Division

- 1. For unsigned/+tive integers

Sequential Circuit Binary Divisor

(based on division by hand)

0011---M (Divisor) (+3)

0111---Q (Dividend) (+7)

0011)0111(1 0 Try 0000 0 1st bit of dividend

11 1101 -3

01 remainder 1101 -tive, Quotient=0

0011 +3 restore 0000

Division

Try 0001 01 msb 2 bits of dividend

1101 -3

1110 -tive Quotient =0

0011 +3 restore

Try 0011 011 msb 3 bits of dividend

1101 -3

0000 +tive

Put 1 in Quotient Q

Division

Try 0001- 1 next msb bit of dividend

1101 -3

1110 -tive Quotient =0

0011 +3 restore

0001 remainder

Restore Division Algorithm

Restoring Division Algorithm

Do n times: (n – number of digits of dividend)

1. Shift A and Q left 1 binary position
2. Subtract M from A, place in A
3. If the sign of A=1 (-tive)

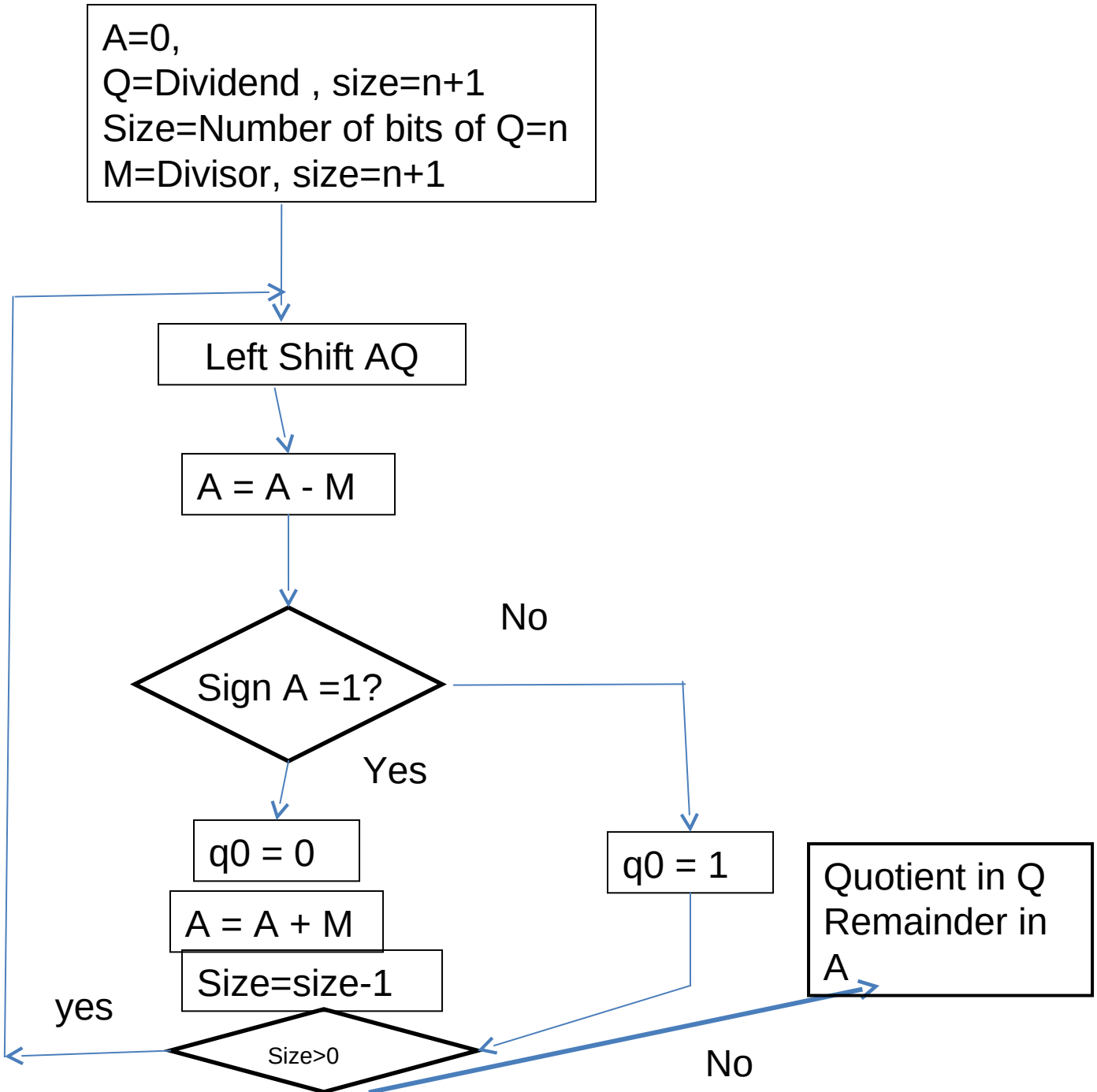
set q_0 to 0

Add M to A (restore A)

