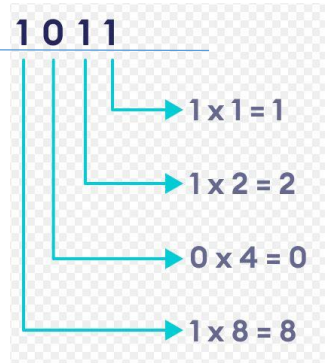
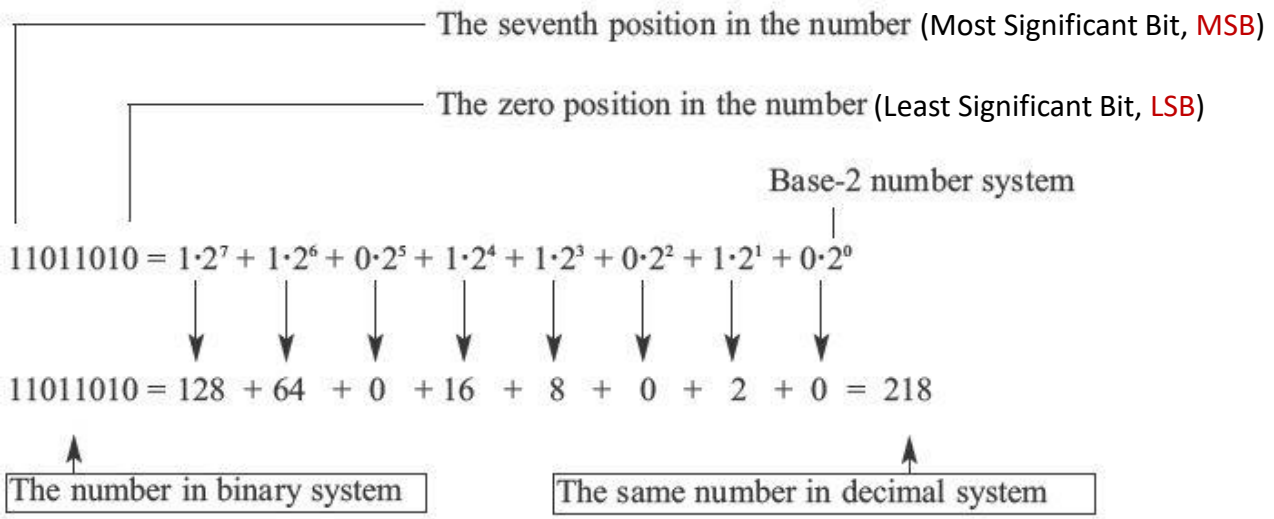
Binary numbers

Decimal	Binary
0	0000
1	0001
2	0010
3	0011
4	0100
5	0101
6	0110
7	0111
8	1000
9	1001
10	1010
11	1011
12	1100
13	1101
14	1110
15	1111



