SH7231 Group

Using 32kHz Timer

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Abstract

This document describes an example of using clock function with one-second period of the 32kHz timer (TIM32C) on the SH7231 Group.

Products

SH7231

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

The TIM32C channel 2 is used as a compare match timer in one-second period. The lower 4-bit value of timing counter variable which is counted up by the interrupt with this period is output to four ports respectively connected to the LEDs.

When the IRQ0 rising is detected during the normal operation, the TIM32C transits to the deep software standby mode. The TIM32C continues its operation during the mode and returns to normal operation mode every time the TIM32C compare match interrupt with one-second period occurs. After changing the value of the timing counter variable, the TIM32C again transits to the deep software standby mode.

When the TIM32C detects the IRQ1 falling during the deep software standby mode, it returns to the normal operational state.

Table 1.1 lists the Peripheral Functions and Their Applications, and Figure 1.1 shows the State Transition Diagram.

Table 1.1 Peripheral Functions and Their Applications

Peripheral Function	Application
32kHz Timer (TIM32C)	Uses compare match function of channel 2 as one-second timing counter
Interrupt controller (INTC)	Sets priority levels for respective interrupts
Control of power-down mode	Uses deep software standby mode

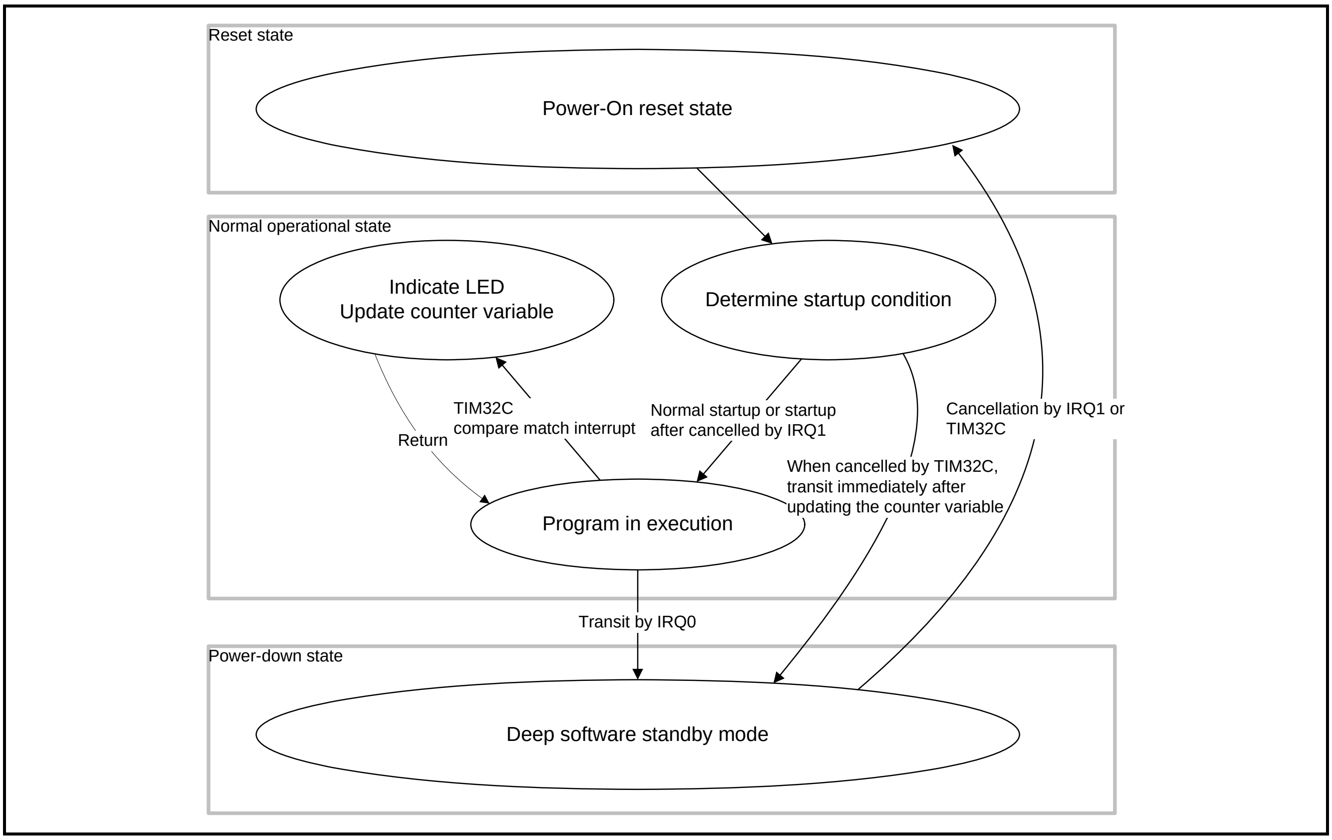

Figure 1.1 State Transition Diagram

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	SH7231
Operating frequency	Main clock: 100MHz Bus clock: 50MHz Peripheral clock: 50MHz
Operating voltage	Vcc: 3.3V
Integrated development environment	Renesas Electronics Corporation High-performance Embedded Workshop Ver.4.08.00
C compiler	Renesas Electronics Corporation SuperH RISC engine family C/C++ compiler package Ver.9.04 Release 00
	Compile options: -cpu=sh2afpu -fpu=single -include="$(WORKSPDIR)\inc","$(WORKSPDIR)\src\common" -object="$(CONFIGDIR)\$(FILELEAF).obj" -debug -gbr=auto -chgincpath -errorpath -global_volatile=0 -opt_range=all -infinite_loop=0 -del_vacant_loop=0 -struct_alloc=1 -nologo
Operating mode	Single chip mode
Sample code version	1.00
Board used	R0K572310C000BR
Device used	None

