R8C/M12A Group

Timer RC in PWM Mode

R01AN0090EJ0110
Rev.1.10
Mar. 10, 2011

1. Abstract

This document describes a setting method and an application example of PWM waveform output for timer RC in PWM mode in the R8C/M12A Group.

2. Introduction

The application example described in this document applies to the following microcomputer (MCU) and parameter:

- MCU: R8C/M12A Group
- XIN clock frequency: 20 MHz

This application note can be used with other R8C Family MCUs which have the same special function registers (SFRs) as the above group. Check the manual for any modifications to functions. Careful evaluation is recommended before using the program described in this application note.

3. Application Example

3.1 Program Outline

Three PWM waveforms with 100 µs periods are output. The PWM period is generated at a compare match of the timer RC counter (TRCCNT) and general register A (TRCGRA). PWM change points for each are generated at the compare match of the TRCCNT register and general registers TRCGRB, TRCGRC, and TRCGRD. An interrupt is generated at the compare match of registers TRCCNT and TRCGRA. Output signals are as follows:

TRCIOB pin when inactive level is low: 25 µs = 1/20 MHz × (TRCGRB + 1) = 50 ns × 500
TRCIOB pin when inactive level is high: 75 µs = 1/20 MHz × ((TRCGRA + 1) – (TRCGRB + 1))
= 50 ns × (2000 – 500) = 50 ns × 1500
TRCIOC pin when inactive level is low: 50 µs = 1/20 MHz × (TRCGRC + 1) = 50 ns × 1000
TRCIOC pin when active level is high: 50 µs = 1/20 MHz × ((TRCGRA + 1) – (TRCGRC + 1))
= 50 ns × (2000 – 1000) = 50 ns × 1000
TRCIOD pin when inactive level is low: 75 µs = 1/20 MHz × (TRCGRD + 1) = 50 ns × 1500
TRCIOD pin when active level is high: 25 µs = 1/20 MHz × ((TRCGRA + 1) – (TRCGRD + 1))
= 50 ns × (2000 – 1500) = 50 ns × 500
The 100 µs PWM period is set to the TRCGRA register.
100 µs = 1/20 MHz × (TRCGRA + 1)
= 50 ns × 2000

Settings

- Use f1 (XIN clock: 20 MHz) as the count source.
- Clear the TRCCNT register at the compare match of the TRCGRA register.
- Select the TRCIOB pin output level as active high and the initial output level as inactive low.
- Select the TRCIOC pin output level as active high and the initial output level as inactive low.
- Select the TRCIOD pin output level as active high and the initial output level as inactive low.
- Output an active level (high) from the TRCIOB pin at the compare match of registers TRCCNT and TRCGRB.
- Output an active level (high) from the TRCIOC pin at the compare match of registers TRCCNT and TRCGRC.
- Output an active level (high) from the TRCIOD pin at the compare match of registers TRCCNT and TRCGRD.
- Output an inactive level (low) from pins TRCIOB, TRCIOC, and TRCIOD at the compare match of registers TRCCNT and TRCGRA.
- Do not use the timer output disable function.
- Do not use the waveform output manipulation function.
- Do not use an A/D conversion start trigger.
- Use the timer RC interrupt.

Figure 3.1 shows a Block Diagram and Figure 3.2 shows a Timing Diagram. Table 3.1 lists the pins used and their functions.