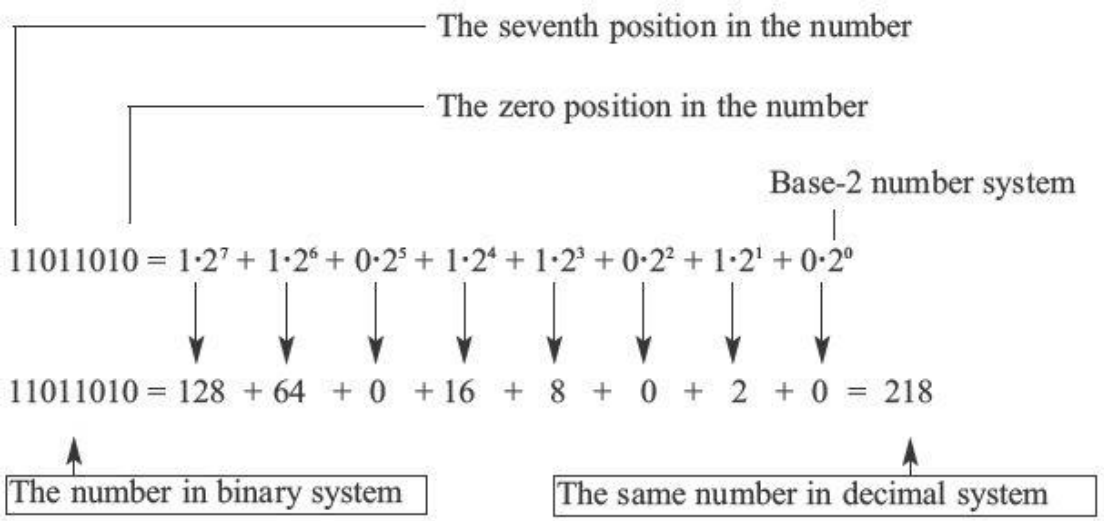
Binary Weights



Number of bits in a binary number

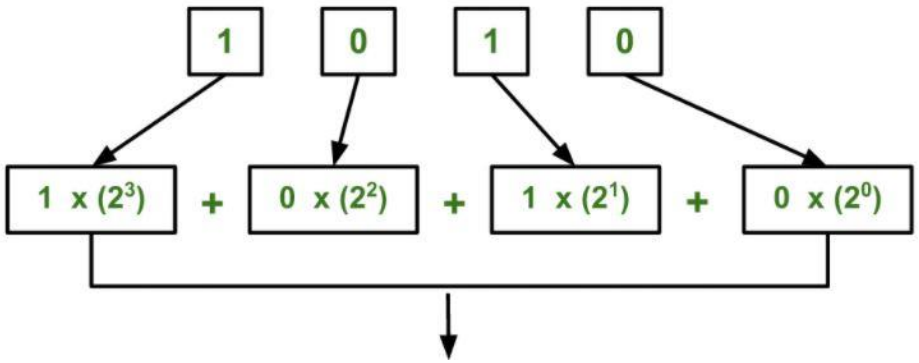
An n-bit number produces 2^n combinations of 0s and 1s in n bits

An 8-bit number produces $2^8 = 256$ Combinations (that is from 0 to 255)



