EECS 3215 – Lab B: More on FPGAs in Embedded Systems

Dr. James Andrew Smith, PEng

Summary: How do we measure time on an embedded system?

Pre-Lab: Have a quick look at

- http://www.johnloomis.org/digitallab/diglab/diglab3/diglab3.html and
- http://www.johnloomis.org/digitallab/diglab/diglab1/DE2-Mechanics.html

Intro

With few exceptions, it's important for an embedded system to be able to

- Measure Time
- Report Time

How accurately and to what precision is entirely dependent on the requirements of the application and the hardware and software that govern the embedded system.

We will be using the excellent lab tutorial written by John Loomis as the basis for this lab with the Altera DE2 FPGA board.

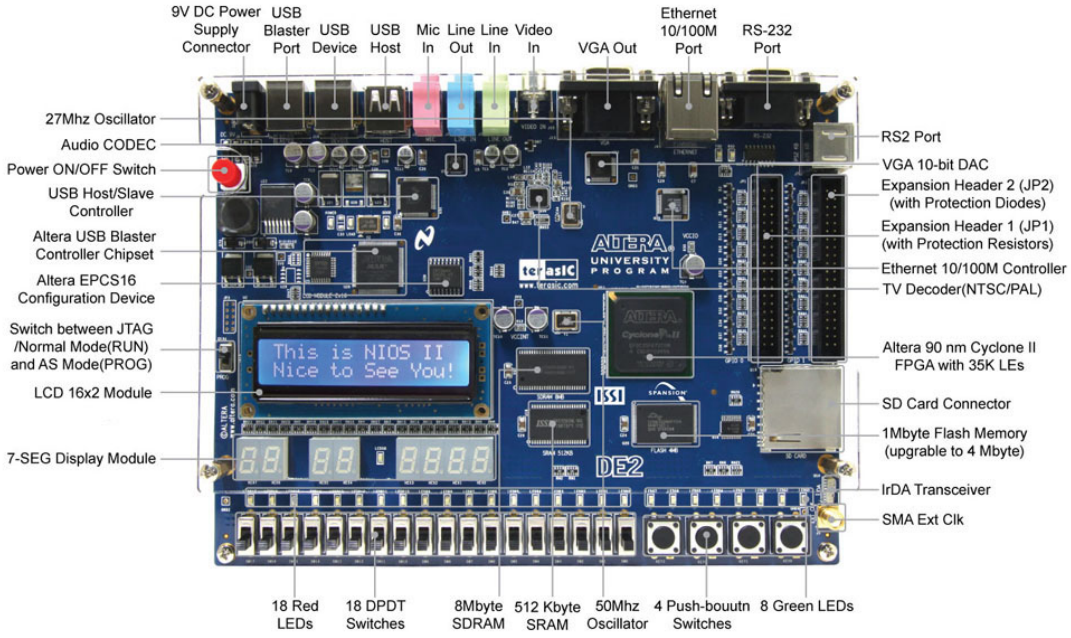

Figure 1 The Intel/Altera DE2 FPGA board. (c/o https://www.terasic.com.tw/attachment/archive/30/image/image_58_thumb.jpg)

Due date for Lab Report. No report. Just demos in the lab.

Marking Guide:

Positive Marks		Possible	Actual	
	Demo 1	3		1.5 marks if partly working, 0 if not working or not attempted.
	Demo 2	3		1.5 marks if partly working, 0 if not working or not attempted.
	Demo 3	4		2 marks if partly working, 0 if not working or not attempted.
Deductions				
	You missed the lab / were significantly late or left significantly early	-10		
		Final mark		out of 10

Lab Instructions

Part 1: Partner-up

We will be setting up partner groups for the labs in the first few weeks of the course. Choose a partner for the lab (before or during the lab). Get contact information (email, etc.) and make sure to get their "official" York naming information, as that is what is looked for during grading of reports, etc. We'll use the names on the report PDFs to set up the groups on Moodle.

Part 2: Modify Seven Segment LEDs on the DE2 board

Go to John Loomis' website and read over Digital Lab 3 for the DE2 board (http://www.johnloomis.org/digitallab/diglab/diglab3/diglab3.html) Follow the instructions for setting up the project using Quartus II on the Windows computers in the Lab.

