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2350 Project 1 Report:

Problem statement:

The problem was to create a design meeting the specifications of the project. The specifications are as follows, switch 10 is down, have the seven segment display show one of our birthdays, when Key 1 is pressed, switch to the other partner's birthday. While switch 10 is still down the LEDs above the rightmost 8 switches will be on when the respective switch is down. If Key 0 is pressed, the state of the LEDs is flipped. If switch 10 is up, then the design goes into mode 2, where the 8 rightmost switches are split into groups of 4 and they are used to represent a 4 bit binary value. These values are compared with the hex display showing one number on the left and one number on the right. If the left is greater, then the middle is left blank, if it is less than, a L is displayed between the numbers, if they are equal, an E is displayed in the middle.

Theory of operation:

The project consists of four modules that were designed to do this task. The top level module, integratedProj.v, consists of a multiplexer to switch between the outputs of the two design units. The two design units are instantiated in the top level and switch 10 switches between either output depending on its state. The multiplexer is created using an always block checking the switches state, and a series of if then else statements to assign the design unit outputs to intermediate values that will then be assigned to the LEDs and Seven segment displays.

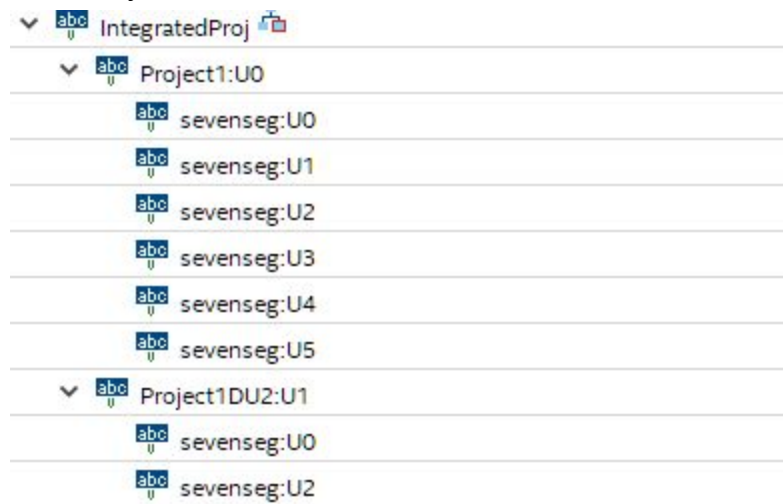
Going lower into project1.v. we get to our first module which outputs are used if switch 10 is down. This module will output an on signal for the eight rightmost LEDs if their respective switch is down, and an off signal if up. Pressing KEY0 will flip the LED outputs. Values for our birthdays are defined in the module, the module instantiates sevenseg.v to decode the birthdays into values to be sent to the seven segment displays, which will be explained later. By default it will use my birthday, but when KEY1 is pressed down, it will use my partners, Matt King, birthday.

In the other design unit, project1DU2.v, two four bit values are compared and the result of the comparison is to be shown on the segment display. DU2's outputs are displayed when switch 10 is up. Switches 1-9 are split into two groups of four and are used to represent the 4 bit binary values. The left value is displayed on the leftmost seven segment display, the right value is displayed on the second rightmost display, and depending on the result of the comparison, an L is displayed between both numbers for less than, an E for equal, and blank for greater than. The three rightmost

