M16C/5LD, M16C/56D, M16C/5L, M16C/56, M16C/5M, M16C/57, and M16C/6C Groups
Method for Measuring the Pulse Width or Pulse Period When the 16-bit Base Timer Exceeds the Count Range in Timer S

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Abstract

This document describes a method for using the time measurement function of timer S in the M16C/5LD, M16C/56D, M16C/5L, M16C/56, M16C/5M, M16C/57, and M16C/6C Groups to measure the pulse width or pulse period that exceeds the 16-bit base timer count range.

Products

MCUs: M16C/5LD, M16C/56D, M16C/5L, M16C/56, M16C/5M, M16C/57, and M16C/6C Groups

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 pulse width or pulse period of input pulses is measured using the time measurement function of timer S.

When overflows occur between time measurement triggers, count the number of overflows. When a time measurement trigger is input, the pulse width or pulse period is calculated. While taking the number of overflows into account when calculating, the pulse width or pulse period that exceeds the 16-bit base timer count range can be measured.

This application note describes measuring a pulse period from one rising edge to the next rising edge.

When a signal is input as shown in Figure 1.1, the value obtained at the first rising edge of an input pulse on the INPC1_0 pin is 'm', and the value obtained at second rising edge is 'n'. When the base timer overflows 'k' times from the first rising edge to the second rising edge, the calculation formula for the pulse period measured at the second rising edge is as follows:

$$\text{Pulse period} = (10000h \times k) + n - m$$

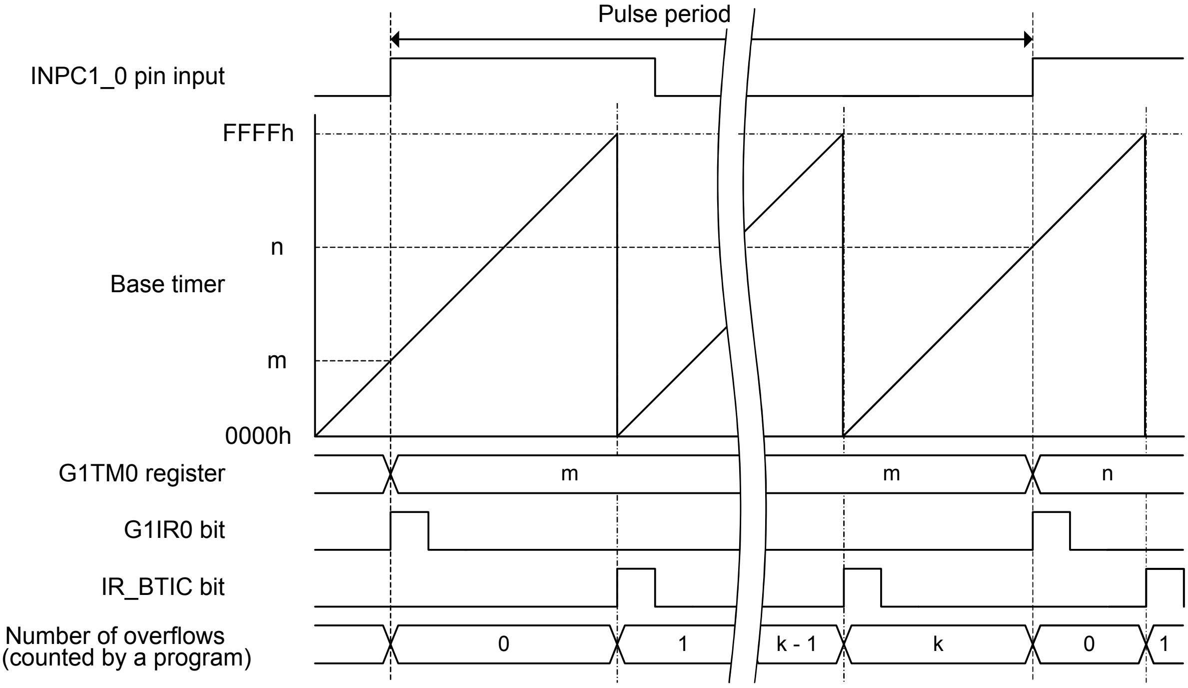
Table 1.1 lists the Pulse Measurement Specification and Table 1.2 lists the Peripheral Function and Its Usage. Figure 1.1 shows a Usage Example.

Table 1.1 Pulse Measurement Specification

Item	Description
Pin to input pulse	INPC1_0 (P2_0)
Time measurement trigger	Rising edge of an input pulse
Period for time measurement	From the rising edge of an input pulse to the rising edge of the next input pulse
Pulses for measuring time	Period between the rising edges of input pulses up to 16 seconds

Table 1.2 Peripheral Function and Its Usage

Peripheral Function	Usage
Timer S	Pulse period measurement



G1IR0 bit: Bit in the G1IR register
IR_BTIC bit: Bit in the BTIC register

The above assumes the following:
- In the G1TMCRj (j = 0 to 7) register, bits CTS1 and CTS0 are 01b (rising edge is selected as the time measurement trigger), the PR bit is 0 (prescaler not used), and the GT bit is 0 (gate function not used).
- The RST4 bit in the G1BCR0 register is 0, and bits RST2 and RST1 in the G1BCR1 register are 0 (base timer is not reset).
- Bits UD1 and UD0 in the G1BCR1 register are 00b (increment).

Figure 1.1 Usage Example

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	M16C/5LD Group
Operating frequencies	• Main clock: 8 MHz • CPU clock: 32 MHz (PLL operation mode: divided by 2, multiplied by 8)
Operating voltage	5.0 V (available between 2.7 to 5.0 V)
Integrated development environment	Renesas Electronics Corporation High-performance Embedded Workshop Version 4.09
C compiler	Renesas Electronics Corporation M16C Series/R8C Family C Compiler V.5.45 Release 01
	Compile options -c -finfo -dir "$(CONFIGDIR)" (The default setting is used in the integrated development environment.)
Operating mode	Single-chip mode
Sample code version	Version 1.00

3. Reference Application Notes

Application notes associated with this application note are listed below. Refer to these application notes for additional information.

- M16C/5LD, M16C/56D, M16C/5L, M16C/56, M16C/5M, M16C/57, and M16C/6C Groups
  Pulse Width Measurement with Time Measurement Function of Timer S (R01AN0833EJ)
- M16C/5LD, M16C/56D, M16C/5L, M16C/56, M16C/5M, M16C/57, and M16C/6C Groups
  Time Measurement Function of Timer S with Gate Function (R01AN0834EJ)
- M16C/5LD, M16C/56D, M16C/5L, M16C/56, M16C/5M, M16C/57, and M16C/6C Groups
  Time Measurement Function of Timer S with Prescaler Function (R01AN0835EJ)

4. Peripheral Functions

This chapter provides supplementary information on time measurement using the time measurement function of timer S and notes on timer S. Refer to the User's Manual: Hardware for details.

4.1 Time Measurement Using the Time Measurement Function of Timer S

The base timer counts the count source with free-running operation. With the time measurement function, when a time measurement trigger is input to the INPC1_j pin, the current base timer value is stored in the G1TMj register (j = 0 to 7). The value stored in the G1TMj register is not the time between time measurement triggers, but the value of the base timer. Therefore, to measure a pulse width or pulse period, calculate the difference between values obtained at two successive time measurement triggers.

In Figure 4.1, when the base timer value measured at the first time measurement trigger is 'a', and the value at the second time measurement trigger is 'b' (a measured value is stored in the G1TMj register), the pulse period is 'b - a'.

