Microcontrollers Lab

Week 7 – Timers and Counters Management

April 13th 30th – Due April 27th 2020

In this lab, we will see how to configure and operate the timers and counters of the ARM M0 MCU contained in the KL25Z board. We won't need any extra hardware for this lab, only the board and we will display the results in our board's LEDs.

Part 1. Make use of the SysTick timer to toggle the led in the KL25z board. A counter should be used and its value must be shifted 4 places to the right so that the changes can be slow enough to be visible in the LED of the board (connect the output to the red LED, PTB18)

Part 2. Toggling green LED using SysTick delay. This program should make use of the SysTick to generate one second delay to toggle the green LED. System clock is running at 41.94 MHz. SysTick is configure to count down from 41939 to give a 1 ms delay. For every 1000 delays (1 ms * 1000 = 1 sec), toggle the green LED once. The green LED is connected to PTB19.

Part 3. Toggling blue LED using TPM0 delay (prescaler). This program has to make use of the TPM0 to generate maximal delay to toggle the blue LED. MCGFLLCLK (41.94 MHz) is used as timer counter clock. Prescaler must be set to divide by 128 and the Modulo register to 65,535. The timer counter overflows at 41.94 MHz / 128 / 65,536 = 5.0 Hz. The blue LED is connected to PTD1.

Remember the steps for configuring the counter are

1) enable the clock to TPMx module in SIM_SCGC6,

2) select the clock source for timer counter in SIM_SOPT2,

3) disable timer while the configuration is being modified,

4) set the mode as up-counter timer mode with TPMx_SC register,

5) load TPMx_MOD register with proper value,

6) clear TOF flag,

7) enable timer,

8) wait for TOF flag to go HIGH.

Answer the following questions

(a) Show time delay calculation for the program

(b) calculate the largest delay size without prescaler

(c) Find the TPMx_MOD value to generate a delay of 0.1 second. Use the prescaler of 128.

Part 4. Longer time interval. Toggling blue LED using TPM0 delay. The program must use TPM0 to generate long delay to toggle the blue LED. MCGIRCLK (32.768 kHz) is used as timer counter clock. Prescaler is set to divided by 4 and the Modulo register is set to 40,959. The timer counter overflows at 32,768 Hz / 40,960 / 4 = 0.2 Hz. The blue LED is connected to PTD1.

Requirements for the report

1. Include some research about how the timers and counters operate in the corresponding section. Provide enough detail to demonstrate that you understand the basics and how the concepts relate

2. Include the code for each of the sections in the lab. The code should be commented and the report should include a short description of each function and how it works, including images of the registers that have been configured for enabling the different functionalities in your code.

3. Make some research in how to connect the board to the external components. You can use a virtual program to schematize the connection between the board and the external. An example is Fritzing, but there are others

4. Include some research about possible applications and timers in an application (especially in your final project).