3. Reference Application Notes

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

- SH7231 Group Example of Initialization (R01AN0322EJ)
- SH7231 Group Using Deep Software Standby Mode (R01AN0822EJ)

4. Peripheral Functions

This chapter provides supplementary information on peripheral functions. Refer to the SH7231 Group User's Manual (Hardware) for basic information.

4.1 32kHz Timer (TIM32C)

The 32kHz timer (TIM32C) is operated by the clock based on the input from EXTAL21, unlike the CPU or other peripheral modules. The TIM32C continues its operation during the deep software standby mode.

5. Hardware

5.1 Pins Used

Table 5.1 lists the Pins Used and Their Functions.

Table 5.1 Pins Used and Their Functions

Pin Name	Input/Output	Function
PG8 to PG11	Output	Blink LED0 to LED 3 on the board used
PG1/IRQ1	Input	Return from deep software standby mode
PG0/IRQ0	Input	Transit to deep software standby mode

6. Software

6.1 Operation Overview

The following descriptions are based on Figure 6.1.

(1) Checks whether or not the start is a return from the deep software standby mode when entering start-up. Initializes the one-second timing counter variable for reset cancel and makes initial setting for each function to enter the infinite loop. This counter variable is allocated in the 32kHz (for data retention) to keep the value even in the process of transition to the deep software standby mode.

(2) When returning from the deep software standby mode, determines the cancel element (IRQ1 or 32kHz timer) and executes any processing appropriate to the cancel element.

(3) If the cancellation source is the 32kHz timer, transits again to the deep software standby mode after incrementing the counter variable. The LED does not blink.

(4) If the return is caused by the IRQ1 interrupt, moves to the initial setting for each function after cancelling the deep software standby mode and clearing flag of the cancel element.

(5) Increments the one-second timing counter variable and blinks the LED0 to LED3 using the value of lower 4-bit for the exception handling of the compare match interrupt with one-second period 32kHz timer.

(6) Transits to the deep software standby mode when the IRQ0 switch is on. Returns from the deep software standby mode when the 32kHz timer interrupt or the IRQ1 switch interrupt is occurred in the mode.

