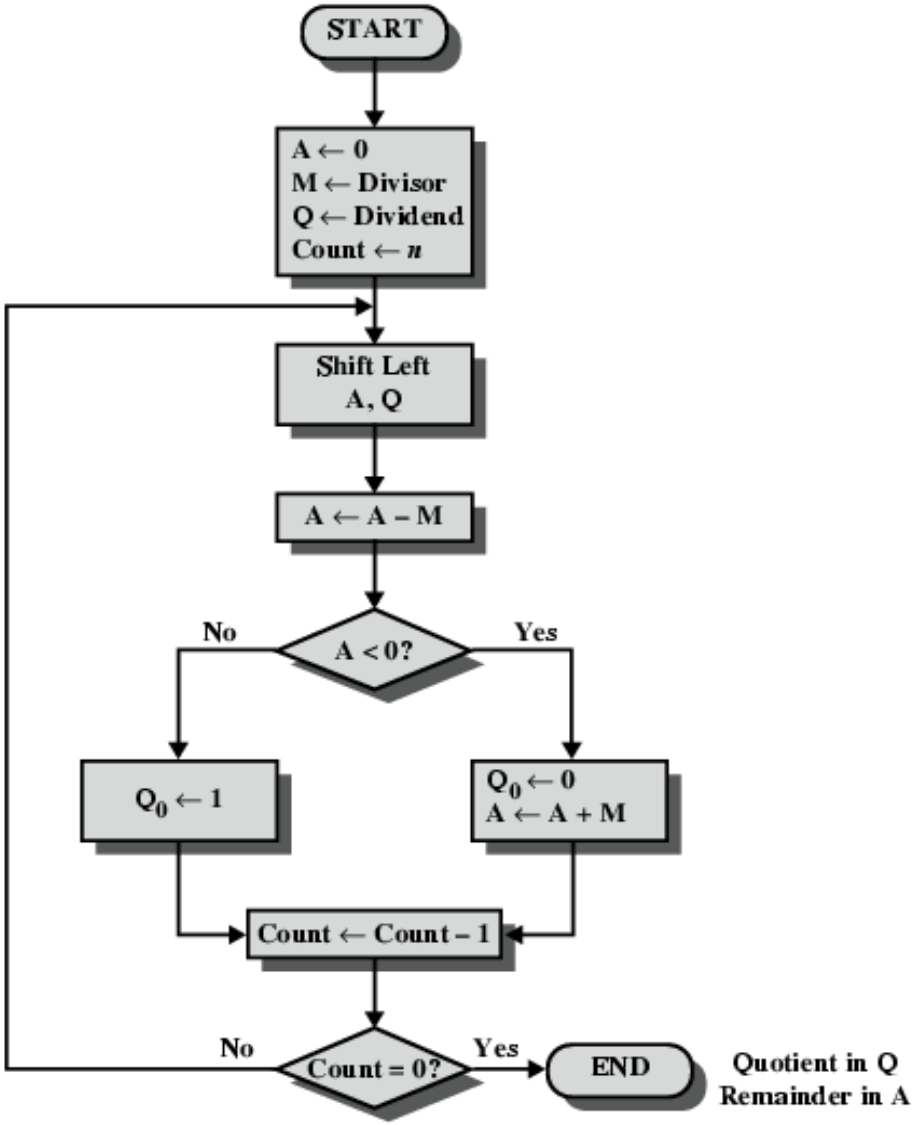


Figure 9.16 Flowchart for Unsigned Binary Division

Restoring division (17)/ (3)

- Dividend Q = $(17)_{10} = (10001)_2$ n= 5 as 17 requires 5 bits
- Divisor M = $(03)_{10} = (000011)_2$ n+1 = 6 bits
- 2's complement of M = $(111101)_2$

C	A	Q	Shift	
0	00000	10001		Initial
			left	
0	00001	0001_		
			A = A – M = A + 2's complement of M	000001 + 111101 = 111110
1	11110	00010		
			Restore	
0	00001	00010		

C	A	Q	Shift	
0	00001	00010		Initial
			left	
0	00010	0010_		
			A = A – M = A + 2's complement of M	000010 + 111101 = 111111
1	11111	0010 **0**		
			Restore	
0	00010	00100		

C	A	Q	Shift	
0	00010	00100		Initial
			left	
0	00100	0100_		
			A = A – M = A + 2's complement of M	000100+ 111101 = 000001
0	00001	01001		

C	A	Q	Shift	
0	00001	01001		Initial
			left	
0	00010	1001_		
			A = A – M = A + 2's complement of M	000010+ 111101 = 111111
1	11111	10010		
			Restore	
0	00010	10010		

C	A	Q	Shift	
0	00010	10010		Initial
			left	
0	00101	0010_		
			A = A – M = A + 2's complement of M	000101 + 111101 = 000010
0	00010	00101		
			Restore	
	000010 remainder	0010 1 quotient		

Restoring division (11)/ (3)

- Dividend Q = $(11)_{10} = (1011)_2$ n= 4 as 11 requires 4 bits
- Divisor M = $(03)_{10} = (00011)_2$ n+1 = 5 bits
- 2's complement of M = $(11101)_2$

