SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY

(DEEMED TO BE UNIVERSITY)

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QUALITY SYSTEM CERTIFICATION DNV·GL ISO 9001:2008

Lecture session

SCSA1201- FUNDAMENTALS OF DIGITAL SYSTEMS

Topic: Complements

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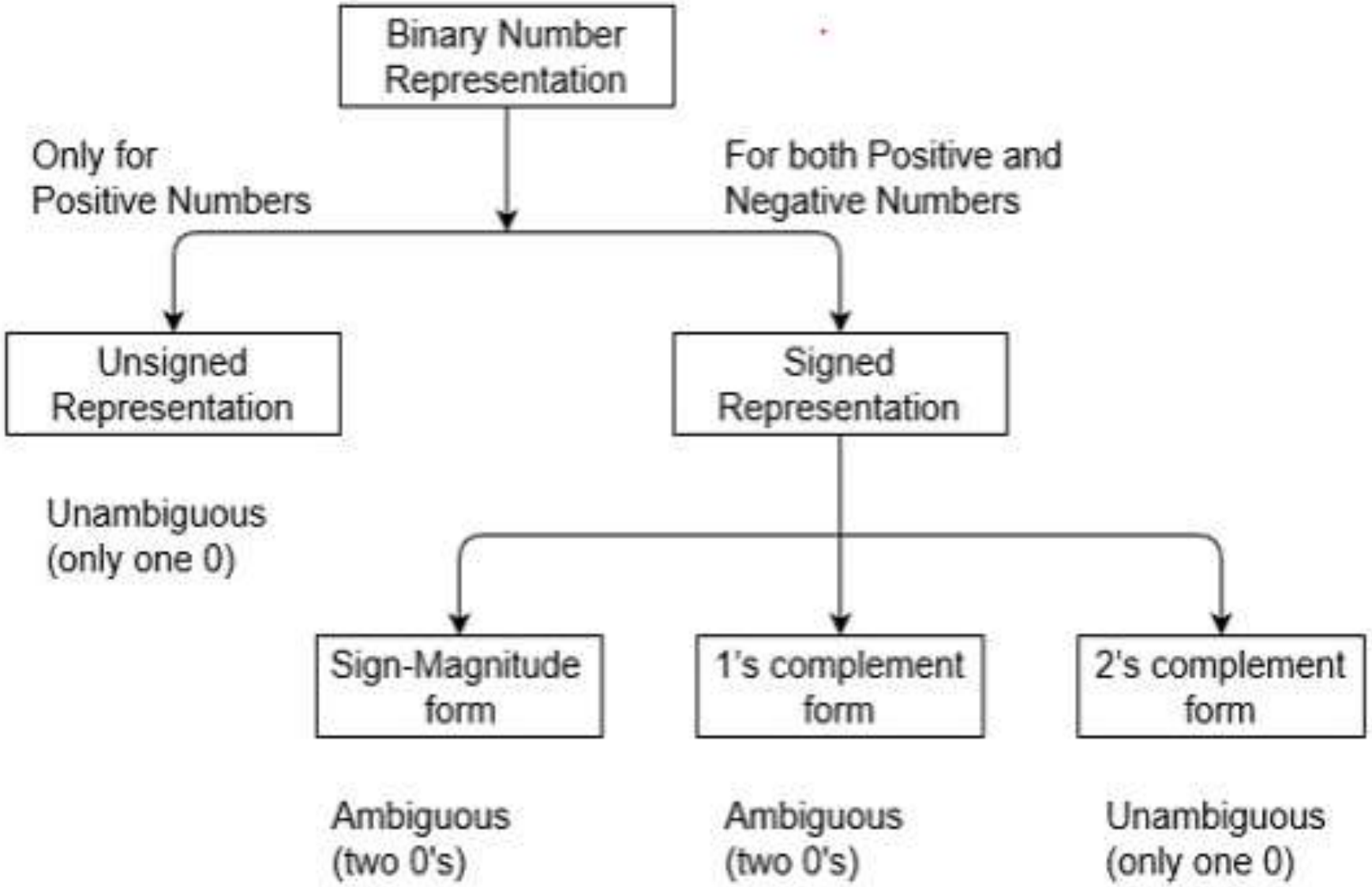
BINARY NUMBER REPRESENTATION



Sign-Magnitude form

In sign-magnitude form, the MSB is used for representing **sign** of the number and the remaining bits represent the **magnitude** of the number. So, just include sign bit at the left most side of unsigned binary number. This representation is similar to the signed decimal numbers representation.

