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Engineering – 303

Lab 5

3/4/2017

Introduction/Description

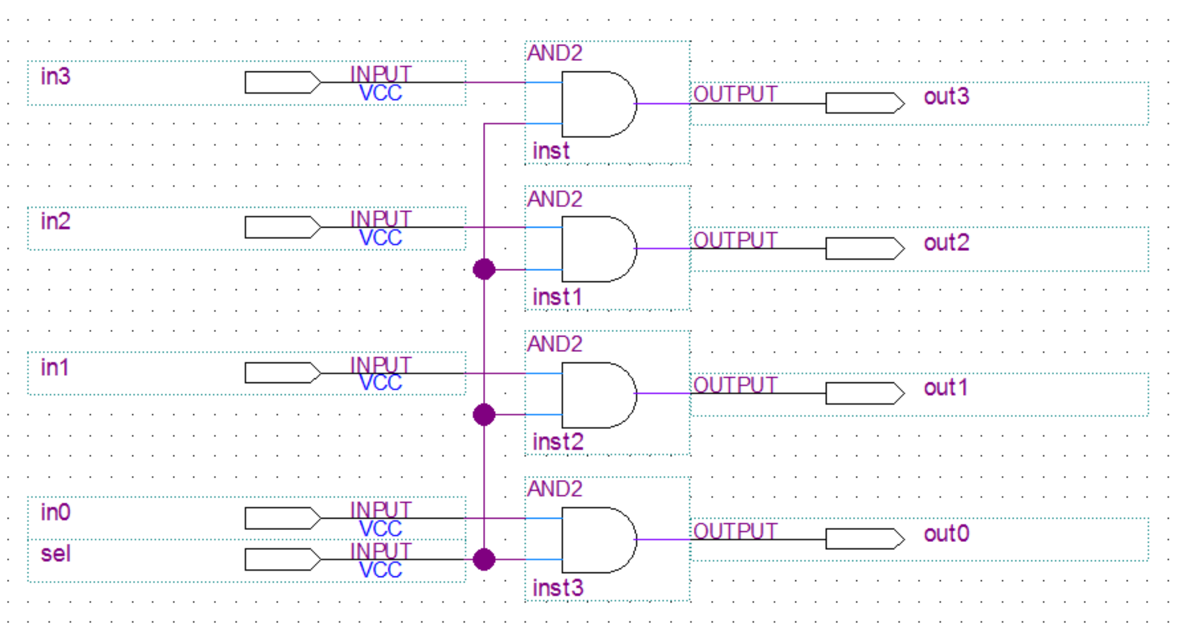
The purpose of this lab was to design several circuits that would be incorporated into one large design by the end of the lab. I was supposed to learn how to create all of the components that a multiplier circuit needed to operate correctly. This included making a circuit called an Andy circuit that would take several inputs and output true or false depending on what was inputted. In addition, this lab discussed the concept of daisy-chaining circuits together to allow for the larger binary number to be entered. Also, this lab used several designs that were created in previous labs.

