ELC 2137 Lab 3: Adders

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Summary

This lab introduced a family of logic chips that can be used to design logic circuits. Using prior knowledge of AND and XOR gates, Half Adder, Full Adder, and 2-Bit Adder circuits were constructed with these chips and tested for functionality. The schematics and wiring diagrams for the Half Adder and Full Adder circuits can be found in Figure 1. The Full Adder is merely two Half Adders combined, and the 2-Bit Adder is two Full Adders combined. Figure 2 shows the Half Adder circuit built in lab, Figure 3 shows the Full Adder circuit, and Figure 4 shows the 2-Bit Adder circuit.

Q&A

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

   An AND gate or an XOR gate could be used for combining the carry bits.

2. Which one should we use and why?

   An XOR gate should be used to combine the carry bits because it will produce a high output when either input is high. As proved in Table 1, the carry outputs of the first and second stage Half Adders cannot both be high at the same time, so an AND gate, which produces a high output when both inputs are high, would be ineffective.

Results

Table 1: Truth Table Proving Effectiveness of XOR Gate

Cin	A	B	A AND B	A XOR B	Cin AND (A XOR B)
0	0	0	0	0	0
0	0	1	0	1	0
0	1	0	0	1	0
0	1	1	1	0	0
1	0	0	0	0	0
1	0	1	0	1	1
1	1	0	0	1	1
1	1	1	1	0	0

A AND B and Cin AND (A XOR B) are never high at the same time (i.e. they never have 1s at the same time), so an XOR gate can be used to combine them instead of an OR gate. OR gates produce high outputs when either input is high and when both inputs are high, but XOR gates only produce high outputs when either input is high. Because neither input is high at the same time in the Full Adder circuit, an OR gate is not necessary, and an XOR gate can be used.

