

## RL78/G14

R01AN1393EJ0110

Rev. 1.10

June. 1, 2013

---

### Timer RG in Phase Counting Mode

---

#### Abstract

This document describes how to detect the phase difference between external input signals from pins TRGCLKA and TRGCLKB using the RL78/G14 timer RG in phase counting mode.

#### Products

RL78/G14

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 .....	3
2. Operation Confirmation Conditions .....	4
3. Hardware .....	4
3.1 Hardware Configuration .....	4
3.2 Pins Used.....	5
4. Software .....	5
4.1 Operation Overview .....	5
4.2 Setting Option Bytes .....	6
4.3 Variables .....	6
4.4 Functions.....	7
4.5 Function Specifications .....	7
4.6 Flowcharts.....	9
4.6.1 Overall Flowchart.....	9
4.6.2 Initialization .....	9
4.6.3 Peripheral Function Initialization.....	9
4.6.4 CPU Clock Initialization .....	10
4.6.5 Timer RG Initialization .....	11
4.6.6 Main Processing .....	20
4.6.7 Setting Timer RG to Start .....	20
4.6.8 Timer RG Interrupt Handling .....	23
5. Sample Code.....	25
6. Reference Documents.....	25

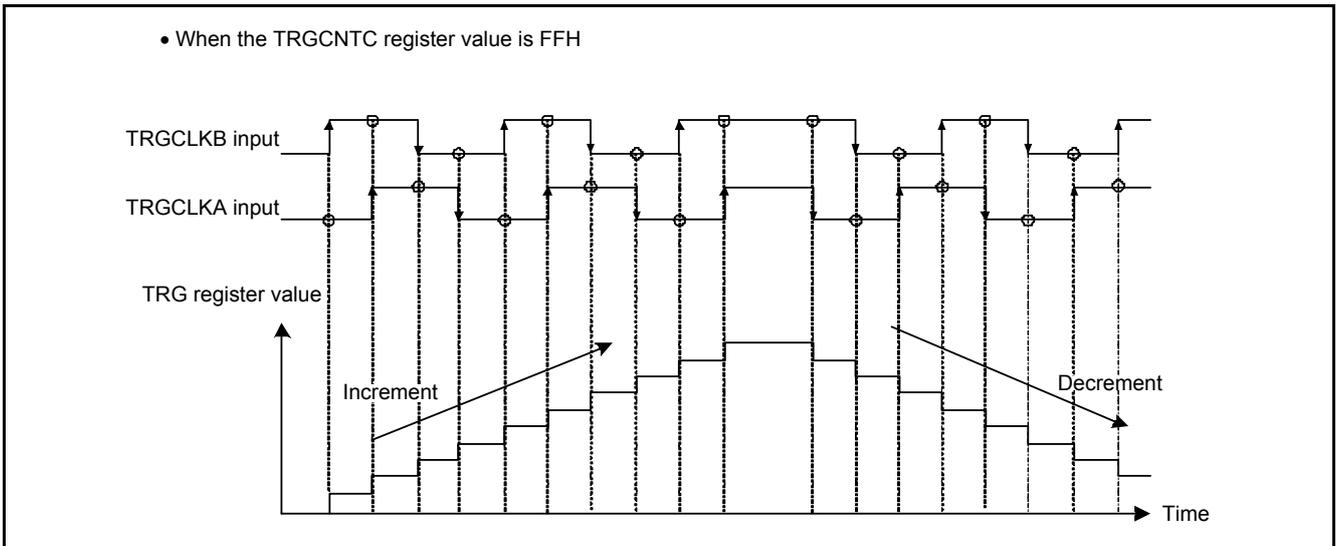
### 1. Specifications

The RL78/G14 MCU detects the phase difference between external input signals from pins TRGCLKA and TRGCLKB and the counter starts counting.

Table 1.1 lists the peripheral function and its application and Figure 1.1 shows an operation overview of phase counting mode.

**Table 1.1 Peripheral Function and Its Application**

Peripheral Function	Application
Timer RG	Detects the phase difference between pins TRGCLKA and TRGCLKB



**Figure 1.1 Operation Overview of Phase Counting Mode**

## 2. Operation Confirmation Conditions

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

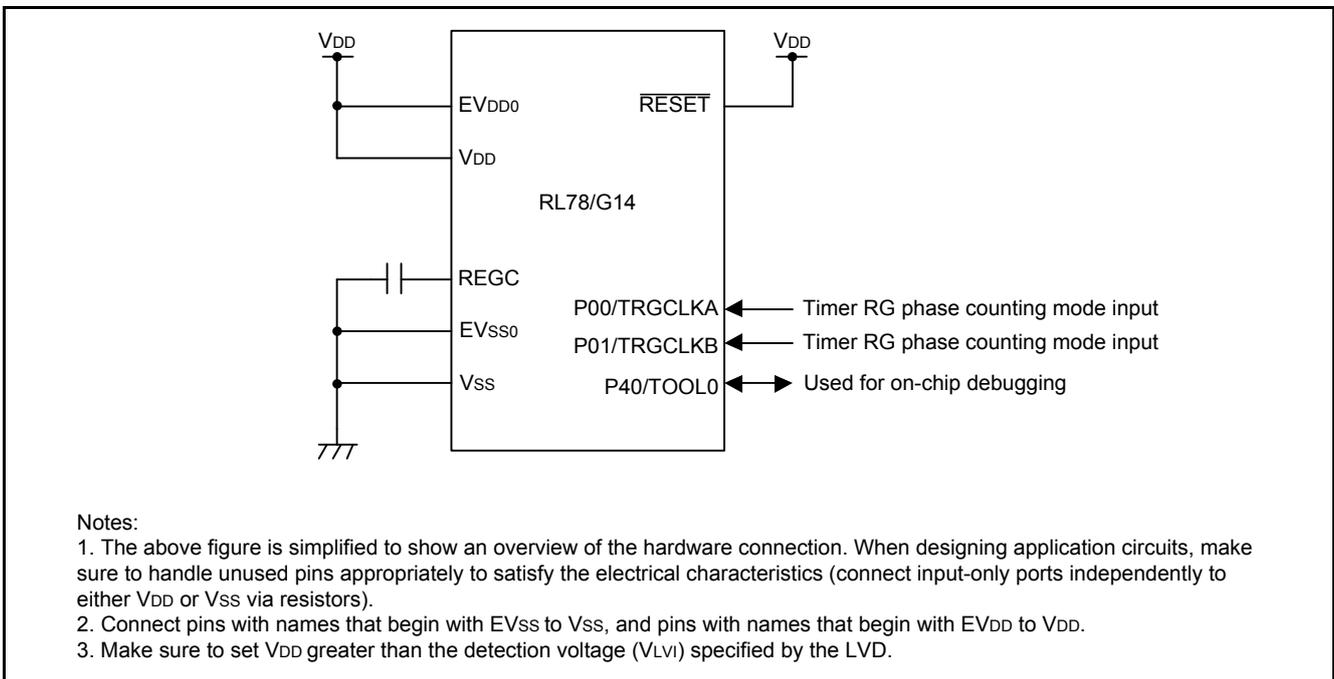
**Table 2.1 Operation Confirmation Conditions**

Item	Contents
MCU used	RL78G14 (R5F104PJA)
Operating frequency	<ul style="list-style-type: none"> <li>High-speed on-chip oscillator clock (fHOCO): 16 MHz (typ.)</li> <li>CPU/peripheral hardware clock (fCLK): 16 MHz</li> </ul>
Operating voltage	5.0 V (operation enabled from 2.9 to 5.5 V) LVD operation (VLVI): 2.81 V at the rising edge or 2.75 V at the falling edge in reset mode
Integrated development environment	Renesas Electronics Corporation CubeSuite+ V1.02.01
C compiler	Renesas Electronics Corporation CA78K0R V1.41
RL78/G14 code library	Renesas Electronics Corporation CodeGenerator for RL78/G14 V1.01.01

## 3. Hardware

### 3.1 Hardware Configuration

Figure 3.1 shows the hardware configuration used in this application note.



