Integer Division

Manual Division

```
        21                   10101
     ______              ___________
 13 ) 274           1101 ) 100010010
      26                   1101
     ----                 ------
       14                   10000
       13                    1101
      ----                 -------
        1                      1110
                               1101
                              ------
                                  1
```

Figure 6.20. Longhand division examples.

Longhand Division Steps

- Position the divisor appropriately with respect to the dividend and performs a subtraction.
- If the remainder is zero or positive, a quotient bit of 1 is determined, the remainder is extended by another bit of the dividend, the divisor is repositioned, and another subtraction is performed.
- If the remainder is negative, a quotient bit of 0 is determined, the dividend is restored by adding back the divisor, and the divisor is repositioned for another subtraction.

Circuit Arrangement

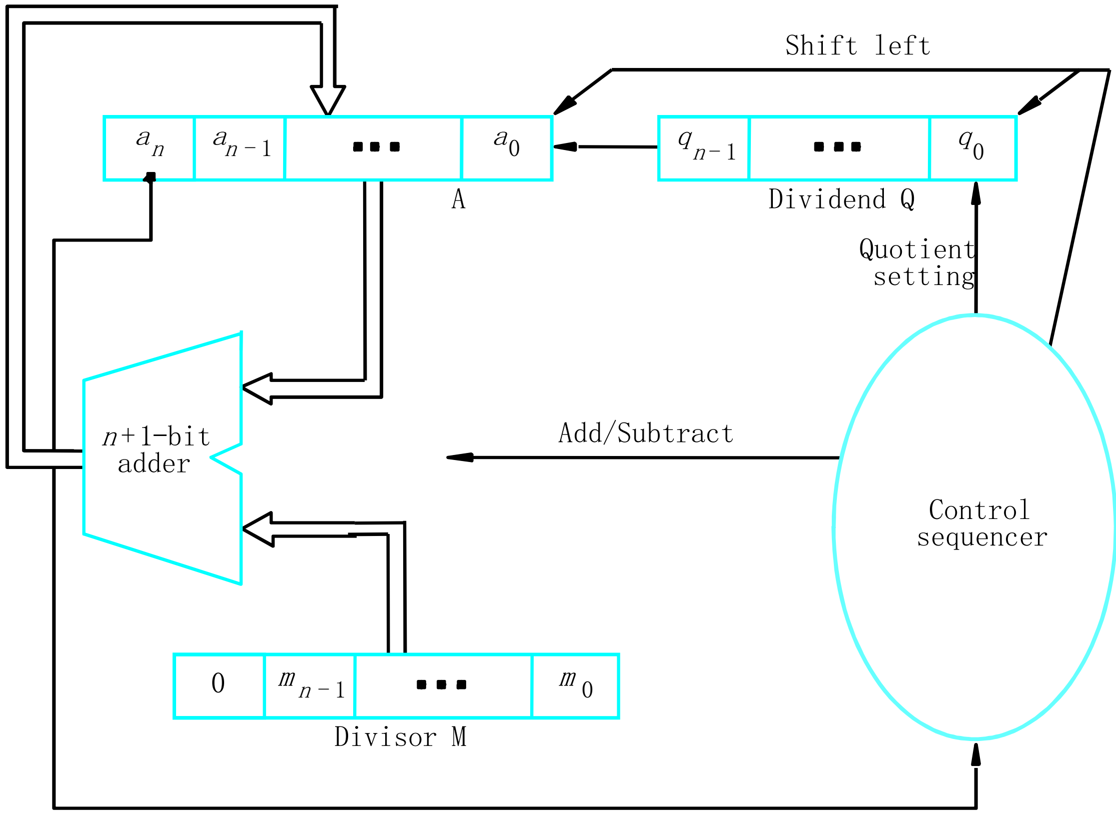

Figure 6.21. Circuit arrangement for binary division.