Design

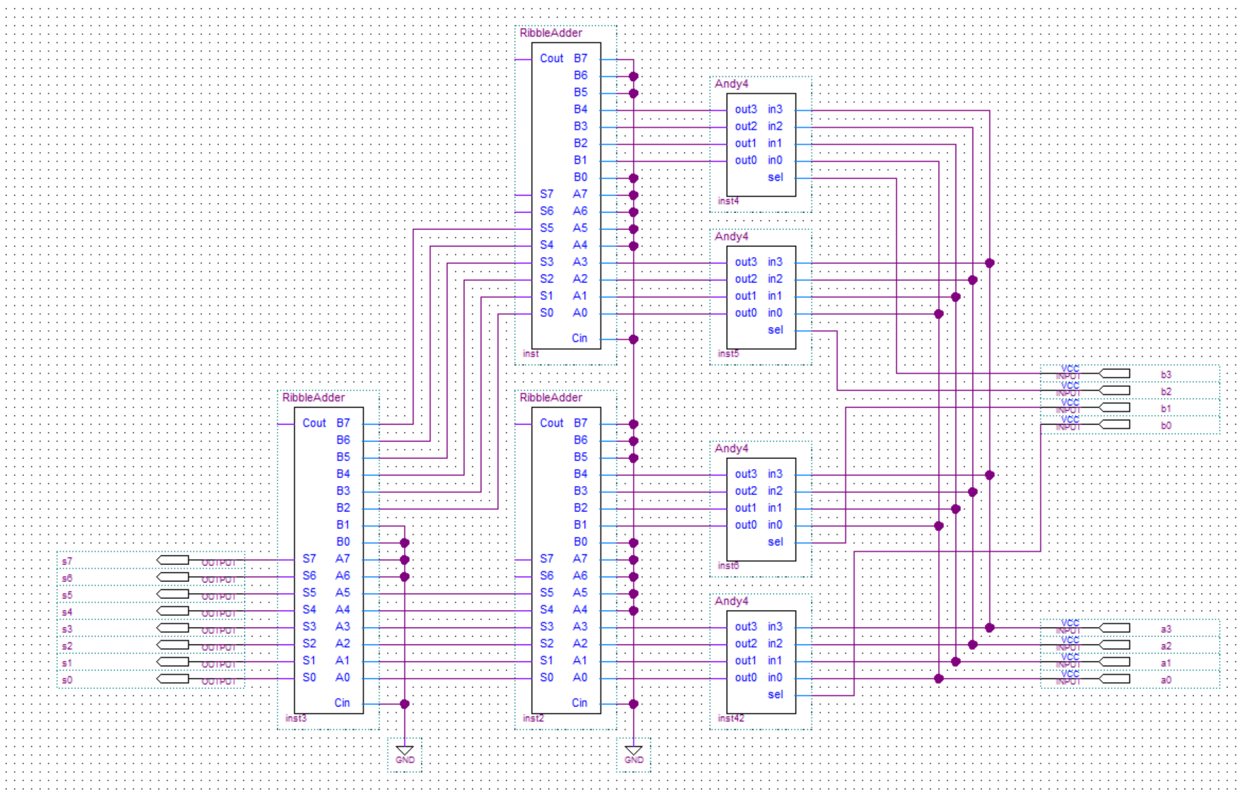
Part 0 – Ander module + 4-bit multiplier

In the first part of the lab, I was instructed to design two circuits. The first was called Andy4 which was capable of taking five inputs and outputting four outputs based on those five entered. The second circuit was called a 4-bit multiplier and was capable of multiplying two 4 bit numbers together and outputting an 8-bit number.

Here is the Block-Diagram design for the Andy4 circuit.



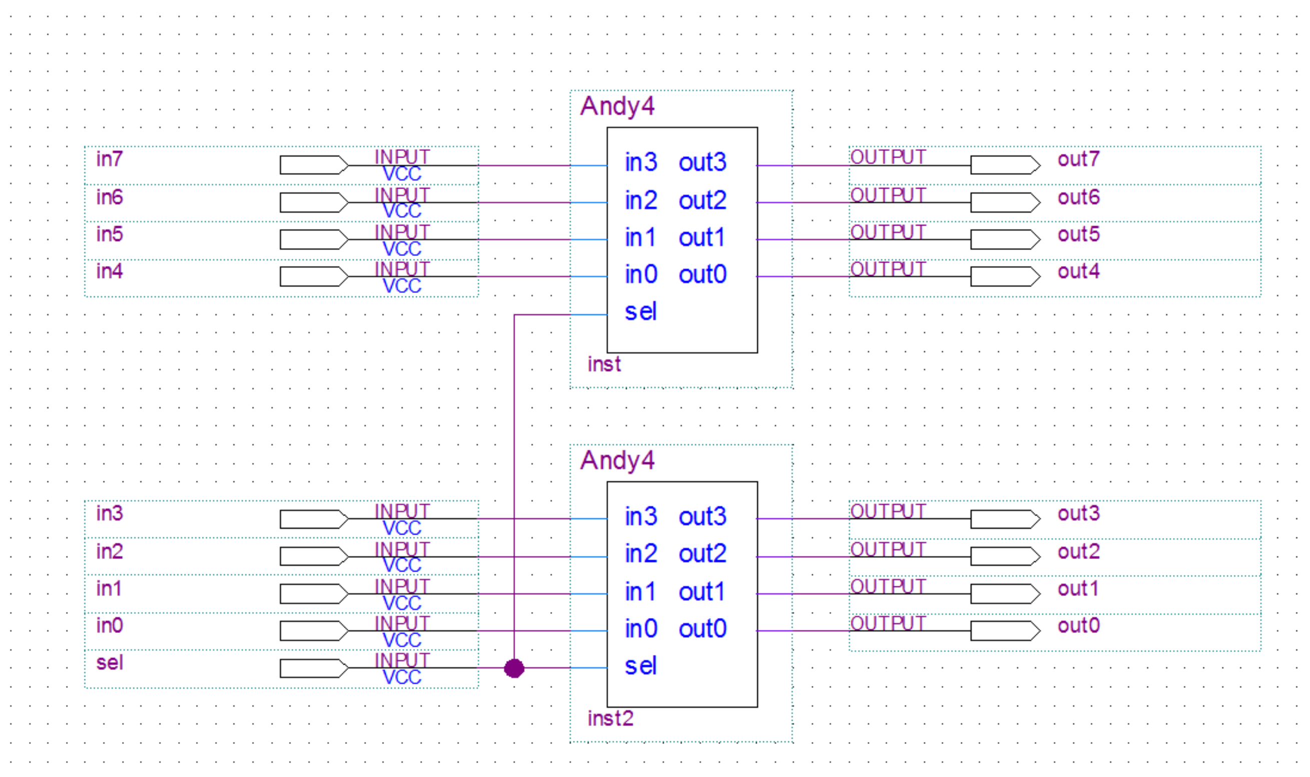
Here is the Block-Diagram design for the 4-bit multiplier circuit.