else

set q_0 to 1

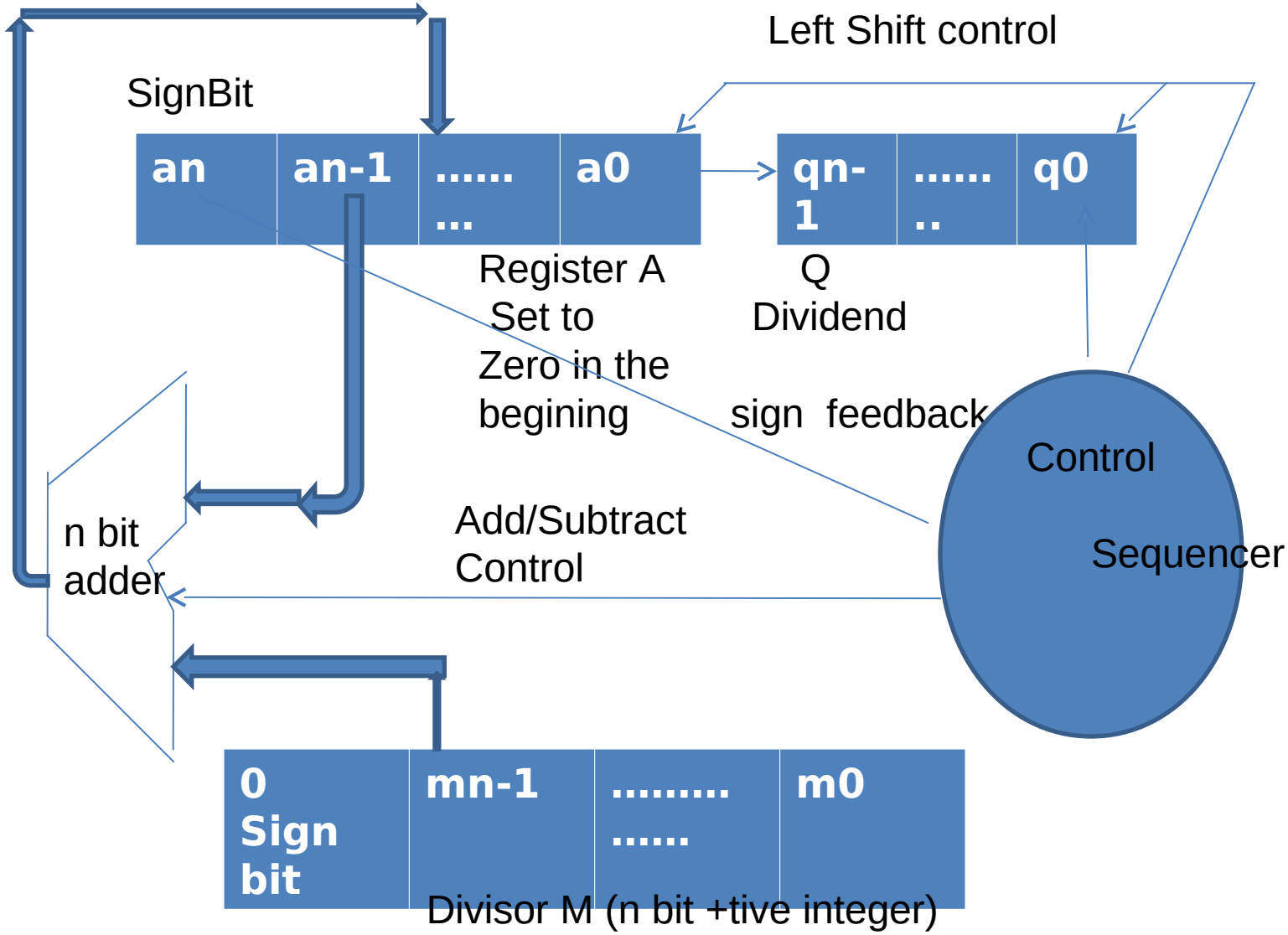
Restoring Division Flowchart



Division with Restore : 7 /3

A	Q	M	-M	Initial State 3bits
0000	111	0011	1101	
0001	11	Left Shift A and Q		Cycle 1=2bits remaining
1101	11	A-M		
1110	110	A –tive,Put 0 in q_0		
0011 0001	110	A+MTo Restore		
0011	10_	Left Shift A and Q		Cycle 2=1 bit remaining “
1101 0000	10_ 101	A-M A +tive.Put 1 in q_0		
0001 1101 1110	01 _ 01_ 010	Left Shift A and Q A-M A –tive,Put 0 in q_0		Cycle 3=0 bit remaining
0011 0001 Remaind	010 010 Quotien	A+M		

Register Configuration(Restoring Division)



Non Restoring Division : 7 /3

	A	Q	M-Divisor	-M	Initial State
	0000	111	0011	1101	
2A-M	0001	11	Left Shift A and Q		Cycle 1
	1101	11_	A-M		
	1110	110	A –tive,Put 0 in q_0		
	0011 0001	110	A+M Restored		
2(A+M)= 2A+2M - M=2A + M	0011	10	Left Shift A and Q		Cycle 2
	1101 0000	10_ 10 1	A-M A +tive.Put 1 in q_0		“ “
	0001 1101 1110	01_ 01_ 010	Shift A-M A –tive,Put 0 in		Cycle 2 Cycle3 ‘’

2. Non restoring Division Algorithm

Do following 2 steps n times(n is number of bits in dividend (Q)) :

1. If sign of A = 0 (+tive)

   Shift left AQ 1 bit position

   A=A – M

   else

   Shift left AQ 1 bit position

   A= A + M

2. If sign of A=0 , q0=1

   else q0=0

3. At end if sign A = 1, A= A+ M(restore remainder)

Non Restoring Division = 7 /3=Q/M

A	Q	M	-M		Initial State
0000	111	0011	1101		
0001	11	Left Shift AQ			Cycle 1
1101	11_	A-M			
1110	110	A –tive.Set 0 in q0			
1101	10_	Shift			Cycle 2
0011	10_	A+M			
0000	101	A+tive.Set 1 in q0			
0001 1101 1110	01_ 01_ 010	Shift A-M A -tive.Put 0in q0			Cycle3

Non Restoring Division : 7 /3 contd….

A	Q		-M	
1110	010		1101	
0011 0001 Remainder	0010 Quotient	A+M To Restore remainder		

Exercise

- Use restoring division algorithm to divide decimal numbers 23 by 6
- Use non-restoring division algorithm to divide decimal numbers 29 by 7