**Figure 3.1 Hardware Configuration**

### 3.2 Pins Used

Table 3.1 lists the pins used and their functions.

**Table 3.1 Pins Used and Their Functions**

Pin Name	I/O	Function
P00/TRGCLKA	Input	Inputs an external signal
P01/TRGCLKB	Input	Inputs an external signal

## 4. Software

### 4.1 Operation Overview

Use timer RG in phase counting mode to detect the phase difference between external input signals from pins TRGCLKA and TRGCLKB, and increment or decrement the TRG register.

Set timer RG as follows:

- Use timer RG in phase counting mode
- Do not clear the TRG register
- Digital filter is disabled in pins TRGCLKA and TRGCLKB
- Set 0000H in the TRG register as a default value
- Specify the counter enable bit to increment or decrement
- Enable overflow and underflow interrupts
- Set pins PM01 and PM00 to input mode

Table 4.1 lists increment or decrement conditions of the TRG register.

**Table 4.1 Increment or Decrement Conditions of the TRG Register**

TRGCLKB pin	$\uparrow$	H	$\downarrow$	L	H	$\downarrow$	L	$\uparrow$
TRGCLKA pin	L	$\uparrow$	H	$\downarrow$	$\downarrow$	L	$\uparrow$	H
Bits CNTEN7 to CNTEN0 in the TRGCNTC register	CNTEN7	CNTEN6	CNTEN5	CNTEN4	CNTEN3	CNTEN2	CNTEN1	CNTEN0
Increment/decrement	+1	+1	+1	+1	-1	-1	-1	-1

Figure 4.1 shows the operation of phase counting mode.

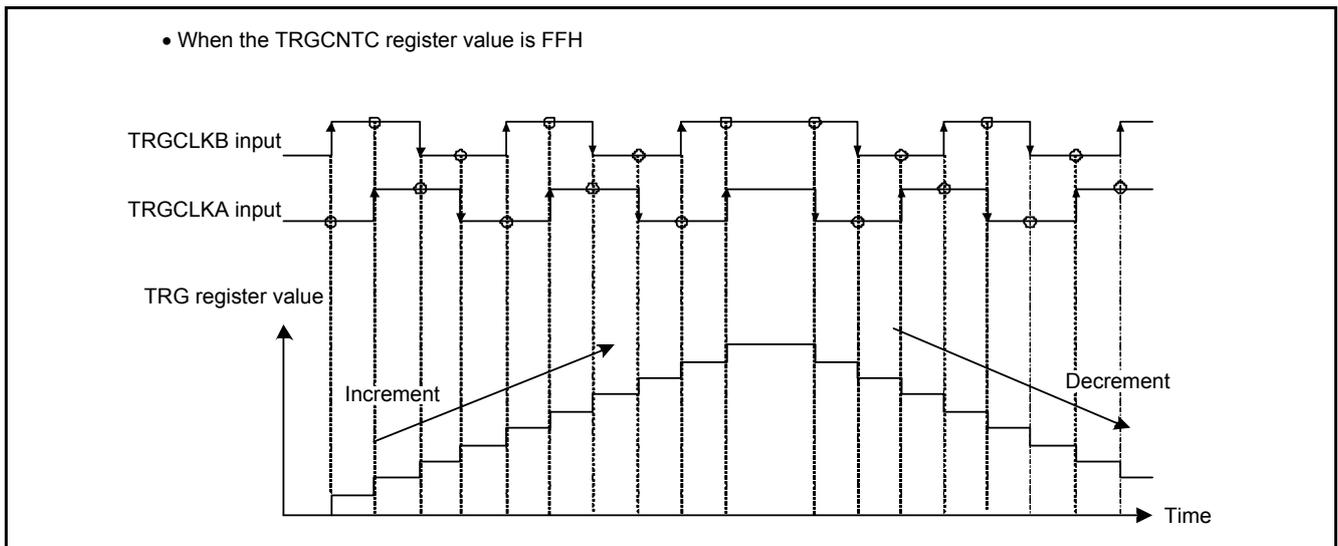


Figure 4.1 Operation Example of Phase Counting Mode

## 4.2 Setting Option Bytes

Table 4.2 lists the option byte setting.

Table 4.2 Option Bytes

Address	Setting Value	Contents
000C0H/010C0H	11101111B	Stops the watchdog timer (counting is stopped after 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	11101001B	Sets the high-speed on-chip oscillator clock as 16 MHz, and the flash operating mode in HS (high-speed) mode
000C3H/010C3H	10000100B	Enables on-chip debugging

## 4.3 Variables

Table 4.3 lists the global variables.

Table 4.3 Global Variables

Type	Variable Name	Contents	Function Used
uint8_t	intrtg_over_cnt	Number of overflows	r_tmr_rg0_interrupt
uint8_t	intrtg_under_cnt	Number of underflows	r_tmr_rg0_interrupt

## 4.4 Functions

Table 4.4 lists the functions.

**Table 4.4 Functions**

Function Name	Outline
hdwinit	Initialization
R_Systeminit	Peripheral functions initialization
R_CGC_Create	CPU clock initialization
R_TMR_RG0_Create	Timer RG initialization
main	Main processing
R_TMR_RG0_Start	Timer RG start setting
r_tmr_rg0_interrupt	Timer RG interrupt handling

## 4.5 Function Specifications

The following tables list the sample code function specifications.

hdwinit	
<b>Outline</b>	Initialization
<b>Header</b>	None
<b>Declaration</b>	void hdwinit(void)
<b>Description</b>	Initializes the peripheral functions.
<b>Arguments</b>	None
<b>Return Value</b>	None
R_Systeminit	
<b>Outline</b>	Peripheral functions initialization
<b>Header</b>	None
<b>Declaration</b>	void R_Systeminit(void)
<b>Description</b>	Initializes the peripheral function used in this application note.
<b>Arguments</b>	None
<b>Return Value</b>	None
R_CGC_Create	
<b>Outline</b>	CPU clock initialization
<b>Header</b>	r_cg_cgc.h
<b>Declaration</b>	void R_CGC_Create(void)
<b>Description</b>	Initializes the CPU clock.
<b>Arguments</b>	None
<b>Return Value</b>	None

