ECE272 Lab 1
Spring 2018

Basic Combinational Logic and the MachXO3LF

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1. Introduction

This lab aims to introduce students to the lattice software and focuses mostly on getting the first parts of the FPGA soldered and fishing the soldering of the button board. An FPGA is a re-programmable integrated circuit. One of the benefits of using an FPGA is that you are able to test and prototype on the FPGA before spending a fortune on making the first IC (although the ones made after the first are very cheap to make)

2. Design

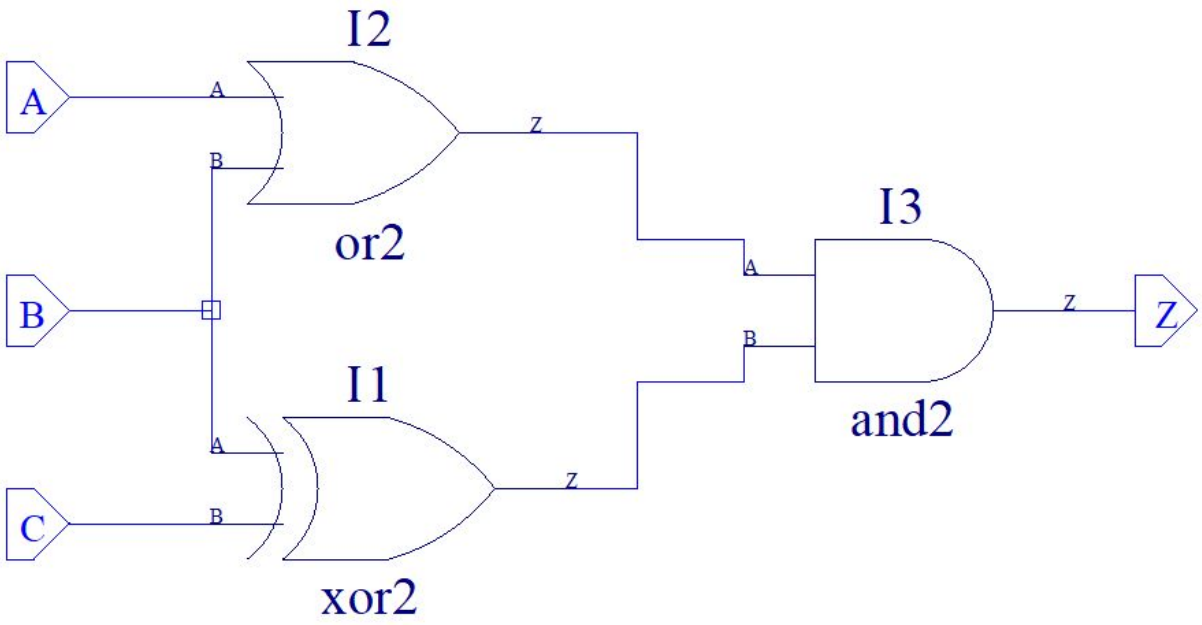


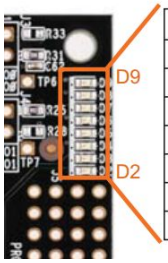
Figure 1: Schematic of logic block

	FPGA PIN	PULLMODE
INPUT A	A3	UP
INPUT B	A4	UP
INPUT C	A5	UP
OUTPUT Z	H11	DOWN

Table 1: Chosen Pins and Pull Modes

I chose pins A3, A4, and A5 for my input pins as shown in the figure above. I set these to pullmode up because the button board buttons are active low. Meaning that they are sending a 1

when not pushed down and a 0 when pushed down. If I had set my pins to pullmode down I would not see a difference when the buttons were pressed or not.



LED	Net	MachXO3L Ball
D9	LED0	H11
D8	LED1	J13
D7	LED2	J11
D6	LED3	L12
D5	LED4	K11
D4	LED5	L13
D3	LED6	N15
D2	LED7	P16

Figure 2: LED pins

I chose the pin H11 arbitrarily based off of the figure above. H11 is associated with the D9 LED on the FPGA. Having an output LED let's the user know what the output of the logic block is according to the inputs they supplied.

