 function (RTC second interval interrupt processing routine) is shown in figure 10.

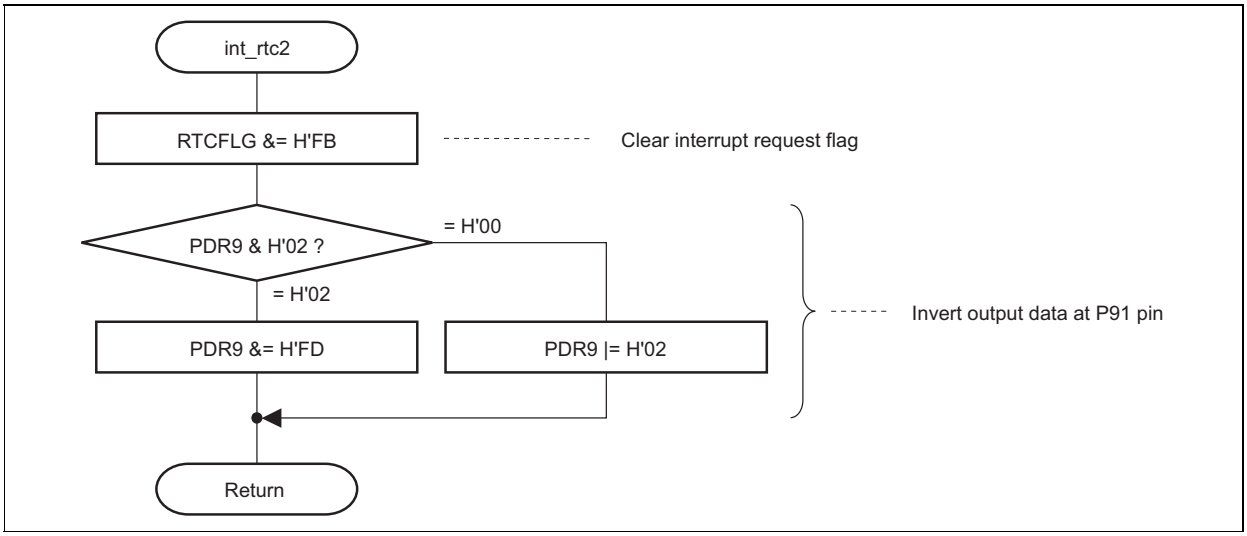

Figure 10 int_rtc2 Function (RTC Second Interval Interrupt Processing Routine) Flowchart

5.4.4 user_prog Function (User Program Subroutine)

(1) Function overview

Sets up module standby mode for the on-chip flash memory, enables RTC interrupts (second interval interrupts), waits for the press of the switch (SW3) connected to the $\overline{\text{IRQ3}}$ input pin, disables RTC interrupts (second interval interrupts), turns off the LED connected to the P91 output pin, releases the on-chip flash memory from module standby state, and waits for the time required for the on-chip flash memory to restore from standby state to normal operating state.

(2) Argument

None

(3) Return value

None

(4) Flowchart

The flowchart of the user_prog function (user program subroutine) is shown in figure 11.

