

Event Counters, Timers, and the Real Time Clock

Chapter 8

Renesas Electronics America Inc.
Embedded Systems using the RX63N

Rev. 1.0

Topics

- Timer
- Prescaler
- RX63N timers
- Compare match
- Pulse output
- TMR registers
- Real time clock

Timer

- Timer is a counter which counts clock pulses of the microcontroller clock.
- The value in timer register increases with each clock cycle and overflows to zero after reaching to its maximum count.
- The time can be measured as :
$$\text{Time} = \text{timer register} / \text{clock frequency}$$
- For example, an 8-bit timer with 10MHz clock frequency can measure a maximum of:
$$(2^8) / 10 \text{ MHz} = 25.5 \mu\text{s}$$

Prescaler

- In the last example, the timer could measure only 25.5 μ s before resetting.
- Prescaler setting can be used to increase this measured time.
- Suppose prescaler is set to 64, the timer register will increment by 1 after 64 clock cycles.
- So the same timer can measure a maximum time of:
 $[(2^8) / 10\text{MHz}] * 64 = 1.63 \text{ ms.}$
- For RX63N's 8-bit timer the prescaler setting can be set to 2, 8, 32, 64, 1024, or 8192.

RX63N Timers

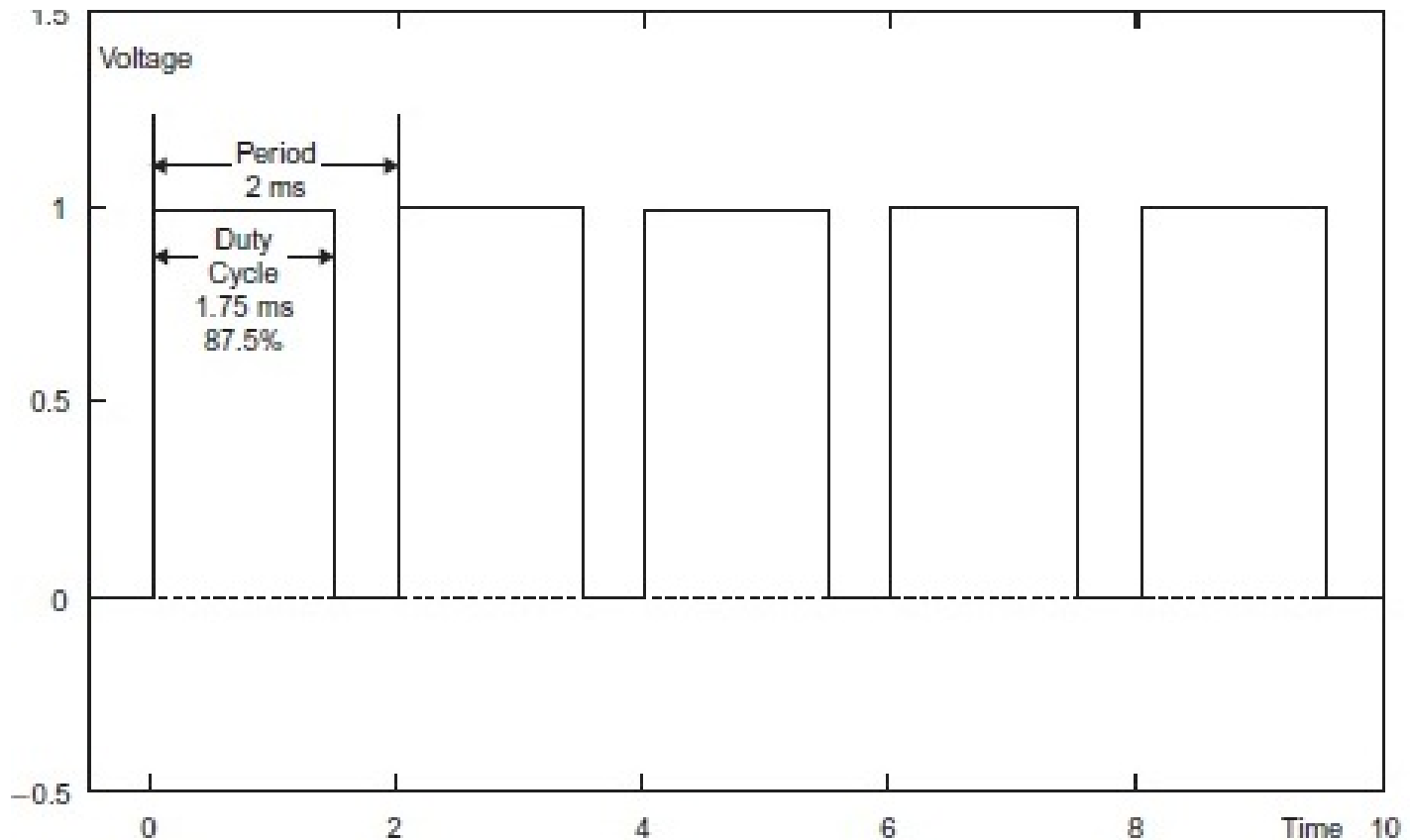
- Two 8-bit channels.
- Each channel has two timers (TMRn, n=0 to 3).
- The 8-bit channels can be cascaded to form a 16-bit counter.
- In addition, there are two units of 16-bit timer TPU (Timer Pulse Unit) and each unit has 6 timers (TPUn, n=0 to 11).

