

EE4363 / CSci 4203 – Computer Architecture Machine Problem 1

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Provide a brief summary of your experiment.

In this experiment I used, <https://www.edaplayground.com/home>, to simulate operations of the MIPS ALU Verilog module. I have modified the testbench to six operations since the original file is configured only for four operations. I used information from table or Figure C.5.13 on page C-36 in Appendix-C-Computer-Organization.pdf. I added two lines because it makes easy to check in the waveform the result for each operation. Now, I can see how the times of the operations are.

The setup was modified as below (last two lines):

```
#10 ALUctl=4'b0000;  
#10 ALUctl=4'b0001;  
#10 ALUctl=4'b0010;  
#10 ALUctl=4'b0110;  
#10 ALUctl=4'b0111;  
#10 ALUctl=4'b1100;
```

For all these six operations:

```
0: ALUOut <= A & B;  
1: ALUOut <= A | B;  
2: ALUOut <= A + B;  
6: ALUOut <= A - B;  
7: ALUOut <= A < B ? 1 : 0;  
12: ALUOut <= ~(A | B); // result is nor
```

For all 4 experiments with 4 different values for A and B, I have verified that the results produced by the MIPS ALU are correct. To confirm these answers, I have the results of Zero (1 or 0) for each operation in the following graphs below.

I clearly can see in the waveform that for each operation it takes around 10ns.

Include waveforms for your simulation showing all ports of the ALU (as a function of simulated time).

EXPERIMENT WITH VALUE 1

```
A=32'b0000_0000_0000_0000_0000_0000_1101_0101;
```

```
B=32'b0000_0000_0000_0000_0000_0000_0101_0101;
```

VCD info: dumpfile MIPSAlu.vcd opened for output.

```
0 A = 000000d5 B = 00000055 ALUOut = 00000000 Zero = 1
10 A = 000000d5 B = 00000055 ALUOut = 00000055 Zero = 0
20 A = 000000d5 B = 00000055 ALUOut = 000000d5 Zero = 0
30 A = 000000d5 B = 00000055 ALUOut = 0000012a Zero = 0
40 A = 000000d5 B = 00000055 ALUOut = 00000080 Zero = 0
50 A = 000000d5 B = 00000055 ALUOut = 00000000 Zero = 1
60 A = 000000d5 B = 00000055 ALUOut = ffffffff2a Zero = 0
```

Figure 1: Value 1 output for Zero

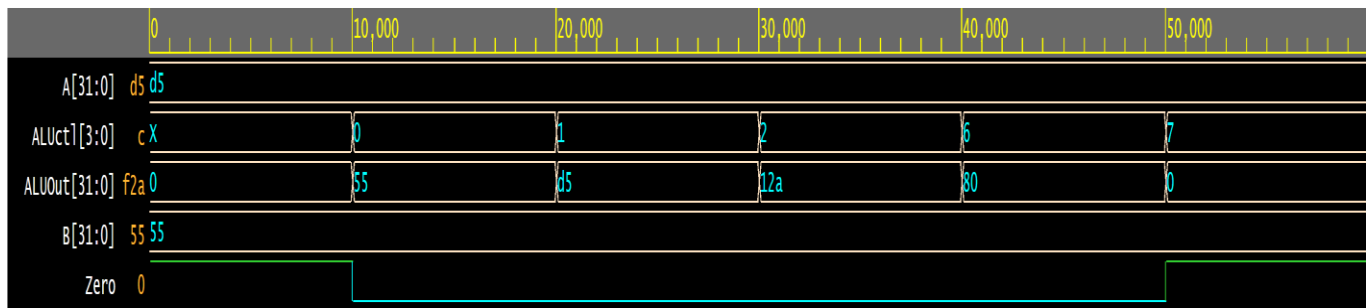


Figure 2: Value 1 Waveform

EXPERIMENT WITH VALUE 2

```
A=32'b0000_0000_0000_0000_0000_0000_0001_0101;
```

```
B=32'b0000_0000_0000_0000_0000_0000_0101_0101;
```

VCD info: dumpfile MIPSAlu.vcd opened for output.

```
0 A = 00000015 B = 00000055 ALUOut = 00000000 Zero = 1
10 A = 00000015 B = 00000055 ALUOut = 00000015 Zero = 0
20 A = 00000015 B = 00000055 ALUOut = 00000055 Zero = 0
30 A = 00000015 B = 00000055 ALUOut = 0000006a Zero = 0
40 A = 00000015 B = 00000055 ALUOut = ffffffff c0 Zero = 0
50 A = 00000015 B = 00000055 ALUOut = 00000001 Zero = 0
60 A = 00000015 B = 00000055 ALUOut = ffffffff aa Zero = 0
```

