

## M16C/26

### Using Timer A in Pulse Output Mode

#### 1.0 Abstract

The following article describes how to use the M16C/26 timer A as square wave generators (Pulse Output Mode).

#### 2.0 Introduction

The Renesas M30262 is a 16-bit MCU based on the M16C/60 series CPU core. The MCU features include up to 64K bytes of Flash ROM, 2K bytes of RAM, and 4K bytes of Virtual EEPROM. The peripheral set includes 10-bit A/D, UARTS, Timers, DMA, and GPIO. The MCU has eight timers that consists of five Timer A's and three Timer B's. All 8 timers can operate in 'Event Counter Mode'. Only the five Timer A's can operate in Pulse Output Mode. Timer A also has the following additional modes of operation:

- Timer Mode (without Pulse Output)
- Event Counter Mode
- PWM Mode
- One Shot Mode

Figure 1 shows the block diagram of timer A. The remainder of this document will focus on setting up timer A0 in Pulse Output Mode.

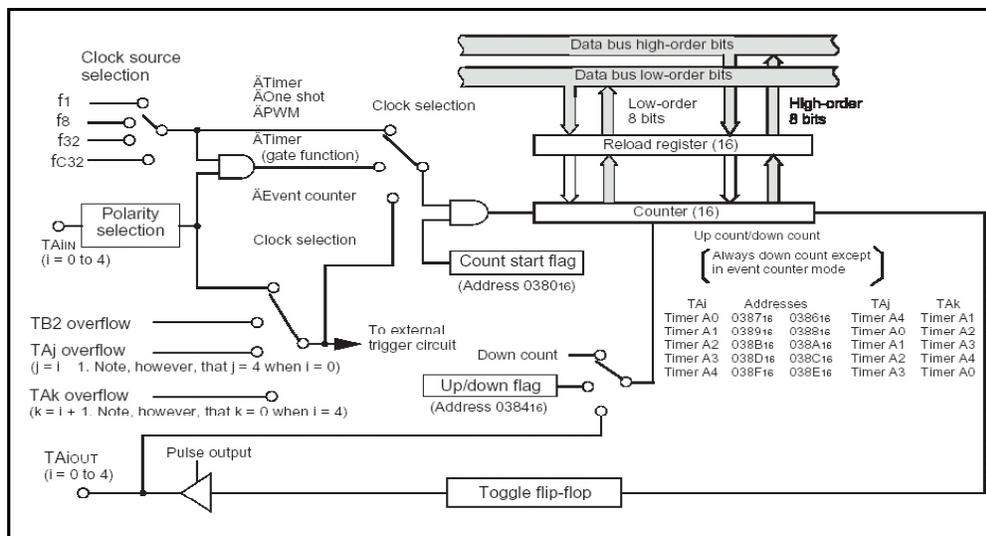


Figure 1 Block Diagram of Timer A

### 3.0 Pulse Output Mode Description

In Pulse Output Mode, the counter register counts down using the selected clock source until the counter underflows (0000 to FFFFh). At this point, the timer output pin toggles, the contents of the reload register is loaded into the counter and countdown continues. At the same time, the timer interrupt request bit is set and an interrupt is generated if the timer interrupt priority level is set above the current CPU priority level (if the I flag in the CPU flag registers is cleared, the interrupt will not be serviced until the flag is set). Note that the pulse output is free running and interrupts need not be serviced. If at any time during countdown the count start flag is cleared, the corresponding output is cleared and count suspended until set. Figure 2 illustrates this operation.

