R8C/LA8A Group

Timer RJ in Pulse Period Measurement Mode

R01AN0078EJ0100
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Apr. 25, 2011

1. Abstract

This document describes a setting method and an application example for the R8C/LA8A Group using timer RJ in pulse period measurement mode.

2. Introduction

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

- MCU: R8C/LA8A 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

The pulse period of the external signal input to the TRJ0IO pin is measured.

Settings

- Use timer RJ0.
- Use pulse period measurement mode.
- Select f1 as the count source of timer RJ0.
- Select one edge to the TRJ0IO input polarity.
- Measure a period from one rising edge to the next rising edge of the measurement pulse.
- Use the active edge judgment flag.
- Use the timer RJ0 underflow flag.
- Use the P6_2/TRJ0IO pin as the input pin.
- Use the timer RJ0 interrupt.
- Do not use the TRJ0IO input filter.

Figure 3.1 shows a Block Diagram and Figure 3.2 shows a Timing Diagram. Table 3.1 lists the Pin Used and Its Function.

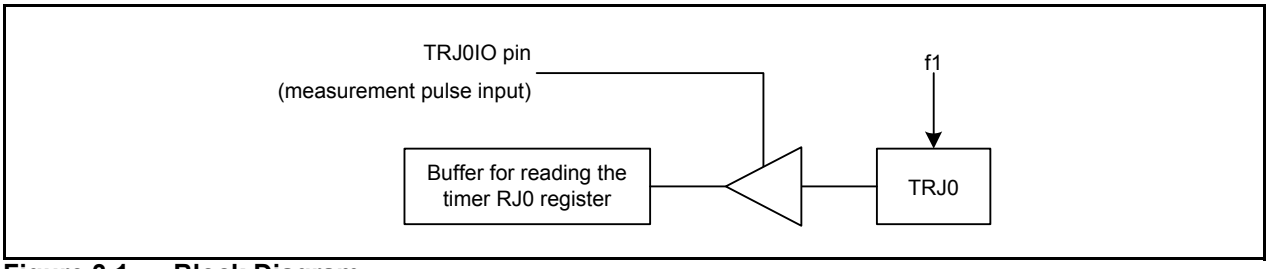


Figure 3.1 Block Diagram

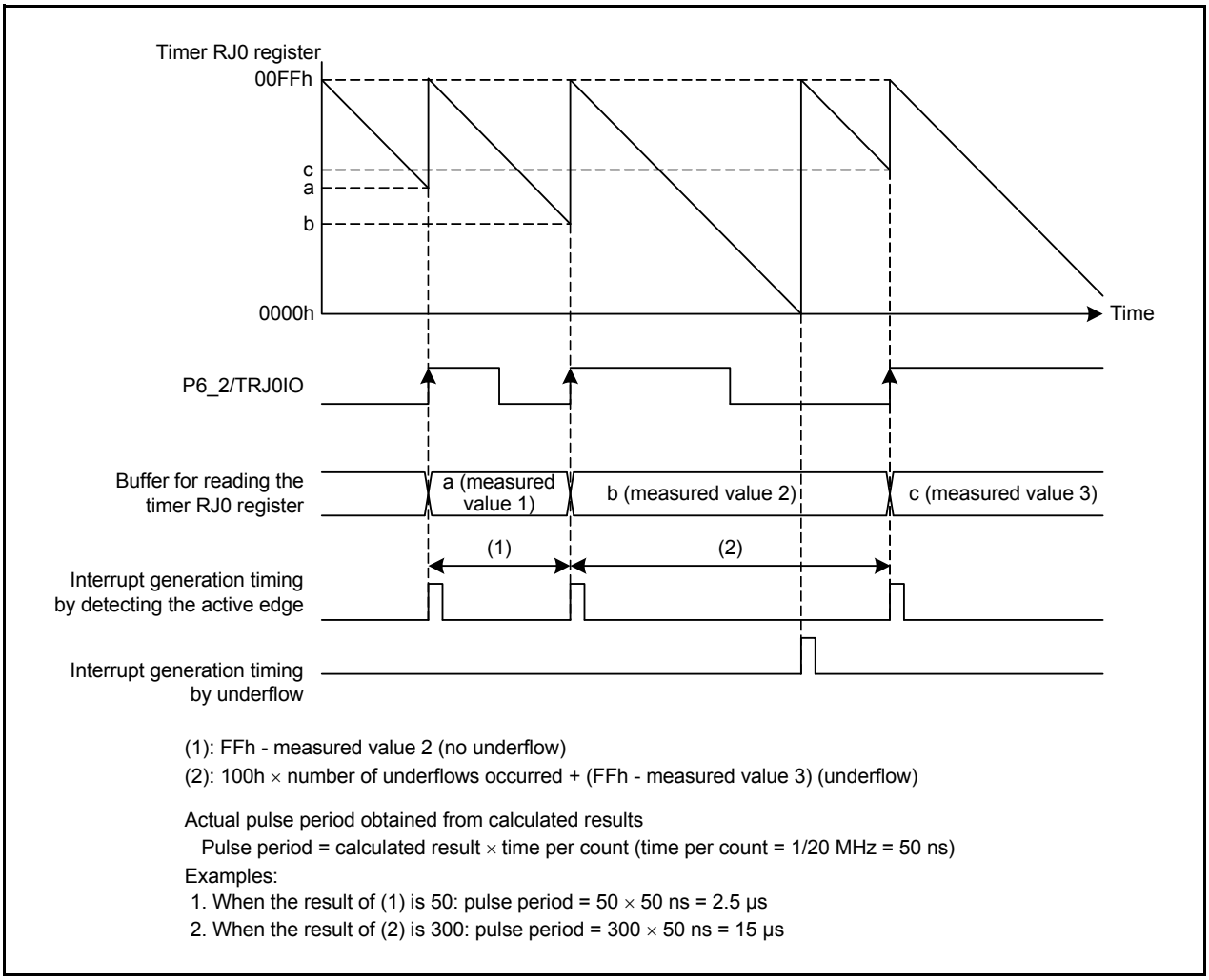


Figure 3.2 Timing Diagram

Table 3.1 Pin Used and Its Function

Pin Name	I/O	Function
P6_2/TRJ0IO	Input	Measurement pulse input

3.2 Memory

