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R8C/25 Group

Timer RB in Programmable One-shot Generation Mode

1. Abstract

This document describes how to set up and use the timer RB in programmable one-shot generation mode on the R8C/25 Group device.

2. Introduction

The application example described in this document is applied to the following:

- MCU: R8C/25 Group
- XIN clock: 20 MHz

This program can be used with other R8C/Tiny Series which have the same SFR (special function register) as the R8C/25 Group. Check the manual for any additions and modifications to functions. Careful evaluation is recommended before using this application note.

3. Applications

3.1 Timer RB

Timer RB is an 8-bit timer with an 8-bit prescaler.
The prescaler and timer each consist of a reload register and counter. The reload register and counter are allocated at the same address (refer to Table 3.1 Programmable One-shot Generation Mode Specifications for access to the reload register and counter).
Timer RB has timer RB primary and timer RB secondary as reload registers.
The count source for timer RB is the operating clock that regulates the timing of timer operations such as counting and reloading.
Figure 3.1 shows a Block Diagram of Timer RB.

Timer RB has four operation modes listed as follows:

- Timer mode: The timer counts an internal count source (peripheral function clock or timer RA underflows).
- Programmable waveform generation mode: The timer outputs pulses of a given width successively.
- Programmable one-shot generation mode: The timer outputs a one-shot pulse.
- Programmable wait one-shot generation mode: The timer outputs a delayed one-shot pulse.