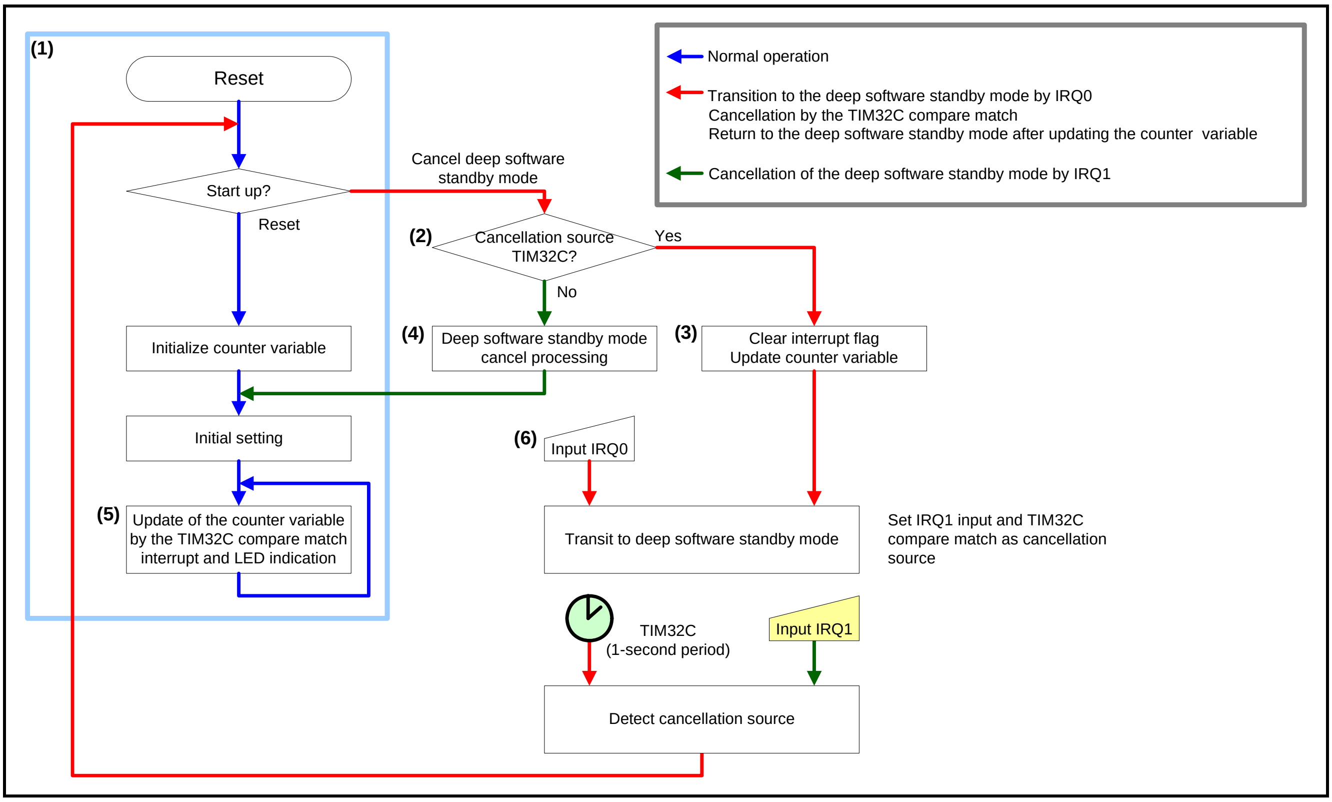

Figure 6.1 Operation Overview

6.2 Variable

Table 6.1 lists the Global Variable.

Table 6.1 Global Variable

Type	Variable Name	Contents	Function used
uint16_t	g_tim32c_1sec_counter	One-second timing counter (16-bit)	main, INT_TIM32C_CH2

6.3 Functions

Table 6.2 lists the Functions.

Table 6.2 Functions

Function Name	Outline
main	Main processing
io_init_pfc	Pin function controller setting
io_init_intc	Interrupt controller setting
io_init_tim32c	32kHz timer setting
goto_deep_standby	Transition processing to deep software standby mode
cancel_deep_standby	Cancellation processing of deep software standby mode
INT_TIM32C_CH2	32kHz timer interrupt exception handling
INT_IRQ0	IRQ0 interrupt exception handling

6.4 Function Specifications

The following tables list the sample code function specifications.

main	
Outline	Main processing
Header	
Declaration	void main(void)
Description	Determines whether or not the start is a return from the deep software standby mode when entering start-up. When normally started by reset, executes the initial setting processing for each function and enters into the main loop after zero clearing the one-second timing counter g_tim32c_1sec_counter. When the start is a return from the deep software standby mode, determines the cancellation source. If the cancellation source is identified as the TIM32C interrupt, transits to the deep software standby mode after incrementing the one-second timing counter g_tim32c_1sec_counter. If the cancellation source is identified as other cause except the TIM32C interrupt, executes the initial setting processing for each function to enter into the main loop after returning from the deep software standby mode.
Arguments	None
Return Value	None

io_init_pfc	
Outline	Pin function controller setting
Header	
Declaration	void io_init_pfc(void)
Description	Sets the LED control and port G pin function for the IRQ0 and IRQ1 inputs.
Arguments	None
Return Value	None

io_init_intc	
Outline	Interrupt controller setting
Header	
Declaration	void io_init_intc(void)
Description	Sets the IRQ0 interrupt request signal detection to rising edge to set the priority levels of the IRQ0 and the 32kHz timer.
Arguments	None
Return Value	None

io_init_tim32c	
Outline	32kHz timer setting
Header	
Declaration	void io_init_tim32c(void)
Description	Sets the channel 2 as a compare match timer with one-second period to validate the interrupt.
Arguments	None
Return Value	None

goto_deep_standby	
Outline	Transition processing to deep software standby mode
Header	
Declaration	void goto_deep_standby(void)
Description	Supplies power to the RAM (for data detention) on the process of transition to the deep software standby mode. Transits to the deep software standby mode after setting the IRQ1 and the TIM32C as cancellation sources.
Arguments	None
Return Value	None

cancel_deep_standby	
Outline	Cancellation processing of deep software standby mode
Header	
Declaration	void cancel_deep_standby(void)
Description	Clears bit for the deep software standby mode setting and the cancellation source flag.
Arguments	None
Return Value	None

INT_TIM32C_CH2	
Outline	32kHz timer interrupt exception handling
Header	
Declaration	void INT_TIM32C_CH2(void)
Description	Increments the g_tim32c_1sec_counter after output lower 4-bit data of the g_tim32c_1sec_counter from port G to the LED.
Arguments	None
Return Value	None

INT_IRQ0	
Outline	IRQ0 interrupt exception handling
Header	
Declaration	void INT_IRQ0(void)
Description	Executes the deep software standby mode transit function goto_deep_standby.
Arguments	None
Return Value	None

6.5 Flowcharts

6.5.1 Main Processing

Figure 6.2 shows the Main Processing.

