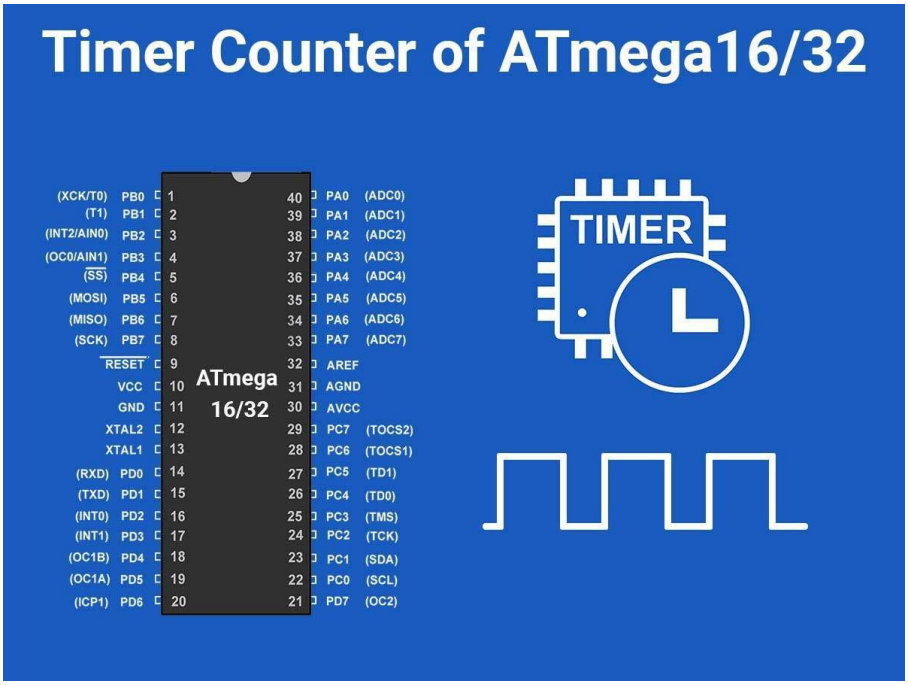
Timer in AVR ATmega16/ATmega32



Introduction

Generally, we use a timer/counter to generate time delays, waveforms, or to count events. Also, the timer is used for PWM generation, capturing events, etc.

In AVR ATmega16 / ATmega32, there are three timers:

- Timer0: 8-bit timer
- Timer1: 16-bit timer
- Timer2: 8-bit timer

Basic registers and flags of the Timers

TCNTn: Timer / Counter Register

Every timer has a timer/counter register. It is zero upon reset. We can access value or write a value to this register. It counts up with each clock pulse.

TOVn: Timer Overflow Flag

Each timer has a Timer Overflow flag. When the timer overflows, this flag will get set.

TCCRn: Timer Counter Control Register

This register is used for setting the modes of timer/counter.

OCRn: Output Compare Register

The value in this register is compared with the content of the TCNTn register. When they are equal, the OCFn flag will get set.

Let us see Timer0 to understand the timers in ATmega16 / ATmega32

Timer0

First, we need to understand the basic registers of the Timer0

1. **TCNT0: Timer / Counter Register 0**

   It is an 8-bit register. It counts up with each pulse.

2. **TCCR0: Timer / Counter Control register 0**

   This is an 8-bit register used for the operation mode and the clock source selection.

7	6	5	4	3	2	1	0
FOC0	WGM00	COM01	COM00	WGM01	CS02	CS01	CS00

Bit 7- FOC0: Force compare match

Write only a bit, which can be used while generating a wave. Writing 1 to this bit causes the wave generator to act as if a compare match has occurred.

Bit 6, 3 - WGM00, WGM01: Waveform Generation Mode

WGM00	WGM01	Timer0 mode selection bit
0	0	Normal
0	1	CTC (Clear timer on Compare Match)
1	0	PWM, Phase correct
1	1	Fast PWM

Bit 5:4 - COM01:00: Compare Output Mode

These bits control the waveform generator. We will see this in the compare mode of the timer.

Bit 2:0 - CS02:CS00: Clock Source Select

These bits are used to select a clock source. When CS02: CS00 = 000, then timer is stopped. As it gets a value between 001 to 101, it gets a clock source and starts as the timer.

CS02	CS01	CS00	Description
0	0	0	No clock source (Timer / Counter stopped)
0	0	1	clk (no pre-scaling)
0	1	0	clk / 8
0	1	1	clk / 64
1	0	0	clk / 256
1	0	1	clk / 1024
1	1	0	External clock source on T0 pin. Clock on falling edge
1	1	1	External clock source on T0 pin. Clock on rising edge.