Binary to decimal conversion

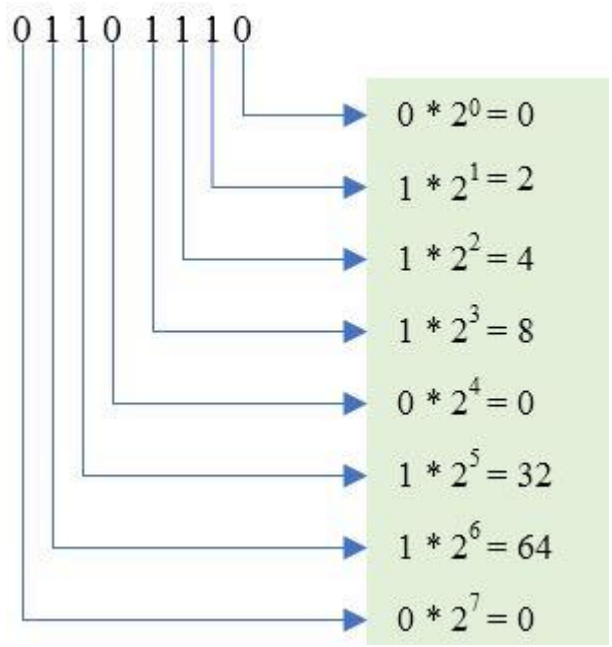
4-bit Binary number: 1010



Decimal number: 8+0+2+0 = 10

Binary to decimal conversion

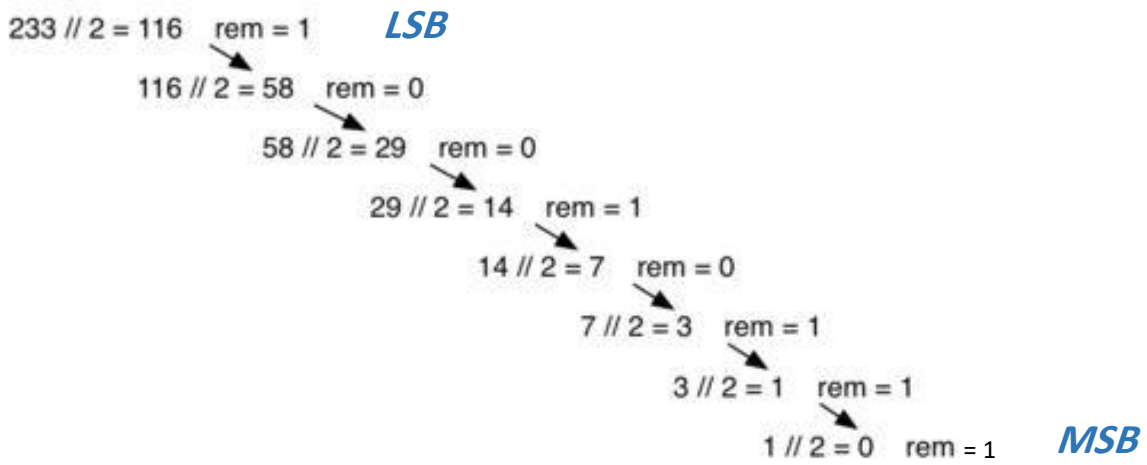
8-bit Binary number: 01101110



Decimal number: 0+2+4+8+0+32+64+0 = 110

Decimal to binary conversion

Decimal number: 233



Binary number: 11101001

Binary addition

Example 1:

1 1	
00110 +	*6 +*
00011	*3*
01001	*9*

Example 2:

10000 +	*16 +*
00111	*7*
10111	*23*

Example 3:

1 1	
10011 +	*19 +*
10001	*17*
1 ← 00100	*36*

Overflow
Need more than five bits for the sum

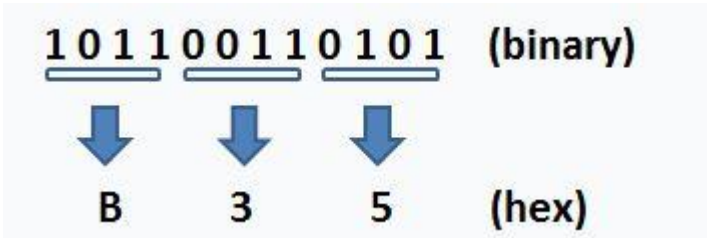
Octal and **Hexadecimal** numbers are closely related to binary numbers

Decimal Base-10	Binary Base-2	Octal Base-8	Hexa Decimal Base-16
	2^1	2^3	2^4
0	0	0	0
1	1	1	1
2	10	2	2
3	11	3	3
4	100	4	4
5	101	5	5
6	110	6	6
7	111	7	7
8	1000	10	8
9	1001	11	9
10	1010	12	A
11	1011	13	B
12	1100	14	C
13	1101	15	D
14	1110	16	E
15	1111	17	F
16	10000	20	10

Binary to Hexadecimal conversion

2^1 2^3 2^4

Decimal Base-10	Binary Base-2	Octal Base-8	Hexa Decimal Base-16
0	0	0	0
1	1	1	1
2	10	2	2
3	11	3	3
4	100	4	4
5	101	5	5
6	110	6	6
7	111	7	7
8	1000	10	8
9	1001	11	9
10	1010	12	A
11	1011	13	B
12	1100	14	C
13	1101	15	D
14	1110	16	E
15	1111	17	F
16	10000	20	10



16^2 16^1 16^0

2^{4^2} 2^{4^1} 2^{4^0}

2^8 2^4 2^0

Binary to Hexadecimal conversion

	2^1	2^3	2^4
Decimal Base-10	Binary Base-2	Octal Base-8	Hexa Decimal Base-16
0	0	0	0
1	1	1	1
2	10	2	2
3	11	3	3
4	100	4	4
5	101	5	5
6	110	6	6
7	111	7	7
8	1000	10	8
9	1001	11	9
10	1010	12	A
11	1011	13	B
12	1100	14	C
13	1101	15	D
14	1110	16	E
15	1111	17	F
16	10000	20	10

Find the Hex Equivalent for Binary 1011010

101 ***1010***

group 2 group 1

Group 2 containing only 3 bits, so add 0 to the left

0101 ***1010***

⇩ ⇩

5 ***A***

Hexadecimal to binary conversion

	2^1	2^3	2^4
Decimal Base-10	Binary Base-2	Octal Base-8	Hexa Decimal Base-16
0	0	0	0
1	1	1	1
2	10	2	2
3	11	3	3
4	100	4	4
5	101	5	5
6	110	6	6
7	111	7	7
8	1000	10	8
9	1001	11	9
10	1010	12	A
11	1011	13	B
12	1100	14	C
13	1101	15	D
14	1110	16	E
15	1111	17	F
16	10000	20	10

Binary to Hexadecimal Conversion

Convert the binary number 1111110101110011_2 to its hexadecimal equivalent.

