# Programming and Testing the Altera DE2 Board

**PRELAB!**

**Read** the entire lab, and **complete** the prelab questions (Q1-Q2) on the answer sheet **before** coming to the laboratory.

## 1.0 Objectives

The main objective of this lab is to gain more experience in programming the Altera DE2 board. We will design a circuit to control several 7-segment displays that will display an input value based on the position of a group of toggle switches. Then we will test each possible input and observe the output.

## 2.0 Setup

Begin by creating a new folder **/home/*username*/CPRE281/Lab05**, and then two sub-folders **/Lab05/lab5step0** and **/Lab05/lab5step1**. You will be saving your work for this lab in these directories.

Information about the DE2 board, such as hardware device pin assignments, can be found in the user's manual provided with the Lab05 files, or at the following address: ftp://ftp.altera.com/up/pub/Webdocs/DE2_UserManual.pdf. A picture of the DE2 board has also been provided with the Lab05 files.

## 3.0 The 7-segment Display (lab5step0)

Start a new project, in the *lab5step0* folder, and name it **seven_seg_decoder. Do not click on the Finish button.** As you have done in previous labs, ensure that you assign the proper Cyclone II device **EP2C35F672C6**. Then click **Finish**.
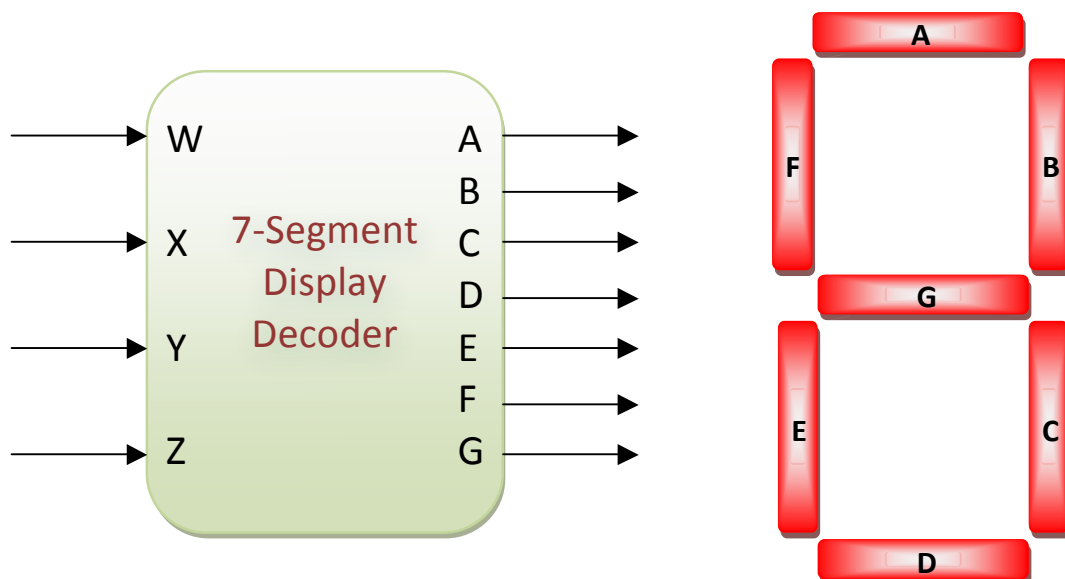


**Figure 1: 7-Segment Display Decoder**

A 7-segment display is shown in **Figure 1**. The decoder provides the outputs A-G needed to light the proper segments of the 7-segment display based on a 4-bit input.

**IMPORTANT:**
Note that the LED's of the 7-segment display are lit when there is a logic 0 instead of a logic 1 connected to them**.**

Create the decoder in Verilog. Your inputs {Z, Y, X, W} represent a hexadecimal value (W is the LSB). Your outputs are {A, B, C, D, E, F, G}. Review previous lab instructions if needed for Verilog code. Name your Verilog module **seven_seg_decoder** (same as your project name). The choice of Verilog coding method is left to you.

Compile your code and fix any errors. Then assign toggle switches SW3, SW2, SW1, and SW0 as your input devices. Assign HEX4 as your output device. Program the DE2 board with your design and demonstrate it to your TA for all values from 0 to F on the 7-segment display.

## 4.0 Creating Symbols - Design for Reuse (lab5step1)
You have designed a circuit to display hexadecimal values on single 7-segment display. Now you will need to create a circuit that will control four 7-segment displays each with its own set of toggle switches for input. In order to do this it would be nice to be able to utilize your existing design, and just duplicate it four times. This can be done by simply turning your **seven_seg_decoder** design into a symbol that can be used (and reused) in a schematic (or block diagram).

While still in your *seven_seg_decoder* project select the **seven_seg_decoder.v** tab to view your Verilog code. Then click **Processing->Analyze Current File**. Select the **seven_seg_decoder.v** tab again to view your Verilog code. Click **File->Create / Update->Create Symbol Files for Current File**. When successful, you have created a symbol that you can use again.

**Using Custom Symbols:**
- Navigate to your *lab5step0* folder and copy the **seven_seg_decoder.bsf** and **seven_seg_decoder.v** files to your *lab5step1* folder.
- Create a new project in the *lab5step1* folder and name it *lab5step1*.
- Create a new block diagram and save it as *lab5step1.bdf*.
- Click on the **Symbol Tool** in the upper toolbar. Notice that there is a **Project** directory under '*Libraries:*', and your new symbol is now available for use.
- Place 4 instances of the **seven_seg_decoder** symbol.

Finally, create input and output pins and assign the appropriate FPGA pins so that Hex7 Hex6, Hex5, and Hex4 are each controlled by their own set of 4 toggle switches. For Hex7 use SW17 down to SW14, for Hex6 use SW13 down to SW10, for Hex 5 use SW9 down to SW6, and for Hex4 use SW5 down to SW2.

Verify your circuit on the DE2 board and show your results to the TA.

## 5.0 Complete

You are done with this lab. Ensure that all lab files are closed, exit Quartus II, log off the computer, and hand in your answer sheet. **Don't forget to write down your name, student ID, and your lab section number**.