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EE5311

MODULE-6 - MULTIPLIERS

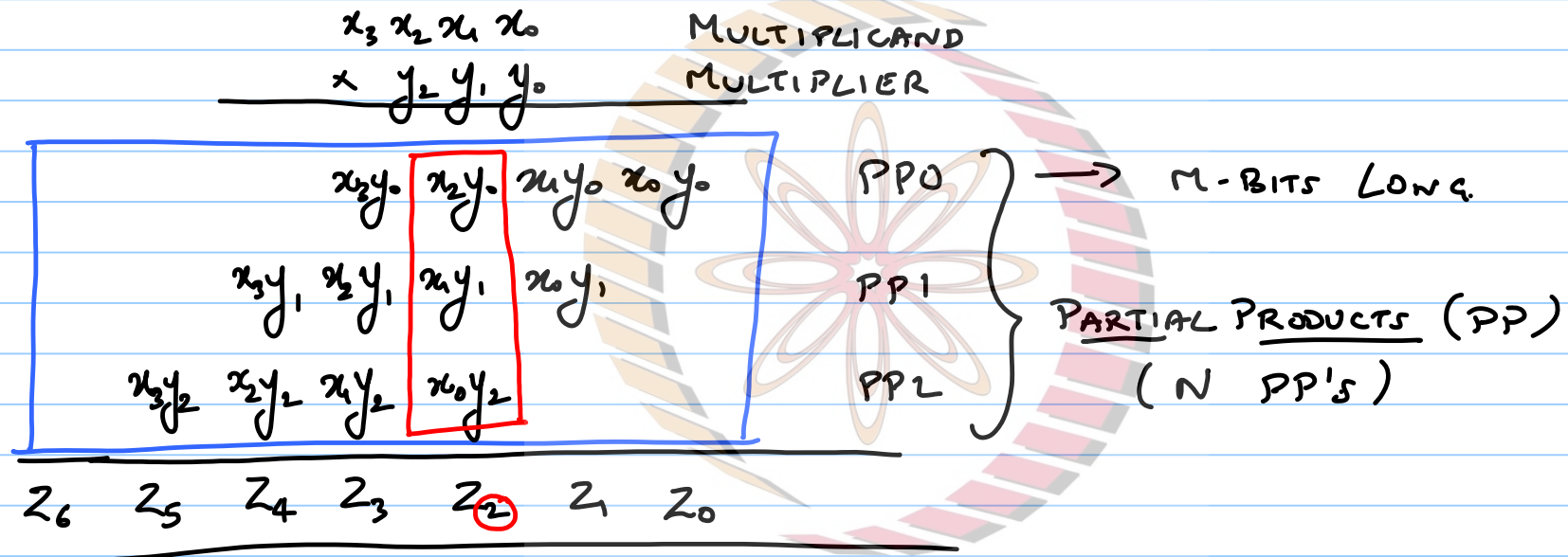
$X \rightarrow M \text{ BIT NUMBER}$
 $Y \rightarrow N \text{ BIT NUMBER.}$ } UNSIGNED

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

$$Z = XY$$

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

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



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

SIGNED NUMBERS

2's COMPLEMENT REP

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

$$L \rightarrow -2^{(N-1)} a_{N-1} + \underbrace{\sum_{i=0}^{N-2} a_i 2^i}_{\leq (2^{N-1} - 1)}$$

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

$$-2^{N-1} + \binom{N-1}{2} = -1$$

IF $a_{N-1} = 1$; THEN THE NUMBER = $\left(\begin{matrix} \text{1's COMPLEMENT} \\ + \\ 1 \end{matrix} \right) - \text{ve.}$

$$\begin{array}{l} 1101 = \\ -2^3 + 2^2 + 0 + 2^0 = -3 \end{array}$$

$$\begin{array}{r} 1101 \\ \rightarrow 0010 \rightarrow 1111 - \{a_3 a_2 a_1 a_0\} \\ + \quad 1 \quad + 1 \\ \hline \text{-ve}(0011) \end{array}$$

$$\begin{aligned} & \{a_{N-1} a_{N-2} \dots a_0\} + \{\bar{a}_{N-1} \bar{a}_{N-2} \dots \bar{a}_0\} \\ & = (1 \ 1 \ 1 \ 1 \dots 1) \text{ N times.} \end{aligned}$$

$$\begin{aligned} \{a_{N-1} a_{N-2} \dots a_0\} &= (1 \ 1 \dots 1) - \{\bar{a}_{N-1} \bar{a}_{N-2} \dots \bar{a}_0\} \\ &\downarrow \\ &= -1 - \{\bar{a}_{N-1} \bar{a}_{N-2} \dots \bar{a}_0\} \\ &= -(1 + \{\bar{a}_{N-1} \bar{a}_{N-2} \dots \bar{a}_0\}) \end{aligned}$$

NPTEL

$$\begin{array}{r}
 -3 = 1101 \\
 \times -5 \quad \times 1011 \leftarrow -2^3 + () \\
 \hline
 +15
 \end{array}
 \quad +15 \rightarrow \underline{01111}$$

$$N \text{ BIT 2'S COMP NO.} = [-2^{N-1}, 2^{N-1}-1]$$

1000...0

011111

1011

X

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

$$\begin{array}{r}
 \begin{array}{ccccccc}
 & & & & 1 & 1 & 0 & 1 \\
 & & & & \times & 1 & 0 & 1 & 1 \\
 \hline
 1 & 1 & 1 & 1 & 1 & 1 & 0 & 1 & \\
 1 & 1 & 1 & 1 & 1 & 1 & 0 & 1 & \\
 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & \\
 0 & 0 & 0 & 0 & 1 & 1 & & & \\
 \hline
 0 & 0 & 0 & 0 & 0 & 0 & 1 & 1 & 1 & 1
 \end{array}
 \end{array}$$

$(-X) \times 2^3$

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'

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

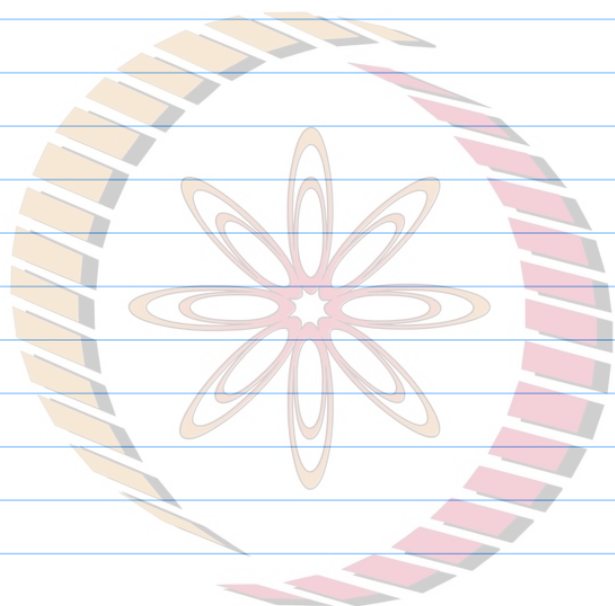
M times.

M+N Bit No.

$$= \frac{-2^{(M+N-1)} a_{N-1} + 2^{(M+N-2)} a_{N-1} + \dots + 2^N a_{N-1} + 2^{N-1} a_{N-1} + \sum_{k=0}^{N-2} a_k 2^k}{}$$

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

$$= \underline{-2^{N-1} a_{N-1} (2^M - (2^M - 1))} \quad (2^M - 1)$$



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