COA
Division Algorithm

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Restoring Division Algorithm

Division of unsigned integers

Division is more complex operation than multiplication.

We know:

If Dividend = D
Divisor = V
Quotient = Q
& Remainder = R

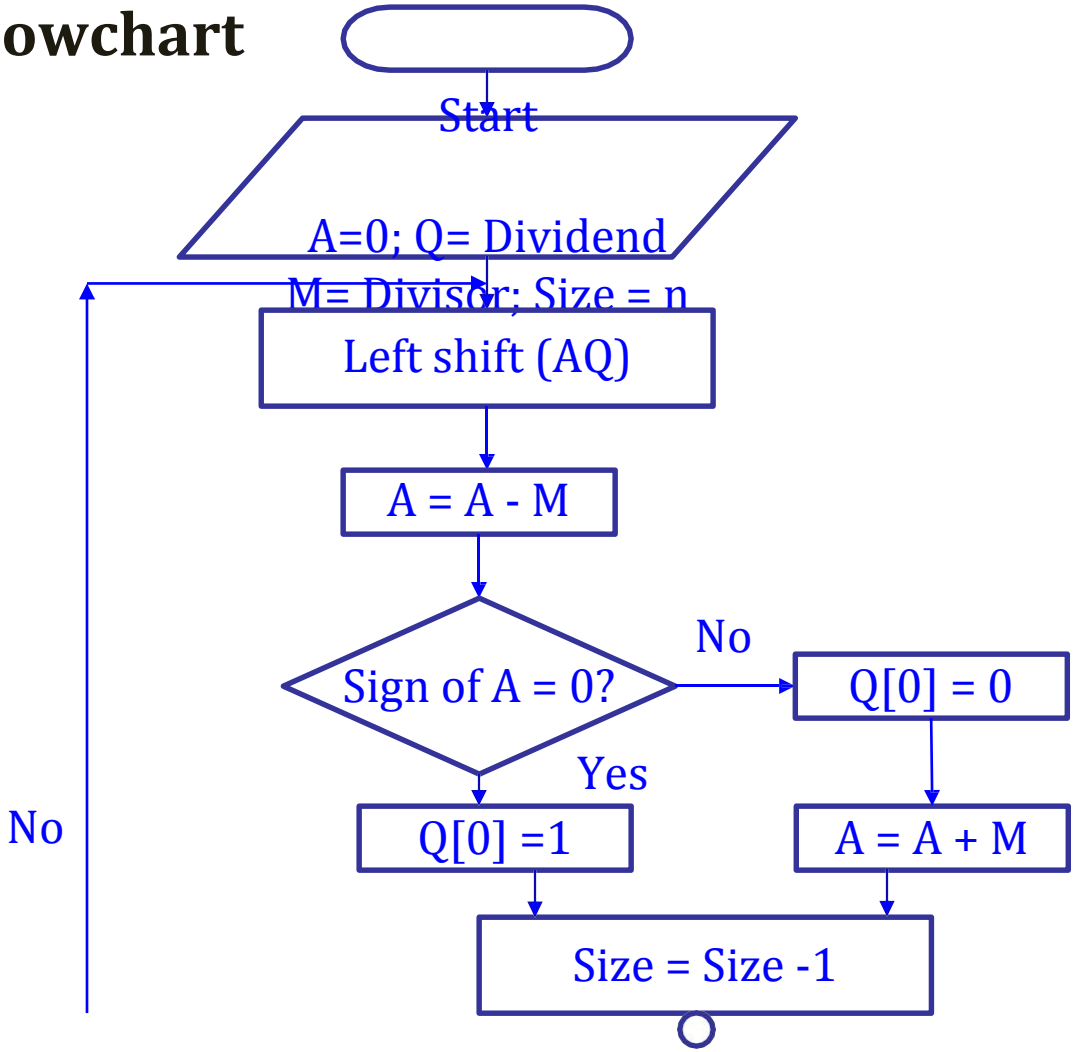
Then, D= QV + R where 0 ≤ R ≤ V

In case of Restoring Division method, three n bit registers: A, M, & Q are used
for dividing two n bit
numbers. Here, M = Holding
the Divisor

