


Timers

Embedded Systems Interfacing

1




Overview

- Timer 1 – Type A¹
- Timers 2/4 – Type B
- Timers 3/5 – Type C

¹ PIC24F Family Reference Manual


2



Material Sources

- PIC24F Family Reference Manual – Timers – Section 14 ([39704a.pdf](#))
- PIC24FJ128GA010 Family Data Sheet – Sections 10 and 11 ([39747d.pdf](#))


3



Timer Modes

- Timer Mode
 - Uses F_{CYC} Clock
 - Variant A, B and C
- Synchronous Counter Using External Clock Input
 - Double Sampled by F_{OSC} which is not available during sleep mode
 - Variant A, B, and C


4



Timer Modes

- Asynchronous Counter Using External Clock Input
 - Not synchronized by F_{OSC} and available during sleep mode
 - Variant A only
- Gated Timer
 - Counts F_{CYC} while gate is high
 - Variant A, B, and C

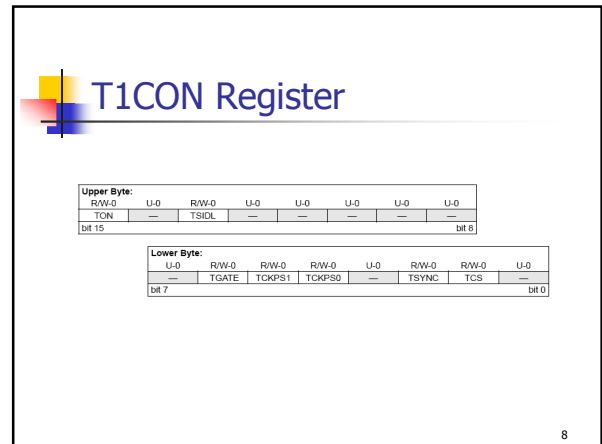
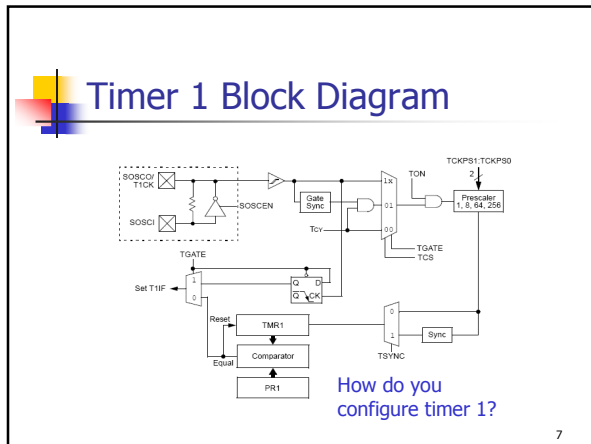
5



Timer 1

- 16-Bit Timer
- 16-Bit Synchronous Counter
- 16-Bit Asynchronous Counter
- 16-Bit Gated Timer

6



T1CON Register

bit 15 **TON**: Timer1 On bit
 1 = Starts 16-bit Timer1
 0 = Stops 16-bit Timer1

bit 14 **Unimplemented**: Read as '0'

bit 13 **TSIDL**: Stop in Idle Mode bit
 1 = Discontinue module operation when device enters Idle mode
 0 = Continue module operation in Idle mode

bit 12-7 **Unimplemented**: Read as '0'

T1CON Register

bit 6 **TGATE**: Timer1 Gated Time Accumulation Enable bit
 When TCS = 1:
 This bit is ignored.
 When TCS = 0:
 1 = Gated time accumulation enabled
 0 = Gated time accumulation disabled

bit 5-4 **TCKPS1:TCKPS0**: Timer1 Input Clock Prescale Select
 11 = 1:256
 10 = 1:64
 01 = 1:8
 00 = 1:1

bit 3 **Unimplemented**: Read as '0'

T1CON Register

bit 2 **TSYNC**: Timer1 External Clock Input Synchronization Select bit
 When TCS = 1:
 1 = Synchronize external clock input
 0 = Do not synchronize external clock input
 When TCS = 0:
 This bit is ignored.

bit 1 **TCS**: Timer1 Clock Source Select bit
 1 = External clock from pin T1CK (on the rising edge)
 0 = Internal clock (FOSC/2)

bit 0 **Unimplemented**: Read as '0'

Timer 1 Clock Source

- $TIMER1bits.TCS = 1$
- External 32,768 Xtal
 - Interrupt once per second: Prescale=1:1, PR= 32767 (Prescale=1:8, PR=4095)
 - Interrupt once per minute: Prescale=1:64, PR=30719 (Prescale=1:256, PR=7679)
 - Interrupt once per 8 minutes: Prescaler 1:256, PR=61439

Timer 1 Interrupt Routine

```
#define PERIOD 32768

// Timer 1 interrupt service routine
void __attribute__((interrupt,no_auto_psv))
    _T1Interrupt(void){
    Nop();    //Break point
    _T1IF=0; // clear interrupt flag
}
}
```

13

Timer 1 Initialization

```
int main(void){
//initialization
    _T1IF=0; // clear interrupt flag before enabling
    _T1IE=1; // enable Timer 1 interrupts
    _IPL=0;  // set default interrupt level
    _T1IP=4; // Set interrupt priority (default)

    TMR1=0; // clear timer 1
    PR1=PERIOD-1; // set the period count
}
```