Pulse period = b - a
a: First value stored in the G1TMj register, b: Second value stored in the G1TMj register

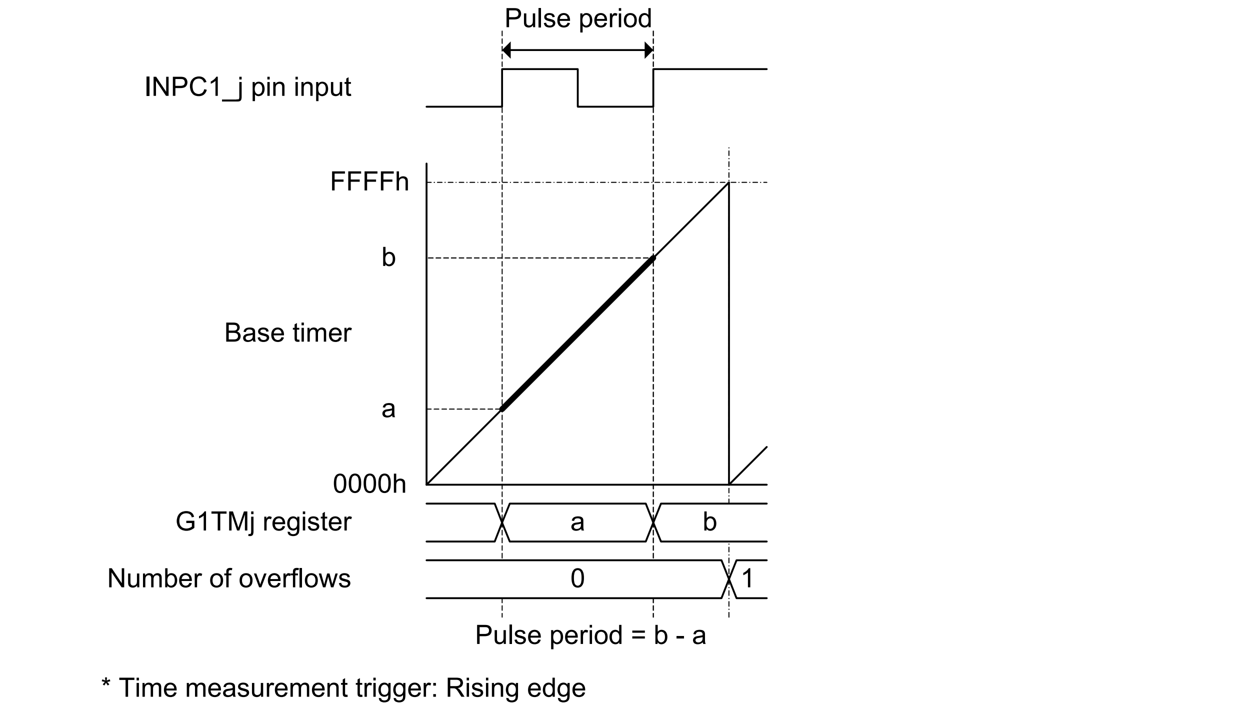


Figure 4.1 Example of Measuring a Pulse Period Using the Time Measurement Function

As shown in Figure 4.2, when an overflow occurs between the first and second time measurement triggers, the pulse period cannot be calculated with 'd - c'. For this case, 10000h needs to be added to the second obtained value as the number of overflows. By doing this, the second value can be considered as the value without the overflow.
Formula for calculating the pulse period with overflow is as follows:

Pulse period = (10000h × number of overflows) + d - c
c: First value stored in the G1TMj register, d: Second value stored in the G1TMj register

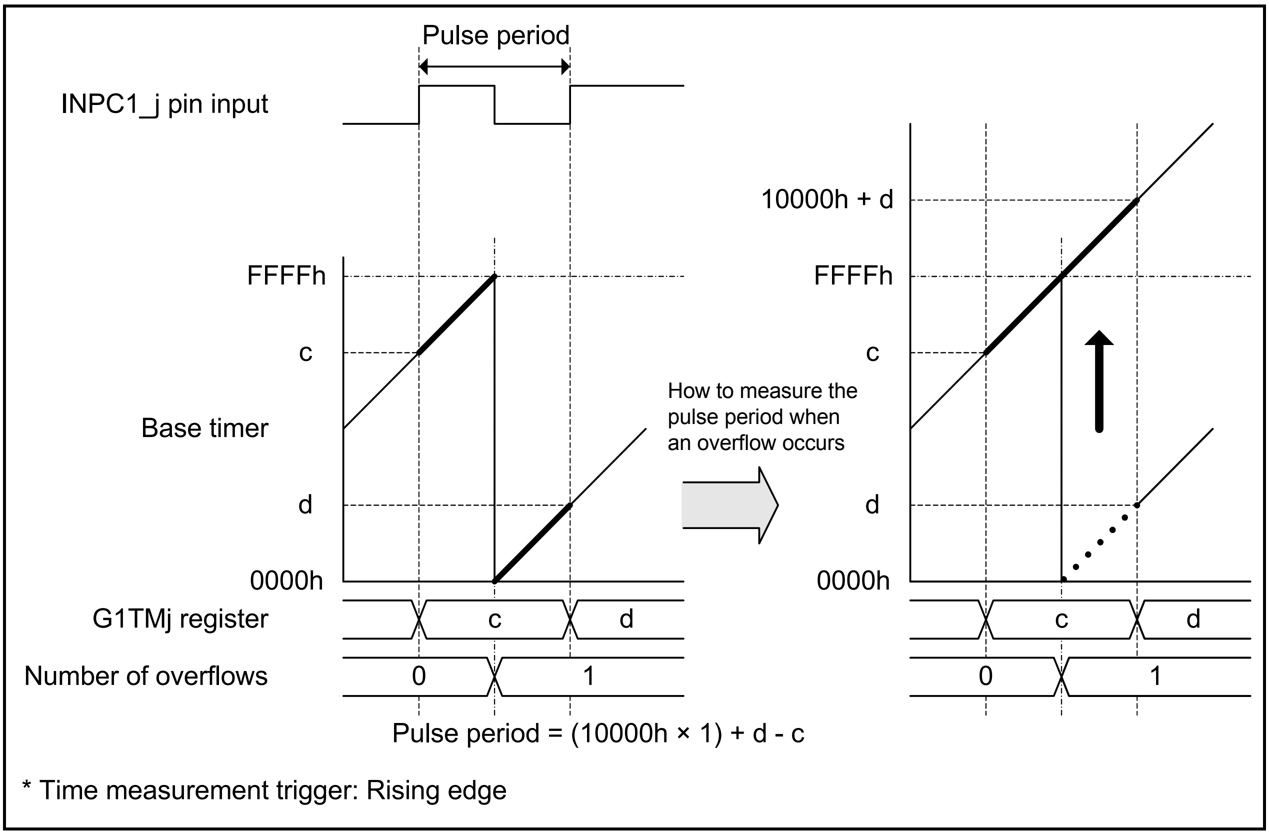


Figure 4.2 Example of Measuring a Pulse Period Using the Time Measurement Function when the Base Timer Overflows

4.2 Notes on Timer S

4.2.1 Interrupt Request When Selecting the Time Measurement Function

When the FSCj bit (j = 0 to 7) in the G1FS register is set to 1 (time measurement function selected), and the IFEj bit in the G1FE register is also set to 1, the G1IRj bit in the G1IR register, or the IR bits in registers ICOCiIC (i = 0, 1) or ICOCHjIC (j = 0 to 3) may become 1 (interrupt requested) after a maximum of two fBT1 cycles (1).
When using IC/OC interrupt i or IC/OC channel j interrupt, set bits FSCj and IFEj to 1, then perform the following:

(1) Wait for two or more fBT1 cycles (1).
(2) Set the IR bit in the ICOCiIC register and/or the ICOCHjIC register to 0.
(3) Wait for three or more fBT1 cycles (1) after the time measurement function is selected. Set the G1IR register to 00h (2) after setting the IR bit in the ICOCiIC register to 0.

Notes:
1. When using the digital filter, time required for the function also needs to be considered.
2. Verify the value in the G1IR register is 00h by reading. If the read value is not 00h, repeat writing 00h to the G1IR register.

5. Hardware

5.1 Example of Hardware Configuration

Figure 5.1 shows a Connection Example.

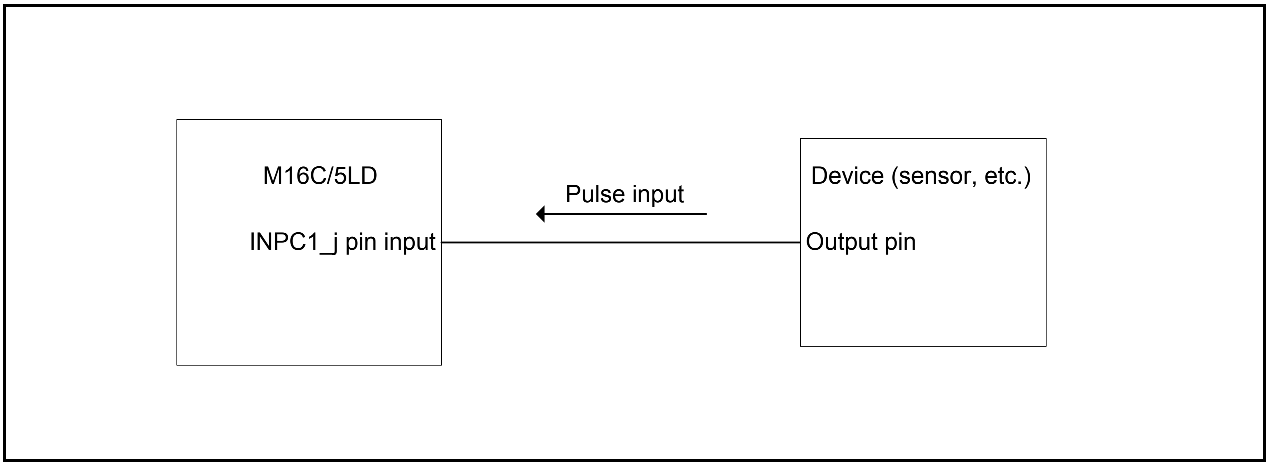


Figure 5.1 Connection Example

5.2 Pin Used

Table 5.1 lists the Pin Used and Its Function.

