Adders

Objectives:

The main objective of this lab was to build simulation circuitry to add and subtract binary numbers.

Introduction:

In order to add and subtract four bit numbers we need to use the four bit adders in Logicworks. I achieved this through the using XOR gates in order to convert signed binary to two's complement for negative numbers, adding the numbers using the 4-bit adder gate in logic works then converting the number back to signed binary at the end with more XOR gates.

Procedure:

Step 1.) The first step is design the first circuit to add three numbers together on paper. We will do this by using two 4-bit adders. One to add the first two numbers together and then the second is used to add the sum of the first two numbers together with the third and finally number.

Step 2.) Once the circuit is complete on paper you can then implement it on logic works with confidence.

Step 3.) After the first addition of three numbers circuit is complete it is now time to design the final circuit in this lab. To do this draw out on paper the design using XOR gates to invert the numbers. Then run a binary probe to the most significant bit and add one to the fully inverted number by using a 4-bit adder.

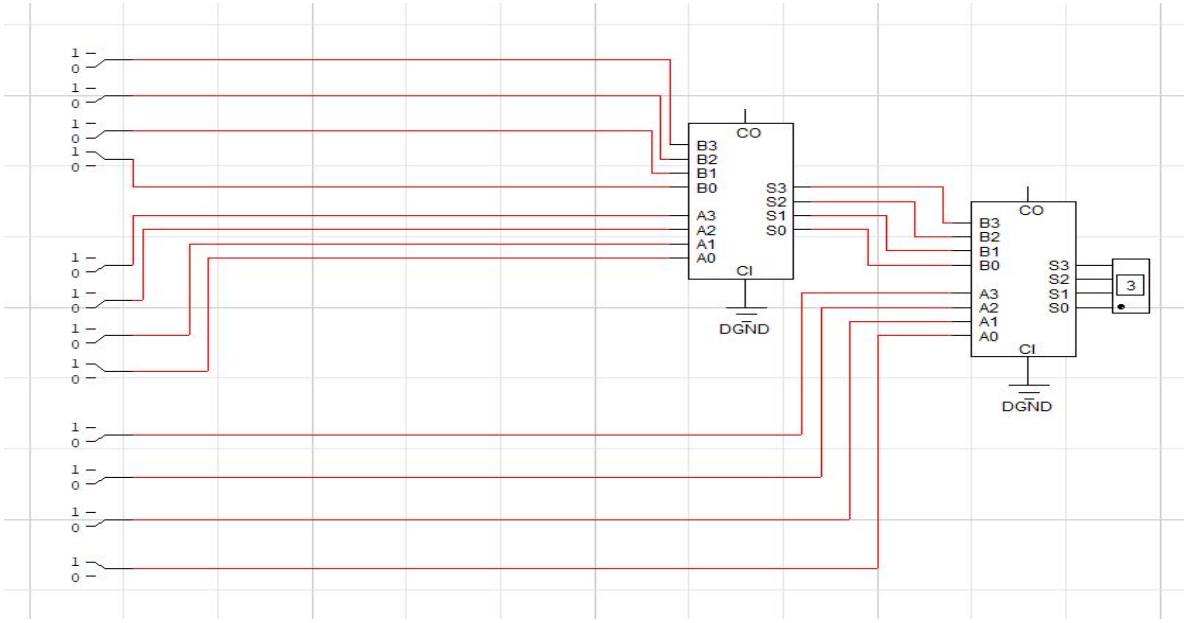
Step 4.) Repeat this process for the second number and then use an adder to add those two numbers. Finally use XOR gates and a binary probe to reinvent the final number if need be and attach a hex display to show the output.