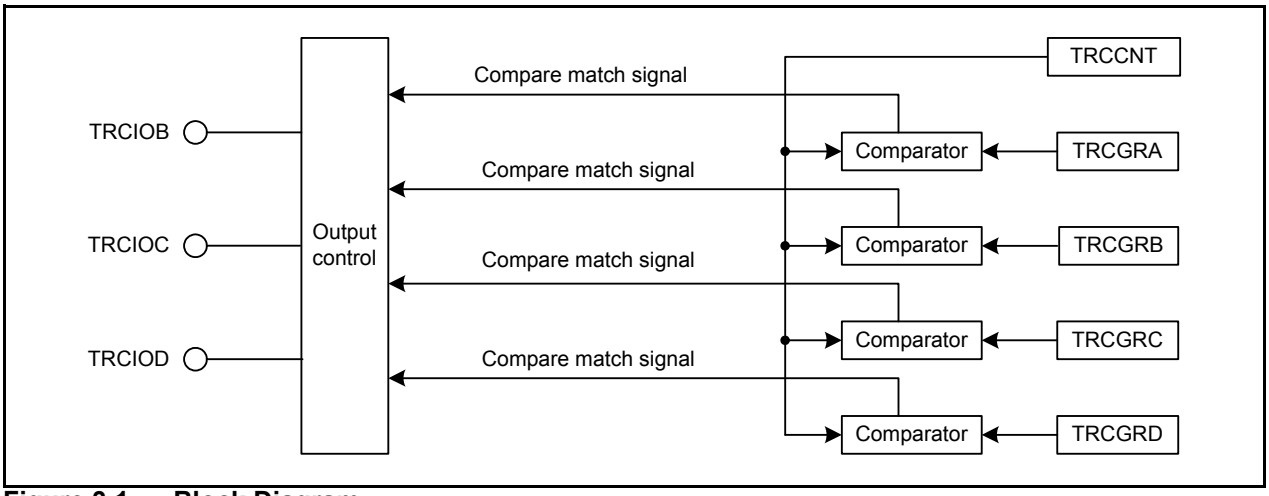


Figure 3.1 Block Diagram

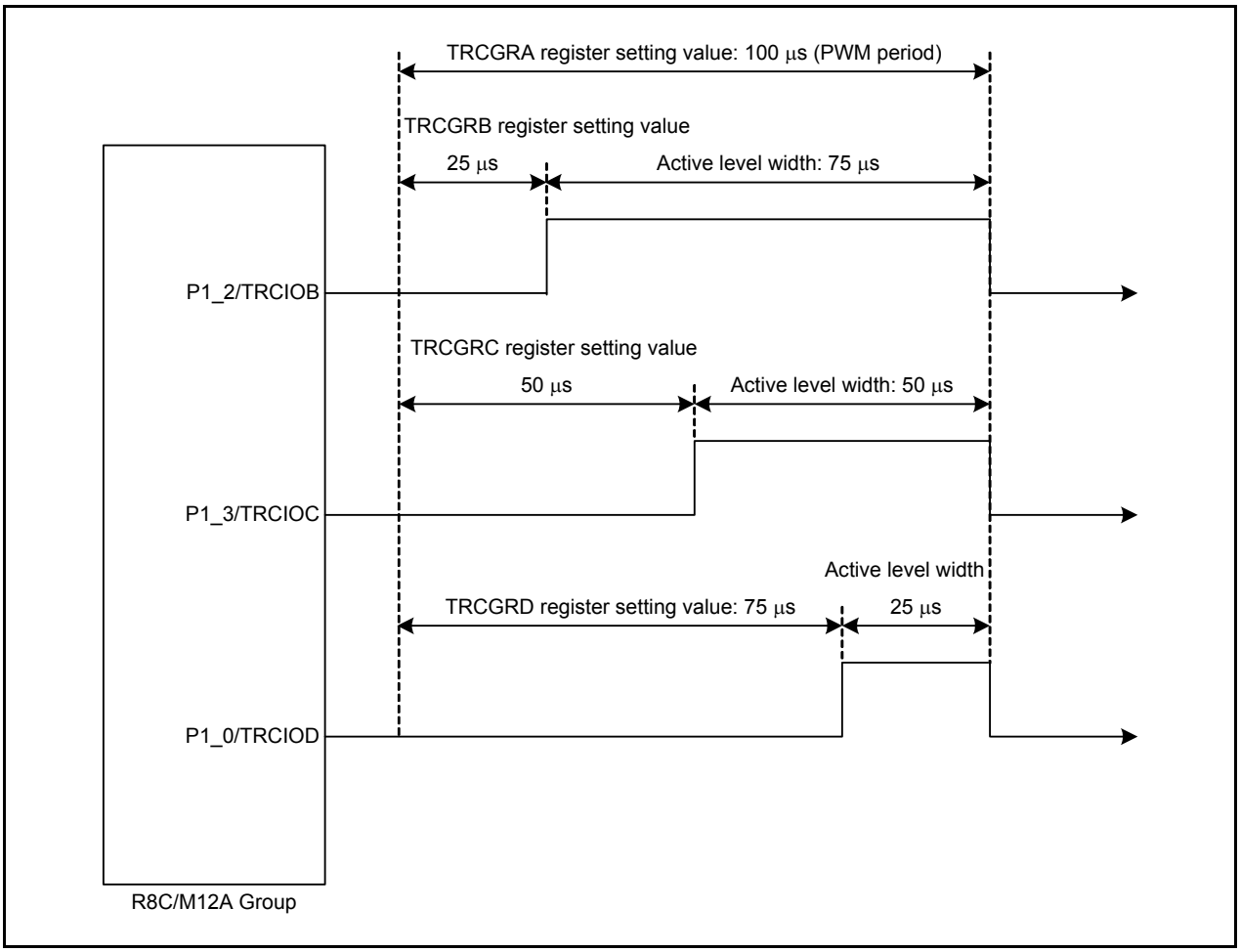


Figure 3.2 Timing Diagram

Table 3.1 Pins and Their Functions

Pin Name	I/O	Function
P1_2/TRCIOB	Output	PWM output
P1_3/TRCIOC	Output	PWM output
P1_0/TRCIOD	Output	PWM output

3.2 Memory

Table 3.2 Memory

Memory	Size	Remarks
ROM	213 bytes	In the r01an0090_src.c module
RAM	0 bytes	In the r01an0090_src.c module
Maximum user stack	10 bytes	
Maximum interrupt stack	18 bytes	

Memory size varies depending on the C compiler version and compile options.
The above applies to the following conditions:
C compiler: M16C Series, R8C Family C Compiler V.5.45 Release 01
Compile options: -c -finfo -dir “$(CONFIGDIR)” -R8C

4. Software

This section shows the initial setting procedures and values to set the example described in section **3. Application Example**. Refer to the latest **R8C/M12A Group** hardware user's manual for details on individual registers.