Table 5.1 Pin Used and Its Function

Pin Name	I/O	Function
P2_0/INPC1_0	Input	Input of measured pulse

6. Software

Use the time measurement function of timer S to measure the time from the rising edge of an input pulse to the rising edge of next input pulse.
Configure the overflow counter to measure pulse periods that exceed the 16-bit base timer count range. The counter is incremented by 1 every time the base timer overflow interrupt occurs.
For the interrupt by the time measurement trigger input, the base timer value is stored in the new_capture_val variable when the time measurement trigger is input. Calculate the pulse period using the new_capture_val and old_capture_val variables and overflow counter (refer to Table 6.1 for descriptions of terminologies).

The formula for calculating a pulse period is as follows:

Pulse period = (10000h × overflow counter value) + new_capture_val - old_capture_val

If the processing timing for an overflow and time measurement trigger input are the same, it is necessary to determine if one occurred before the other, or if they occurred simultaneously. The G1TM0 register can be used to determine the timing.

- When the G1TM0 register is smaller than 8000h, the time measurement trigger is input after the overflow.
- When the G1TM0 register is greater than 8000h, the time measurement trigger is input before the overflow, or they occur simultaneously.

The boundary value here is 8000h. One of the following operations is performed depending on the G1TM0 register value.

- When the value is smaller than 8000h, calculate the pulse period after processing the overflow.
- When the value is greater than 8000h, calculate the pulse period before processing the overflow.

Table 6.1 lists Terminologies Used in This Application Note.

Table 6.1 Terminologies Used in This Application Note

Terminology	Description
Overflow	Base timer overflow
Overflow counter	Variable to count the number of overflows
Count delay flag	When the processing timings for an overflow and time measurement input trigger overlap, and the value in the new_capture_val variable is obtained before the overflow, use this flag to increment the overflow counter by 1 after calculating the pulse period.

6.1 Operation Overview

Figure 6.1 shows the Input Pulse and Update Timing of Registers.

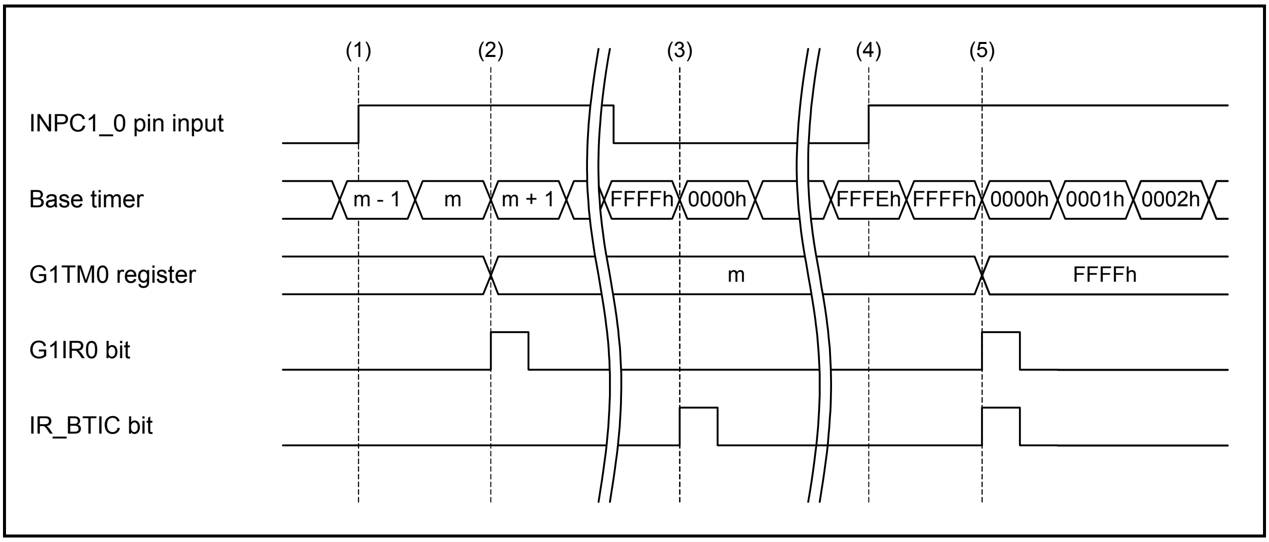


Figure 6.1 Input Pulse and Update Timing of Registers

Operations listed in Figure 6.1 are explained as follows:

(1) Input the time measurement trigger from the INPC1_0 pin.

(2) An interrupt request for IC/OC interrupt 0 is generated at the second count of the base timer from the time measurement trigger input (a maximum delay of two fBT1 cycles occurs).
Calculate the pulse period with the new_capture_val and old_capture_val variables and base time counter in the interrupt handler.

(3) When the base timer overflows, a base timer interrupt request is generated.
Increment the overflow counter by 1 in the interrupt handler.

(4) A time measurement trigger is input to the INPC1_0 pin when the base timer is FFFEh.

(5) An interrupt request for IC/OC interrupt 0 is generated at the second count of the base timer from the time measurement trigger input. Simultaneously, the base timer overflows and a base timer interrupt request is generated. Calculate the pulse period with the count of the overflow counter, new_capture_val and old_capture_val variables, and base time counter in the interrupt handler.

Processing when only IC/OC interrupt 0 occurs in (2) is described in 6.1.1 Processing When the IC/OC Interrupt 0 Occurs.
Processing when only the base timer interrupt occurs in (3) is described in 6.1.2 Processing When the Base Timer Interrupt Occurs.
Processing when IC/OC interrupt 0 and the base timer interrupt occur simultaneously in (5) is described in 6.1.3 Processing When the Base Timer Interrupt and IC/OC Interrupt 0 Occur Simultaneously.

6.1.1 Processing When the IC/OC Interrupt 0 Occurs

This section describes the processing for IC/OC interrupt 0 ((2) in Figure 6.1) which occurs when the time measurement trigger is input to the INPC1_0 pin ((1) in Figure 6.1).

Figure 6.2 shows the Processing when IC/OC Interrupt 0 Occurs. i to v correspond to i to v in the figure below.

i. Call the timer S interrupt common processing function.
ii. After IC/OC interrupt 0 occurs, call the pulse period calculation function.
iii. Read the value in the G1TM0 register and store it in the new_capture_val variable.
Calculate the pulse period with the new_capture_val and old_capture_val variables and overflow counter.
Then store the value of the new_capture_val variable in the old_capture_val variable.
iv. Reset the overflow counter to 0.
v. The count delay flag is 0 (global variables are reset to 0 in the initial setting). Thus the overflow counter is not incremented.

When the pulse period is calculated by the IC/OC interrupt 0 the first time, the old_capture_val variable is undefined. Thus the calculation result also becomes undefined.
When the time measurement trigger is input again before the pulse period calculation is completed, the calculation cannot be completed correctly.

