EECS 3201 :: Lab 2
Seven-Segment Decoder

Demonstration: Labs must be demonstrated during labs period no later than the week of Oct 5-9. You may also demonstrate on the week of Sep 28-Oct 2 (as long as the TA agrees).

Note: The TAs will be extremely busy towards the end of the lab. You are **strongly advised** to prepare as much as possible in advance, work efficiently in the lab, and to demonstrate as early as possible. **Leaving the demonstration to the last minute is at your own risk.**

Overview

In this lab you will implement a seven-segment decoder and connect it to a seven-segment display on the DE10-lite board.

You may work in groups of **at most two**. Working by yourself is OK if there is enough equipment. Groups of three or larger are **not allowed.** There is no need to stay with the same lab partner as in previous labs, but you can if you want to.

To make the best use of your time in the lab, you should do some preparatory work before your lab period. See below under "preparatory work".

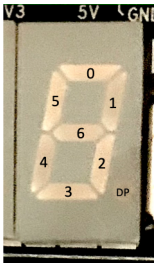
Scoring:

- This lab is scored out of 5 marks.
    - *Demonstration:* Once done, you will demonstrate your work to the TA. Correctly demonstrating the result is worth 3 marks. If you can't get the design to work, you can still demonstrate, but you will lose marks. *You will get a grade of zero if you don't demonstrate anything by the end of the lab period.*
    - *Question:* The TA will ask **each** group member a question, for example to modify the circuit. Correctly answering the question is worth 2 marks.
- It is possible for group members to receive different grades, for example, different grades can be received on the question.

Value:

- This lab is worth 2/10 of your total lab score and 2% of your final grade.

Seven-segment displays and decoders



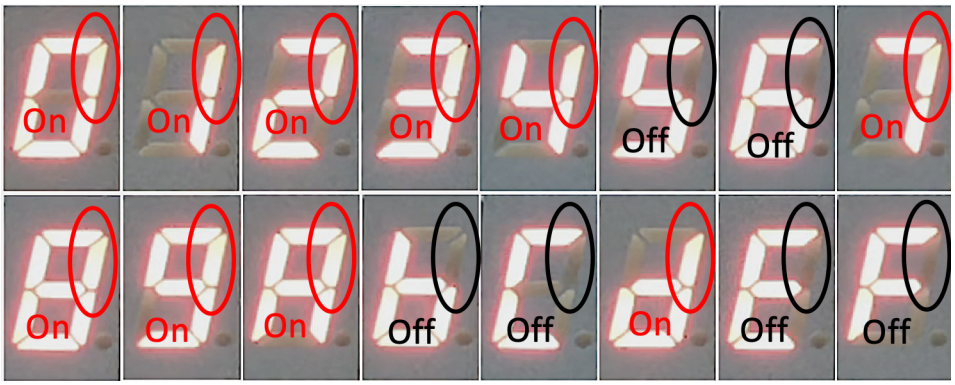
The above figure depicts a seven-segment display on the DE10-Lite, with seven LEDs (numbered 0, 1, …, 6), as well as a decimal point (DP). The LEDs can be illuminated to depict any hexadecimal number in 0,1,…,9,A,…,F. These numbers are shown below.



Each LED in the display has an associated binary function:

- The **input** to the function is a four-bit binary number, representing the hexadecimal digit 0 through F. For example, 0000 = 0, 0011 = 3, 0101 = 5, 1101 = D, etc.

- The **output** of the function represents the illumination state of the LED. For example, consider the upper right LED in the display (the LED numbered 1 in the top figure): this LED is on for digits 0, 1, 2, 3, 4, 7, 8, 9, A, and D, and off for digits 5, 6, B, C, E, and F. As an illustration of this example, see the figure below.



*An **important fact** about the **seven-segment displays** DE10-Lite board:*

*Logic 0 = LED **on**, and logic 1 = LED **off***

***It is the opposite for the plain LEDs** on the board, which are on for logic 1 and off for logic 0. Confusing!*

So, the function for the upper-right LED can be described on a truth table, with output 0 for the digits where it is on, and output 1 for the digits where it is off. You will need to do this for each of the 7 LEDs, designing a binary function so that the LED is on or off for each digit.

Preparatory work (you should do this before the lab period):

- Write a truth table for each of the seven LEDs in the seven-segment display.
- Generate a Boolean function for each LED using either the minterm or maxterm method, whichever you prefer.
- Write a Verilog module implementing this set of functions. You can use the Verilog module from Lab 1 as a template. The difference is that we now have four inputs and seven outputs; for each output, you can use an **assign** statement to assign the output to its function. (Note: Here is a useful Verilog tutorial: https://wiki.eecs.yorku.ca/course_archive/2013-14/F/3201/_media/verilog-tutorial_harvard.pdf)
- Have your module take one input and one output, where both input and output are defined as multi-bit buses.
- Compile your module in Quartus and correct any errors.

In the lab:

- Compile, assign pins, and upload your program to the board. (It is up to you which switches and display to use on the board. Pin labels are given in the DE10-Lite user manual.)
- Check for errors and fix them.
- Once you are happy with your design, demonstrate it to the TA. The TA may ask to see your Verilog module, and will also ask each group member a question about your design.