The × in the register's Setting Value represents bits not used in this application, blank spaces represent bits that do not change, and the dash represents reserved bits or bits that have nothing assigned.

4.1 Function Tables

Declaration	void main (void)		
Outline	Main function		
Argument	Argument name		Meaning
	None		—
Variable (global)	Variable name		Contents
	None		—
Returned value	Type	Value	Meaning
	None	—	—
Function	Initialize the system clock and timer RC.		

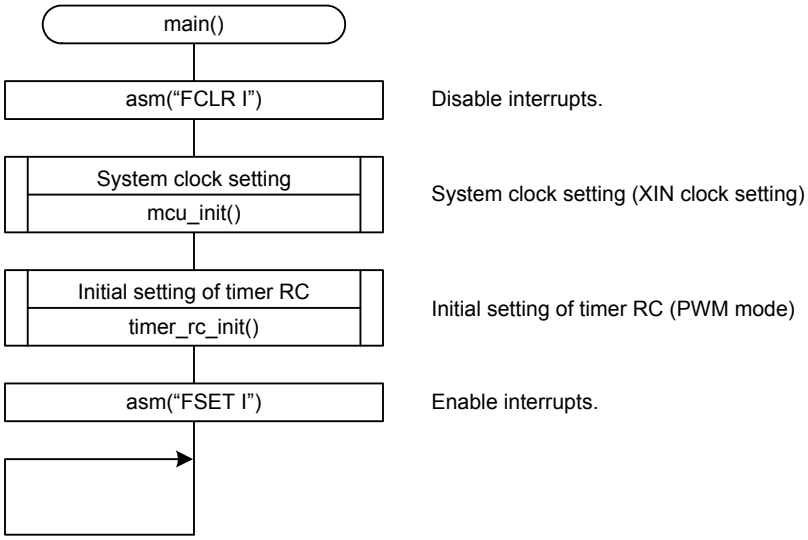
Declaration	void mcu_init (void)		
Outline	System clock setting		
Argument	Argument name		Meaning
	None		—
Variable (global)	Variable name		Contents
	None		—
Returned value	Type	Value	Meaning
	None	—	—
Function	Set the system clock (XIN clock).		

Declaration	void timer_rc_init (void)		
Outline	Initial setting of timer RC		
Argument	Argument name		Meaning
	None		—
Variable (global)	Variable name		Contents
	None		—
Returned value	Type	Value	Meaning
	None	—	—
Function	Initialize SFRs to use timer RC in PWM mode.		

Declaration	void _timer_rc (void)		
Outline	Timer RC interrupt handling		
Argument	Argument name		Meaning
	None		—
Variable (global)	Variable name		Contents
	None		—
Returned value	Type	Value	Meaning
	None	—	—
Function	Perform timer RC interrupt handling.		