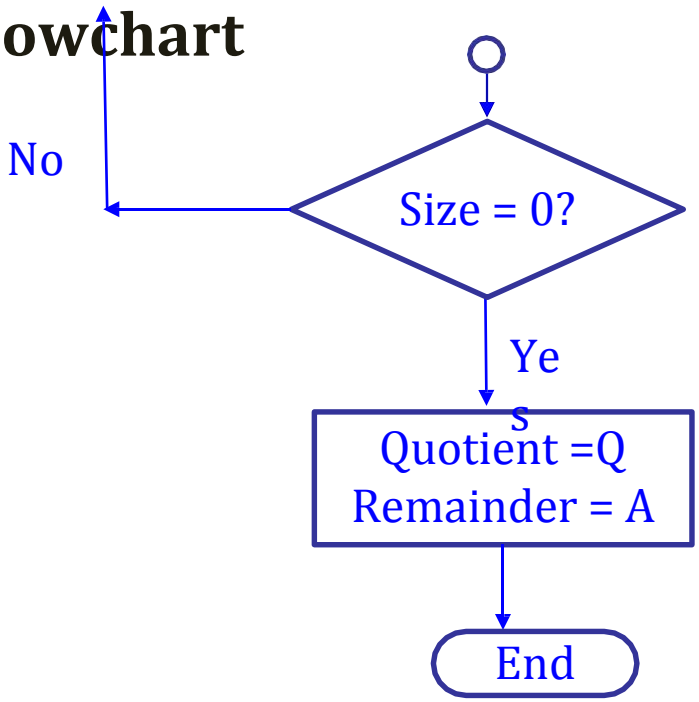
When the algorithm terminates, register A contains the remainder and Q = Holding the quotient result.

- At the beginning, initialize register A = 0
- Register Q = Holding the Dividend

Restoring Division Algorithm Flowchart



Restoring Division Algorithm Flowchart



Restoring Division Algorithm Example

Let us consider, Dividend Q = 7 = 0111 Divisor M = 3 = 0011

Initial Configuration:	**M**	**A**	**Q**		**Size**
	00011	00000	0111		4
Step 1:					
LS (AQ)	00011	00000	111		
A=A-M	00011	11101	111		
As Sign of A = -ve Set Q[0] = 0 & Restore A	00011	00000	1110		3
Step 2:					
LS (AQ)	00011	00001	110		
A=A-M	00011	11110	110		
As Sign of A = -ve Set Q[0] = 0 & Restore A	00011	00001	1100		2

Restoring Division Algorithm Example

Previous Configuration:	M	A	Q	Size
	00011	00001	1100	2
Step 3:				
LS (AQ)	00011	00011	100	
A=A-M	00011	00000	100	
As Sign of A = +ve				
Set Q[0] = 1	00011	00000	1001	1
Step 4:				
LS (AQ)	00011	00001	001	
A=A-M	00011	11110	001	
As Sign of A = -ve				
Set Q[0] = 0				
& Restore A	00011	00001	0010	0

Therefore, Quotient Q = 0010 = 2

& Remainder A = 00001 = 1

Non Restoring Division Algorithm

In case of Restoring Division method, some extra additions are required to restore the number, when A is –ve. Proper restructuring of the Restoring Division algorithm can eliminate that restoration step. This is known as Non restoring Division algorithm.

