Computer Organization & Architecture

2-7 Integer Division

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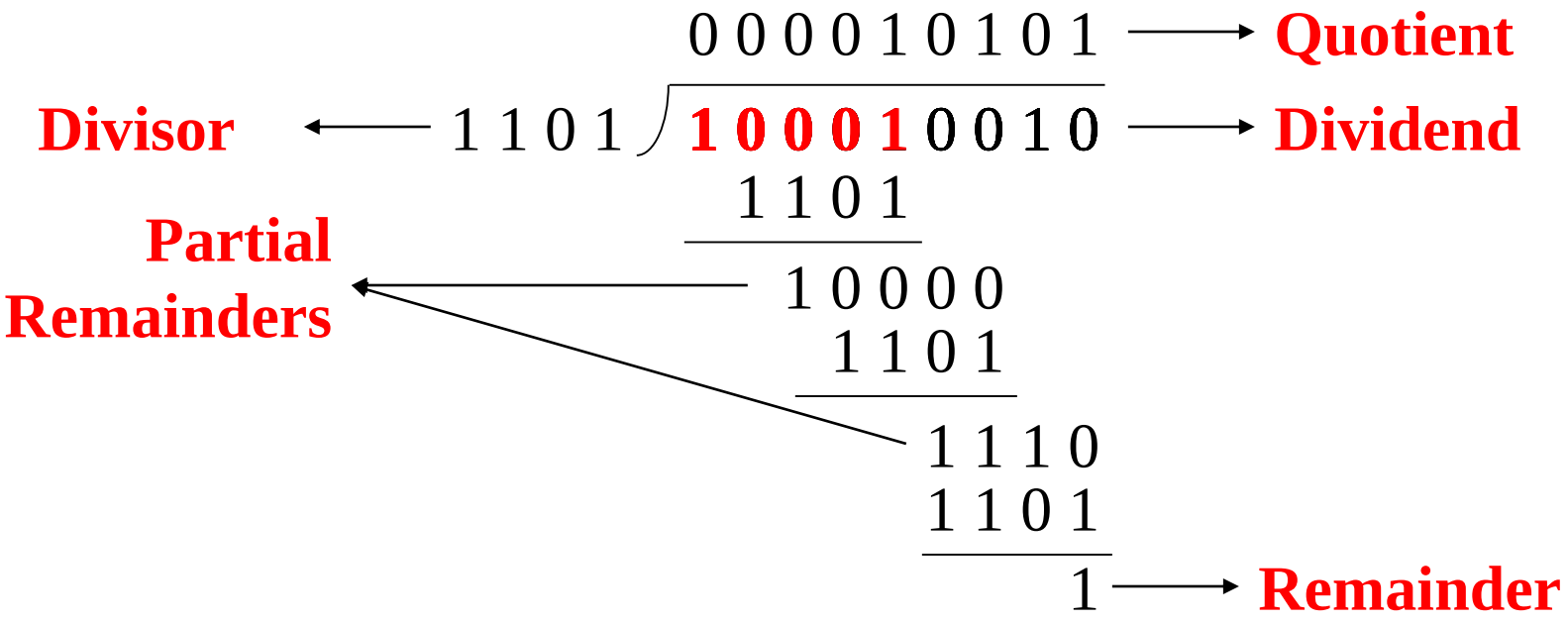
Contents of this lecture

- Manual Division of Positive Integers
- Restoring Division
- Non-Restoring Division

