

EECS 3215 – Lab A: Intro to Embedded Systems (FPGA)

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Summary: Check out how a simple embedded system works.

Pre-Lab: Have a quick look at

1. How to generally program the DE2 FPGA board using the Quartus II software
 - <http://www.johnloomis.org/digitallab/diglab/diglab1/DE2-Mechanics.html>
2. How to program the board to specifically make the 7-segment displays change values
 - <http://www.johnloomis.org/digitallab/diglab/diglab1/diglab1.html>

Intro

Embedded systems come in all shapes and sizes. Some are controlled by Field Programmable Gate Array chips, like the Intel/Altera Cyclone II found on the DE2 evaluation board used in this lab.

In this lab you will execute a **sample Verilog project on the DE2 board**. The Verilog code connects the black toggle switches (aka DPTD or DIP) at the bottom of the board to the individual segments in the red “7 segment LED” display on the board. The “KEY3” pushbutton near the bottom right of the board is also used to confirm changes to the toggle switches prior to executing the changes to the 7-segment display.

Why are we doing this? Because the components used in this lab are basic building blocks for embedded systems. We don’t need to know the details of how they work, yet, but it’s important for you to have a hands-on feeling for **how they behave in real life**. In this semester we will learn how about the LEDs inside the 7-segment blocks work, why we use particular switches and design decisions related to using FPGAs (like the Cyclone II here) versus microcontrollers like the NXP KL43 you may have previously encountered or the LPC802 that you will use in a couple of weeks.

For now, explore the process from a high-level perspective and get the 7-segment to light up!

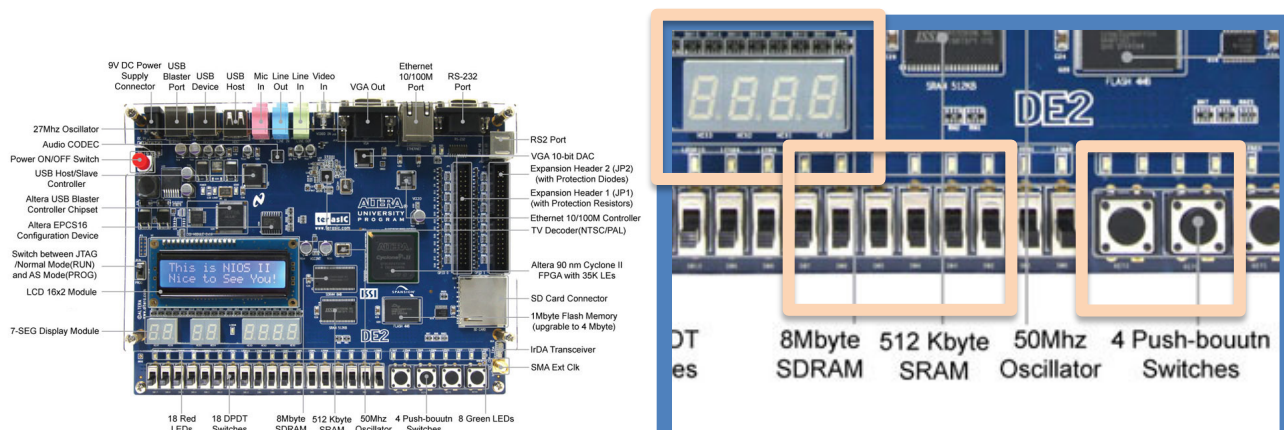


Figure 1 The Intel/Altera DE2 FPGA board (left) and a closeup on the four digit 7-segment display, the switches and the pushbutton you'll be using in this lab. (image c/o https://www.terasic.com.tw/attachment/archive/30/image/image_58_thumb.jpg)

Due date for Lab Report. The reports are all **due** on Monday, January 20 at 11:55pm. Submit two reports (identical PDF to each student account) to moodle.yorku.ca.

There is no lab report.

Just do the demo and Lab 0.

Marking Guide:

Positive Marks				
	Demo of 7-seg values		+8	8 if all correct. 4 if partially correct. 0 if nothing right. Each partner is responsible for their own demo.
	Lab 0		+2	Did it (2). Didn't do it (0)
Negative Marks				
	Partner did the work for you		-10	Practice! It's important. Don't let your partner hog the machine.
	Missed lab		-10	
Total			/10	

If one partner doesn't do the Lab 0 or is late it only affects the grade for that specific partner.

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.

Part 2: Modify Seven Segment LEDs on the DE2 board

Go over the instructions on the John Loomis website for basic programming of the DE2 FPGA board. Note that you need to reboot the lab computers into Windows (log in the Linux first, then search for Windows by pressing the Windows keyboard icon, then typing in Windows). Log in and fire up Quartus.

