Booth’s Algorithm

CO-Tutorial Class

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Introduction

- To multiply two integers
- Multiply binary equivalent's of decimal numbers
- We shall learn this algorithm in three parts
  - Positive * Positive
  - Positive * Negative
  - Negative * Negative

BOOTH's ALGORITHM.

PART 01 - (+ve) × (+ve)

$$+(\text{Number } 1) \times +(\text{Number } 2)$$

$$= +(\text{Product}).$$

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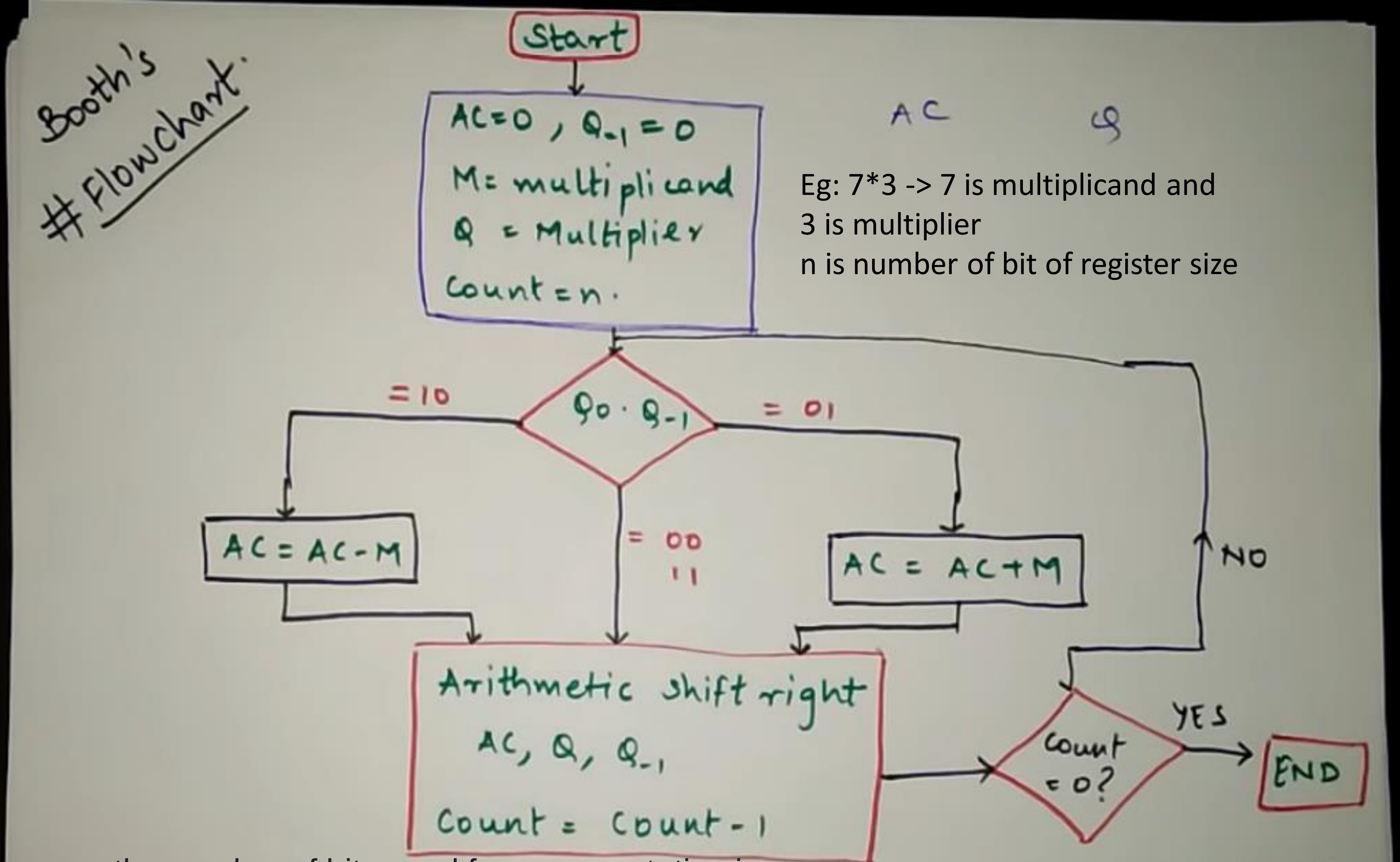

Eg: 7*3 -> 7 is multiplicand and
3 is multiplier
n is number of bit of register size

n >= the number of bits used for representation in binary(both positive numbers)

n + 1 >= the number of bits used for representation in binary(any one number negative)