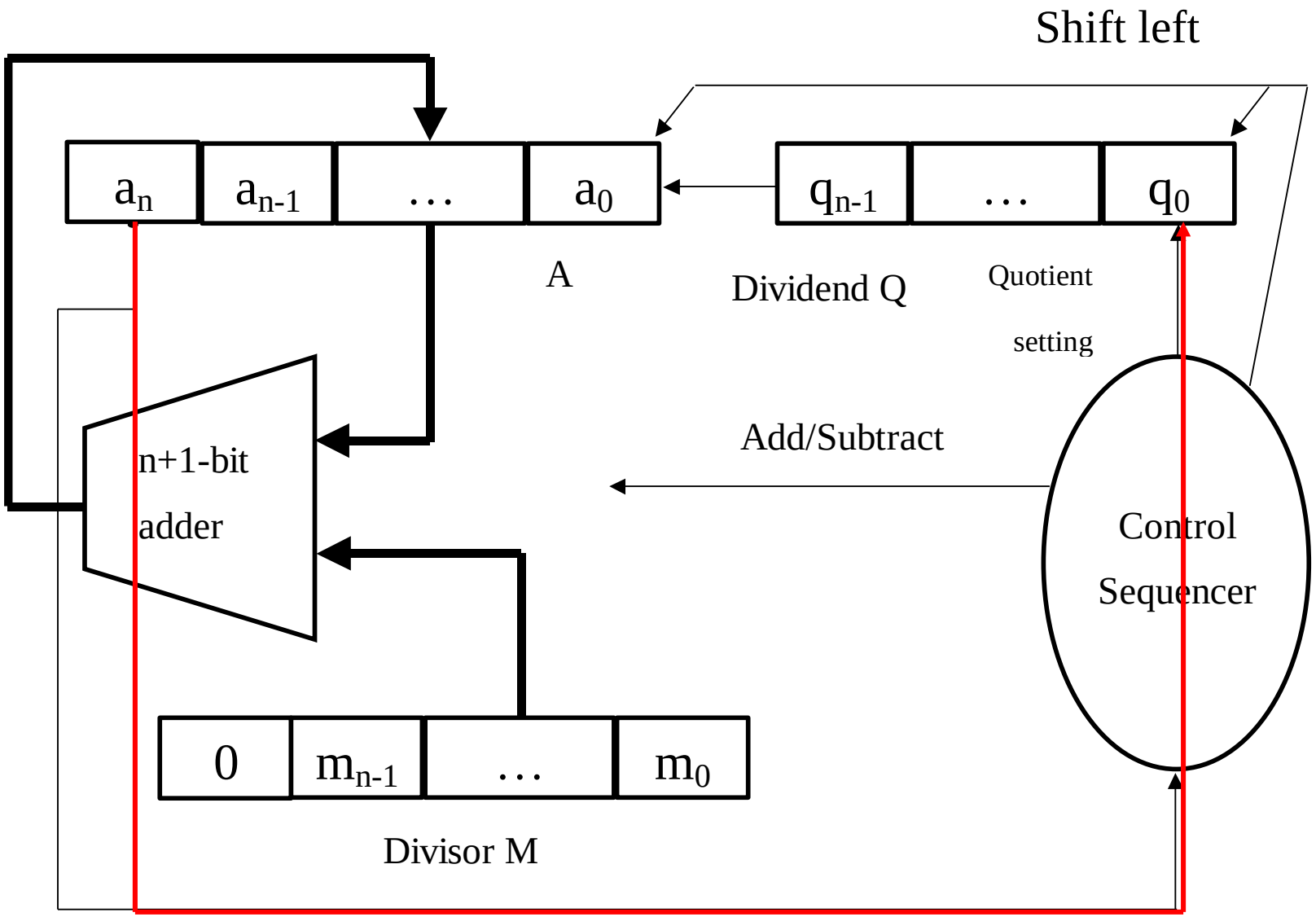
Manual Division of Positive Integers

- Example: calculate 100010010 ÷ 1101



