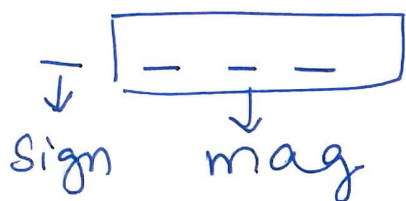


Decimal	Signed Magnitude	1's Complement	2's Complement
+7	0111	0111	0111
+6	0110	0110	0110
+5	0101	0101	0101
+4	0100	0100	0100
+3	0011	0011	0011
+2	0010	0010	0010
+1	0001	0001	0001
+0	<u>0000</u>	0000	0000
-0 →	<u>1000</u>	1111	0000
-1 →	1001	1110	1111
-2 →	1010	1101	1110
-3 →	1011	1100	1101
-4 →	1100	1011	1100
-5 →	1101	1010	1011
-6 →	1110	1001	1010
-7 →	1111	1000	1001
-8 →	—	—	1000

# 1's Complement representation for binary number signed one's Comp

How to write:-

+ve  $\rightarrow$  Same as Signed magnitude



-ve no  $(-x)$ , then 1st the counterpart  $(+x)$   
then take 1's Comp or can directly write  
2's Comp & subtract 1

-5

1) Step 1:- +5 (+ve Counterpart)  
 $\rightarrow 0101$

2) Step 2:- Take 1's Comp

1010  $\rightarrow -5$

How to read:- If first bit 0, then the no  
Same as Signed magnitude

if first bit is <sup>1 or</sup> -ve, then take 1's Comp of  
the number, if we read  $(+x)$  then  
no is  $-x$

$$\begin{array}{rcl}
 1100 & \leftarrow & -3 \\
 \textcircled{0011} & \rightarrow & 1's \text{ Comp} \\
 = +3 & & 
 \end{array}$$

$$\begin{array}{rcl}
 1 & 0 & 1 & 1 & 0 & 1 & \leftarrow \\
 0 & 1 & 0 & 0 & 1 & 0 & \\
 \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \\
 2^5 & 2^4 & 2^3 & 2^2 & 2^1 & 2^0 & \\
 16 & + & 2 & = & \underline{\underline{+18}} & & 
 \end{array}
 \quad -18$$

Range :-  $-(2^{n-1}-1)$  to  $(2^{n-1}-1)$

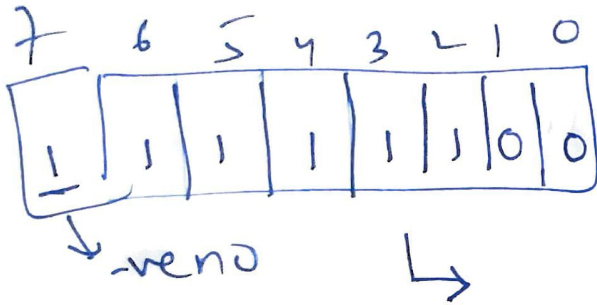
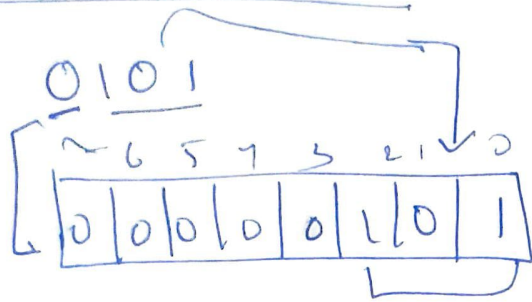
Adv:- Calculation is easy & leads to 2's Complement

Dis:- Extra notation +0 & -0  
Not a weighted Code

$$\begin{array}{rcl}
 345 & \rightarrow & 300 + 40 + 5 \\
 \hline
 & & \downarrow \\
 & & \text{weighted Code}
 \end{array}$$

Cannot be read or write, addition & subtraction will be difficult.

# Signed Extension



1100

00000011 → +3

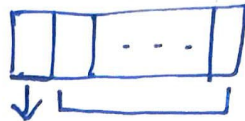
← -2



## 2's Complement

\* Any Computer uses 2's Complement for signed numbers.