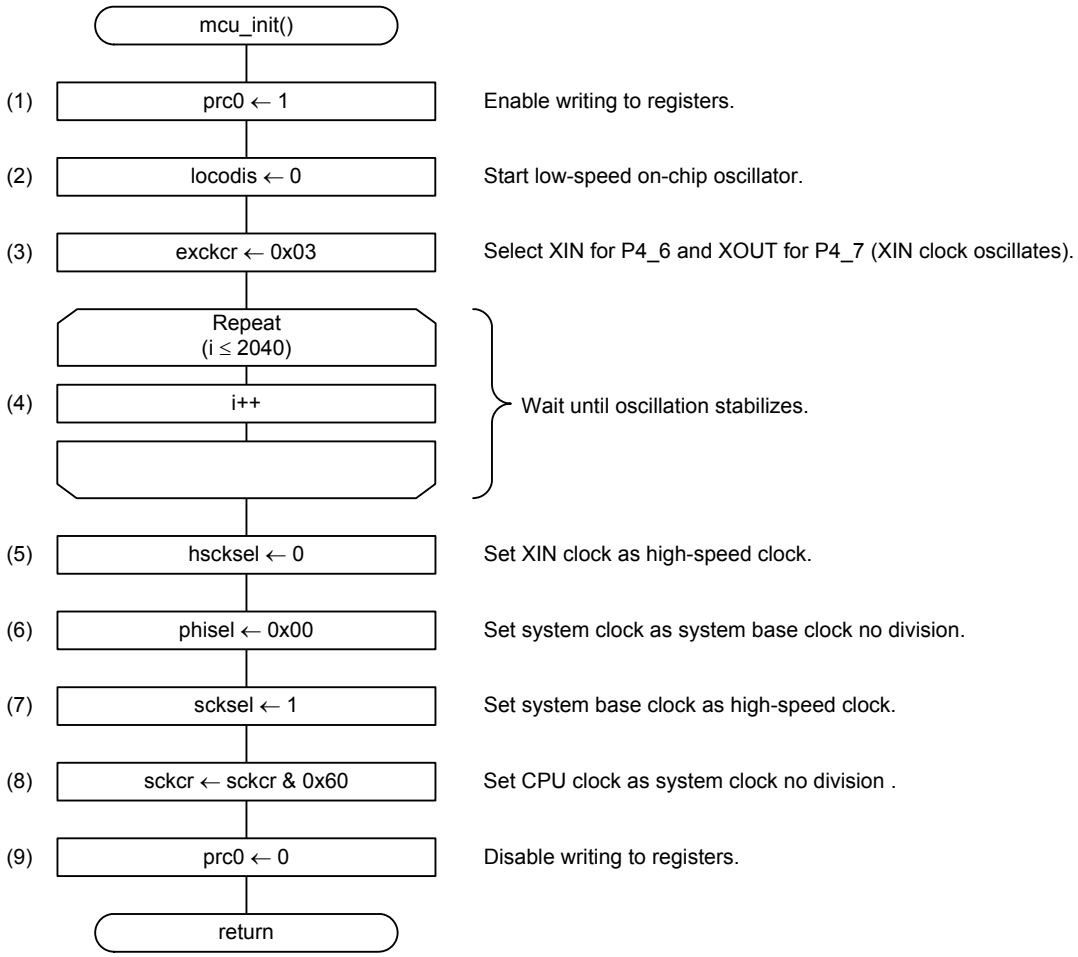
4.2 Main Function

• Flowchart



4.3 System Clock Setting

• Flowchart



• Register settings

(1) Enable writing to registers EXCKCR, OCOCR, SCKCR, PHISEL, CKSTPR, CKRSCR, BAKCR, FRV1, and FRV2.

Protect Register (PRCR)

Bit	b7	b6	b5	b4	b3	b2	b1	b0
Setting Value	—	—	—	x	x	—	x	1

Bit	Symbol	Bit Name	Function	R/W
b0	PRC0	Protect bit 0	Enables writing to registers EXCKCR, OCOCR, SCKCR, PHISEL, CKSTPR, CKRSCR, BAKCR, FRV1, and FRV2 1: Enabled	R/W

(2) Start the low-speed on-chip oscillator.

On-Chip Oscillator Control Register (OCOCR)

Bit	b7	b6	b5	b4	b3	b2	b1	b0
Setting Value	—	—	—	—	—	—	0	x

Bit	Symbol	Bit Name	Function	R/W
b1	LOCODIS	Low-speed on-chip oscillator oscillation stop bit	0: Low-speed on-chip oscillator on	R/W

(3) Oscillate the XIN clock.

External Clock Control Register (EXCKCR)

Bit	b7	b6	b5	b4	b3	b2	b1	b0
Setting Value	—	x	—	—	—	—	1	1

Bit	Symbol	Bit Name	Function		R/W
b0	CKPT0	Port P4_6 and P4_7 pin function select bits	P4_6 pin b1 b0 1 1: XIN	P4_7 pin b1 b0 1 1: XOUT	R/W
b1	CKPT1				R/W

(4) Wait until the XIN clock oscillation stabilizes.

(5) Set the high-speed clock as the XIN clock.

System Clock f Control Register (SCKCR)

Bit	b7	b6	b5	b4	b3	b2	b1	b0
Setting Value	—	0	x	—	—			

Bit	Symbol	Bit Name	Function	R/W
b6	HSCKSEL	High-speed on-chip oscillator/ XIN clock select bit	0: XIN clock	R/W

(6) Set the system clock as the system base clock with no division.

System Clock f Select Register (PHISEL)

Bit	b7	b6	b5	b4	b3	b2	b1	b0
Setting Value	0	0	0	0	0	0	0	0

Bit	Symbol	Bit Name	Function	R/W
b0	PHISEL0	System clock division select bits	These bits used to set the division ratio of the system base clock (fBASE) to generate the system clock (f) System clock (f) f = fBASE/(n + 1) n: Binary value set by the PHISEL register	R/W
b1	PHISEL1			R/W
b2	PHISEL2			R/W
b3	PHISEL3			R/W
b4	PHISEL4			R/W
b5	PHISEL5			R/W
b6	PHISEL6			R/W
b7	PHISEL7			R/W

(7) Set the system base clock as the high-speed clock.