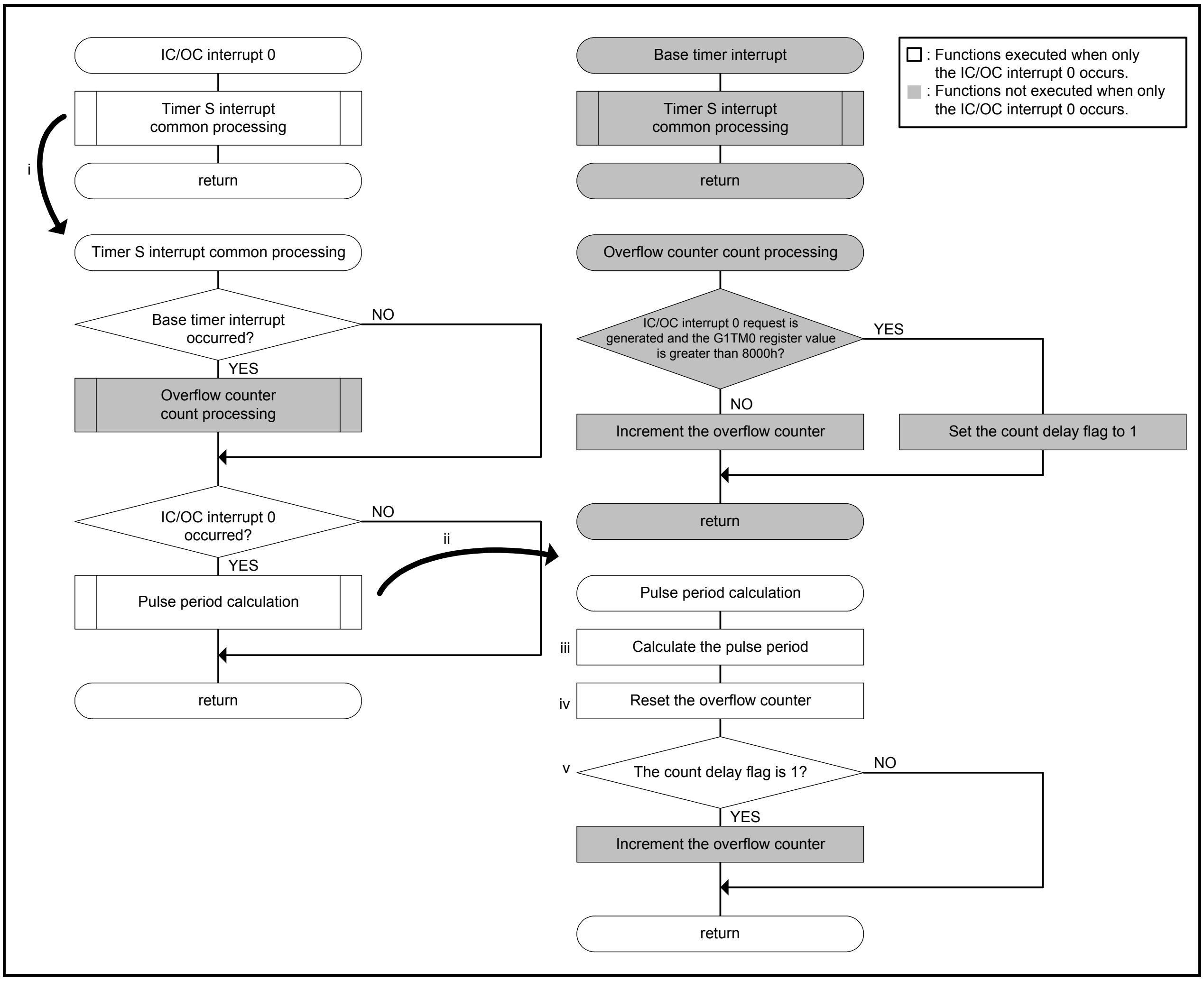


Figure 6.2 Processing when IC/OC Interrupt 0 Occurs

6.1.2 Processing When the Base Timer Interrupt Occurs

This section describes processing the base timer interrupt which occurs when the base timer overflows ((3) in Figure 6.1).

Figure 6.3 shows the Processing when the Base Timer Interrupt Occurs. i to iv correspond to i to iv in the figure below.

i. Call the timer S interrupt common processing function.
ii. After the base timer interrupt occurs, call the overflow counter count processing function.
iii. Determine whether an IC/OC interrupt 0 request is generated and also if the new_capture_val variable is greater than 8000h.
iv. Increment the overflow counter by 1.

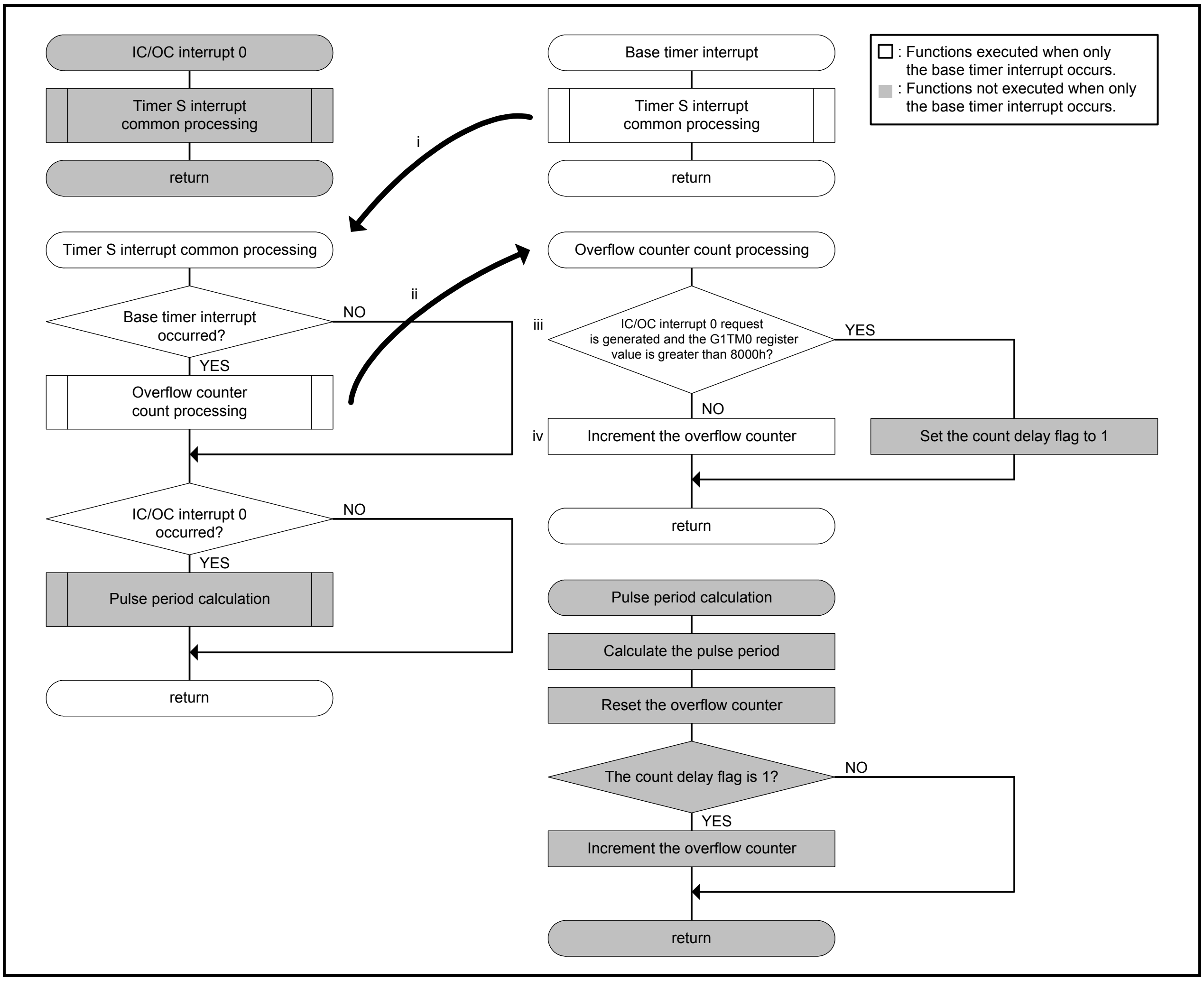


Figure 6.3 Processing when the Base Timer Interrupt Occurs

6.1.3 Processing When the Base Timer Interrupt and IC/OC Interrupt 0 Occur Simultaneously

This section describes the processing when IC/OC interrupt 0 and the base timer interrupt occur simultaneously ((5) in Figure 6.1). IC/OC interrupt 0 occurs when the time measurement trigger is input to the INPC1_0 pin ((4) in Figure 6.1), and the base timer interrupt occurs when the base timer overflows.

If two or more interrupt requests are generated simultaneously in a module which has multiple interrupts, the interrupt which has a lower interrupt priority level may be accepted before the interrupt which has a higher interrupt priority.

From the reason above, if requests for the base timer interrupt and IC/OC interrupt 0 are generated simultaneously, either one may be accepted first despite the interrupt priorities assigned to them. Therefore, in order to make the interrupt handling procedure the same regardless of which interrupt occurs, the same function is called in both interrupt handlers.

The following describes the processing when the base timer interrupt is accepted first. Figure 6.4 shows the Processing when Interrupt Requests are Generated Simultaneously and the Base Timer Interrupt is Accepted First. i to viii correspond to i to viii in the figure below.

i. Call the timer S interrupt common processing function.
ii. After the base timer interrupt occurs, call the overflow counter count processing function.
iii. Determine whether the time measurement trigger is input before or after the overflow.
iv. As the time measurement is input at the same time the base timer overflows, the overflow counter is not incremented. Instead, set 1 to the count delay flag to increment the overflow counter after the pulse period calculation.
v. After the IC/OC interrupt 0 occurs, call the pulse period calculation function.
vi. Read the value in the G1TM0 register and store it in the new_capture_val variable.
Calculate the pulse period with the new_capture_val and old_capture_val variables and overflow counter.
Then store the value of the new_capture_val variable in the old_capture_val variable.
vii. Reset the overflow counter to 0.
viii. As the count delay flag is 1, increment the overflow counter by 1.

When the pulse period calculated due to IC/OC interrupt 0 the first time, the old_capture_val variable is undefined. Thus the calculation result also becomes undefined.
When the time measurement trigger is input again before the pulse period calculation is completed, the calculation cannot be completed correctly.

