

COUNTER PROGRAMMING

- ❑ Timers can also be used as counters counting events happening outside the 8051
 - When it is used as a counter, it is a pulse outside of the 8051 that increments the TH, TL registers
 - TMOD and TH, TL registers are the same as for the timer discussed previously
- ❑ Programming the timer in the last section also applies to programming it as a counter
 - Except the source of the frequency



COUNTER PROGRAMMING

C/T Bit in TMOD Register

- ❑ The C/T bit in the TMOD registers decides the source of the clock for the timer
 - When $C/T = 1$, the timer is used as a counter and gets its pulses from outside the 8051
 - The counter counts up as pulses are fed from pins 14 and 15, these pins are called T0 (timer 0 input) and T1 (timer 1 input)

Port 3 pins used for Timers 0 and 1

Pin	Port Pin	Function	Description
14	P3.4	T0	Timer/counter 0 external input
15	P3.5	T1	Timer/counter 1 external input



COUNTER PROGRAMMING

C/T Bit in TMOD Register (cont')

Example 9-18

Assuming that clock pulses are fed into pin T1, write a program for counter 1 in mode 2 to count the pulses and display the state of the TL1 count on P2, which connects to 8 LEDs.

Solution:

```
MOV    TMOD,#01100000B ;counter 1, mode 2,  
                                ;C/T=1 external pulses  
MOV    TH1,#0 ;clear TH1  
SETB   P3.5 ;make T1 input  
AGAIN: SETB   TR1 ;start the counter  
BACK:  MOV    A,TL1 ;get copy of TL  
        MOV    P2,A ;display it on port 2  
        JNB    TF1,Back ;keep doing, if TF = 0  
        CLR    TR1 ;stop the counter 1  
        CLR    TF1 ;make TF=0  
        SJMP   AGAIN ;keep doing it
```

Notice in the above program the role of the instruction SETB P3.5.

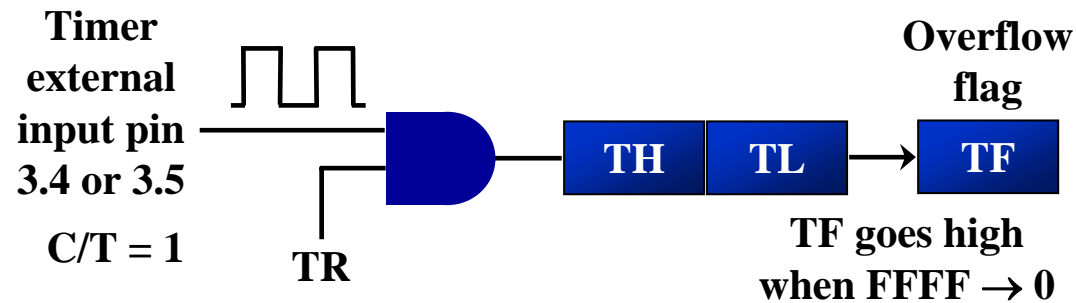
Since ports are set up for output when the 8051 is powered up, we make P3.5 an input port by making it high. In other words, we must configure (set high) the T1 pin (pin P3.5) to allow pulses to be fed into it.



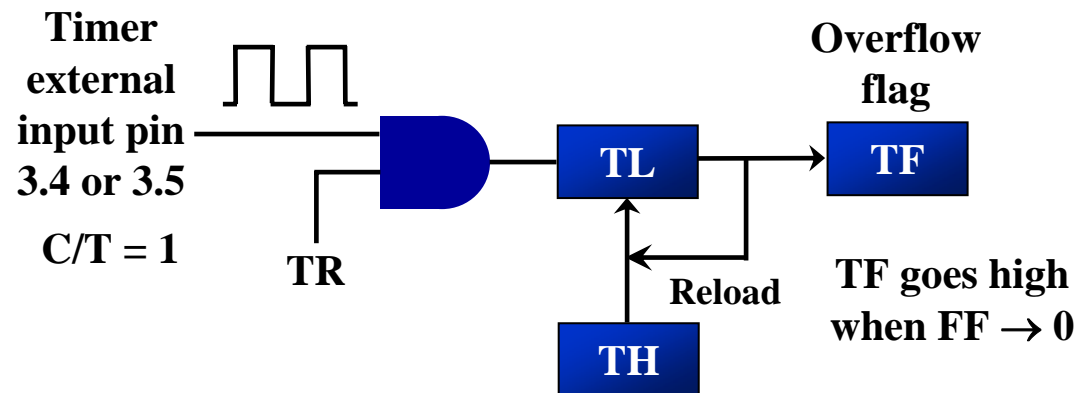
COUNTER PROGRAMMING

C/T Bit in TMOD Register (cont')

Timer with external input (Mode 1)



Timer with external input (Mode 2)



COUNTER PROGRAMMING

TCON Register

- ❑ TCON (timer control) register is an 8-bit register

TCON: Timer/Counter Control Register



The upper four bits are used to store the TF and TR bits of both timer 0 and 1

The lower 4 bits are set aside for controlling the interrupt bits



COUNTER PROGRAMMING

TCON Register (cont')

- TCON register is a bit-addressable register

Equivalent instruction for the Timer Control Register

For timer 0

SETB TR0 = SETB TCON.4

CLR TR0 = CLR TCON.4

SETB TF0 = SETB TCON.5

CLR TF0 = CLR TCON.5

For timer 1

SETB TR1 = SETB TCON.6

CLR TR1 = CLR TCON.6

SETB TF1 = SETB TCON.7

CLR TF1 = CLR TCON.7



COUNTER PROGRAMMING

TCON Register

Case of GATE = 1

- ❑ If GATE = 1, the start and stop of the timer are done externally through pins P3.2 and P3.3 for timers 0 and 1, respectively
 - This hardware way allows to start or stop the timer externally at any time via a simple switch

