

ECE 376 - Homework #9

Timer 0/1/2/3 Interrupts. Due Monday, November 7th

1) Write a C routine using Timer0 interrupts to measure time to 100ns. Using this routine, determine how long the following operations in C take:

a) LCD display routine

```
long int A;  
A = 123456789;  
LCD_Out(A, 10, 7); // time to execute this instruction
```

- Time = 6.2543ms



b) The time it takes you to press all buttons on PORTB sequentially

```
TRISB = 0xFF;  
while(!RB0); // start  
while(!RB1);  
while(!RB2);  
while(!RB3);  
while(!RB4);  
while(!RB5);  
while(!RB6);  
while(!RB7); // end
```

- 3.7177538 seconds
- 2.9201041 seconds



c) The time it takes you to press and release RB0 10 times

```
TRISB = 0xFF;
for(i=0; i<10; i++) {           // start
    while(!RB0);
    while(RB0);
}                                // end
```

- 1.4195560 seconds
- 1.4686776 seconds
- 1.3608501 seconds



2) Write a C routine using Timer0 / Timer1 / Timer2 / Timer3 interrupts to play 4 notes at the same time when you press button RB0 (4-string Violin)

Output Pin	RC0	RC1	RC2	RC3
Note	E4	F4	F4#	G4
Frequency (Hz)	329.63 Hz	349.23 Hz	369.99 Hz	392.00 Hz
Interrupt	Timer0	Timer1	Timer2	Timer3
N	15,168.52	14,317.21	13,513.87	12,755.1
PS	1	1	A = 14, C = 4 B = 241	1
Measured	329.9 Hz	349.4 Hz	370.6 Hz	392.0 Hz
Error (%)	+0.0819%	+0.0487%	+0.1649%	+0%

T2CON = 0x6D

7	6	5	4	3	2	1	0
0	1	1	0	1	1	0	1
A = 14				C = 4			

Code

```

:
:
:
:

```

Problem 3-7) Write a C program which uses at least two interrupts Timer0/1/3 interrupts. Some suggestions are

Iambic Paddle

3) Requirements: Explain what the inputs are / what the outputs are / and how they relate. Also explain how each timer interrupt is used in your embedded system.

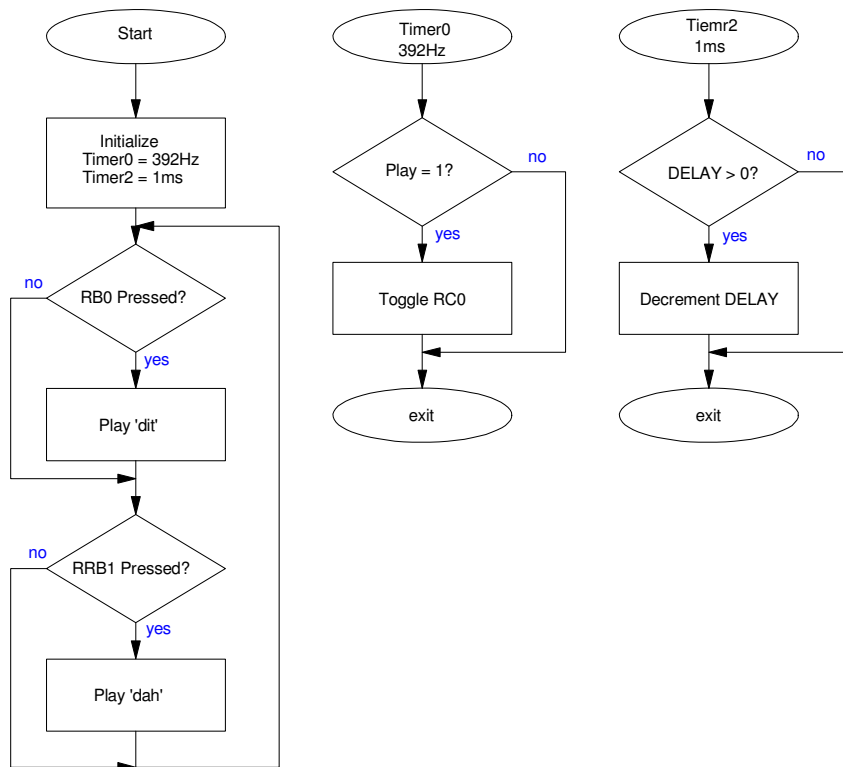
Generate Morse code when you press RB0 and RB1

- RB0: Output a dit: Play 392Hz for 200ms, then pause 200ms
- RB1: Output a dash: Play 392Hz for 600ms, then pause for 200ms
- If you hold down RB0, it plays a series of dits
- If you hold down RB1, it plays a series of dashes
- If you hold both buttons down, it alternates, dit-dah-dit-dah

Timer0: Set the frequency (392Hz)

Timer2: Set the duration (measures time to 1ms)

4) C-Code and flow chart.