3. TIFR: Timer Counter Interrupt Flag register

7	6	5	4	3	2	1	0
OCF2	TOV1	ICF1	OCF1A	OCF1B	TOV1	OCF0	TOV0

Bit 0 - TOV0: Timer0 Overflow flag

0 = Timer0 did not overflow

1 = Timer0 has overflown (going from 0xFF to 0x00)

Bit 1 - OCF0: Timer0 Output Compare flag

0 = Compare match did not occur

1 = Compare match occurred

Bit 2 - TOV1: Timer1 Overflow flag

Bit 3 - OCF1B: Timer1 Output Compare B match flag

Bit 4 - OCF1A: Timer1 Output Compare A match flag

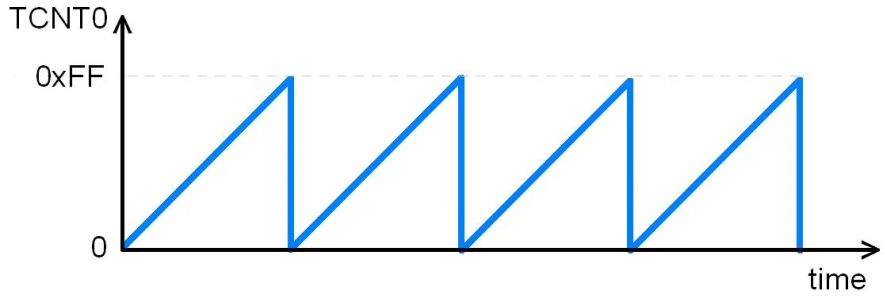
Bit 5 - ICF1: Input Capture flag

Bit 6 - TOV2: Timer2 Overflow flag

Bit 7 - OCF2: Timer2 Output Compare match flag

Timer0 Overflow

Normal mode: When the counter overflows i.e. goes from 0xFF to 0x00, the TOV0 flag is set.



Creating Delay Using Timer0

Steps to Program Delay using Timer0

1. Load the TCNT0 register with the initial value (let's take 0x25).

2. For normal mode and the pre-scaler option of the clock, set the value in the TCCR0 register. As soon as the clock Prescaler value gets selected, the timer/counter starts to count, and each clock tick causes the value of the timer/counter to increment by 1.

3.Timer keeps counting up, so keep monitoring for timer overflow i.e. TOV0 (Timer0 Overflow) flag to see if it is raised.

4. Stop the timer by putting 0 in the TCCR0 i.e. the clock source will get disconnected and the timer/counter will get stopped.

5. Clear the TOV0 flag. Note that we have to write 1 to the TOV0 bit to clear the flag.

6. Return to the main function.

Program for Timer Delay

```
/*
Generating delay using ATmega16 Timer0
http://www.electronicwings.com
*/


#include <avr/io.h>

void T0delay();

int main(void)
{
        DDRB = 0xFF;            /* PORTB as output*/

        while(1)                /* Repeat forever*/
        {
                PORTB=0x55;
                T0delay();      /* Give some delay */
                PORTB=0xAA;
                T0delay();
        }
}
```

The time delay generated by above code

As Fosc = 8 MHz

T = 1 / Fosc = 0.125 µs

Therefore, the count increments by every **0.125 µs**.

In above code, the number of cycles required to roll over are:

0xFF - 0x25= 0xDA i.e. decimal 218

Add one more cycle as it takes to roll over and raise TOV0 flag: 219

Total Delay = 219 x 0.125 µs = **27.375 µs**

Example

Let us generate a square waveform having 10 ms high and 10 ms low time:

First, we have to create a delay of 10 ms using timer0.

*Fosc = 8 MHz

Use the pre-scalar 1024, so the timer clock source frequency will be,

8 MHz / 1024 = **7812.5 Hz**

Time of 1 cycle = 1 / 7812.5 = **128 µs**

Therefore, for a delay of 10 ms, number of cycles required will be,

10 ms / 128 µs = **78 (approx)**

We need 78 timer cycles to generate a delay of 10 ms. Put the value in TCNT0 accordingly.

Value to load in TCNT0 = 256 – 78 (78 clock ticks to overflow the timer)
= 178 i.e. 0xB2 in hex

Thus, if we load 0xB2 in the TCNT0 register, the timer will overflow after 78 cycles i.e. precisely after a delay of 10 ms.

*Note - All calculations are done by considering 8 MHz CPU frequency. If you are using another value of CPU frequency, modify the calculations accordingly; otherwise, the delay will mismatch.

Program for 10ms Delay Using Timer0

```
/*
 Generating a delay of 10 ms using ATmega16 Timer0
 www.electronicwings.com
*/


#include <avr/io.h>

void T0delay();

int main(void)
{
        DDRB = 0xFF;            /* PORTB as output */
        PORTB=0;
        while(1)                /* Repeat forever */
        {
                PORTB= ~ PORTB;
                T0delay();
        }
}

void T0delay()
```

Timer Interrupt

TIMSK: Timer / Counter Interrupt Mask Register

7	6	5	4	3	2	1	0
OCIE2	TOIE2	TICIE1	OCIE1A	OCIE1B	TOIE1	OCIE0	TOIE0

We have to set the TOIE0 (Timer0 Overflow Interrupt Enable) bit in the TIMSK register to set the timer0 interrupt so that as soon as the Timer0 overflows, the controller jumps to the Timer0 interrupt routine.