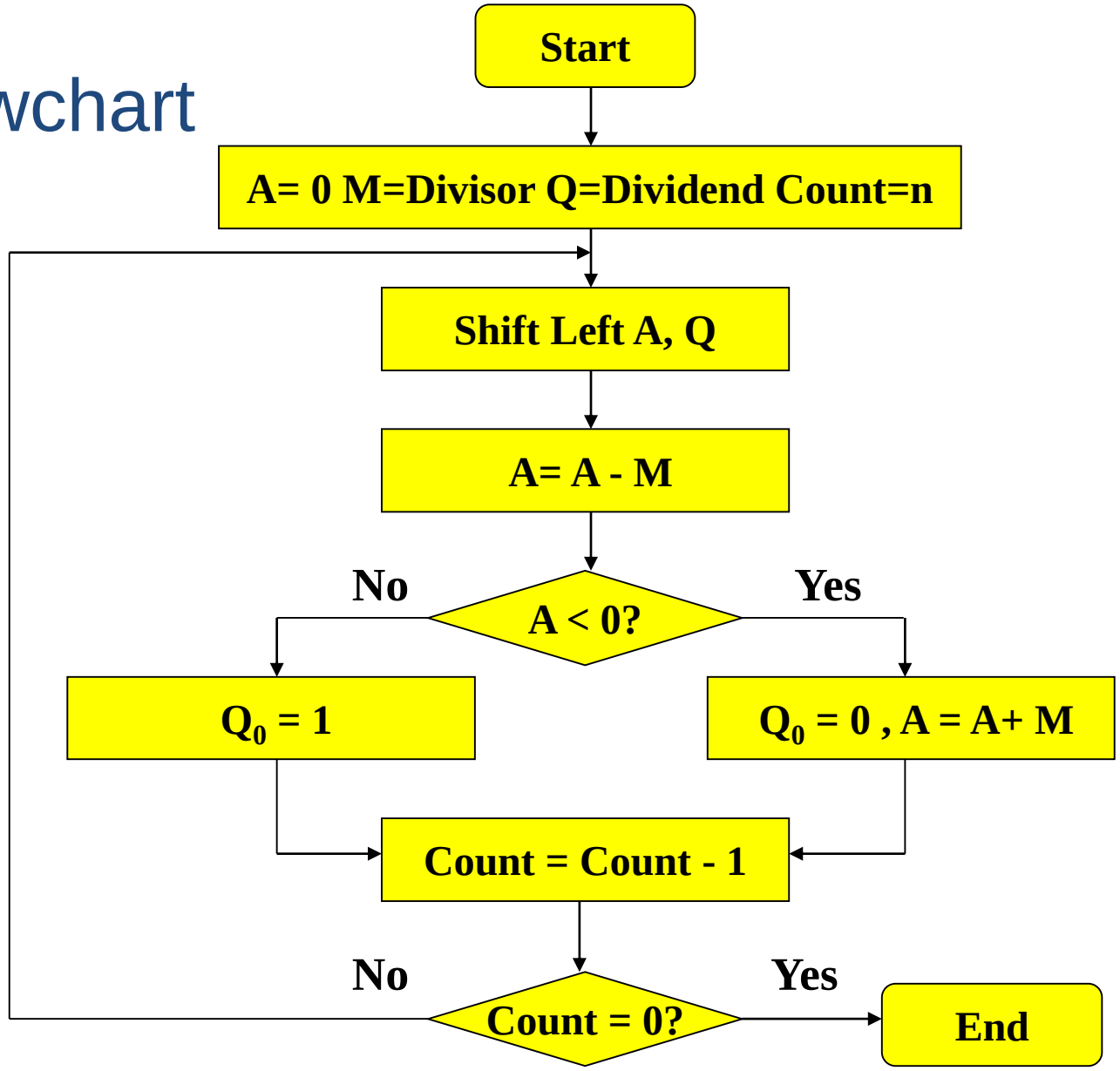
Restoring Division (1)

- Hardware



Restoring Division (2)

