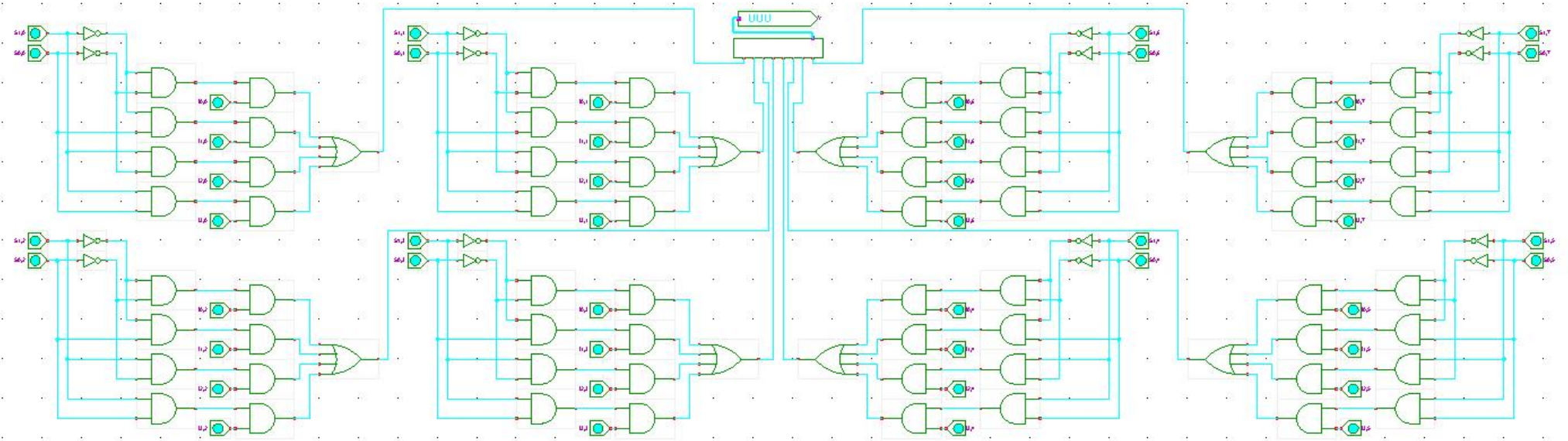
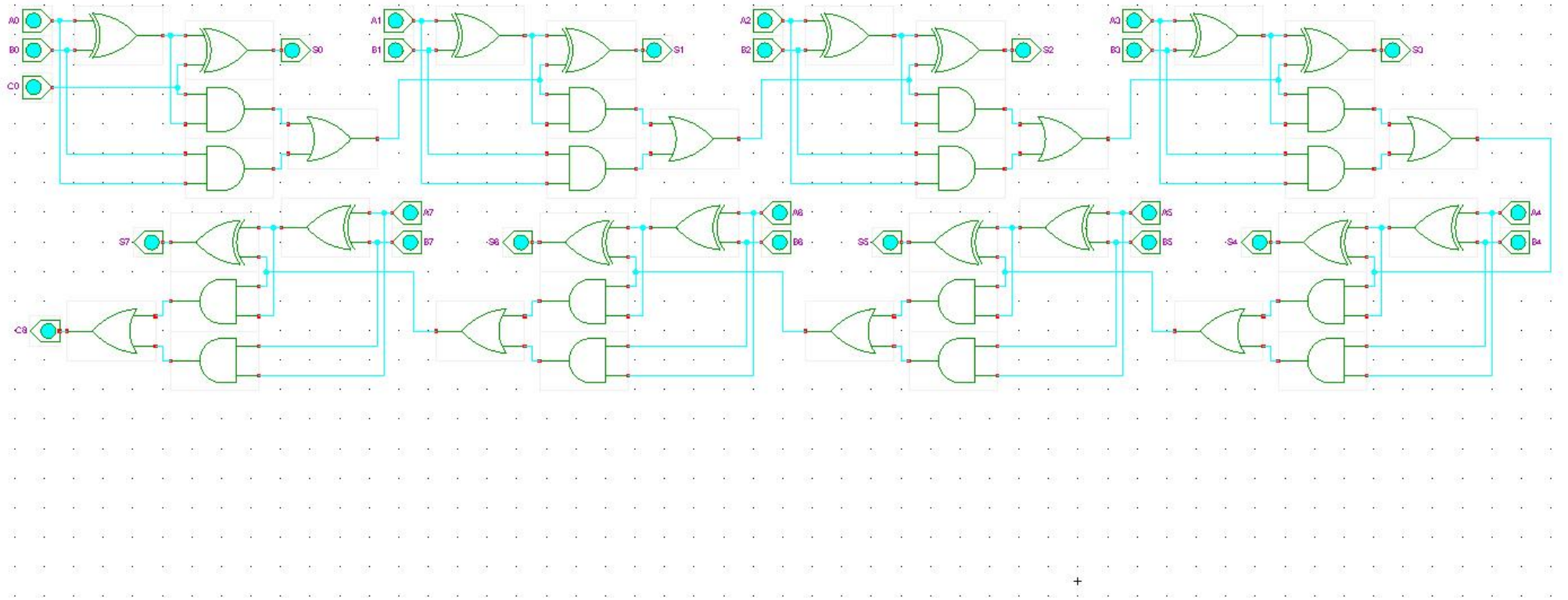