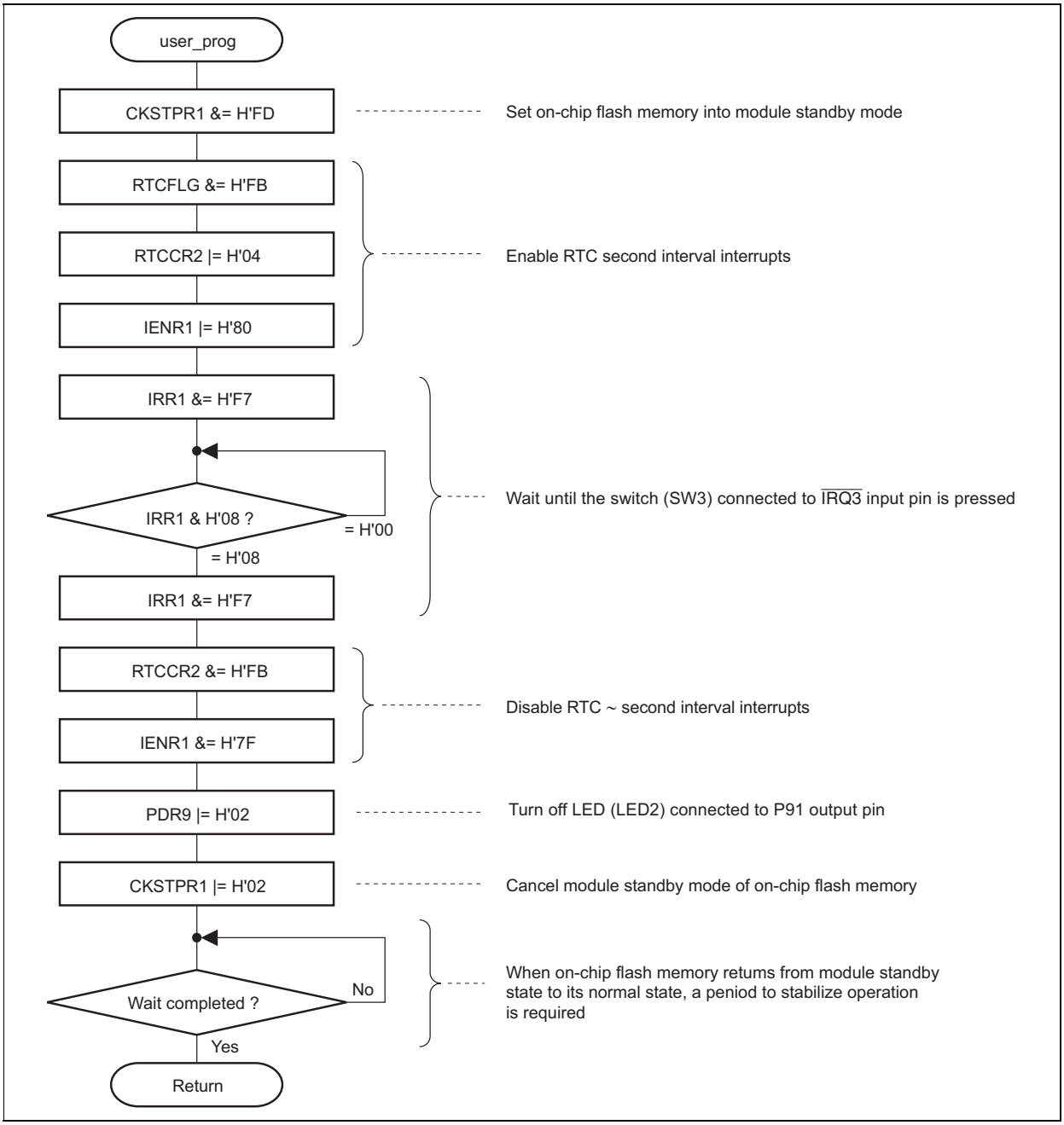

Figure 11 user_prog Function (User Program Subroutine) Flowchart

Website and Support

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

Inquiries
http://www.renesas.com/inquiry
csc@renesas.com

Revision Record

Rev.	Date	Description Page	Summary
1.00	Dec.12.07	—	First edition issued

Notes regarding these materials

1. This document is provided for reference purposes only so that Renesas customers may select the appropriate Renesas products for their use. Renesas neither makes warranties or representations with respect to the accuracy or completeness of the information contained in this document nor grants any license to any intellectual property rights or any other rights of Renesas or any third party with respect to the information in this document.
2. Renesas shall have no liability for damages or infringement of any intellectual property or other rights arising out of the use of any information in this document, including, but not limited to, product data, diagrams, charts, programs, algorithms, and application circuit examples.
3. You should not use the products or the technology described in this document for the purpose of military applications such as the development of weapons of mass destruction or for the purpose of any other military use. When exporting the products or technology described herein, you should follow the applicable export control laws and regulations, and procedures required by such laws and regulations.
4. All information included in this document such as product data, diagrams, charts, programs, algorithms, and application circuit examples, is current as of the date this document is issued. Such information, however, is subject to change without any prior notice. Before purchasing or using any Renesas products listed in this document, please confirm the latest product information with a Renesas sales office. Also, please pay regular and careful attention to additional and different information to be disclosed by Renesas such as that disclosed through our website. (http://www.renesas.com)
5. Renesas has used reasonable care in compiling the information included in this document, but Renesas assumes no liability whatsoever for any damages incurred as a result of errors or omissions in the information included in this document.
6. When using or otherwise relying on the information in this document, you should evaluate the information in light of the total system before deciding about the applicability of such information to the intended application. Renesas makes no representations, warranties or guaranties regarding the suitability of its products for any particular application and specifically disclaims any liability arising out of the application and use of the information in this document or Renesas products.
7. With the exception of products specified by Renesas as suitable for automobile applications, Renesas products are not designed, manufactured or tested for applications or otherwise in systems the failure or malfunction of which may cause a direct threat to human life or create a risk of human injury or which require especially high quality and reliability such as safety systems, or equipment or systems for transportation and traffic, healthcare, combustion control, aerospace and aeronautics, nuclear power, or undersea communication transmission. If you are considering the use of our products for such purposes, please contact a Renesas sales office beforehand. Renesas shall have no liability for damages arising out of the uses set forth above.
8. Notwithstanding the preceding paragraph, you should not use Renesas products for the purposes listed below:
   (1) artificial life support devices or systems
   (2) surgical implantations
   (3) healthcare intervention (e.g., excision, administration of medication, etc.)
   (4) any other purposes that pose a direct threat to human life

   Renesas shall have no liability for damages arising out of the uses set forth in the above and purchasers who elect to use Renesas products in any of the foregoing applications shall indemnify and hold harmless Renesas Technology Corp., its affiliated companies and their officers, directors, and employees against any and all damages arising out of such applications.
9. You should use the products described herein within the range specified by Renesas, especially with respect to the maximum rating, operating supply voltage range, movement power voltage range, heat radiation characteristics, installation and other product characteristics. Renesas shall have no liability for malfunctions or damages arising out of the use of Renesas products beyond such specified ranges.
10. Although Renesas endeavors to improve the quality and reliability of its products, IC products have specific characteristics such as the occurrence of failure at a certain rate and malfunctions under certain use conditions. Please be sure to implement safety measures to guard against the possibility of physical injury, and injury or damage caused by fire in the event of the failure of a Renesas 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 applicable measures. Among others, since the evaluation of microcomputer software alone is very difficult, please evaluate the safety of the final products or system manufactured by you.
11. In case Renesas products listed in this document are detached from the products to which the Renesas products are attached or affixed, the risk of accident such as swallowing by infants and small children is very high. You should implement safety measures so that Renesas products may not be easily detached from your products. Renesas shall have no liability for damages arising out of such detachment.
12. This document may not be reproduced or duplicated, in any form, in whole or in part, without prior written approval from Renesas.
13. Please contact a Renesas sales office if you have any questions regarding the information contained in this document, Renesas semiconductor products, or if you have any other inquiries.