Compare Match

- We can take an action like toggling an output signal or triggering an interrupt when the timer count reaches a preset value.
- A match occurs when count register value TCNT reaches the preset compare match register TCORn (n=A or B).

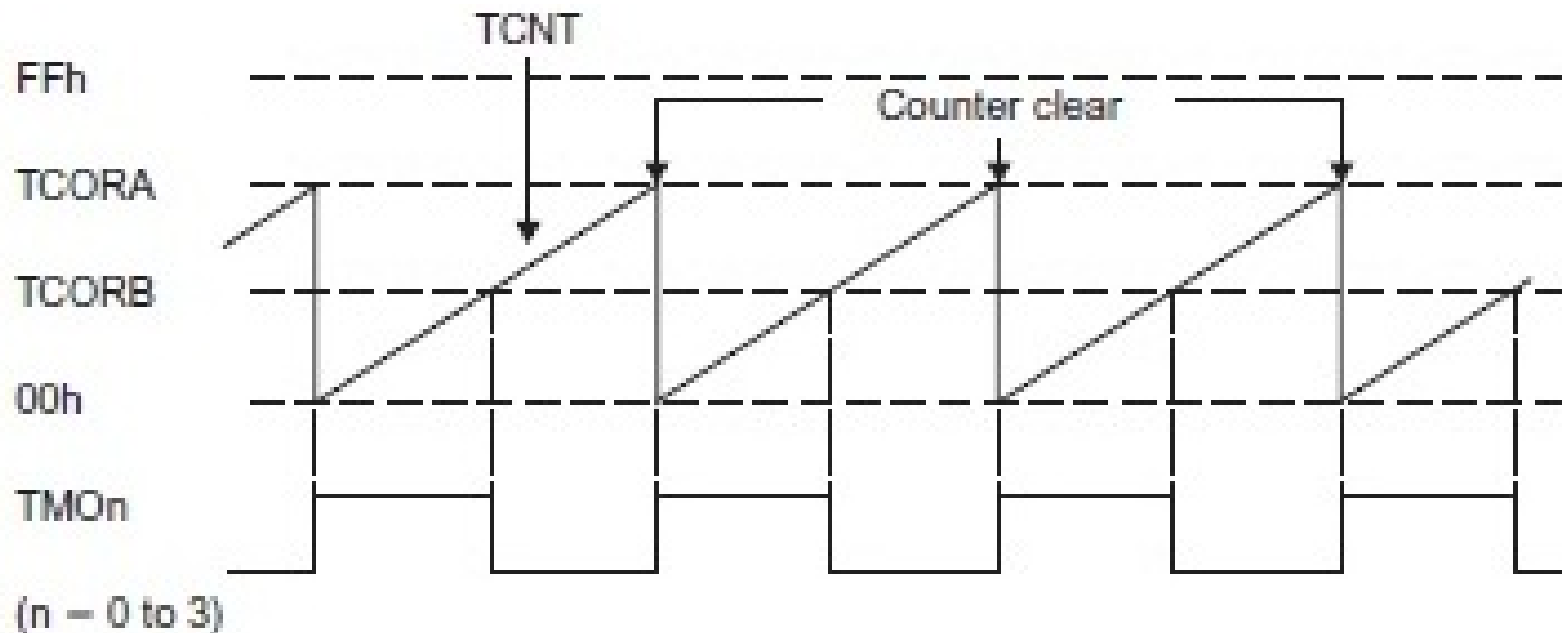
Pulse Output Operation

- For a pulse or rectangular wave, the duty cycle and time period defines the wave.
- $\text{Duty cycle (\%)} = \text{High time/period} * 100$



Pulse Output Operation

- We can set compare match registers TCORA and TCORB to produce a pulse output on a TMO_n (n=0 to 3) pin of RX63N.
- In timer control register TCSR, we can set OSA and OSB bits to output '1' on TMO_n pin on compare match A and output '0' on compare match B.

