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R8C/25 Group

Timer RB in Programmable Wait One-shot Generation Mode

1. Abstract

This document describes how to set up and use the timer RB in programmable wait 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 Wait 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.

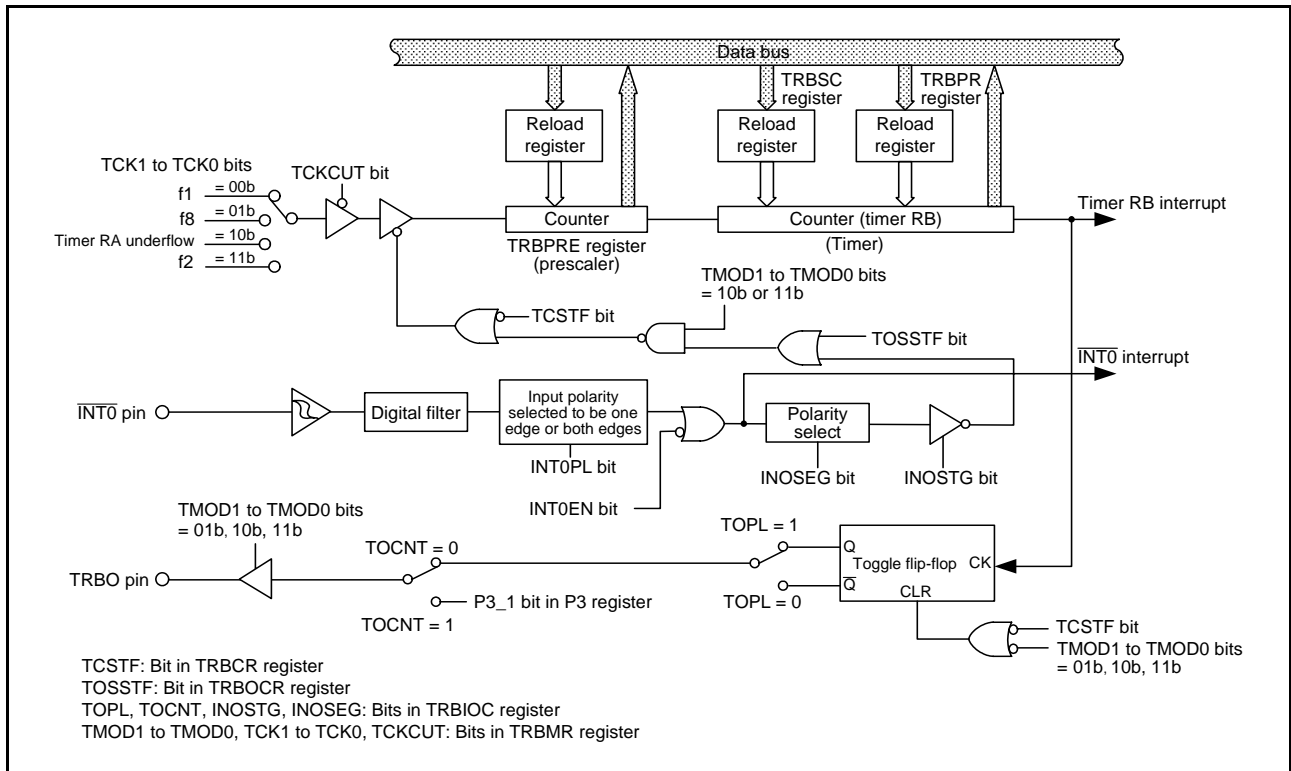


Figure 3.1 Block Diagram of Timer RB

3.2 Programmable Wait One-shot Generation Mode

In programmable wait one-shot mode, a one-shot pulse is output from the TRBO pin by a program or an external trigger input (input to the $\overline{\text{INT0}}$ pin) (refer to Table 3.1). When a trigger is generated from that point, the timer outputs a pulse only once for a given length of time equal to the setting value in the TRBSC register after waiting for a given length of time equal to the setting value in the TRBPR register.

Figure 3.2 shows Registers TRBCR and TRBOCR in Programmable Wait One-shot Generation Mode, and Figure 3.3 shows Registers TRBIOC and TRBMR in Programmable Wait One-shot Generation Mode, Figure 3.4 shows Registers TRBPRES, TRBCSC, and TRBPR in Programmable Wait One-shot Generation Mode. Figure 3.5 shows an Operating Example of Timer RB in Programmable Wait One-shot Generation Mode.