Go over the basic programming guide for Quartus:

- <http://www.johnloomis.org/digitallab/diglab/diglab1/DE2-Mechanics.html>

When setting up a new project, note that the big Cyclone II chip's identification info will be required to set up the project properly. Make sure to select:

1. The "Cyclone II" family of chips
2. The specific "EP2C35F672C6" device (475 user I/Os, 483840 memory bits)

Go to John Loomis' website and read over Digital Lab 1 for the DE2 board

(<http://www.johnloomis.org/digitallab/diglab/diglab1/diglab1.html>). Follow the instructions for setting up the project using Quartus II on the Windows computers in the Lab (*it's a free download from Intel/Altera, so you can use your own Windows computer if you wish*).

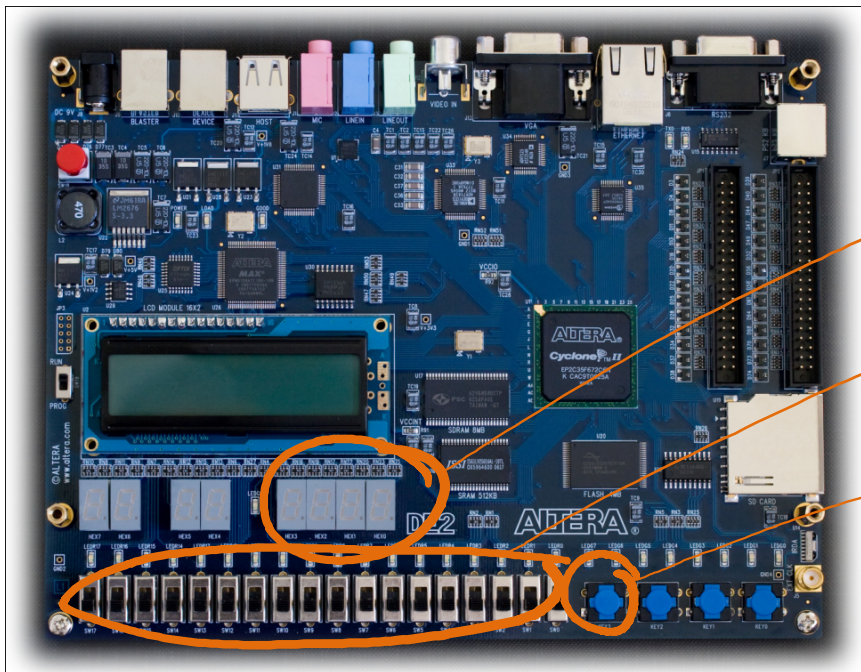


Figure 2 The Intel/Altera DE2 board. This lab focuses on the switches and 7 segment LEDs at the bottom of the board. (image c/o <https://www.cl.cam.ac.uk/teaching/1011/ECAD+Arch/images/DE2-large.PNG>)

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:

- The project in Quartus II (version 12, web edition) has to be called **diglab1**
- Import the **project** files:
 - This is the "Setup project" step on Loomis' Mechanics of Altera DE2 page.

- When importing files into Quartus II make sure to import John Loomis' "hex_7seg.v" and "diglab1.v" Verilog files
- You don't need to import the DE2_default.v file from John Loomis' site.
- Import the device **mapping** file
 - This is the "Import Assignments" step on Loomis' Mechanics of Altera DE2 page.
 - While you could import Loomis' .csv file for mapping all the parts on the DE2 board, it's better if you use the QSF file from the 3215 Moodle page.
- 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>

Once your project files are imported and you've got a good mapping file installed, then you need to

- Compile the project files
 - This is the "Compile Project" step on Loomis' Mechanics of Altera DE2 page.
- Download the compiled file on to the board.
 - This is the "Program the DE2 Board" step on Loomis' page.
 - Ensure your USB cable connects to the "Blaster"-labelled port
 - Ensure that you have plugged the power jack into the wall outlet and pressed the red power button (LEDs will light up)
 - Make sure that the Tools-Programmer window shows the "USB-Blaster" is identified. If not, use "Hardware Setup"
 - Make sure to load the diglab1's ".sof" file into the "File" portion of the Tools-Programmer window.
 - Click on the Program/Configure checkbox.
 - Click on the Start button... and it should program the board.

Rather than do the activities listed at the end of the Loomis lab, do the following:

By changing the toggle / DIP switches and then pressing the KEY3 pushbutton, make the four-digit, 7-segment display write out the **last four digits of your student ID** (for each lab partner).

Having trouble figuring out which switch does what? Set them all to the "down" position (closest to you). They are all now set to "logic zero." Then move SW0, SW4, SW8 and SW12 to the "up" position. These are now set to "logic one." Press the KEY3 button to enter these values. What values appear on the four digit 7-segment display? Change SW1 to "up". Press KEY3. What happened? Try it some more.

Show the TA. The TA will record your accomplishment.

There is no lab report. Just the demo.