Restoring Division

- Shift A and Q left one binary position
- Subtract M from A, and place the answer back in A
- If the sign of A is 1, set q_0 to 0 and add M back to A (restore A); otherwise, set q_0 to 1
- Repeat these steps *n* times

Examples

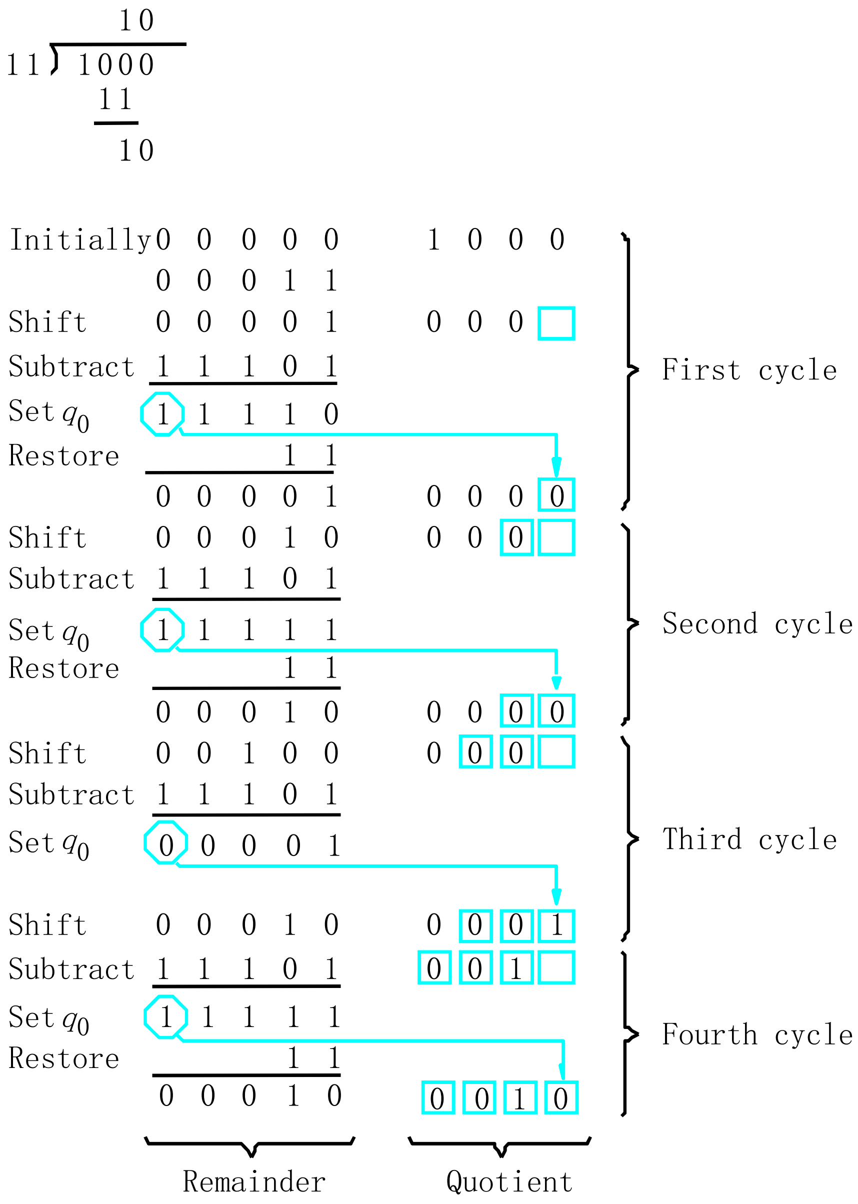

Figure 6.22. A restoring-division example.

Nonrestoring Division

- Avoid the need for restoring A after an unsuccessful subtraction.
- Any idea?
- Step 1: (Repeat *n* times)
  - If the sign of A is 0, shift A and Q left one bit position and subtract M from A; otherwise, shift A and Q left and add M to A.
  - Now, if the sign of A is 0, set q_0 to 1; otherwise, set q_0 to 0.
- Step2: If the sign of A is 1, add M to A

Examples

Initially	0 0 0 0 0	1 0 0 0	
	0 0 0 1 1		
Shift	0 0 0 0 1	0 0 0 □	First cycle
Subtract	1 1 1 0 1		
Set q_0	1 1 1 1 0	0 0 0 0	
Shift	1 1 1 0 0	0 0 0 □	Second cycle
Add	0 0 0 1 1		
Set q_0	1 1 1 1 1	0 0 0 0	
Shift	1 1 1 1 0	0 0 0 □	Third cycle
Add	0 0 0 1 1		
Set q_0	0 0 0 0 1	0 0 0 1	
Shift	0 0 0 1 0	0 0 1 □	Fourth cycle
Subtract	1 1 1 0 1		
Set q_0	1 1 1 1 1	0 0 1 0	
		Quotient	
Add	1 1 1 1 1		Restore remainder
	0 0 0 1 1		
	0 0 0 1 0		
	Remainder		

Figure 6.23. A nonrestoring-division example.