---

**R\_TMR\_RG0\_Create**

---

<b>Outline</b>	Timer RG Initialization
<b>Header</b>	r_cg_timer.h
<b>Declaration</b>	void R_TMR_RG0_Create(void)
<b>Description</b>	Initializes timer RG for use in phase counting mode.
<b>Arguments</b>	None
<b>Return Value</b>	None

---

**main**

---

<b>Outline</b>	Main processing
<b>Header</b>	None
<b>Declaration</b>	void main(void)
<b>Description</b>	Performs main processing.
<b>Arguments</b>	None
<b>Return Value</b>	None

---

**R\_TMR\_RG0\_Start**

---

<b>Outline</b>	Timer RG start setting
<b>Header</b>	r_cg_timer.h
<b>Declaration</b>	void R_TMR_RG0_Start(void)
<b>Description</b>	Sets timer RG to start in phase counting mode.
<b>Arguments</b>	None
<b>Return Value</b>	None

---

**r\_tmr\_rg0\_interrupt**

---

<b>Outline</b>	Timer RG interrupt handling
<b>Header</b>	r_cg_timer.h
<b>Declaration</b>	__interrupt static void r_tmr_rg0_interrupt(void)
<b>Description</b>	Counts the number of overflows when the timer overflows, or the number of underflows when the timer underflows.
<b>Arguments</b>	None
<b>Return Value</b>	None

## 4.6 Flowcharts

### 4.6.1 Overall Flowchart

Figure 4.2 shows the overall flow.

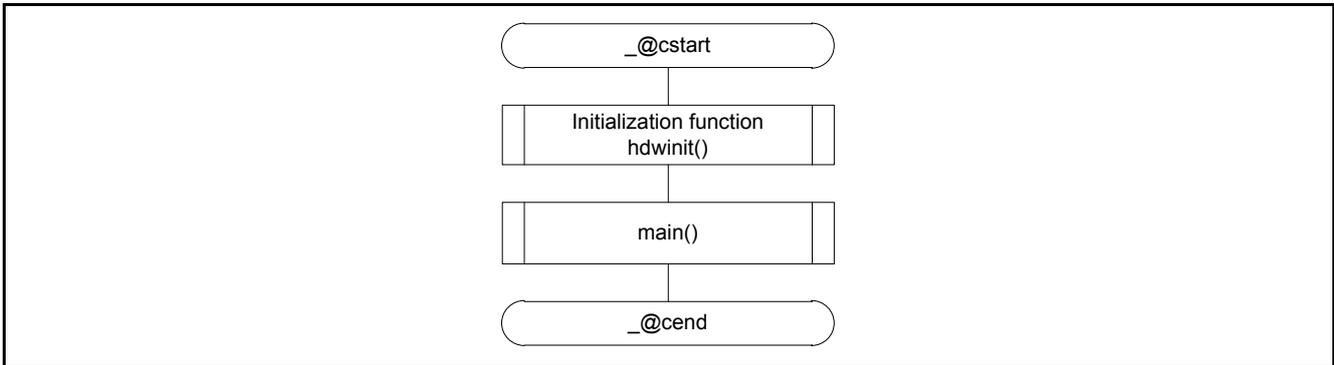


Figure 4.2 Overall Flow

### 4.6.2 Initialization

Figure 4.3 shows the initialization.

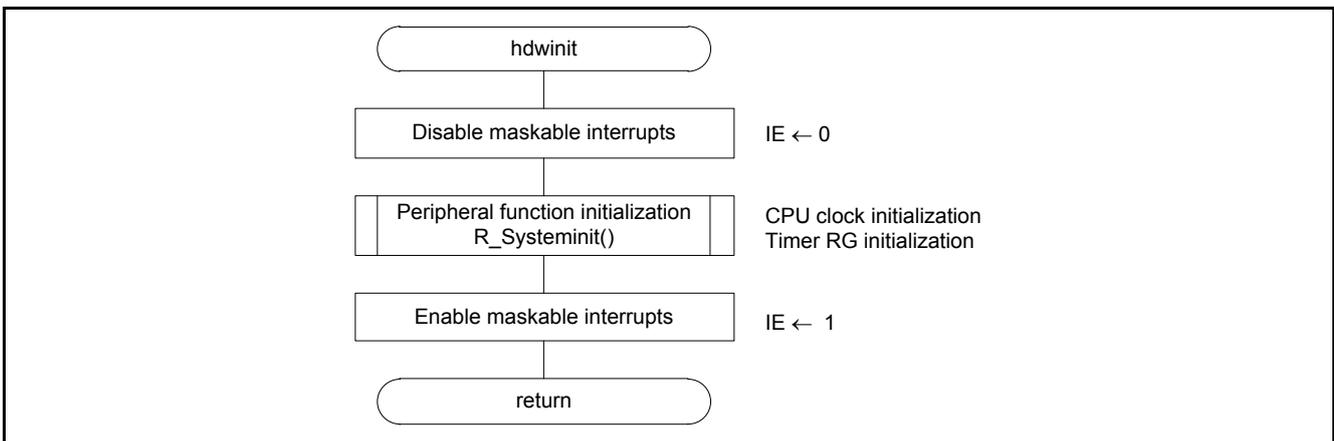


Figure 4.3 Initialization

### 4.6.3 Peripheral Function Initialization

Figure 4.4 shows the peripheral function initialization.

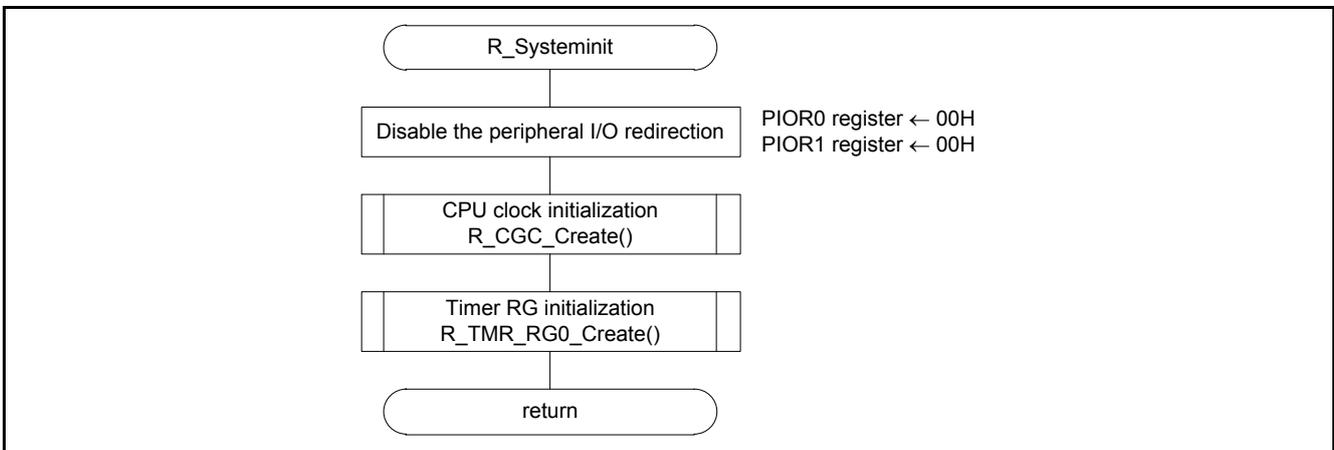


Figure 4.4 Peripheral Function Initialization

4.6.4 CPU Clock Initialization

Figure 4.5 shows the CPU clock initialization.