Clock Stop Control Register (CKSTPR)

Bit	b7	b6	b5	b4	b3	b2	b1	b0
Setting Value	1	—	—	—	—	x	x	x

Bit	Symbol	Bit Name	Function	R/W
b7	SCKSEL	System base clock select bit	1: fHSCK	R/W

(8) Set the CPU clock as the system clock with no division.

System Clock f Control Register (SCKCR)

Bit	b7	b6	b5	b4	b3	b2	b1	b0
Setting Value	—		x	—	—	0	0	0

Bit	Symbol	Bit Name	Function	R/W
b0	PHISSEL0	CPU clock division select bits	b2 b1 b0 0 0 0: System clock with no division	R/W
b1	PHISSEL1			R/W
b2	PHISSEL2			R/W

(9) Disable writing to registers EXCKCR, OCOCR, SCKCR, PHISEL, CKSTPR, CKRSCR, BAKCR, FRV1, and FRV2.

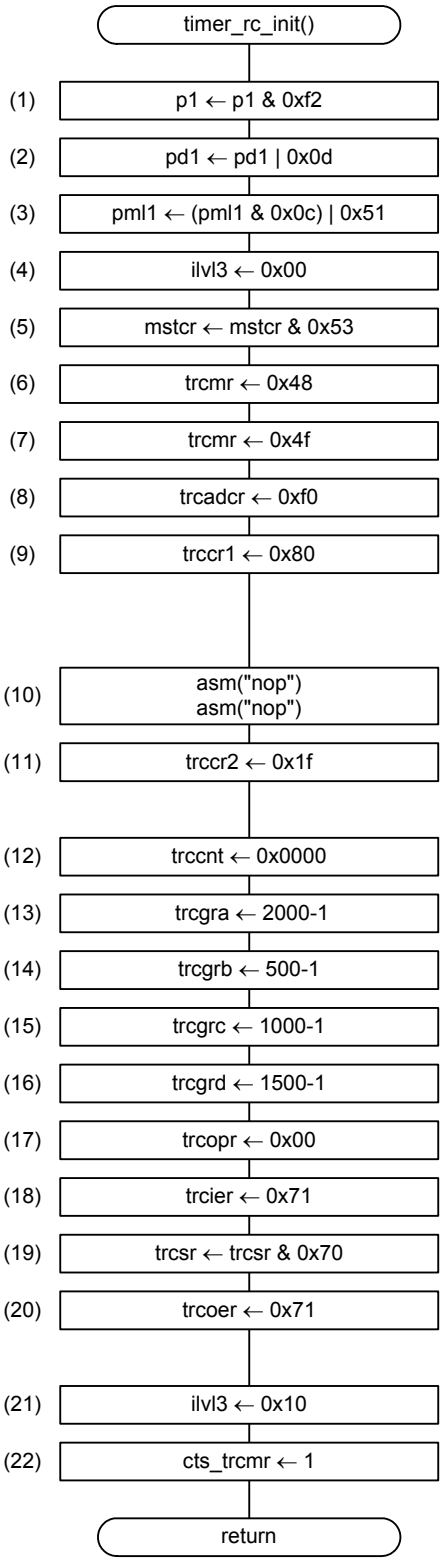
Protect Register (PRCR)

Bit	b7	b6	b5	b4	b3	b2	b1	b0
Setting Value	—	—	—	x	x	—	x	0

Bit	Symbol	Bit Name	Function	R/W
b0	PRC0	Protect bit 0	Enables writing to registers EXCKCR, OCOCR, SCKCR, PHISEL, CKSTPR, CKRSCR, BAKCR, FRV1, and FRV2 0: Disabled	R/W

4.4 Initial Setting of Timer RC

• Flowchart



Set ports P1_3, P1_2, and P1_0 to low.

Set ports P1_3, P1_2, and P1_0 to output mode.

Select TRCIOC for port P1_3, TRCIOB for port P1_2, and TRCIOD for port P1_0.

Disable timer RC interrupt.

Set timer RC to active.

Select PWM mode and stop timer RC count.

Select PWM mode for TRCIOB, TRCIOC, and TRCIOD.

Disable A/D conversion start trigger.

Select low for initial output level of pins TRCIOB, TRCIOC, and TRCIOD.
Select f1 as count source.
Clear TRCCNT counter at compare match A.

After switching the count sources, wait for at least two cycles of the system clock before writing to the registers associated with timer RC.

Select active high for TRCIOB, TRCIOC, and TRCIOD output level controls.
Continue counting after compare match with TRCGRA register.

Initialize TRCCNT register count value to 0000h.

Set 100 μs (50 ns × 2000 = 100 μs) for PWM period.

Set 25 μs (50 ns × 500 = 25 μs) for TRCIOB pin low width.