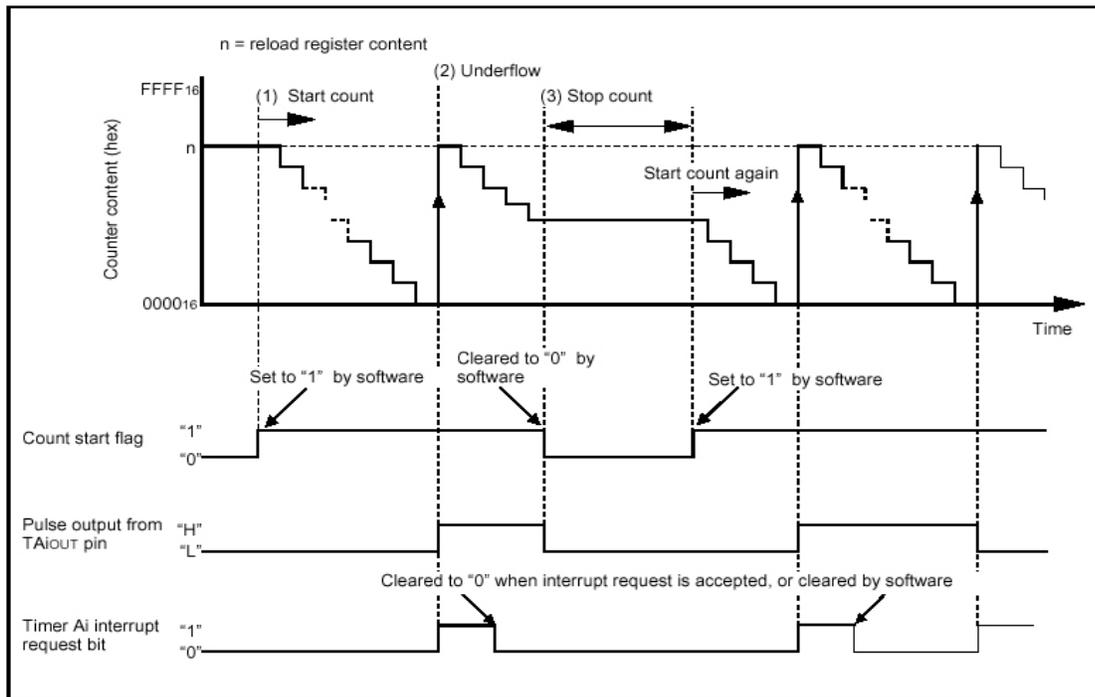


Figure 2 Operation timing of timer mode, pulse output mode

### 4.0 Configuring Pulse Output Mode

The steps to configure timer A for Pulse Output Mode are shown below.

1. Load the TAI register (which also loads the reload register) with the count source
2. Load the timer mode register, TAIMR
  - Select timer mode: bits TMOD0, TMOD1 = 0.
  - Select pulse out: MR0 bit = 1
  - Select the clock source (f1, f/8, f/32, or fc/32): bits TCK0, TCK1
3. Load the timer 'interrupt priority level', TAILC with a value of at least 1 if interrupts are required
4. Ensure interrupts are enabled (CPU I flag set)
5. Set the 'start count' flag bit, TAI5 in the 'count start flag' register, TABSR

For the most part, the order shown above is not important, but the count register should be loaded before the 'start count' flag is set. Also, the priority level should not be modified when there is a chance of an interrupt occurring.

Figure 3 to Figure 6 shows the registers for configuring timer A in pulse output mode.

