BECE204P-Microprocessors & Microcontrollers Lab

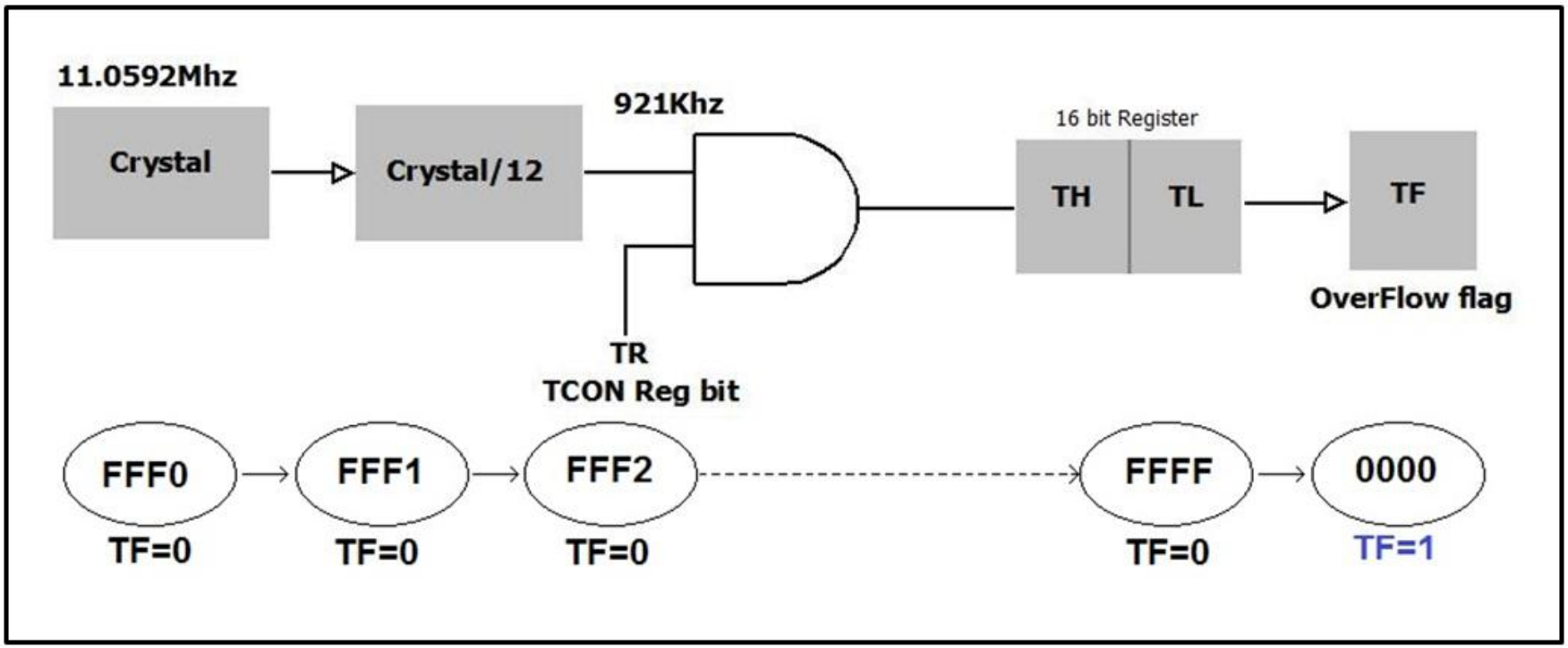
LAB-9

TIMER/COUNTER PROGRAMMING IN 8051

TIMERS/COUNTERS

- 8051 has two timers/counters (Timer 0 and Timer 1), both are 16-bit wide. They can be used either as
  - ✓ Timers to generate a time delay
  - ✓ To generate a waveform with specific frequency
  - ✓ To generate baud rate signal for serial communication
  - ✓ Event counters to count events happening outside the microcontroller
- Register related to work with 8051 timers are:
  1. TH & TL Timer/counter register– To hold the value for generating time delay
  2. TMOD Register - to define mode of timer operation
  3. TCON Register – To control the timer operation

