

# Event Counters, Timers, and the Real Time Clock

## Chapter 8

Renesas Electronics America Inc.  
Advanced Embedded Systems using the RX63N

Rev. 0.1

# 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, 8-bit timer with 10MHz clock frequency can measure maximum of :  
$$(2^8) / 10\text{MHz} = 25.5\mu\text{s}$$

# Prescaler

- In the last example, the timer could measure only 25.5us 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, 8192

# RX63N Timers

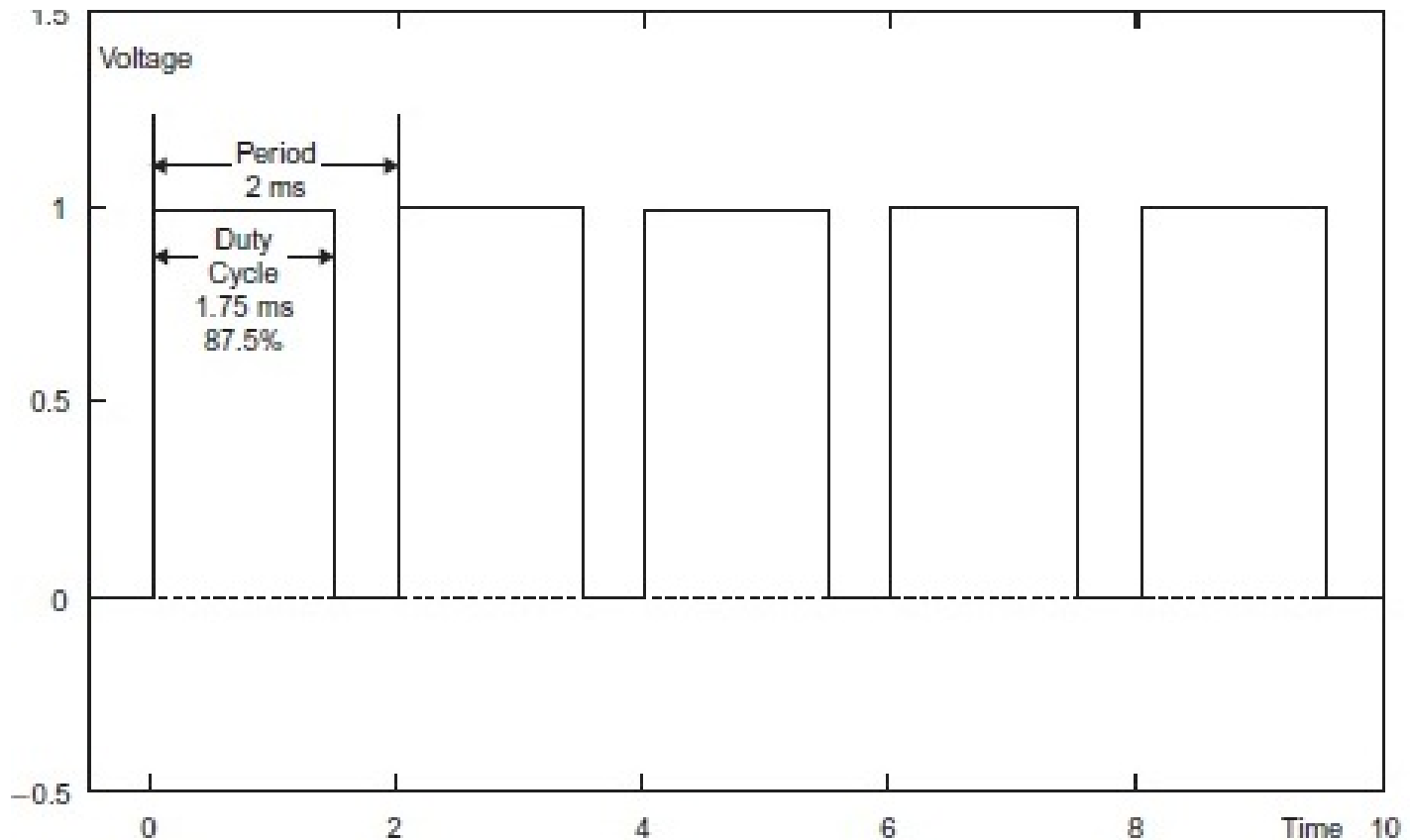
- Two 8-bit channels
- Each channel has 2 timers (TMRn, n=0 to 3)
- The 8-bit channels can be cascaded to form a 16-bit counter
- In addition, there are two units of 16-bit timer TPU (Timer Pulse Unit) and each unit has 6 timers (TPUn, n=0 to 11)

