

Paper 7, TDC Part-3
Chapter– 3, Number Systems and Codes
Electronics
Lecture - 3

By:

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Number Systems and Codes

Q1) Find the 1's complement of following binary numbers?

- a) 110101001 (b) 0010110
(c) 1000111

Soln: (a) 1's complement of 110101001 \rightarrow 001010110

(b) 1's complement of 0010110 \rightarrow 1101001

(c) 1's complement of 1000111 \rightarrow 0111000

Q2) Represent the following number in 1's complement form.

(a) +24 and -24 (b) +1 and -1

(c) +15 and -15

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(a) +24 and -24 (b) +1 and -1
(c) +15 and -15

1's complement representation.

Soln (a) $(+24)_{10} = (011000)_2$

$$(-24)_{10} = (100111)_2$$

(b) $(+1)_{10} = (0001)_2$ in 4-bit

$$(-1)_{10} = (1110)_2 \text{ in 4-bit.}$$

(c) $(+15)_{10} = (01111)_2$

$$(-15)_{10} = (10000)_2$$

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From ~~it~~ so for n -bit number, the maximum positive number which can be represented is $(2^{n-1} - 1)$ and the maximum negative number is $-(2^{n-1} - 1)$ in 1's complement.

2's Complement Representation of binary numbers.

2's Complement of a binary number is obtained by adding '1' to the ~~1's~~ ~~complement~~ LSB of 1's complement of the binary number.

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Example → Find 2's complement of $(11011)_2$

Binary Number → 11011

1's complement → 00100

+ 1 ← Add

2's Complement 00101

Find 2's complement of $(011100)_2$

Binary Number → 011100

1's complement → 100011

+ 1 ← Add

2's complement 100100

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An alternative direct method to find the 2's complement is :->

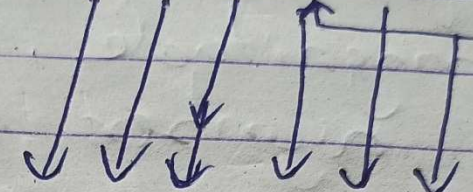
1.) Starting from the right that is LSB, copy the bit's as it ~~binary~~ is in the given binary number, upto the 1st '1' encounter.

2.) After that complement (invert) the remaining bits.

Example :-> 1) Binary No. \rightarrow 1 1 0 1 1 \leftarrow 1st One Encounter
2's Complement \rightarrow 0 0 1 0 1 So copy it
 $\underbrace{\hspace{10em}}$ \rightarrow Complementing remaining bits.

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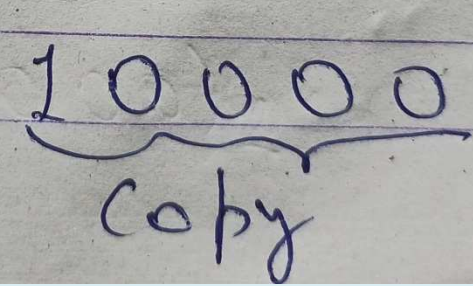
2) Binary No. \rightarrow 011100

2's Complement \rightarrow  Copy the bits
Up to this
1st '1'

100100

Inverting
the remaining bits. Copy

Binary no. \rightarrow 10000

2's Complement \rightarrow  Copy the bits
Up to this 1st
'1'.

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As there is no bits after the last '1' encounter so no bits will be inverted.

To convert from a 1's or 2's complement back to the original number, use the same process as used for finding 1's or 2's complement.

For an n -bit number, maximum positive number which can be represented in 2's complement form is $(2^{n-1} - 1)$ and the maximum ~~number~~ negative number is -2^{n-1} .

at 4-bit

Let us look, the binary number representation of some decimal number in sign-magnitude, 1's and 2's complement binary number system in the table

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Decimal Number	4-bit Binary Sign-Magnitude Representation	1's Complement	2's Complement
0	0000	0000	0000
1	0001	0001	0001
2	0010	0010	0010
3	0011	0011	0011
4	0100	0100	0100
5	0101	0101	0101
6	0110	0110	0110
7	0111	0111	0111
-8	—	—	1000
-7	1111	1000	1001

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0	—	—	1000
-7	1111	1000	1001
-6	1110	1001	1010
-5	1101	1010	1011
-4	1100	1011	1100
-3	1011	1100	1101
-2	1010	1101	1110
-1	1001	1110	1111
-0	1000	1111	—

Table for different binary numbers.

From table it is clear that using 4-bits in sign magnitude we can represent from -7 to 7, and same is the ^{range} ~~case~~ for 1's complement while with 4-bits in 2's

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complement we can represent from
-8 to +7.

In sign magnitude & 1's complement representation '+0' & '-0' can be represented, while with 2's complement representation ~~it is not possible~~ '-0' can not be represented.

Q Represent (-23)₁₀ in - (i) sign magnitude
(ii) 1's complement (iii) 2's complement

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Solution The minimum number of bits required to represent $(+23)_{10}$ is 6 in signed number system.

$$(+23)_{10} = (0 \underbrace{10111})_2$$

Sign Bit
Magnitude Bit.

∴ (i) Sign Magnitude representation of

$$(-23)_{10} = (110111)_2$$

(ii) 1's Complement representation of $(-23)_{10} = (101000)_2$

(iii) 2's Complement representation of $(-23)_{10} = (101001)_2$

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Thank You