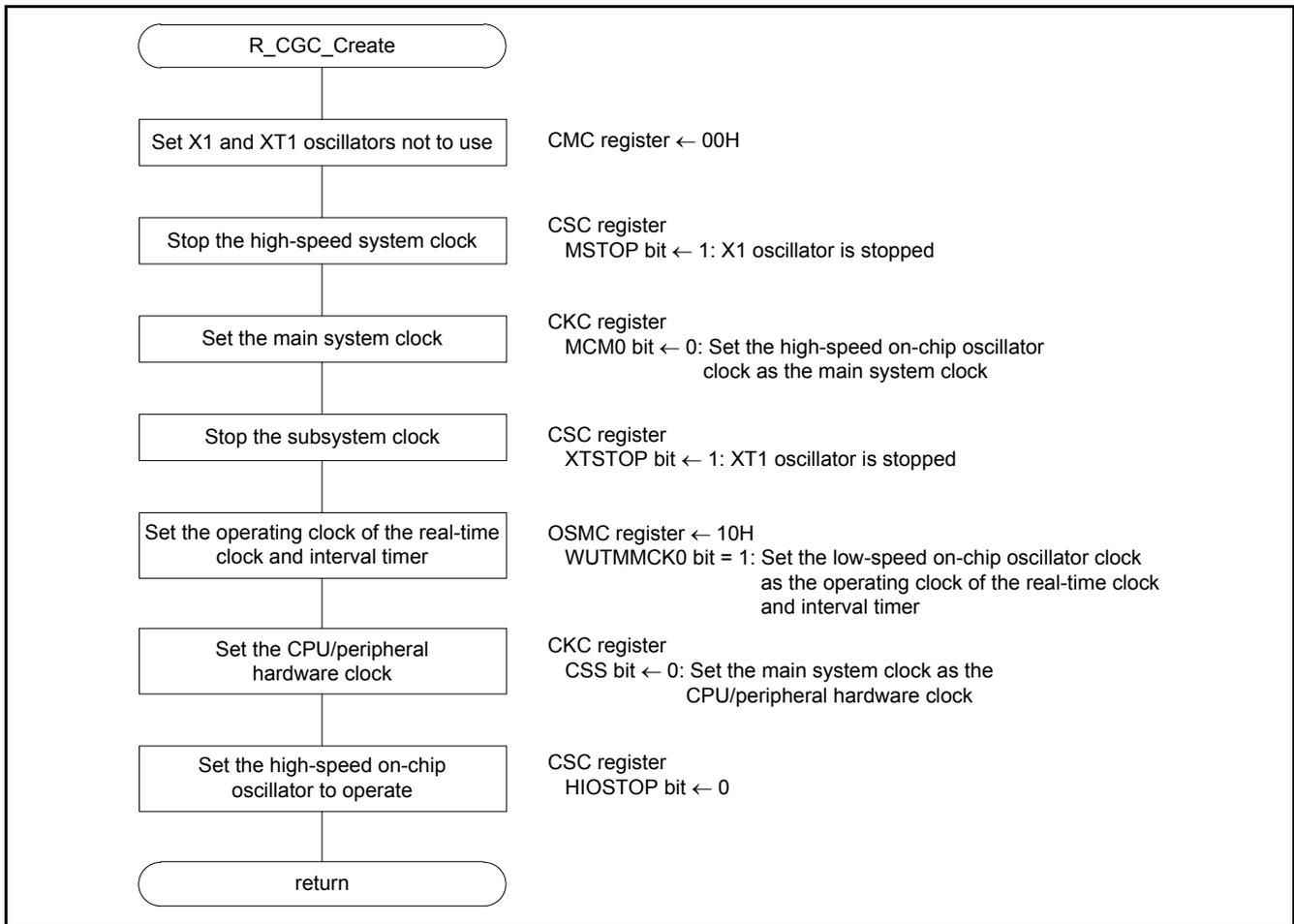


Figure 4.5 CPU Clock Initialization

4.6.5 Timer RG Initialization

Figure 4.6 shows the timer RG initialization.

