

# ELC 2137 Lab 3: Adders

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## Summary

The purpose of this experiment was to learn how to build different kinds of adders. By examining the truth tables to half, full, and two-bit adders, occasionally with their decimal equivalent, it was easier to examine what types of gate combinations were necessary for each type of adder. For example, with the half-adder, it becomes apparent that an XOR gate is necessary to get the correct value of the sum (S), while the carry (C) utilizes an AND gate to correctly add the binary digits. This also formed the basis for forming the more complicated full-adder and two-bit adder circuits. Additionally, students used schematics and wiring diagrams to aid in the construction of the adders.

## Q&A

1. Which gates could we use for combining the carry bits?

To combine the carry bits we could use the AND, XOR as well as an OR gate. Normally an AND gate is preferable for finding the carry bit itself from an input, but the XOR is easier for combining two carry bits into a higher carry bit.

2. Which one should we use and why?

We should use the XOR gate because it combines both the carry bits but only when exclusively one is high. That way all cases of the bits only being high one at a time are accounted for, and not when they both are high.

## Results

The included documents below demonstrate the construction of each of the three adders being built along with the corresponding truth table outputs they produce.

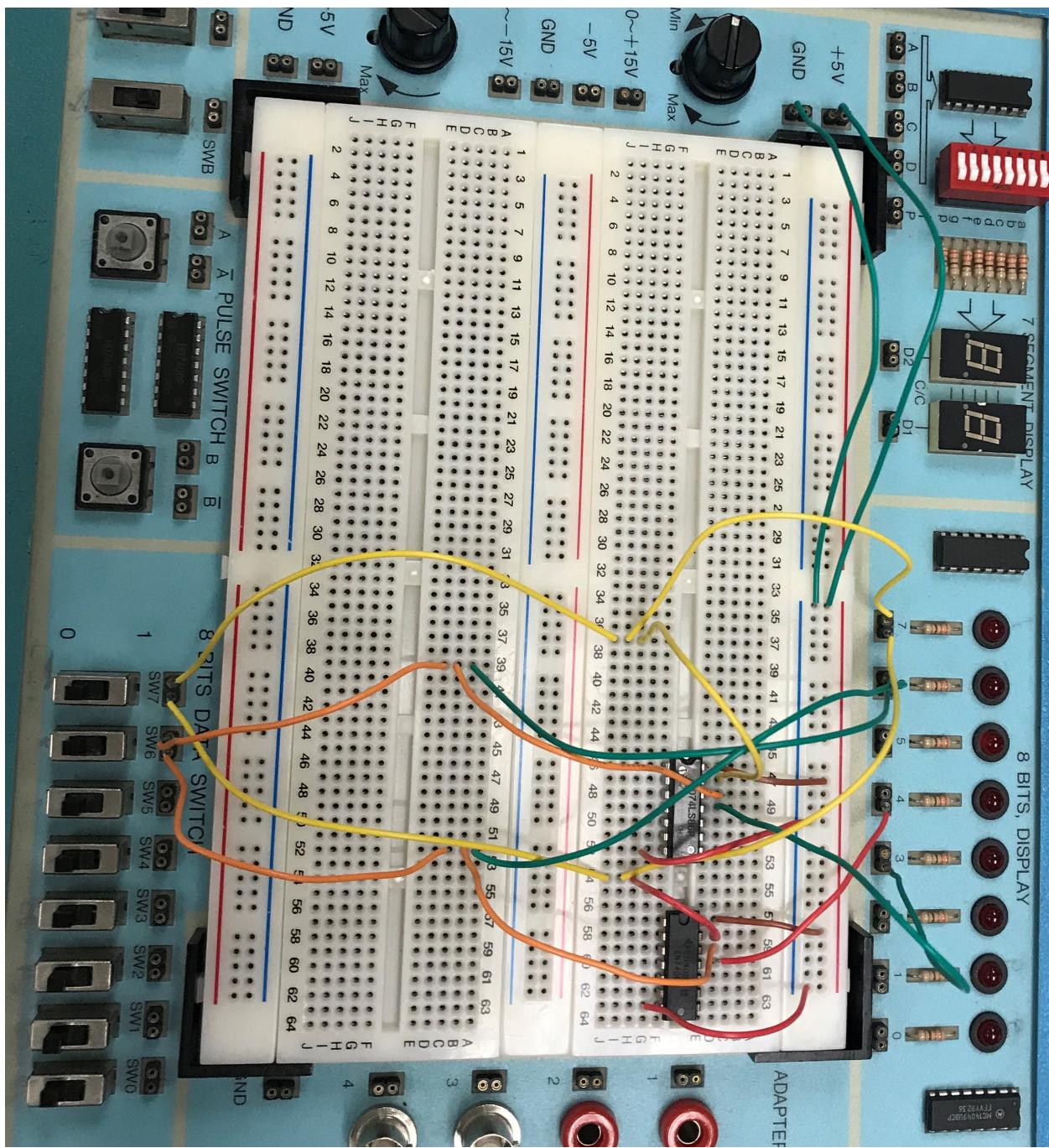


Figure 1: Half Adder Circuit

A	B	C	S	Decimal
0	0	0	0	0
0	1	0	1	1
1	0	0	1	1
1	1	1	0	2

Figure 2: Half adder truth table

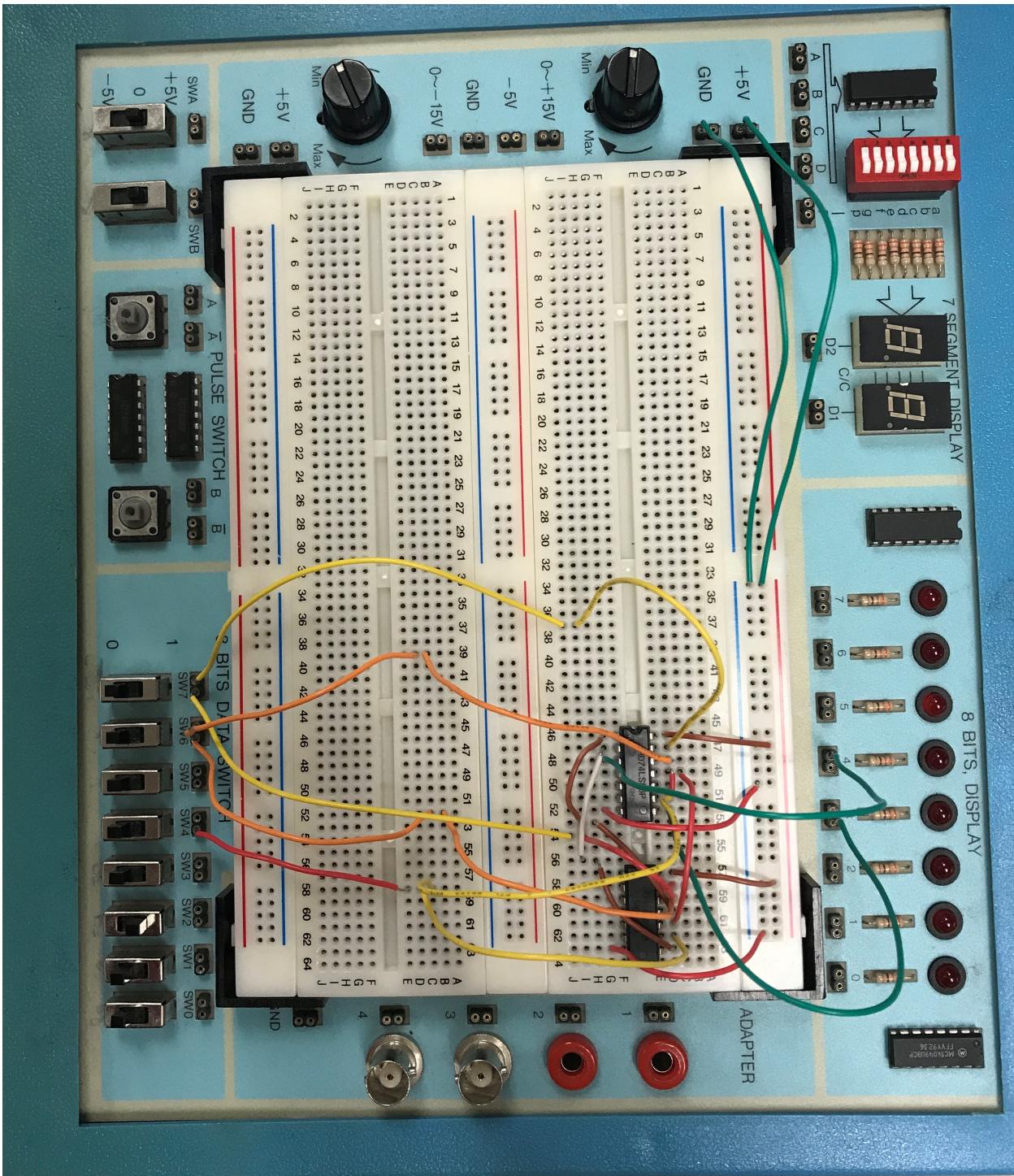


Figure 3: Full Adder Circuit

$C_m$	A	B	$C_{out}$	S	Decimal
0	0	0	0	0	0
0	0	1	0	1	1
0	1	0	0	1	1
0	1	1	1	0	2
1	0	0	0	1	1
1	0	1	1	0	2
1	1	0	1	0	2
1	1	1	1	1	3