Set 50 μs (50 ns × 1000 = 50 μs) for TRCIOC pin low width.

Set 75 μs (50 ns × 1500 = 75 μs) for TRCIOD pin low width.

Disable waveform output manipulation.

Set IMFA bit in TRCSR register to enable IMIA interrupt request.

Clear timer RC status flag.

Enable TRCIOB, TRCIOC, and TRCIOD output.
When a low level is input to the $\overline{\text{INT0}}$ pin, bits EA to ED do not change.

Enable timer RC interrupt (level 1).

Start timer RC count.

• Register settings

(1) Set initial output levels to ports P1_0, P1_2, and P1_3.

Port P1 Register (P1)

Bit	b7	b6	b5	b4	b3	b2	b1	b0
Setting Value	x	x	x	x	0	0	x	0

Bit	Symbol	Bit Name	Function	R/W
b0	P1_0	Port P1_0 bit	0: “L” level	R/W
b2	P1_2	Port P1_2 bit		R/W
b3	P1_3	Port P1_3 bit		R/W

(2) Set ports P1_0, P1_2, and P1_3 to output mode.

Port P1 Direction Register (PD1)

Bit	b7	b6	b5	b4	b3	b2	b1	b0
Setting Value	x	x	x	x	1	1	x	1

Bit	Symbol	Bit Name	Function	R/W
b0	PD1_0	Port P1_0 direction bit	1: Output mode (functions as an output port)	R/W
b2	PD1_2	Port P1_2 direction bit		R/W
b3	PD1_3	Port P1_3 direction bit		R/W

(3) Set port 1 function mapping register 0.

Port 1 Function Mapping Register 0 (PML1)

Bit	b7	b6	b5	b4	b3	b2	b1	b0
Setting Value	0	1	0	1	x	x	0	1

Bit	Symbol	Bit Name	Function	R/W
b0	P10SEL0	Port P1_0 function select bits	b1 b0 0 1: TRCIOD	R/W
b1	P10SEL1			R/W
b4	P12SEL0	Port P1_2 function select bits	b5 b4 0 1: TRCIOB	R/W
b5	P12SEL1			R/W
b6	P13SEL0	Port P1_3 function select bits	b7 b6 0 1: TRCIOC	R/W
b7	P13SEL1			R/W

(4) Disable the timer RC interrupt.

Interrupt Priority Level Register 3 (ILVL3)

Bit	b7	b6	b5	b4	b3	b2	b1	b0
Setting Value	—	—	0	0	—	—	—	—

Bit	Symbol	Bit Name	Function	R/W
b4	ILVL34	Interrupt priority level setting bits	b5 b4 0 0: Level 0 (interrupt disabled)	R/W
b5	ILVL35			R/W

(5) Set timer RC to active.

Module Standby Control Register (MSTCR)

Bit	b7	b6	b5	b4	b3	b2	b1	b0
Setting Value	—	x	0	x	—	—	x	x

Bit	Symbol	Bit Name	Function	R/W
b5	MSTTRC	Timer RC standby bit	0: Active	R/W

(6) Stop the timer RC count and set to PWM mode.

Timer RC Mode Register (TRCMR)

Bit	b7	b6	b5	b4	b3	b2	b1	b0
Setting Value	0	—			1			

Bit	Symbol	Bit Name	Function	R/W
b3	PWM2	PWM2 mode select bit	1: Timer mode or PWM mode	R/W
b7	CTS	TRCCNT count start bit	0: Count is stopped	R/W

(7) Set the timer RC mode register.

Timer RC Mode Register (TRCMR)

Bit	b7	b6	b5	b4	b3	b2	b1	b0
Setting Value		—	0	0		1	1	1

Bit	Symbol	Bit Name	Function	R/W
b0	PWMB	TRCIOB PWM mode select bit	1: PWM mode	R/W
b1	PWMC	TRCIOC PWM mode select bit		R/W
b2	PWMD	TRCIOD PWM mode select bit		R/W
b4	BUFEA	TRCGRC register function select bit	0: Output compare or input capture register	R/W
b5	BUFEB	TRCGRD register function select bit	0: Output compare or input capture register	R/W

(8) Disable the A/D conversion start trigger.

Timer RC A/D Conversion Trigger Control Register (TRCADCR)

Bit	b7	b6	b5	b4	b3	b2	b1	b0
Setting Value	—	—	—	—	0	0	0	0

Bit	Symbol	Bit Name	Function	R/W
b0	ADTRGAE	TRCGRA A/D conversion start trigger enable bit	0: No A/D conversion start trigger occurs at compare match A	R/W
b1	ADTRGBE	TRCGRB A/D conversion start trigger enable bit	0: No A/D conversion start trigger occurs at compare match B	R/W
b2	ADTRGCE	TRCGRC A/D conversion start trigger enable bit	0: No A/D conversion start trigger occurs at compare match C	R/W
b3	ADTRGDE	TRCGRD A/D conversion start trigger enable bit	0: No A/D conversion start trigger occurs at compare match D	R/W

(9) Set timer RC control register 1.