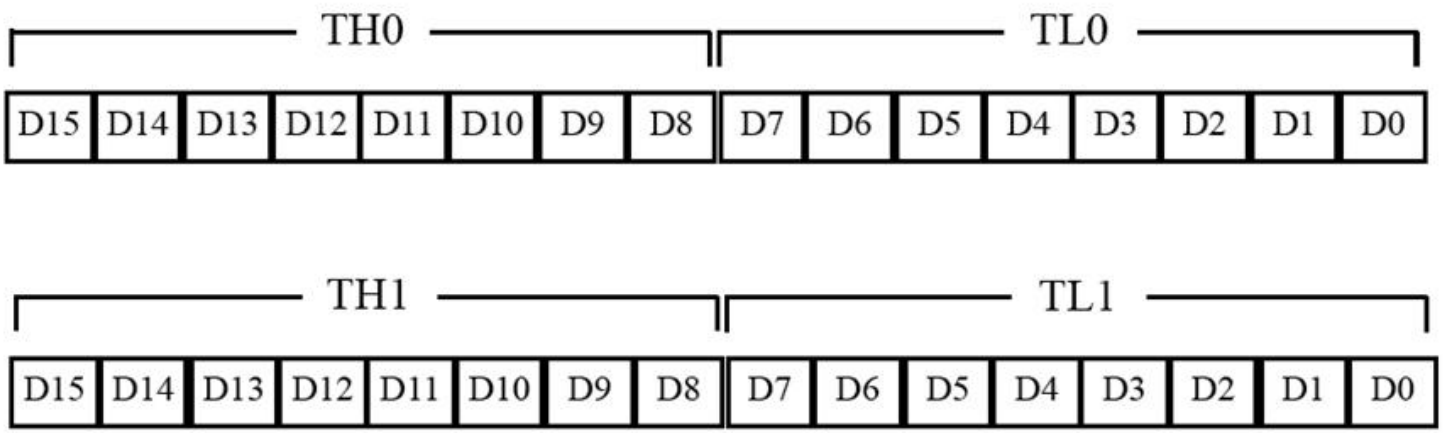
TIMERS / COUNTERS



TIMERS / COUNTERS

TIMERS/COUNTER REGISTERS

- 8051 has two timers/counters registers (Timer 0 and Timer 1), each 16-bits wide and accessed as two separate registers of low byte and high byte
  - ✓ The low byte register is called TL0/TL1 and
  - ✓ The high byte register is called TH0/TH1



TIMERS / COUNTERS

TIMERS/COUNTER REGISTERS

- Steps to calculate values to be loaded into the TL and TH registers
  1. Divide the desired time delay by 1.085us (if operating frequency is 11.0592 MHz)
  2. Perform 65536 – n, where "n" is the decimal value got in Step1 (if 16-bit counter mode is selected)
  3. Convert the result of Step2 to hex value and represent in four digits (ex: xxyy)
  4. If "xxyy" is the hex value to be loaded into the timer's register, then set TH = xx and TL = yy

- Example: 500us time delay

  Step1: 500us/1.085us = 461 pulses

  Step2: P=65536-461=65075

  Step3: 65074 converted by hexa decimal =FE33

  Step4: TH1=0xFE; TL1=0x33;

TIMERS / COUNTERS

TMOD REGISTER

Gating Control:

- If GATE=1 – Timer/Counter is enable only while INTx pin is HIGH and the TRx control pin is SET
- If GATE=0, the timer is enabled whenever the TRx control bit is set

Counter/Timer Selction:

- C/T=1 – Act as a counter and receive external input signal from P3.5 pin for T1, (P3.4 for T0)
- C/T=0 – Act as a timer and receive input signal from internal system clock

