ECE-340 | Lab 4 Questions | Owen Blair

Timer 1 limitations

- 16 Bit
- 10 MHz (FPB)
- PRx is 32 bit #

Longest period?

$$\#\text{ of combos} = \sum_{n=0}^{15} 2^n = 65535 \text{ ticks}$$

$10 \cdot 10^6$ cycles per second $\quad \frac{65535}{10 \cdot 10^6} = 0.0065533$ seconds for 1 full timer count

PRx = 32 bits at maximum

↳ $\sum_{n=0}^{31} 2^n = 4.294967295 \cdot 10^{16}$ combinations

If PRx = 0xFFFFFFFF then timer 1 will need to fully increment to add +1 to the PRx comparison.

Maximum time = (# of PRx iterations) $4.294967295 \cdot 10^{16}$ (time for PRx to add +1) (0.0065535)

$= 1.361925195 \cdot 10^9$ years

The longest period that timer 1 can be set for using the PR1 register is about $1.361925195 \cdot 10^9$ years.

Shortest period?

PRx = 1 so timer 1 needs to increment once

$$T = \frac{1}{f} = \frac{1}{10 \cdot 10^6} = 10^{-7} \text{ seconds}$$

The shortest period would be 0.1 μS (1 clock cycle)

Calculate % Error induced by increasing PRx by 1

Using FPB = 10 MHz, having to count 1 more step would add $+10^{-7}$ seconds to the time needed to count?

$$T2\text{-}TICK = \left(\frac{FPB}{Prescale}\right) / \text{Toggles per sec}$$

$$= \left(\frac{10 \cdot 10^6}{1}\right) / 10^3 = \frac{10^7}{10^3} = 10^4 \text{ iterations for 1 ms}$$

(10^4: iterations 1ms; 10^{-7}: time for 1 iteration)

$$\left| \frac{\left[10^4 \times (10^{-7})\right] - \left[(10^4 + 1) \times 10^{-7}\right]}{10^4 \times 10^{-7}} \right| = \% \text{ Error}$$

$$\left| \frac{10^{-3} - 1.0001 \cdot 10^{-3}}{10^{-3}} \right| = 10^{-10} \% \text{ Error}$$

Increasing PR1 from 10^4 to $[10^4 + 1]$ gives a 10^{-10} % Error added to the timing of Timer 1 Interrupt FLag