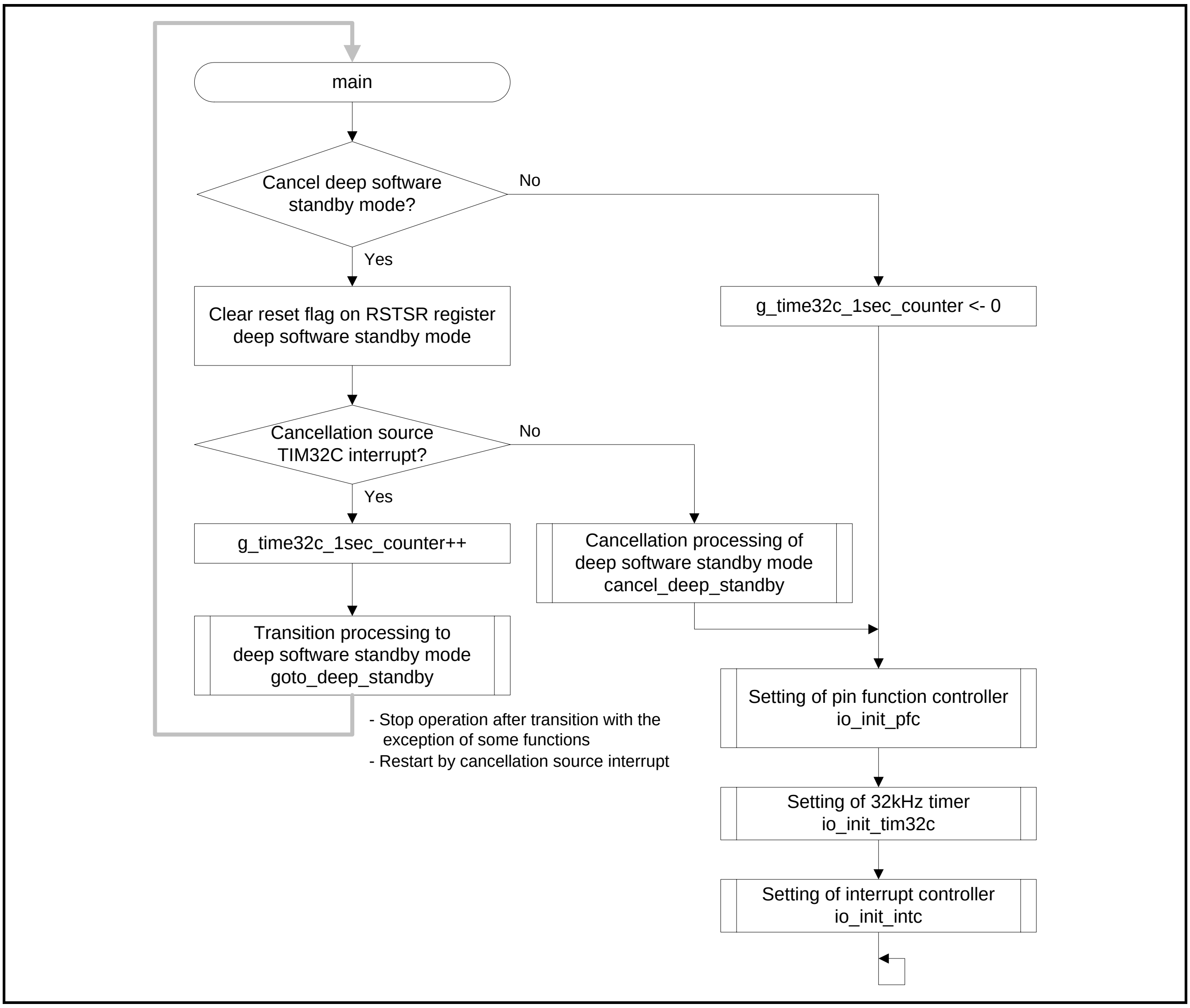

Figure 6.2 Main Processing

6.5.2 Pin Function Controller Setting

Figure 6.3 shows the procedure of Pin Function Controller Setting.