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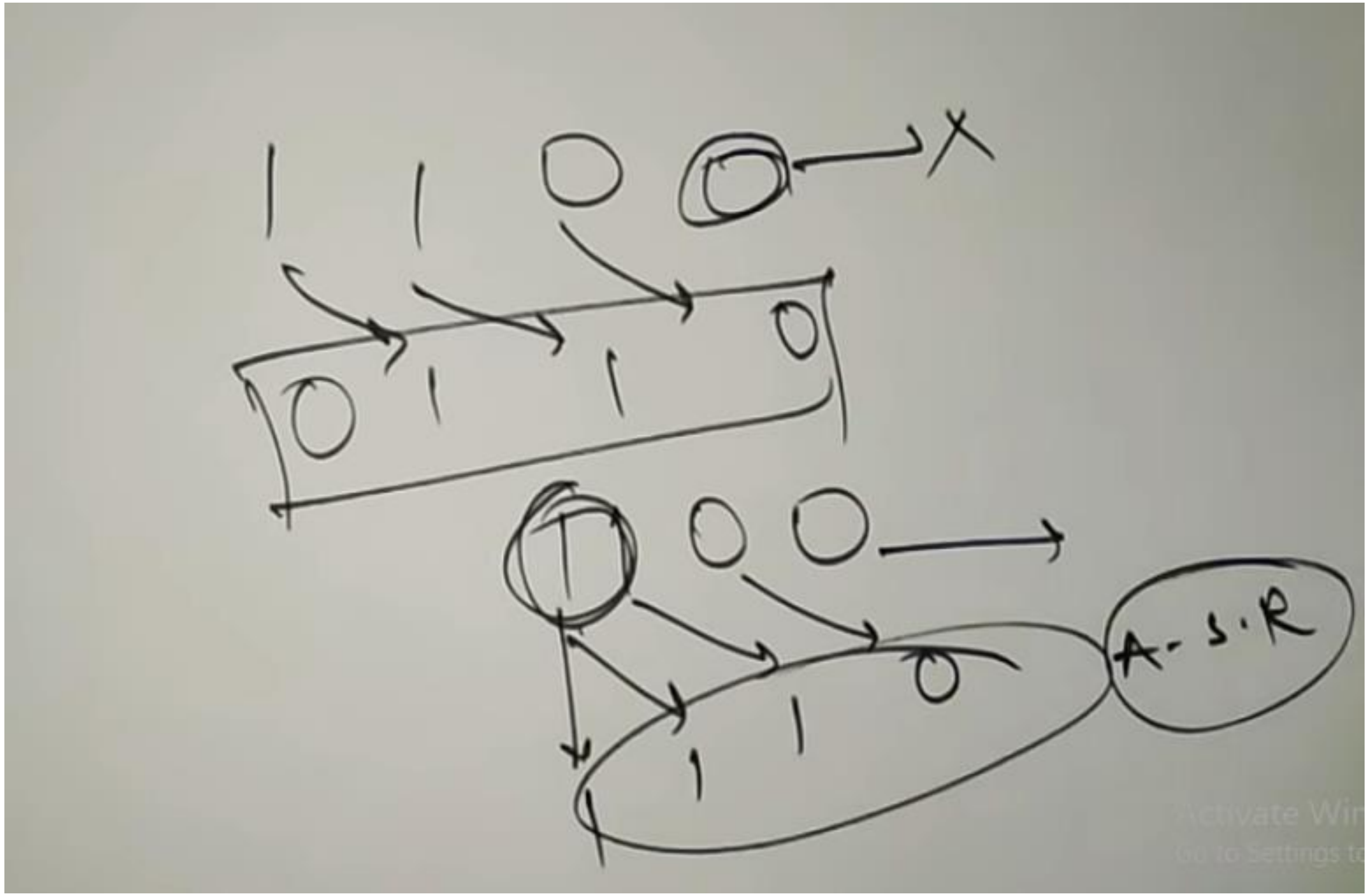
Difference between SR and ASR



Example

- Multiply 7 and 3 using Booth's algorithm.