Example:

Binary representation of 108 is 1101100

Consider the **negative decimal number -108**

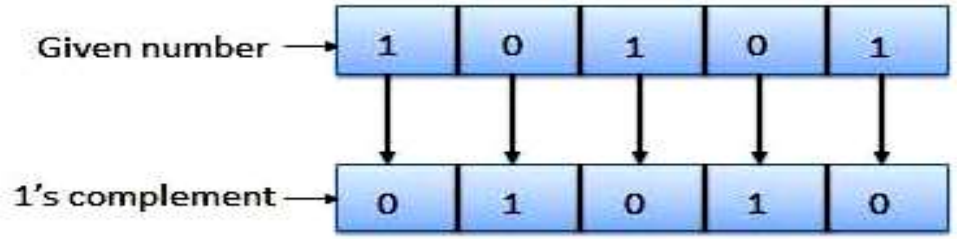
The sign-magnitude representation of -108 is **1**1101100

Binary system complements

As the binary system has base r = 2. So the two types of complements for the binary system are 2's complement and 1's complement.

1's complement

The 1's complement of a number is found by changing all 1's to 0's and all 0's to 1's. This is called as taking complement or 1's complement. Example of 1's Complement is as follows.



Consider the **negative decimal number -108**.

1.signed binary representation of 108 is 01101100.

2.**1's complement of** 108_{10} is 00010011_2.

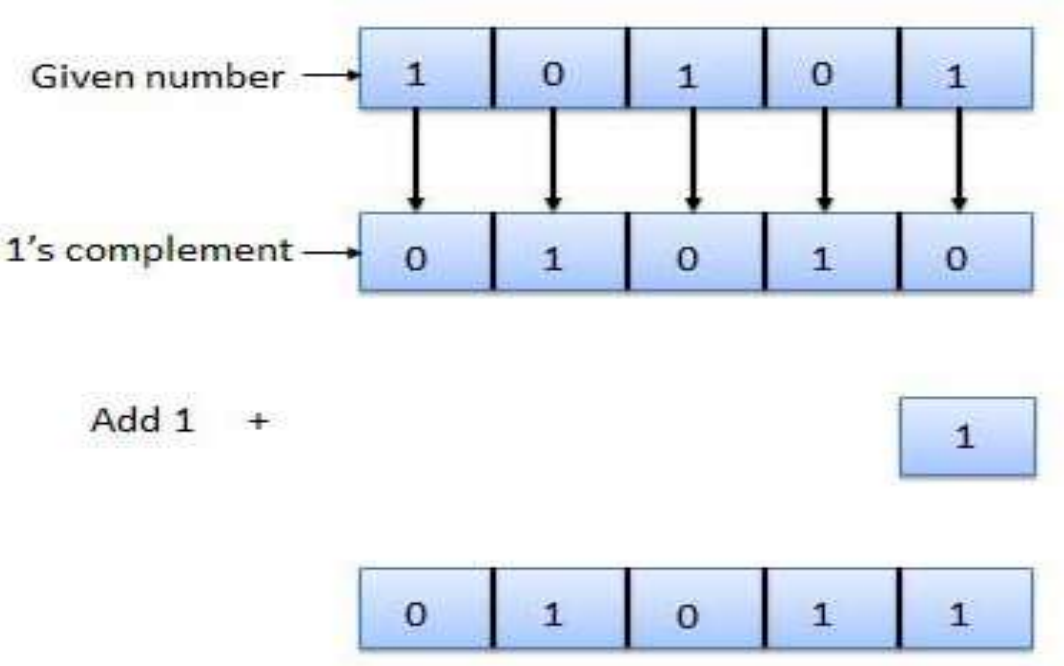
3.Therefore, the **1's complement of** -108_{10} is 10010011_2.

2's complement

The 2's complement of binary number is obtained by adding 1 to the Least Significant Bit (LSB) of 1's complement of the number.

2's complement = 1's complement + 1

Example of 2's Complement is as follows.



Example:

Consider the **negative decimal number -108**.

We know the 1's complement of $(\mathbf{108})_{\mathbf{10}}$ is $(\mathbf{10010011})_{\mathbf{2}}$

2's compliment of 108_{10} = *1's compliment of* 108_{10} + *1*.

= 10010011 + 1

= 10010100

Therefore, the **2's complement of** 108_{10} is 10010100_{2}.

Subtraction of numbers by 1's Complement.

1. Convert the negative numbers to their 1's Complement form, leaving the sign as 1.

2. Add to produce sum.

3. If there is a carry generated bring it round and add it to LSB of the sum. The sum is positive.

4. If there is no carry, the answer is a negative number in 1's complement form.

5. Reconversion is to be done to get the original

Example:

Subtract +2 from +9.

Binary equivalent of 9 = 0 1001

Binary equivalent of -2 = 1 0010

1's Complement of -2 = 1 1101

0 1001

Add 9, -2 = (1) 0 0 1 1.0

Carry → 1

0,0 1 1 1

Answer is +7

2. find the solution of -9 ; +4

Binary equivalent of -9 ⇒ 1, 1001

Binary equivalent of +4 ⇒ 0 0100

1's Complement of -9 ⇒ 1 0110

Add 4 ⇒ 0 0100

1, 1010

No carry is generated, Answer has to Complemented

1, 0101 = -5

3. Add -8 and -9.

Sum may exceed the no. of bits so Choose

$n = 5$.

Binary equivalent of -8 = 101000

Binary equivalent of -9 = 101001

1's Complement of -8 = 110111

1's Complement of -9 = 110110 (+)

Add 1,101101

Carry 1

1,011110

1's Complement of the Answer gives.

