Lab session Arithmetic Logic Unit

Group A: October 19, 2009
Group B: October 20, 2009

Work in the given groups of two. Submit your solutions to the respective assignment on Blackboard. The file name is:
`a03_s0XXXXX_s0XXXXX.tar.gz`
One of the group members commits your solution. Keep an eye on the deadline (see Blackboard)!

1 Project

Read section C.5 of Appendix C. Build a arithmetic logic unit (ALU) for 16-bit two's complement data words. To do this, create a circuit that implements a 1-bit ALU. Combine them to obtain a 16-bit ALU. Implement the operations below, giving each operation a 4-bit binary code. Your ALU will execute the right operation according to a 4-bit operation input. Next to this, your ALU should have two 16-bit words as input, one 16-bit word as output, and one "error" bit as output, denoting an error. Summarizing:

Input	a (16-bit)
	b (16-bit)
	operation (4-bit)
Output	result (16-bit)
	error (1-bit)

Your ALU should be able to perform the following operations:

1. AND. Example:

a	0010010010101010
b	1010100101010010
result	0010000000000010

2. OR. Example:

a	0010010010101010
b	1010100101010010
result	1010110111111010

3. NOT. Example:

a	0010010010101010
result	1101101101010101

4. generate 0. Example:

result	0000000000000000

5. numeric inverse (two's complement). Example:

a	0010010010101010
result	1101101101010110

Mind overflow!

6. numeric addition (two's complement). Ripple carry addition suffices. Example:

a	0010010010101010
b	1010100101010010
result	1100110111111100

Mind overflow!

7. numeric subtraction (two's complement). Re-use numeric inverse and numeric addition Example:

a	0010010010101010
b	1010100101010010
result	0111101101011000

Mind overflow!

8. shift left. Example:

a	0010010010101010
result	0100100101010100

9. shift right. Example:

a	0010010010101010
result	0001001001010101

10. signed shift left (two's complement). This implements "times two". Example:

a	0010010010101010
result	0100100101010100

Mind overflow!

11. signed shift right (two's complement). This implements "divide by two". Example:

a	0010010010101010
result	0001001001010101

Mind overflow!

12. less than. Results in 1 if a $<$ b, 0 if a $\geq$ b. Use subtraction. Example:

a	0010010010101010
b	1010100101010010
result	0000000000000000

Mind overflow!

13. greater than. Results in 1 if a $>$ b, 0 if a $\leq$ b. Use subtraction. Example:

a	0010010010101010
b	1010100101010010
result	0000000000000001

Mind overflow!

14. equals. Results in 1 if a = b, 0 if a $\neq$ b. Use subtraction. Example:

a	0010010010101010
b	1010100101010010
result	0000000000000000

Mind overflow!