Circuit Diagram: 4-to-1 Multiplexer



Circuit Diagram: 8-bit Adder



Circuit Description: 4-to-1 Multiplexer

In general, a multiplexer is a combination of circuits that uses binary information from multiple inputs and directs information into a single output. For a 4-to-1 multiplexer, it should follow this truth table:

S ₁ S ₀	I ₃ I ₂ I ₁ I ₀	F	S ₁ S ₀	I ₃ I ₂ I ₁ I ₀	F	S ₁ S ₀	I ₃ I ₂ I ₁ I ₀	F	S ₁ S ₀	I ₃ I ₂ I ₁ I ₀	F
0 0	0 0 0 0	0	0 1	0 0 0 0	0	1 0	0 0 0 0	0	1 1	0 0 0 0	0
0 0	0 0 0 1	1	0 1	0 0 0 1	0	1 0	0 0 0 1	0	1 1	0 0 0 1	0
0 0	0 0 1 0	0	0 1	0 0 1 0	1	1 0	0 0 1 0	0	1 1	0 0 1 0	0
0 0	0 0 1 1	1	0 1	0 0 1 1	1	1 0	0 0 1 1	0	1 1	0 0 1 1	0
0 0	0 1 0 0	0	0 1	0 1 0 0	0	1 0	0 1 0 0	1	1 1	0 1 0 0	0
0 0	0 1 0 1	1	0 1	0 1 0 1	0	1 0	0 1 0 1	1	1 1	0 1 0 1	0
0 0	0 1 1 0	0	0 1	0 1 1 0	1	1 0	0 1 1 0	1	1 1	0 1 1 0	0
0 0	0 1 1 1	1	0 1	0 1 1 1	1	1 0	0 1 1 1	1	1 1	0 1 1 1	0
0 0	1 0 0 0	0	0 1	1 0 0 0	0	1 0	1 0 0 0	0	1 1	1 0 0 0	1
0 0	1 0 0 1	1	0 1	1 0 0 1	0	1 0	1 0 0 1	0	1 1	1 0 0 1	1
0 0	1 0 1 0	0	0 1	1 0 1 0	1	1 0	1 0 1 0	0	1 1	1 0 1 0	1
0 0	1 0 1 1	1	0 1	1 0 1 1	1	1 0	1 0 1 1	0	1 1	1 0 1 1	1
0 0	1 1 0 0	0	0 1	1 1 0 0	0	1 0	1 1 0 0	1	1 1	1 1 0 0	1
0 0	1 1 0 1	1	0 1	1 1 0 1	0	1 0	1 1 0 1	1	1 1	1 1 0 1	1
0 0	1 1 1 0	0	0 1	1 1 1 0	1	1 0	1 1 1 0	1	1 1	1 1 1 0	1
0 0	1 1 1 1	1	0 1	1 1 1 1	1	1 0	1 1 1 1	1	1 1	1 1 1 1	1