Timer0 Interrupt Program

```
Generating 10 ms delay pulse on PORTB using ATmega16 Timer interrupt
www.electronicwings.com
*/

#include <avr/io.h>
#include <avr/interrupt.h>

/* timer0 overflow interrupt */
ISR(TIMER0_OVF_vect)
{
        PORTB=~PORTB;           /* Toggle PORTB */
        TCNT0 = 0xB2;
}


int main( void )
{
        DDRB=0xFF;              /* Make port B as output */

        sei();
```

Video

Powered By (https://www.mouser.in?utm_source=electronicswings&utm_medium=display&utm_campaign=mouser-componentslisting&utm_content=0x0)

Components Used

ATmega 16 ATmega 16	X 1	(https://www.mouser.in/ProductDetail/Microchip-Technology-Atmel/ATMEGA16L-8PU?qs=%2Fha2pyFaduiGCJtTvs2wv8fVZbVAalLu7Iq%2FglTS0tALAx6fMenLvg%3D%3D&utm_source=electronicswings&utm_medium=display&utm_campaign=mouser-componentslisting&utm_content=0x0) Datasheet (/components/atmega-16/1/datasheet)
Atmega32 Atmega32	X 1	(https://www.mouser.in/ProductDetail/Microchip-Technology-Atmel/ATMEGA32-16PU?qs=aqrrBurbvGdpkmgj7RWmsQ%3D%3D&utm_source=electronicswings&utm_medium=display&utm_campaign=mouser-componentslisting&utm_content=0x0) Datasheet (/components/atmega32/1/datasheet)

Downloads

ATmega_Timer_Interrupt_Project_File	Download (/api/download/platform-attachment/302)
ATmega_Timer_Delay_Project_File	Download (/api/download/platform-attachment/305)

Comments

Comment

tamas
(/users/tamas/profile)
2019-06-12 02:56:44

Please clarify...
I read on this page that there is a third timer, Timer2, available in Atmega32, at the same time when I search the data sheet for Timer2, zero hits come up and there is no mention of a third counter... Is there a third one or is there not?

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mobo7171
(/users/mobo7171/profile)
2019-10-27 21:37:56

Yes, there is a third one similar to timer zero,
Timer0 and Timer2 are of 8-bit
Timer1 is of 16-bit

Reply Like

dileepmampillil
(/users/dileepmampillil/profile)
2020-03-30 06:46:17

I have a doubt...
Wen timer 0 in wave generation mode, WGM values are
00-normal
01-CTC
10- phase correct PWM
11- fast PWM

But wen timer 0 at PWM mode,the WGM values changed to
00-normal
01-phase correct PWM
10-CTC
11- fast PWM

How and why????

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rivalhistorical
(/users/rivalhistorical/profile)

2020-12-24 02:32:44 • Edited

they are the same man just matter of order, how you arrange WGM writing

WGM00 ----WGM10---------- or WGM10--------WGM00

0---------- 0-------- Normal---------- 0----------0 ------Normal
0----------1--------CTC----------0----------1------ Ph.Correct PWM
1----------0--------PhCo.PWM----------1---------- 0------ CTC
1----------1--------Fast PWM----------1---------- 1-------Fast PWM

don't be confuse just be sure to put WGM00 =0 and WGM10 =1 for CTC mode

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hobbyelectronics21
(/users/hobbyelectronics21/profile)
2020-08-10 19:27:36

Best Tutorial on AVR timers!.

Reply Like

chandannegi902
(/users/chandannegi902/profile)
2020-08-25 14:59:58

please suggest me best avr burner with high speed for maximum code size.
thanks

Reply Like

stijovalayil
(/users/stijovalayil/profile)
2020-08-28 15:00:37

please upload the codes without using libraries, from direct datasheet how to use timer interrupt without ISR ....please dont reply back why re-inventing wheels and all

Reply Like

RajaKumar
(/users/RajaKumar/profile)
2020-09-14 19:13:02

1. Write an if-else statement with a condition which checks whether the ADC conversion for the selected channel is complete or not.
2. If the ADC has completed its conversion for the selected channel return true, else return false.....
how write this statement????

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mooezz999
(/users/mooezz999/profile)
2021-03-28 00:57:46

Wheres I2C bro?

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mohamedashrafragab
(/users/mohamedashrafragab/profile)
2021-12-10 19:11:23

what's the difference between "Peridoic Time (T)" and "Tick Time"?

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