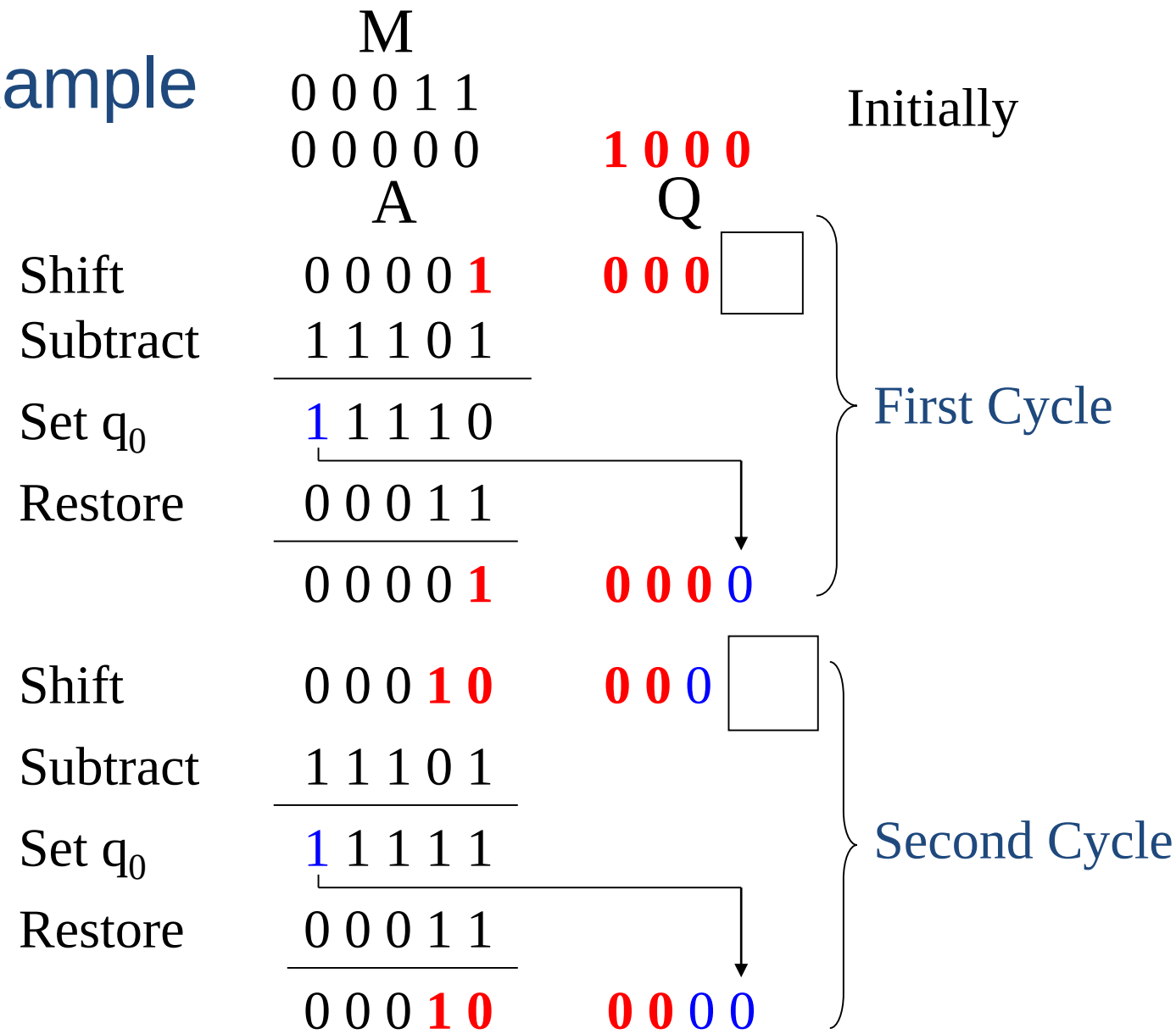
- Flowchart



Quotient in Q
Remainder in A