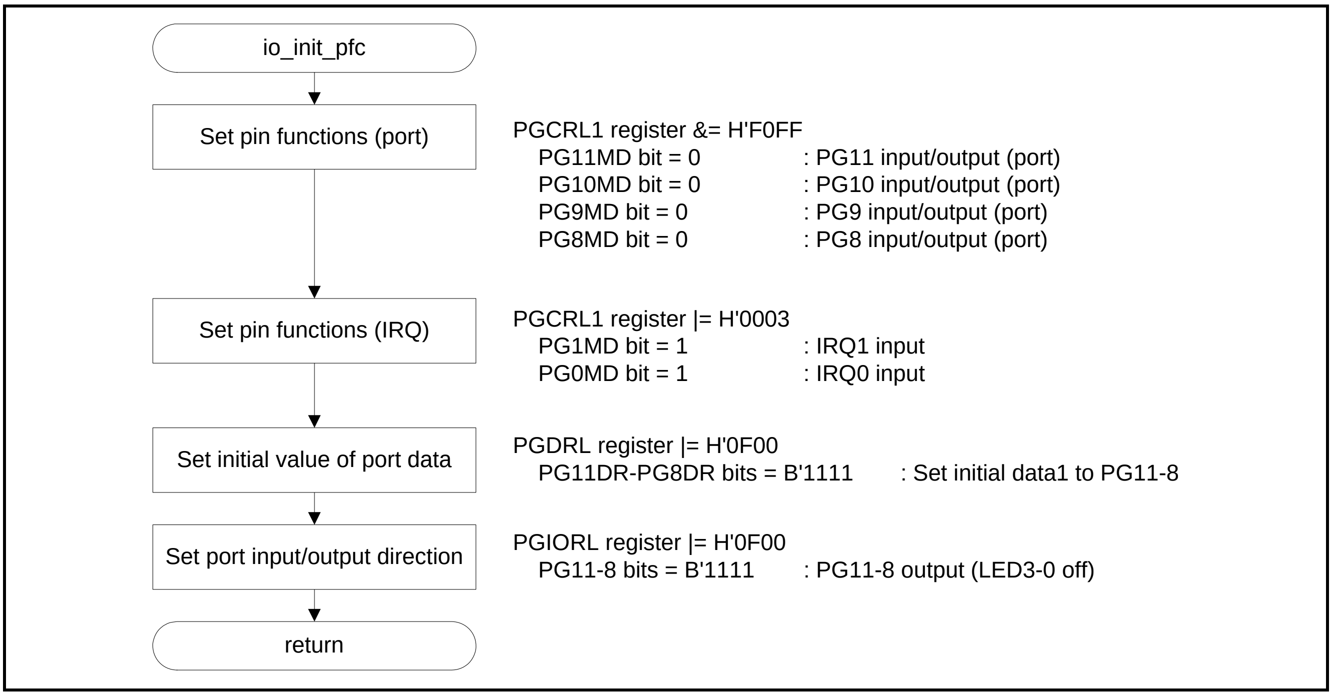

Figure 6.3 Pin Function Controller Setting

6.5.3 Interrupt Controller Setting

Figure 6.4 shows the procedure of Interrupt Controller Setting.

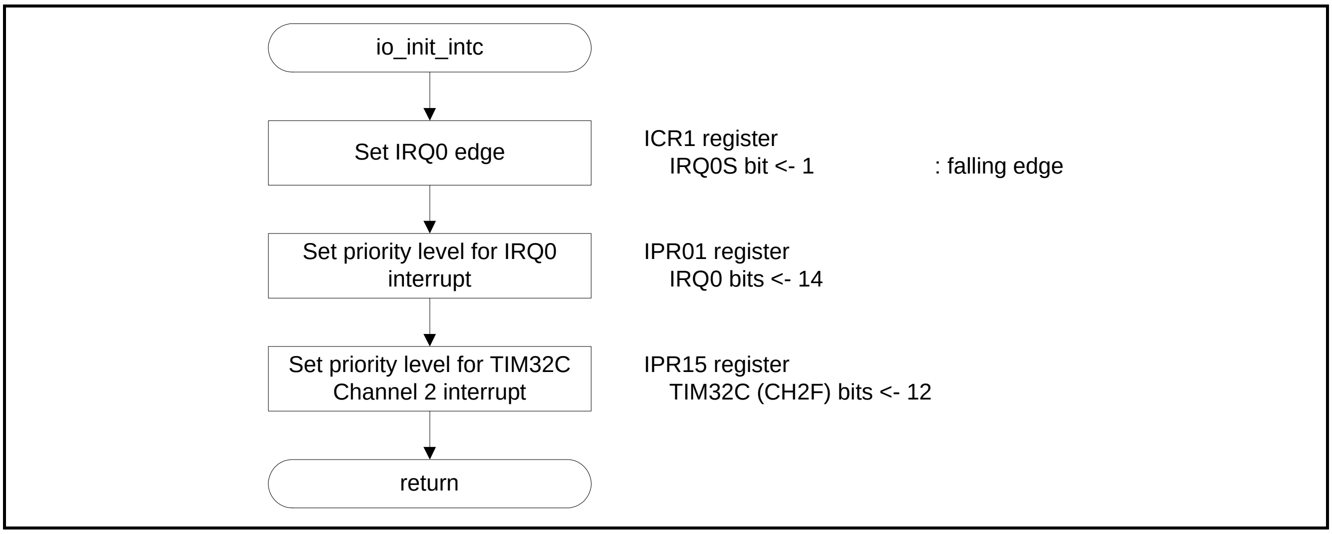

Figure 6.4 Interrupt Controller Setting

6.5.4 32kHz Timer Setting

Figure 6.5 shows the procedure of 32kHz timer setting.