# 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)

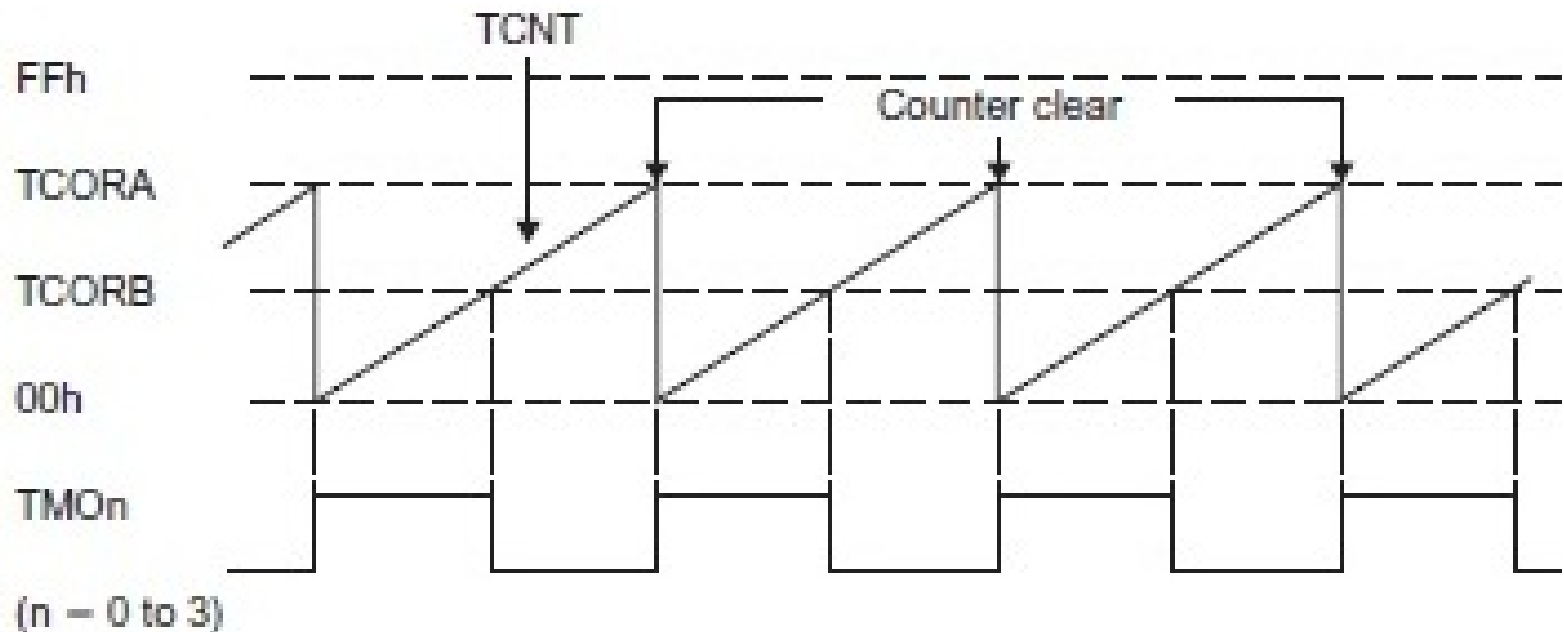
# Pulse Output Operation

- 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<sub>n</sub> (n=0 to 3) pin of RX63N
- In timer control register TCSR, we can set OSA and OSB bits to output '1' on TMO<sub>n</sub> pin on compare match A and output '0' on compare match B