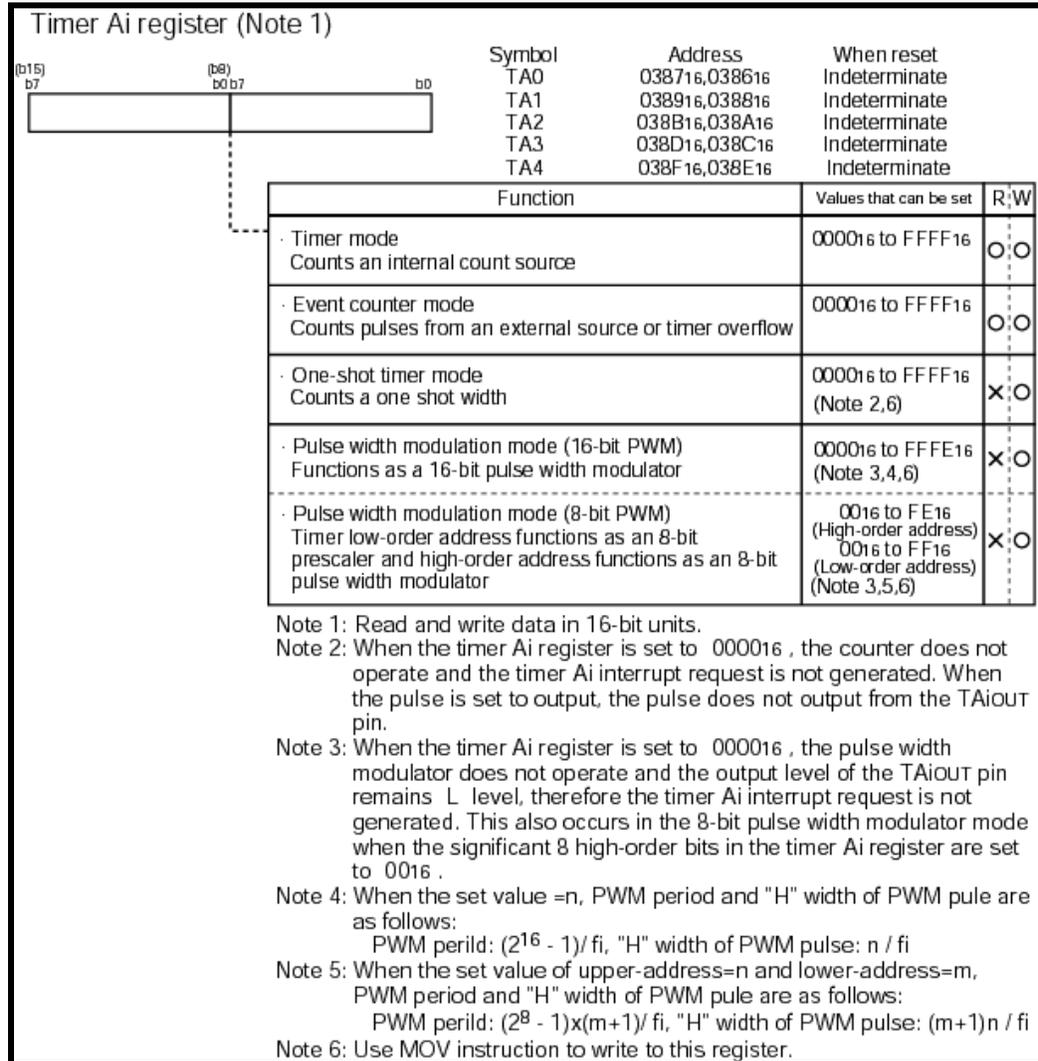


Figure 3 Timer Ai Register

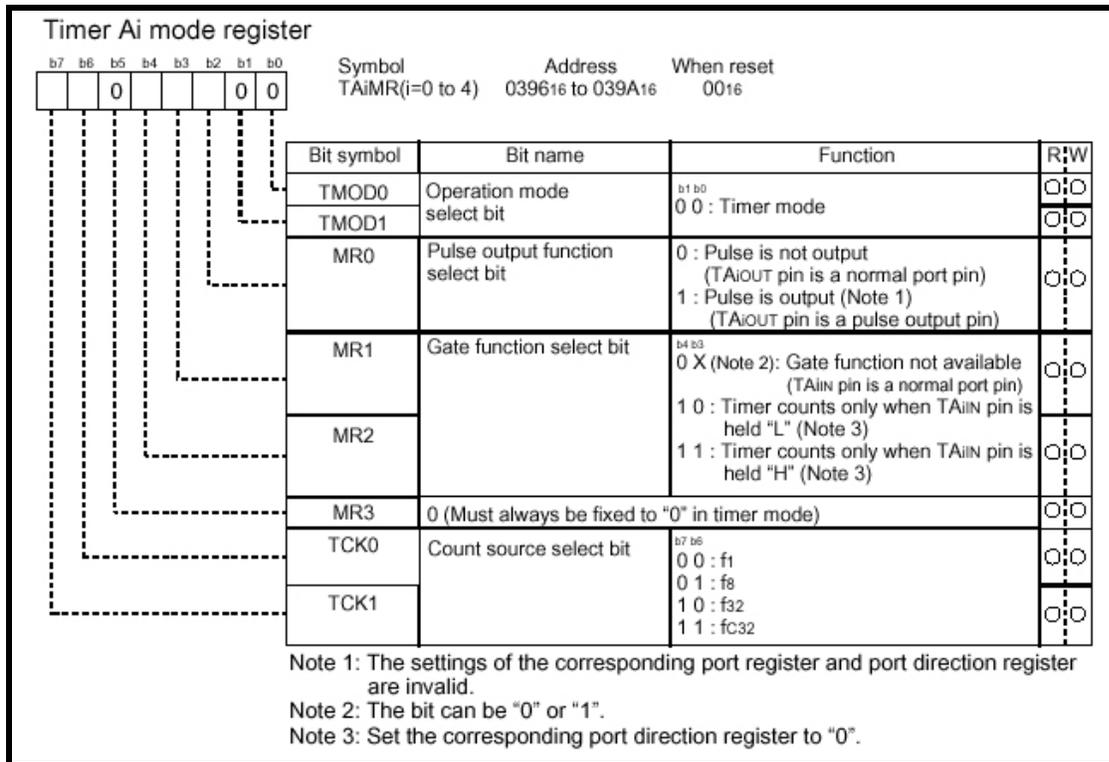


Figure 4 Timer Ai mode register

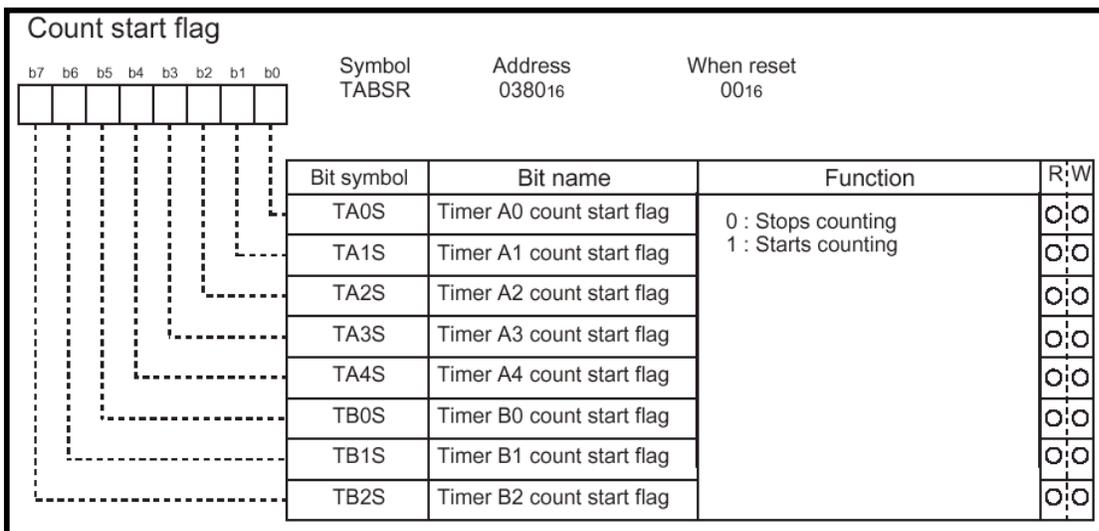


Figure 5 Count start flag register

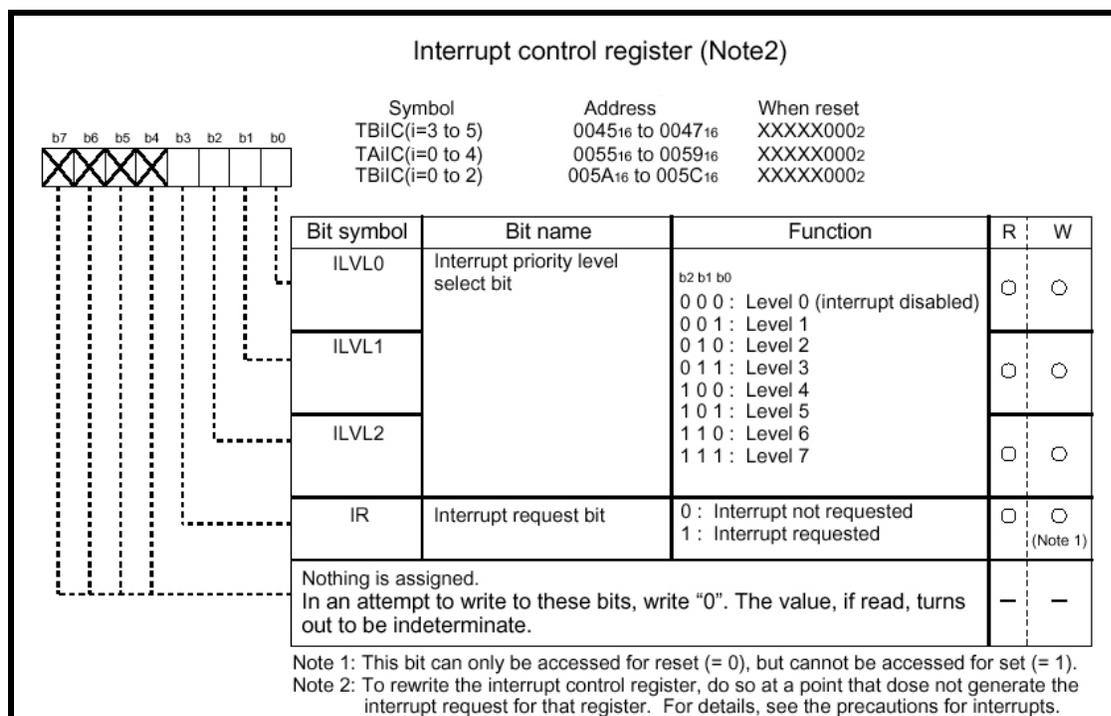


Figure 6 Interrupt control register

## 5.0 Reference

Renesas Technology Corporation Semiconductor Home Page

<http://www.renesas.com>

### E-mail Support

[support\\_apl@renesas.com](mailto:support_apl@renesas.com)

### Data Sheets

- M16C/26 datasheet, M30262eds.pdf

### User's Manual

- KNC30 Users Manual, KNC30UE.PDF
- M16C/60 and M16C/20 C Language Programming Manual, 6020EC.PDF
- Writing interrupt handlers in C for the M16C Application Note
- MSV30262-SKP or MSV-Mini26-SKP Quick start guide
- MSV30262-SKP or MSV-Mini26-SKP Users Manual
- MDECE30262 or MSV-Mini26-SKP Schematic

## 6.0 Software Code

A simple program written in C and compiled using the KNC30 compiler to illustrate how to set up Pulse Output Mode on timer A0 is shown below. This program runs on the MSV30262 Starter Kit Board and generates a 125 Hz square wave on P7.0.