14

Timer 1 Initialization

```
OSCCONbits.SOSCEN=1; //enable secondary oscillator
#ifdef _myDebug
T1CONbits.TCS=0; //Internal clock for debugging
#else
T1CONbits.TCS=1; //External clock from pin T1CK
#endif
T1CONbits.TGATE=0;
T1CONbits.TSYNC=1; //synchronize external clock
T1CONbits.TCKPS1=0; // Prescale 1;1
T1CONbits.TCKPS0=0;
T1CONbits.TSIDL=0; //Continue module in idle mode
T1CONbits.TON=1; //Turn on 16-bit timer 1
```

15

TIMER1

Timer 1 Endless Loop

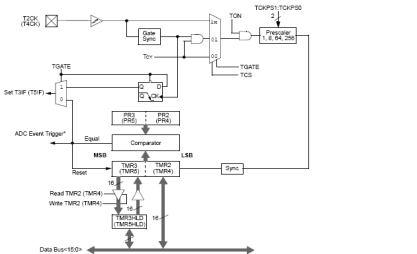
```
//endless loop
again:
    Nop(); //Twiddle Thumbs
    goto again; //one more time
    return(0);
}
```

16

- ### Timer 2/3 OR 4/5
- Timer 2 and 4 are variant B
 - Timers 3 and 5 are variant C
 - Three Modes
 - Two 16-bit Timers
 - Single 32-bit Timer
 - Single 32-bit Counter
 - Supported Features
 - Timer gate operation
 - Selectable prescale setting
- 17

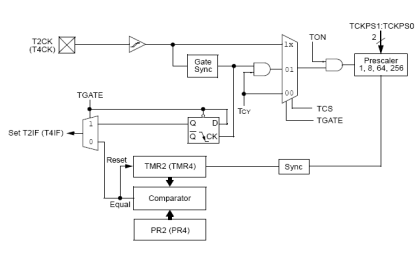
- ### Timer 2/3 OR 4/5
- Supported Features Continued
 - Timer operation during idle and sleep modes
 - Interrupt on 32-bit register match
 - ADC event trigger for 4/5 timer only
- 18

32-bit Timer 2/3 or 4/5



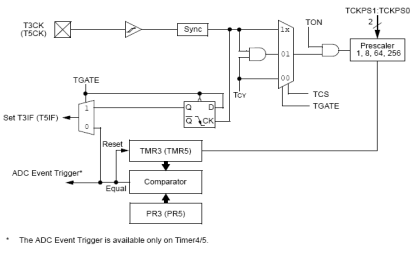
19

16-Bit Synchronous Counter



20

16-Bit Asynchronous Counter



21

32-Bit Timer Interrupt

```
#define PERIOD 937500L //60 second period
//with 1:256 Prescaler
#define MAXWORD 65536L //Maximum Word value

// Timer 1 interrupt service routine
void __attribute__((interrupt,no_auto_psv))
_T3Interrupt(void){
    Nop();
    _T3IF=0; // clear interrupt flag
}
```

23

32-Bit Time Initialization

```
int main(void){
//initialization
_T3IF=0; // clear interrupt flag before enabling
_T3IE=1; // enable Timer 1 interrupts
_IPL=0; // set default interrupt level
_T3IP=4; // Set interrupt priority (default)

TMR2=0; // clear timer 2
TMR3=0; // clear timer 3
PR2=(PERIOD%MAXWORD)-1; // set the period count
PR3=(PERIOD/MAXWORD); // set the period count
```

24

32-Bit Time Initialization

```
#ifdef _INTERNAL_OSC
T2CONbits.TCS=0; //Internal clock from TOSC/2
#else
T2CONbits.TCS=1; //External clock from pin T2CK
#endif
T2CONbits.T32=1; //single 32-bit timer
T2CONbits.TGATE=0;
T2CONbits.TCKPS1=1; // Prescale 1;256
T2CONbits.TCKPS0=1;
T2CONbits.TSIDL=0; //Continue module in idle mode
T2CONbits.TON=1; //Turn on 16-bit timer 1
//In 32-bit mode T3CON has
Nop(); //no effect
```

25

Long Timer

32-Bit Time Endless Loop

```
//endless loop
again:
  Nop();           //Twiddle Thumbs
  goto again;     //one more time
  return(0);
}
```

26

Explore-16 Dev. Board

Fosc MHz	Prescaler 1 to N	16-Bit Maximum Tcy	32-Bit Maximum Tcy	Resolution ns
8	1	65,536	4,294,967,296	250.00
8	8	524,288	34,359,738,368	2000.00
8	64	4,194,304	274,877,906,944	16000.00
8	256	16,777,216	1,099,511,627,776	64000.00
32	1	65,536	4,294,967,296	62.50
32	8	524,288	34,359,738,368	500.00
32	64	4,194,304	274,877,906,944	4000.00
32	256	16,777,216	1,099,511,627,776	16000.00

27

Homework

- Exercise 1 (Timer 1 Registers)
- Exercise 2 (Timer 1 Configuration)
- Exercise 3 (Timer 2/3 Registers)
- Exercise 4 (Timer 2/3 Configuration)

29

Links

- PIC24FJ128GA Datasheet
- PIC24F Family Reference Manual

30