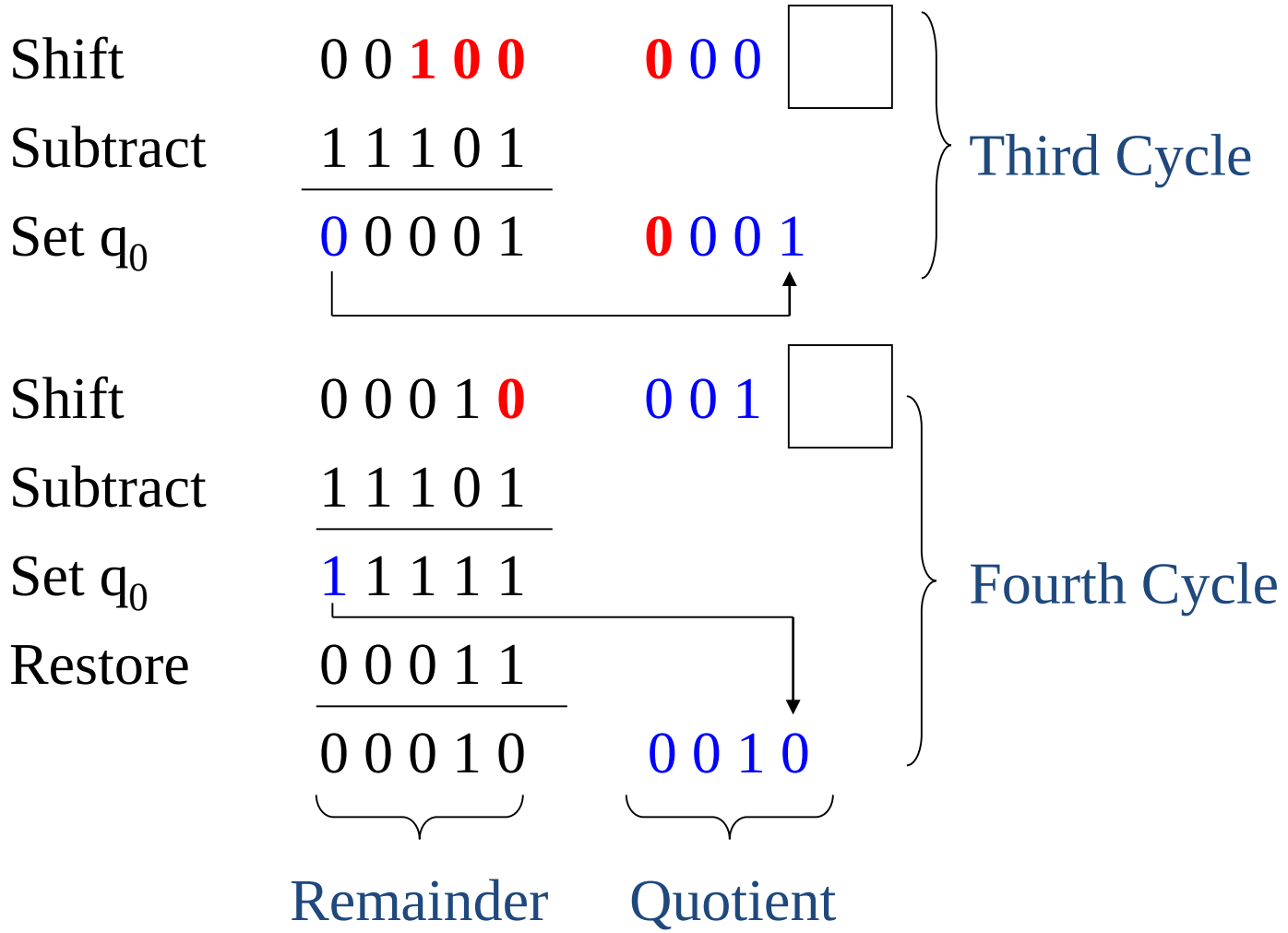
Restoring Division (3)

- Example



Restoring Division (4)