Table 3.2 Memory

Memory	Size	Remarks
ROM	335 bytes	In the r01an0078_src.c module
RAM	6 bytes	In the r01an0078_src.c module
Maximum user stack	10 bytes	
Maximum interrupt stack	19 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/LA8A 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	After initializing the system clock and timer RJ0, call the calculation processing of the pulse period.		

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).		

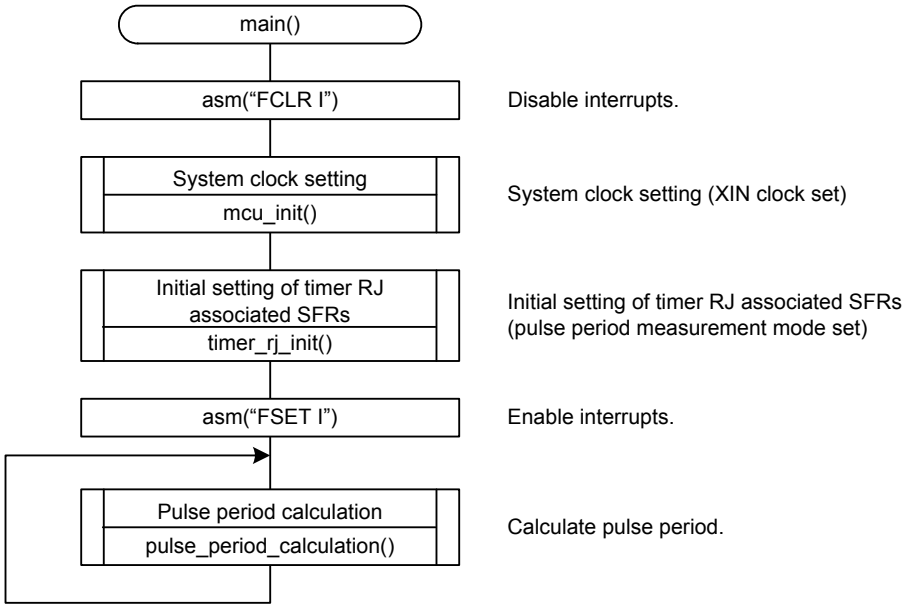
Declaration	void timer_rj_init (void)		
Outline	Initial setting of timer RJ associated SFRs		
Argument	Argument name		Meaning
	None		—
Variable (global)	Variable name		Contents
	None		—
Returned value	Type	Value	Meaning
	None	—	—
Function	Initialize SFRs to use timer RJ0 in pulse period measurement mode.		

Declaration	void pulse_period_calculation (void)		
Outline	Pulse period calculation		
Argument	Argument name		Meaning
	None		—
Variable (global)	Variable name		Contents
	unsigned char f_edge		Active edge flag
	unsigned char undf_cnt		Underflow count
	unsigned short present_value		Timer RJ0 register obtained value
	unsigned short measurement_value		Measured value
Returned value	Type	Value	Meaning
	None	—	—
Function	Calculate the pulse period based on the measured value in pulse period measurement mode.		