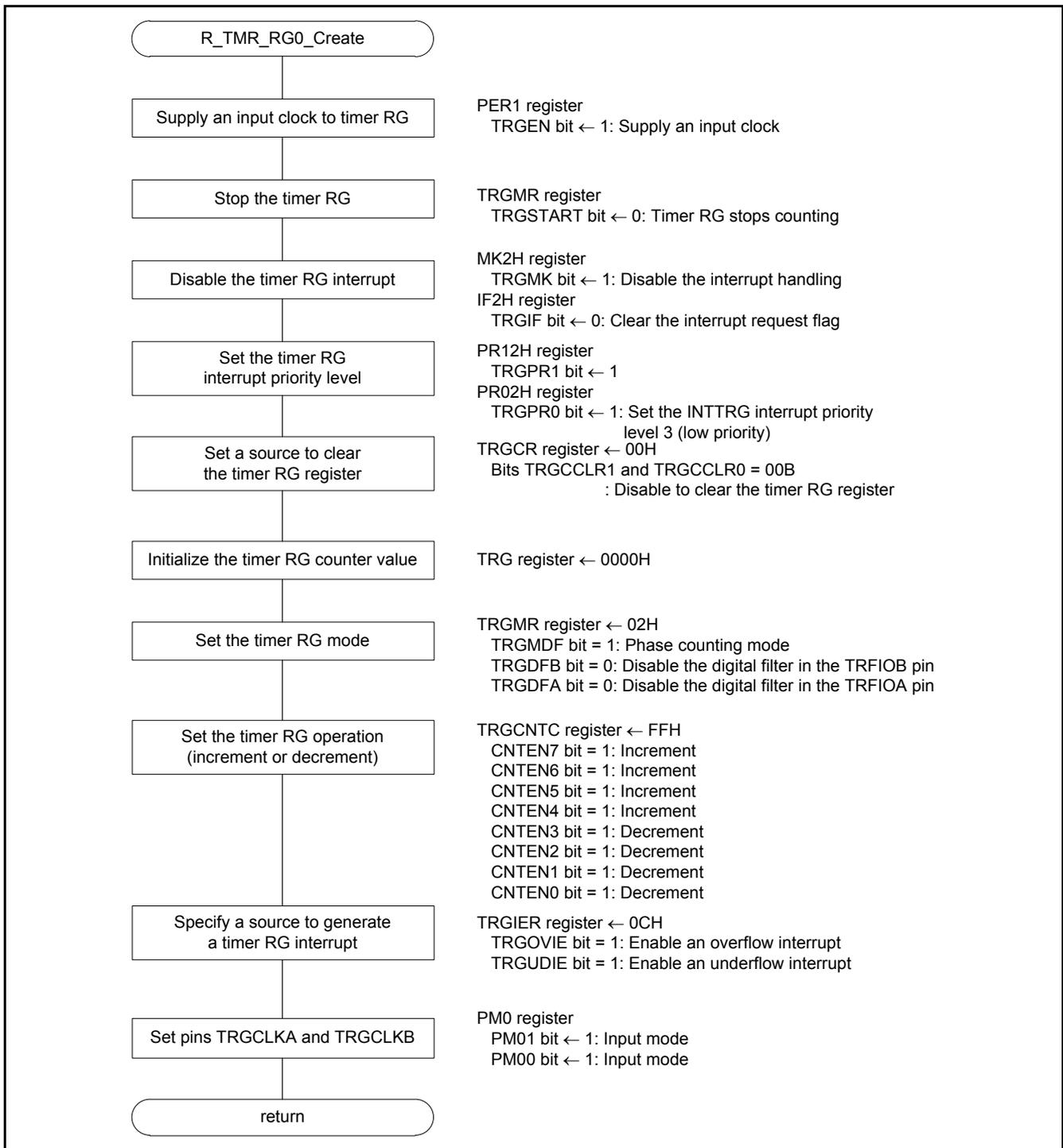


Figure 4.6 Timer RG Initialization

Supplying an input clock to timer RG

- Peripheral enable register 1 (PER1)  
Enables to supply the clock to timer RG

Symbol	7	6	5	4	3	2	1	0
<b>PER1</b>	DACEN	TRGEN	CMPEN	TRD0EN	DTCEN	0	0	TRJOEN
<b>Value</b>	x	1	x	x	x	–	–	x

- Bit 6

TRGEN	Function
0	Stops supplying an input clock to timer RG <ul style="list-style-type: none"> <li>Writing to the SFR which is used by timer RG is disabled</li> <li>Timer RG is in reset status</li> </ul>
1	Supplies an input clock to timer RG <ul style="list-style-type: none"> <li>Reading or writing to the SFR which is used by timer RG is enabled</li> </ul>

Timer RG stops counting

- Timer RG mode register (TRGMR)  
Stops timer RG to count

Symbol	7	6	5	4	3	2	1	0
<b>TRGMR</b>	TRGSTART	TRGELCICE	TRGDFCK1	TRGDFCK0	TRGDFA	TRGDFB	TRGMDF	TRGPWM
<b>Value</b>	0	x	x	x				x

- Bit 7

TRGSTART	Function
0	Stops the TRG to count, and initializes the PWM output signal (TRGIOA pin) in PWM mode
1	Sets the TRG to start counting

For details on register setting, refer to the RL78/G14 User's Manual: Hardware.

Legend symbol:

x: Unused bit

Blank cell: Unchanged bit

–: Reserved bit or unallocated bit

Disabling timer RG interrupt

- Interrupt mask flag register (MK2H)  
Disables an INTTRG interrupt

Symbol	7	6	5	4	3	2	1	0
<b>MK2H</b>	FLMK	IICAMK1	1	SREMK3 TMMK13H	TRGMK	TRDMK1	TRDMK0	PMK11 CMPMK1
<b>Value</b>	x	x	–	x	1	x	x	x

- Bit 3

TRGMK	Function
0	Enables an interrupt handling
1	Disables an interrupt handling

- Interrupt request flag register (IF2H)  
Clears the INTTRG interrupt request flag

Symbol	7	6	5	4	3	2	1	0
<b>IF2H</b>	FLIF	IICAIF1	0	SREIF3 TMIF13H	TRGIF	TRGIF1	TRDIF0	PIF11 CMPIF1
<b>Value</b>	x	x	–	x	0	x	x	x

- Bit 3

TRGIF	Function
0	Interrupt request signal is not generated
1	Interrupt request signal is generated and interrupt-requested status

For details on register setting, refer to the RL78/G14 User's Manual: Hardware.

Legend symbol:

x: Unused bit

Blank cell: Unchanged bit

–: Reserved bit or unallocated bit

Setting the timer RG interrupt priority level

- Priority specification flag registers (PR12H, PR02H)  
Sets the timer RG interrupt priority to level 3 (low priority)

Symbol	7	6	5	4	3	2	1	0
<b>PR12H</b>	FLPR1	IICAPR11	1	SREPR13 TMPR113H	TRGPR1	TRDPR11	TRDPR10	PPR111 CMPPR11
<b>Value</b>	x	x	–	x	1	x	x	x

Symbol	7	6	5	4	3	2	1	0
<b>PR02H</b>	FLPR0	IICAPR01	1	SREPR03 TMPR013H	TRGPR0	TRDPR01	TRDPR00	PPR011 CMPPR01
<b>Value</b>	x	x	–	x	1	x	x	x

TRGPR1	TRGPR0	Priority level
0	0	Specifies level 0 (high priority)
0	1	Specifies level 1
1	0	Specifies level 2
1	1	Specifies level 3 (low priority)

For details on register setting, refer to the RL78/G14 User's Manual: Hardware.

Legend symbol:

×: Unused bit

Blank cell: Unchanged bit

–: Reserved bit or unallocated bit

Setting a source to clear timer RG

- Timer RG control register (TRGCR)  
Sets a source to clear the TRG register and count source

<b>Symbol</b>	<b>7</b>	<b>6</b>	<b>5</b>	<b>4</b>	<b>3</b>	<b>2</b>	<b>1</b>	<b>0</b>
<b>TRGCR</b>	–	TRGCCLR1	TRGCCLR0	TRGCKEG1	TRGCKEG0	TRGTCK2	TRGTCK1	TRGTCK0
<b>Value</b>	–	0	0	×	×	×	×	×

- Bits 6 and 5

TRGCCLR1	TRGCCLR0	Function
0	0	Clearing the TRG register is disabled
0	1	Clears the register by the TRGGRA input capture/compare match
1	0	Clears the register by the TRGGRB input capture/compare match
1	1	Do not set

Initializing the timer RG counter value

- Timer RG counter (TRG)  
Specifies the counter as an initial value

<b>Symbol</b>	<b>15</b>	<b>14</b>	<b>13</b>	<b>12</b>	<b>11</b>	<b>10</b>	<b>9</b>	<b>8</b>	<b>7</b>	<b>6</b>	<b>5</b>	<b>4</b>	<b>3</b>	<b>2</b>	<b>1</b>	<b>0</b>
<b>TRG</b>	TRG15	TRG14	TRG13	TRG12	TRG11	TRG10	TRG9	TRG8	TRG7	TRG6	TRG5	TRG4	TRG3	TRG2	TRG1	TRG0
<b>Value</b>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

TRG15 to TRG0	Function	Setting Range
Bits 15 to 0	Timer RG increments or decrements in phase counting mode	0000H to FFFFH

For details on register setting, refer to the RL78/G14 User’s Manual: Hardware.

Legend symbol:

×: Unused bit

Blank cell: Unchanged bit

–: Reserved bit or unallocated bit

Setting timer RG mode

- Timer RG mode register (TRGMR)  
Sets timer RG in phase counting mode

Symbol	7	6	5	4	3	2	1	0
TRGMR	TRGSTART	TRGELCICE	TRGDFCK1	TRGDFCK0	TRGDFB	TRGDFA	TRGMDF	TRGPWM
Value		x	x	x	0	0	1	x

- Bit 3

TRGDFB	Function
0	Disables the digital filter
1	Enables the digital filter

- Bit 2

TRGDFA	Function
0	Disables the digital filter
1	Enables the digital filter

- Bit 1

TRGMDF	Function
0	Specifies to increment
1	Specifies phase counting mode

For details on register setting, refer to the RL78/G14 User's Manual: Hardware.