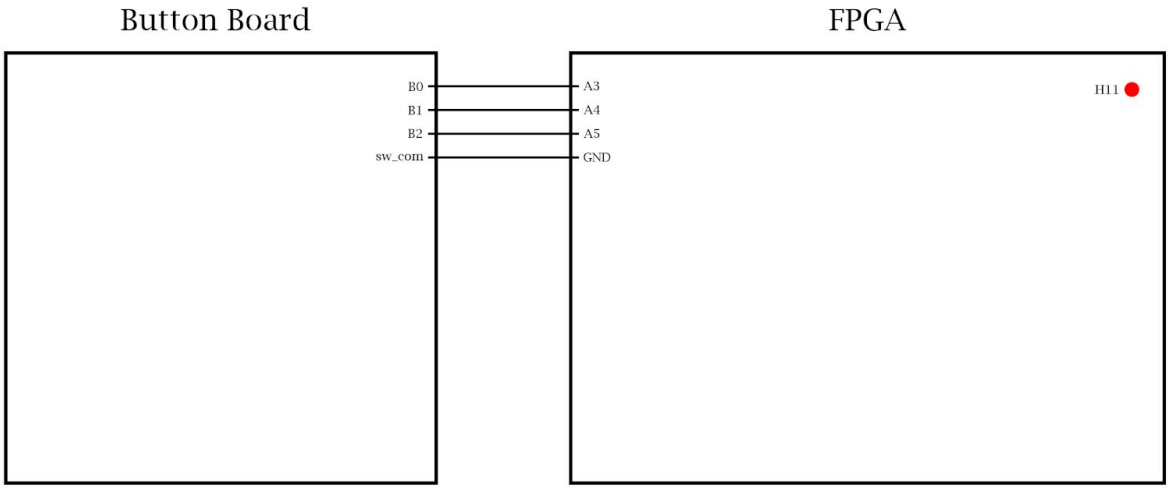


Figure 3: Block Diagram for Hardware

This diagram shows that the pins B0, B1, and B2 on the button board are connected to the FPGA pins A3, A4, and A5 respectfully. This also shows that the button board pin sw_com is grounded. Finally, it shows on the FPGA that the led pin H11 is used as output.

3. Results

A	B	C	Expected Z	Actual Z
0	0	0	0	0
0	0	1	0	0
0	1	0	1	1
0	1	1	0	0
1	0	0	0	0
1	0	1	1	1
1	1	0	1	1
1	1	1	0	0

Table 2: Truth table for logic design

4. Experiment Notes

This lab went took me 10 hours to complete. I had never soldered before and my board was dropped by a TA which led to it breaking and I had to get a new one. Once I had learned how to solder things started going better and I was finally able to work on the programming part. Programming took 2 of the total work hours.

Study Questions:

1. **Describe any problems encountered in this lab and your solutions to those problems.**
   Problems encountered included not knowing how to solder and having a broken board. I was able to overcome these problems by brute force learning how to solder by trial and error. I remedied the board problem by getting a new board.

2. **Give an example of where discrete logic ICs (7400 series logic chips) are used in industry and why.**
   7400 ICs were used in HP computers. Specifically the 1000, 3000, and 21MX series.[1]

[1] https://en.wikipedia.org/wiki/7400_series

3. **Give an example of when you should use an FPGA instead of a PLA and explain why.**

PLAs have no startup time, FPGAs do, also PLAs can't be reprogrammed, FPGAs can be reprogrammed.[2]

4. **Give an example of when you should use an PLA instead of a FPGA and explain why.**

Someone would want to use a PLA if start up times were a critical need of the device. For example an emergency stop system. People don't want an emergency stop system to have to warm up before it can stop the system.

5. **Summarize the main differences between FPGAs and CPLDs, other than the difference described in the note in section 1.1.**

FPGA uses SRAM which results in FPGAs having faster logic operations than the CPLDs. However, CPLD doesn't require boot up time while the FPGA does. So what people give up in logic operation time they gain in start up time.

Appendix

No code this time.

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[2] https://electronics.stackexchange.com/questions/8231/what-are-programmable-logic-ics-of-different-complexity-used-for