Table 3.1 Programmable Wait One-shot Generation Mode Specifications

Item	Specification
Count sources	f1, f2, f8, timer RA underflow
Count operations	<ul style="list-style-type: none"> • Decrement the timer RB primary setting value. • When a count of the timer RB primary underflows, the timer reloads the contents of timer RB secondary before the count continues. • When a count of the timer RB secondary underflows, the timer reloads the contents of timer RB primary 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.
Wait time	$(n+1)(m+1)/f_i$ <i>f_i</i> : Count source frequency <i>n</i> : Value set in the TRBPRES register, <i>m</i> : Value set in the TRBPR register
One-shot pulse output time	$(n+1)(p+1)/f_i$ <i>f_i</i> : Count source frequency <i>n</i> : Value set in the TRBPRES register, <i>p</i> : Value set in the TRBSC register
Count start conditions	<ul style="list-style-type: none"> • 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 INT0 pin
Count stop conditions	<ul style="list-style-type: none"> • When reloading completes after timer RB underflows during primary period. • When the TOSSP bit in the TRBOCR register is set to 0 (one-shot stops). • When the TSTART bit in the TRBCR register is set to 0 (count starts). • 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 timer RB underflows during secondary period (complete at the same time as waveform output from the TRBO pin) [timer RB interrupt].
TRBO pin function	Pulse output
INT0 pin function	<ul style="list-style-type: none"> • When the INOSTG bit in the TRBIOC register is set to 0 ($\overline{\text{INT0}}$ one-shot trigger disabled): programmable I/O port or 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 TRBPRES.
Write to timer	<ul style="list-style-type: none"> • When registers TRBPRES, TRBSC, and TRBPR are written while the count stops, values are written to both the reload register and counter. • When registers TRBPRES, TRBSC, and TRBPR are written to during count operation, values are written to the reload registers only.⁽¹⁾
Select functions	<ul style="list-style-type: none"> • Output level select function The TOPL bit in the TRBIOC register selects 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 registers TRBSC and TRBPR.