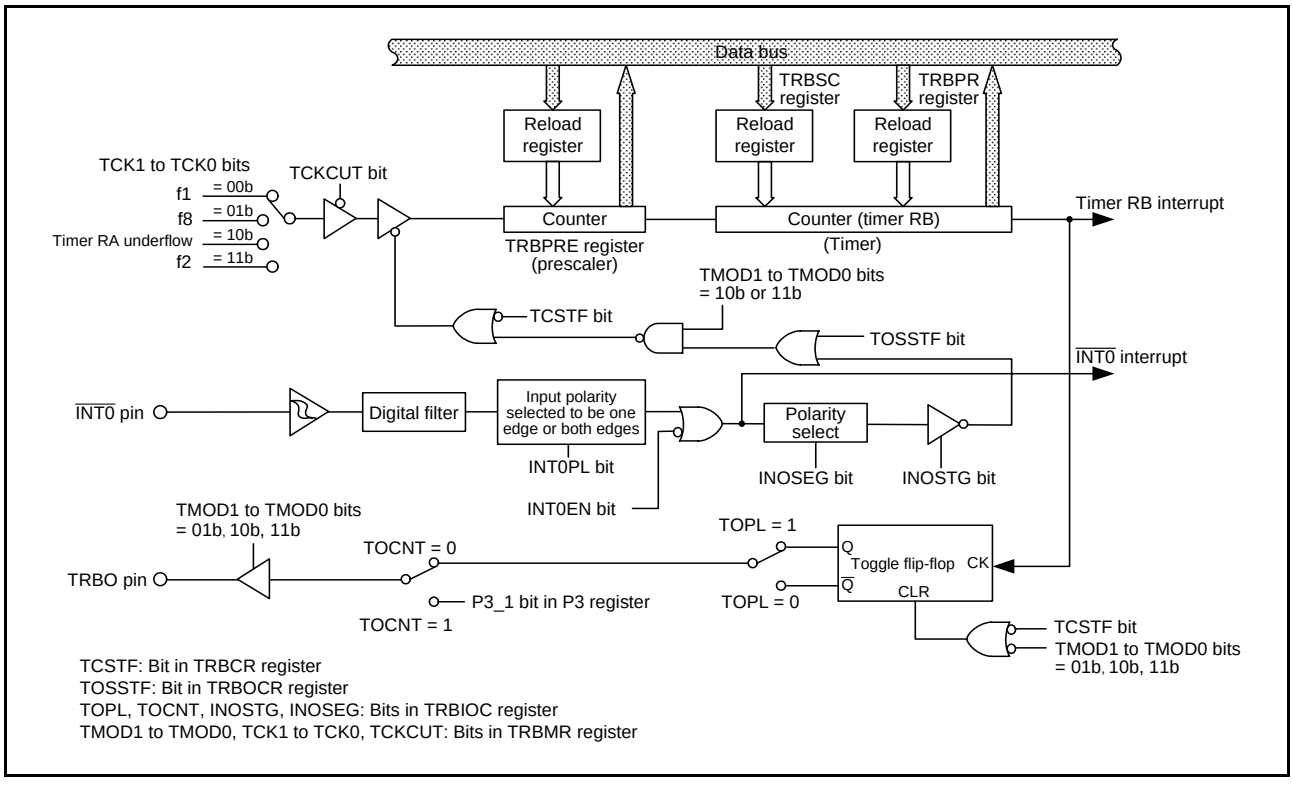


Figure 3.1 Block Diagram of Timer RB

3.2 Programmable One-shot Generation Mode

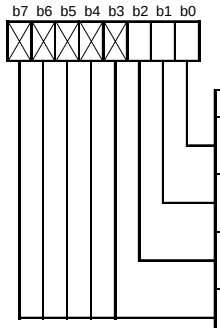
In programmable one-shot generation mode, a one-shot pulse is output from the TRBO pin by a program or an external trigger input (input to the INT0 pin) (refer to Table 3.1). When a trigger is generated, the timer starts operating from that point only once for a given period equal to the set value in the TRBPR register. The TRBSC register is not used in this mode.
Figure 3.2 shows Registers TRBCR and TRBOCR in Programable One-shot Generation Mode, and Figure 3.3 shows Registers TRBIOC and TRBMR in Programable One-shot Generation Mode, Figure 3.4 shows Registers TRBPRE and TRBPR in Programable One-shot Generation Mode. Figure 3.5 shows an Operating Example of Timer RB in Programmable One-shot Generation Mode.

Table 3.1 Programmable One-shot Generation Mode Specifications

Item	Specification
Count sources	f1, f2, f8, timer RA underflow
Count operations	• Decrement the setting value in the TRBPR register • When the timer underflows, it reloads the contents of the reload register before the count completes and the TOSSTF bit is set to 0 (one-shot stops). • When the count stops, the timer reloads the contents of the reload register before it stops.
One-shot pulse output time	(n+1)(m+1)/fi fi: count source frequency, n: Setting value in TRBPRE register, m: Setting value in TRBPR register
Count start conditions	• The TSTART bit in the TRBCR register is set to 1 (count starts) and the next trigger is generated. • Set the TOSST bit in the TRBOCR register to 1 (one-shot starts) • Input trigger to the $\overline{\text{INT0}}$ pin
Count stop conditions	• When reloading completes after timer RB underflows during primary period. • When the TOSSP bit in the TRBOCR register is set to 1 (one-shot stops). • When the TSTART bit in the TRBCR register is set to 0 (count stops). • When the TSTOP bit in the TRBCR register is set to 1 (count forcibly stops).
Interrupt request generation timing	In half a cycle of the count source, after the timer underflows (at the same time as the TRBO output ends) [timer RB interrupt]
TRBO pin function	Pulse output
$\overline{\text{INT0}}$ pin functions	• When the INOSTG bit in the TRBIOC register is set to 0 ($\overline{\text{INT0}}$ one-shot trigger disabled): programmable I/O port or $\overline{\text{INT0}}$ interrupt input • When the INOSTG bit in the TRBIOC register is set to 1 ($\overline{\text{INT0}}$ one-shot trigger enabled): external trigger ($\overline{\text{INT0}}$ interrupt input)
Read from timer	The count value can be read out by reading registers TRBPR and TRBPRE.
Write to timer	• When registers TRBPRE and TRBPR are written while the count is stopped, values are written to both the reload register and counter. • When registers TRBPRE and TRBPR are written during the count, values are written to the reload register only (the data is transferred to the counter at the following reload)(1).
Select functions	• Output level select function The TOPL bit in the TRBIOC register can select the output level of the one-shot pulse waveform. • One-shot trigger select function Refer to **3.3 One-Shot Trigger Selection**.

NOTES:
1. The set value is reflected at the following one-shot pulse after writing to the TRBPR register.