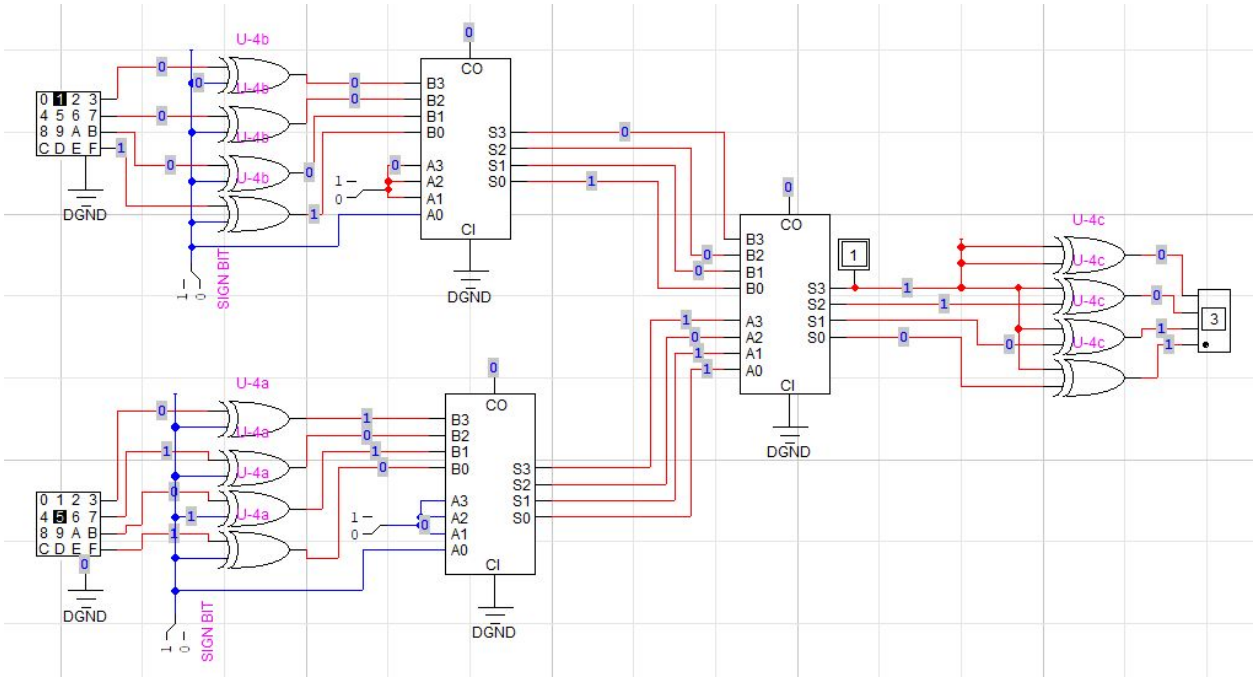
Results:

My circuit that adds two number runs perfectly and a table of inputs/outputs along with a screenshot is below. However, my second circuit always produces one less than what it should when it the result is supposed to be a negative number in terms of absolute value. The tables and screenshots are below. First Circuit Input-Output Table:

Input	Output
1+3+1	5
2+4+1	6
6+0+1	7
3+3+0	6

Input	Output
0+6	6
5+-5	0
0+-4	-3
2+2	4
-1+7	6
-3+-1	-1


CO
B3
B2
B1
B0
S3
S2
S1
S0
A3
A2
A1
A0
CI
DGND
3


U-4b
U-4a
U-4c
SIGN BIT
DGND
CO
CI
3

DIscussion:

Both circuits I created are highly efficient but I could not figure out how to fix the error in my second circuit where the resultant is always one less than it should be when its a negative number in terms of absolute value.

Conclusion:

Through my completion of this lab I gained more knowledge with regards to how to convert between two's complement and signed binary representations of numbers. I also was able to gain more experience in using logic works. The lab like the last one however, should have more in class time to be done because the virtual desktop experience is almost unusably slow.

Questions:

1. Since in practice we cannot test all possibilities of our circuit I chose to test five different scenarios to prove that the circuit can handle every possible situation. The five different scenarios were a negative plus positive, zero plus a negative, zero plus a positive, positive plus positive, and negative plus negative.