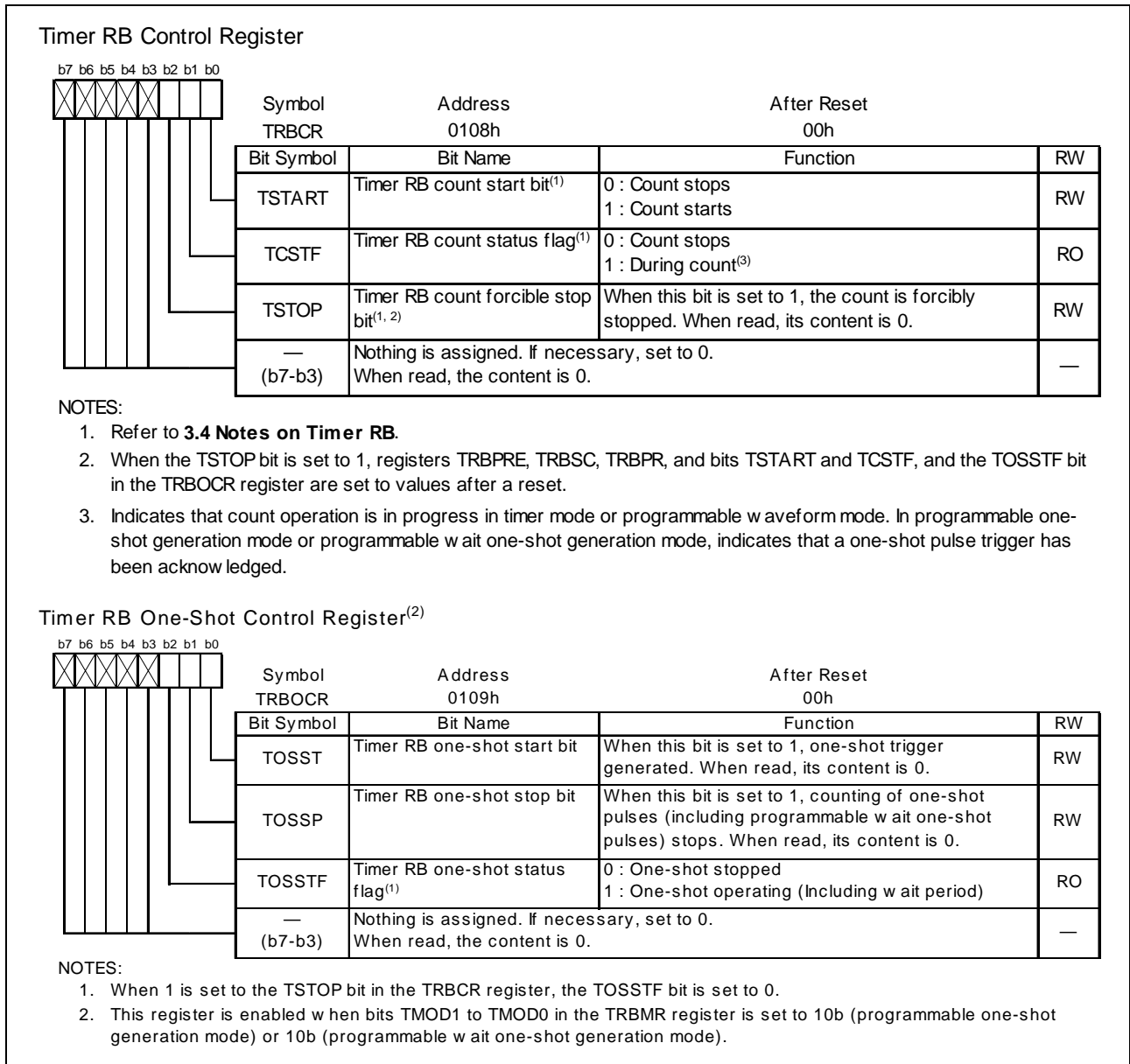


Figure 3.2 Registers TRBCR and TRBOCR in Programmable Wait One-shot Generation Mode

