Objectives

- To execute the instructions of Lab 0 (ECE 3710 Lab 0.pdf) from the course wiki*.
- To be introduced and familiar with the functions and capabilities of the following devices via hands-on interfacing and their respective documentation:
  - Tektronix MDO3014 Mixed Domain Oscilloscope
  - Tiva C Series TM4C123GH6PM Microcontroller

Overview

"This lab serves as an introduction to logic analyzers (used for debugging and verification) and provides practice in reading datasheets (the main way engineers become familiar with device components). Proficiency in reading datasheets/technical literature and utilizing the information provided therein is an essential skill for an engineer to possess." (ECE 3710 Lab 0.pdf)

Preparation

- Download device documentation from the course wiki*.
- Obtain the following items from the department lab store:
  - Lab Kit
  - Power Cable Set x 2

* https://spaces.usu.edu/display/ece3710/Home

Procedure

About the TM4C123GH6PM Microcontroller

Sources
- Tiva™ C Series TM4C123GH6PM Microcontroller Data Sheet (MDS)
- Tiva™ C Series TM4C123G LaunchPad Evaluation Board User's Guide (BUG)

1. A memory map is a convenient way to depict the memory addresses of registers and descriptions of registers.
   a. Which section describes Cortex-M4's memory map?
      Section 2.4. Memory Model (pg. 90 – MDS)
   b. What table number indicates the memory map of Cortex-M4 processor?
      Table 2-4. Memory Map (pg. 90 – MDS)
2. Each peripheral has a specific memory address, what is the base memory address of GPIO_A (general input/output port A)?
   0x4000.4000 (pg. 90 – MDS)
3. Each peripheral has a number of registers that control its functionality. For a given peripheral, it's often easier to use the offset of a register with respect to the peripheral base address rather than the absolute address of the register. A peripheral's registers and their associated offsets are usually summarized in a register map.

   a. Which section describes the General-Purpose Input / Output (GPIO) register map?
      Section 10.4. Register Map (pg. 656 – MDS)
   b. What is the table number for the GPIO register map?
      Table 10-6. GPIO Register Map (pg. 657 – MDS)
4. The register map table in the TI documentation contains the name, offset, and description of a register. Which register corresponds to the direction of a GPIO port? Write down the name of this register, its memory offset, and the absolute address for port A of this register.
   GPIODIR – 0x400 – 0x4000.4400 (pg. 660 – MDS)
5. Click the page number of the GPIODIR register on the register map table.
   a. What binary value corresponds to an output?
      1 (pg. 660 – MDS)
   b. If pins 0, 4, and 7 were inputs, but the rest were outputs, what would the state of this register (in binary values)?
      01101110 (pg. 660 – MDS)
   c. What would be the state of this register using hexadecimal values?
      6E
6. Which timer is located at memory address 0x4003.2000?
   16/32-bit Timer 2 (pg. 91 – MDS)
7. Find the register map for General Purpose Timers. Which register is located at offset 0x068? Provide a brief description of this register.
   GPTM Timer B Prescale Value (GPTMTBPV) - For the 32/64-bit Wide GPTM, this register shows the current free-running value of the Timer B prescaler in the 32-bit modes. (pg. 769 – MDS)
8. On this board, a few pins are wired together. Record the pins that are wired together. (Hint: look in the Tiva™ C Series TM4C123G LaunchPad Evaluation Board User's Guide Schematic found on the Lab Supplements page)
   PF2 and PF3 - Table 2-2. User Switches and RGB Signals (pg. 9 – BUG)

Introduction to the MDO3014 Mixed Domain Oscilloscope

Sources
- MDO3000 Series Mixed Domain Oscilloscopes User Manual (OUM)

1. Name three potential uses for the logic analyzer.
   1. Interfacing
   2. Testing
   3. Debugging
2. A properly configured trigger will remove guesswork and chance from capturing the output behavior of a signal.
   a. Write down how you would configure the trigger to capture on a falling edge.
   b. Write down how you would configure the trigger to capture on a rising edge.
      1. Push Trigger **Menu**.
      2. Push **Type** to bring up the **Trigger Type** side menu.
      3. Turn **Multipurpose a** to select the desired trigger type.
      4. Select **Edge**.
      5. Complete the trigger setup using the lower menu controls displayed for the trigger type.
         a. Set the **Source** to the appropriate pin(s) on the **Logic Probe** to be observed.
         b. Set the **Coupling**.
         c. Set the **Slope** to either a **Falling** or **Rising** Edge.
         d. Set the **Level**.