Register size = 4

$(M) \rightarrow (7)_{10} \rightarrow (0111)_2$

$(Q) \rightarrow (3)_{10} \rightarrow (0011)_2$

$(-M) \rightarrow$ 2's comp $(0111)_2 \rightarrow (1001)_2$

$$
\begin{array}{rcccc}
 & 0 & 1 & 1 & 1 \\
1\text{'s} \rightarrow & 1 & 0 & 0 & 0 \\
2\text{'s} \rightarrow & + & & & 1 \\
\hline
 & (1 & 0 & 0 & 1)_2
\end{array}
$$

$AC + (-M)$

$AC = AC - M$

$AC = AC + M$

AC	Q	Q-1	Operation.
1st 0000	0011	0	i) AC = AC − M
			0000 + 1001 = (1001)
1001	0011	0	ii) A.S.R.
1100	1001	1	
2nd 1110	0100	1	i) A.S.R. $Q_0 \cdot Q_{-1} = 11$
3rd 0101	0100	1	i) $Q_0 \cdot Q_{-1} = 01$
			AC = AC + M
			1110 + 0111 = 0101
0010	1010	0	ii) A.S.R. (D)iscard

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i) $Q_0 \cdot Q_{-1} = 01$

$AC = AC + M$

$$\begin{array}{r} 1110 \\ +\,0111 \\ \hline 0101 \end{array}$$

Operation.

$Q_0 \cdot Q_{-1} = 00$

3rd

AC	Q	Q_{-1}
0101	0100	1
0010	1010	0

4th

AC	Q	Q_{-1}
0001	0101	$\cancel{0}$

$(00010101)_2 = (21)_{10}$

$7 \times 3 = (21)$

$(7)_{10} \times (3)_{10} = +(21)_{10}$

BOOTH's ALGORITHM

PART 02 – $(+ve) \times (-ve)$ / $(-ve) \times (+ve)$

$$+(\text{Number } 1) \times -(\text{Number } 2)$$

$$= -(\text{Product}).$$

Ac
Go

• Multiply -7 and +3 using Booth's algorithm.

register bits = $\boxed{5}$

→

$$\begin{array}{r} 00111 \\ 11000 \\ +\quad 1 \\ \hline 11001 \end{array}$$

$M \rightarrow (-7)_{10} \rightarrow (11001)_2$

$Q \rightarrow (3)_{10} \rightarrow (00011)_2$

$(-M) \rightarrow (7)_{10} \rightarrow (00111)_2$

	AC	(5)	Q (Q_0)	Q-1	Operation.
1st	00000		00011	0	i) AC = AC − M 00000 + 00111 00111
	00111		00011	0	ii) A.S.R
	00011		10001	1	
2nd	00001		11000	1	i) A.S.R.
3rd	11010		11000	1	i) AC = AC + M 00001 11001 11010
	11101		01100	0	ii) A.S.R.

0011 10001 1

0001 11000 1 i) A.S.R.

i) AC = AC + M

00001

11010 11 000 1

AC	Q	Q-1	Operation
11110	10110	0	i) A.S.R
11111	01011	0	i) A.S.R.

$(1003)_{10}$

$(1111101011)_2$

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Go to Se

2nd

1 0 1 1 0

0

i) A·S·R

A C

4th

1 1 1 1 0

i) A·S·R.

5th

1 1 1 1 1 0 1 0 1 1

$-7 \times 3 = (-)$

$(1001)_{10}$

$(1111101011)_2$

0000010100

1's → 0000010100

1

0000010101

2's 0000010101

$-7 \times 3 = (-21)_{10}$

BOOTH's ALGORITHM

PART 03 - (−ve) × (−ve)

$$-(\text{Number } 1) \times -(\text{Number } 2)$$

$$= +(\text{Product}).$$

- Multiply -7 and -3 using Booth's Algo.

Register size = 4 bits.

→

Activate Windows
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• Multiply −7 and −3 using Booth's Algo.

Register size = $\boxed{4 \text{ bits}}$.

→

$M \rightarrow (-7)_{10} \rightarrow (1001)_2$

$-M \rightarrow (7)_{10} \rightarrow (0111)_2$

$Q \rightarrow (-3)_{10} \rightarrow (1101)_2$

$$\begin{array}{rr} & \boxed{0111} \\ 1's & 1000 \\ + & 1 \\ \hline 2's & (1001)_2 \end{array}$$

$$\begin{array}{rr} & 0011 \\ 1's & 1100 \\ + & 1 \\ \hline 2's & (1101)_2 \end{array}$$

	A C			
1st	0000	1101	0	i) AC = AC − M 0000 + 0111 0111
	0111	1101	0	ii) A.S.R.
	0011	1110	1	
2nd	1100	1110	1	i) AC = AC + M 0011 + 1001 1100
				ii) A.S.R
	1110	0111	0	

Activ
Go to

	AC	Q	Q-1	Operation
3rd	0101	0111	0	i) AC = AC − M
				$\begin{array}{r} 1110 \\ +\ 0111 \\ \hline 0101 \end{array}$
				(Discard cry)
	0010	1011	1	ii) A.S.R
4th	0001	0101	1	i) A.S.R

$(00010101)_2$