Logical Design
Lecture 6

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Negative Numbers Representation in Computers

There are three common ways to represent negative numbers within the computer.

- Signed magnitude representation.

- 1's compliment representation.

- 2's complement representation.

Sign-magnitude notation

The representation of a signed binary number is commonly referred to as the sign-magnitude notation and **if the sign bit is "0", the number is positive. If the sign bit is "1", then the number is negative**. When dealing with binary arithmetic operations, it is more convenient to use the complement of the negative number.
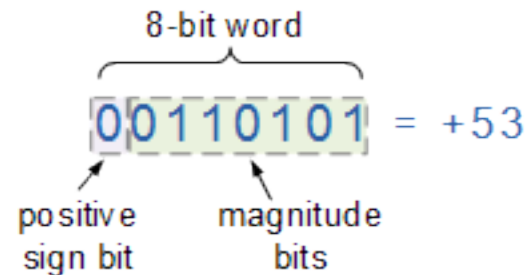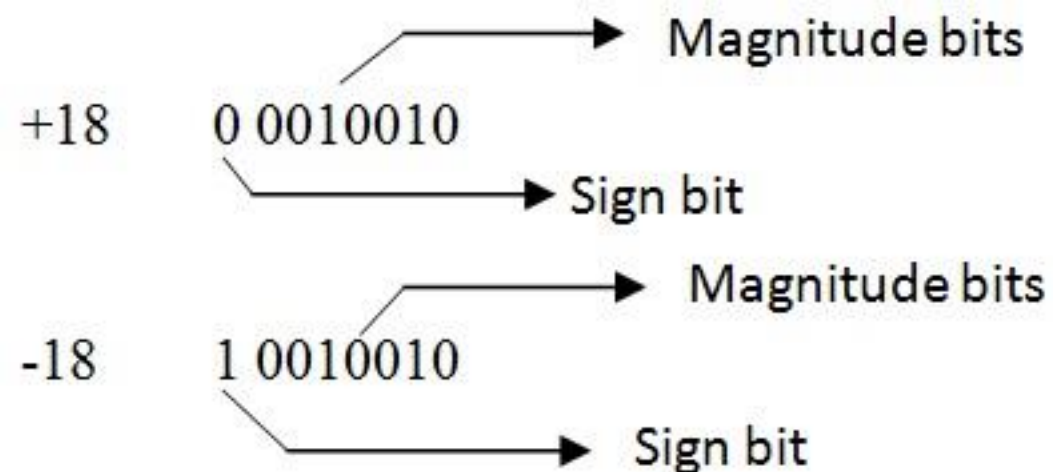
Sign-magnitude notation

Ex: 1001 — > + 9 (positive) 1 001 — > – 1 (negative)

This is the simplest way of representing the both positive and negative numbers in binary system. In the signed magnitude representation,

- Positive number is represented with '0' at its most significant bit (MSB).

- Negative number is represented with '1' at its most significant bit (MSB).

One's Complement of a Signed Binary Number

A positive number always starts with 0, at its MSB while a negative number always starts with 1, at its MSB.

1's compliment of a number is created by replacing all 0's with 1's & all 1's with 0's.

For example, if a binary number is **01101001**, then its one's complement is **10010110.**

Ex: -33 =?

33 is represented as $(100001)_2$, In <u>8-bit notation</u>, it is represented as $(0010\ 0001)_2$

Now, -33 is represented in one's compliment as $(1101\ 1110)_2$

Ex: -127 =?

In 8 bit notation, 127 is represented as $(0111\ 1111)_2$

Now, -127 is represented in one's compliment as $(1000\ 0000)_2$

Two's Complement of a Signed Binary Number

To find the 2's compliment of a binary number,

- First, find the 1's compliment of that number.

- Then "1" is added to the 1's compliment.

Ex 1: -33 =?

33 is represented as $(100001)_2$, In 8-bit notation, it is represented as $(0010\ 0001)_2$

Now, -33 is represented in one's compliment as $(1101\ 1110)_2$

Adding 1 (0000 0001) to it, The result is $(1101\ 1111)_2$.

Therefore, the two's complement of the number – 33 is $(1101\ 1111)_2$.

Two's Complement of a Signed Binary Number

Ex 2: -127 =?

In 8 bit notation, 127 is represented as $(0111\ 1111)_2$

Now, -127 is represented in one's compliment as $(1000\ 0000)_2$

Adding 1 $(0000\ 0001)$ to it, The result is $(1000\ 0001)_2$

Therefore, the two's complement of the number -127 is $(1000\ 0001)_2$

Ex 3: -1 =?

1 is represented as $(001)_2$ In 8 bit notation, it is represented as $(0000\ 0001)_2$

Now, -1 is represented in one's compliment as $(1111\ 1110)2$

Adding 1 $(0000\ 0001)$ to it, The result is $(1111\ 1111)_2$

Therefore, the two's complement of the number -1 is $(1111\ 1111)_2$