Note that when you stop the program (under KD30), the square wave output does not stop until the system is reset.

To get familiar with the timer, try changing the output frequency, the clock source or even switch to a different timer (e.g. TA1, etc).

```

/*****
*
*   File Name: pulsout.c
*
*   Content: Example program for the "TIMER PULSE OUTPUT MODE ON THE
*           M16C/26" application note. Generates a 125 Hz square wave
*           on the P7.0 pin. For the MSV30262 starter kit board.
*
*   Compiled with KNC30.
*
*   All timing based on 20 Mhz Xtal
*
*   Copyright 2003 Renesas Technology America, Inc.
*   All rights reserved.
*=====
*   $Log:$
*=====*/
#include "sfr26.h"

#define TIME_CONFIG 0x44 /* 01000100 value to load into Timer Ai mode register
                        |||||_|_  TMOD0,TMOD1: TIMER MODE SELECTED
                        |||||_|_  MR0:      PULSE OUTPUT
                        |||||_|_  MR1,MR2:  GATE FUNCTION NOT SELECTED
                        |||_|_     MR3:      SET TO 0 IN TIMER MODE
                        ||_|_     TCK0,TCK1: F DIVIDED BY 8 SELECTED */

#define CNTR_IPL 0x00 // TAO priority interrupt level: interrupts not required

//prototypes
void initial(void);

/*****
Name:    main()
Parameters: none
Returns: nothing
Description: initializes variables. Then does nothing but wait for TAO interrupts.
***** */

void main (void)

```

```
{  
  
    init();  
    while (1);      // square wave output is free running  
}  
/*****  
Name:  init ()  
Parameters:  none  
Returns:  nothing  
Description:  timer TA0 setup for Pulse Output Mode.  
***** */  
void init()  
{  
    ta0 = 10000; //8 times 10,000 counts divide by 20meg xtal ->4msec pulse widths.  
  
/* the following procedure for writing an Interrupt Priority Level follows that as  
described in the M16C data sheets under 'Interrupts' */  
  
    _asm ("    fclr i" ) ;      // turn off interrupts before modifying IPL  
    ta0ic &= CNTR_IPL;      // *?* use read-modify-write instruction to write IPL  
    ta0mr = TIME_CONFIG;  
    _asm ("    fset i" );  
  
    ta0s = 1; //start counting  
}
```

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