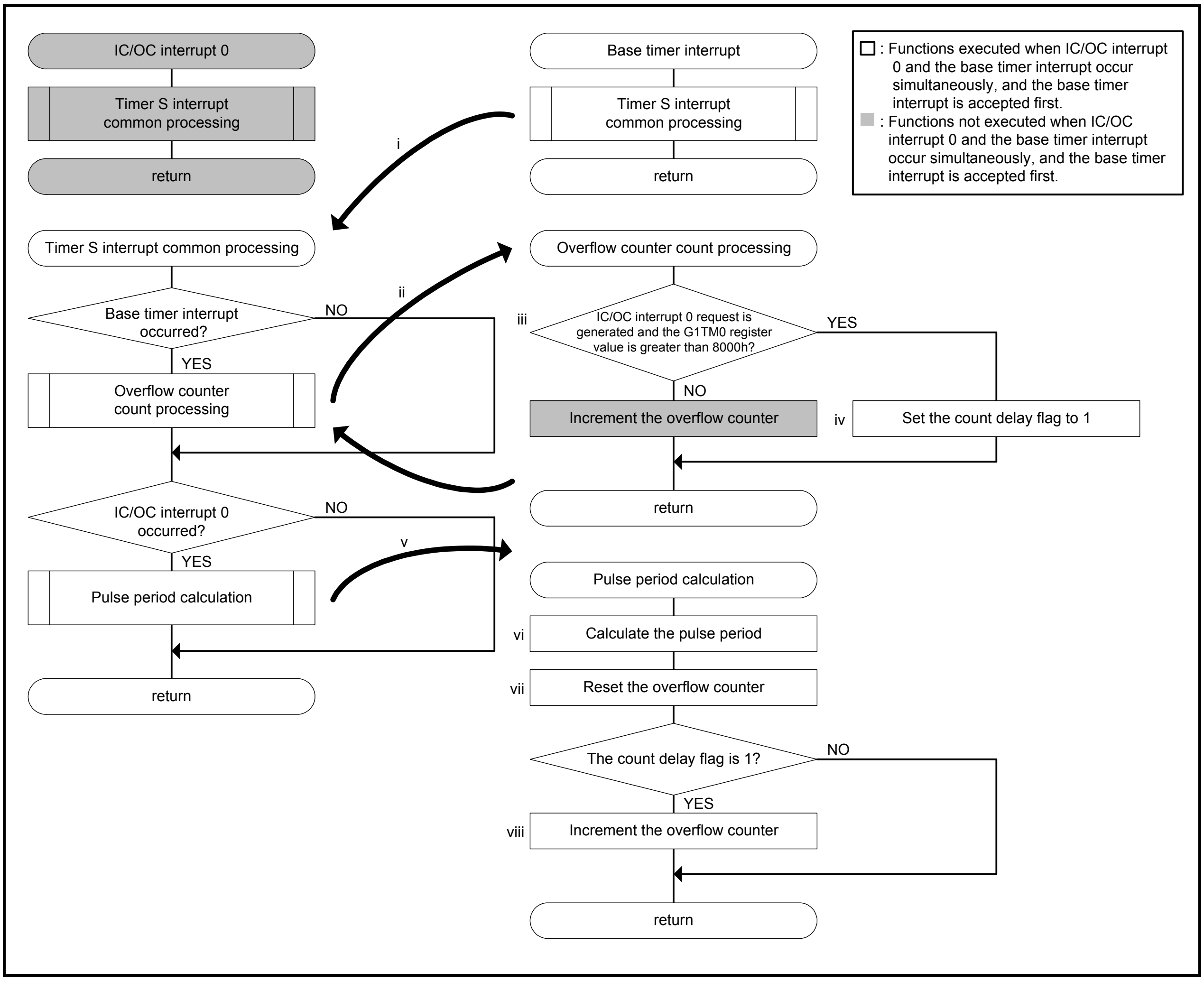


Figure 6.4 Processing when Interrupt Requests are Generated Simultaneously and the Base Timer Interrupt is Accepted First

The following describes the processing when the IC/OC interrupt 0 is accepted first. Figure 6.5 shows the Processing when Interrupt Requests are Generated Simultaneously and the IC/OC Interrupt is Accepted First. i to viii correspond to i to viii in the figure below.

i. Call the timer S interrupt common processing function.
ii. After the base timer interrupt occurs, call the overflow counter count processing function.
iii. Determine whether the time measurement trigger is input before or after the overflow.
iv. As the time measurement is input at the same time the base timer overflows, the overflow counter is not incremented. Instead, set 1 to the count delay flag to increment the overflow counter after the pulse period calculation.
v. After the IC/OC interrupt 0 occurs, call the pulse period calculation function.
vi. Read the value in the G1TM0 register and store it in the new_capture_val variable.
Calculate the pulse period with the new_capture_val and old_capture_val variables and overflow counter.
Then store the value of the new_capture_val variable in the old_capture_val variable.
vii. Reset the overflow counter to 0.
viii. As the count delay flag is 1, increment the overflow counter by 1.

When the pulse period is calculated due to IC/OC interrupt 0 the first time, the old_capture_val variable is undefined. Thus the calculation result also becomes undefined.
When the time measurement trigger is input again during the pulse period calculation, the calculation cannot be completed correctly.

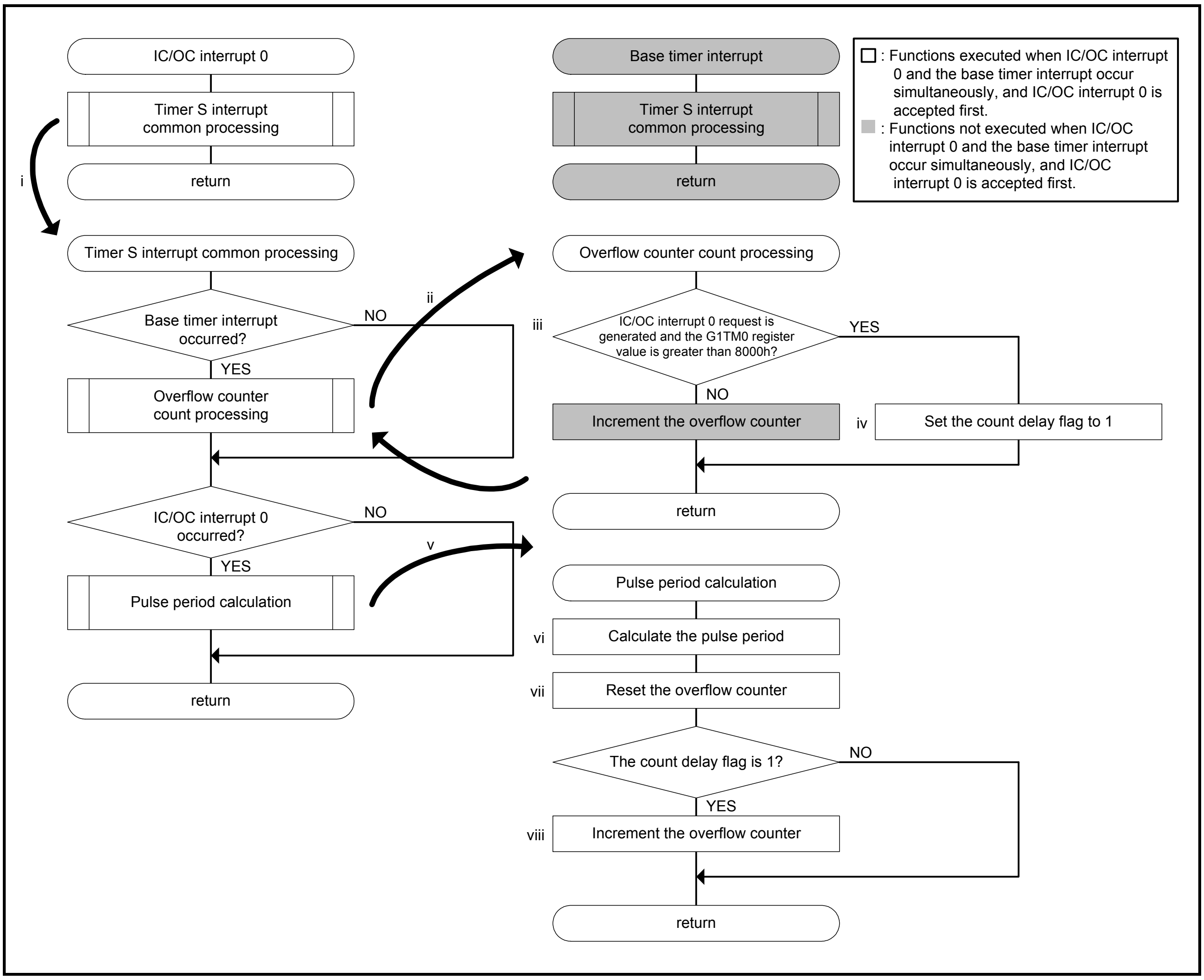


Figure 6.5 Processing when Interrupt Requests are Generated Simultaneously and the IC/OC Interrupt is Accepted First

6.2 Variables

Table 6.2 lists the Global Variables.

