

28/10/2019

EES311

MODULE-6 - MULTIPLIERS

X → M BIT NUMBER
Y → N BIT NUMBER. } UNSIGNED

$$\Rightarrow X = \sum_{i=0}^{M-1} x_i 2^i$$

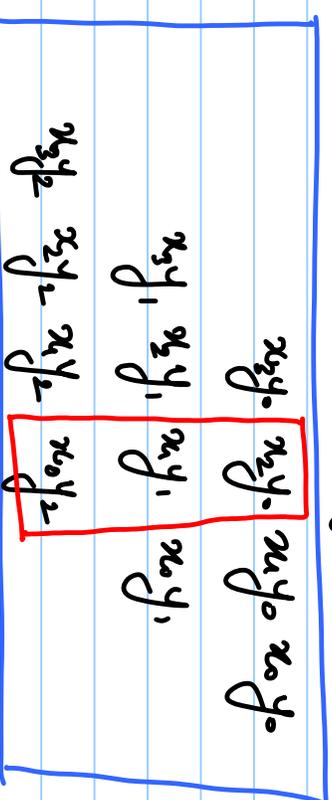
$$Y = \sum_{j=0}^{N-1} y_j 2^j$$

$$Z = XY$$

$$\sum_{k=0}^{(M+N-1)} z_k 2^k = \sum_{i=0}^{M-1} x_i 2^i \cdot \sum_{j=0}^{N-1} y_j 2^j = \sum_{i=0}^{M-1} \sum_{j=0}^{N-1} (x_i y_j) 2^{(i+j)}$$

$$z_k = \sum_{(i+j=k)} x_i y_j$$

$$\begin{array}{r} x_3 x_2 x_1 x_0 \\ \times y_2 y_1 y_0 \\ \hline \end{array} \quad \begin{array}{l} \text{MULTIPLICAND} \\ \text{MULTIPLIER} \end{array}$$



PP_0 PP_1 PP_2 \rightarrow n -BITS LONG
 PARTIAL PRODUCTS (PP)
 (N PP'S)

z_6 z_5 z_4 z_3 z_2 z_1 z_0

- * PARTIAL PRODUCT GENERATION \rightarrow AND GATES
- * PP SHIFTING \rightarrow WIRING
- * PP ACCUMULATION \rightarrow ARRAY OF FULL ADDERS.
- * FINAL VECTOR ADDITION \rightarrow FAST ADDER ARCHITECTURE (CLA)

SIGNED NUMBERS

2's COMPLEMENT REP

$$\{a_{N-1} \ a_{N-2} \ \dots \ a_0\} \longrightarrow \sum_{i=1}^{N-1} a_i 2^i \quad \text{— UNSIGNED}$$

$$\left\{ \begin{array}{l} \longrightarrow -2^{(N-1)} a_{N-1} + \sum_{i=0}^{N-2} a_i 2^i \end{array} \right.$$

$$\underbrace{\left(\sum_{i=0}^{N-1} 2^i - 1 \right)}$$

$$\sum_{i=0}^{N-2} a_i 2^i \leq \sum_{i=0}^{N-2} 2^i = (2^{N-1} - 1)$$

$$-2^{N-1} + (2^{N-1} - 1) = -1$$

If $a_{n-1} = 1$; THEN THE NUMBER = $(1 \text{ 's COMPLEMENT}) -ve$.

$$1101 = -2^2 + 2^1 + 0 + 2^0 = -3$$

$$\{ a_{n-1} a_{n-2} \dots a_0 \} + \{ \bar{a}_{n-1} \bar{a}_{n-2} \dots \bar{a}_0 \} = (111111\dots 1) \text{ n times.}$$

$$1101$$

$$\rightarrow 0010 \rightarrow 1111 - \{ a_n a_{n-1} a_{n-2} \dots a_0 \} \{ \bar{a}_{n-1} \bar{a}_{n-2} \dots \bar{a}_0 \} = (11\dots 1) - \{ \bar{a}_{n-1} \bar{a}_{n-2} \dots \bar{a}_0 \}$$

$$+ \frac{1}{+1} = -1 - \{ \bar{a}_{n-1} \bar{a}_{n-2} \dots \bar{a}_0 \}$$

$$-ve(0011) = -(1 + \{ \bar{a}_{n-1} \bar{a}_{n-2} \dots \bar{a}_0 \})$$

$$-3 = 1101 \quad +15 \rightarrow \underline{01111}$$

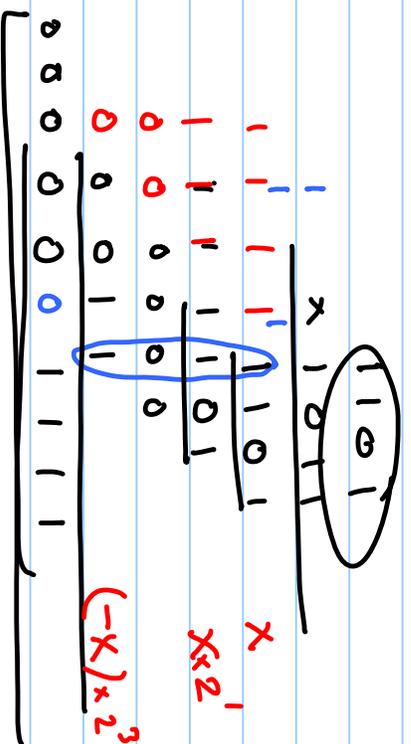
$$\frac{x-5}{+15}$$

$$\frac{x}{+15} \quad \frac{x}{+15} \quad \frac{x}{+15} \quad \frac{x}{+15} \quad \frac{x}{+15}$$

N Bit 2's Comp No. = $[-2^{N-1}, 2^{N-1}-1]$

1000...0

01111



$$1011 \quad x = (-2^3 + 2^1 + 2^0) = -2^3x + 2^1x + 2^0x$$

$(-x) \times 2^3$

SIGN EXTENSION OF 2'S COMP NO'S DOES NOT ALTER THE VALUE

$$\{a_{N-1} \dots a_0\} = -2^{N-1} a_{N-1} + \sum_{k=0}^{N-2} a_k 2^k$$

SIGN EXTENDED 'a'

$$\{ \underbrace{a_{N-1} \dots a_{N-1}}_{M \text{ times}} \cdot a_{N-1} a_{N-1} \dots a_0 \}$$

M+N BIT NO.

$$= -2^{(M+N-1)} a_{N-1} + 2^{(M+N-2)} a_{N-1} + \dots + 2^N a_{N-1} + 2^{N-1} a_{N-1}$$

$$+ \sum_{k=0}^{N-2} a_k 2^k$$

$$= -2^{N-1} a_{N-1} \left(+2^M - 2^{M-1} - 2^{M-2} - \dots - 1 \right)$$

$$= -2^{N-1} a_{N-1} \left(2^M - (2^M - 1) \right) \left(2^M - 1 \right)$$