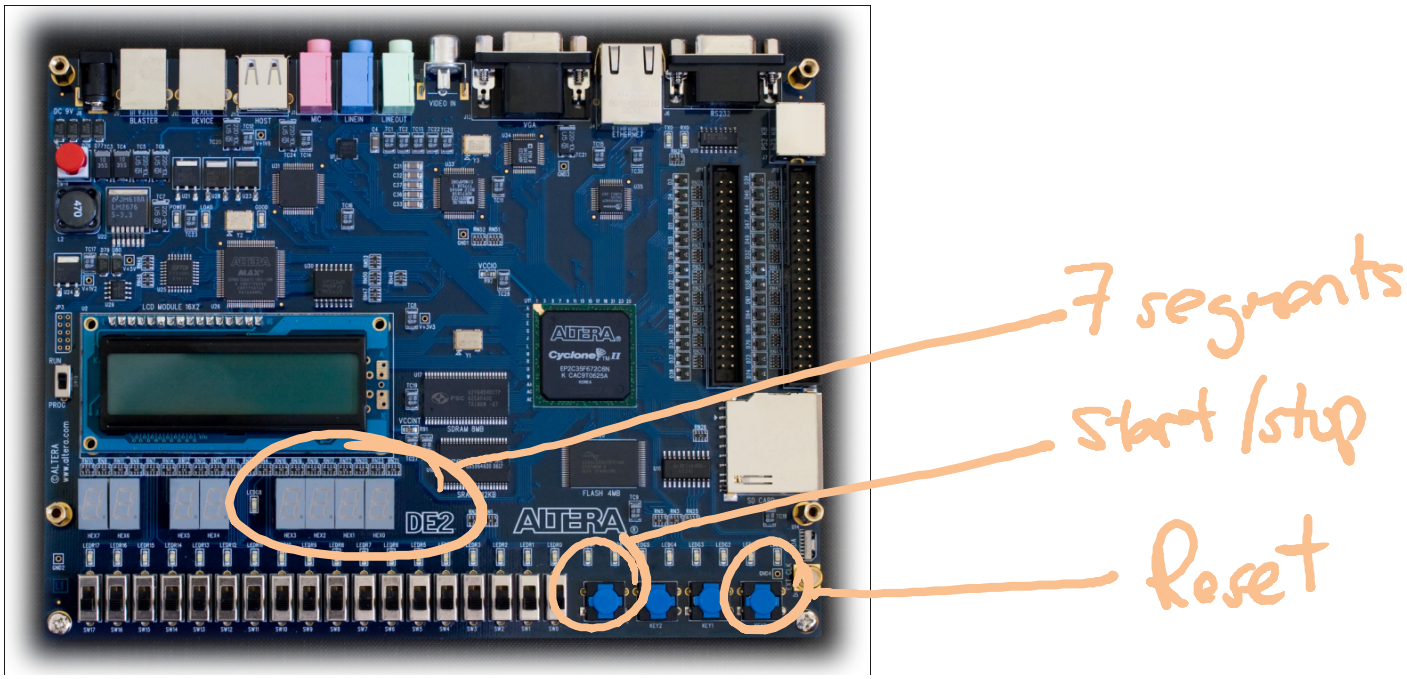

Figure 2 The Intel/Altera DE2 board. This lab focuses on the switches and 7 segment LEDs at the bottom of the board. (image c/o https://www.cl.cam.ac.uk/teaching/1011/ECAD+Arch/images/DE2-large.PNG)

Once you load the files, compile and download the executable to the DE2 board you'll be able to set the switches at the bottom of the board to modify the digital segment display, also at the bottom of the screen.

Hints

- Make sure to import all the verilog (.v) files
- Import the .CSV pin mapping file (or the .QSF alternative from Lab A)
- Compile the Verilog model via the Processing menu in Quartus.
- Make sure to select the USB Blaster option in the Programming menu. Don't forget to press the "Start" button on the screen, either.
- If you are having trouble importing the .CSV pin map file, then import the .QSF file from Lab A.
- If you are having trouble setting up, compiling or downloading to the board, review the instructions at http://www.johnloomis.org/digitallab/diglab/diglab1/DE2-Mechanics.html

Note that the 7-segment LEDs are each set to count from 0 to 9. The right-most 7-segment runs at $1/100^{th}$ of a second. The next one runs at $1/10^{th}$ of a second, and so on.

While there are no specific activities listed in Loomis' Lab 3, please do the following **activities**:

0. **Verify the update rate on the 7-segment displays.** The right-most 7-segment should be updating at a rate of 100 Hz (1/100th of a second period), while the second-from-the-left should be updating at 1 Hz (once per second). An easy way to verify is to use a stop-watch on your wristwatch or cell phone and start both the DE2 and your timer at the same time and run them for 60 seconds. You should be able to verify the time to an accuracy of less than 1%. You don't need to show the TA this. This is a simple check that your embedded system is working as planned.

1. Change (a) the pushbutton key for starting-up and stopping the timer and (b) the pushbutton for resetting the timer. *(Hint: take a look at the KEY keywords in diglab3.v)*
   - Lab 1 & 5: Blue Key 1 for start/stop Blue Key 3 for reset
   - Lab 2: Blue Key 2 for start/stop Blue Key 0 for reset
   - Lab 3: Blue Key 0 for start/stop Blue Key 1 for reset
   - Lab 4: Blue Key 1 for start/stop Blue Key 2 for reset

   Demo this to the **TA**.

2. Change the frequency of the rightmost 7 segment LED. This will also change the update rate of the other 7-segments that are attached to it.
   - Lab 1 & 5: Rightmost 7-segment should run at 1/1000th of a second. The leftmost will run at 1 second.
   - Lab 2: Rightmost 7-segment should run at 1/10000th of a second. The leftmost will run at 1/10th of a second as a result.
   - Lab 3: Rightmost 7-segment should run at 1/10th of a second. As a result the leftmost will update every 100 seconds.
   - Lab 4: Rightmost 7-segment at 1 second update rate. As a result the leftmost will update every 1000 seconds.

   Demo this to the **TA**.

3. Finally, do the following:
   - Lab 1 & 5: Start the counter at 9999. Count down (i.e. "decrement") from 9999 to 0000 in steps of 1.
   - Lab 2: Reverse the order of the four 7-segment displays. Count as normal, but this time the really fast update is happening on the leftmost 7-segment and the slower update is happening on the rightmost 7-segment.
   - Lab 3. Count in 2's at the default update rate. Each 7-segment should go 0, 2, 4, 6, 8, 0, 2,…
   - Lab 4: Count in Base 16 (i.e. "hex": 0, 1, 2, 3,…, D, E, F, …) on all four 7-segments at the default update rate.

   Demo this to the **TA**.

Writing a Report

No report this week. Just demo, live, in the lab.