- Example



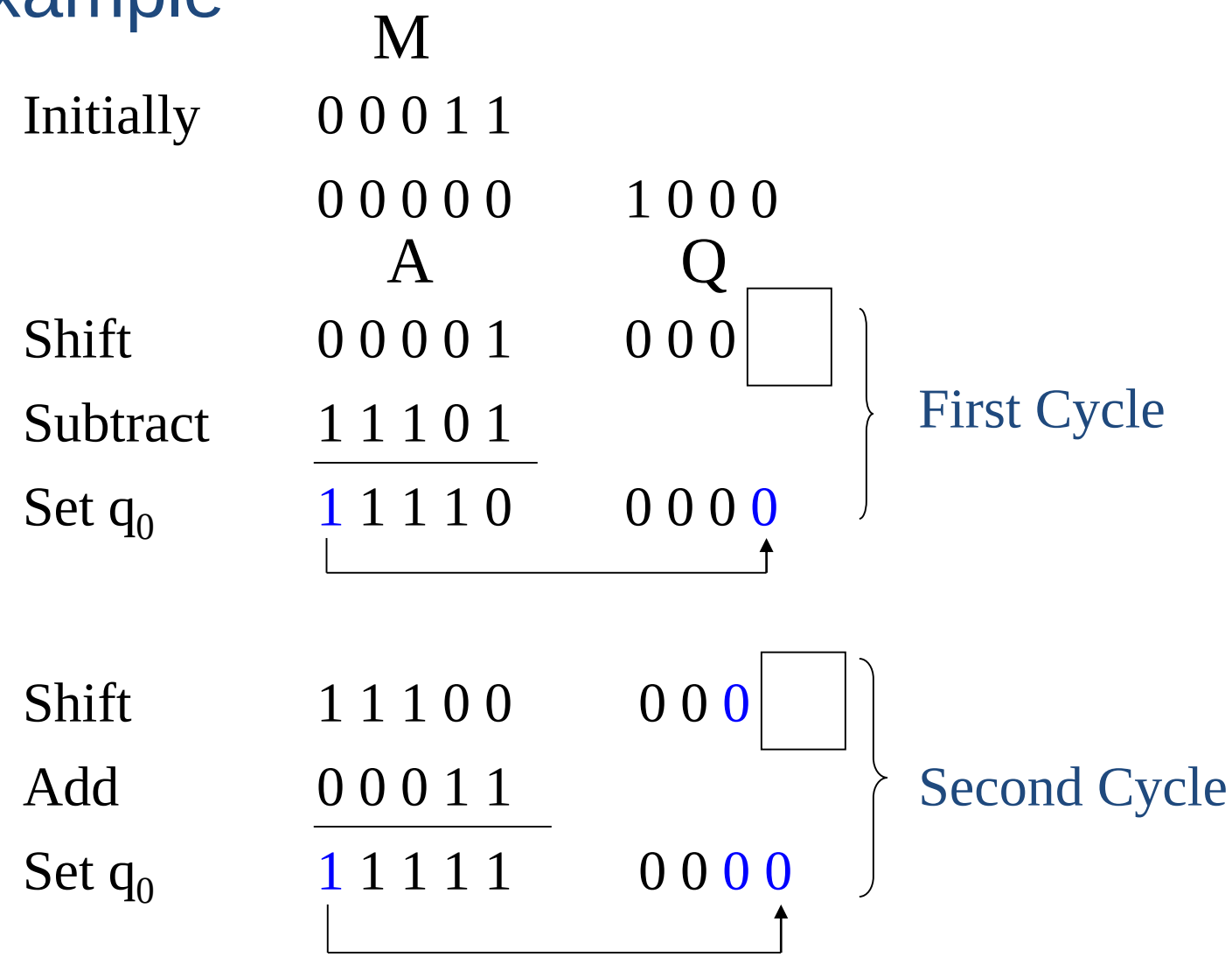
$$
\begin{array}{r}
1\,0 \\
1\,1 \;\overline{)\;1\,0\,0\,0} \\
\underline{1\,1\;\;} \\
1\,0
\end{array}
$$

Non-Restoring Division (1)

- In Restoring Division
  - (i-1) step, R_{i-1}
  - i step, $R_i'=2R_{i-1} - M$
    - $R_i' > 0$, $Q_0 = 1$, $R_i = R_i'$
    - $R_i' < 0$, $Q_0 = 0$, $R_i = R_i' + M$
  - (i + 1) step, $R_{i+1}'= 2R_i - M$
    - $R_i' > 0$, $R_i = R_i'$, $R_{i+1}' = 2R_i' - M$
    - $R_i' < 0$, $R_i = R_i' + M$, $R_{i+1}' = 2(R_i' + M) - M= 2R_i' + M$