      (pg. 90 – OUM)

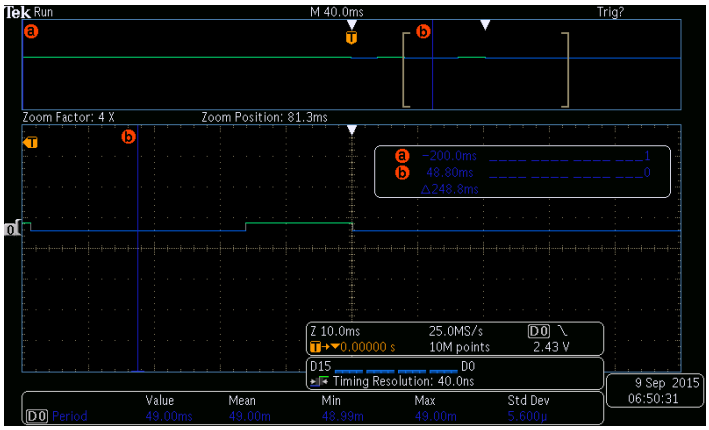
3. How do you change the sample period of the logic analyzer?
   a. Change the sample period to 200 ns.
      Turn **Horizontal Scale** knob CW to 200 ns.

Set Up the Board

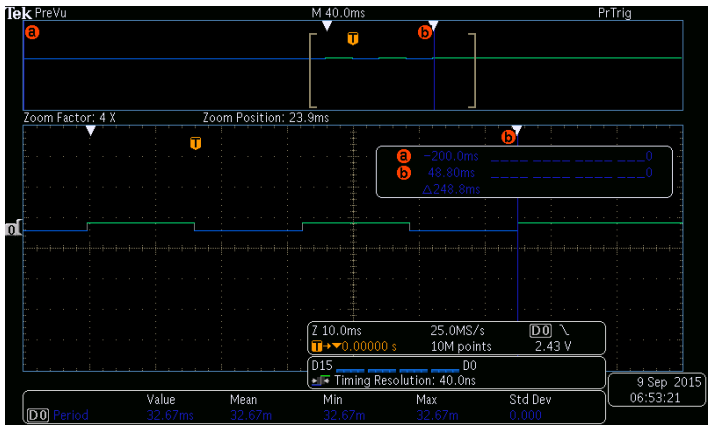
After completing the board setup by flashing the Blinky program to the board (steps A through G – ECE 3710 Lab 0.pdf), what is the program doing? Press SW1 and observe the behavior of the microcontroller. Now press SW2 and observe. Estimate the rate at which the lights are flashing.

After reset, we see that light D1 is off. Then only after pressing SW1 followed by SW2 will D1 turn on. When pressing S1 next, the light D1 goes off again. The estimated rate of flashing is 10 Hz.

Use the logic analyzer and triggers to measure the rate of the flashing light (steps 1 through 4 – ECE 3710 Lab 0.pdf). Record the amount of time between flicker states.



SW1
$\downarrow_1$ to $\uparrow_1$ = 15.47 ms
$\downarrow_2$ to $\uparrow_2$ = 32.67 ms
$\downarrow_I$ to $\downarrow_F$ = **81.30 ms**



SW2
$\uparrow_1$ to $\downarrow_1$ = 16.16 ms
$\uparrow_2$ to $\downarrow_2$ = 16.16 ms
$\uparrow_I$ to $\uparrow_F$ = **64.78 ms**

Using the Analog Comparator of the TM4C123GH6PM Microcontroller

1. Open the Comparator project.
2. The project contains code which will turn on a light when the voltage on analog comparator C1- (found in Table 19-1) rises above a certain level. What are the pin assignments for this configuration?
   Pin Mux / Pin Assignment = PC4 (pg. 1211)
3. Chapter 19 gives information about the configuration of this peripheral. Which register stores the information about internal reference?
   ACREFCTL (pg. 1212)
4. Use the system viewer to **Select Peripherals** → **System Viewer** → **COMP** to show the analog comparator registers. Run the program and observe the configuration of the register found in step 3.

5. Using the information from the above register, determine the RNG value and the VREF value. Finally, determine the actual internal voltage reference which will activate the light.
   ACREFCTL = 0x0000037 RNG = ☑ VREF = 0x07
   V_{IREF} Min = 0.971 Ideal V_{IREF} = 1.044 V_{IREF} Max = 1.118 Unit = V (pg. 1213 – MDS Table 19-4)
6. Test your answer with a voltage source. To avoid damage to your board, start the voltage at 0.
   The light D1 begins to turn on at 1.104 V and achieves full brightness at 1.109 V.

Commentary

- Lab 0 was completed with only marginal complications insufficient for me to document or provide ample commentary for.
- From **Procedure** → **About the TM4C123GH6PM Microcontroller** → 8, it is not readily apparent to me how it was derived that the noted pins I submitted for my response are considered wired together. When looking through the Schematics section or searching the relevant keywords of the source documentation, it is not readily apparent how the reader is suppose to determine when pins are wired together. My response is simply given based on the word of the lab TA.
- When plugging the microcontroller into the USB ports of lab's desktop computers, it has been found that only the USB ports located at the back end of the desktop chassis will allow the Keil uVision software to recognize the microcontroller.