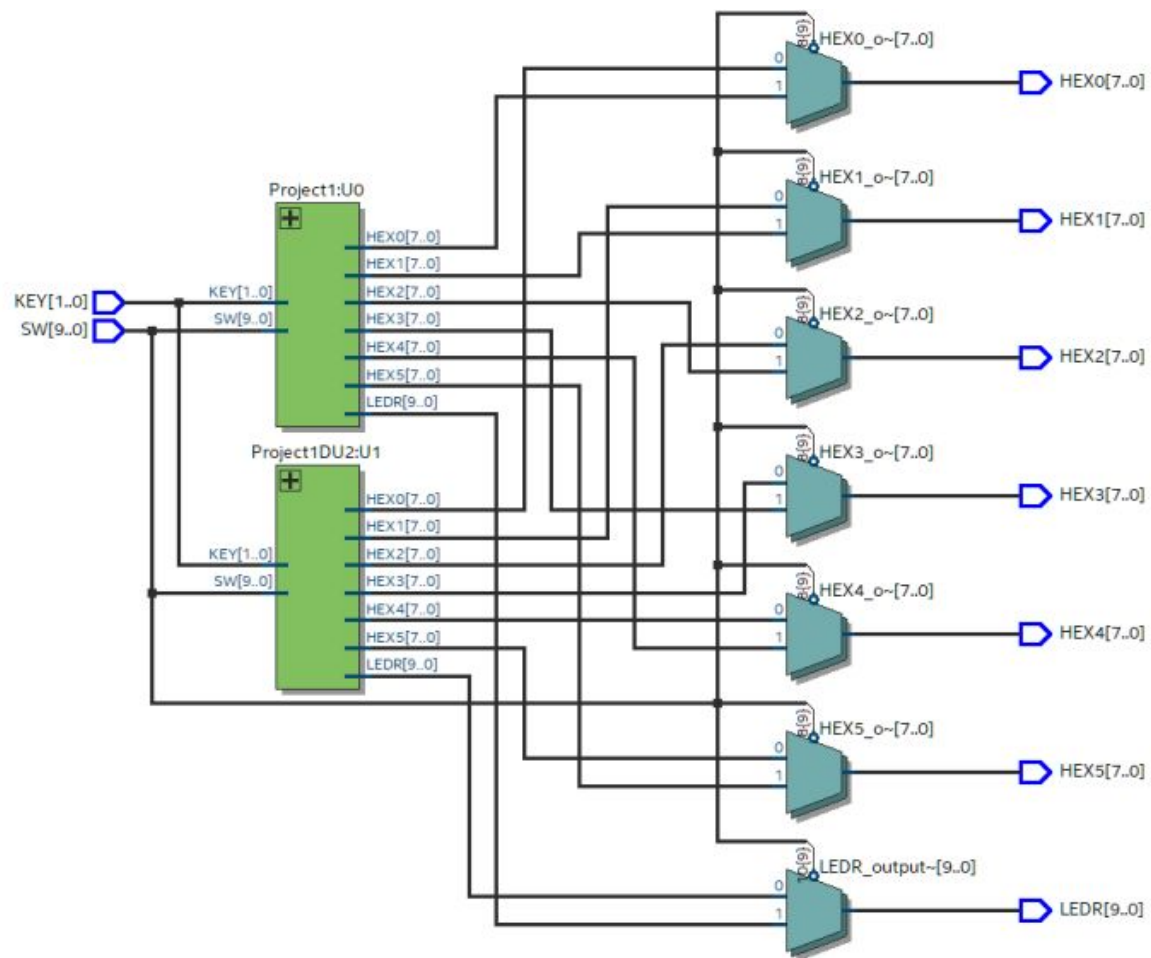
LEDs will also represent the result of the comparison, the left of the 3 being on means less than, the middle meaning equal, and the rightmost being greater than.

Sevensseg.v is our final module, this module takes in a 4 bit binary number and turns it into an 8 bit representation that can be sent to the seven segment displays in order to display the HEX value for the 4 bit number.

Hierarchy:



Block Diagram:



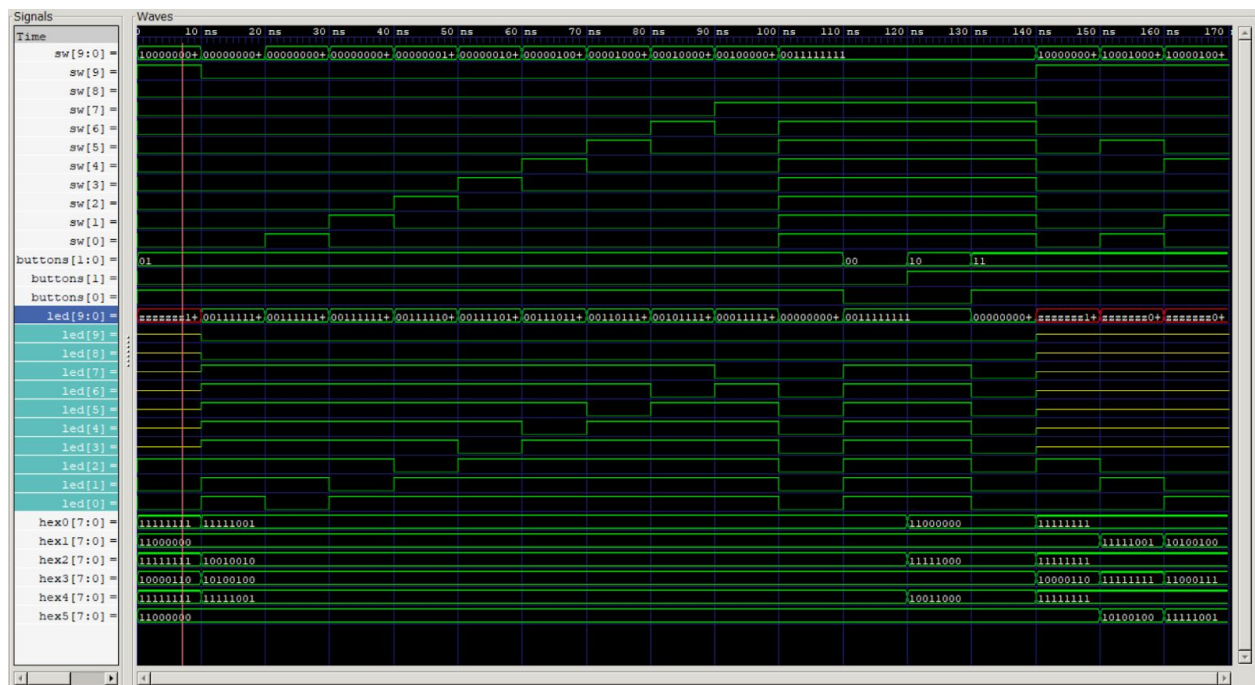
Description of Testbench operation:

The testbench instantiates IntegratedProj and first testing DU1 by flipping switch 10 to 0, going through each switch separately to test the LEDs, lastly turning both keys to 0 to test both the LED inverting and birthday switching. Then testing DU2 by setting switch 10 to 1, it tests three cases, one where the result is equal, one less, and one greater and displays the outputs using a monitor statement.