Declaration	void _timer_rj_ch0 (void)		
Outline	Timer RJ0 interrupt handling		
Argument	Argument name		Meaning
	None		—
Variable (global)	Variable name		Contents
	unsigned char f_edge		Active edge flag
	unsigned char undf_cnt		Underflow count
	unsigned short present_value		Timer RJ0 register obtained value
Returned value	Type	Value	Meaning
	None	—	—
Function	Perform timer RJ0 interrupt handling. When an active edge is received, read the TRJ0 register value. When timer RJ underflows, count the number of underflows. When the active edge is received and timer RJ underflows, set the obtained value to 0000h regardless of the RJ0 register value.		

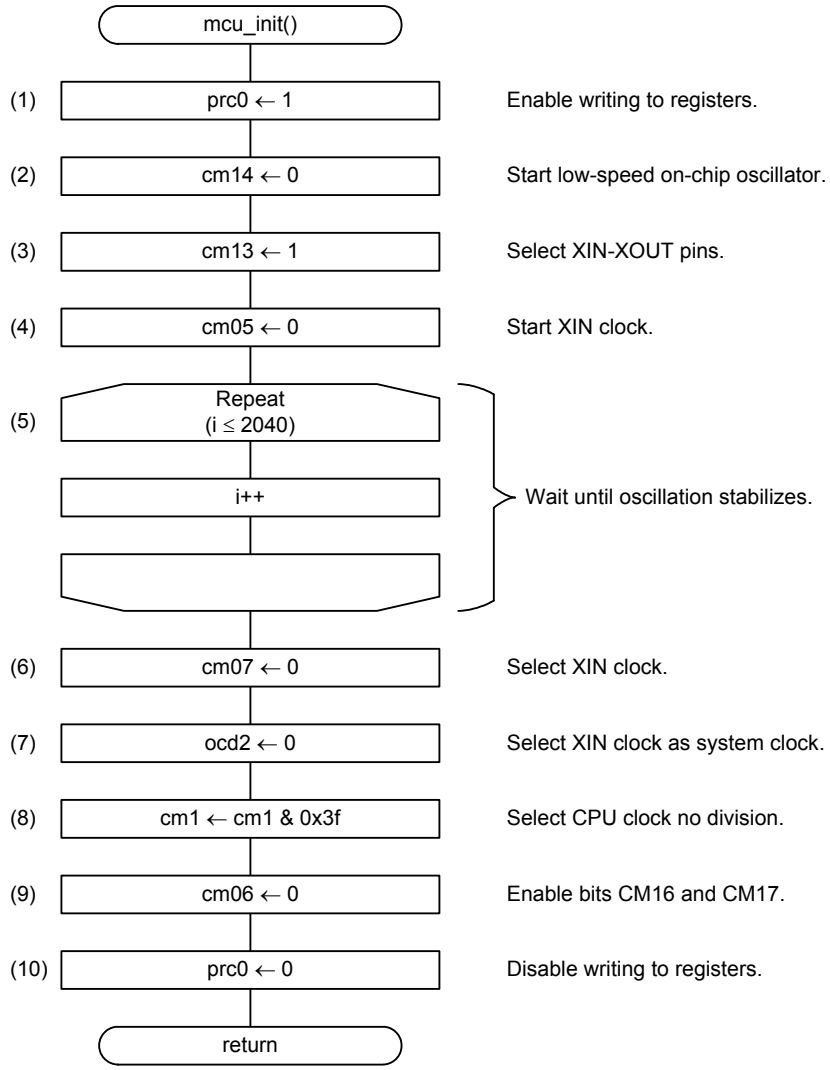
4.2 Main Function

• Flowchart



4.3 System Clock Setting

• Flowchart



• Register settings

(1) Enable writing to registers CM0, CM1, CM3, OCD, FRA0, FRC0, FRA2, and FRC1.

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 CM0, CM1, CM3, OCD, FRA0, FRC0, FRA2, and FRC1 1: Write enabled	R/W

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

System Clock Control Register 1 (CM1)

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

Bit	Symbol	Bit Name	Function	R/W
b4	CM14	Low-speed on-chip oscillator oscillation stop bit	0: Low-speed on-chip oscillator on	R/W

(3) Select the XIN-XOUT pins.