Legend symbol:

×: Unused bit

Blank cell: Unchanged bit

–: Reserved bit or unallocated bit

Setting the timer RG operation

- Timer RG count control register (TRGCNTC)  
Sets the count conditions in phase counting mode

Symbol	7	6	5	4	3	2	1	0
<b>TRGCNTC</b>	CNTEN7	CNTEN6	CNTEN5	CNTEN4	CNTEN3	CNTEN2	CNTEN1	CNTEN0
<b>Value</b>	1	1	1	1	1	1	1	1

- Bit 7

CNTEN7	Function
0	Disabled
1	Increments (When the TRGCLKA input is at low level and the TRGCLKB input is at the rising edge)

- Bit 6

CNTEN6	Function
0	Disabled
1	Increments (When the TRGCLKB input is at high level and the TRGCLKA input is at the rising edge)

- Bit 5

CNTEN5	Function
0	Disabled
1	Increments (When the TRGCLKA input is at high level and the TRGCLKB input is at the falling edge)

- Bit 4

CNTEN4	Function
0	Disabled
1	Increments (When the TRGCLKB input is at low level and the TRGCLKA input is at the falling edge)

For details on register setting, refer to the RL78/G14 User's Manual: Hardware.

Legend symbol:

×: Unused bit

Blank cell: Unchanged bit

–: Reserved bit or unallocated bit

- Bit 3

CNTEN3	Function
0	Disabled
1	Decrements (When the TRGCLKB input is at high level and the TRGCLKA input is at the falling edge)

- Bit 2

CNTEN2	Function
0	Disabled
1	Decrements (When the TRGCLKA input is at low level and the TRGCLKB input is at the falling edge)

- Bit 1

CNTEN1	Function
0	Disabled
1	Decrements (When the TRGCLKB input is at low level and the TRGCLKA input is at the rising edge)

- Bit 0

CNTEN0	Function
0	Disabled
1	Decrements (When the TRGCLKA input is at high level and the TRGCLKB input is at the rising edge)

For details on register setting, refer to the RL78/G14 User's Manual: Hardware.

Legend symbol:

×: Unused bit

Blank cell: Unchanged bit

–: Reserved bit or unallocated bit

Specifying a source to generate a timer RG interrupt

- Timer RG interrupt enable register (TRGIER)  
Enables interrupts by bits TRGOVF and TRGUDF

Symbol	7	6	5	4	3	2	1	0
<b>TRGIER</b>	–	–	–	–	TRGOVIE	TRGUDIE	TRGIMIEB	TRGIMIEA
<b>Value</b>	–	–	–	–	1	1	×	×

- Bit 3

TRGOVIE	Function
0	Disables an interrupt by the TRGOVF bit
1	Enables an interrupt by the TRGOVF bit

- Bit 2

TRGUDIE	Function
0	Disables an interrupt by the TRGUDF bit
1	Enables an interrupt by the TRGUDF bit

Setting pins TRGCLKA and TRGCLKB

- Port mode register 0 (PM0)  
Sets pins TRGCLKA and TRGCLKB in input mode

Symbol	7	6	5	4	3	2	1	0
<b>PM0</b>	1	PM06	PM05	PM04	PM03	PM02	PM01	PM00
<b>Value</b>	–	×	×	×	×	×	1	1

- Bit 1

PM01	Function
0	Output mode (output buffer is on)
1	Input mode (output buffer is off)

- Bit 0

PM00	Function
0	Output mode (output buffer is on)
1	Input mode (output buffer is off)

For details on register setting, refer to the RL78/G14 User’s Manual: Hardware.

Legend symbol:

×: Unused bit

Blank cell: Unchanged bit

–: Reserved bit or unallocated bit

### 4.6.6 Main Processing

Figure 4.7 shows the main processing.

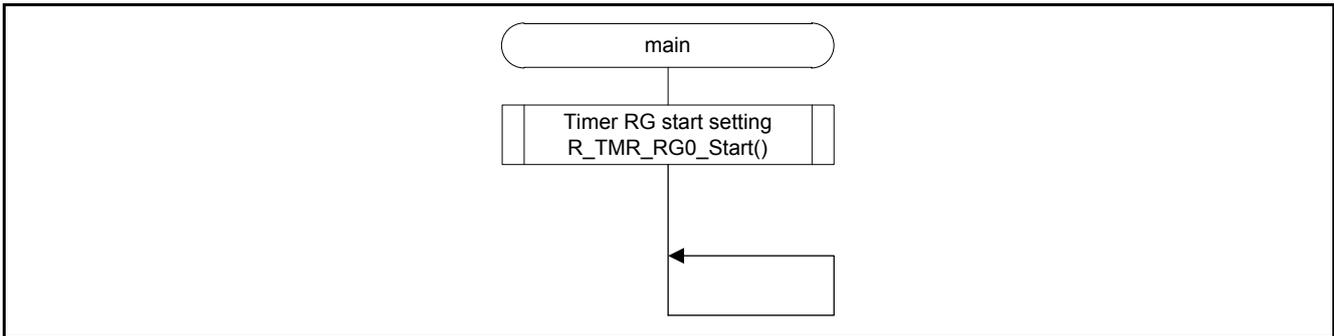


Figure 4.7 Main Processing

### 4.6.7 Setting Timer RG to Start

Figure 4.8 shows setting timer RG to start counting.