For my 4-to-1 multiplexer, I combined eight single-bit 4-to-1 multiplexers, merging their outputs into a 8-bit bus output. On the right is an example of a single-bit 4-to-1 multiplexer I used in my circuit. I only tested this circuit with a few of the possible inputs since there are a lot of possible inputs altogether and would take a long time to test them all.

Circuit Description: 8-bit Adder

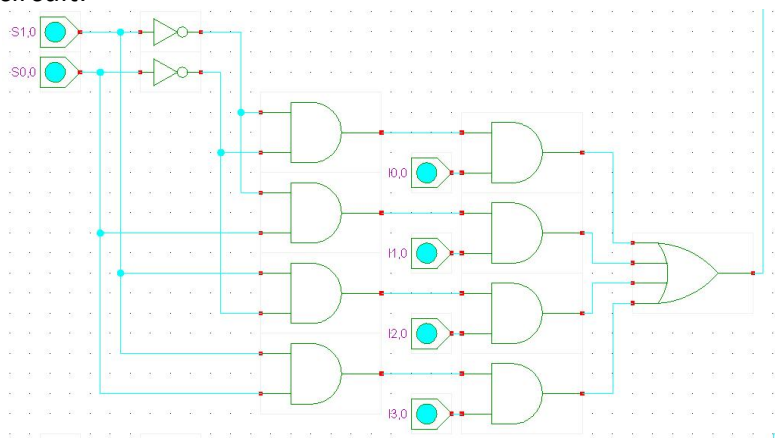
Firstly, as *Logic and Computer Design Fundamentals* states, a full adder is a "combinational circuit that forms the arithmetic sum of three input bits". Altogether, a full adder contains three inputs and two outputs. A full adder should follow this truth table:

X	Y	Z	C	S
0	0	0	0	0
0	0	1	0	1
0	1	0	0	1
0	1	1	1	0
1	0	0	0	1
1	0	1	1	0
1	1	0	1	0
1	1	1	1	1

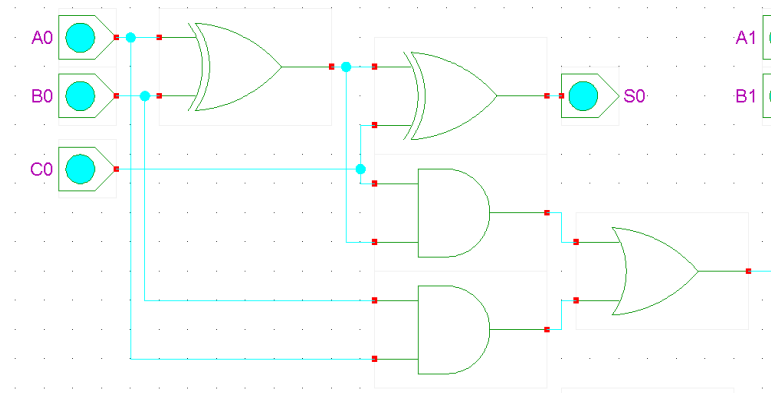
For my 8-bit adder, I took full adders and connected the C-outputs to the C-inputs of the next full adder until I had a total of eight connected full adders. I tested this circuit with all possible inputs since there are only 8 possible combinations as shown in the previous truth table.