System Clock Control Register 1 (CM1)

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

Bit	Symbol	Bit Name	Function	R/W
b3	CM13	Port/XIN-XOUT switch bit	1: XIN-XOUT pins	R/W

(4) Oscillate the XIN clock.

System Clock Control Register 0 (CM0)

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

Bit	Symbol	Bit Name	Function	R/W
b5	CM05	XIN clock (XIN-XOUT) stop bit	0: XIN clock oscillates	R/W

(5) Wait until oscillation stabilizes.

(6) Select the XIN clock.

System Clock Control Register 0 (CM0)

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

Bit	Symbol	Bit Name	Function	R/W
b7	CM07	System clock select bit	0: XIN clock or on-chip oscillator clock	R/W

(7) Select the XIN clock as the system clock.

Oscillation Stop Detection Register (OCD)

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

Bit	Symbol	Bit Name	Function	R/W
b2	OCD2	On-chip oscillator clock select bit	0: XIN clock selected	R/W

(8) Set CPU clock division select bit 1.

System Clock Control Register 1 (CM1)

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

Bit	Symbol	Bit Name	Function	R/W
b6	CM16	CPU clock division select bit 1	b7 b6 0 0: No division mode	R/W
b7	CM17			R/W

(9) Set CPU clock division select bit 0.

System Clock Control Register 0 (CM0)

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

Bit	Symbol	Bit Name	Function	R/W
b6	CM06	CPU clock division select bit 0	0: Bits CM16 and CM17 in CM1 register enabled	R/W

(10)Disable writing to registers CM0, CM1, CM3, OCD, FRA0, FRC0, FRA2, and FRC1.

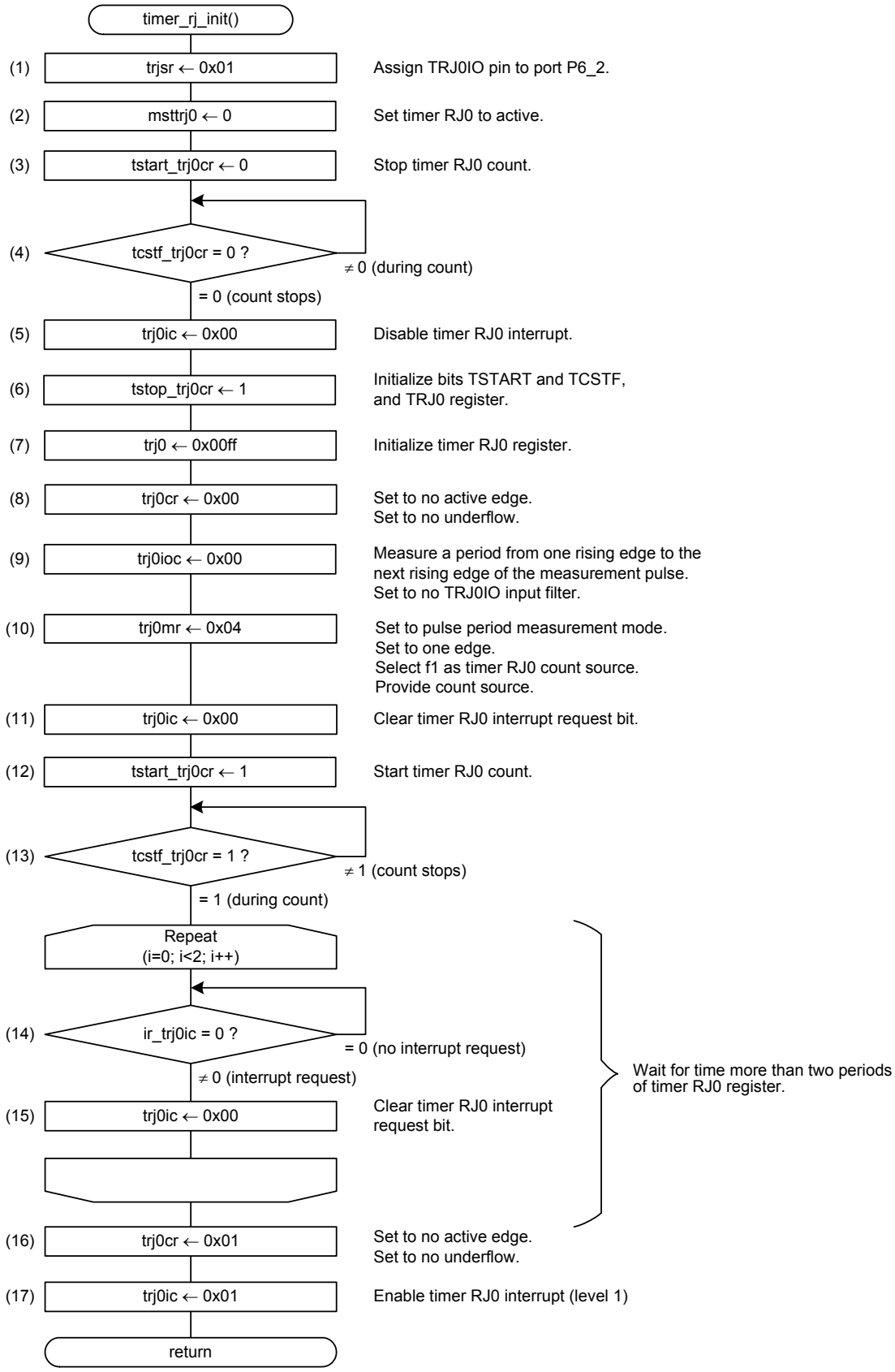
Protect Register (PRCR)