Terminal Output:

```
PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL 1: powershell
VCD info: dumpfile output.vcd opened for output.
0 SW = 1000000000, buttons = 01, leds = zzzzzzz100, Hex0 = 11111111, Hex1 = 11000000, Hex2 = 11111111, Hex3 = 10000110, Hex4 = 11111111, Hex5 = 11
000000
10 SW = 0000000000, buttons = 01, leds = 0011111111, Hex0 = 11111001, Hex1 = 11000000, Hex2 = 10010010, Hex3 = 10100100, Hex4 = 11111001, Hex5 = 11
000000
20 SW = 0000000001, buttons = 01, leds = 0011111110, Hex0 = 11111001, Hex1 = 11000000, Hex2 = 10010010, Hex3 = 10100100, Hex4 = 11111001, Hex5 = 11
000000
30 SW = 0000000010, buttons = 01, leds = 0011111101, Hex0 = 11111001, Hex1 = 11000000, Hex2 = 10010010, Hex3 = 10100100, Hex4 = 11111001, Hex5 = 11
000000
40 SW = 0000000100, buttons = 01, leds = 0011111011, Hex0 = 11111001, Hex1 = 11000000, Hex2 = 10010010, Hex3 = 10100100, Hex4 = 11111001, Hex5 = 11
000000
50 SW = 0000001000, buttons = 01, leds = 0011110111, Hex0 = 11111001, Hex1 = 11000000, Hex2 = 10010010, Hex3 = 10100100, Hex4 = 11111001, Hex5 = 11
000000
60 SW = 0000010000, buttons = 01, leds = 0011101111, Hex0 = 11111001, Hex1 = 11000000, Hex2 = 10010010, Hex3 = 10100100, Hex4 = 11111001, Hex5 = 11
000000
70 SW = 0000100000, buttons = 01, leds = 0010111111, Hex0 = 11111001, Hex1 = 11000000, Hex2 = 10010010, Hex3 = 10100100, Hex4 = 11111001, Hex5 = 11
000000
80 SW = 0001000000, buttons = 01, leds = 0010111111, Hex0 = 11111001, Hex1 = 11000000, Hex2 = 10010010, Hex3 = 10100100, Hex4 = 11111001, Hex5 = 11
000000
90 SW = 0010000000, buttons = 01, leds = 0001111111, Hex0 = 11111001, Hex1 = 11000000, Hex2 = 10010010, Hex3 = 10100100, Hex4 = 11111001, Hex5 = 11
000000
100 SW = 0011111111, buttons = 01, leds = 0000000000, Hex0 = 11111001, Hex1 = 11000000, Hex2 = 10010010, Hex3 = 10100100, Hex4 = 11111001, Hex5 = 11
000000
110 SW = 0011111111, buttons = 00, leds = 0011111111, Hex0 = 11111001, Hex1 = 11000000, Hex2 = 10010010, Hex3 = 10100100, Hex4 = 11111001, Hex5 = 11
000000
120 SW = 0011111111, buttons = 10, leds = 0011111111, Hex0 = 11000000, Hex1 = 11000000, Hex2 = 11111000, Hex3 = 10100100, Hex4 = 10011000, Hex5 = 11
000000
130 SW = 0011111111, buttons = 11, leds = 0000000000, Hex0 = 11000000, Hex1 = 11000000, Hex2 = 11111000, Hex3 = 10100100, Hex4 = 10011000, Hex5 = 11
000000
140 SW = 1000000000, buttons = 11, leds = zzzzzzz100, Hex0 = 11111111, Hex1 = 11000000, Hex2 = 11111111, Hex3 = 10000110, Hex4 = 11111111, Hex5 = 11
000000
150 SW = 1000100001, buttons = 11, leds = zzzzzzz010, Hex0 = 11111111, Hex1 = 11111001, Hex2 = 11111111, Hex3 = 11111111, Hex4 = 11111111, Hex5 = 10
100100
160 SW = 1000010010, buttons = 11, leds = zzzzzzz001, Hex0 = 11111111, Hex1 = 10100100, Hex2 = 11111111, Hex3 = 11000111, Hex4 = 11111111, Hex5 = 11
111001
```

GTKWave Output:



Summary:

All of our design goals were reached. Our project is able to do all that was required in the specifications.