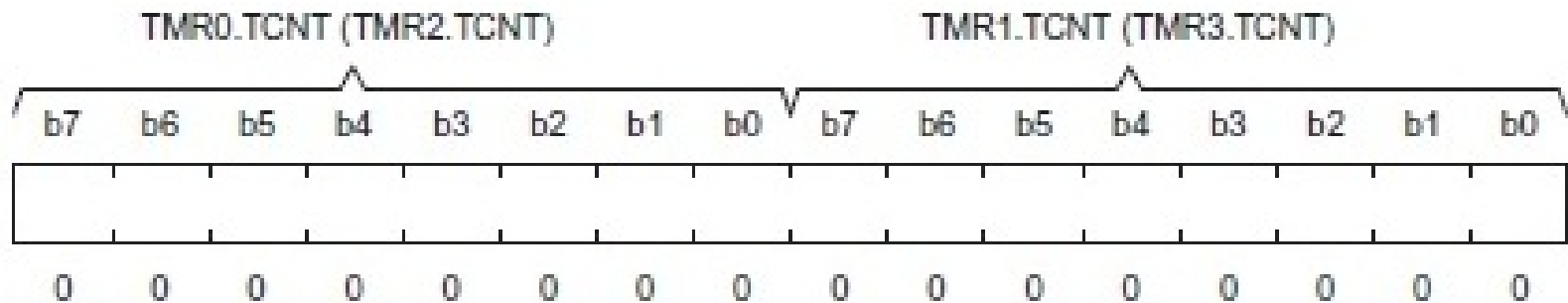


TMR registers

Some of the important 8-bit timer registers are:

■ Timer Counter (TCNT):

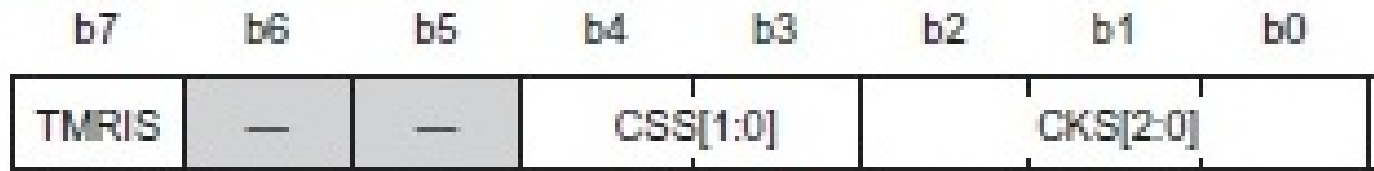
- TCNT0, TCNT1, TCNT2, TCNT3 are 8-bit counter registers.
- TCNT0 and TCNT1 can be cascaded to form 16-bit timers by assigning TMR1 as count source for TMR0.
- Similarly for TCNT2 and TCNT3.



Value after reset:

TMR registers

- Timer Counter Control Register (TCCR):
 - The CKS bits select prescalers for clock source.
 - The CSS bits select external clock or PCLK as clock source.
 - Timer Reset Detection Condition Select(TMRIS): Set '1' to reset timer when external reset is high and set '0' to reset timer on rising edge of external reset.



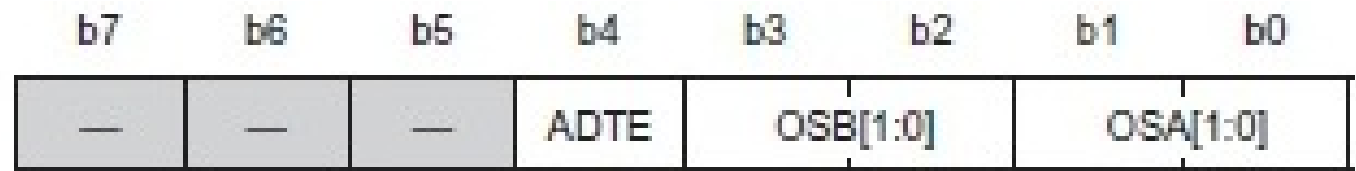
Value after reset:

0 0 0 0 0 0 0 0

TMR registers

■ Timer Control/Status Register (TCSR):

- The OSA bits select whether to change output on TMO pin to '1' or '0' or no change on compare match A.
- The OSB bits select whether to change output on TMO pin to '1' or '0' or no change on compare match B.
- A/D Trigger Enable (ADTE): Set to '1' to enable A/D conversion of selected channel on compare match A.