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 CM0, CM1, CM3, OCD, FRA0, FRC0, FRA2, and FRC1 0: Write disabled	R/W

4.4 Initial Setting of Timer RJ Associated SFRs

• Flowchart



• Register settings

(1) Set the timer RJ pin select register.

Timer RJ Pin Select Register (TRJSR)

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

Bit	Symbol	Bit Name	Function	R/W
b0	TRJ0IOSEL0	TRJ0IO pin select bit	b1 b0 0 1: P6_2 assigned	R/W
b1	TRJ0IOSEL1			R/W

(2) Set timer RJ0 to active.

Module Standby Control Register 1 (MSTCR1)

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

Bit	Symbol	Bit Name	Function	R/W
b3	MSTTRJ0	Timer RJ0 standby bit	0: Active	R/W

(3) Stop the timer RJ0 count.

Timer RJ0 Control Register (TRJ0CR)

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

Bit	Symbol	Bit Name	Function	R/W
b0	TSTART	Timer RJ0 count start bit	0: Count stops	R/W

(4) Wait until the timer RJ0 count stops.

Timer RJ0 Control Register (TRJ0CR)

Bit	Symbol	Bit Name	Function	R/W
b1	TCSTF	Timer RJ0 count status flag	0: Count stops 1: During count operation	R

(5) Disable the timer RJ0 interrupt.

Interrupt Control Register (TRJ0IC)

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

Bit	Symbol	Bit Name	Function	R/W
b0	ILVL0	Interrupt priority level select bit	b2 b1 b0 0 0 0: Level 0 (interrupt disabled)	R/W
b1	ILVL1			R/W
b2	ILVL2			R/W
b3	IR	Interrupt request bit	0: No interrupt requested	R/W

(6) Initialize bits TSTART and TCSTF, and the TRJ0 register.

Timer RJ0 Control Register (TRJ0CR)

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

Bit	Symbol	Bit Name	Function	R/W
b2	TSTOP	Timer RJ0 count forcible stop bit	When this bit is set to 1, the count is forcibly stopped. When read, the content is 0.	R/W

(7) Initialize the timer RJ0 register to 00FFh.

Timer RJ0 Register (TRJ0)

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

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

Bit	Mode	Function	Setting Range	R/W
b15-b0	Pulse period measurement mode	Measures the pulse period of input pulses from external (counts an internal count source).	0001h to FFFFh	R/W

(8) Set the timer RJ0 control register.

Timer RJ0 Control Register (TRJ0CR)

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

Bit	Symbol	Bit Name	Function	R/W
b4	TEDGF	Active edge judgment flag	0: Active edge not received	R/W
b5	TUNDF	Timer RJ0 underflow flag	0: No underflow	R/W

(9) Set the timer RJ0 I/O control register.

Timer RJ0 I/O Control Register (TRJ0IOC)

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

Bit	Symbol	Bit Name	Function	R/W
b0	TEDGSEL	TRJ0IO polarity switch bit	0: Period from one rising edge to next rising edge of measured pulse is measured	R/W
b1	TOPCR	TRJ0IO output control bit	Set to 0 in pulse period measurement mode.	R/W
b2	TOENA	TRJ0O output enable bit		R/W
b4	TIPF0	TRJ0IO input filter select bit	b5 b4 0 0: No filter	R/W
b5	TIPF1			R/W
b6	TIOGT0	TRJ0IO event input control bit	Set to 0 in pulse period measurement mode.	R/W
b7	TIOGT1			R/W

(10) Set the timer RJ0 mode register.