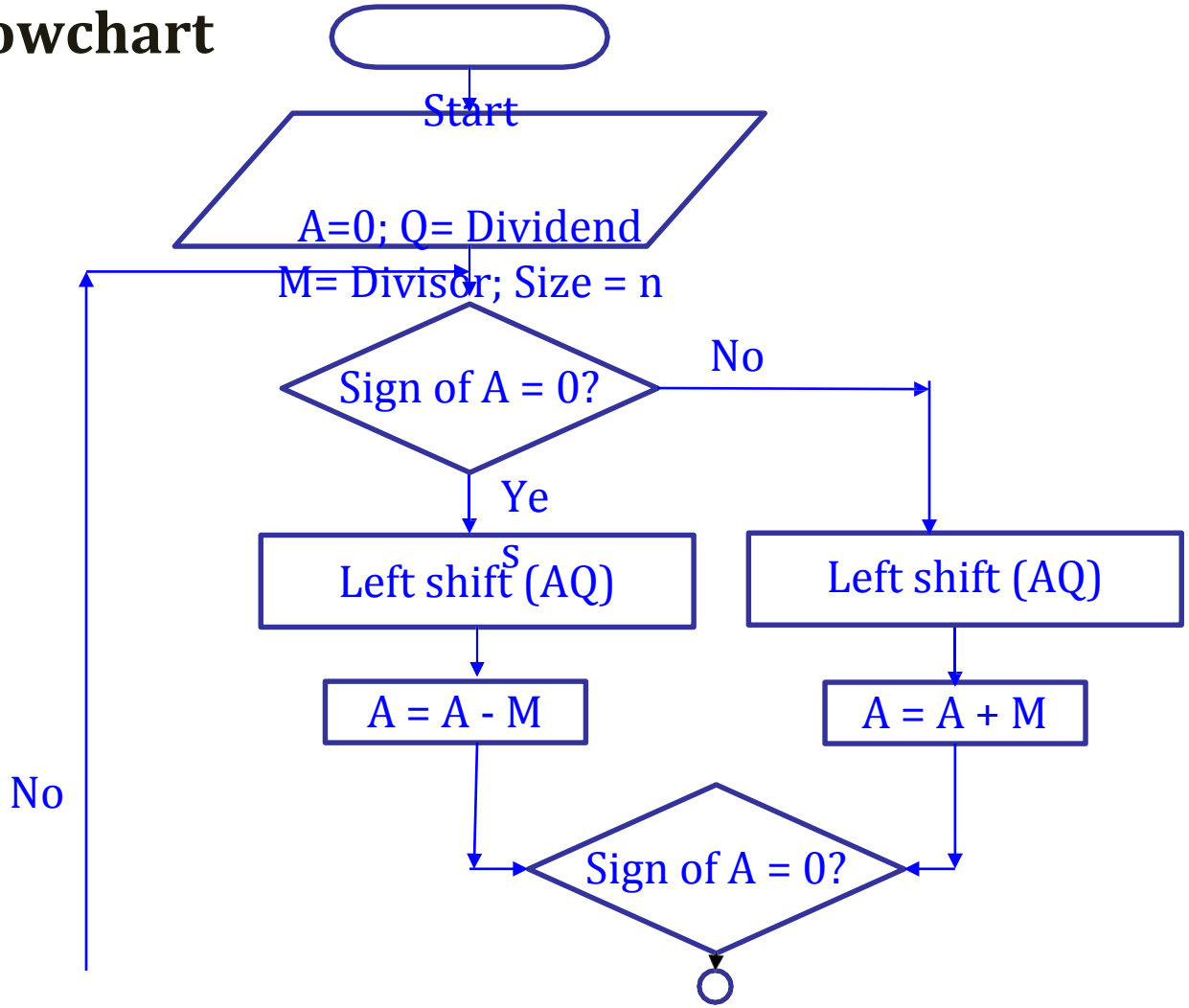
The three steps of Restoring Division algorithm were:

1. **Shift content of AQ register pair to the left one position.**
2. **A = A – M**
3. **If the sign of A is +ve after step 2, set Q[0] = 1; otherwise set Q[0] = 0 and restore A.**

