Group 17\_Lab03

Exercise 1:

Write a C program to toggle an LED connected to pin 5 of PORTB register (PB5) every 2ms. Use TIMER0, normal mode, and a suitable pre-scalar to create the delay. Assume XTAL= 16 MHz. What is the selected prescaler? What is the initial counter value? Explain the output. What is the reason for it?

XTAL = 16MHz → Txtal \_clock = 1/ 16 µs

Prescaler = 1:256 → Tcounter\_clock = 256 × 1/ 16 µs = 16 µs

Counter increments needed = 2000 µs / 16µs =125 increments

Initial counter value = 1+255 – 125 = 131

Exercise 2:

Try to increase the delay in Exercise 2 to 500ms. Talk to an instructor and explain how this can be done, or why this cannot be done.

XTAL = 16MHz → Txtal \_clock = 1/ 16 µs

Selecting the prescaler to the maximum value,

Prescaler = 1:1024 → Tcounter\_clock = 1024 × 1/ 16 µs = 64 µs

Counter increments needed = 500,000µs / 64µs =7,812.5 increments

But using timer0 we can only get 256 numbers of increments before the flag bit is set to 1.

Also, we can implement this by using timer1, because it has two bytes allocated for the counter and it can have 65536 increments

Therefore, delay cannot be made 500ms even with the highest prescaler.

Exercise 3:

Find out the highest possible countable time interval using TIMER0, normal mode, and a suitable pre-scalar. Assume XTAL= 16MHz. What is the selected prescaler? What is the highest countable time interval?

XTAL = 16MHz → Txtal \_clock = 1/ 16 µs

Selecting the prescaler to the maximum value,

Prescaler = 1:1024 → Tcounter\_clock = 1024 × 1/ 16 µs = 64 µs

Highest number of clock cycles for timer0 = 256

Highest delay for timer0 = 256 \* 64 µs

= 16.384ms (16384 µs)

-Prescale and the number of clock cycles were taken as their maximum value, since the maximum delay needed to be calculated.

Exercise 4:

Write a program that toggles an LED connected to PB5 pin every second using TIMER1, while at the same time operating a Knight Rider style circuit of 4 LEDs (from Lab 1). For the LED toggle you must use the timer overflow interrupts. For the Knight Rider style circuit, you are allowed use either timer interrupts, polling, software delays or any other method.

XTAL = 16MHz → Txtal \_clock = 1/ 16 µs

Selecting the prescaler to the maximum value,

Prescaler = 1:256 → Tcounter\_clock = 256 × 1/ 16 µs = 16 µs

Counter increments needed = 1,000,000µs / 16µs =62500

Initial counter value = 1+65535 – 62500 = 3036

Exercise 5:

You found out the maximum interval you can implement using TIMER0 in exercise 4. However, by using an 8-bit counter variable and interrupts, you can make this interval much longer. Develop a program to blink an LED with a 100ms interval using TIMER0

XTAL = 16MHz → Txtal \_clock = 1/ 16 µs

Selecting the prescaler to the maximum value,

Prescaler = 1:1024 → Tcounter\_clock = 1024 × 1/ 16 µs = 64 µs

Counter increments needed = 10,000µs / 64µs =156.25 (~156 increments)

Initial counter value = 1+255 – 156 = 100

Exercise 6:

You found out the maximum interval you can implement using TIMER0 in exercise 4. However, by using an 8-bit counter variable and interrupts, you can make this interval much longer. Develop a program to blink an LED with a 100ms interval using TIMER0

XTAL = 16MHz → Txtal \_clock = 1/ 16 µs

Selecting the prescaler to the maximum value,

Prescaler = 1:256 → Tcounter\_clock = 256 × 1/ 16 µs = 16 µs

Counter increments needed = 500,000µs / 16µs =31250

Initial counter value = 1+65535 – 31250 = 34286