Timer RJ0 Mode Register (TRJ0MR)

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

Bit	Symbol	Bit Name	Function	R/W
b0	TMOD0	Timer RJ0 operating mode select bit	b2 b1 b0 1 0 0: Pulse period measurement mode	R/W
b1	TMOD1			R/W
b2	TMOD2			R/W
b3	TEDGPL	TRJ0IO input polarity select bit	0: One edge	R/W
b4	TCK0	Timer RJ0 count source select bit	b6 b5 b4 0 0 0: f1	R/W
b5	TCK1			R/W
b6	TCK2			R/W
b7	TCKCUT	Timer RJ0 count source cut off bit	0: Count source provided	R/W

(11)Set to no timer RJ0 interrupt request.

Interrupt Control Register (TRJ0IC)

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

Bit	Symbol	Bit Name	Function	R/W
b3	IR	Interrupt request bit	0: No interrupt requested	R/W

(12) Start the timer RJ0 count.

Timer RJ0 Control Register (TRJ0CR)

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

Bit	Symbol	Bit Name	Function	R/W
b0	TSTART	Timer RJ0 count start bit	1: Count starts	R/W

(13)Wait until the timer RJ0 count starts.

Timer RJ0 Control Register (TRJ0CR)

Bit	Symbol	Bit Name	Function	R/W
b1	TCSTF	Timer RJ0 count status flag	0: Count stops 1: During count operation	R

(14)Determine the timer RJ0 interrupt request bit.

Interrupt Control Register (TRJ0IC)

Bit	Symbol	Bit Name	Function	R/W
b3	IR	Interrupt request bit	0: No interrupt requested 1: Interrupt requested	R/W

(15) Set to no timer RJ0 interrupt request.

Interrupt Control Register (TRJ0IC)

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

Bit	Symbol	Bit Name	Function	R/W
b3	IR	Interrupt request bit	0: No interrupt requested	R/W

(16) Set to no active edge and no underflow.

Timer RJ0 Control Register (TRJ0CR)

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

Bit	Symbol	Bit Name	Function	R/W
b4	TEDGF	Active edge judgment flag	0: Active edge not received	R/W
b5	TUNDF	Timer RJ0 underflow flag	0: No underflow	R/W

(17) Enable the timer RJ0 interrupt (level 1).

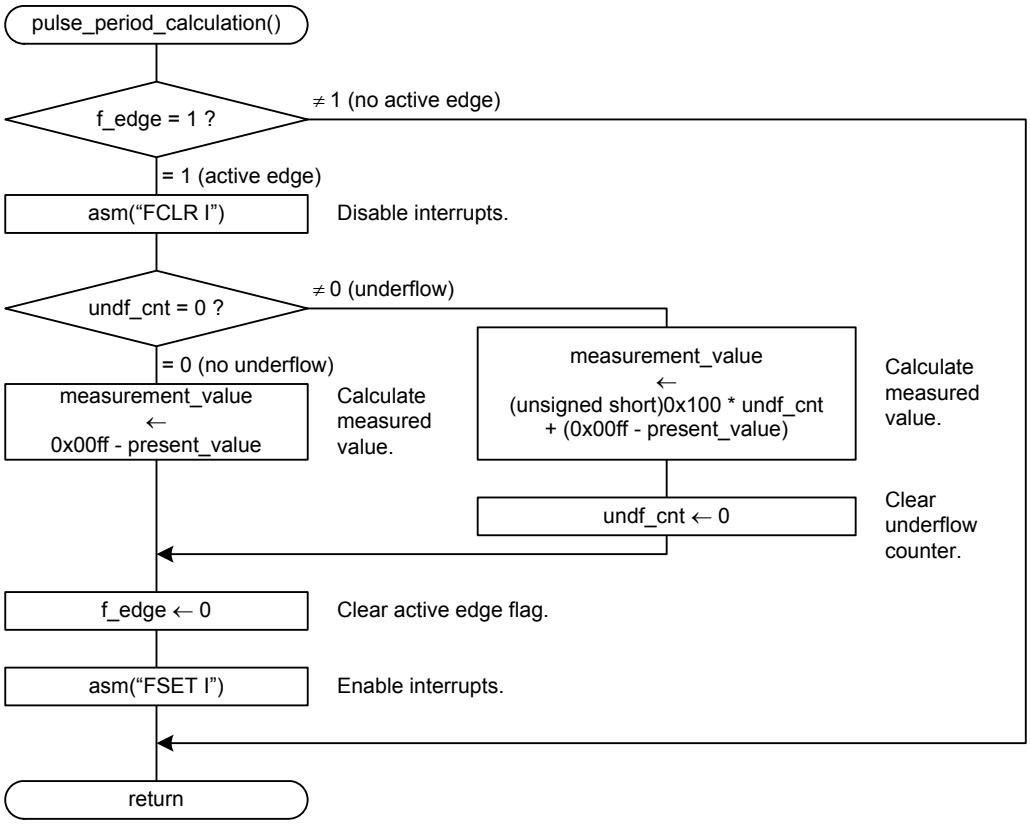
Interrupt Control Register (TRJ0IC)