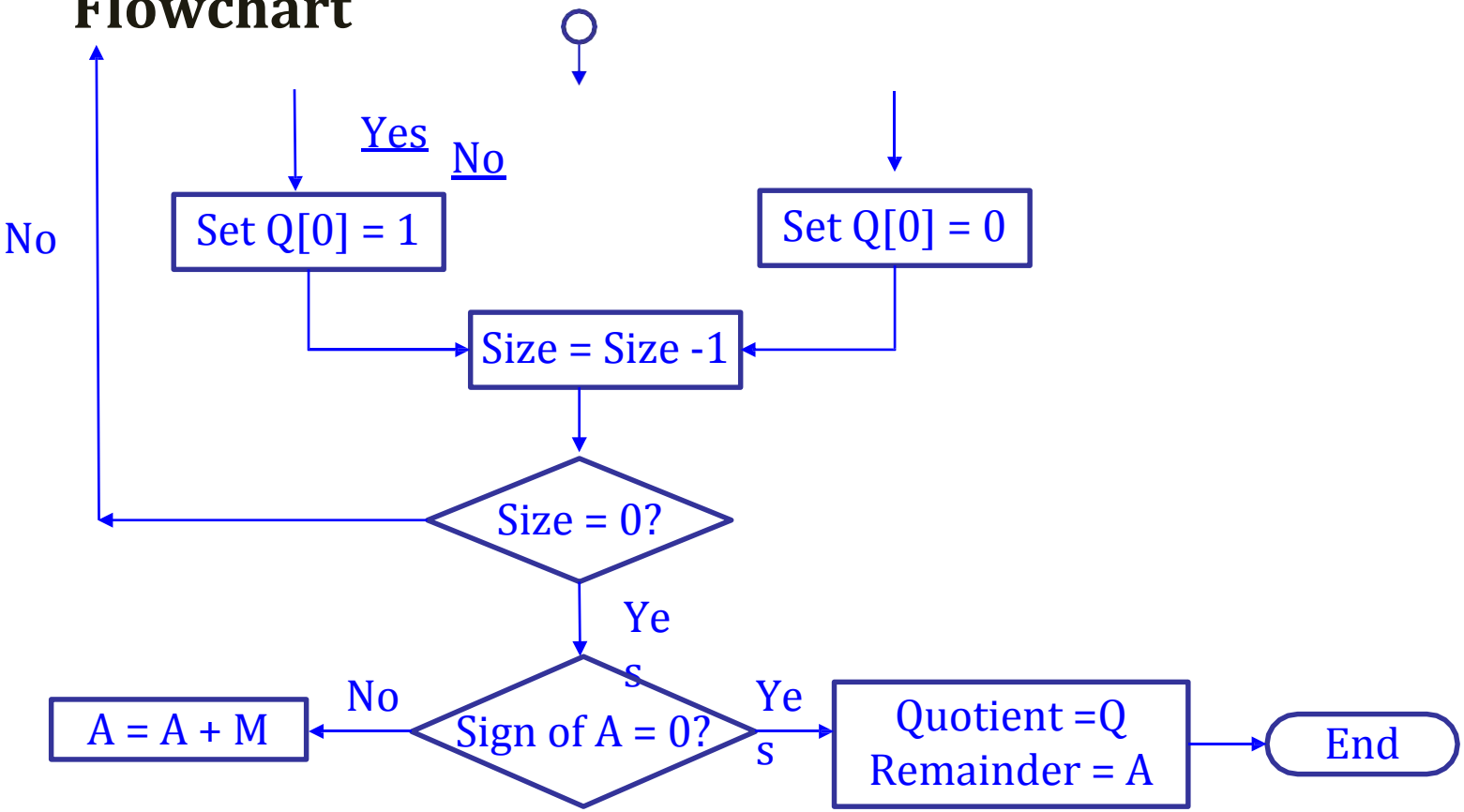
Now, if step 3 is performed first and then step 1 followed by step 2, we may get two cases:

1. If A is +ve, shifting A register to the left one position ≡ 2A – M
2. When A is –ve, first restore A by adding the content of M and then shift A to the left one position. After that A will be subtracted from; i.e. ≡ 2A + M

Non Restoring Division Algorithm Flowchart



Restoring Division Algorithm Flowchart



Non Restoring Division Algorithm Example

Let us consider, Dividend Q = 7 = 0111 Divisor M = 3 = 0011

Initial Configuration:	**M**	**A**	**Q**		**Size**
	00011	00000	0111		4
Step 1:					
As Sign of A = +ve					
Left Shift (AQ)	00011	00000		111	
A= A- M	00011	11101		111	
As Sign of A = -ve					
Set Q[0] = 0	00011	11101	1110		3
Step 2:					
As Sign of A = -ve					
Left Shift (AQ)	00011	11011		110	
A = A + M	00011	11110	110		
As Sign of A = -ve					
Set Q[0] = 0	00011	11110	1100	2	

Non Restoring Division Algorithm Example

	M	A	Q		Size
Previous Configuration:		00011	11110	1100	2
Step 3:					
As Sign of A = -ve					
Left Shift (AQ)		00011	11101	100	
A= A + M		00011	00000	100	
As Sign of A = +ve					
Set Q[0] = 1		00011	00000	1001	1
Step 4:					
As Sign of A = +ve					
Left Shift (AQ)		00011	00001	001	
A = A - M		00011	11110	001	
As Sign of A = -ve					
Set Q[0] = 0		00011	11110	0010	0

Therefore, Quotient Q = 0010 = 2

& Remainder A = 00001 = 1 (A = A + M)