M1	M0	Operating Mode
0	0	13-bit Timer Mode (Mode-0): 8-bit Timer/Counter THx with TLx as 5-bit prescaler
0	1	16-bit Timer Mode (Mode-1): 16-bit Timer/Counter THx and TLx are cascaded, no prescaler
1	0	8-bit Auto-reload Mode (Mode-2): 8-bit auto reload Timer/Counter; THx holds the value which is to be reloaded when TLx overflows each time
1	1	Split-timer Mode (Mode-3)

*Where x represent 0 for Timer0 and 1 for Timer 1

TIMERS / COUNTERS

TMOD REGISTER

- TFx: Timerx Overflow Flag
  - TFx =1 means Timerx overflow occurred (i.e. Timerx goes to its max and roll over back to zero).
  - TFx =1 means Timerx overflow not occurred.

- ITx: External Interruptx Trigger Type Select Bit
  - ITx=1 means Interrupt occurs on falling edge at INTx pin.
  - ITx=0 means Interrupt occur on a low level at the INTx pin.

- TRx: Timerx Run Control Bit
  - TRx =1 means Timerx start.
  - TRx =0 means Timerx stop.

- IEx: External Interruptx Edge Flag
  - IEx=1 means External interruptx occurred.
  - IEx=0 means External interruptx Processed.

*Where x represent 0 for Timer0 and 1 for Timer 1

TIMERS / COUNTERS

STEPS TO PROGRAM 0 MODE 1 (16-BIT TIMER)

1. Load the TMOD value register indicating which timer (timer 0 or timer 1) and timer mode (0 or 1) is selected. MOV TMOD,#01H.

2. Load registers TL and TH with initial count value. MOV TH0,#FFH; MOV TL0,#FCH.

3. Start the timer using SETB TRx. SETB TR0.

4. Keep monitoring the timer flag (TF). AGAIN: JNB TF0, AGAIN.

5. Stop the timer using CLR TRx. CLR TR0.

6. Clear the TF flag for the next round. CLR TF0.

7. Go back to Step 2 to load TH and TL again. SJMP STEP2.

TIMERS/COUNTERS

- 8051 has two timers/counters (Timer 0 and Timer 1), both are 16-bit wide. They can be used either as
  - ✓ Timers to generate a time delay
  - ✓ To generate a waveform with specific frequency
  - ✓ To generate baud rate signal for serial communication
  - ✓ Event counters to count events happening outside the microcontroller
- Register related to work with 8051 timers are:
  1. TH & TL Timer/counter register– To hold the value for generating time delay
  2. TMOD Register - to define mode of timer operation
  3. TCON Register – To control the timer operation

LAB TASK-1

Write an 8051 assembly language program using timers to blink the LED connected at P1.7 TON of 0.75 seconds and TOFF of 0.25 seconds. Assume the crystal frequency as 11.0592 MHz. Verify the output using ESA 8051 Microcontroller kit.

Delay Calculation (TON = 0.75 Seconds):

- 0.75 s/ 1.085 us = 691244 cycles
- Since above cycles can't be accommodated in timers registers, we need to use Loop instruction (DJNZ) to achieve the desired delay
- Assume the loop count as 255 then, 691244 / 255 = 2710. By repeating 2710 cycles for 255 times we can achieve the desired delay of 0.75 seconds
- Therefore, we need to calculate initial count value by , 65536-2710 = 62825 = F569H

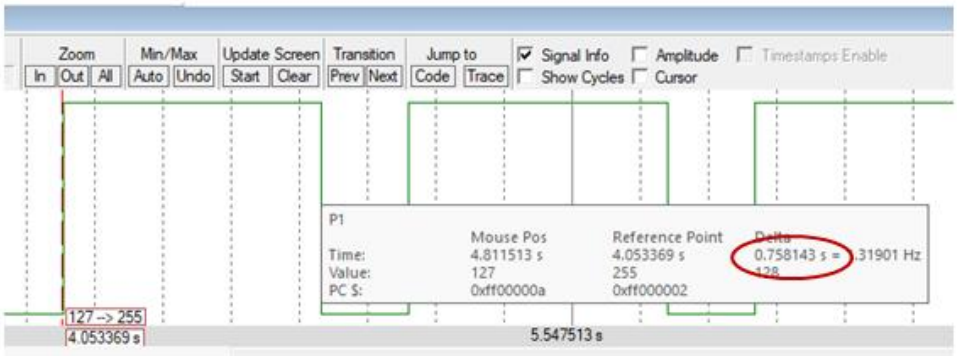
Delay Calculation (TON = 0.25 Seconds):