Table 6.2 Global Variables

Type	Variable Name	Contents	Function Used
unsigned long	pulse_width	Calculation result of a pulse period	main, pulse_width_calc_func
unsigned short	new_capture_val	Variable to store the value of the base timer when the time measurement trigger is input	main, pulse_width_calc_func
unsigned short	old_capture_val	Variable to store the current value of the new_capture_val variable for calculating the next pulse period	main, pulse_width_calc_func
unsigned char	bt_ovrflw_counter	Overflow counter: Variable to count the number of overflows	main, bt_ovrflw_cnt_func, pulse_width_calc_func
unsigned char	f_delay_ovrflw_cnt	Count delay flag 0: The overflow counter is incremented by 1 before the pulse period calculation 1: The overflow counter is incremented by 1 after the pulse period calculation	main, bt_ovrflw_cnt_func, pulse_width_calc_func
unsigned char	f_bt_int	Base timer interrupt flag 0: Base timer interrupt not requested 1: Base timer interrupt requested	main, _ic_oc_basetimer, ts_int_common_func
unsigned char	f_icoc0_int	IC/OC interrupt 0 flag 0: IC/OC interrupt 0 not requested 1: IC/OC interrupt 0 requested	main, _ic_oc0, ts_int_common_func

6.3 Functions

Table 6.3 lists the Functions.

Table 6.3 Functions

Function Name	Outline
main	Main processing
mcu_init	CPU clock initialization
peripheral_init	Peripheral function initialization
_ic_oc_basetimer	Base timer interrupt handler
_ic_oc0	IC/OC interrupt 0 handler
ts_int_common_func	Timer S interrupt common processing
bt_ovrflw_cnt_func	Overflow counter count processing
pulse_width_calc_func	Pulse period calculation

6.4 Function Specifications

The following tables list the sample code function specifications.

main	
Outline	Main processing
Header	None
Declaration	void main(void)
Explanation	Call the CPU clock initialization and peripheral function initialization to initialize the CPU clock and peripherals. Reset global variables to 0. Enable maskable interrupts and start the base timer counting.
Argument	None
Returned value	None

mcu_init	
Outline	CPU clock initialization
Header	None
Declaration	void mcu_init(void)
Explanation	This function is called in the main processing. Set the CPU clock to PLL clock multiplied by 4 (divided by 2, multiplied by 8).
Argument	None
Returned value	None

peripheral_init	
Outline	Peripheral function initialization
Header	None
Declaration	void peripheral_init(void)
Explanation	This function is called in the main processing. Set channel 0 of timer S to the time measurement function.
Argument	None
Returned value	None

_ic_oc_basetimer	
Outline	Base timer interrupt handler
Header	None
Declaration	void _ic_oc_basetimer(void)
Explanation	This function is called when the base timer overflows and the base timer interrupt occurs. Set the base timer interrupt flag to 1 (interrupt requested). Then call the timer S interrupt common processing.
Argument	None
Returned value	None

_ic_oc0	
Outline	IC/OC interrupt 0 handler
Header	None
Declaration	void _ic_oc0(void)
Explanation	This function is called when the time measurement trigger is input and IC/OC interrupt 0 occurs. Set the IC/OC interrupt 0 flag to 1 (interrupt requested). Then call the timer S interrupt common processing.
Argument	None
Returned value	None

ts_int_common_func	
Outline	Timer S interrupt common processing
Header	None
Declaration	void ts_int_common_func(void)
Explanation	This function is called in the base timer interrupt handler and the IC/OC interrupt 0 handler. Check the interrupt request flag (IR flag) to determine if requests for the base timer interrupt and IC/OC interrupt 0 are generated simultaneously. • When checking the base timer interrupt request, if the IR flag is 1 (interrupt requested), set the base timer interrupt flag to 1 (interrupt requested). • When checking the IC/OC interrupt 0 request, if the IR flag is 1 (interrupt requested), set the IC/OC interrupt 0 flag to 1 (interrupt requested). When the base timer interrupt flag is 1, call the overflow counter count processing. When the IC/OC interrupt 0 flag is 1, call the pulse period calculation.
Argument	None
Returned value	None

bt_ovrflw_cnt_func	
Outline	Overflow counter count processing
Header	None
Declaration	void bt_ovrflw_cnt_func(void)
Explanation	When the base timer interrupt flag is 1 (interrupt requested), this function is called in the timer S interrupt common processing. Increment the overflow counter by 1. However if the IC/OC interrupt 0 flag is 1, and the value in the time measurement register is greater than 8000h (an overflow does not occur when the time measurement trigger is input), set the count delay flag to 1.
Argument	None
Returned value	None

pulse_width_calc_func	
Outline	Pulse period calculation
Header	None
Declaration	void pulse_width_calc_func(void)
Explanation	When the IC/OC interrupt 0 flag is 1 (interrupt requested), this function is called in the timer S interrupt common processing. Store the G1TMj register value in the new_capture_val variable. Calculate the pulse period with the new_capture_val and old_capture_val variables and overflow counter value. The calculation formula is as follows: Pulse period = (10000h × overflow counter value) + new_capture_val - old_capture_val After calculation, store the value of the new_capture_val variable in the old_capture_val variable. Reset the overflow counter. If the count delay flag is 1, increment the overflow counter by 1.
Argument	None
Returned value	None

6.5 Flowcharts

6.5.1 Main Processing

Figure 6.6 shows the Main Processing.

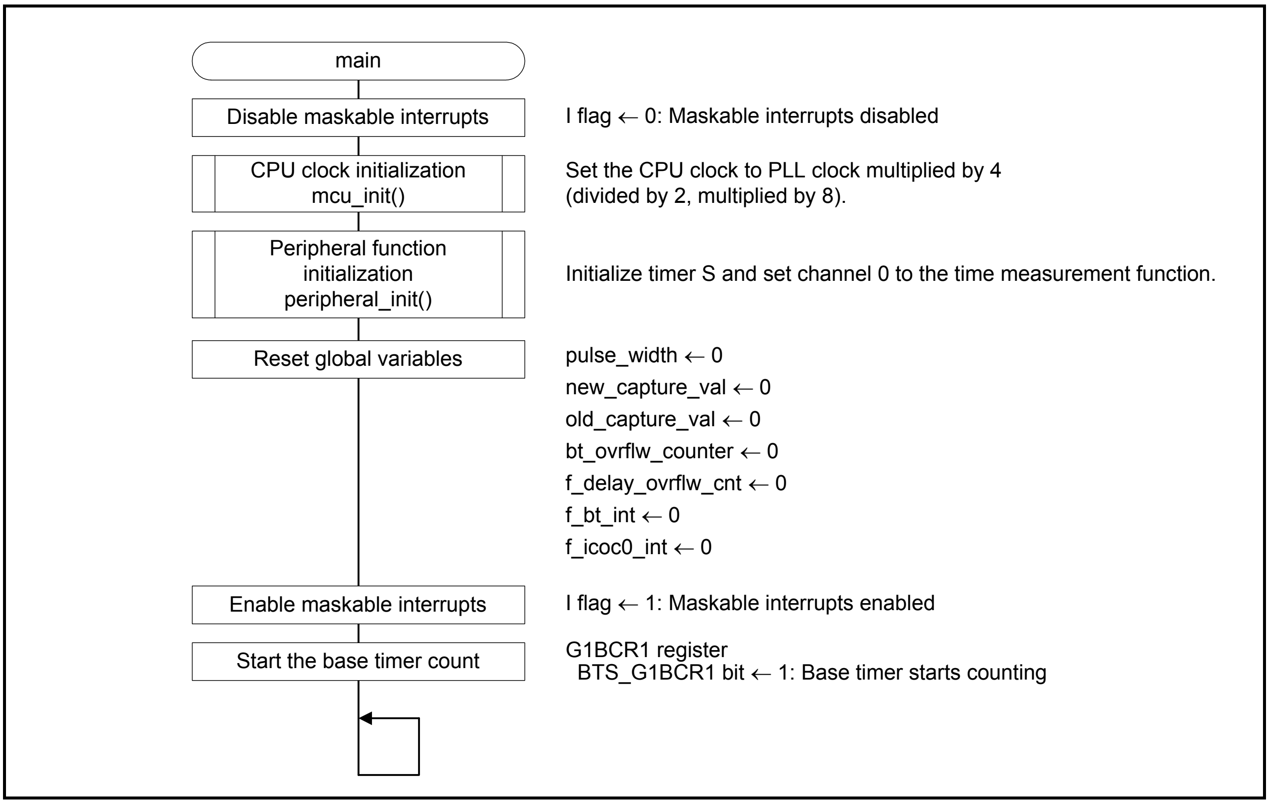


Figure 6.6 Main Processing

6.5.2 Peripheral Function Initialization

Figure 6.7 shows the Peripheral Function Initialization.

