

بسم الله الرحمن الرحيم

\* Number systems.

\* Addition & subtraction

Direct

1's Comp.

2's Comp.

→ 9's Comp.

→ 10's Comp.

\* Signed Numbers:

→ un sign.

→ signed magnitude

→ 1's Comp.

→ 2's Comp.

→ Excess - notation

$$\underbrace{(0 \overset{8}{\mid} 0 \overset{2}{\mid} 1)}_2 \rightarrow (?)_{10}$$

unsign  $(5)_{10}$

leftmost  
bit

$$(0 \overset{4}{\mid} 0 \overset{2}{\mid} 1)_2$$

$0 \rightarrow +$
$1 \rightarrow -$

sign

magnitude (value)

singed  
magnitude

$$(+5)_{10}$$

$$(0 \overset{8}{\mid} 0 \overset{2}{\mid} 1)_2 \rightarrow (?)_{10}$$

1's Comp.  $(+5)_{10}$

$$(0 \overset{8}{\mid} 0 \overset{2}{\mid} 1)_2$$

2's Comp.  $(+5)_{10}$

(2)

$$(1101)_2 \rightarrow ( )_{10}$$

unsign :  $(13)_{10}$

$1 \rightarrow -$   
 $0 \rightarrow +$

$$(\underline{1} \underline{101})_2$$

Signed magnitude :  $(-5)_{10}$

$$(\underline{1} \underline{101})_2$$

$$\hookrightarrow 1's \text{ Comp.} = - \underline{1's \text{ Comp. of } (101)} \\ = - \underline{010} \\ = (-2)_{10}$$

$$(\underline{1} \underline{101})_2$$

$$\hookrightarrow 2's \text{ Comp.} = - 2^3 \text{ Comp. of } (\underline{101}) \\ = - \underline{011} \\ = (-3)_{10}$$

③

$$(1101111)_2 \rightarrow ( )_{10}$$

→ unsigned:

$$( \begin{array}{cccccc} 1 & 1 & 0 & 1 & 1 & 1 \\ | & | & | & | & | & | \end{array} )_2$$

integer      fraction

$$\begin{aligned} & (1 * 2^4) + (1 * 2^3) + (1 * 2^1) + (1 * 2^0) \\ & + (1 * 2^{-1}) + (1 * 2^{-2}) \end{aligned}$$

$$16 + 8 + 2 + 1 + \frac{1}{2} + \frac{1}{4}$$

$$\Rightarrow (27.75)_{10} \quad \text{(index method.)}$$

$$\overbrace{16 \ 8 \ 4 \ 2 \ | \ . \ 2^{-1} \ 2^{-2}}^{0 \ 1 \ 1 \ 1}$$

$$16 + 8 + 2 + 1 + \frac{1}{2} + \frac{1}{4}$$

(Weight Method)

④

$$\overbrace{(11011 \cdot 11)_2} \rightarrow (.?)_{10}$$

unsigned:  $(27.75)_{10}$

$$(1\overset{3}{0}\overset{4}{1}\overset{2}{1}\overset{1}{1}\overset{-2}{1})_2 \quad | \rightarrow - \\ \circ \rightarrow +$$

signed magnitude:  $(-11.75)_{10}$

$$(11011 \cdot 11)_2$$

$$1^{\text{st}} \text{ comp.} = -1^{\text{st}} \text{ comp. of } (1011 \cdot 11) \\ = -0\overset{4}{1}\overset{2}{0}\overset{1}{0}0.00 \\ = (-4)_{10}$$

$$(11011 \cdot 11)_2$$

$$2^{\text{nd}} \text{ comp.} = -2^{\text{nd}} \text{ comp. of } (1011 \cdot \cancel{11}) \\ = -0100.01 \\ = (-4.25)_{10} \quad (5)$$