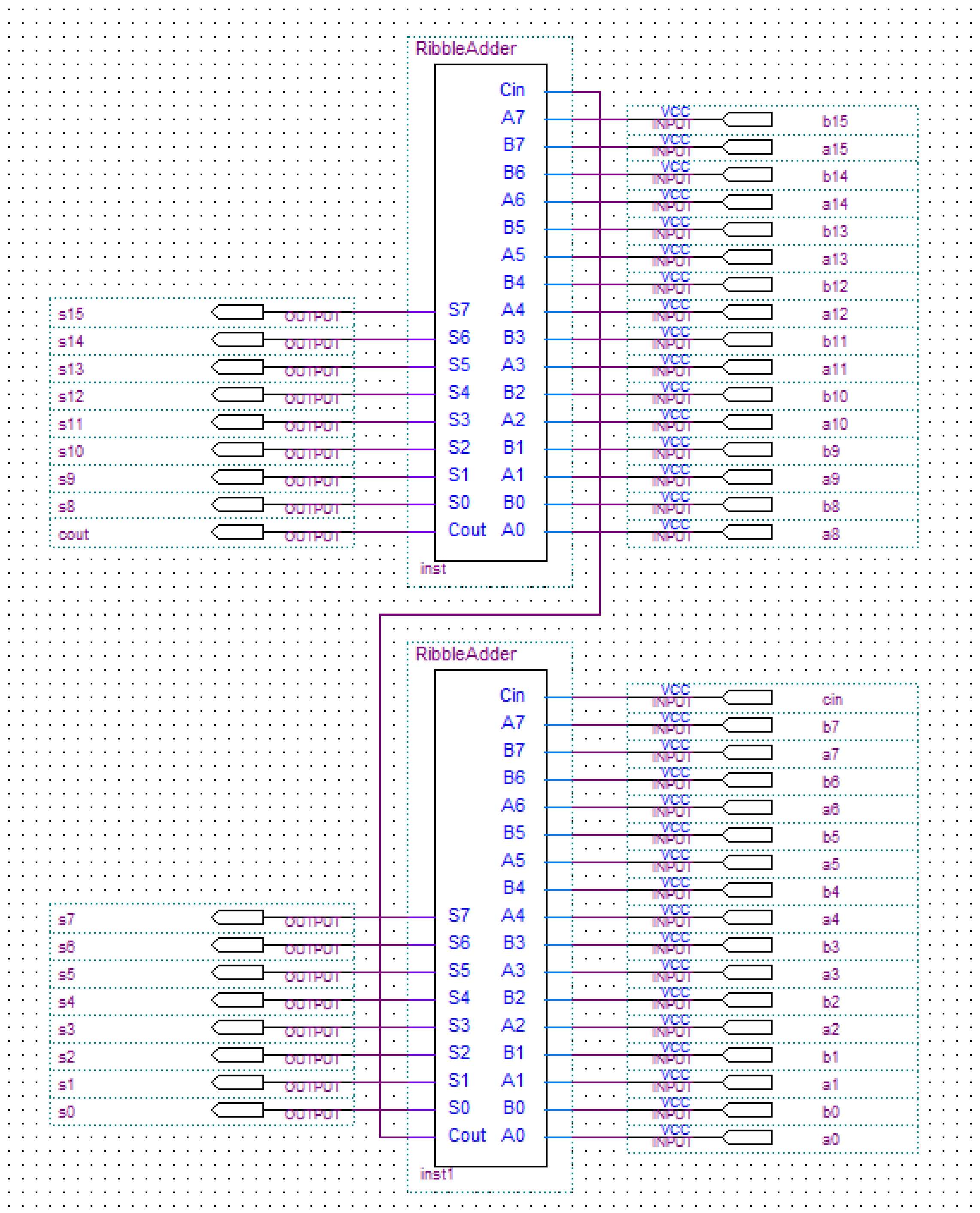
Part 1 – 8-bit multiplier

In the second part of the lab, I was told to create an 8-bit multiplier. This circuit would be capable of multiplying two 8 bit numbers together and then output the result as a 16-bit number. However, to create this circuit I would need to daisy chain a couple