Timer RB Control Register

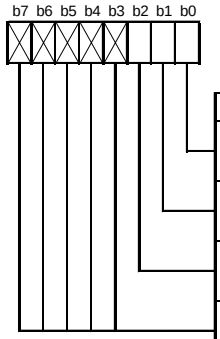


Symbol	Address	After Reset
TRBCR	0108h	00h

Bit Symbol	Bit Name	Function	RW
TSTART	Timer RB count start bit(1)	0 : Count stops 1 : Count starts	RW
TCSTF	Timer RB count status flag(1)	0 : Count stops 1 : During count(3)	RO
TSTOP	Timer RB count forcible stop bit(1, 2)	When this bit is set to 1, the count is forcibly stopped. When read, its content is 0.	RW
— (b7-b3)	Nothing is assigned. If necessary, set to 0. When read, the content is 0.		—

NOTES:
1. Refer to **3.4 Notes on Timer RB**.
2. When the TSTOP bit is set to 1, registers TRBPRE, TRBSC, TRBPR, and bits TSTART and TCSTF, and the TOSSTF bit in the TRBOCR register are set to values after a reset.
3. Indicates that count operation is in progress in timer mode or programmable w aveform mode. In programmable one-shot generation mode or programmable w ait one-shot generation mode, indicates that a one-shot pulse trigger has been acknow ledged.

Timer RB One-Shot Control Register(2)



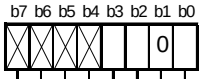
Symbol	Address	After Reset
TRBOCR	0109h	00h

Bit Symbol	Bit Name	Function	RW
TOSST	Timer RB one-shot start bit	When this bit is set to 1, one-shot trigger generated. When read, its content is 0.	RW
TOSSP	Timer RB one-shot stop bit	When this bit is set to 1, counting of one-shot pulses (including programmable w ait one-shot	RW
TOSSTF	Timer RB one-shot status flag(1)	0 : One-shot stopped 1 : One-shot operating (Including w ait period)	RO
— (b7-b3)	Nothing is assigned. If necessary, set to 0. When read, the content is 0.		—

NOTES:
1. When 1 is set to the TSTOP bit in the TRBCR register, the TOSSTF bit is set to 0.
2. This register is enabled w hen bits TMOD1 to TMOD0 in the TRBMR register is set to 10b (programmable one-shot generation mode) or 10b (programmable w ait one-shot generation mode).

Figure 3.2 Registers TRBCR and TRBOCR in Programable One-shot Generation Mode

Timer RB I/O Control Register

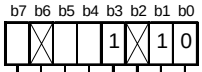


Symbol	Address	After Reset
TRBIOC	010Ah	00h

Bit Symbol	Bit Name	Function	RW
TOPL	Timer RB Output Level Select Bit	0 : Outputs one-shot pulse "H" Outputs "L" when the timer is stopped 1 : Outputs one-shot pulse "L" Outputs "H" when the timer is stopped	RW
TOCNT	Timer RB Output Switch Bit	Set to 0 in programmable one-shot generation mode.	RW
INOSTG	One-Shot Trigger Control Bit(1)	0 : $\overline{INT0}$ pin one-shot trigger disabled 1 : $\overline{INT0}$ pin one-shot trigger enabled	RW
INOSEG	One-Shot Trigger Polarity Select Bit(1)	0 : Falling edge trigger 1 : Rising edge trigger	RW
— (b7-b4)	Nothing is assigned. When write, set to 0. When read, its content is 0.		—

NOTE:
1. Refer to **3.3 One-Shot Trigger Selection**.

Timer RB Mode Register



Symbol	Address	After Reset
TRBMR	010Bh	00h

Bit Symbol	Bit Name	Function	RW
TMOD0	Timer RB operating mode select bits(1)	b1 b0 1 0: Programmable one-shot generation mode	RW
TMOD1			RW
— (b2)	Nothing is assigned. If necessary, set to 0. When read, the content is 0.		—
TWRC	Timer RB write control bit	Set to 1 in programmable one-shot generation mode.	RW
TCK0	Timer RB count source select bits(1)	b5 b4 0 0: f1 0 1: f8 1 0: Timer RA underflow 1 1: f2	RW
TCK1			RW
— (b6)	Nothing is assigned. If necessary, set to 0. When read, the content is 0.		—
TCKCUT	Timer RB count source cutoff bit(1)	0: Provides count source 1: Cuts off count source	RW

NOTES:
1. Change bits TMOD1 and TMOD0; TCK1 and TCK0; and TCKCUT when both the TSTART and TCSTF bits in the TRBCR register set to 0 (count stops).