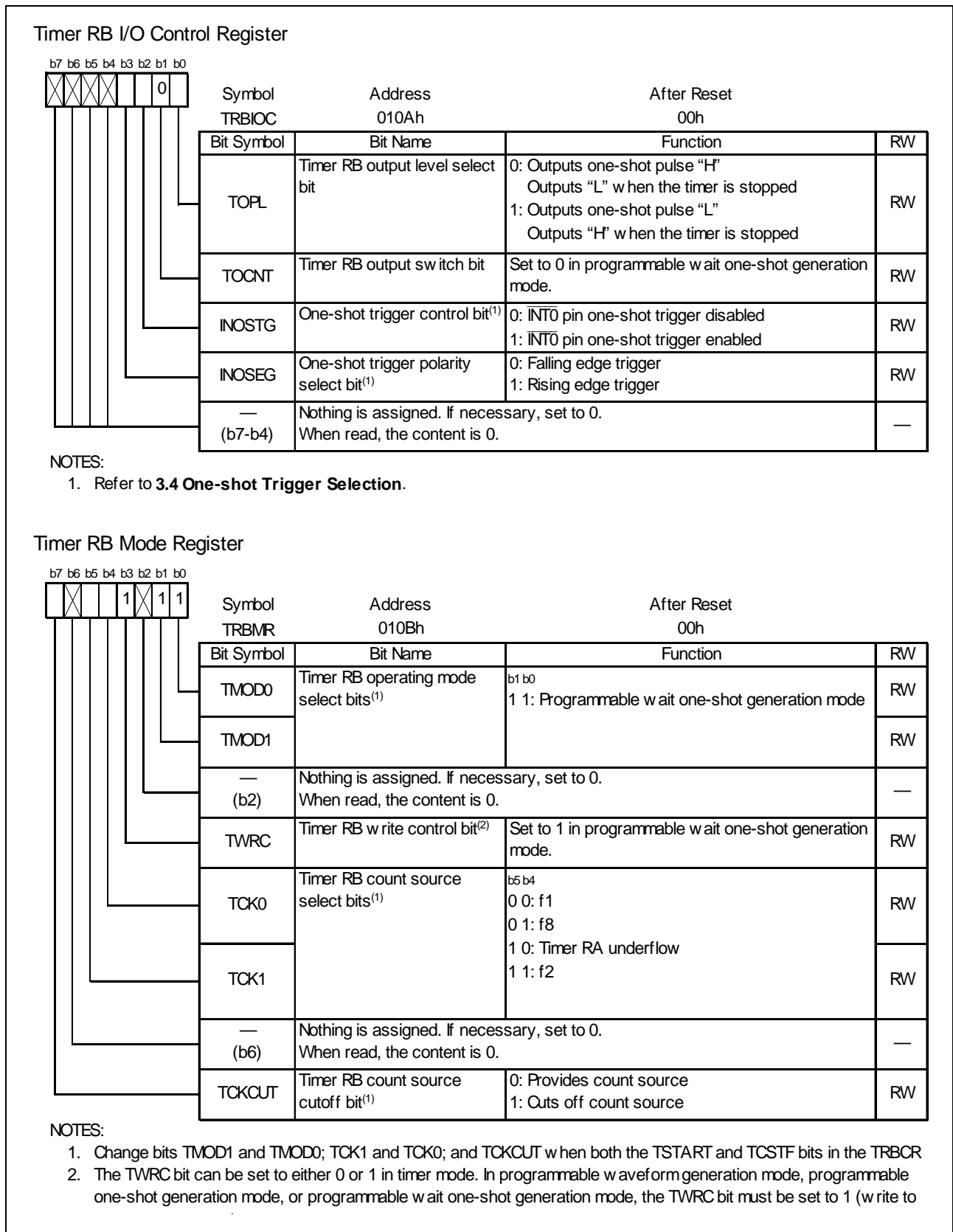


Figure 3.3 Registers TRBIOC and TRBMR in Programmable Wait One-shot Generation Mode

