

Unsigned Numbers

Unsigned numbers are non-negative integers. They can be represented using a variety of methods, including:

Binary: Unsigned numbers can be represented in binary using a sequence of 0s and 1s. The most significant bit (MSB) is the leftmost bit, and the least significant bit (LSB) is the rightmost bit. The value of an unsigned binary number is the sum of the values of its individual bits. For example, the unsigned binary number 101101 represents the decimal number 45.

Signed Numbers

Signed numbers are numbers that can be either positive or negative. They can be represented using a variety of methods, including:

Sign-magnitude: In sign-magnitude representation, the sign of a number is represented by a single bit. The MSB is the sign bit, and the remaining bits represent the magnitude of the number. If the sign bit is 0, the number is positive. If the sign bit is 1, the number is negative. For example, the sign-magnitude representation of the decimal number -45 is 101101.

Two's complement: In two's complement representation, the sign of a number is represented by the MSB. If the MSB is 0, the number is positive. If the MSB is 1, the number is negative. The magnitude of a negative number in two's complement representation is the complement of its positive representation plus 1. For example, the two's complement representation of the decimal number -45 is 1100101.

Signed Magnitude Form

The signed-magnitude form is a way of representing signed numbers in binary. It is similar to the way we represent signed numbers in decimal, where the first digit of the number indicates whether the number is positive or negative.

In the signed-magnitude form, the most significant bit (MSB) of the number is used to indicate the sign of the number. If the MSB is 0, the number is positive. If the MSB is 1, the number is negative.

The remaining bits of the number represent the magnitude of the number. The magnitude of a number is the absolute value of the number, without regard to its sign.

Advantages of Signed Magnitude Representation

The signed-magnitude form has several advantages over other ways of representing signed numbers in binary.

The signed-magnitude form is very simple to implement in hardware. This is because the only operation that is required is a comparison of the MSB to 1.

Compatibility: The signed-magnitude form is compatible with the way that we represent signed numbers in decimal. This makes it easy to convert between signed numbers in binary and decimal.

Fixed-point number system for signed numbers.

A fixed-point number system represents real numbers using a fixed number of bits where the position of the binary point (fraction point) is fixed.

In signed fixed-point representation:

1. Sign Bit The MSB (most significant bit) is the sign bit.

0 → positive

1 → negative

2. Integer + Fraction Parts

Representation Methods: Signed fixed-point values can be stored using: Sign magnitude , 1's complement , 2's complement (most common).

Represent the signed 4-bit numbers using:

i. Sign Magnitude: MSB = sign bit , Remaining 3 bits = magnitude

Decimal	Representation
+0	0000
-0	1000
+1	0001
-1	1001
+2	0010
-2	1010
+3	0011
-3	1011
+4	0100
-4	1100
+7	0111
-7	1111

Range: -7 to +7

ii. 1's Complement Positive numbers = normal binary

Negative numbers = bitwise complement of positive value

Decimal	Representation
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+0	0000
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-0	1111
----	------

+1	0001
----	------

-1	1110
----	------

+2	0010
----	------

-2	1101
----	------

+3	0011
----	------

-3	1100
----	------

+4	0100
----	------

-4	1011
----	------

+7	0111
----	------

-7	1000
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Range: -7 to +7, but has two zeros.

iii. 2's Complement: Positive numbers = normal binary

Negative numbers = 2's complement (invert bits + 1)

Decimal Representation

+0 0000

+1 0001

+2 0010

+3 0011

+4 0100

+5 0101

+6 0110

+7 0111

-1 1111

-2 1110

-3 1101

-4 1100

-5 1011

-6 1010

-7 1001

-8 1000

Range: -8 to +7, unique zero.