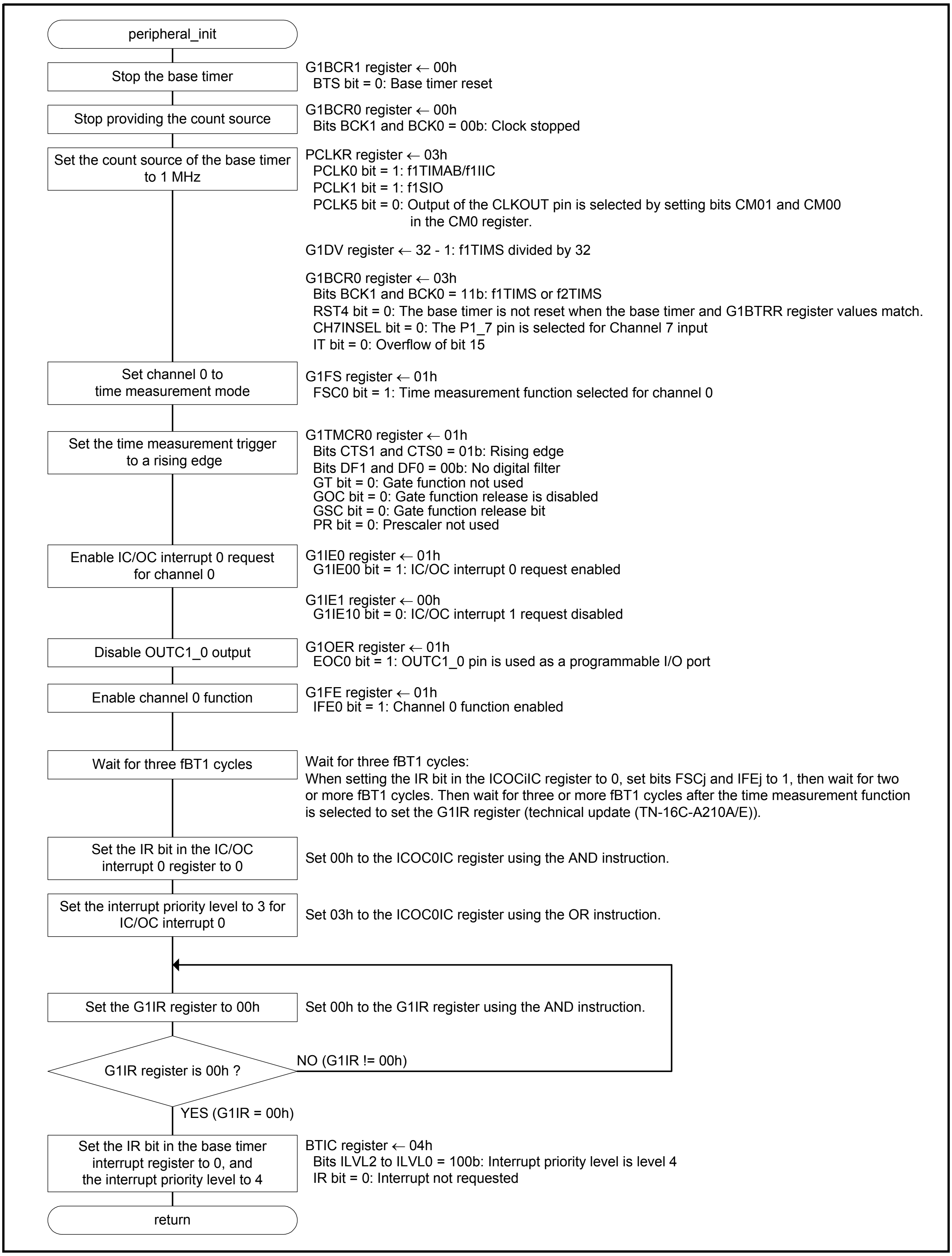


Figure 6.7 Peripheral Function Initialization

6.5.3 Base Timer Interrupt Handler

Figure 6.8 shows the Base Timer Interrupt.

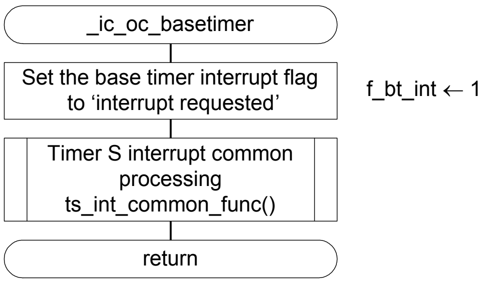


Figure 6.8 Base Timer Interrupt

6.5.4 IC/OC Interrupt 0 Handler

Figure 6.9 shows the IC/OC Interrupt 0.

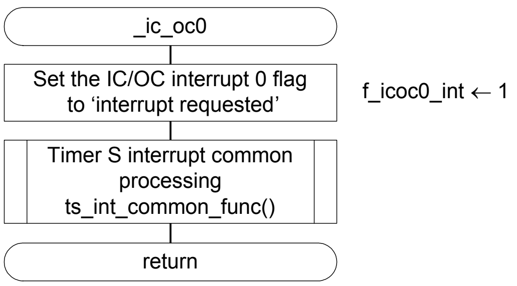


Figure 6.9 IC/OC Interrupt 0

6.5.5 Timer S Interrupt Common Processing

Figure 6.10 shows the Timer S Interrupt Common Processing.

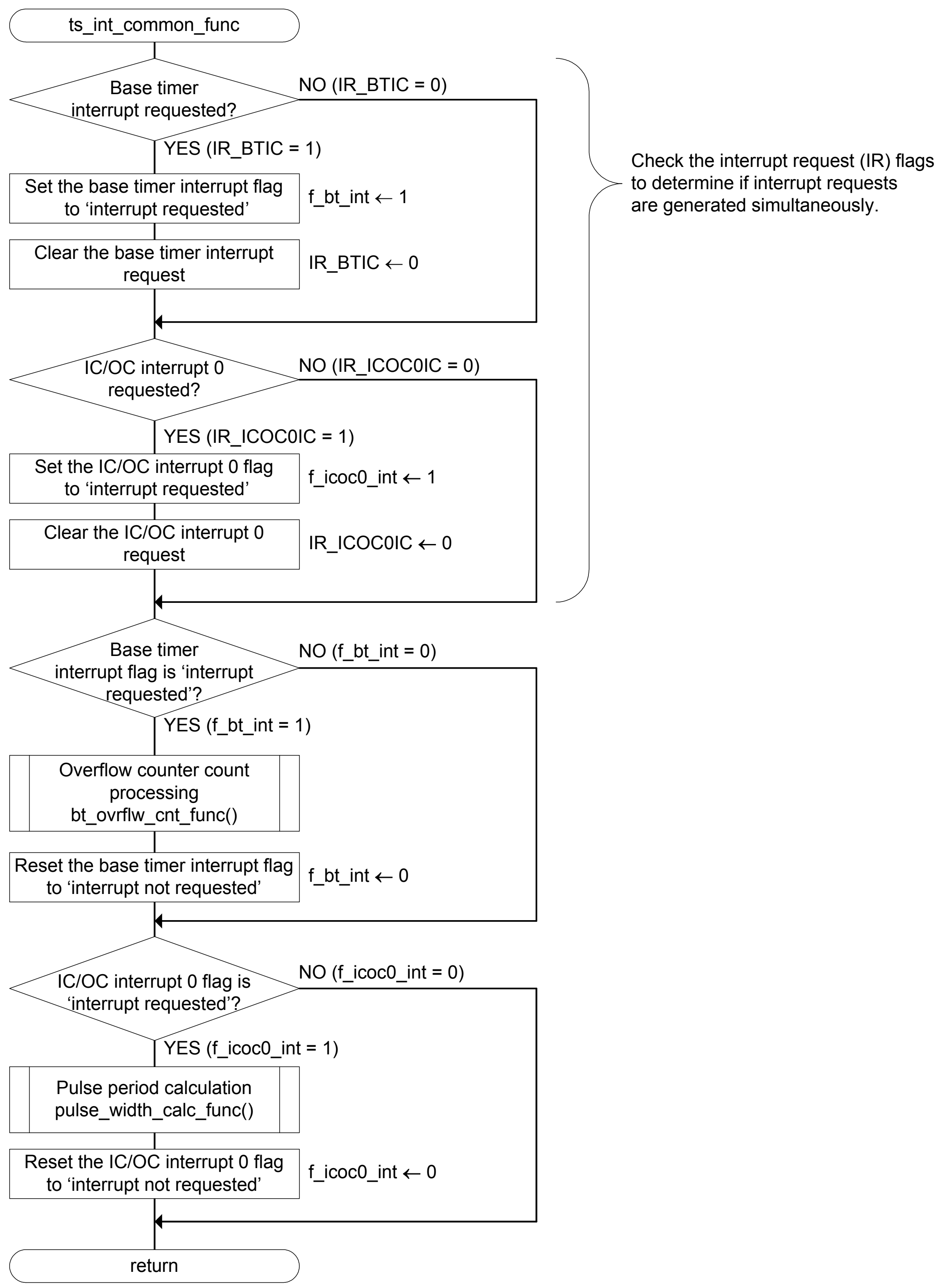


Figure 6.10 Timer S Interrupt Common Processing

6.5.6 Overflow Counter Count Processing

Figure 6.11 shows the Overflow Counter Count Processing.