Figure 3: Value 2 output for Zero

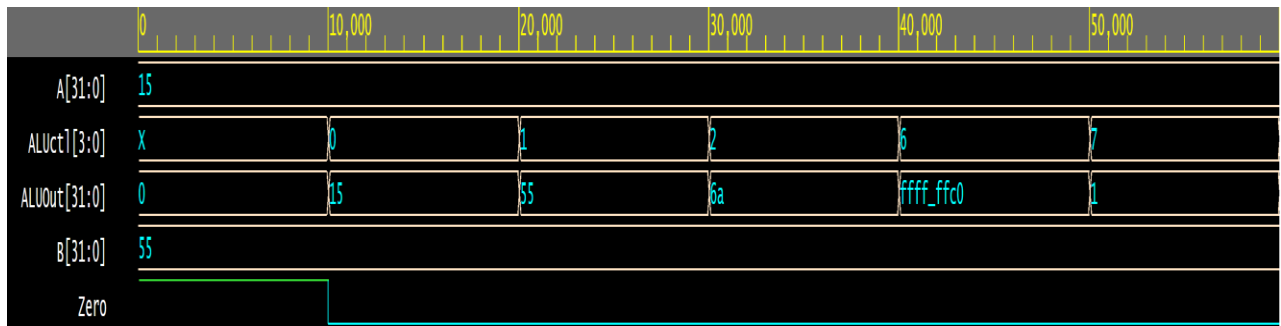


Figure 4: Value 2 Waveform

EXPERIMENT WITH VALUE 3

A=32'b0000_0000_0000_0000_0000_0000_0001;

B=32'b0000_0000_0000_0000_0000_0000_0101_0101;

VCD info: dumpfile MIPSAlu.vcd opened for output.

```

0 A = 00000001 B = 00000055 ALUOut = 00000000 Zero = 1
10 A = 00000001 B = 00000055 ALUOut = 00000001 Zero = 0
20 A = 00000001 B = 00000055 ALUOut = 00000055 Zero = 0
30 A = 00000001 B = 00000055 ALUOut = 00000056 Zero = 0
40 A = 00000001 B = 00000055 ALUOut = ffffffffac Zero = 0
50 A = 00000001 B = 00000055 ALUOut = 00000001 Zero = 0
60 A = 00000001 B = 00000055 ALUOut = ffffffffaa Zero = 0

```

Figure 5: Value 3 output for Zero

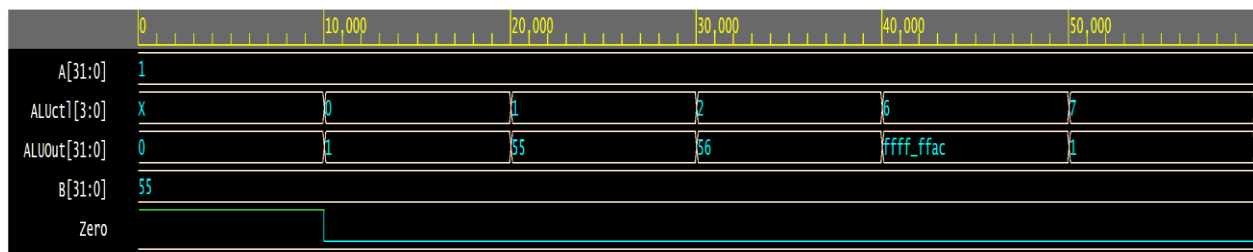


Figure 6: Value 3 Waveform

EXPERIMENT WITH VALUE 4

```
A=32'b0000_0000_0000_0000_0000_0101_0101;
```

```
B=32'b0000_0000_0000_0000_0000_0000_0001;
```

VCD info: dumpfile MIPSAlu.vcd opened for output.

```
0 A = 00000055 B = 00000001 ALUOut = 00000000 Zero = 1
10 A = 00000055 B = 00000001 ALUOut = 00000001 Zero = 0
20 A = 00000055 B = 00000001 ALUOut = 00000055 Zero = 0
30 A = 00000055 B = 00000001 ALUOut = 00000056 Zero = 0
40 A = 00000055 B = 00000001 ALUOut = 00000054 Zero = 0
50 A = 00000055 B = 00000001 ALUOut = 00000000 Zero = 1
60 A = 00000055 B = 00000001 ALUOut = ffffffff Zero = 0
```

Figure 7: Value 4 output for Zero

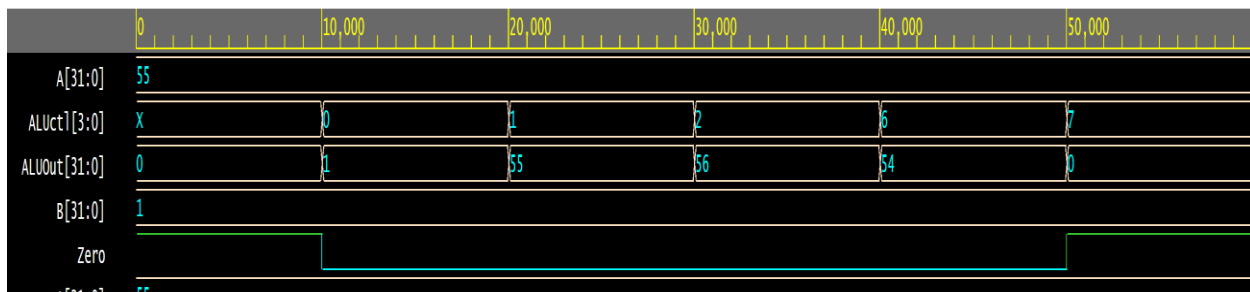


Figure 8: Value 4 Waveform