of previous designs together to allow for this larger circuit design. I had to do this to my Ripple Adder circuit from lab 4 and to the Andy4 module created earlier in the lab.

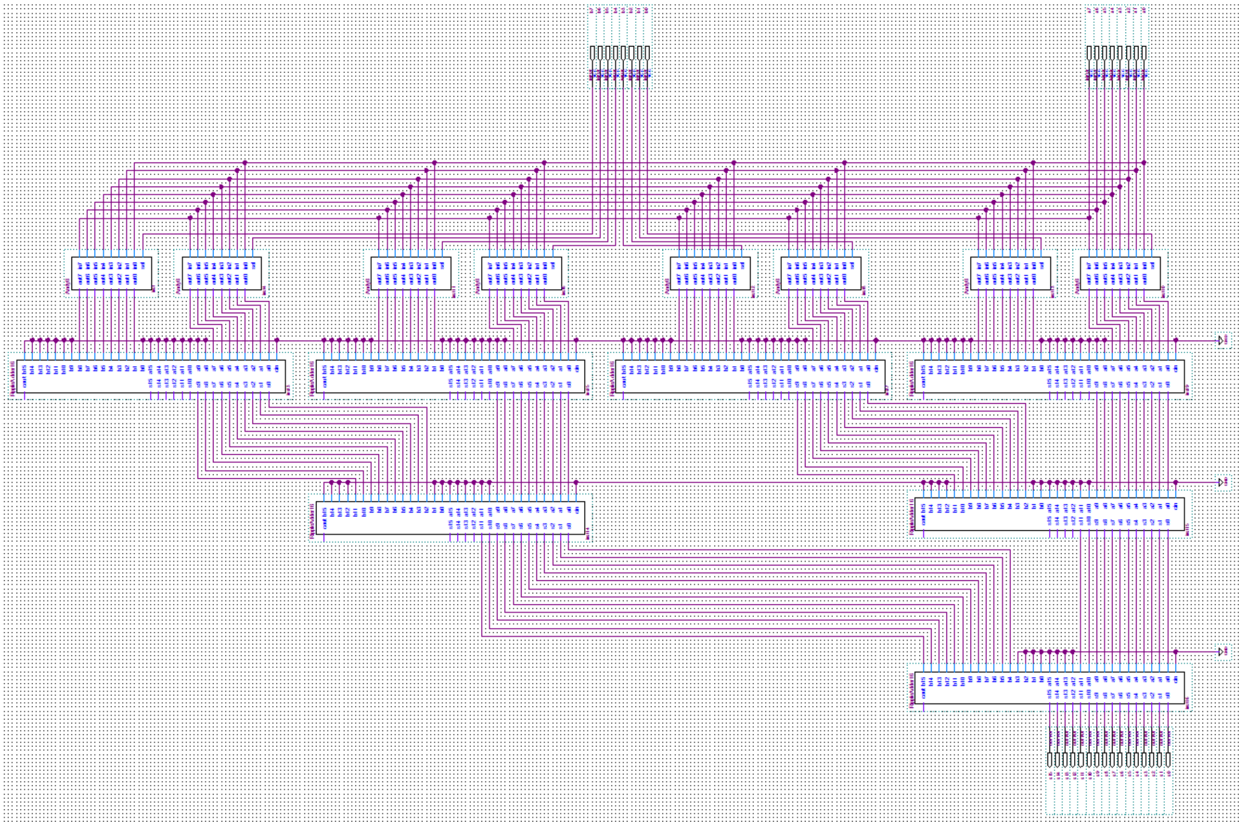
Here is the Block-Diagram design for the Andy8 circuit created by daisy-chaining the Andy 4 circuit.