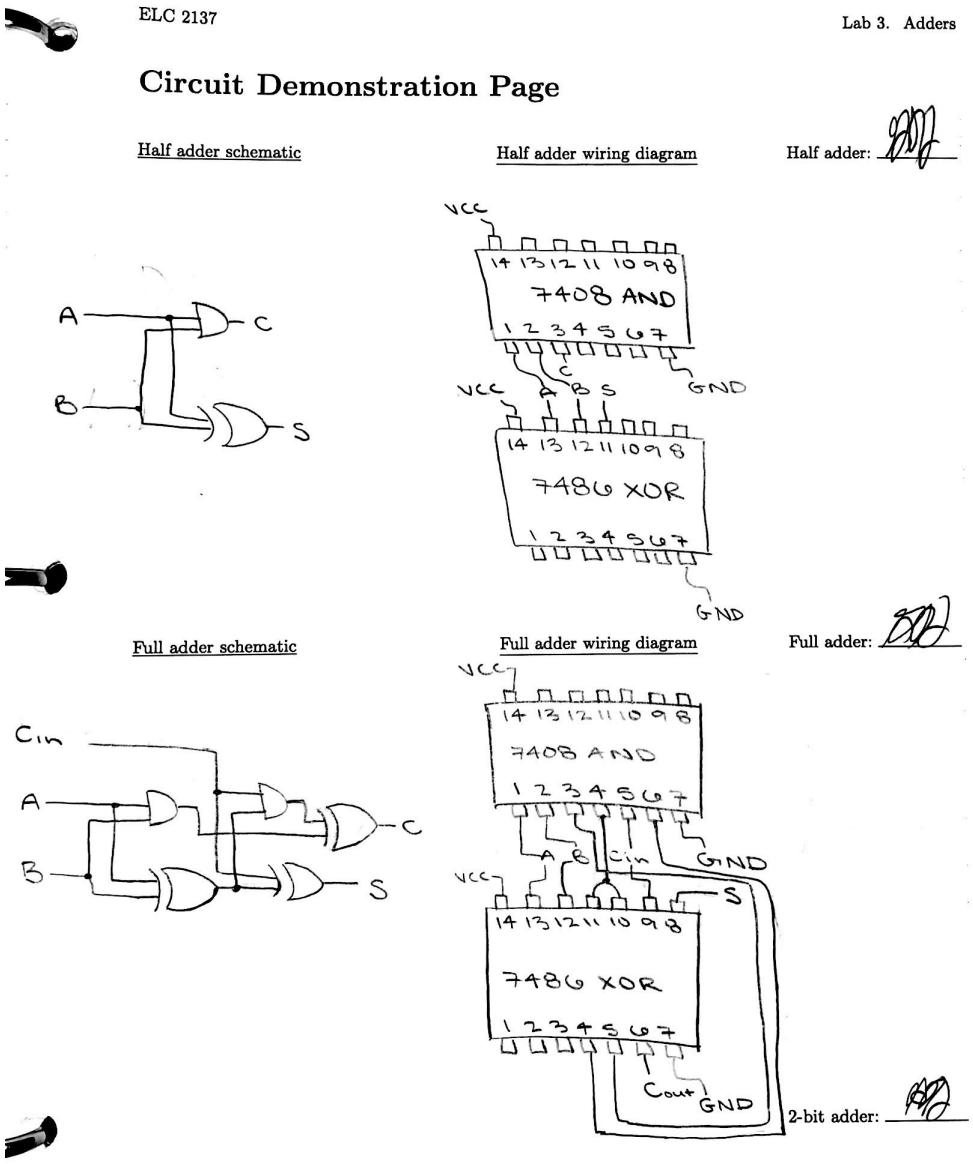

Figure 1: In-Class Circuit Demonstration

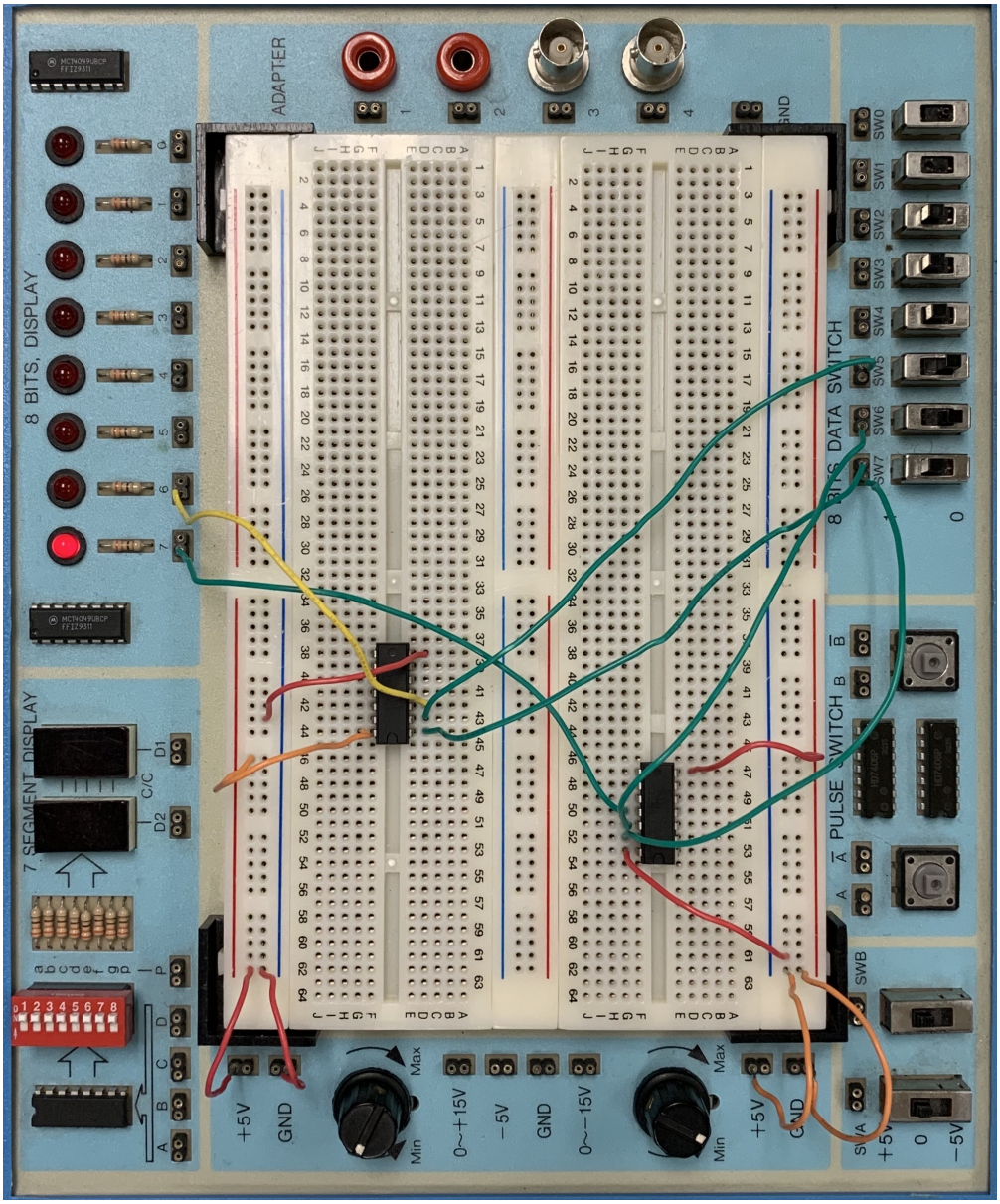

Figure 2: Half Adder Circuit

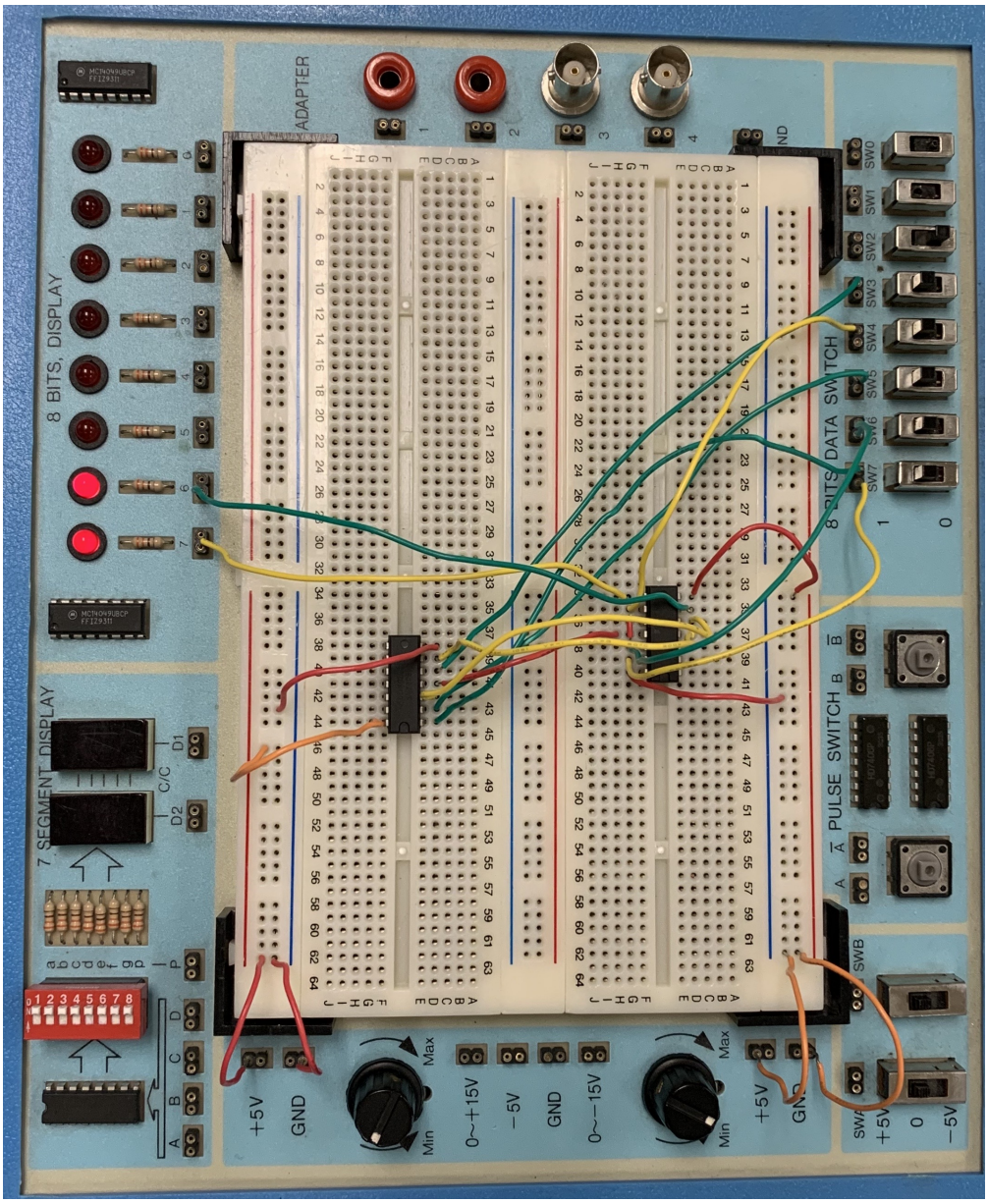

