



COURSE NAME : 23ITT202 – COMPUTER ORGANIZATION AND ARCHITECTURE

II YEAR/ III SEMESTER

UNIT – II ARITHMETIC OPERATIONS

Topic: SIGNED – OPERAND MULTIPLICATION

Signed-Operand Multiplication

Booth Algorithm

						1	0	0	1	1	(-13)
					x	0	1	0	1	1	(+11)
					<hr/>						
	1	1	1	1	1	1	0	0	1	1	
	1	1	1	1	1	0	0	1	1		
Sign extension is shown in blue	0	0	0	0	0	0	0	0			
	1	1	1	0	0	1	1				
	0	0	0	0	0	0					
	<hr/>										
	1	1	0	1	1	1	0	0	0	1	(-143)

Figure 6.8 Sign extension of negative multiplicand.

45*30

$$\begin{array}{r}
 0101101 \\
 00+1+1+1+10 \\
 0000000 \\
 0101101 \\
 0101101 \\
 0101101 \\
 0101101 \\
 0000000 \\
 0000000 \\
 \hline
 000101010000110
 \end{array}$$

$$\begin{array}{r}
 0101101 \\
 0+1000-10 \\
 000000000000000 \\
 1111111010011 \leftarrow \text{2's complement of the multiplicand} \\
 000000000000000 \\
 000000000000000 \\
 0000000000000 \\
 000101101 \\
 000000000 \\
 \hline
 000101010000110
 \end{array}$$

Figure 6.9 Normal and Booth multiplication schemes.

difference between two numbers:

$$\begin{array}{r}
 0100000 \quad (32) \\
 -000010 \quad (2) \\
 \hline
 0011110 \quad (30)
 \end{array}$$

$$\begin{array}{cccccccccccccccc}
 0 & 0 & 1 & 0 & 1 & 1 & 0 & 0 & 1 & 1 & 1 & 0 & 1 & 1 & 0 & 0 \\
 \Downarrow & & & & & & & & & & & & & & & \\
 0 & +1 & -1 & +1 & 0 & -1 & 0 & +1 & 0 & 0 & -1 & +1 & -1 & +1 & 0 & -1 & 0 & 0
 \end{array}$$

Figure 6.10 Booth recoding of a multiplier.

Multiplier		Version of multiplicand selected by bit i
Bit i	Bit $i - 1$	
0	0	$0 \times M$
0	1	$+1 \times M$
1	0	$-1 \times M$
1	1	$0 \times M$

Figure 6.12 Booth multiplier recoding table.

$$\begin{array}{r}
 01101 \quad (+13) \\
 \times 11010 \quad (-6) \\
 \hline
 \end{array}
 \quad \Rightarrow \quad
 \begin{array}{r}
 01101 \\
 0-1+1-10 \\
 \hline
 0000000000 \\
 111110011 \\
 00001101 \\
 1110011 \\
 000000 \\
 \hline
 1110110010 \quad (-78)
 \end{array}$$

Figure 6.11 Booth multiplication with a negative multiplier.

Worst-case multiplier	0101010101010101 \downarrow $+1-1+1-1+1-1+1-1+1-1+1-1+1-1$
Ordinary multiplier	1100010110111100 \downarrow $0-100+1-1+10-1+1000-100$
Good multiplier	0000111110000111 \downarrow $000+10000-1000+100-1$

Figure 6.13 Booth recoded multipliers.