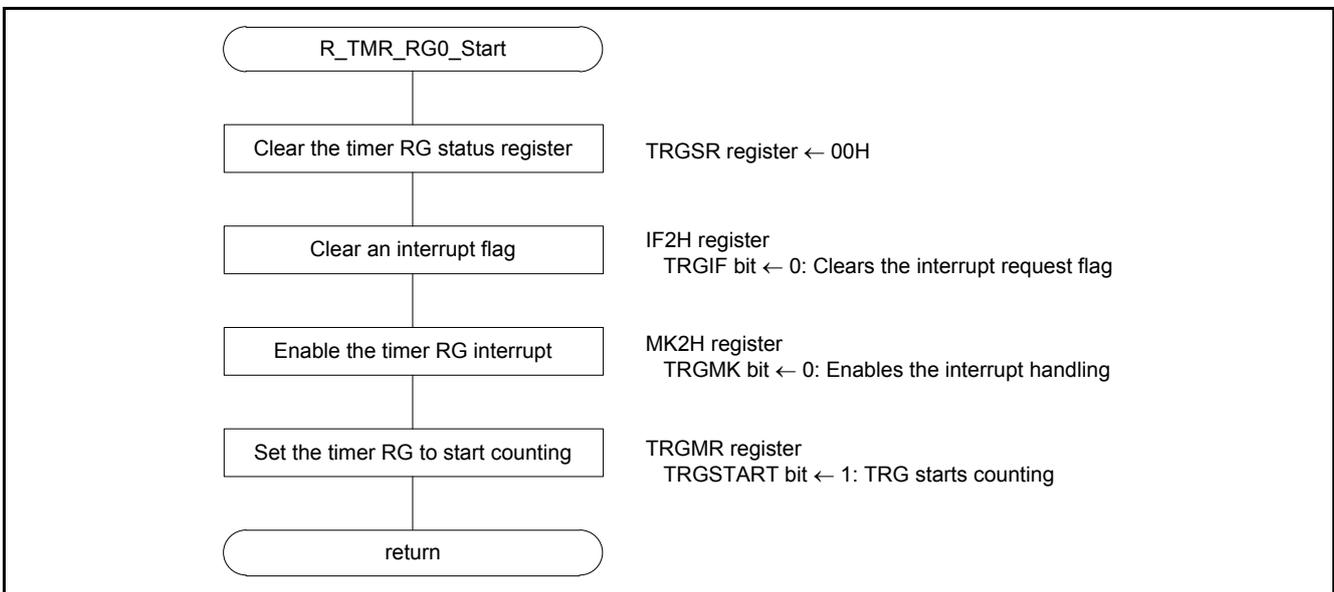


Figure 4.8 Setting Timer RG to Start

Clearing the timer RG status register

- Timer RG status register (TRGSR)  
Reads the timer RG status register, and clears flags overflow and underflow

Symbol	7	6	5	4	3	2	1	0
<b>TRGSR</b>	–	–	–	TRGDIRF	TRGOVF	TRGUDF	TRGIMFB	TRGIMFA
<b>Value</b>	–	–	–	x	0	0	x	x

- Bit 3

TRGOVF	Overflow flag	R/W
Condition to be 0: Write 0 after reading the bit		R/W

- Bit 2

TRGUDF	Underflow flag	R/W
Condition to be 0: Write 0 after reading the bit		R/W

Clearing an interrupt flag

- Interrupt request flag register (IF2H)  
Clears the INTTRG interrupt request flag

Symbol	7	6	5	4	3	2	1	0
<b>IF2H</b>	FLIF	IICAIF1	0	SREIF3 TMIF13H	TRGIF	TRDIF1	TRDIF0	PIF11 CMPIF1
<b>Value</b>	x	x	–	x	0	x	x	x

- Bit 3

TRGIF	Function
0	Interrupt request signal is not generated
1	Interrupt request signal is generated and interrupt-requested status

For details on register setting, refer to the RL78/G14 User’s Manual: Hardware.

Legend symbol:

x: Unused bit

Blank cell: Unchanged bit

–: Reserved bit or unallocated bit

Enabling the timer RG interrupt

- Interrupt mask flag register (MK2H)  
Enables the INTTRG interrupt

Symbol	7	6	5	4	3	2	1	0
<b>MK2H</b>	FLMK	IICAMK1	–	SREMK3 TMMK13H	TRGMK	TRDMK1	TRDMK0	PMK11 CMPMK1
<b>Value</b>	x	x	–	x	0	x	x	x

- Bit 3

TRGMK	Function
0	Interrupt request is enabled
1	Interrupt request is disabled

Sets timer RG to start counting

- Timer RG mode register (TRGMR)  
Sets timer RG to start counting

Symbol	7	6	5	4	3	2	1	0
<b>TRGMR</b>	TRGSTART	TRGELCICE	TRGDFCK1	TRGDFCK0	TRGDFB	TRGDFA	TRDMDF	TRGPWM
<b>Value</b>	1	x	x	x				x

- Bit 7

TRGSTART	Function
0	Stops the TRG to count, and initializes the PWM output signal (TRGIOA pin) is in PWM mode
1	Sets the TRG to start counting

For details on register setting, refer to the RL78/G14 User's Manual: Hardware.

Legend symbol:

×: Unused bit

Blank cell: Unchanged bit

–: Reserved bit or unallocated bit

4.6.8 Timer RG Interrupt Handling

Figure 4.9 shows the timer RG interrupt handling.

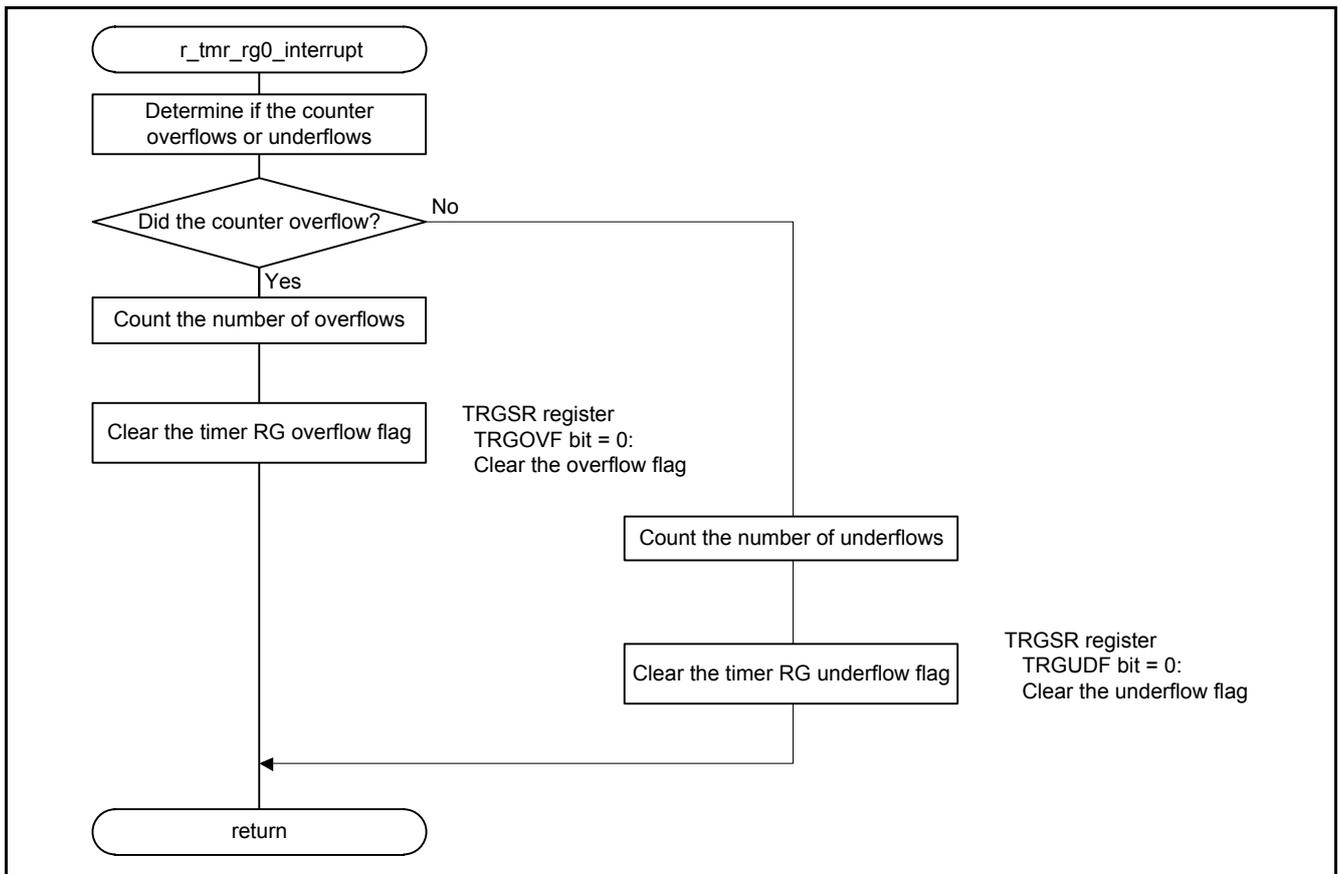


Figure 4.9 Timer RG Interrupt Handling

Clearing the timer RG overflow flag

- Timer RG status register (TRGSR)  
Clears the overflow flag after reading the timer RG status register

Symbol	7	6	5	4	3	2	1	0
TRGSR	–	–	–	TRGDIRF	TRGOVF	TRGUDF	TRDIMFB	TRGIMFA
Value	–	–	–	x	0		x	x

- Bit 3

TRGOVF	Overflow flag	R/W
Condition to be 0: Write 0 after reading the bit		R/W

For details on register setting, refer to the RL78/G14 User’s Manual: Hardware.