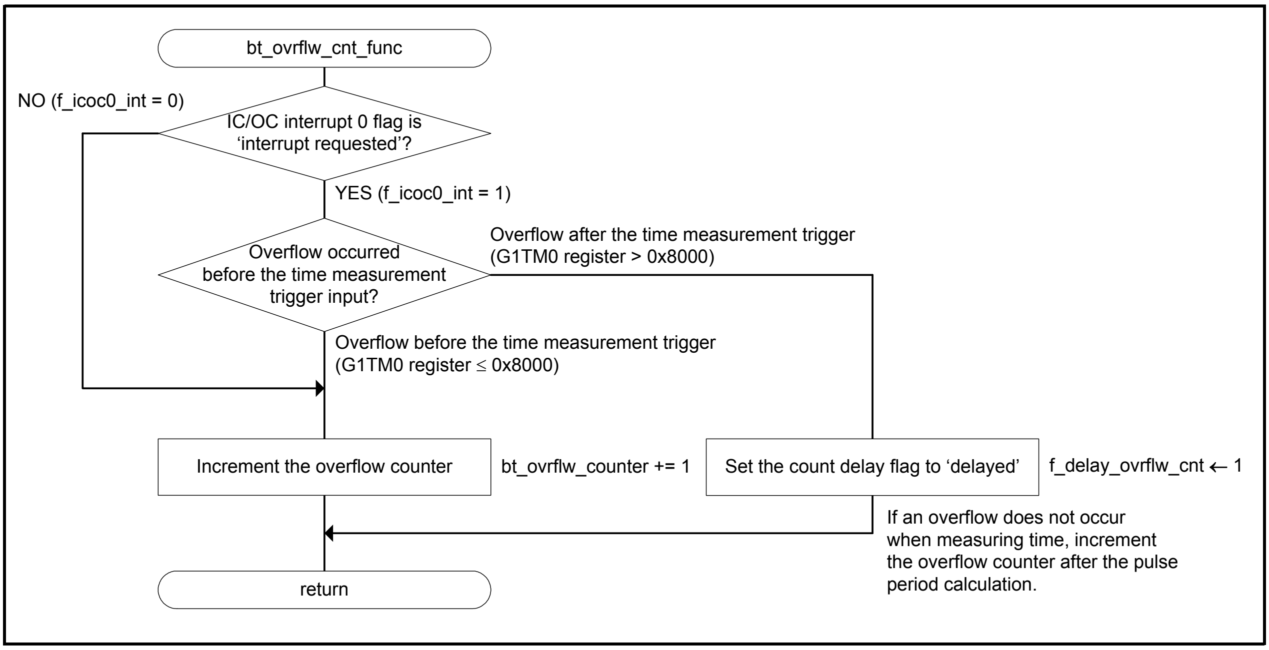


Figure 6.11 Overflow Counter Count Processing

6.5.7 Pulse Period Calculation

Figure 6.12 shows the Pulse Period Calculation.

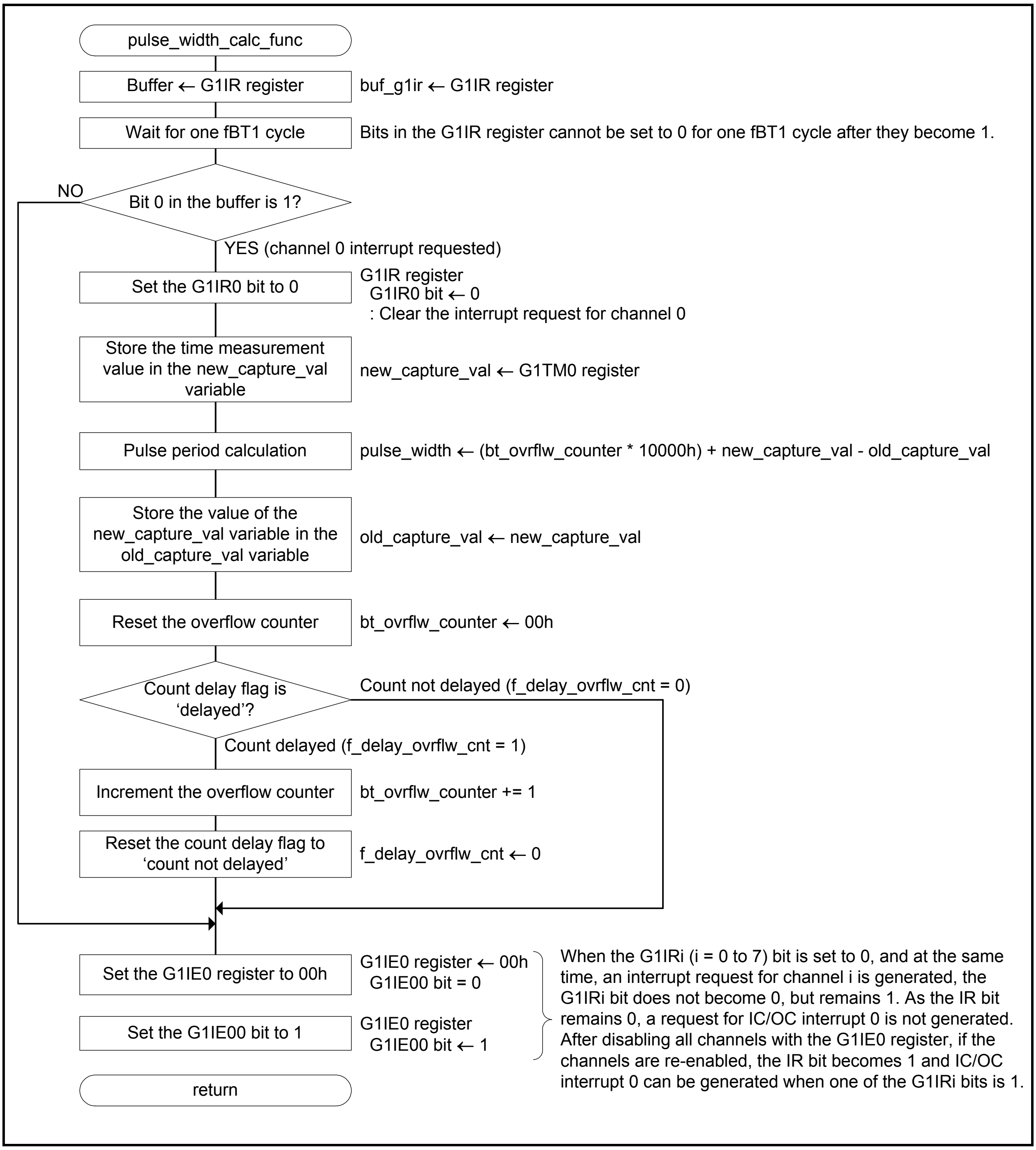


Figure 6.12 Pulse Period Calculation

7. Sample Code

Sample code can be downloaded from the Renesas Electronics website.

8. Reference Documents

M16C/5LD Group, M16C/56D Group User's Manual: Hardware Rev.1.20
M16C/5L Group, M16C/56 Group User's Manual: Hardware Rev.1.10
M16C/5M Group, M16C/57 Group User's Manual: Hardware Rev.1.10
M16C/6C Group User's Manual: Hardware Rev.2.00
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.

C Compiler User's Manual
M16C Series, R8C Family C Compiler Package V.5.45
C Compiler User's Manual Rev.2.00
The latest version can be downloaded from the Renesas Electronics website.

Website and Support

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

Inquiries
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Revision History	M16C/5LD, M16C/56D, M16C/5L, M16C/56, M16C/5M, M16C/57, and M16C/6C Groups Method for Measuring the Pulse Width or Pulse Period When the 16-bit Base Timer Exceeds the Count Range in Timer S

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		Page	Summary
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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 part number, confirm that the change will not lead to problems.

   — The characteristics of MPU/MCU in the same group but having different part numbers may differ because of the differences in internal memory capacity and layout pattern. When changing to products of different part numbers, implement a system-evaluation test for each of the products.

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