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

Bit	Symbol	Bit Name	Function	R/W
b0	ILVL0	Interrupt priority level select bit	b2 b1 b0 0 0 1: Level 1	R/W
b1	ILVL1			R/W
b2	ILVL2			R/W
b3	IR	Interrupt request bit	0: No interrupt requested	R/W

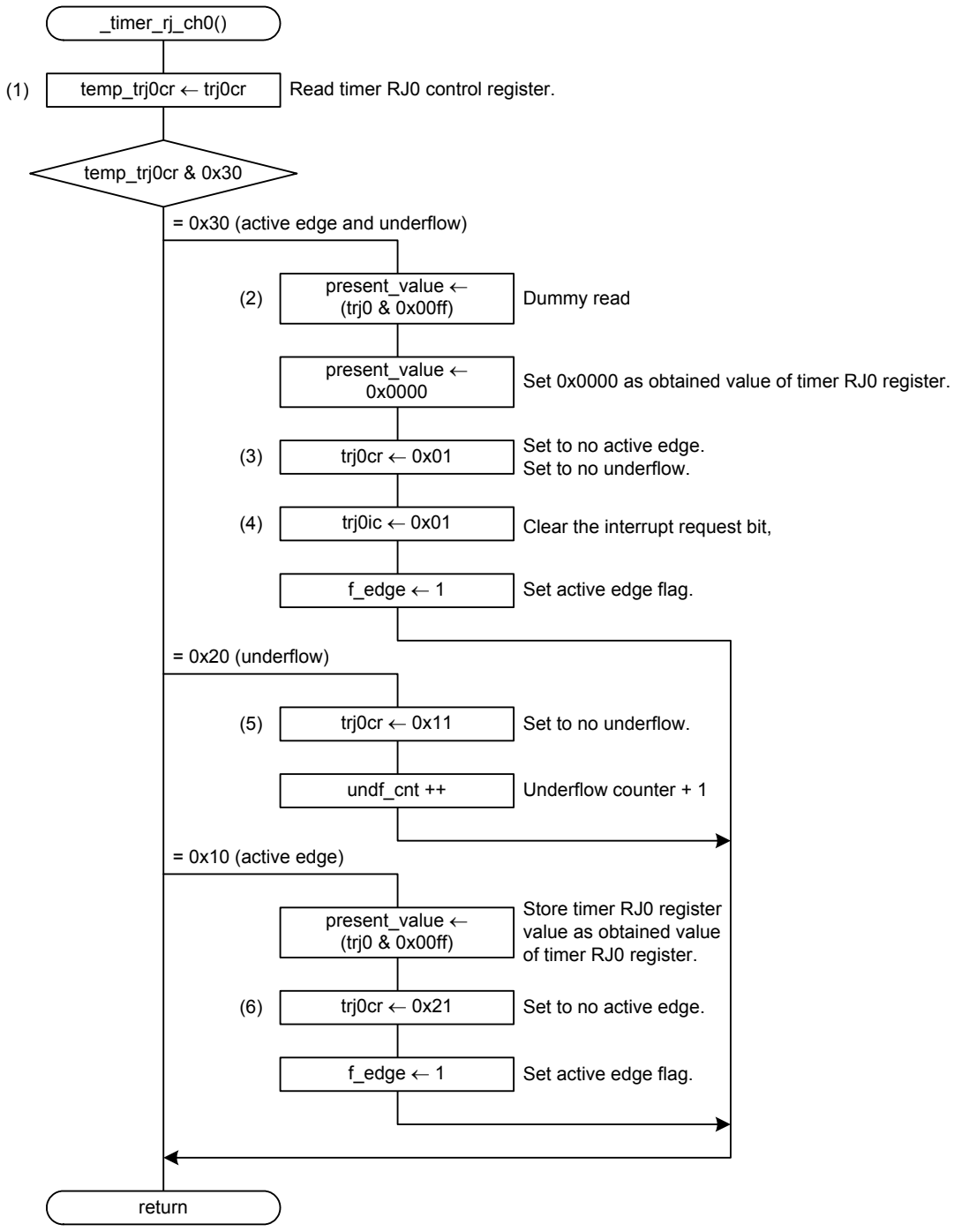
4.5 Pulse Period Calculation

• Flowchart



4.6 Timer RJ0 Interrupt Handling

• Flowchart



• Register settings

(1) Read the timer RJ0 control register to determine the statuses of the active edge and underflow.