Figure 3: Full Adder Circuit

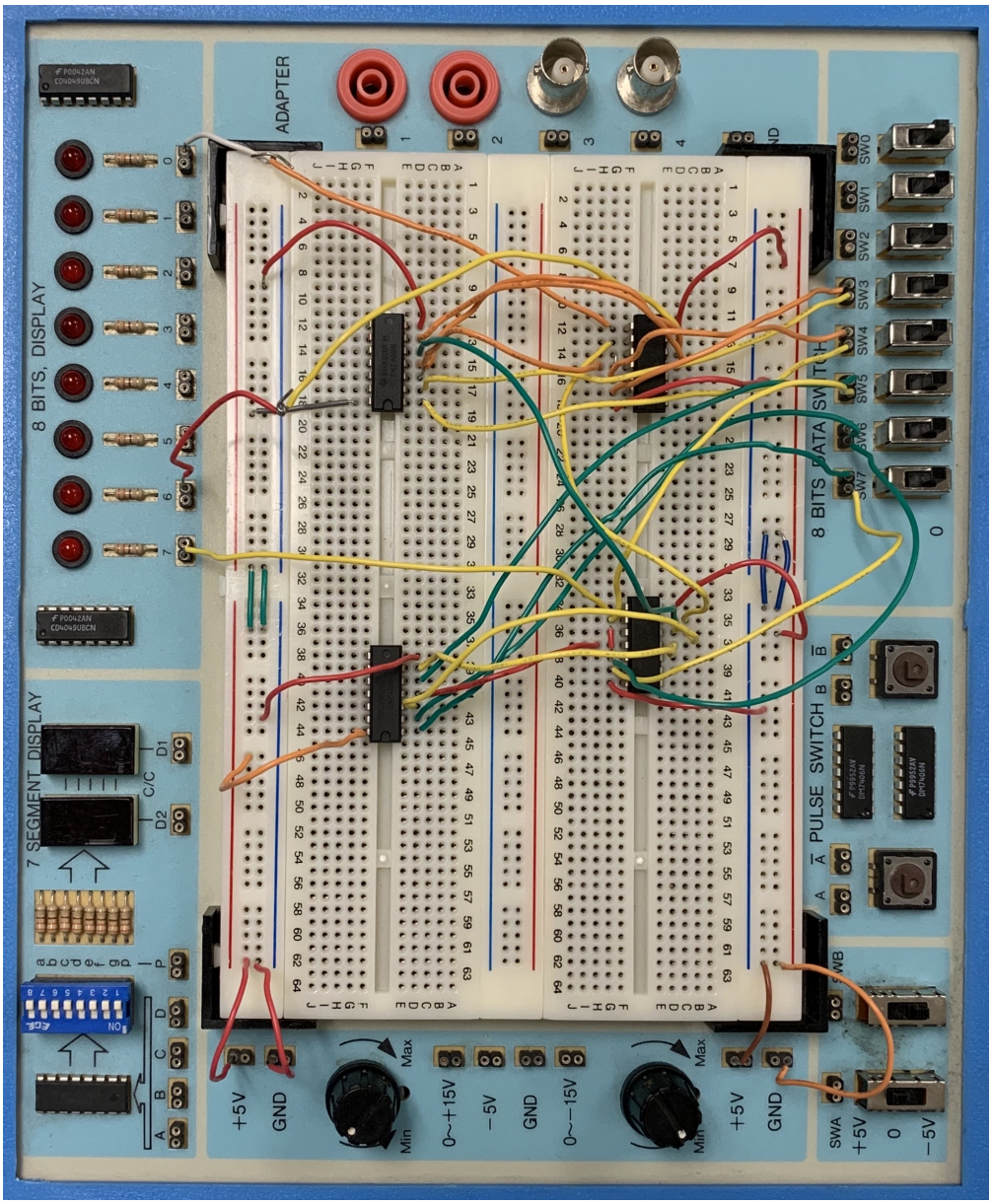

Figure 4: 2-Bit Adder Circuit

The connections in some of the switches on the blue box were problematic, so we had to incorporate additional wires and switches to let the Half Adder and Full Adder circuits function properly. A different blue box, with functional switches and connections, was used to build the 2-Bit Adder circuit.