Circuit Diagram: Closer Look at Previous Circuits

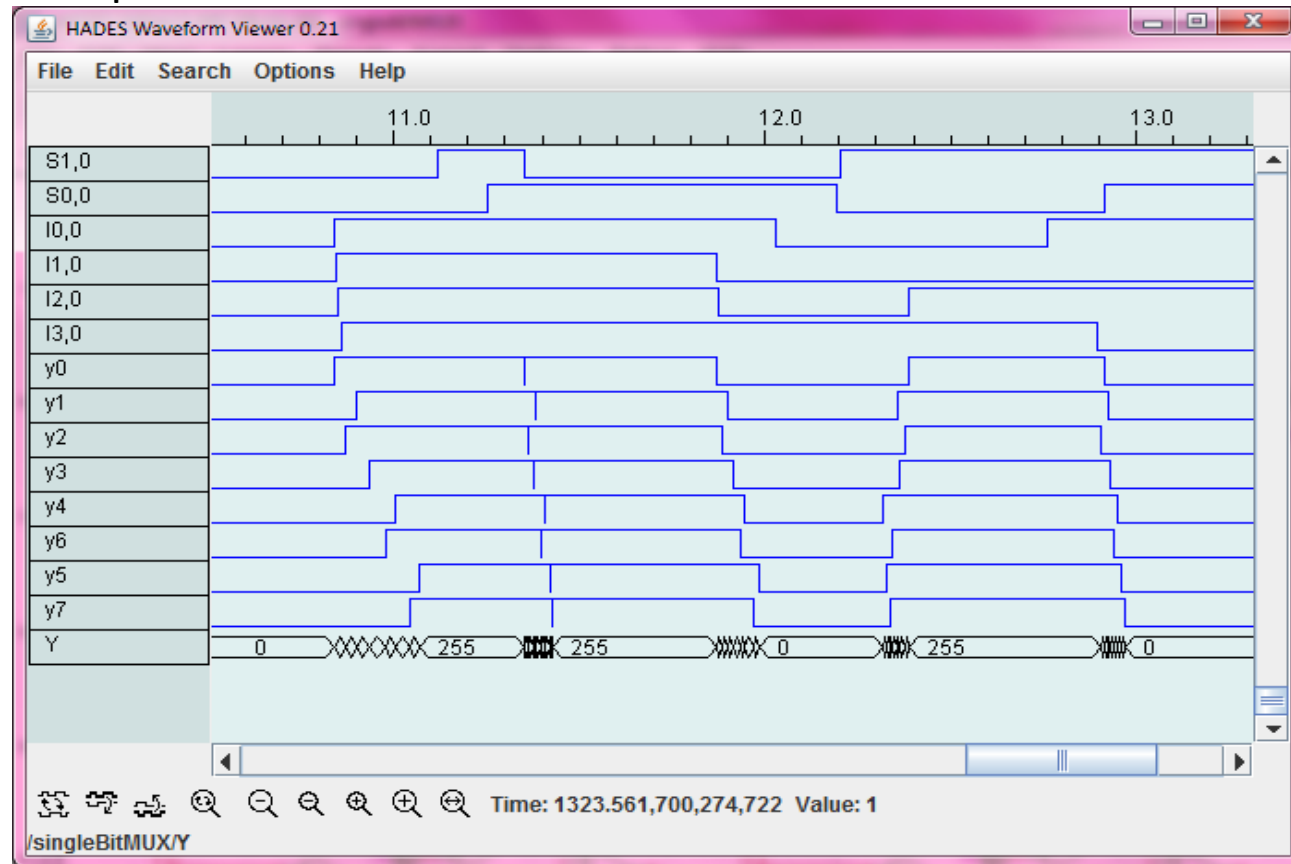
Below is an example of a single-bit 4-to-1 multiplexer used in my circuit:



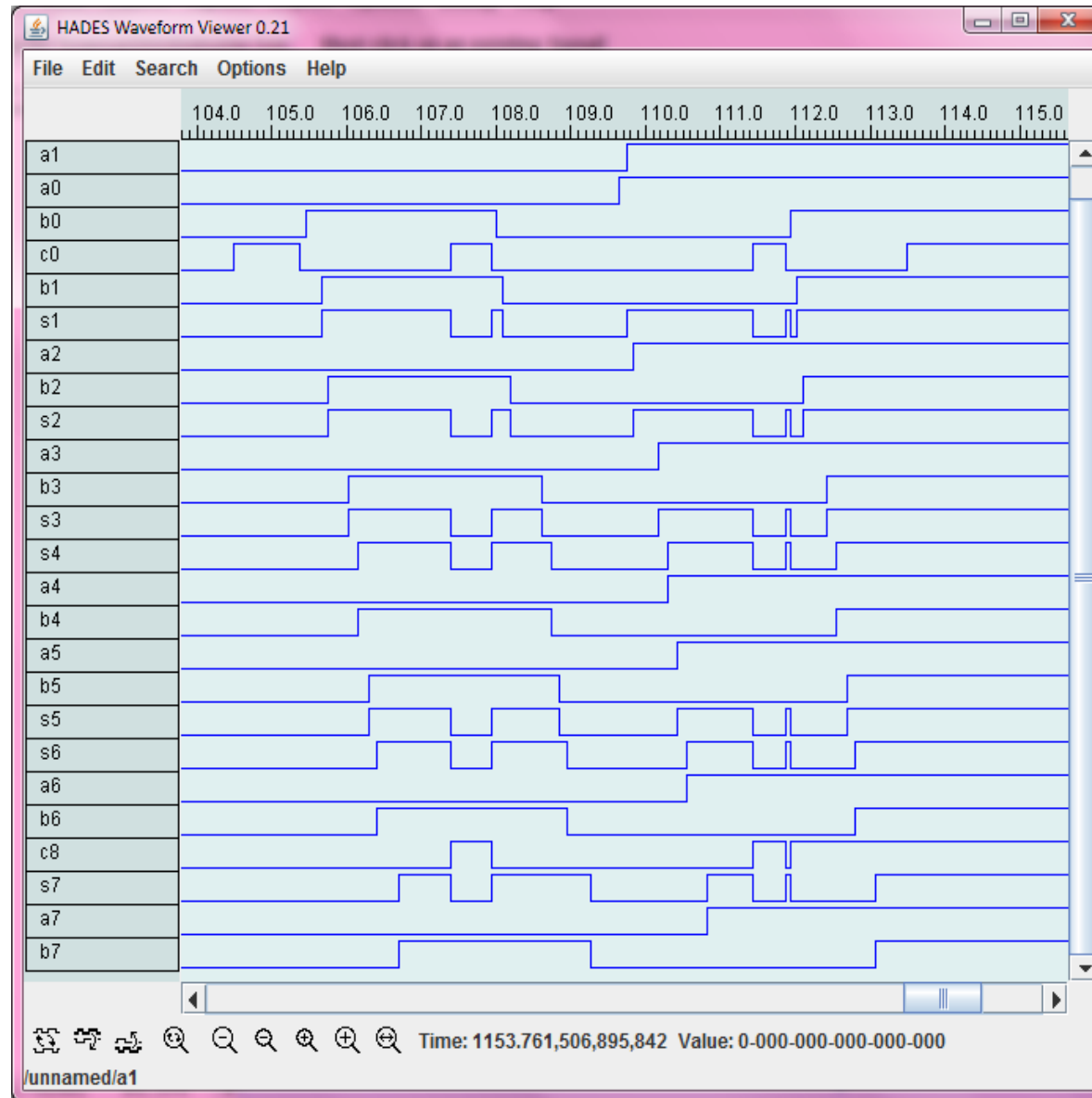
Below is an example of a full adder used in my circuit:



Waveform: 4-to-1 Multiplexer



Waveform: 8-bit Adder



References:

Mano, Morris M., and Charles R. Kime. *Logic and Computer Design Fundamentals*. 4th ed. Upper Saddle River, NJ: Pearson Education, Inc., 2008.