Figure 3.3 Registers TRBIOC and TRBMR in Programable One-shot Generation Mode

Timer RB Prescaler Register(1)

b7 b0

Symbol	Address	After Reset
TRBPRE	010Ch	FFh

Function	Setting Range	RW
Counts an internal count source or timer RA underflows	00h to FFh	RW

NOTE:
1. When the TSTOP bit in the TRBCR register is set to 1, the TRBPRE register is set to FFh.

Timer RB Primary Register(1)

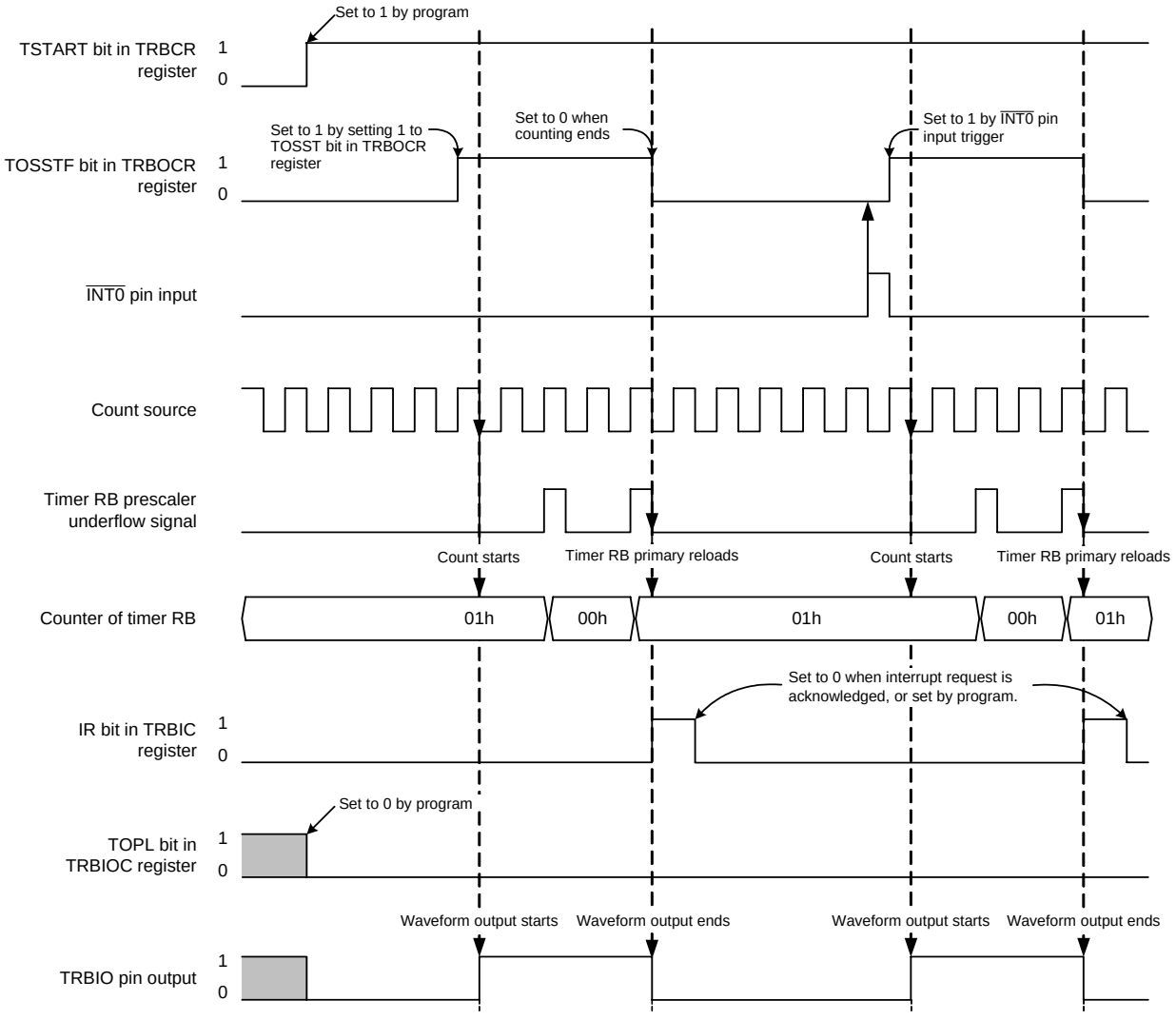
b7 b0

Symbol	Address	After Reset
TRBPR	010Eh	FFh

Function	Setting Range	RW
Counts timer RB prescaler underflows (one-shot width is counted)	00h to FFh	RW

NOTES:
1. When the TSTOP bit in the TRBCR register is set to 1, the TRBPRE register is set to FFh.

Figure 3.4 Registers TRBPRE and TRBPR in Programable One-shot Generation Mode



The above applies under the following conditions.

TRBPRE = 01h, TRBPR = 01h
TRBIOC register TOPL = 0, TOCNT = 0
INOSTG = 1 (INT0 one-shot trigger enabled)
INOSEG = 1 (edge trigger at rising edge)

Figure 3.5 Operating Example of Timer RB in Programmable One-shot Generation Mode

3.3 One-Shot Trigger Selection

In programmable one-shot generation mode and programmable wait one-shot generation mode, operation starts when a one-shot trigger is generated while the TCSTF bit in the TRBCR register is set to 1 (count starts).
A one-shot trigger can be generated by either of the following causes:

- 1 is written to the TOSST bit in the TRBOCR register by a program.
- Trigger input from the $\overline{\text{INT0}}$ pin.

When a one-shot trigger occurs, the TOSSTF bit in the TRBOCR register is set to 1 (one-shot operation in progress) after one or two cycles of the count source have elapsed. Then, in programmable one-shot generation mode, count operation begins and one-shot waveform output starts. (In programmable wait one-shot generation mode, count operation starts for the wait period.) If a one-shot trigger occurs while the TOSSTF bit is set to 1, no retriggering occurs.

To use trigger input from the $\overline{\text{INT0}}$ pin, input the trigger after making the following settings:

- Set the PD4_5 bit in the PD4 register to 0 (input port).