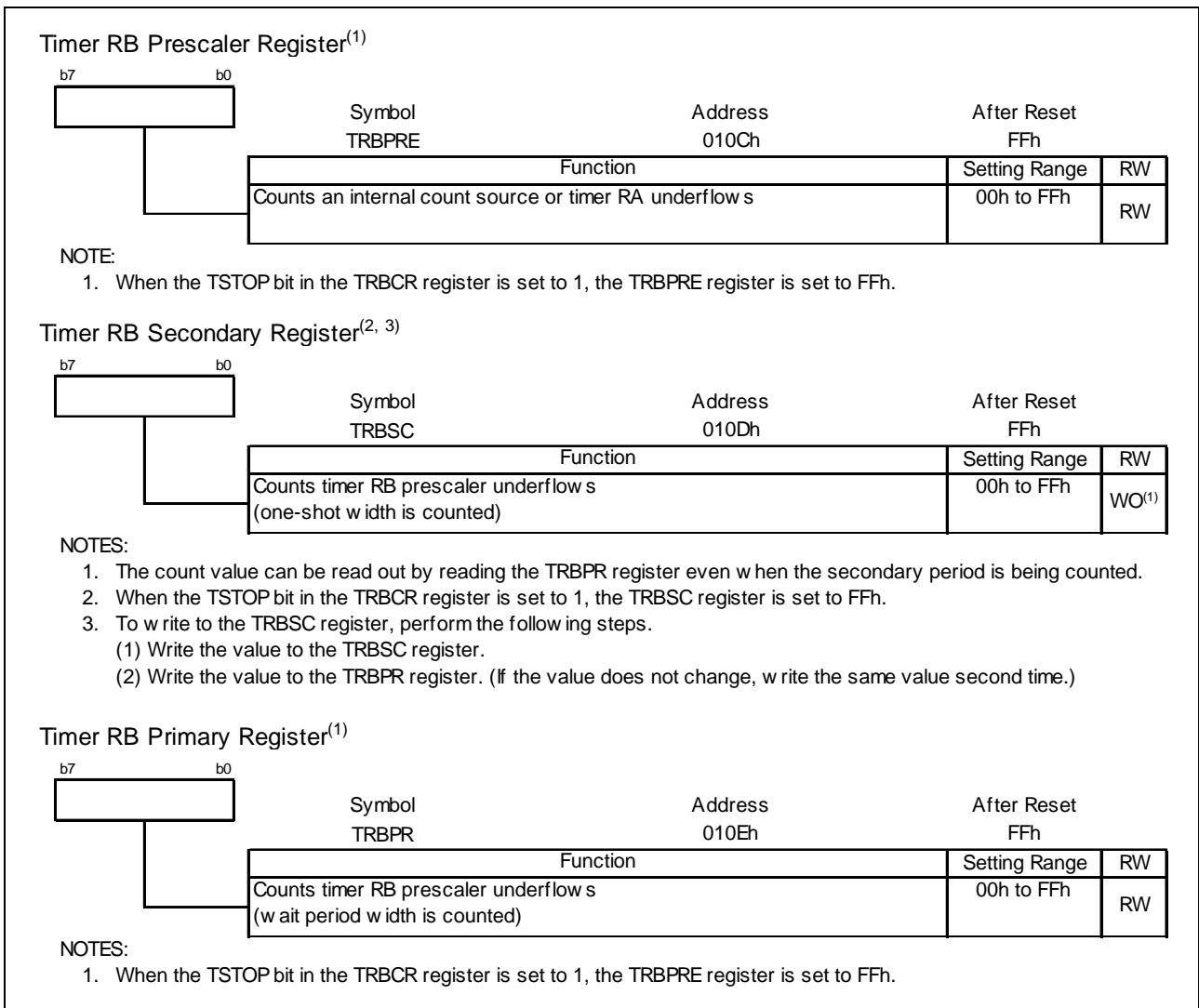


Figure 3.4 Registers TRBPRES, TRBSC, and TRBPR in Programmable Wait One-shot Generation Mode

