CECS 440 Lab 3 Report - Designing Arithmetic and Logic Unit (ALU)

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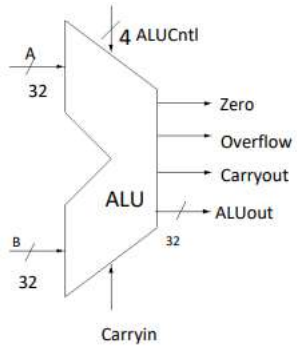
1. Lab objective and approaching in designing the ALU unit:

We design an ALU using VHDL and the ALU is defined using the behavior model. The ALU executes logic and arithmetic operations such as AND, OR, XOR, NOR, addition, and subtraction.



ALUCntl	Function
0000	And
0001	Or
0011	Xor
0010	Add
0110	Subtract
1100	Nor

The ALU has two 32-bit data input signals A and B, and 4-bit control signals (ALUCntl) that will specify which operation to be performed. For some cases, Carryin is a don't care value that can be either 0 or 1. The ALU will output a 32-bit result signal (ALUout) which depends on the control signals and three status flag bits Zero, Overflow, and Carryout.

Overflow indicates integer flow of add and subtract functions. Overflow occurs when two signed 2's complement numbers are added and, if both operands are positive but the result is negative; or when both operands are negative but the result is positive. In addition, Zero output indicates if all ALUout lines have value 0, and Carryout indicates carry out and unsigned integer overflow.

To test this design, we calculate the ALU, Zero, Overflow and Carryout values in Table 2. Then we write a test bench to test the design for inputs of A, B, Carryin, and ALUCntl and compare the results with the calculated values.

2. Calculation of Table 2: Test Vectors for testing the design

#	A(hex)	B(hex)	Carryin	ALUCntl	ALUout(hex)	Zero	Overflow	Carryout
1	FFFFFFFF	00000000	0	0000	00000000	1	0	0
2	98989898	89898989	0	0001	99999999	0	0	0
3	01010101	10101010	0	0011	11111111	0	0	0
4	00000001	FFFFFFFF	0	0010	00000000	1	1	1

5	6389754F	AD5624E6	0	0010	10DF9A35	0	1	1
6	00000001	FFFFFFFF	1	0010	00000001	0	1	1
7	6389754F	AD5624E6	1	0010	10DF9A36	0	1	1
8	FFFFFFFF	FFFFFFFF	1	0010	FFFFFFFF	0	0	1
9	00000000	00000001	1	0110	FFFFFFFF	0	1	0
10	F9684783	F998D562	1	0110	FFCF7221	0	1	0
11	9ABCDEDF	9ABCDEFD	1	1100	65432100	0	1	0
12	89BCDE34	C53BD687	1	0010	4EF8B4BC	0	1	1

3. Conclusion: Using VHDL, we designed and implemented a 32-bit ALU. ALU is one component of CPU that performs all arithmetic computations such as addition and subtraction and all sorts of basic logical operations such as AND, OR, XOR, NOR, and NOT.