Here is the Block-Diagram design for the daisy-chained Ripple Adder.



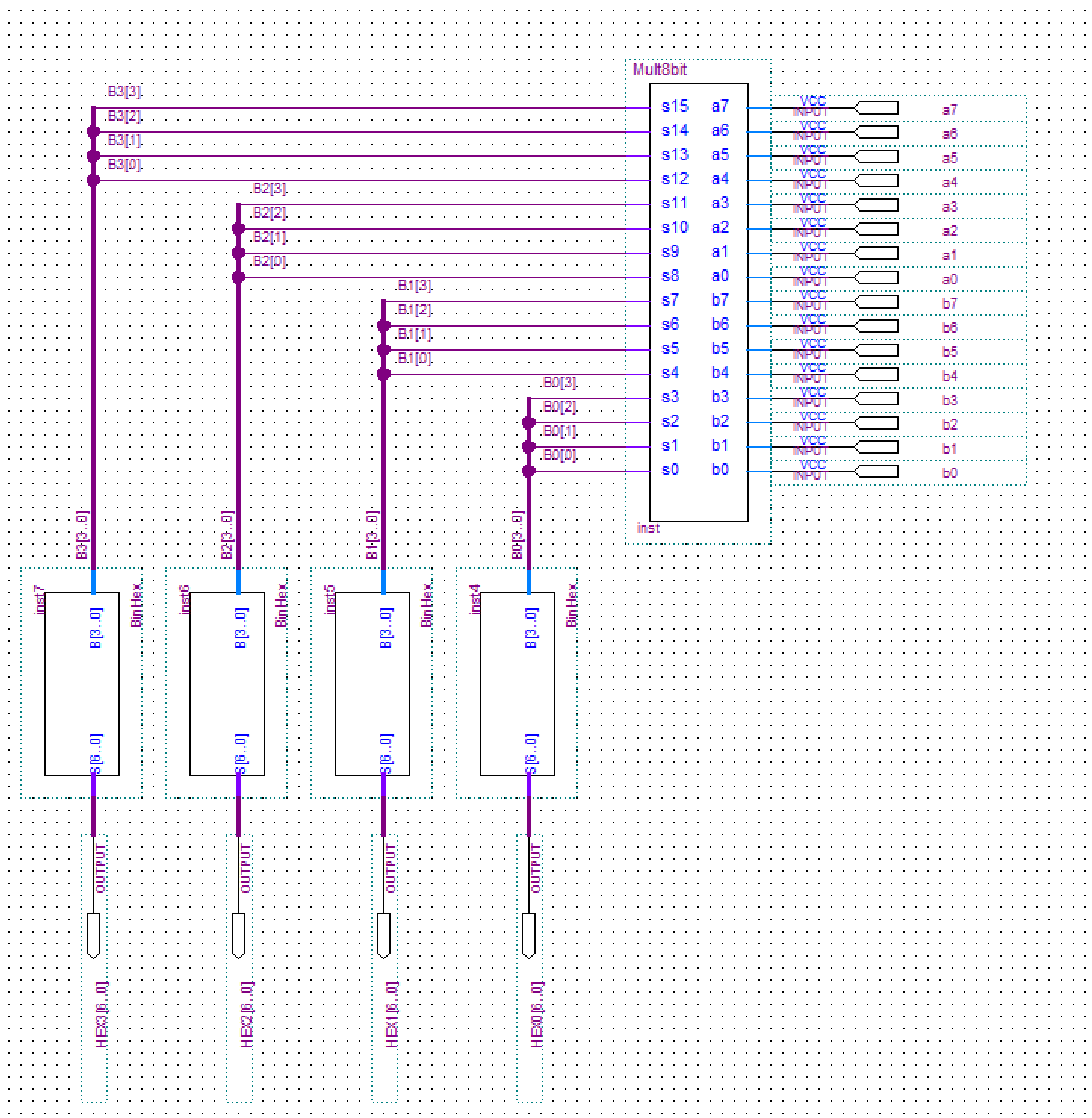
Here is the Block-Diagram design for the finished 8-bit multiplier.