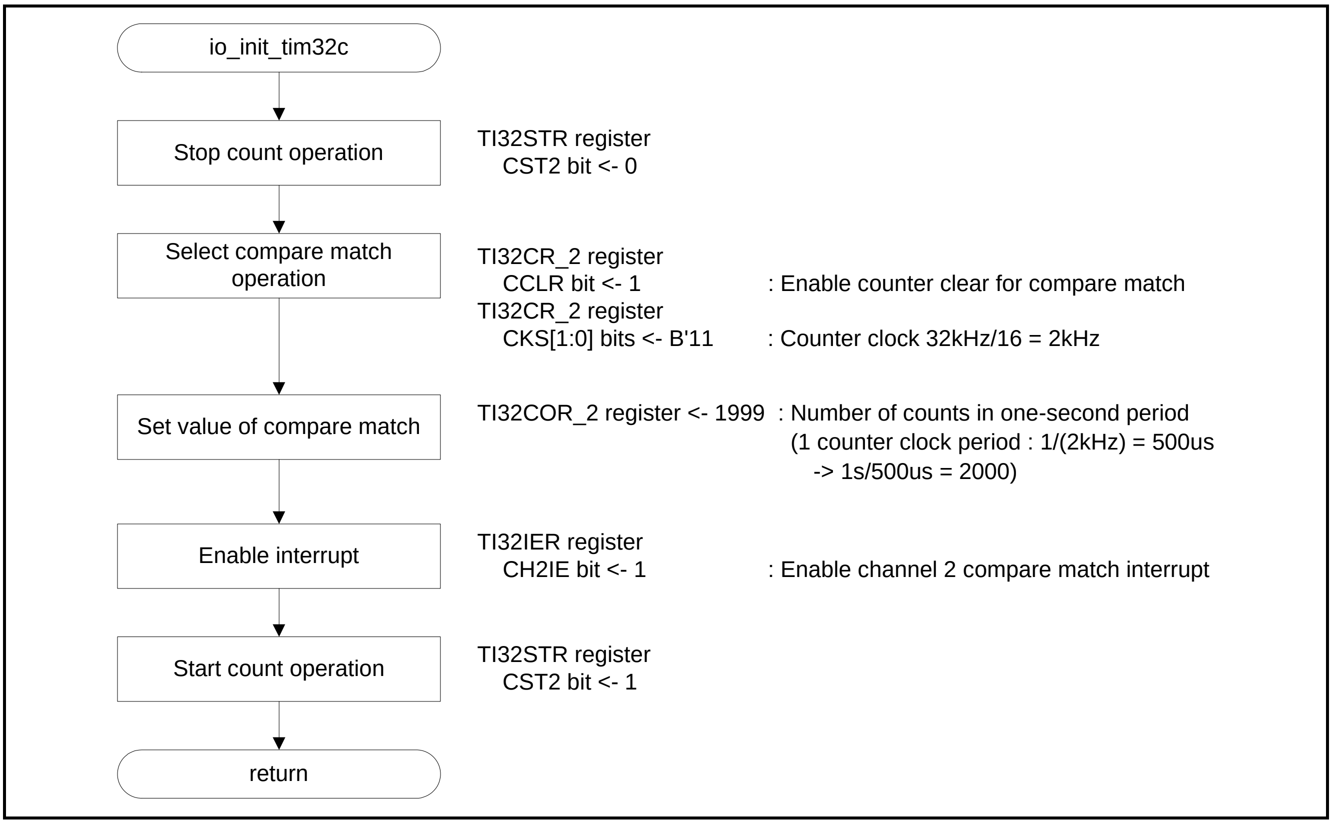

Figure 6.5 32kHz timer setting

6.5.5 Transition Processing to Deep Software Standby Mode

Figure 6.6 shows the Transition Processing of Deep Software Standby Mode.