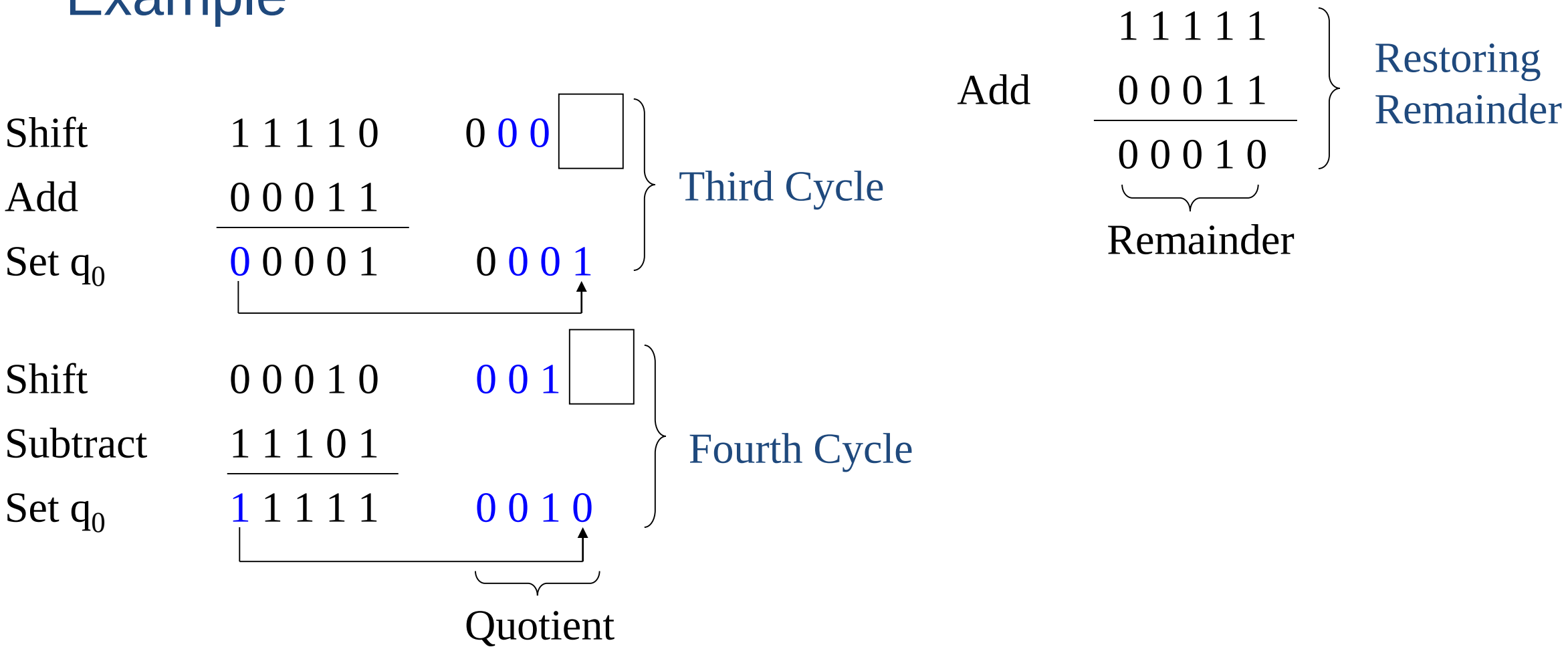
Non-Restoring Division (3)

- Example



Non-Restoring Division (4)

