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

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Number Systems and Codes

- **<u>Signed Binary Numbers : -</u>**

Like decimal number system, binary number system also deals with the signed numbers. As mentioned in first lecture digital circuits understands only two symbols, ‘0’ and ‘1’; so in binary number systems we use ‘0’ and ‘1’ to represent a positive number and negative number.

An additional bit is used with the binary numbers to indicate a positive or negative number, known as the sign bit. This sign bit is placed to the left of the number that is as the most significant bit (MSB).

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For example in a 8-bit signed number, the first seven bits from right to left represents magnitude of the number while the last 8^{th} bit tells the sign of the number.

Example: - 11001111

Represents magnitude of the signed number that is $(1001111)_2 = (69)_{10}$

This '1' tells that the number is -ve signed number

Similarly in '01001111'; $(1001111)_2 = (69)_{10}$ represents the magnitude and the last most significant bit '0' tell that the number is +ve signed number.

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This representation of binary number is known as sign-magnitude representation.

Q1) For the following sign-magnitude binary numbers find the decimal equivalent number.

a) 000100 b) 101110 c) 001110

Solution- (a) In 000100 the sign bit is ‘0’ so the number is +ve and the remaining bits tells the magnitude that is $(00100)_2 = (4)_{10}$.

So $(000100)_2 = (+4)_{10} = (4)_{10}$

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Solution- (b) In 101110 the sign bit is ‘1’ so the number is -ve and the remaining bits tells the magnitude that is $(01110)_2 = (14)_{10}$.

So $(001110)_2 = (-14)_{10}$

(c) In 001110 the sign bit is ‘0’ so the number is +ve and the remaining bits tells the magnitude that is $(01110)_2 = (14)_{10}$.

So $(001110)_2 = (+18)_{10} = (18)_{10}$

Note :- With unsigned binary number we can represent upto larger value as compared to signed binary numbers. For example 4-bit unsigned binary number can represent from 0 to 15 while 4-bit signed binary number can represent from -7 to +7

- **Complements of Binary Numbers: -**

Complements of binary number permits the representation of negative numbers. The arithmetic operation with negative numbers in digital circuit can be performed in simplified manner using complement of the number.

Binary number systems uses two types of complement – the 1's complement and the 2's complement. The 2's complement arithmetic is commonly used in digital system to handle –ve numbers.

- **One's (1's) Complements of Binary Numbers: -**

Binary number systems uses two types of complement – the 1's complement and the 2's complement. The 2's complement arithmetic is commonly used in digital system to handle –ve numbers.

2's complement method also simplify addition and subtraction of positive and negative numbers in digital systems.

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1's Complement Representation of Binary Number

The 1's complement of a binary number is obtained by inverting each bit of the binary number, this means that all 0s in a binary number number is replaced by 1s and all 1s of the binary number is replaced by 0s.

Binary Number → 1 1 0 0 1 0 1

1's complement of (1100101) → 0 0 1 1 0 1 0

So for 1's complement replace all 1's → 0's
and all 0's → 1's

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So "0011010" is 1's complement of "1100101" and "1100101" is 1's complement of "0011010". If one of the number is positive, then ~~the other~~ its 1's complement is negative with the same magnitude.

Example → (0111) represents $(+7)_{10}$,

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1's complement of $(0111)_2$ is $(1000)_2$ represents $(-7)_{10}$.

The simplest way to obtain 1's complement of a binary number with a digital circuit is to use parallel inverters (NOT gate) for each bit of the binary number.

Figure below shows the digital ckt to obtain 1's complement of 4-bit binary number.

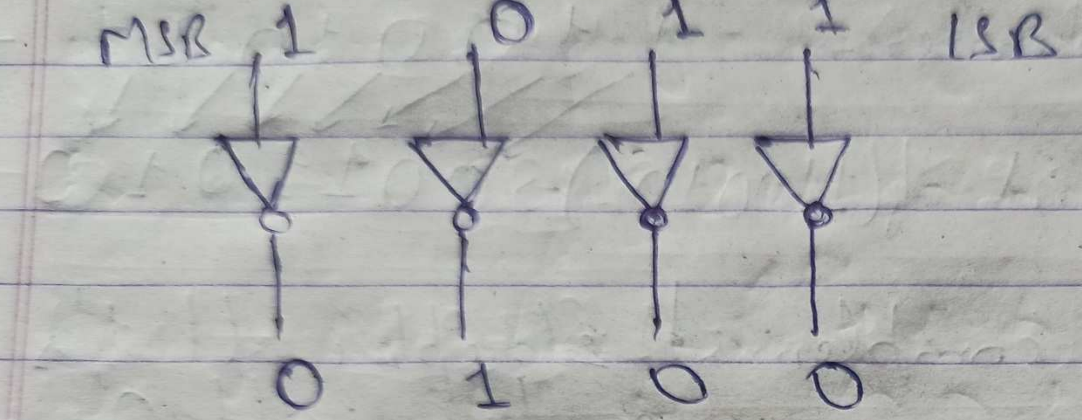

Figure 1 → Digital Circuits to obtain 1's complement of 4bit -binary number.

Similarly to obtain 1's complement of 8-bit binary number we will increase ~~the~~ 4 more NOT gate. and so on.

Let's see few problems on 1's complement

Thank You