1. ***Separate the digits into groups from right to left side; each group contains 4 bits of binary number.***

1111 1101 0111 0011

2. ***Find the equivalent hexadecimal number for each group.***

1111 1101 0111 0011

F D 7 3

Hexadecimal to binary conversion

	2^1	2^3	2^4
Decimal Base-10	Binary Base-2	Octal Base-8	Hexa Decimal Base-16
0	0	0	0
1	1	1	1
2	10	2	2
3	11	3	3
4	100	4	4
5	101	5	5
6	110	6	6
7	111	7	7
8	1000	10	8
9	1001	11	9
10	1010	12	A
11	1011	13	B
12	1100	14	C
13	1101	15	D
14	1110	16	E
15	1111	17	F
16	10000	20	10

Hex to Binary Number Conversion

Convert the hexadecimal $9DB5_{16}$ to its binary equivalent.

1. ***Separate the digits of the given hexadecimal, if more than 1 digit.***

9 D B 5

2. ***Find the equivalent binary number for each digit of hex number, add 0's to the left if any of the binary number is shorter than 4 bits.***

9 D B 5

1001 1110 1011 0101

Binary to Octal conversion

2^1 2^3 2^4

Decimal Base-10	Binary Base-2	Octal Base-8	Hexa Decimal Base-16
0	0	0	0
1	1	1	1
2	10	2	2
3	11	3	3
4	100	4	4
5	101	5	5
6	110	6	6
7	111	7	7
8	1000	10	8
9	1001	11	9
10	1010	12	A
11	1011	13	B
12	1100	14	C
13	1101	15	D
14	1110	16	E
15	1111	17	F
16	10000	20	10

Binary to Octal Conversion

Convert the binary number 1111100110012 to its octal equivalent.

1. ***Separate the digits of a given binary number into groups from right to left side, each containing 4 bits.***

111 110 011 001

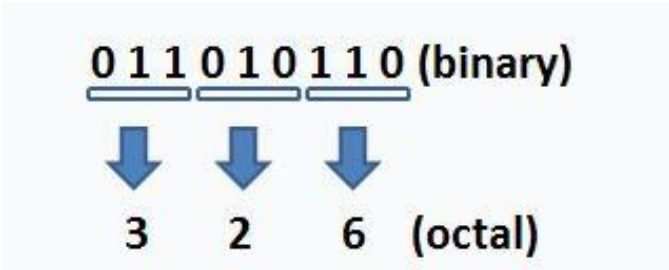
2. ***Find the equivalent octal number for each group.***

111 110 011 001

7 6 3 1

Binary to Octal conversion

	2^1	2^3	2^4
Decimal Base-10	Binary Base-2	Octal Base-8	Hexa Decimal Base-16
0	0	0	0
1	1	1	1
2	10	2	2
3	11	3	3
4	100	4	4
5	101	5	5
6	110	6	6
7	111	7	7
8	1000	10	8
9	1001	11	9
10	1010	12	A
11	1011	13	B
12	1100	14	C
13	1101	15	D
14	1110	16	E
15	1111	17	F
16	10000	20	10



Octal to Binary conversion

	2^1	2^3	2^4
Decimal Base-10	Binary Base-2	Octal Base-8	Hexa Decimal Base-16
0	0	0	0
1	1	1	1
2	10	2	2
3	11	3	3
4	100	4	4
5	101	5	5
6	110	6	6
7	111	7	7
8	1000	10	8
9	1001	11	9
10	1010	12	A
11	1011	13	B
12	1100	14	C
13	1101	15	D
14	1110	16	E
15	1111	17	F
16	10000	20	10

Octal to Binary Conversion

Convert the octal 7631_8 to its binary equivalent.

1. ***Separate the digits of the given octal number, if it contains more than 1 digit.***

   7 6 3 1

2. ***Find the equivalent binary number for each digit of octal number. Add 0's to the left if any of the binary equivalent is shorter than 3 bits.***

   7 6 3 1

   111 110 011 001