\* the no is same (signed mag)



\* -ve no

i)  $-x$  is converted to  $+x$ , takes 1's Comp and add 1

$$+6 \rightarrow 0110$$

$$\begin{array}{r} \bar{5} \\ \downarrow \\ \rightarrow +5 \rightarrow \begin{array}{r} 0101 \\ 1010 \\ \hline 1111 \end{array} \end{array}$$

$\rightarrow$  1's Comp  
 $\rightarrow$  add 1

2)  $-x$  is converted first one is -ve mag and remaining the mag.

$$-5$$

$$-8 + 3$$

$$\begin{array}{r} 1011 \\ \swarrow \\ 2^3 2^2 2^1 2^0 \end{array}$$

-ve weight

$$-8 + 3$$

$$-9 \rightarrow -4 + 21$$

$$13$$

$$-16 + 3 \rightarrow \begin{array}{r} 10011 \\ \downarrow \\ -ve \end{array} \text{ rest positive.}$$

$$-2^0 = -1$$

$$-2^1 = -2$$

$$-2^2 = -4$$

$$-2^3 = -8$$

$$-2^4 = -16$$

$$-6$$

$$-8 + 2$$

$$\begin{array}{r} 1010 \\ \swarrow \downarrow \downarrow \\ 2^3 2^2 2^1 \end{array}$$

$$-8$$

$$-0 \rightarrow 0000 \rightarrow -0$$

$$\begin{array}{r} 1111 \\ + \quad 1 \\ \hline 10000 \end{array}$$

Carry discarded

↳ 1000 → is not used

→ -8 is used in 2's Comp.

$$0011 \rightarrow +3$$

$$1101$$

↓

$$-8 + 4 + 1 = -3$$

$$\begin{array}{r} 1101 \xleftarrow{-3} \\ 0010 \\ + \\ \hline 0011 \rightarrow +3 \end{array}$$

$$\left\{ \begin{array}{r} 1101 \\ - \quad 1 \\ \hline 1100 \\ 0011 \end{array} \right\} \leftarrow \text{1's Comp}$$

How to read:- If 1st bit 0, read it directly  
 If bit is 1, Subtract 1 from number to  
 Convert to 1's Comp, then <sup>read</sup> ~~add~~ (+x), then  
 -x, otherwise \*

$$-0 \rightarrow 0000 \rightarrow -0$$

$$\begin{array}{r} 1111 \\ + \quad 1 \\ \hline \end{array}$$

$$\begin{array}{r} 1 \quad 0000 \\ \hline \end{array}$$

Carry  
discarded

↳ 1000 → is not used

→ -8 is used in 2's Comp.

$$0011 \rightarrow +3$$

$$1101$$

↓

$$-8 + 4 + 1 = -3$$

$$\begin{array}{r} 1101 \quad \leftarrow -3 \\ 0010 \\ \hline 1+ \\ 0011 \rightarrow +3 \end{array}$$

$$\left\{ \begin{array}{r} 1101 \\ - \quad 1 \\ \hline 1100 \\ 0011 \end{array} \right\} \leftarrow \text{1's Comp}$$

How to read:- If 1st bit 0, read it directly  
If bit is 1, Subtract 1 from number to  
Convert to 1's Comp, then ~~add~~<sup>read</sup> (+x), then  
-x, otherwise &

Range:-  $-2^{n-1}$  to  $(2^{n-1}-1)$ , then  $2^n$

16 nos are used

Same 8 bits range

$-128$  to  $+127$

↳ It follows 2's Comp

Adv

:- Weighted code

:- Can read & write directly

:- Arithmetic & logical ops are easy

Dis :- Complex

Number Extension

0110

0	0	0	0	0	1	1	0
---	---	---	---	---	---	---	---

1110  $\rightarrow -2$

1	1	1	1	1	1	1	0
---	---	---	---	---	---	---	---

↓

↳ Take

no to extreme  
left &  
fill with 1's

00000001

+

00000001  $\rightarrow -2$



$$\begin{array}{r} \textcircled{101} \\ \hline \downarrow \end{array}$$

$$-4 + 1 = -3$$

$$\begin{array}{r} 110 \\ \hline \downarrow \\ -2 \end{array}$$

$$\begin{array}{r} 11011 \\ \hline \downarrow \end{array}$$

$$-8 + 2 + 1$$

$$= -5$$