Homework Assignment #3

Due: **March 13, 2019, before midnight**

1. **(40 pt)** Maximum delay using Timer 1
   a. **(10 pt)** What is the maximum delay that Timer 1 (16-bit) can generate? Assume that the PIC24 microcontroller is running at 16MHz.

PR1_max*62.5ns*Prescalar_max= $(2^{16}-1)62.5 \cdot 256$

$= 1.048565$

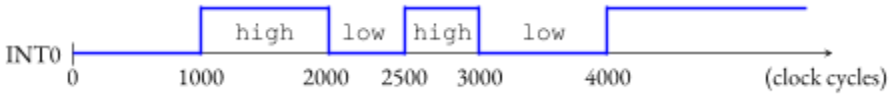
   b. **(20 pt)** Write a program in C to implement the maximum delay using Timer 1. Reuse the example code `int_first_t1.c` which is available in course Canvas. Implement both polling and interrupt versions. Submit your c file.

   c. **(10 pt)** Measure the time using Stopwatch and report the results. Set a break point at the line `IFS0bits.T1IF = 0;` (or `_T1IF = 0;`) in the infinite loop (polling) and the `_T1Interrupt` ISR (interrupt) and measure the time between the line using Stopwatch. Report the results of the Stopwatch.

Target halted. Stopwatch cycle count = 16652044 (1.040753 s)

Almost but not quite the maximum

2. **(60 pt)** Assume that INT0 pin receives the following electric signal.



Note that the unit of time is the clock cycle. The goal is to measure the time (in clock cycles) of the high period and the low period and save them to `high` and `low` variables. Use Timer 1 and its register `TMR1` to measure the time. To simulate the signal to INT0, use Stimulus (Pin/Register Actions)[1].

a. **(20 pt)** Write a C program using **polling** and run the simulation. Report the value of `high` and `low` variables (i.e. 4 numbers).

```
Stopwatch cleared. Stopwatch cycle count = undefined
Target halted. Stopwatch cycle count = 128 (8 µs)
Target halted. Stopwatch cycle count = 876 (54.75 µs)
Target halted. Stopwatch cycle count = 1001 (62.5625 µs)
Target halted. Stopwatch cycle count = 501 (31.3125 µs)
Target halted. Stopwatch cycle count = 501 (31.3125 µs)
Target halted. Stopwatch cycle count = 1001 (62.5625 µs)
Target halted. Stopwatch cycle count = 96460668 (6.028792 s)
```

b. **(20 pt)** Write a C program using an **interrupt** and run the simulation. Report the value of `high` and `low` variables

```
Target halted. Stopwatch cycle count = 1018 (63.625 µs)
Target halted. Stopwatch cycle count = 8 (500 ns)
Target halted. Stopwatch cycle count = 991 (61.9375 µs)
Target halted. Stopwatch cycle count = 8 (500 ns)
Target halted. Stopwatch cycle count = 492 (30.75 µs)
Target halted. Stopwatch cycle count = 8 (500 ns)
Target halted. Stopwatch cycle count = 492 (30.75 µs)
Target halted. Stopwatch cycle count = 8 (500 ns)
Target halted. Stopwatch cycle count = 992 (62 µs)
Target halted. Stopwatch cycle count = 8 (500 ns)
Target halted. Stopwatch cycle count = 3644661 (227.791313 ms)
```

c. **(20 pt)** Are these `high` and `low` variables close to 1000, 500, 500, 1000? Briefly discuss why the results you obtained are not exactly the same to the ideal values.

These are not ideal because of the overhead to run the code.

[1] **Stimulus**: You can find a video tutorial of using Stimulus in MPLAB X IDE at https://youtu.be/4gzeR4YnMFY.