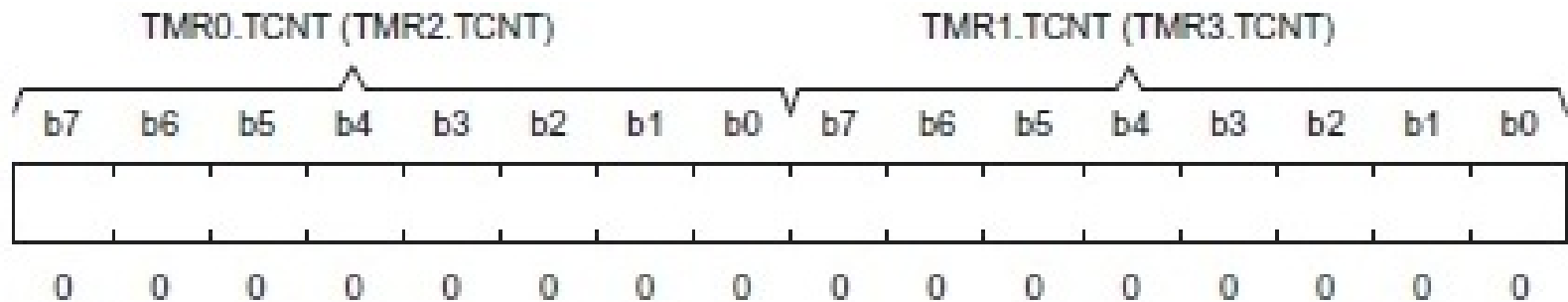


# TMR registers

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

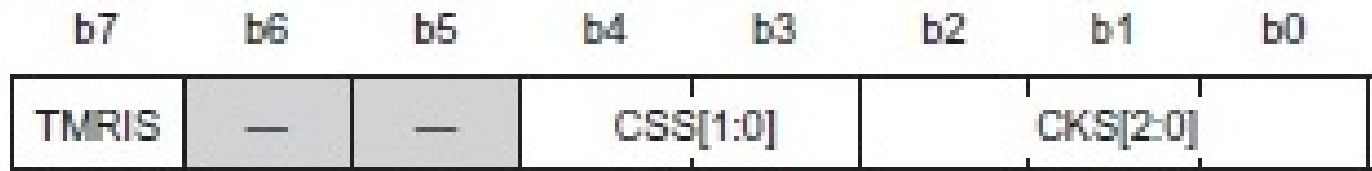


Value after reset:

# 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



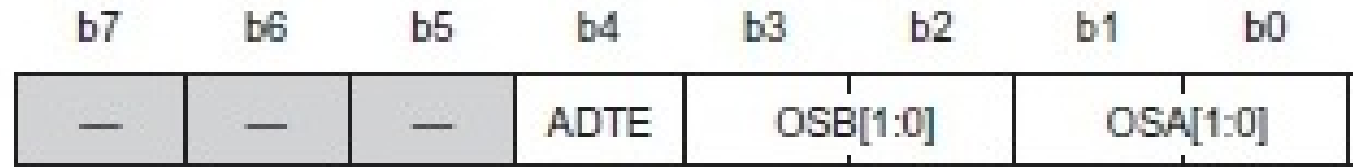
Value after reset:

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:

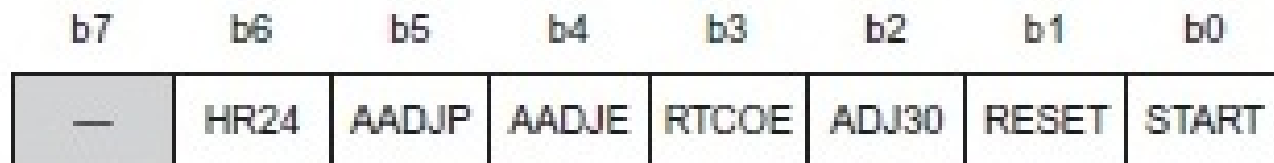
x      x      x      0      0      0      0      0

# Real Time Clock

- RTC uses dedicated 32.768kHz 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

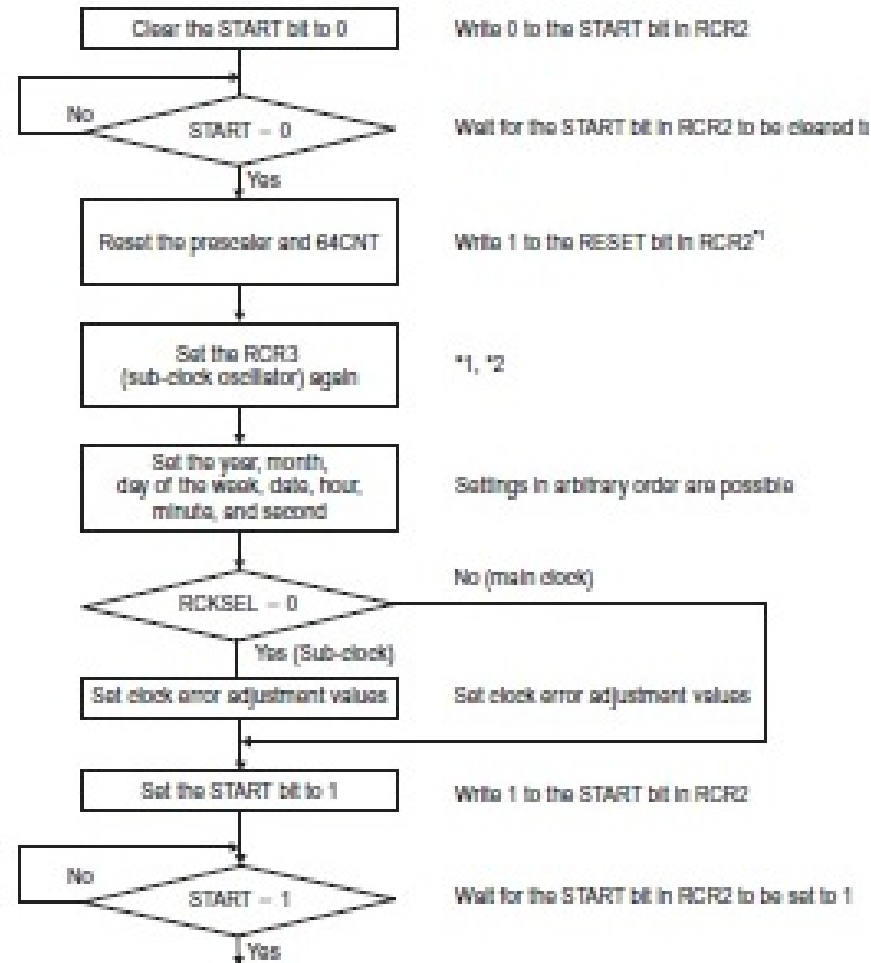
- In RTC Control register 2 (RCR2), some important controls are:
  - START: Set to '1' to start the RTC and '0' to stop the RTC
  - RESET: Set to '1' to reset prescaler and target registers
  - HR24: Set to '1' to operate in 24-hour mode and '0' to operate in 12-hour mode



Value after reset:  
x: Undefined

# Real Time Clock

- There are 4 control registers RCRn (n=1 to 4). They are set in 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., *RX63N Group, RX631 Group  
User's Manual: Hardware, Rev 1.60, February 2013*





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