Legend symbol:

×: Unused bit

Blank cell: Unchanged bit

–: Reserved bit or unallocated bit

Clearing the timer RG underflow flag

- Timer RG status register (TRGSR)  
Clears the underflow flag after reading the timer RG status register

Symbol	7	6	5	4	3	2	1	0
<b>TRGSR</b>	–	–	–	TRGDIRF	TRGOVF	TRGUDF	TRDIMFB	TRGIMFA
<b>Value</b>	–	–	–	x		0	x	x

- Bit 2

TRGUDF	Underflow flag	R/W
Condition to be 0: Write 0 after reading the bit		R/W

For details on register setting, refer to the RL78/G14 User’s Manual: Hardware.

Legend symbol:

x: Unused bit

Blank cell: Unchanged bit

–: Reserved bit or unallocated bit

## 5. Sample Code

Sample code can be downloaded from the Renesas Electronics website.

## 6. Reference Documents

User's Manual: Hardware

RL78/G14 User's Manual: Hardware Rev.1.00

RL78 Family User's Manual: Software Rev.1.00

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.

## Website and Support

Renesas Electronics website

<http://www.renesas.com>

Inquiries

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

<b>REVISION HISTORY</b>	RL78/G14 Timer RG in Phase Counting Mode
-------------------------	--

Rev.	Date	Description	
		Page	Summary
1.00	Mar. 19, 2013	—	First edition issued
1.10	June 1, 2013	4	Fixed typo in Table 2.1
		4	Fixed typo in Figure 3.1

All trademarks and registered trademarks are the property of their respective owners.

## 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 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 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.

## Notice

1. Descriptions of circuits, software and other related information in this document are provided only to illustrate the operation of semiconductor products and application examples. You are fully responsible for the incorporation of these circuits, software, and information in the design of your equipment. Renesas Electronics assumes no responsibility for any losses incurred by you or third parties arising from the use of these circuits, software, or information.
2. Renesas Electronics has used reasonable care in preparing the information included in this document, but Renesas Electronics does not warrant that such information is error free. Renesas Electronics assumes no liability whatsoever for any damages incurred by you resulting from errors in or omissions from the information included herein.
3. Renesas Electronics does not assume any liability for infringement of patents, copyrights, or other intellectual property rights of third parties by or arising from the use of Renesas Electronics products or technical information described in this document. No license, express, implied or otherwise, is granted hereby under any patents, copyrights or other intellectual property rights of Renesas Electronics or others.
4. You should not alter, modify, copy, or otherwise misappropriate any Renesas Electronics product, whether in whole or in part. Renesas Electronics assumes no responsibility for any losses incurred by you or third parties arising from such alteration, modification, copy or otherwise misappropriation of Renesas Electronics product.
5. Renesas Electronics products are classified according to the following two quality grades: "Standard" and "High Quality". The recommended applications for each Renesas Electronics product depends on the product's quality grade, as indicated below.  
"Standard": Computers; office equipment; communications equipment; test and measurement equipment; audio and visual equipment; home electronic appliances; machine tools; personal electronic equipment; and industrial robots etc.  
"High Quality": Transportation equipment (automobiles, trains, ships, etc.); traffic control systems; anti-disaster systems; anti-crime systems; and safety equipment etc.  
Renesas Electronics products are neither intended nor authorized for use in products or systems that may pose a direct threat to human life or bodily injury (artificial life support devices or systems, surgical implantations etc.), or may cause serious property damages (nuclear reactor control systems, military equipment etc.). You must check the quality grade of each Renesas Electronics product before using it in a particular application. You may not use any Renesas Electronics product for any application for which it is not intended. Renesas Electronics shall not be in any way liable for any damages or losses incurred by you or third parties arising from the use of any Renesas Electronics product for which the product is not intended by Renesas Electronics.
6. You should use the Renesas Electronics products described in this document within the range specified by Renesas Electronics, especially with respect to the maximum rating, operating supply voltage range, movement power voltage range, heat radiation characteristics, installation and other product characteristics. Renesas Electronics shall have no liability for malfunctions or damages arising out of the use of Renesas Electronics products beyond such specified ranges.
7. Although Renesas Electronics endeavors to improve the quality and reliability of its products, semiconductor products have specific characteristics such as the occurrence of failure at a certain rate and malfunctions under certain use conditions. Further, Renesas Electronics products are not subject to radiation resistance design. Please be sure to implement safety measures to guard them against the possibility of physical injury, and injury or damage caused by fire in the event of the failure of a Renesas Electronics product, such as safety design for hardware and software including but not limited to redundancy, fire control and malfunction prevention, appropriate treatment for aging degradation or any other appropriate measures. Because the evaluation of microcomputer software alone is very difficult, please evaluate the safety of the final products or systems manufactured by you.
8. Please contact a Renesas Electronics sales office for details as to environmental matters such as the environmental compatibility of each Renesas Electronics product. Please use Renesas Electronics products in compliance with all applicable laws and regulations that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive. Renesas Electronics assumes no liability for damages or losses occurring as a result of your noncompliance with applicable laws and regulations.
9. Renesas Electronics products and technology may not be used for or incorporated into any products or systems whose manufacture, use, or sale is prohibited under any applicable domestic or foreign laws or regulations. You should not use Renesas Electronics products or technology described in this document for any purpose relating to military applications or use by the military, including but not limited to the development of weapons of mass destruction. When exporting the Renesas Electronics products or technology described in this document, you should comply with the applicable export control laws and regulations and follow the procedures required by such laws and regulations.
10. It is the responsibility of the buyer or distributor of Renesas Electronics products, who distributes, disposes of, or otherwise places the product with a third party, to notify such third party in advance of the contents and conditions set forth in this document, Renesas Electronics assumes no responsibility for any losses incurred by you or third parties as a result of unauthorized use of Renesas Electronics products.
11. This document may not be reproduced or duplicated in any form, in whole or in part, without prior written consent of Renesas Electronics.
12. Please contact a Renesas Electronics sales office if you have any questions regarding the information contained in this document or Renesas Electronics products, or if you have any other inquiries.

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

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



### SALES OFFICES

Renesas Electronics Corporation

<http://www.renesas.com>

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

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

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

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

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

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

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

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

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

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

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

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