1st Cycle

C	A	Q	Shift	
0	0000	1011		Initial
			left	
0	0001	011_		
			A = A – M = A + 2's complement of M	00001 + 11101= 11110
1	1110	0110		

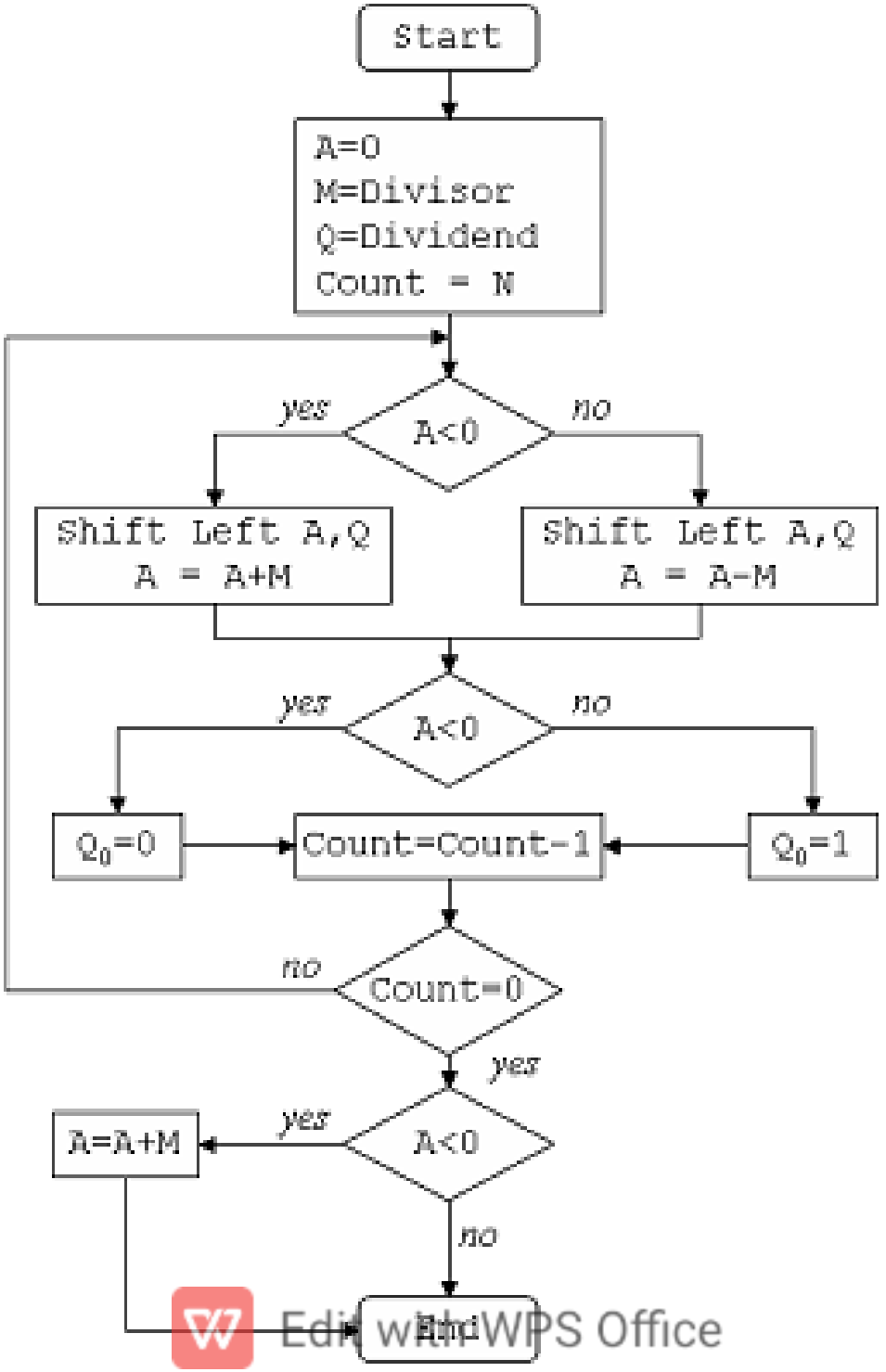
C	A	Q	Shift	
0	0001	0110		Initial
			left	
0	0010	110_		
			A = A – M = A + 2’s complement of M	00010 + 11101= 11111
1	1111	1100		
			Restore	
0	0010	1100		

C	A	Q	Shift	
0	0010	1100		Initial
			left	
0	0101	100_		
			A = A – M = A + 2’s complement of M	00101 + 11101= 00010
0	0010	1001		

4^{th} Cycle

C	A	Q	Shift	
0	0010	1001		Initial
			left	
0	0101	001_		
			A = A – M = A + 2's complement of M	00101 + 11101= 00010
0	0010	0011		
	remainder	quotient		

Non restoring Division



Non Restoring division (11)/ (3)

