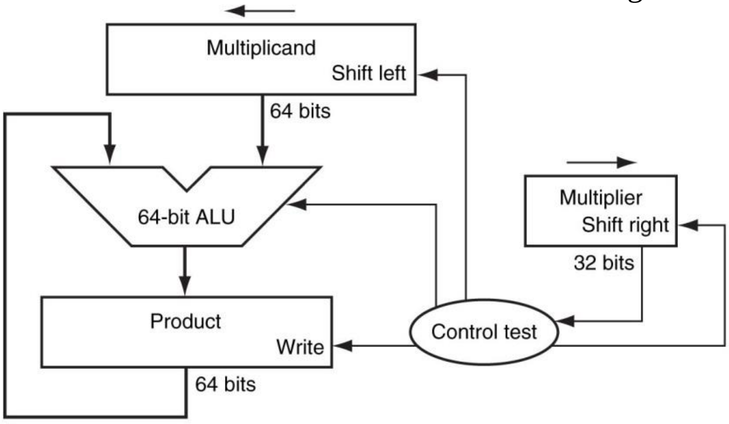
Computer Organization and Structure

Homework #3
Due: 2015/12/1

1. Let's look in more detail at multiplication. We will use the numbers in the following table.

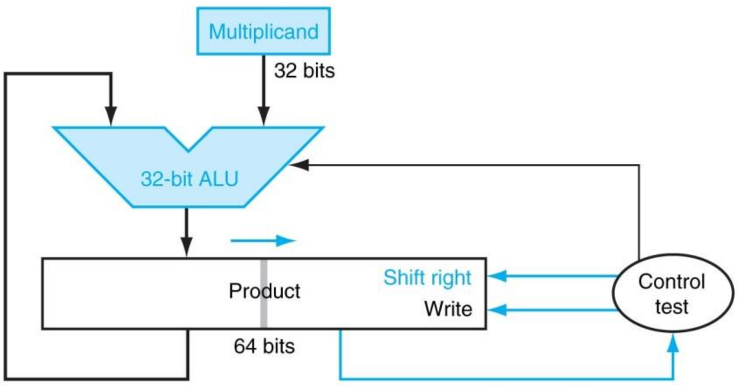
	A	B
1	50	23
2	66	04



a. Using a table similar to the following one, calculate the product of the octal unsigned 6-bit integers A and B using the hardware as shown in the right figure. You should show the contents of each register on each step.

Iteration	Step	Multiplier	Multiplicand	Product
0	Initial values	0011	0000 0010	0000 0000
1	1a: 1⇒Prod=Prod+Mcand	0011	0000 0010	0000 0010
	2: Shift left Multiplicand	0011	0000 0100	0000 0010
	3: Shift right Multiplier	0001	0000 0100	0000 0010
2	1a: 1⇒Prod=Prod+Mcand	0001	0000 0100	0000 0110
	2: Shift left Multiplicand	0001	0000 1000	0000 0110
	3: Shift right Multiplier	0000	0000 1000	0000 0110
3	1: 0⇒No operation	0000	0000 1000	0000 0110
	2: Shift left Multiplicand	0000	0001 0000	0000 0110
	3: Shift right Multiplier	0000	0001 0000	0000 0110
4	1: 0⇒No operation	0000	0001 0000	0000 0110
	2: Shift left Multiplicand	0000	0010 0000	0000 0110
	3: Shift right Multiplier	0000	0010 0000	0000 0110

b. Using a table similar to the above one, calculate the product of the hexadecimal unsigned 8-bit integers A and B using the hardware as shown in the right figure. You should show the contents of each register on each step.



2. The ALU supported set on less than (slt) using just the sign bit of the adder. Let's try a set

on less than operation using the values -7_{ten} and 6_{ten}. To make it simpler to follow the example, let's limit the binary representations to 4 bits: 1001_{two} and 0110_{two}.

$1001_{two} - 0110_{two} = 1001_{two} + 1010_{two} = 0011_{two}$

This result would suggest that $-7_{ten} > 6_{ten}$, which is clearly wrong. Hence we must factor in overflow in the decision. Modify the 1-bit ALU in the following figures to handle slt correctly.

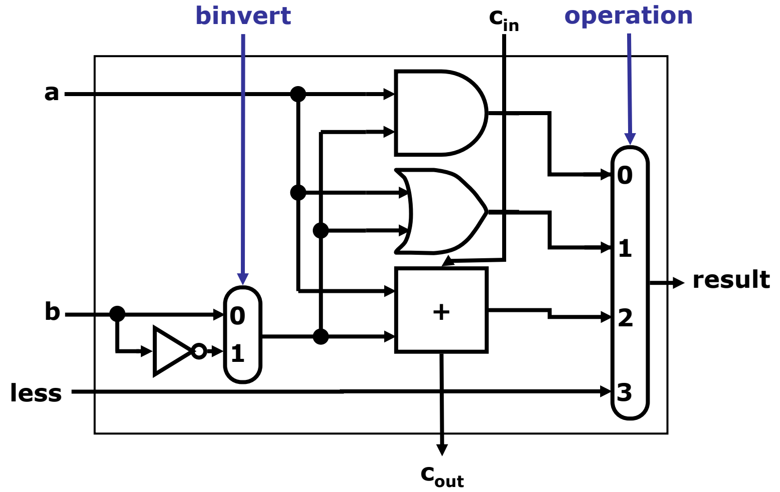


Figure 1: A 1-bit ALU that performs AND, OR, and addition on a and b or b'.

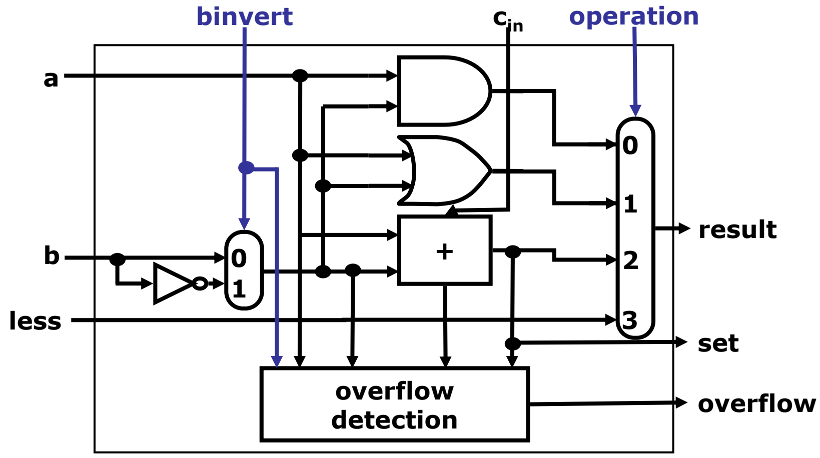


Figure 2: A 1-bit ALU for the most significant bit.

3. Given the bit pattern:

   1010 1101 0001 0000 0000 0000 0000 0010

   what does it represent, assuming that it is

   a. A two's complement integer?
   b. An unsigned integer?

c. A single precision floating-point number? where we use the IEEE 754 floating-point standard which represents a floating-point number as $(-1)^S \times (1+F) \times 2^E$ and encodes the *S*, *F*, and *E* ordering using 1, 23, and 8 bits, respectively.
d. A MIPS instruction?

4. With x = 0000 0000 0000 0000 0000 0000 0101 1011_{two} and y = 0000 0000 0000 0000 0000 0000 0000 1101_{two} representing two's complement signed integers, perform, showing all work:

   a. x+y
   b. x-y
   c. x*y
   d. x/y