- Select the $\overline{\text{INT0}}$ digital filter with bits INT0F1 and INT0F0 in the INTF register.
- Select both edges or one edge with the INT0PL bit in INTEN register. If one edge is selected, further select falling or rising edge with the INOSEG bit in TRBIOC register.
- Set the INT0EN bit in the INTEN register to 0 (enabled).
- After completing the above, set the INOSTG bit in the TRBIOC register to 1 ($\overline{\text{INT}}$ pin one-shot trigger enabled).

Note the following points with regard to generating interrupt requests by trigger input from the $\overline{\text{INT0}}$ pin.

- Processing to handle the interrupts is required. Refer to **12. Interrupts in "R8C/24, R8C/25 Group Hardware Manual" (Document No. REJ09B0244)**, for details.
- If one edge is selected, use the POL bit in the INT0IC register to select falling or rising edge. (The INOSEG bit in the TRBIOC register does not affect $\overline{\text{INT0}}$ interrupts).
- If a one-shot trigger occurs while the TOSSTF bit is set to 1, timer RB operation is not affected, but the value of the IR bit in the INT0IC register changes.

3.4 Notes on Timer RB

- Timer RB stops counting after a reset. Set the values in the timer RB and timer RB prescalers before the count starts.
- Even if the prescaler and timer RB is read out in 16-bit units, these registers are read 1 byte at a time by the MCU. Consequently, the timer value may be updated during the period when these two registers are being read.
- In programmable one-shot generation mode and programmable wait one-shot generation mode, when setting the TSTART bit in the TRBCR register to 0 (count stops) or setting the TOSSP bit in the TRBOCR register to 1 (one-shot stops), the timer reloads the value of reload register and stops. Therefore, in programmable one-shot generation mode and programmable wait one-shot generation mode, read the timer count value before the timer stops.
- The TCSTF bit remains 0 (count stops) for 1 to 2 cycles of the count source after setting the TSTART bit to 1 (count starts) while the count is stopped.