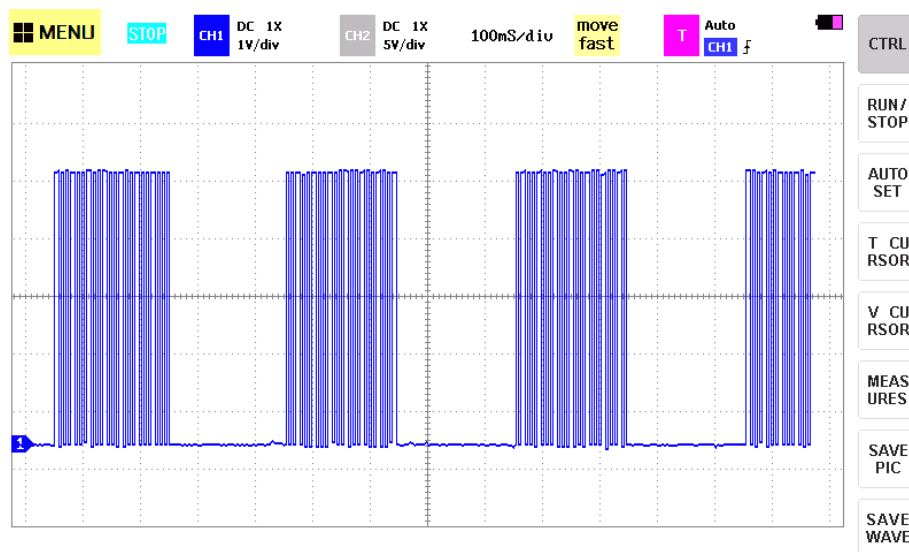


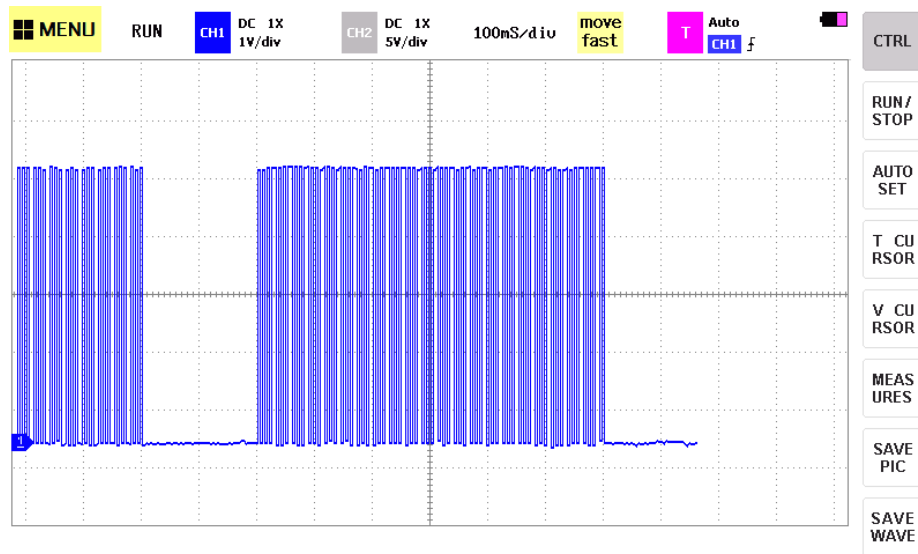
5) Test: Collect data in lab to verify that your interrupts are working properly.

- Frequency = 392.9Hz
- 'dit' on time = 200ms, off time = 200ms
- 'dah' on time = 600ms, off time = 200ms
- Timer2 interrupt = 1.00ms

6) Validation: Collect data in lab to verify you met your requirements

- Holding RB0 plays a series of dits
- Holding down RB1 plays a series of dahs
- Holding both down plays dit-dah and repeats





7) Demo (in person during Zoom office hours or in a video)