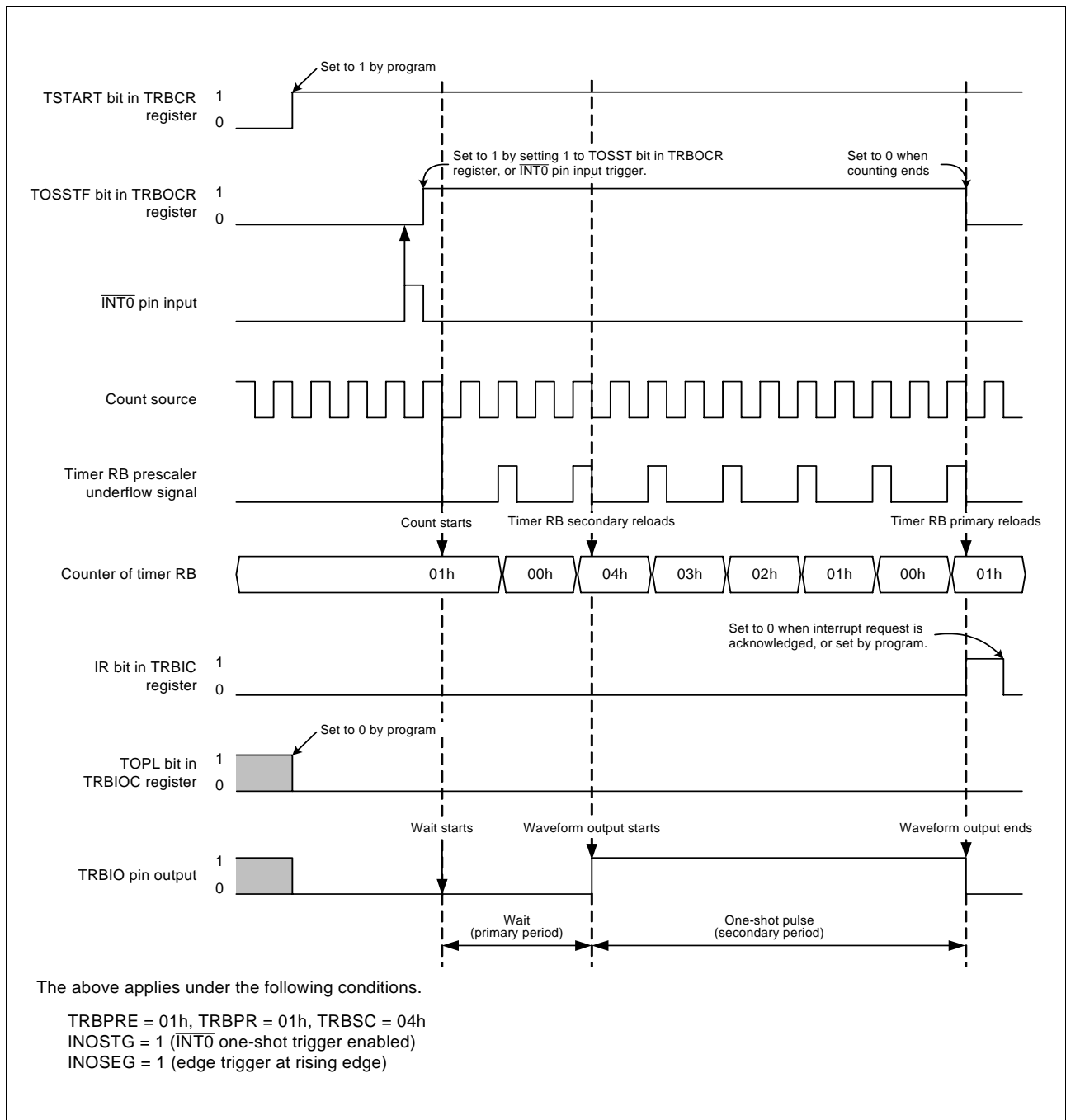


Figure 3.5 Operating Example of Timer RB in Programmable Wait One-shot Generation Mode

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 TOSSTF 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 INTOEN 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 INTOIC 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 INTOIC 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, TRBPRES, 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.

- Wait time: 1 ms
 $1\text{ ms} = 20\text{ MHz} \times f2 \times (\text{TRBPRE} + 1) \times (\text{TRBPR} + 1)$
 $= 50\text{ ns} \times 2 \times (199 + 1) \times (49 + 1)$
- One-shot pulse output time: 2 ms
 $2\text{ ms} = 20\text{ MHz} \times f2 (\text{TRBPRE} + 1) \times (\text{TRBSC} + 1)$
 $= 50\text{ ns} \times 2 \times (199 + 1) \times (99 + 1)$
- “H” output during one-shot pulse and “L” output when timer stops
- $\overline{\text{INTO}}$ pin one-shot trigger disabled

Figure 4.1 shows the Pin Used.