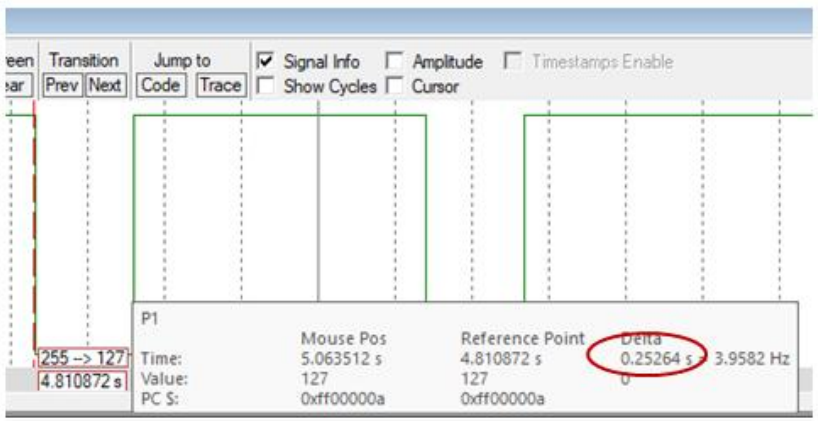
- 0.25 s/ 1.085 us = 230414 cycles
- Since above cycles can't be accommodated in timers registers, we need to use Loop instruction (DJNZ) to achieve the desired delay
- Assume the loop count as 255 then, 230414 / 255 = 903. By repeating 903 cycles for 255 times we can achieve the desired delay of 0.25 seconds
- Therefore, we need to calculate initial count value by , 65536-903 = 64632 = FC78H

LAB TASK-1

```
        //Main program
              ORG 0000H
              CLR P1.7
BACK:         SETB P1.7
              MOV R0, 255
LOOP1:        ACALL DELAY1
              DJNZ R0, LOOP1
              CLR P1.7
              MOV R1, 255
LOOP2:        ACALL DELAY2
              DJNZ R1, LOOP2
              SJMP BACK
```

OUTPUT:





LAB TASK-1

```
DELAY1:MOV TMOD,#10H
MOV TL1,#69H
MOV TH1,#0F5H
SETB TR1
BACK1: JNB TF1,BACK1
CLR TR1
CLR TF1
RET
```

```
DELAY2:MOV TMOD,#10H
MOV TL1,#78H
MOV TH1,#0FCH
SETB TR1
BACK2: JNB TF1,BACK2
CLR TR1
CLR TF1
RET
```

LAB TASK-2

Assuming that clock pulses are fed into pin T1(P3.5), write a 8051 assembly program for counter 1 in mode 2 to count the pulses and display the state of the TL1 count on P1, which connects to 8 LEDs.

```
        ORG 0000H
        SETB P3.5           ; make T1 input
        MOV P1,#00H         ; Make Port 1 as output port
        MOV TMOD, #60H      ; counter 1, mode 2;C/T=1 external pulses
        MOV TH1, #0         ; clear TH1
AGAIN:  SETB TR1            ; start the counter
BACK:   MOV A, TL1          ; get copy of TL
        MOV P1, 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
```

CHALLENGING TASK

1. Write an 8051 assembly language program using timers to toggle the status of the LED connected in port P1.7 for every "PQRS" seconds, where "PQRS" is last four digits of your register number. Assume the crystal frequency as 11.0592 MHz.