  During this time, do not access registers associated with timer RB(1)other than the TCSTF bit.
  The TCSTF bit remains 1 for 1 to 2 cycles of the count source after setting the TSTART bit to 0 (count stops) while the count is in progress.

  During this time, do not access registers associated with timer RB(1) other than the TCSTF bit.
  Timer RB counting is stopped when the TCSTF bit is set to 0.

  NOTE:
  1. Registers associated with timer RB: TRBCR, TRBOCR, TRBMR, TRBPRE, TRBSC, and TRRBPR.

- If the TSTOP bit in the TRBCR register is set to 1 during timer operation, timer RB stops immediately.
- If 1 is written to the TOSST or TOSSP bit in the TRBOCR register, the value of the TOSSTF bit changes after one or two cycles of the count source have elapsed. If the TOSSP bit is written to 1 during the period between when the TOSST bit is written to 1 and when the TOSSTF bit is set to 1, the TOSSTF bit may be set to either 0 or 1 depending on the content state. Likewise, if the TOSST bit is written to 1 during the period between when the TOSSP bit is written to 1 and when the TOSSTF bit is set to 0, the TOSSTF bit may be set to either 0 or 1.

4. Program Overview

By starting one-shot operation, a signal will be output from the TRBO pin as follows.

- One-shot pulse output time: 1 ms
  1 ms = 20 MHz × f2 × (TRBPRE + 1) × (TRBPR + 1)
  = 50 ns × 2 × (199 + 1) × (49 + 1)
- "H" output during one-shot and "L" output when the timer stops.
- $\overline{\text{INTO}}$ pin one-shot trigger disabled.

Figure 4.1 shows the Pin Used.