- Dividend Q = $(11)_{10} = (1011)_2$ n= 4 as 11 requires 4 bits
- Divisor M = $(03)_{10} = (00011)_2$ n+1 = 5 bits
- 2's complement of M = $(11101)_2$

C	A	Q	Shift	
0	0000	1011		Initial
			left	
0	0001	011_		
			A = A – M = A + 2's complement of M	00001 + 11101= 11110
1	1110	0110		

2nd Cycle

C	A	Q	Shift	
1	1110	0110		Initial
			left	
1	1100	110_		
			A = A +M	11100 + 00011= 11111
1	1111	1100		

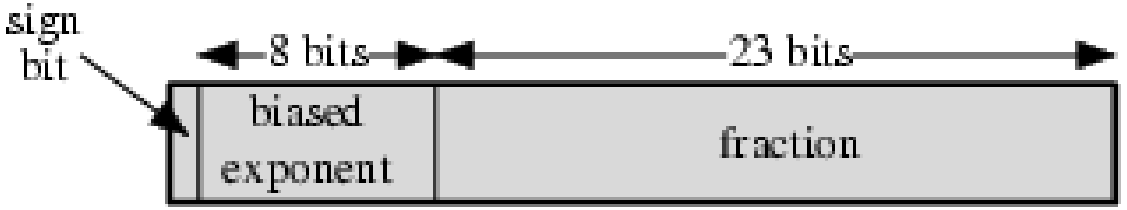
3rd Cycle

C	A	Q	Shift	
1	1111	1100		Initial
			left	
1	1111	100_		
			A = A +M =	11111 + 00011= 00010
0	0010	1001		

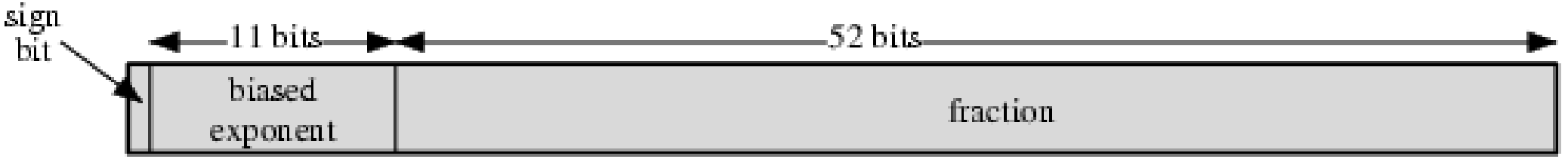
4^{th} Cycle

C	A	Q	Shift	
0	0010	1001		Initial
			left	
0	0101	001_		
			A = A – M = A + 2's complement of M	00101 + 11101= 00010
0	0010 remainder	0011 quotient		

IEEE 754 Formats



(a) Single format



(b) Double format

IEEE 754 Format Parameters

Parameter	Single	Single Extended	Double	Double Extended
Word width (bits)	32	≥ 43	64	≥ 79
Exponent width (bits)	8	≥ 11	11	≥ 15
Exponent bias	127	unspecified	1023	unspecified
Maximum exponent	127	≥ 1023	1023	≥ 16383
Minimum exponent	–126	≤ –1022	–1022	≤ –16382
Number range (base 10)	10^{-38}, 10^{+38}	unspecified	10^{-308}, 10^{+308}	unspecified
Significand width (bits)*	23	≥ 31	52	≥ 63
Number of exponents	254	unspecified	2046	unspecified
Number of fractions	2^{23}	unspecified	2^{52}	unspecified
Number of values	1.98×2^{31}	unspecified	1.99×2^{63}	unspecified

* not including implied bit

Interpretation of IEEE 754 Floating-Point Numbers

	Single Precision (32 bits)				Double Precision (64 bits)			
	Sign	Biased exponent	Fraction	Value	Sign	Biased exponent	Fraction	Value
positive zero	0	0	0	0	0	0	0	0
negative zero	1	0	0	–0	1	0	0	–0
plus infinity	0	255 (all 1s)	0	∞	0	2047 (all 1s)	0	∞
minus infinity	1	255 (all 1s)	0	$-\infty$	1	2047 (all 1s)	0	$-\infty$
quiet NaN	0 or 1	255 (all 1s)	$\neq 0$	NaN	0 or 1	2047 (all 1s)	$\neq 0$	NaN
signaling NaN	0 or 1	255 (all 1s)	$\neq 0$	NaN	0 or 1	2047 (all 1s)	$\neq 0$	NaN
positive normalized nonzero	0	$0 < e < 255$	f	$2^{e-127}(1.f)$	0	$0 < e < 2047$	f	$2^{e-1023}(1.f)$
negative normalized nonzero	1	$0 < e < 255$	f	$-2^{e-127}(1.f)$	1	$0 < e < 2047$	f	$-2^{e-1023}(1.f)$
positive denormalized	0	0	$f \neq 0$	$2^{e-126}(0.f)$	0	0	$f \neq 0$	$2^{e-1022}(0.f)$
negative denormalized	1	0	$f \neq 0$	$-2^{e-126}(0.f)$	1	0	$f \neq 0$	$-2^{e-1022}(0.f)$