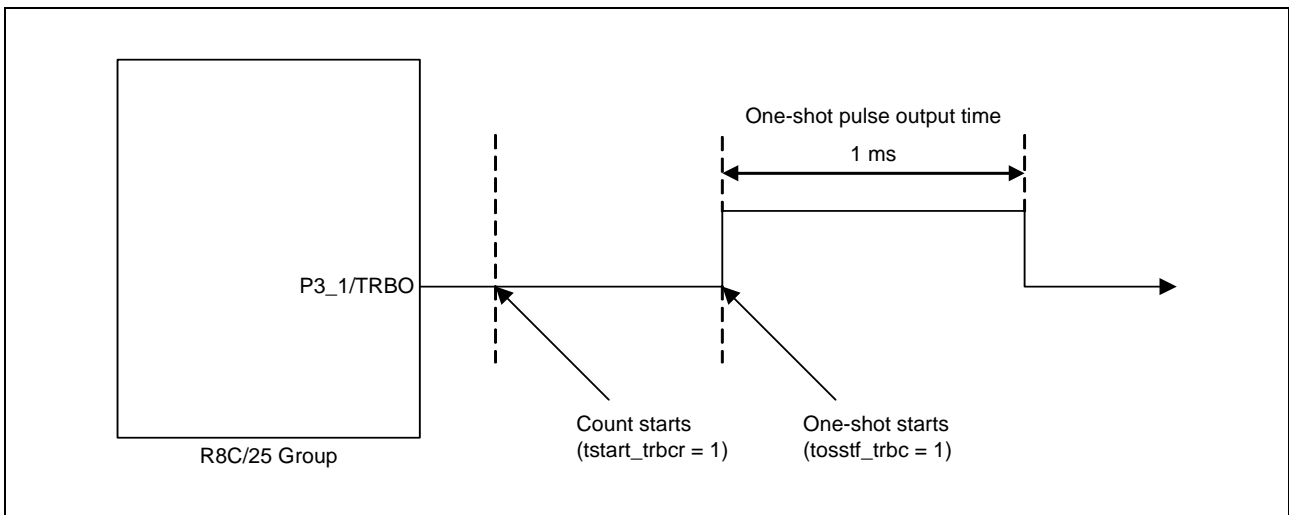


Figure 4.1 Pin Used

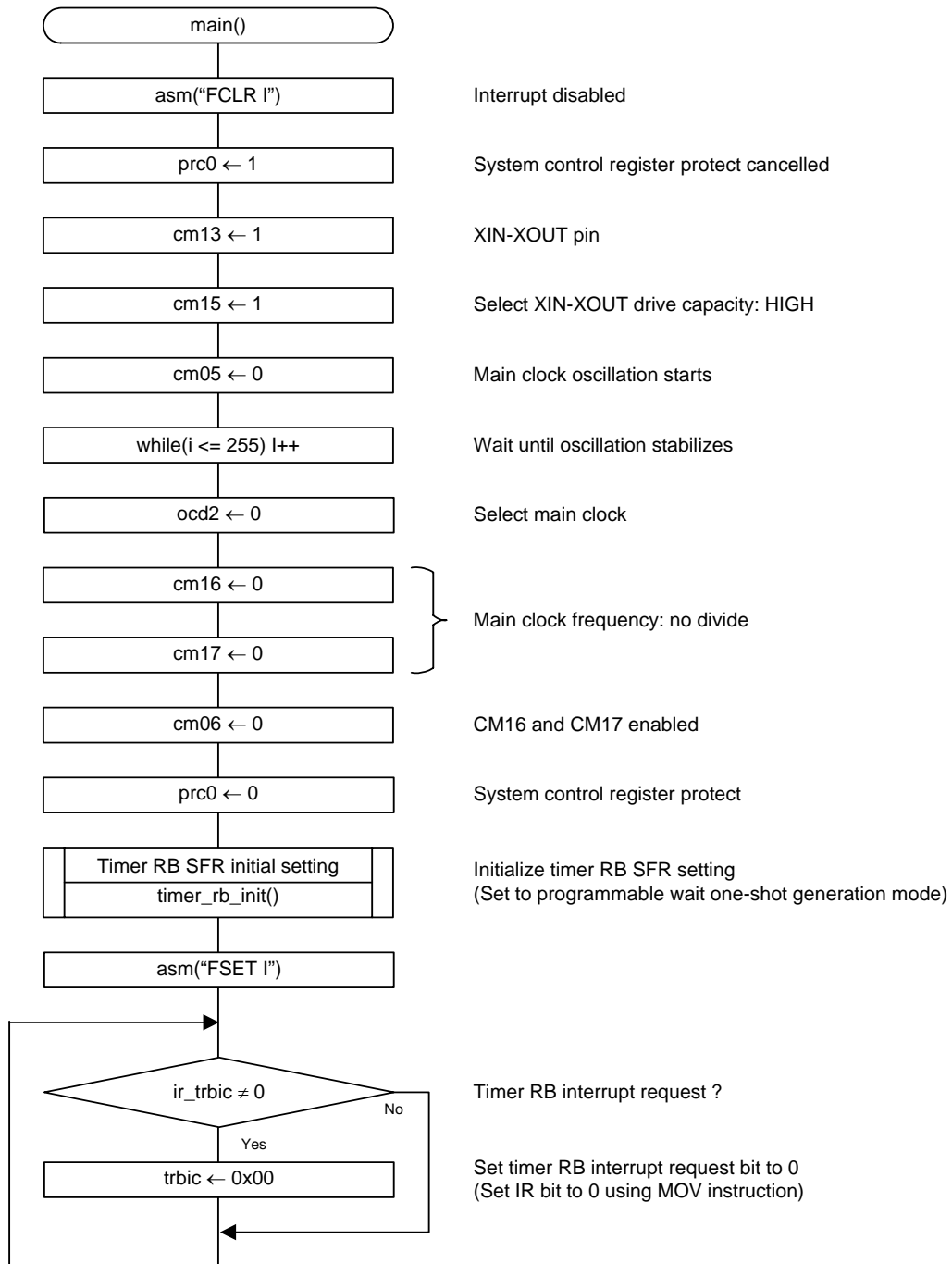
4.1 Faction Table

Table 4.1

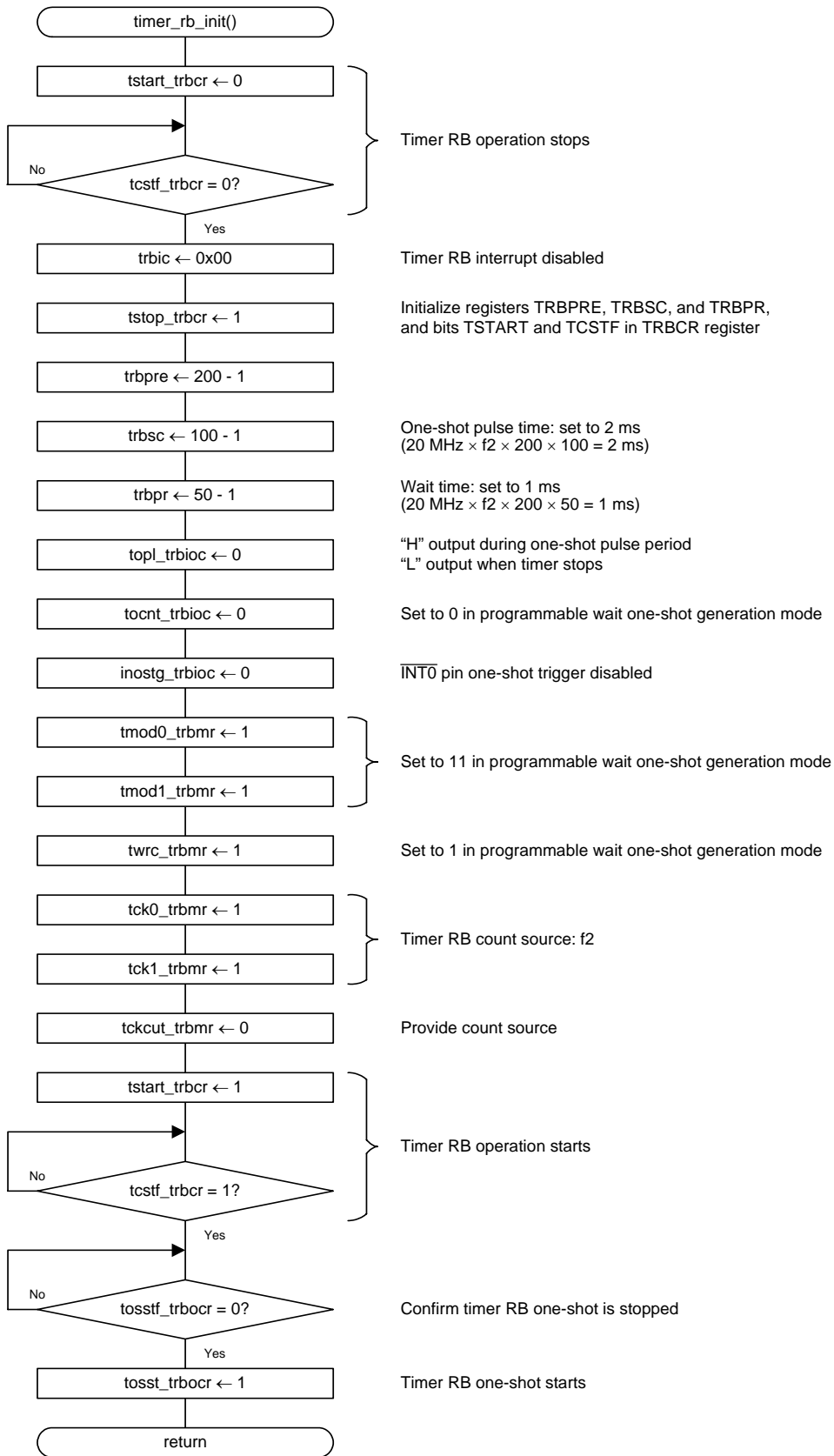
Declaration	void timer_rb_init(void)		
Overview	SFR initial setting associated with timer RB		
Argument	Argument name	Meaning	
	None		
Variable used (global)	Variable name	Usage	
	None		
Return value	Type	Value	Meaning
	None		
Function	Initialize the SFR registers associated with time RB		

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.

To download, click Application Notes in the left-hand side menu on the top page of the R8C/Tiny Series.

6. Reference Document

Hardware Manual

R8C/25 Group Hardware Manual

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REVISION HISTORY	R8C/25 Group Timer RB in Programmable Wait One-shot Generation Mode
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Rev.	Date	Description	
		Page	Summary
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