$$(+12)_{10} \rightarrow (?)_2$$

n. of bits  
~~5 bits~~  
 $\downarrow n$

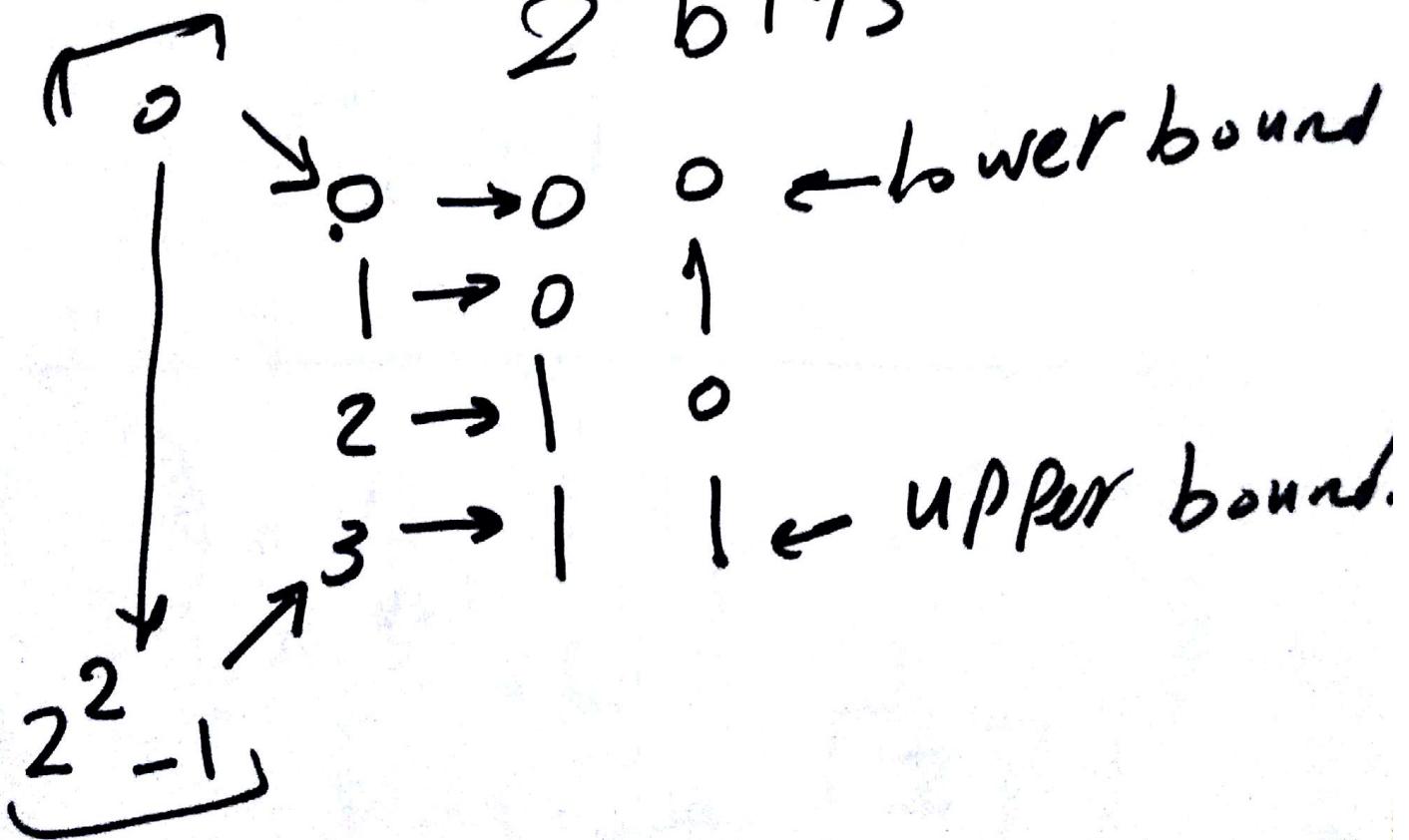
unsigned:

$$\left[ 0, 2^{n^5} - 1 \right] = [0, 31]$$

$(2^5 - 1)$   
 $32 - 1$

[0, 31]

2 bits



(B)

signed magnitude.

$$[-(2^{n-1}-1), + (2^{n-1}-1)]$$

$$[\mp (2^{n-1}-1)]$$

125 Comp.  $\nearrow$

$$\hat{n} = 5$$

$$[\mp (2^{5-1}-1)]$$

$$[\mp 15]$$

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$$n = 4$$

$$[\mp (2^{4-1}-1)]$$

$$\mp 8 - 1 \rightarrow [\mp 7]$$

2's Comp. / Excess Range.

$$[-2^{n-1}), + (2^{n-1})]$$

$$n = 5$$

$$\begin{aligned} &[-(2^{5-1}), + (2^{5-1})] \\ &\quad \begin{array}{c} 4 \\ 2 \\ 16 \end{array} -1 \\ &[-16, +15] \end{aligned}$$

→ unsigned:  $[0, 2^n - 1]$

→ signal:  $[-(2^{n-1})]$

→ 1's Comp.:

→ 2's Comp.:  $[-(2^{n-1}), + (2^{n-1})]$

→ Exam: →

$(+1^2)_{10} \rightarrow ( )_2$

in 5 bits

↳ unsigned  $[0, 31]$

$(01100)_2$

$$2 \div |1^2|$$


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$$\begin{array}{r} 168421 \\ 01100 \end{array}$$

↳ signed magnitude.