Timer RC Control Register 1 (TRCCR1)

Bit	b7	b6	b5	b4	b3	b2	b1	b0
Setting Value	1	0	0	0	0	0	0	x

Bit	Symbol	Bit Name	Function	R/W
b1	TOB	Timer output level select B bit	0: Output value 0	R/W
b2	TOC	Timer output level select C bit		R/W
b3	TOD	Timer output level select D bit		R/W
b4	CKS0	Count source select bits	b6 b5 b4 0 0 0: f1	R/W
b5	CKS1			R/W
b6	CKS2			R/W
b7	CCLR	TRCCNT counter clear select bit	1: TRCCNT counter is cleared by input capture/compare match A	R/W

(10) Wait for at least two cycles of the system clock.

(11) Set timer RC control register 2.

Timer RC Control Register 2 (TRCCR2)

Bit	b7	b6	b5	b4	b3	b2	b1	b0
Setting Value	x	x	0	—	—	1	1	1

Bit	Symbol	Bit Name	Function	R/W
b0	POLB	TRCIOB PWM mode output level control bit	1: Output level is active high	R/W
b1	POLC	TRCIOC PWM mode output level control bit		R/W
b2	POLD	TRCIOD PWM mode output level control bit		R/W
b5	CSTP	Count stop bit	0: Increment is continued	R/W

(12) Initialize the timer RC counter to 0000h.

Timer RC Counter (TRCCNT)

Bit	b7	b6	b5	b4	b3	b2	b1	b0
Setting Value	0	0	0	0	0	0	0	0

Bit	b15	b14	b13	b12	b11	b10	b9	b8
Setting Value	0	0	0	0	0	0	0	0

Bit	Function	Setting Range	R/W
b15-b0	16-bit readable/writable up counter.	0000h to FFFFh	R/W

(13) Set compare value 2000 - 1 (07CFh) with the timer RC counter to timer RC general register A.

Timer RC General Register A (TRCGRA)

Bit	b7	b6	b5	b4	b3	b2	b1	b0
Setting Value	1	1	0	0	1	1	1	1

Bit	b15	b14	b13	b12	b11	b10	b9	b8
Setting Value	0	0	0	0	0	1	1	1

Bit	Function	R/W
b15-b0	Set the PWM period: 50 ns × 2000 = 100 μs	R/W

(14) Set compare value 500 - 1 (01F3h) with the timer RC counter to timer RC general register B.

Timer RC General Register B (TRCGRB)

Bit	b7	b6	b5	b4	b3	b2	b1	b0
Setting Value	1	1	1	1	0	0	1	1

Bit	b15	b14	b13	b12	b11	b10	b9	b8
Setting Value	0	0	0	0	0	0	0	1

Bit	Function	R/W
b15-b0	Set low width of the TRCIOB pin: 50 ns × 500 = 25 μs	R/W

(15) Set compare value 1000 - 1 (03E7h) with the timer RC counter to timer RC general register C.

Timer RC General Register C (TRCGRC)

Bit	b7	b6	b5	b4	b3	b2	b1	b0
Setting Value	1	1	1	0	0	1	1	1

Bit	b15	b14	b13	b12	b11	b10	b9	b8
Setting Value	0	0	0	0	0	0	1	1

Bit	Function	R/W
b15-b0	Set low width of the TRCIOC pin: 50 ns × 1000 = 50 μs	R/W

(16) Set compare value 1500 - 1 (05DBh) with the timer RC counter to timer RC general register D.

Timer RC General Register D (TRCGRD)

Bit	b7	b6	b5	b4	b3	b2	b1	b0
Setting Value	1	1	0	1	1	0	1	1

Bit	b15	b14	b13	b12	b11	b10	b9	b8
Setting Value	0	0	0	0	0	1	0	1

Bit	Function	R/W
b15-b0	Set low width of the TRCIOD pin: 50 ns × 1500 = 75 μs	R/W

(17) Set the timer RC waveform output manipulation register.

Timer RC Waveform Output Manipulation Register (TRCOPR)

Bit	b7	b6	b5	b4	b3	b2	b1	b0
Setting Value	—	—	0	x	x	x	x	x

Bit	Symbol	Bit Name	Function	R/W
b5	OPE	Waveform output manipulation enable bit	0: Waveform output manipulation disabled	R/W

(18) Set the timer RC interrupt enable register.