Value after reset:

x x x 0 0 0 0 0

Real Time Clock

- RTC uses dedicated 32.768 kHz external oscillator to use or display current real time in the program.
- Initially we write into the second counter, minute counter, hour counter, day counter, date counter, month counter, year counter, and then read after starting the RTC.
- Similarly we have alarm registers to set alarm time.
- The values written into or read from all these registers are in BCD format.

Real Time Clock

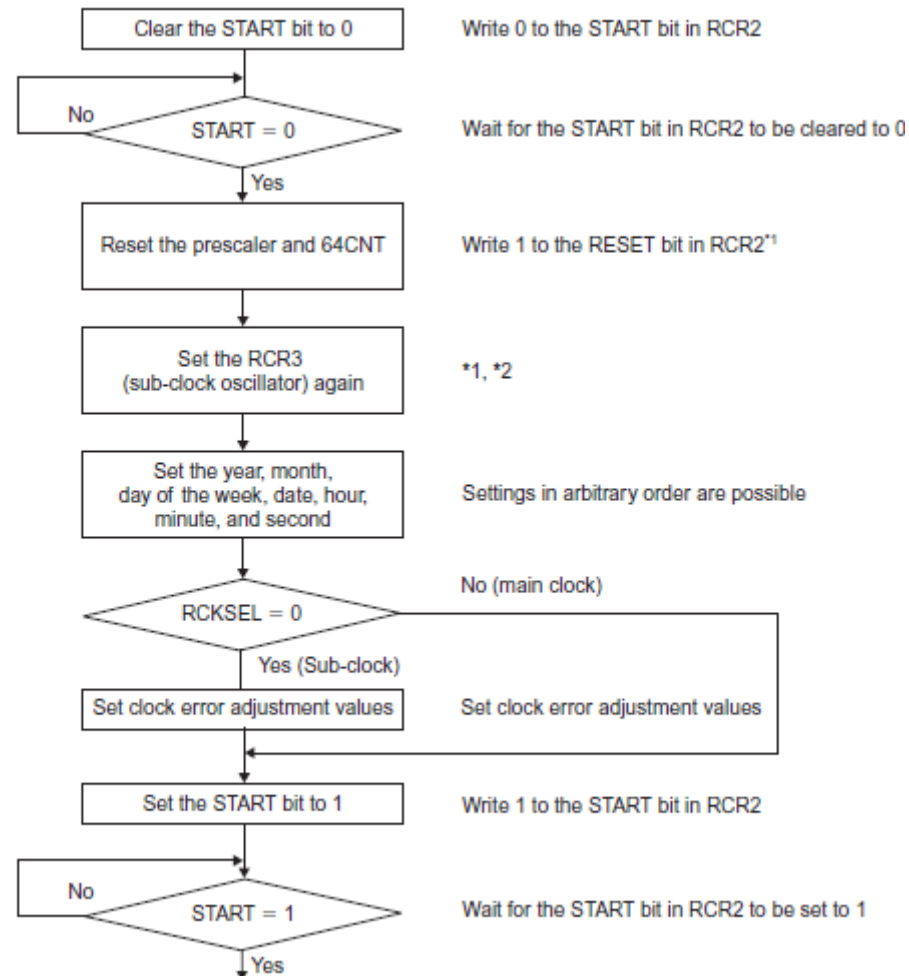
- In RTC Control register 2 (RCR2), some important controls are:
 - START: Set to '1' to start the RTC and '0' to stop the RTC.
 - RESET: Set to '1' to reset prescaler and target registers.
 - HR24: Set to '1' to operate in 24-hour mode and '0' to operate in 12-hour mode.



Value after reset:
x: Undefined

Real Time Clock

- There are four control registers RCRn (n=1 to 4). They are set in the following way to operate the RTC:



Conclusion

- We saw various RX63N timer functions like event counter, compare match, and pulse output generation.
- Using the timer registers, you can setup and run timers on RX63N.
- RTC is a useful feature of the microcontroller and you can now setup time and alarm on RX63N.

References

All images taken from :

Renesas Electronics, Inc. (February, 2013). *RX63N Group, RX631 Group User's Manual: Hardware, Rev 1.60.*



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