Timer RJ0 Control Register (TRJ0CR)

Bit	Symbol	Bit Name	Function	R/W
b4	TEDGF	Active edge judgment flag	0: Active edge not received 1: Active edge received (end of measurement period)	R/W
b5	TUNDF	Timer RJ0 underflow flag	0: No underflow 1: Underflow	R/W

(2) Read the timer RJ0 register.

Timer RJ0 Register (TRJ0)

Bit	Mode	Function	Setting Range	R/W
b15-b0	Pulse period measurement mode	Measures the pulse period of input pulses from external (counts an internal count source).	0001h to FFFFh	R/W

(3) Set to no active edge and no underflow.

Timer RJ0 Control Register (TRJ0CR)

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

Bit	Symbol	Bit Name	Function	R/W
b4	TEDGF	Active edge judgment flag	0: Active edge not received	R/W
b5	TUNDF	Timer RJ0 underflow flag	0: No underflow	R/W

(4) Set to no timer RJ0 interrupt request. When the underflow occurs immediately after interrupt handling by detecting an active edge is started, or an active edge is detected immediately after interrupt handling that occurs from an underflow, the interrupt request bit becomes 1. When the interrupt handling being executed is completed while the interrupt request bit is 1, interrupt handling is executed again immediately after returning from interrupt handling. Set the interrupt request bit to 0 to not execute this interrupt handling.

Interrupt Control Register (TRJ0IC)

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

Bit	Symbol	Bit Name	Function	R/W
b3	IR	Interrupt request bit	0: No interrupt requested	R/W

(5) Set to no underflow. When writing 1 to the TEDGF bit, the TEDGF bit value is retained.

Timer RJ0 Control Register (TRJ0CR)

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

Bit	Symbol	Bit Name	Function	R/W
b4	TEDGF	Active edge judgment flag	0: Active edge not received	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/LA8A Group User’s Manual: Hardware Rev.1.01
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
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Revision History	R8C/LA8A Group Timer RJ in Pulse Period Measurement Mode

Rev.	Date	Description	
		Page	Summary
1.00	Apr. 25, 2011	—	First edition issued

General Precautions in the Handling of MPU/MCU Products

The following usage notes are applicable to all MPU/MCU products from Renesas. For detailed usage notes on the products covered by this manual, refer to the relevant sections of the manual. If the descriptions under General Precautions in the Handling of MPU/MCU Products and in the body of the manual differ from each other, the description in the body of the manual takes precedence.

1. Handling of Unused Pins

   Handle unused pins in accord with the directions given under Handling of Unused Pins in the manual.

   — The input pins of CMOS products are generally in the high-impedance state. In operation with an unused pin in the open-circuit state, extra electromagnetic noise is induced in the vicinity of LSI, an associated shoot-through current flows internally, and malfunctions occur due to the false recognition of the pin state as an input signal become possible. Unused pins should be handled as described under Handling of Unused Pins in the manual.

2. Processing at Power-on

   The state of the product is undefined at the moment when power is supplied.

   — The states of internal circuits in the LSI are indeterminate and the states of register settings and pins are undefined at the moment when power is supplied.

   In a finished product where the reset signal is applied to the external reset pin, the states of pins are not guaranteed from the moment when power is supplied until the reset process is completed.

   In a similar way, the states of pins in a product that is reset by an on-chip power-on reset function are not guaranteed from the moment when power is supplied until the power reaches the level at which resetting has been specified.

3. Prohibition of Access to Reserved Addresses

   Access to reserved addresses is prohibited.

   — The reserved addresses are provided for the possible future expansion of functions. Do not access these addresses; the correct operation of LSI is not guaranteed if they are accessed.

4. Clock Signals

   After applying a reset, only release the reset line after the operating clock signal has become stable. When switching the clock signal during program execution, wait until the target clock signal has stabilized.

   — When the clock signal is generated with an external resonator (or from an external oscillator) during a reset, ensure that the reset line is only released after full stabilization of the clock signal. Moreover, when switching to a clock signal produced with an external resonator (or by an external oscillator) while program execution is in progress, wait until the target clock signal is stable.

5. Differences between Products

   Before changing from one product to another, i.e. to one with a different 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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