Timer RC Interrupt Enable Register (TRCIER)

Bit	b7	b6	b5	b4	b3	b2	b1	b0
Setting Value	x	—	—	—	x	x	x	1

Bit	Symbol	Bit Name	Function	R/W
b0	IMIEA	Input capture/compare match A interrupt enable bit	1: Interrupt request (IMIA) by IMFA bit in TRCSR register is enabled	R/W

(19) Initialize the timer RC status register.

Timer RC Status Register (TRCSR)

Bit	b7	b6	b5	b4	b3	b2	b1	b0
Setting Value	0	—	—	—	0	0	0	0

Bit	Symbol	Bit Name	Function	R/W
b0	IMFA	Input capture/compare match A flag	[Condition for setting to 0] • When 0 is written to this bit after reading it as 1.	R/W
b1	IMFB	Input capture/compare match B flag		R/W
b2	IMFC	Input capture/compare match C flag		R/W
b3	IMFD	Input capture/compare match D flag		R/W
b7	OVF	Timer overflow flag		R/W

(20) Set the timer RC output enable register.

Timer RC Output Enable Register (TRCOER)

Bit	b7	b6	b5	b4	b3	b2	b1	b0
Setting Value	0	—	—	—	0	0	0	1

Bit	Symbol	Bit Name	Function	R/W
b0	EA	TRCIOA output disable bit	1: Output disabled (independent of settings of registers TRCMR and TRCIOR0)	R/W
b1	EB	TRCIOB output disable bit	0: Output enabled (dependent on settings of registers TRCMR and TRCIOR0)	R/W
b2	EC	TRCIOC output disable bit	0: Output enabled (dependent on settings of registers TRCMR and TRCIOR1)	R/W
b3	ED	TRCIOD output disable bit		R/W
b7	PTO	Timer output disable bit	0: Bits EA to ED do not change even if a low level is input to the INT0 pin	R/W

(21) Enable the timer RC interrupt.

Interrupt Priority Level Register 3 (ILVL3)

Bit	b7	b6	b5	b4	b3	b2	b1	b0
Setting Value	—	—	0	1	—	—	—	—

Bit	Symbol	Bit Name	Function	R/W
b4	ILVL34	Interrupt priority level setting bits	b5 b4 0 1: Level 1	R/W
b5	ILVL35			R/W

(22) Start the timer RC count.

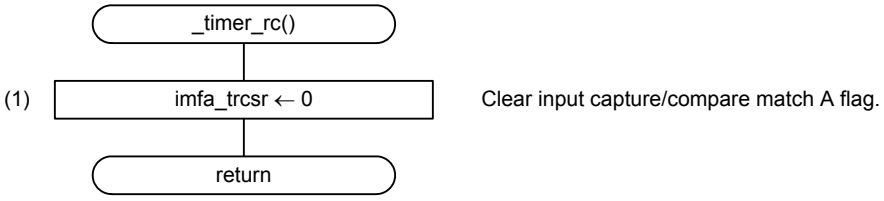
Timer RC Mode Register (TRCMR)

Bit	b7	b6	b5	b4	b3	b2	b1	b0
Setting Value	1	—						

Bit	Symbol	Bit Name	Function	R/W
b7	CTS	TRCCNT count start bit	1: Count is started	R/W

4.5 Timer RC Interrupt Handling

• Flowchart



• Register setting

(1) Clear input capture/compare match A flag.

Timer RC Status Register (TRCSR)

Bit	b7	b6	b5	b4	b3	b2	b1	b0
Setting Value		—	—	—				0

Bit	Symbol	Bit Name	Function	R/W
b0	IMFA	Input capture/compare match A flag	[Condition for setting to 0] • When 0 is written to this bit after reading it as 1.	R/W

5. Sample Program

A sample program can be downloaded from the Renesas Electronics website.
To download, click “Application Notes” in the left-hand side menu of the R8C Family page.

6. Reference Documents

R8C/M12A Group User’s Manual: Hardware Rev.1.00
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.

Website and Support

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

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

Revision History	R8C/M12A Group Timer RC in PWM Mode

Rev.	Date	Description	
		Page	Summary
1.00	Oct. 28, 2010	—	First edition issued
1.10	Mar. 10, 2011	—	R8C/M12A Group hardware user's manual Rev.1.00 reviewed
		7	External clock control register (EXCKCR) revised
		8	System clock f select register (PHISEL) revised System clock f control register (SCKCR) revised
		9, 12	(10) CPU revised as system
		15	(20) Timer RC output enable register 8TRCOER) revised

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.

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.

RENESAS

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: +44-1628-585-100, Fax: +44-1628-585-900

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.
7F, No. 363 Fu Shing North Road Taipei, Taiwan
Tel: +886-2-8175-9600, Fax: +886 2-8175-9670

Renesas Electronics Singapore Pte. Ltd.
1 harbourFront Avenue, #06-10, keppel Bay Tower, Singapore 098632
Tel: +65-6213-0200, Fax: +65-6278-8001

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

Colophon 1.0