ECE-255 Project #2

Objective: Learn how to program the FPGA using VHDL.

1. Design and implement a 4-bit comparator using VHDL and the BASYS boards. The inputs are the 8 switches on the board. The outputs are the three rightmost LEDs. Specifically,

   a. The first 4 switches will be $A = a_3 a_2 a_1 a_0$ and the right 4 will be $B = b_3 b_2 b_1 b_0$

   b. The left LED goes on when $A > B$, the middle LED goes on when $A = B$, and the right LED goes on when $A < B$

   c. The inputs are unsigned numbers.

   d. You must design the circuit from basic AND, OR, and NOT gates. You may not use an adder.

2. Implement a BCD-to-7-segment display code converter. The inputs will be the first 4 switches and the outputs will be the 7 segment LEDS.

   Potential Problem:

   a) A student who has completed this part of the lab noted the followng problem: "when I do the pin out assignments,the 7 segment displays are wrong on the card that Digilent gives you . On the card it says the 4 displays from left to right are AN3, AN2, AN1 AND AN0 with the pinouts being P34, P26, P32, AND P33, respectively. I found (at least with my board, don't know if its just a defect in mine) that the pinouts are shifted by 1: P26, P32, P33, AND P34."

   b) On some of your boards a 0 signal will cause the LED segments to light up, rather than a 1 signal. I suspect there is a configuration parameter that controls which signal lights up the LED segments. Rather than trying to figure out how to set this configuration parameter, simply invert your logic if your board's LEDs light up on a 0 signal.

3. Your documentation should include the following:

   a. VHDL code

   b. Circuit schematic showing switches, LED connections, etc. Specifically I would like to see the following schematics:

      i. A detailed AND/OR/NOT circuit for the a and b segments of the BCD-to-7-segment display code converter. It is not necessary to show me the detailed circuits for the c-g segments.

      ii. A detailed AND/OR/NOT circuit for the comparator circuit.

      iii. A black box schematic for the BCD and comparator circuits showing black boxes for the circuits and the switches and LED connections as inputs and outputs.

      For the detailed schematics you can simply label the inputs and outputs with descriptive names rather than showing the switches or LED connections. For example, you can label the LED outputs for the BCD circuit as a and b and you can label the inputs for the comparator circuit as *a3, a2, a1, a0, b3, b2, b1, b0*.

   c. Truth table**:** For the comparator, it is not necessary to show me all 256 entries for the truth table. Instead use the "x" wildcard character to minimize the number of entries in your truth table. For example:

   let y0 be A=B, y1 be A < B, and y2 be A > B

a3	a2	a1	a0	b3	b2	b1	b0	y2	y1	y0
....										
1	x	x	x	0	x	x	x	1	0	0

This line of the truth table shows that whenever the high order bit of A is 1 and the high order bit of B is 0, then A > B. If you judiciously use the "x" wildcard, your truth tables will be manageable.

d. Operation verified by the instructor or TA.