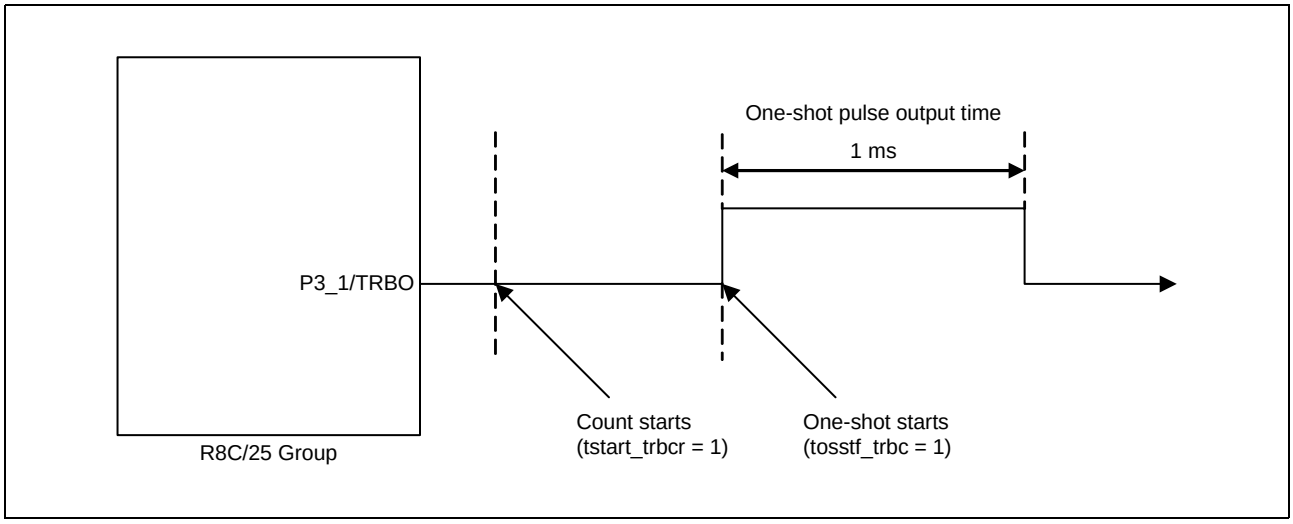


Figure 4.1 Pin Used

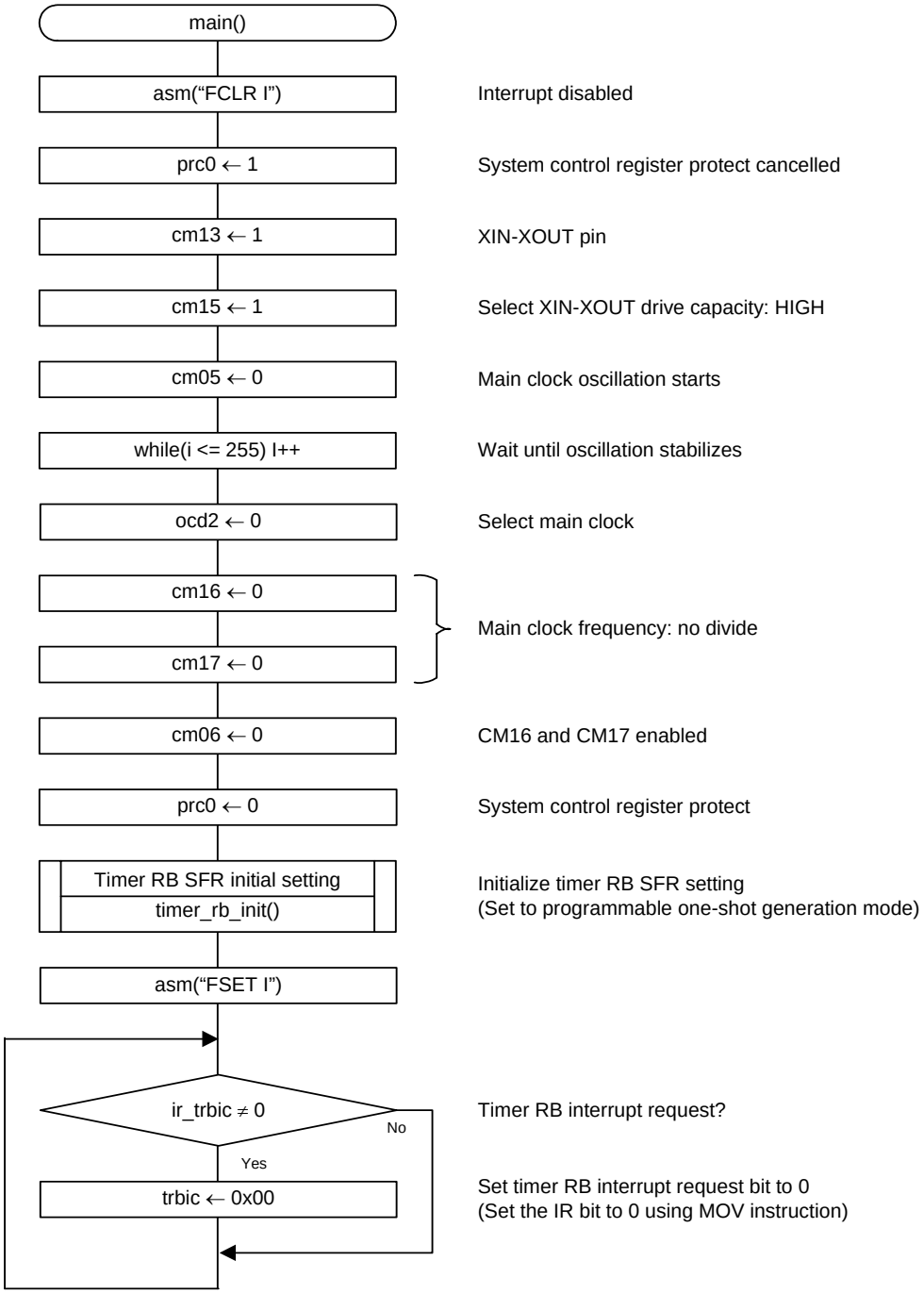
4.1 Faction Table

Table 4.1

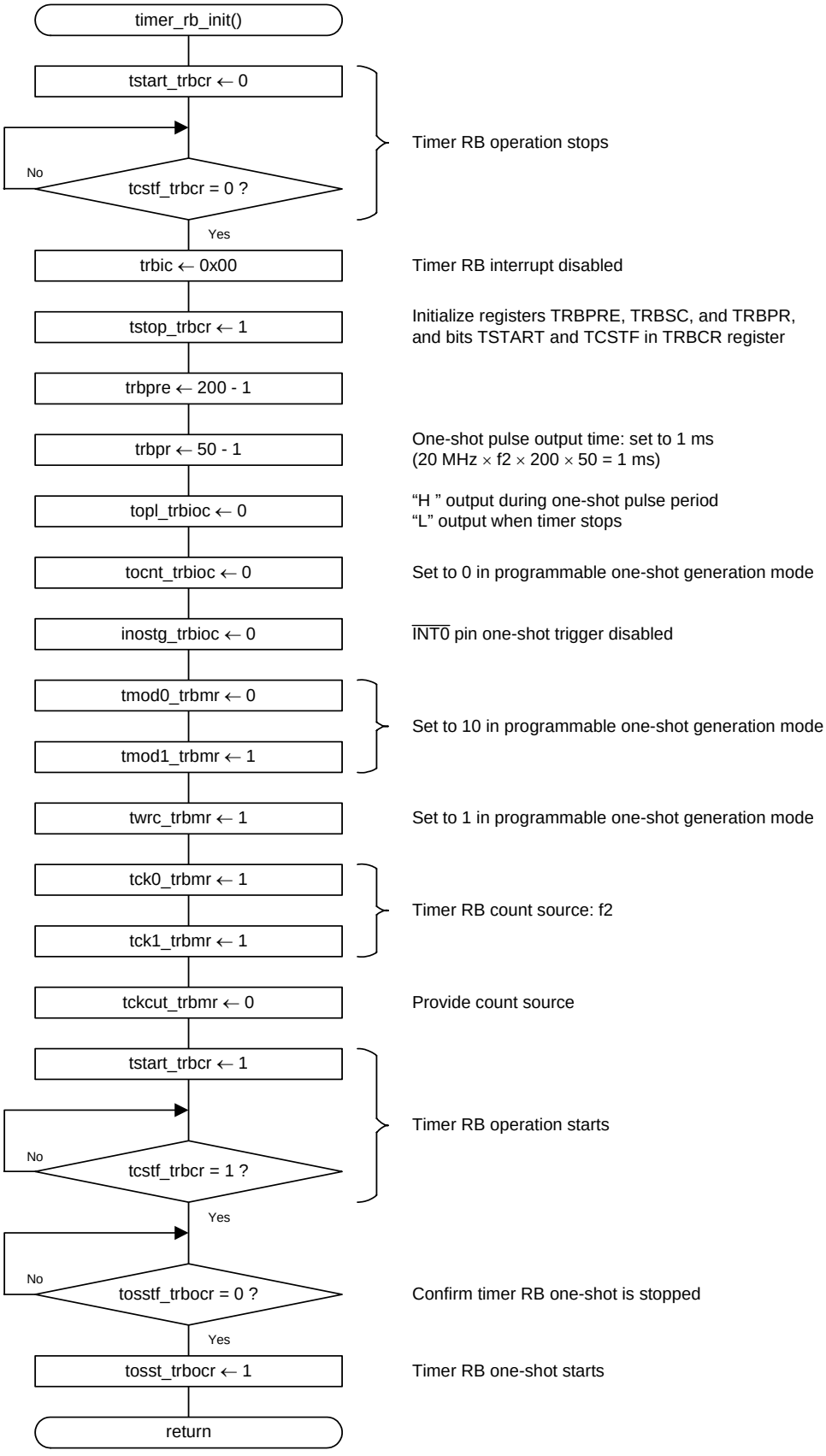
Declaration	void timer_rb_init(void)		
Overview	SFR initial setting associated with timer RB		
Argument	Argument name		Meaning
	None		
Variable used (global)	Variable name		Usage
	None		
Return value	Type	Value	Meaning
	None		
Function	Initialize the SFR registers associated with time RB		

4.2 Flow Chart

4.2.1 Main functions



4.2.2 Timer RB SFR Initial Setting



5. Sample Programming Code

Download a sample program on the Renesas Technology website.
For download, click Application Notes in the left-hand side menu from the top page of the R8C/Tiny Series.

6. Reference Document

Hardware Manual
R8C/25 Group Hardware Manual
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		Page	Summary
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