= 1, 10001

= -17.

Points to remember:

1.Add two positive numbers, carry is obtained and ignored

2.One positive and one negative numbers are added and positive result, carry is obtained and ignored.

3.Negative result ---→ no carry----→the result is converter to 2's complement

4. Two negative numbers are added, the result is negative, carry is generated, carry is ignored and the result converted to 2's complement form.

Add +9 and -7 using 2's complement

Let $n = 8$, 8^{th} bit shows the sign.

Binary equivalent of +9 = 00001001

Binary equivalent of -7 = 10000111

2's complement of -7 = 11111001

Add +9 = 00001001

10.000010

↵ discard the carry

10000111

11111000

1

11111001

sum is $(00000010)_2$

$= +2$

Add +16 and -19.

Binary equivalent of 16 = 00010000.

Binary equivalent of -19 = 10010011

1's Complement of -19 = 11101100

2's Complement of -19 = 11101101

Add 16 = 00010000

11111101

Sign bit is 1 ← result is -ve

* To get the original answer result has to be converted to 2's Complement form.

i.e.,

1,1111101

1's Complement 1 0000010

2's complement 1, 0000011 ⇒ -3

Add −10 with −20.

Binary Equivalent of −10 = 1 0 0 0 1 0 1 0

Binary equivalent of −20 = 1 0 0 1 0 1 0 0

2's complement of −10.

−10 → 1's complement = 1 1 1 0 1 0 1 1

1

1 1 1 0 1 0 1 0 ← (1) 2's complement of −10 =

2's Complement of −20

1's Complement of −20 = 1 1 0 1 0 1 1 1

1

Add 1

1 1 0 1 1 0 0 ← (2) 2's Complement of −20

Add (1) + (2)

1 1 1 1 0 1 1 0

1 1 1 0 1 1 0 0

discard it ↑ Carry ← 1 1 1 1 0 0 0 1 0

To get Correct Answer find the 2's Complement of the Answer.

i.e) 11100010

$$\Rightarrow \begin{array}{r} 10011101 \\ \quad\quad\quad\quad 1 \\ \hline 10011110 \end{array}$$

result is -30

DECIMAL ARITHMETIC

* Subtraction of decimal numbers accomplished by 9's and 10's complement.

* 9's complement → subtracting each digit by 9

* 10's complement → add 1 to the 9's complement

Example:

Find 9's complement of a) 3465 b) 782.54 c) 4526.075.

a) 9999 − 3465 = 6534

b) 999.99 − 782.54 = 217.45

c) 9999.999 − 4526.075 = 5473.924

Find 10's Complement of the following decimal number.

a) 4069 b) 1056.074.

a) 9999
4069
5930 → 9's Complement
(+) 1
5931 → 10's Complement

9999.999
b) 1056.074
8943.925 → 9's Comp
1
8943.926 → 10's Comp

9's Complement Subtraction.

The negative number is converted to 9's Comp and added to the other number.

If carry exists, added to the number and the result is +ve.

If carry not-exists, the answer is -ve and the result is Converted to 9's Complement to get the Correct result.

Example:

Subtract the following numbers using the 9's Complement method.

a) 745.81 − 436.62. b) 436.62 − 745.81.

a) 745.81 − 436.62.

9's complement of − 436.62

$$\begin{array}{r} 999.99 \\ 436.62 \\ \hline 563.37 \end{array} \qquad \begin{array}{r} 745.81 \\ 563.37 \\ \hline 1309.18 \end{array}$$

Carry ← 1

$$309.19$$

If Carry exists the Answer is positive.

b) 436.62 − 745.81.

9's complement of 745.81 => 999.99
745.81
254.18

436.62
254.18
690.80 → No carry exist, Answer is negative.

9's complement of the Answer is
999.99
690.80
309.19

The Result is − 309.19.

10's Complement method of subtraction.

Example:

Subtract the following number by using 10's complement method.

a) 2928.54 - 416.73 b) 416.73 - 2928.54.

a) 2928.54 - 416.73.

10's complement of 416.73

9999.99
0416.73
9583.26
1
9583.27

2928.54
9583.27
12511.81

↓ Carry ignored

Answer is 2511.81.

b) $416.73 - 2928.\overline{54}$

10's Complement of 2928.54 is

$$\begin{array}{r} 9999.99 \\ 2928.54 \\ \hline 7071.45 \\ \hline 1 \\ \hline 7071.46 \\ \hline \end{array}$$

$$\begin{array}{r} 416.73 \\ 7071.46 \\ \hline 7488.19 \\ \hline \end{array} \Rightarrow \text{No Carry}$$

Answer is -ve

Result is -2511.81.

find 10's complement

$$\begin{array}{r} 999999 \\ 7488.19 \\ \hline \end{array}$$

2511.80

$$\begin{array}{r} 2511.80 \\ 1 \\ \hline \end{array}$$

2511.81

THANK YOU

ANY QURIES?