Part 2 – 8-bit multiplier with Seven Segment Decoders

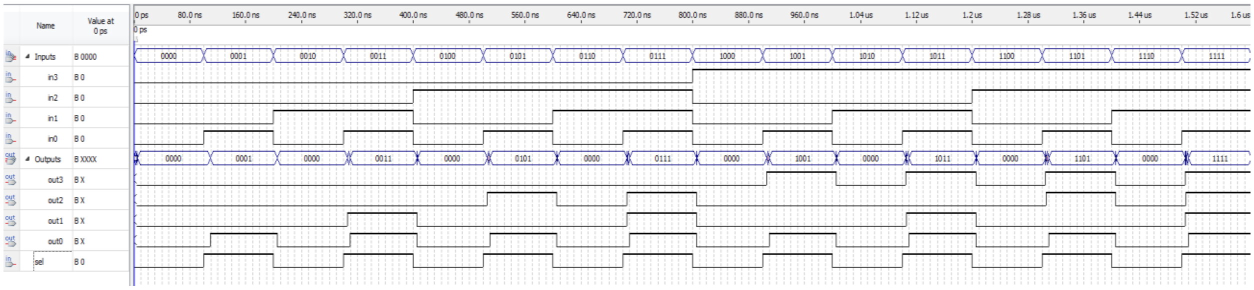
In the last part of the lab, I was instructed to take my 8-bit multiplier circuit and include it in a circuit that would be able to display the outputs of the circuit in hexadecimal on a hex display.

Here is the Block-Diagram design for the circuit.

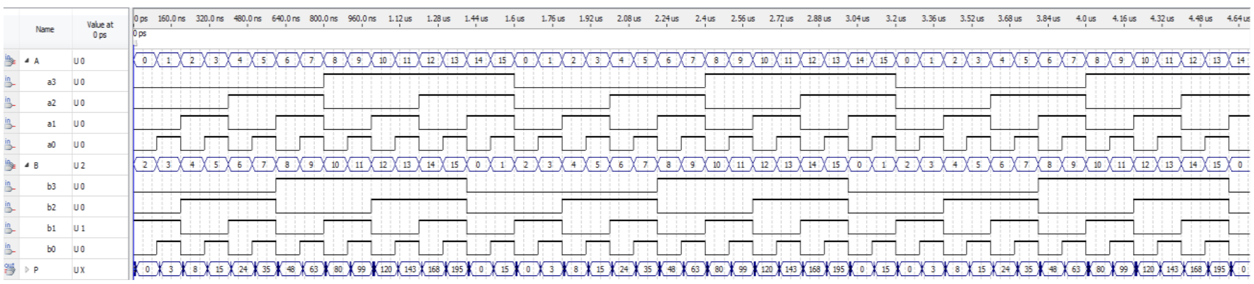


Testing

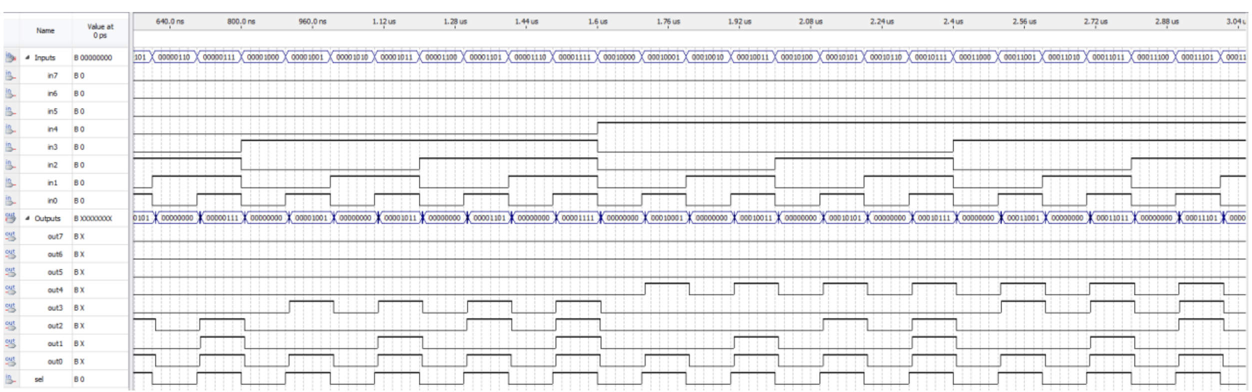
When testing the Andy4 circuit I encountered no problems and it performed as expected for every single input combination.