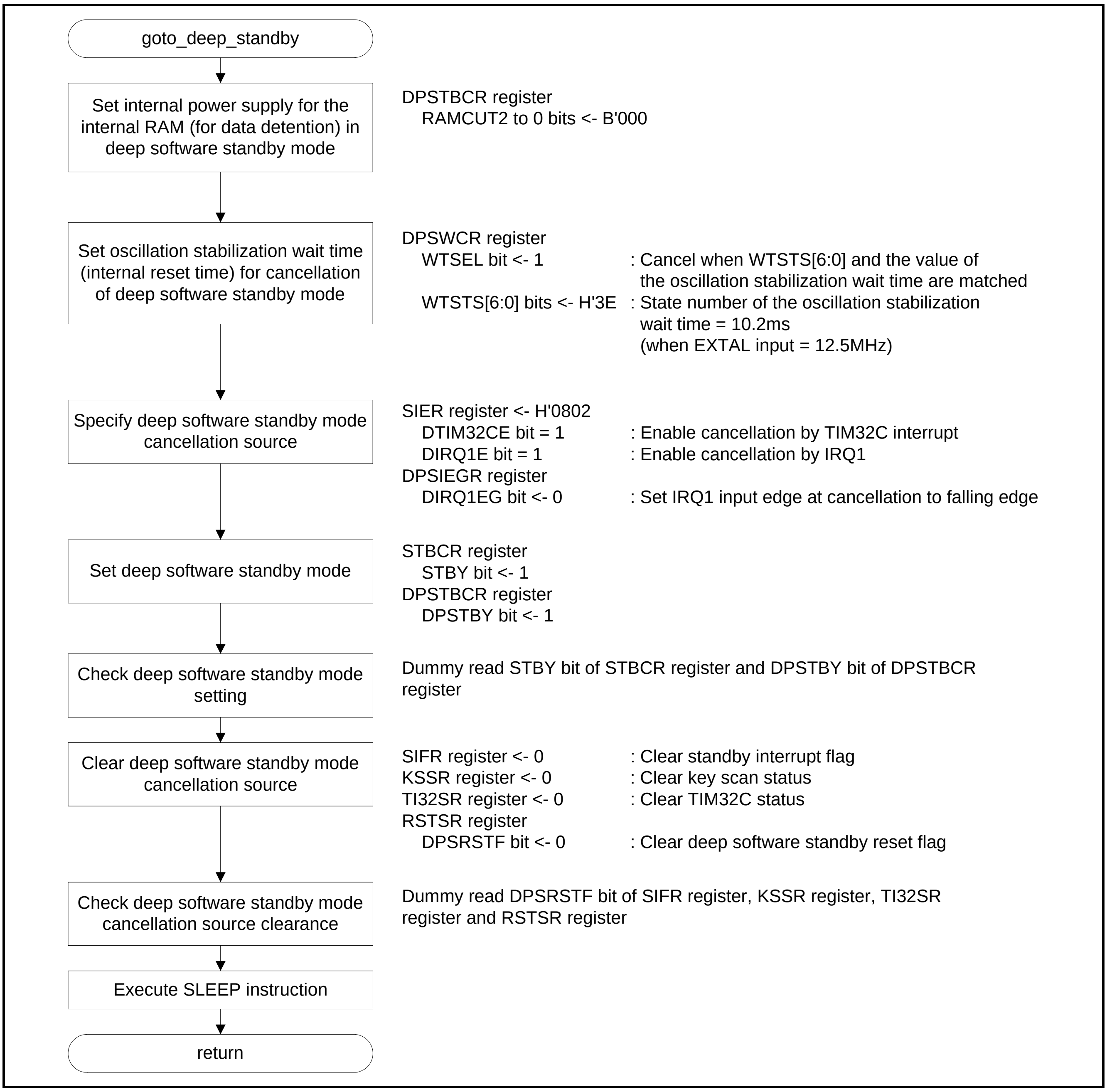

Figure 6.6 Transition Processing of Deep Software Standby Mode

6.5.6 Cancellation Processing of Deep Software Standby Mode

Figure 6.7 shows the Cancellation Processing of Deep Software Standby Mode.

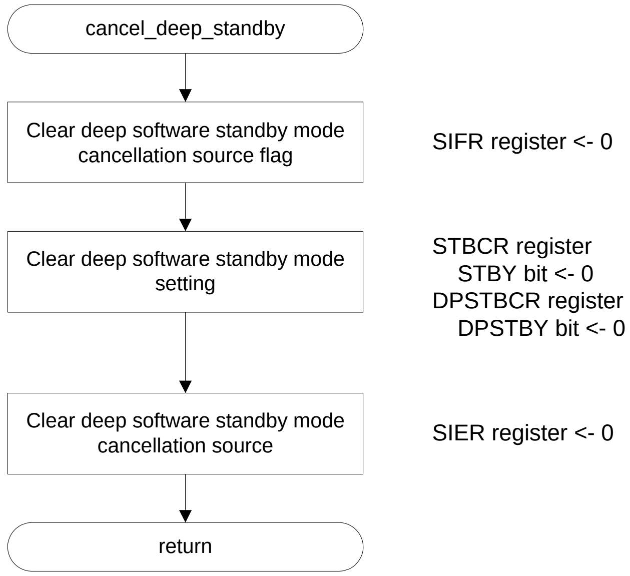

Figure 6.7 Cancellation Processing of Deep Software Standby Mode

6.5.7 32kHz Timer Interrupt Exception Handling

Figure 6.8 shows the 32kHz Timer Interrupt Exception Handling.