- Example

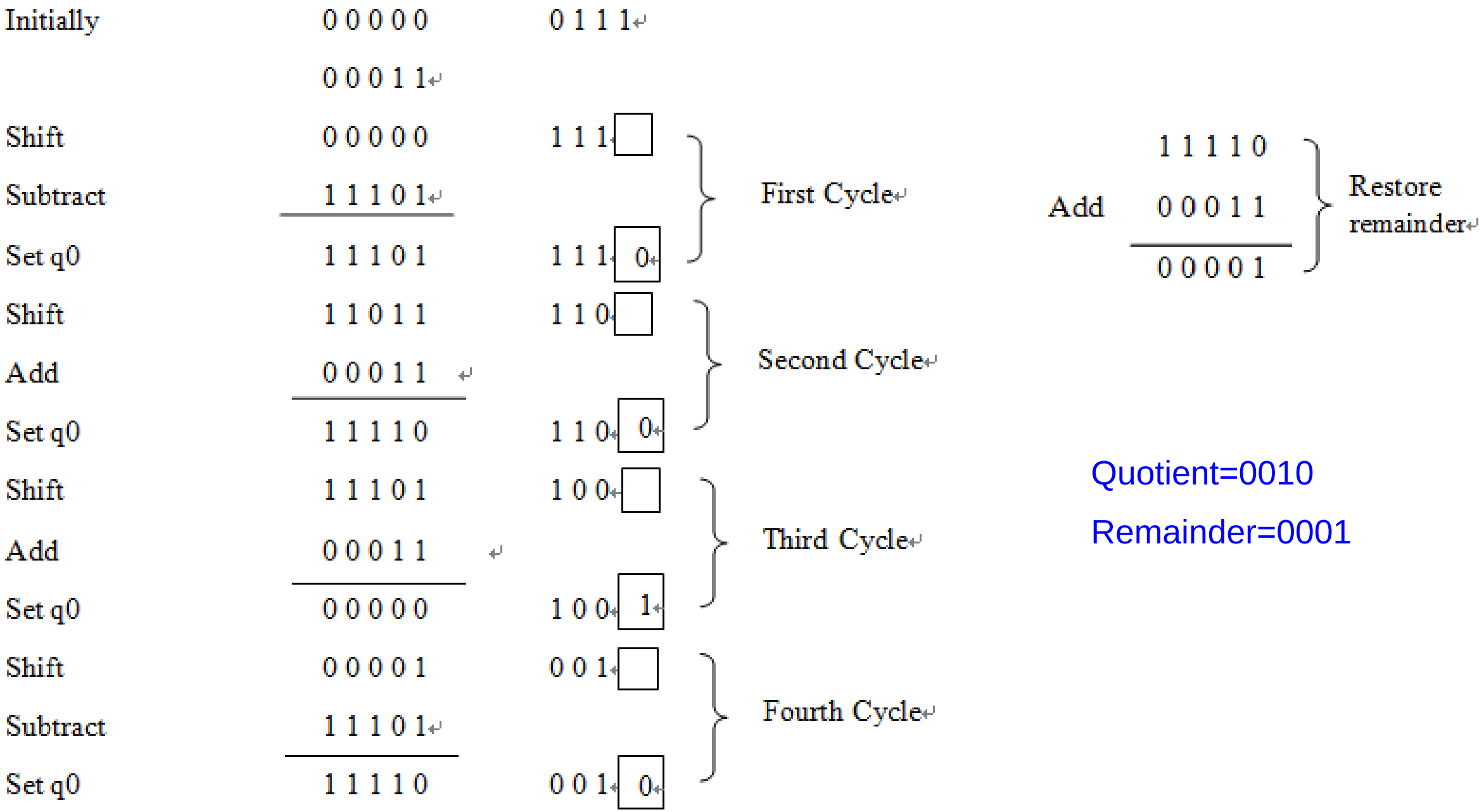


Conclusion

- Notes
  - There are no simple algorithms for directly performing division on signed operands that are comparable to the algorithms for signed multiplication.
  - In division, the operands can be processed to transform them into positive values.
  - After using one of the algorithms (restoring division or non-restoring division), the results are transformed to the correct signed values, as necessary.

Quiz

- Using non-restoring division algorithm, perform the operation A÷B on the 4-bit unsigned numbers A= 0111 and B= 0011.


Initially
0 0 0 0 0
0 1 1 1
0 0 0 1 1
Shift
0 0 0 0 0
1 1 1
Subtract
1 1 1 0 1
Set q0
1 1 1 0 1
1 1 1 0
First Cycle
Shift
1 1 0 1 1
1 1 0
Add
0 0 0 1 1
Set q0
1 1 1 1 0
1 1 0 0
Second Cycle
Shift
1 1 1 0 1
1 0 0
Add
0 0 0 1 1
Set q0
0 0 0 0 0
1 0 0 1
Third Cycle
Shift
0 0 0 0 1
0 0 1
Subtract
1 1 1 0 1
Set q0
1 1 1 1 0
0 0 1 0
Fourth Cycle
1 1 1 1 0
Add
0 0 0 1 1
0 0 0 0 1
Restore remainder
Quotient=0010
Remainder=0001