EECE 144
Fall 2011

Lab Report #3
Section 4
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Submitted by:

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1 Description/Objectives

The objective of this lab is to build a working logic function in hardware along with basic interfacing circuits using switches and LEDs.

2 Procedure

Equation 1 will be used as the logic function to be implemented in this lab.

$$ac + a'b + ab'c' \tag{1}$$

Before wiring the hardware it is a good idea to devise a plan using a truth table and a diagram of the necessary gates. The diagram built in Logisim should look similar to Figure 2. The truth table (Figure 1) can be built by manually calculating the output of the function or by using the Logisim simulation. It is recommended to use both of these methods as this serves as a sanity check for your calculations. This check does not guarantee that they are both correct but it is unlikely that they would both be wrong in exactly the same way.

$ac + a'b + ab'c'$			
a	b	c	z (out)
0	0	0	0
0	0	1	0
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	0
1	1	1	1

Figure 1: Truth table of outputs for the function $ac + a'b + ab'c'$.

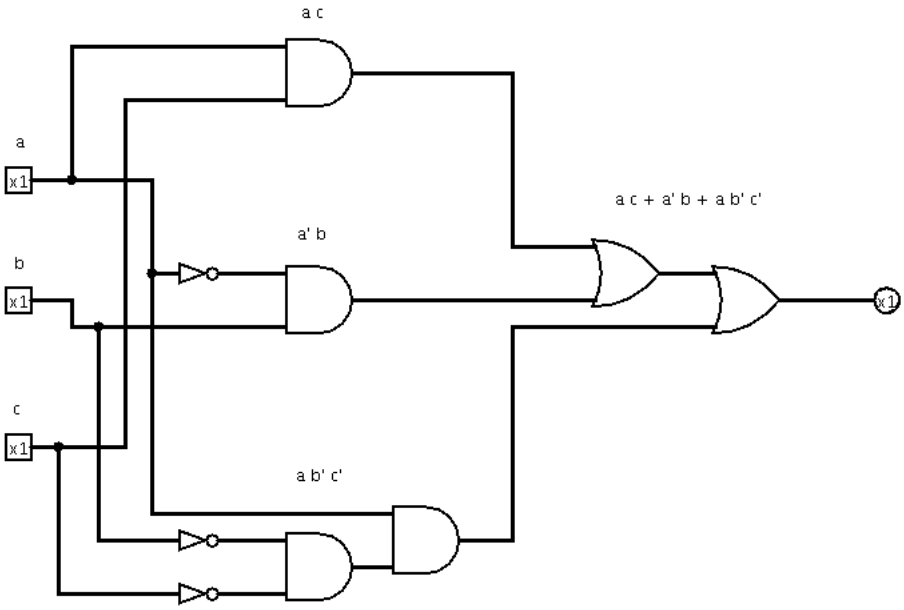

Figure 2: Logic circuit $ac + a'b + ab'c'$ defined in Logisim.

2.1 Interface Circuitry

After the plan has been devised the next step is to implement the function in hardware.

In order to provide hi/lo signals in to the 7400 series chips [3] it is necessary to provide approximately 5 volts for hi and 0 volts for low. This can be done using a mechanical switch with one terminal connected to a 5 volt source. But when the switch opens to indicate 0 volts this open circuit condition is indeterminate and is not guaranteed to be near 0 volts. To remedy this situation a pull down resistor is used as show in Figure 3. Any suitably large value for the resistor should work but it was found that 1k worked whereas 10k did not.

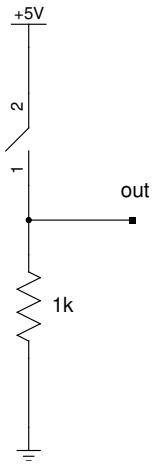

Figure 3: Pull down resistor circuit.

To signal the final result of the logic circuit a LED will be connected to the final output pin. For the LEDs used in this lab the current should be approximately 20 mA. If we assume that the diode behaves as a short circuit with no voltage drop we can use Ohm's Law ($V = i \cdot R$) to calculate a resistor value of 250 ohms ($5/.020 = 250$). Select a resistor with a value greater than or equal to this. Also be aware that LEDs are directional and they will not illuminate if they are backwards.

2.2 Wiring

The task of wiring the chips is tedious but it is nearly impossible without a plan (see Section 2).

To wire the chips it is necessary to have all the pertinent data sheets. These describe the function of each pin, the voltage characteristics and the orientation of the pins. The general procedure is as follows:

- Choose a subset of the circuit to implement from Figure 2.
- Refer to the data sheet for the pin identification of the chip involved.
- Connect wires.
- Repeat until all subsets of the circuit have been implemented.

As an example, the diagram (Figure 2) showed that each pin was connected to the NOT gates first. So the first step was to connect each of the switches which represented the inputs a, b, and c to the corresponding pins on the 7404 NOT gate chip.

To test the output of a pin on a chip a voltmeter can be used. The hi/low outputs will not be exactly 5 volts but they should be close [1].

3 Observations

The output of the logic function should agree with the truth table (Figure 1).

The voltage level outputs are unlikely to be exactly 0 volts and 5 volts for low and high. During this lab it was found that a low of 0.16 volts and a high of 4.68 volts was normal.

[1] Refer to the data sheet for the chip being used for the exact threshold values.

4 Conclusion

The construction of this logic circuit confirmed the expected behavior as predicted through manual calculation and simulation. The benefit of simulation and calculation was also shown by the fact that wiring chips is tedious and time consuming.

5 References

[1] C. Roth Jr., Fundamentals of Logic Design. Cengage Learning, 2009.

[2] Logisim, "Logisim, a graphical tool for designing and simulating logic circuits." `http://ozark.hendrix.edu/~burch/logisim/`, 2011.

[3] Wikipedia, "7400 series — Wikipedia, the free encyclopedia." `http://en.wikipedia.org/wiki/7400_series`, 2011. [Online; accessed 15-September-2011].