When testing the 4-bit multiplier circuit I encountered no problems and it performed as expected for every single input combination.

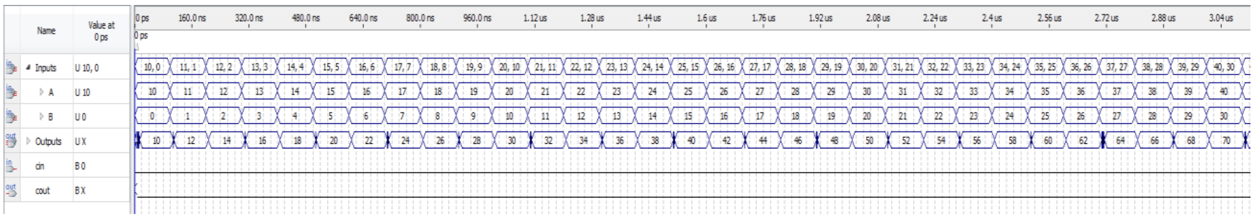


When testing the daisy-chained Andy4 circuit called Andy8 I encountered no problems and it worked as expected for every single input combination.

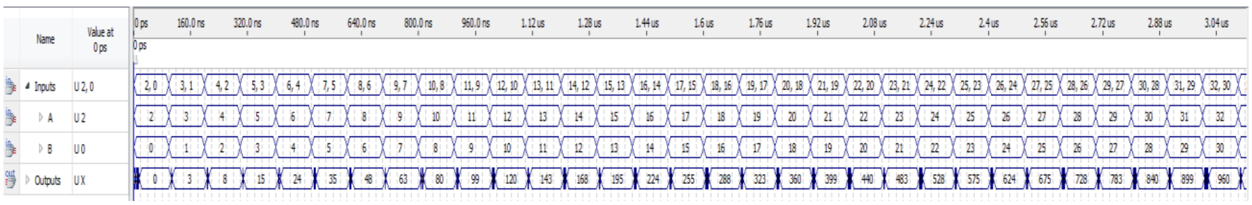


When testing the daisy-chained Ripple Adder circuit I encountered one small problem. After designing and compiling the circuit design my waveform resulted in a +1 to every single output.

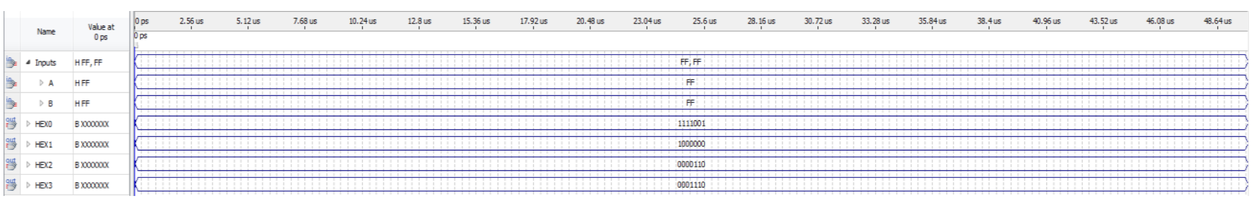
I later discovered this was due to the input ‘cin’ not being connected to anything. After assigning an input pin to ‘cin’ the circuit worked as expected for every single input combination.



When testing the 8-bit multiplier I thankfully encountered no problems and it worked as expected for every single input combination.



When testing the 8-bit multiplier attached to the Seven Segment Decoders I encountered no problems and it worked as expected for every single input combination.



Conclusion

In this lab, I learned how to create multiplier circuits in Quartus. I learned that a circuit can easily be enlarged by daisy-chaining two smaller versions of the circuit together. This allows small circuits to be sized up with great efficiency. This lab enabled be to get more practice in wiring circuits together and also using bus wires. If I was to perform this lab again I would probably investigate if there is any way for the 4-bit multiplier to be daisy-chained with itself to create the 8-bit multiplier instead of having to create and wire the 8-bit multiplier from scratch. Overall this lab proved to be enjoyable and it was great fun to see all my circuits doing what they were supposed to do.