Computer Organization and Design

Homework 4

3.9 Assume 151 and 214 are signed 8-bit decimal integers stored in two's complement format. Calculate 151 + 214 using saturating arithmetic. The result should be written in decimal. Show your work. (必须有过程，无过程不得分)

Solution:
Saturation arithmetic is a version of arithmetic in which all operations such as addition and multiplication are limited to a fixed range between a minimum and maximum value.
151=10010111_2 As it is a signed 8-bit integer, we get:

$$10010111 = -(01101001) = -105$$

214=$11010110_2 = -(00101010) = -42$

Using saturating arithmetic, 151+214=$(-01101001) + (-00101010) = -105 - 42$

$$= -147$$

Since signed 8-bit integers range is -128~127

$$-147 < -128$$

Therefore, the result is -128

3.10 Assume 151 and 214 are signed 8-bit decimal integers stored in two's complement format. Calculate 151−214 using saturating arithmetic. The result should be written in decimal. Show your work. (必须有过程，无过程不得分)

Solution:
151=10010111_2 As it is a signed 8-bit integer, we get:

$$10010111 = -(01101001) = -105$$

214=$11010110_2 = -(00101010) = -42$

Using saturating arithmetic, $151-214$

$$=(-01101001) + (-00101010) = -105 + 42$$
$$= -63$$

Since signed 8-bit integers range is -128~127

$$-128 < -63 < 127$$

Therefore, the result is -63.

3.12 Using a table similar to that shown in Figure 3.6, calculate the product of the octal unsigned 6-bit integers 62 and 12 using the hardware described in Figure 3.3. You should show the contents of each register on each step.
Solution:

$$62_{oct} \times 12_{oct} \rightarrow 110010 \times 001010$$

Step	Action	Multiplier	Multiplicand	Product
0	Initial Vals	001 010	000 000 110 010	000 000 000 000
1	lsb=0, no op	001 010	000 000 110 010	000 000 000 000
	Lshift Mcand	001 010	000 001 100 100	000 000 000 000
	Rshift Mplier	000 101	000 001 100 100	000 000 000 000
2	Prod=Prod+Mcand	000 101	000 001 100 100	000 001 100 100
	Lshift Mcand	000 101	000 011 001 000	000 001 100 100
	Rshift Mplier	000 010	000 011 001 000	000 001 100 100
3	lsb=0, no op	000 010	000 011 001 000	000 001 100 100
	Lshift Mcand	000 010	000 110 010 000	000 001 100 100
	Rshift Mplier	000 001	000 110 010 000	000 001 100 100
4	Prod=Prod+Mcand	000 001	000 110 010 000	000 111 110 100
	Lshift Mcand	000 001	001 100 100 000	000 111 110 100
	Rshift Mplier	000 000	001 100 100 000	000 111 110 100
5	lsb=0, no op	000 000	001 100 100 000	000 111 110 100
	Lshift Mcand	000 000	011 001 000 000	000 111 110 100
	Rshift Mplier	000 000	011 001 000 000	000 111 110 100
6	lsb=0, no op	000 000	011 001 000 000	000 111 110 100
	Lshift Mcand	000 000	110 010 000 000	000 111 110 100
	Rshift Mplier	000 000	110 010 000 000	000 111 110 100

3.13 Using a table similar to that shown in Figure 3.6, calculate the product of the hexadecimal unsigned 8-bit integers 62 and 12 using the hardware described in Figure 3.5. You should show the contents of each register on each step.

Solution: $62_{hex} \times 12_{hex} \rightarrow 0110\ 0010 \times 0001\ 0010$

Step	Action	Multiplicand	Product/Multiplier
0	Initial Vals	0110 0010	0000 0000 0001 0010
1	lsb=0, no op	0110 0010	0000 0000 0001 0010
	Rshift Product	0110 0010	0000 0000 0000 1001
2	Prod=Prod+Mcand	0110 0010	0110 0010 0000 1001
	Rshift Product	0110 0010	0011 0001 0000 0100
3	lsb=0, no op	0110 0010	0011 0001 0000 0100
	Rshift Product	0110 0010	0001 1000 1000 0010
4	lsb=0, no op	0110 0010	0001 1000 1000 0010
	Rshift Product	0110 0010	0000 1100 0100 0001
5	Prod=Prod+Mcand	0110 0010	0110 1110 0100 0001
	Rshift Product	0110 0010	0011 0111 0010 0000
6	lsb=0, no op	0110 0010	0011 0111 0010 0000
	Rshift Product	0110 0010	0001 1011 1001 0000
7	lsb=0, no op	0110 0010	0001 1011 1001 0000
	Rshift Product	0110 0010	0000 1101 1100 1000
8	lsb=0, no op	0110 0010	0000 1101 1100 1000
	Rshift Product	0110 0010	0000 0110 1110 0100