Figure 4: Full Adder Truth Table

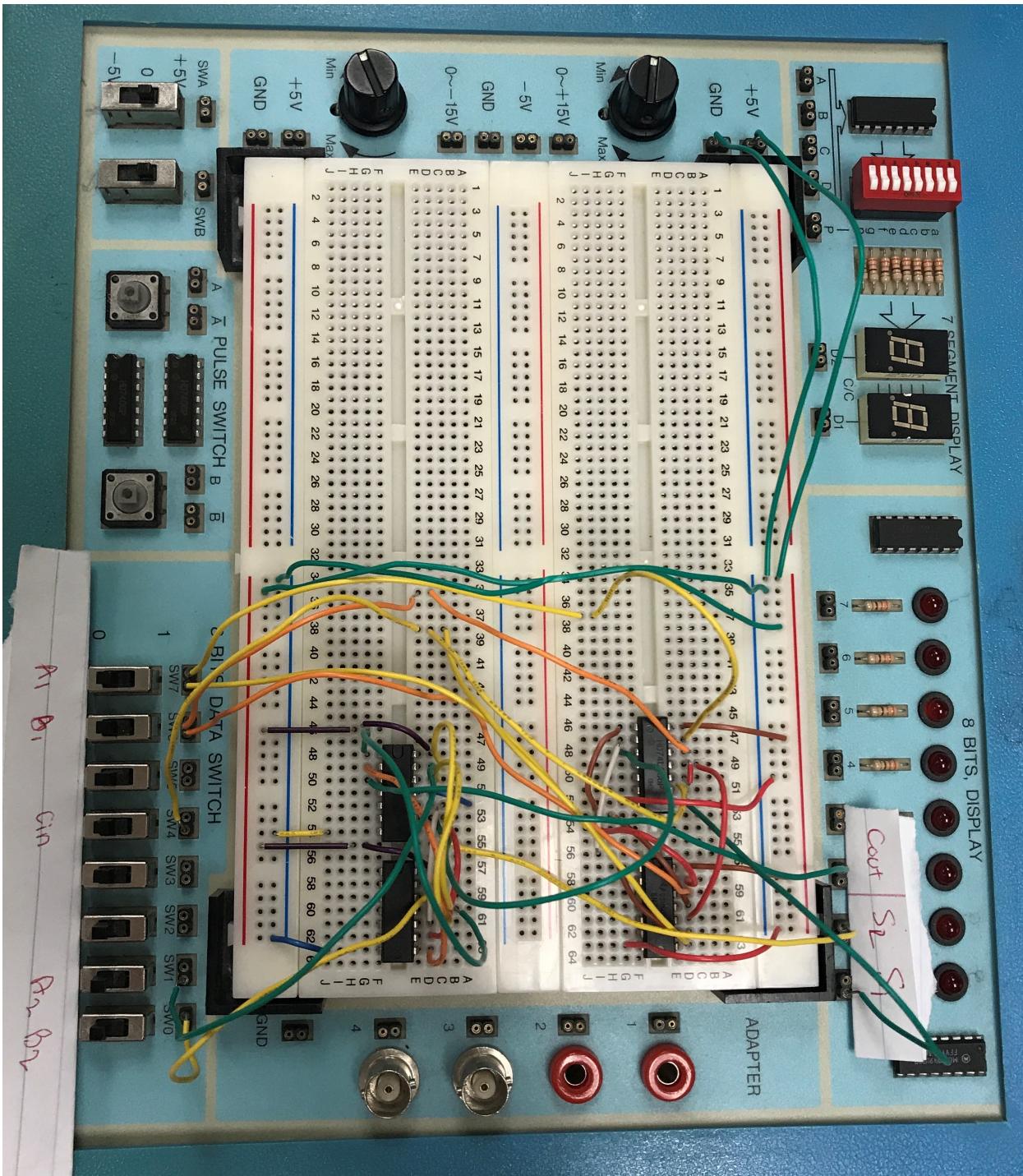


Figure 5: Two-Bit Adder Circuit

$C_{in}$	$A_2A_1$	$B_2B_1$	$\parallel$	$C_{out}S_2S_1$
0	00	00		0 0 0
0	00	01		0 0 1
0	01	01		0 1 0
0	10	01		0 1 1
0	10	10		1 0 0
1	10	10		1 0 1
1	11	11		1 1 1

Figure 6: 2-Bit Adder Truth Table

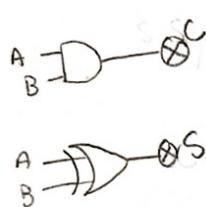
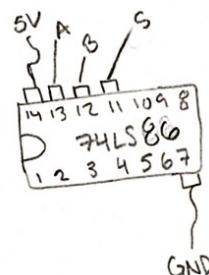
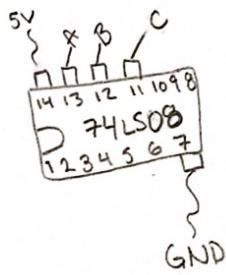
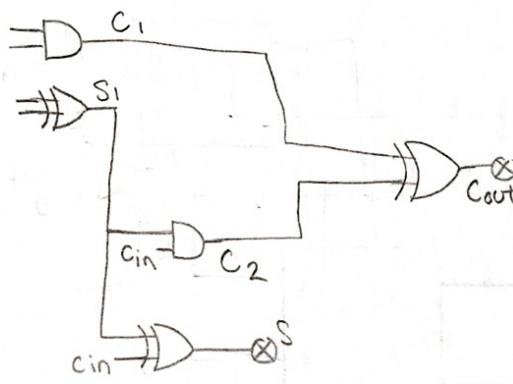
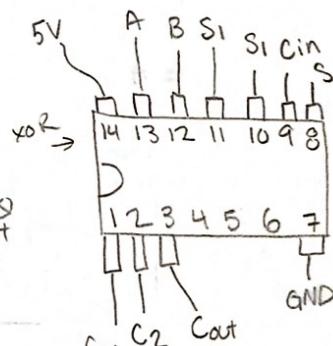
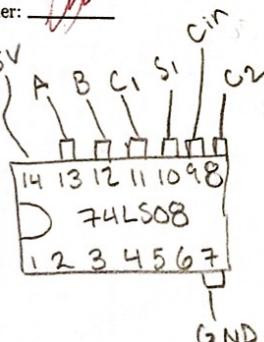
**Circuit Demonstration Page**Half adder schematicHalf adder wiring diagramHalf adder: BBFull adder schematicFull adder wiring diagramFull adder: BB2-bit adder: BB

Figure 7: Schematics and Demonstration page

## Conclusion

This lab demonstrated the ability to build circuits that have additive capabilities using binary digits. While the circuits built did not have the aesthetic appeal and color coded wires necessary for building more complex circuits, not having the exact number and types of wires hindered this ability. Therefore, given the tools in lab, functioning circuits were built, despite not being the prettiest to look at. A useful skill gained from this lab is utilizing the ordering of switches and LEDs to correspond with the truth tables in order to test the circuit with as much ease as possible. As can be noted, in the two-bit adder circuit, labels using paper were utilized to keep track of this order, again to make testing easier. Overall, this lab demonstrated how to build adder circuits. By combining similar structures, although with varying carry-ins as sources for input and output, the AND and XOR gates were sufficient to build half-, full-, and 2-bit adders.