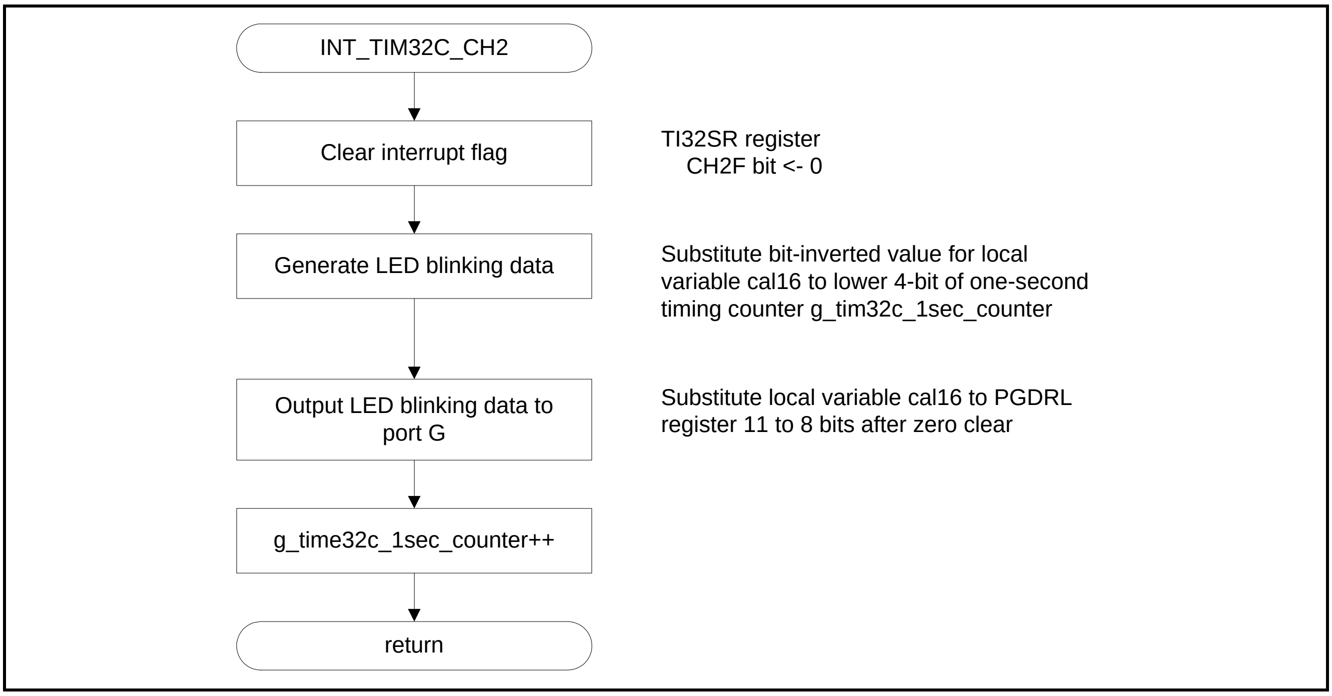

Figure 6.8 32kHz Timer Interrupt Exception Handling

6.5.8 IRQ0 Interrupt Exception Handling

Figure 6.9 shows the IRQ0 Interrupt Exception handling.

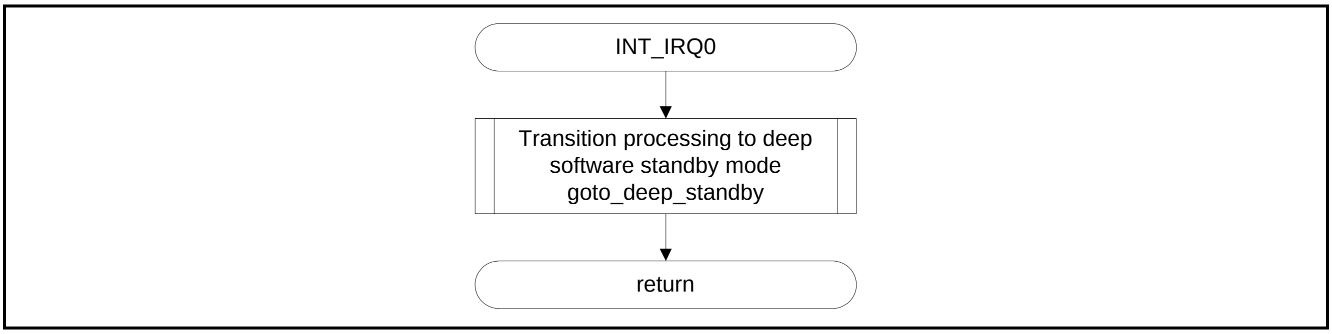

Figure 6.9 IRQ0 Interrupt Exception handling

7. Sample Code

Sample code can be downloaded from the Renesas Electronics website.

8. Reference Documents

User's Manual: Hardware
SH7231 Group User's Manual: Hardware (R01UH0073EJ)
The latest version can be downloaded from the Renesas Electronics website.

Technical Update/Technical News
The latest information can be downloaded from the Renesas Electronics website.

User's Manual: Development Tools
SuperH C/C++ Compiler Package V.9.04 User's Manual (R20UT0704EJ)
The latest version can be downloaded from the Renesas Electronics website.

Website and Support

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

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REVISION HISTORY	SH7231 Group Application Note Using 32kHz Timer

Rev.	**Date**	**Description**	
		Page	**Summary**
1.00	**Jun. 18, 2012**	—	First edition issued

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.
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 the change will not lead to problems.
   — The characteristics of MPU/MCU in the same group but having different type numbers may differ because of the differences in internal memory capacity and layout pattern. When changing to products of different type numbers, implement a system-evaluation test for each of the products.

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

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