$[\mp 15]$

↓  
0 1 + 0 0

↳ 10s Comp.  $[\mp 15]$

$(+1^2) \rightarrow 01100$

↳ 2,5 comp.  $[-16, +15]$

$(\mp 1^2) \rightarrow 01100$

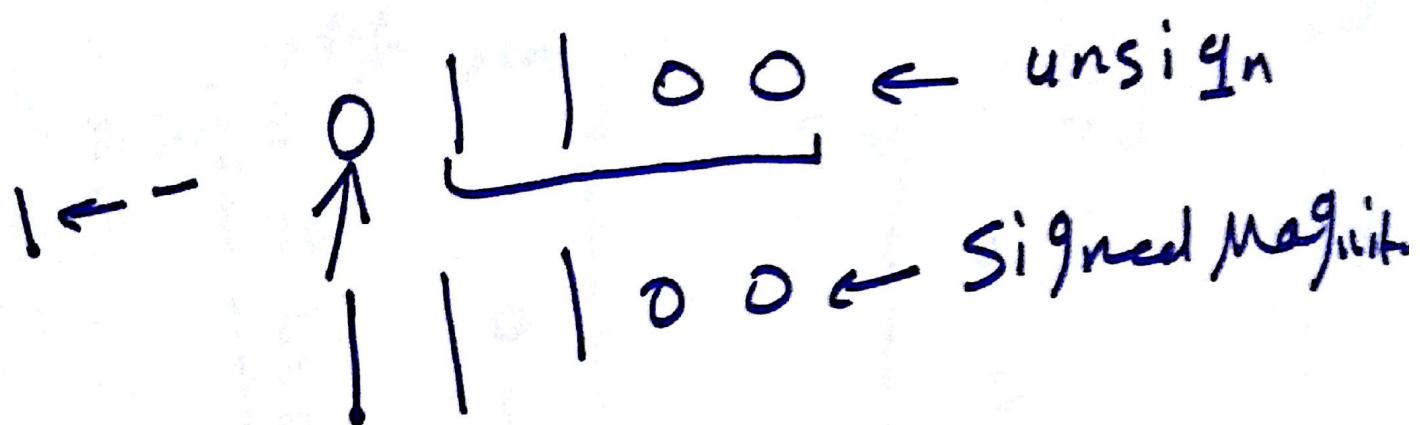
$$(-12) \rightarrow ( )_2$$

in 5 bits.

↳ unsigned [0, 31]

$$\begin{array}{r} 0 \\ | \\ 1 \\ | \\ 1 \\ | \\ 0 \\ | \\ 0 \end{array}$$

↳ signed magnitude [ $\mp 15$ ]



↳ 1's Comp. [ $\mp 15$ ] in 5 bits

$$(-12) \Rightarrow 1\text{'s Comp. } (0 \boxed{1} \boxed{1} 0 0)$$

$$= \boxed{\underline{1 \ 0 \ 0 \ 1 \ 1}}$$

↳ 2's Comp. [-16, +15] in 5 bits

$$(-12) \rightarrow 2\text{'s Comp. } (0 \boxed{1} \boxed{1} 0 0)$$

$$= \boxed{\underline{1 \ 0 \ 1 \ 0 \ 0}} \quad \begin{matrix} \leftarrow \\ (10) \end{matrix}$$

$$(-21.75)_{10} \rightarrow (?)_2$$

6 bits.  
In

unsigned:  $[0, 2^n - 1]$

$[0, 63]$

(-21.75)

		intgr. rem.	
$2 \div$	$2^1$	1	
	1.0	0	
	5	1	
	2	0	
	1	0	
	0	1	

frac.	int
$2 \times 0.75$	1
0.5	1
0	1

$(1010.11)_2$

16	8	4	2	1	$k_2$	$k_4$
0	1	0	1	0	1.	1

unsigned:

②

(Q21.75)

↳ signed magnitude. in 6 bits

$$\left[ \pm \left( 2^{n-1} - 1 \right) \right]$$

$$[ \mp 31 ]$$

out of Range

0 | 0 | 0 | 0 | . | |  
↓  
| | 0 | 0 | 1 | . | | |

( $-21.75$ )

↳ 1's Comp. in 6 bits

[ $\mp 31$ ]

unsign      0 | 0 | 0 | 0 | . | 1 | 1

= 1's Comp. of  $(010101.11)$

101010.00

↳ 2's Comp.  $[-(2^{n-1}), + (2^{n-1}-1)]$

( $-22.75$ )

= 2's Comp. of  $(010101.11)$

101010.01

\* Excess-notation  
 3)  $v_i \leftarrow \frac{v_i}{2^n}$       16 8 4 2 1

\* Excess - 4       $\begin{array}{r} 4 \ 2 \ 1 \\ \hline 1 \ 0 \ 0 \end{array}$       3 bits  
 $[-2^{n-1}, +2^{n-1}-1]$   
 $[-4, +3]$

\* Excess - 8       $\begin{array}{r} 8 \ 4 \ 2 \ 1 \\ \hline 1 \ 0 \ 0 \ 0 \end{array}$       4 bits  
 $[-2^{n-1}, +2^{n-1}-1]$   
 $[-8, +7]$

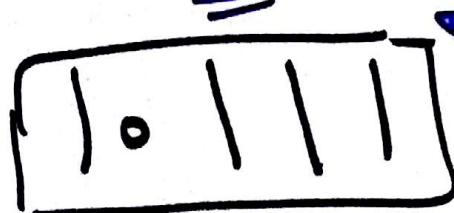
\* Excess - 16       $\begin{array}{r} 16 \ (1 \ 0 \ 0 \ 0 \ 0) \\ \hline \end{array}$       5 bits  
 $[-16, +15]$

\* How to convert from decimal values to its equivalent excess form (Excess-16)  
 $[-16, +15]$  not.

a)  $+7$

$$+7 + 16$$

$$\underline{\underline{23}}$$



$( )_2$   
 Solution  
 not ( )<sub>10</sub> not.

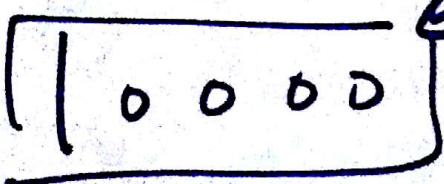
b)  $+16$

out of Range

$$23 = \frac{1}{1} \quad \frac{0}{0} \quad \frac{1}{1} \quad \frac{1}{1} \quad \frac{1}{1}$$

c)  $(0)_1$

$$0 + 16 \rightarrow 16$$



$$\begin{array}{r}
 32 \quad 16 \quad 8 \quad 4 \quad 2 \quad 1 \\
 \mid \quad \mid \quad \mid \quad \mid \quad \mid \\
 0 \quad 1 \quad 1 \quad 1 \quad 1 \\
 \mid \quad 0 \quad 0 \quad 0 \quad 0
 \end{array}$$

\* Convert each of the following excess 4 notations to its equivalent decimal form:

[-4, +3]      100 → (3 bits)

a) 110

$$\begin{array}{r} 110 + 100 \\ \hline 6 - 4 \Rightarrow (+2)_{10} \end{array}$$

$(\ )_2$   
Excess  
not.  
not.  
decimal

b) 111

$$7 - 4 \rightarrow (+3)_{10}$$

c) 101

$$5 - 4 \rightarrow (+1)_{10}$$

d) 000

$$0 - 4 \rightarrow (-4)_{10}$$

e) 1101  
X 4bits

in Excess 4  
3 bits

16

$$\begin{array}{r} 101010 \\ 010110 \end{array}$$
$$\begin{array}{r} 10111000000 \\ 01001000000 \end{array}$$
$$\begin{array}{r} 00.0010 \\ + 10.0000 \\ \hline 10.0010 \end{array}$$
$$\begin{array}{r} 1.001 \\ 01.01 \end{array}$$

Ans.

$$2's \text{ Comp.} = 1's \text{ Comp.} + 1$$

