Digital Fundamentals

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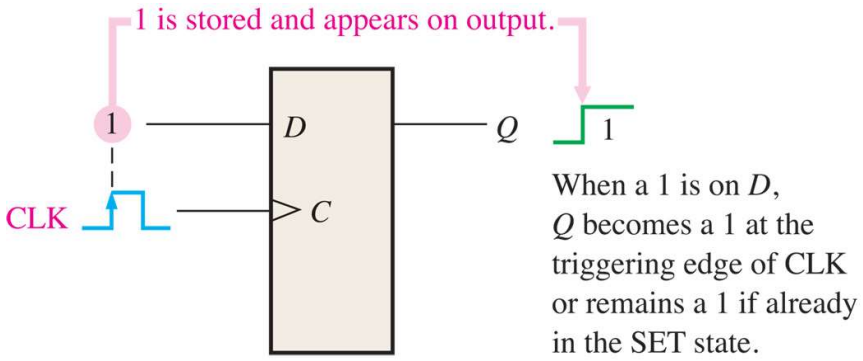
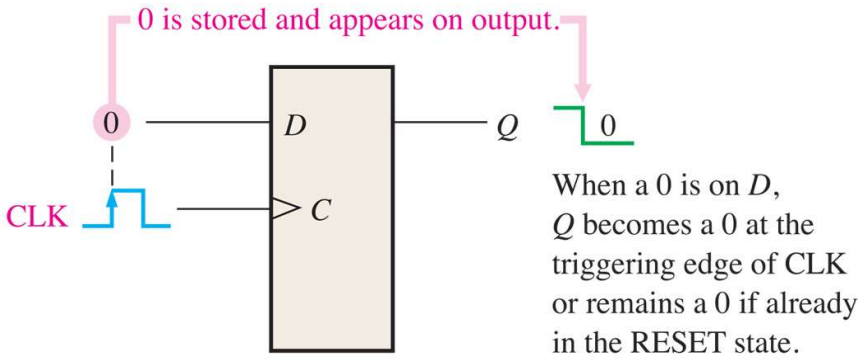
Shift Registers
Chapter 8

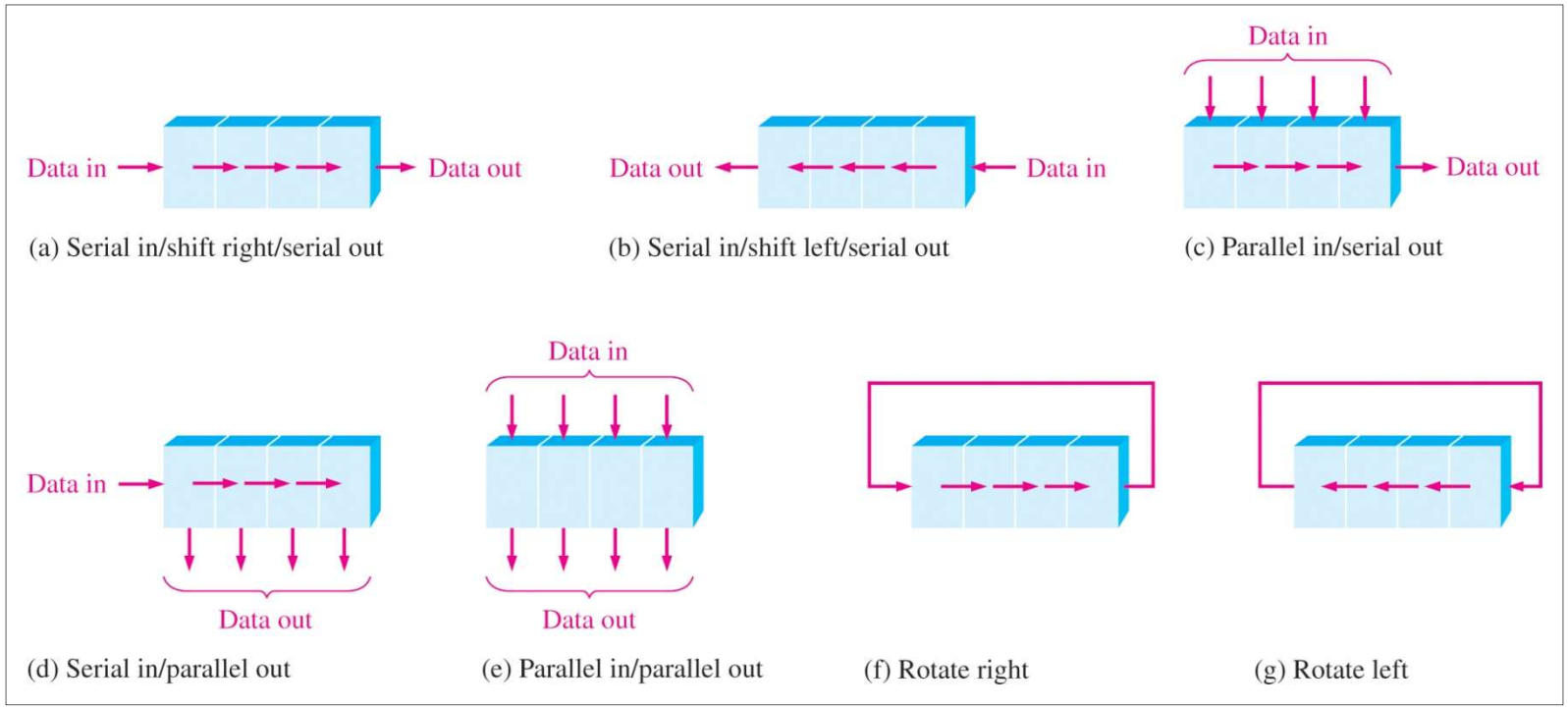
Register: Storage and Movement





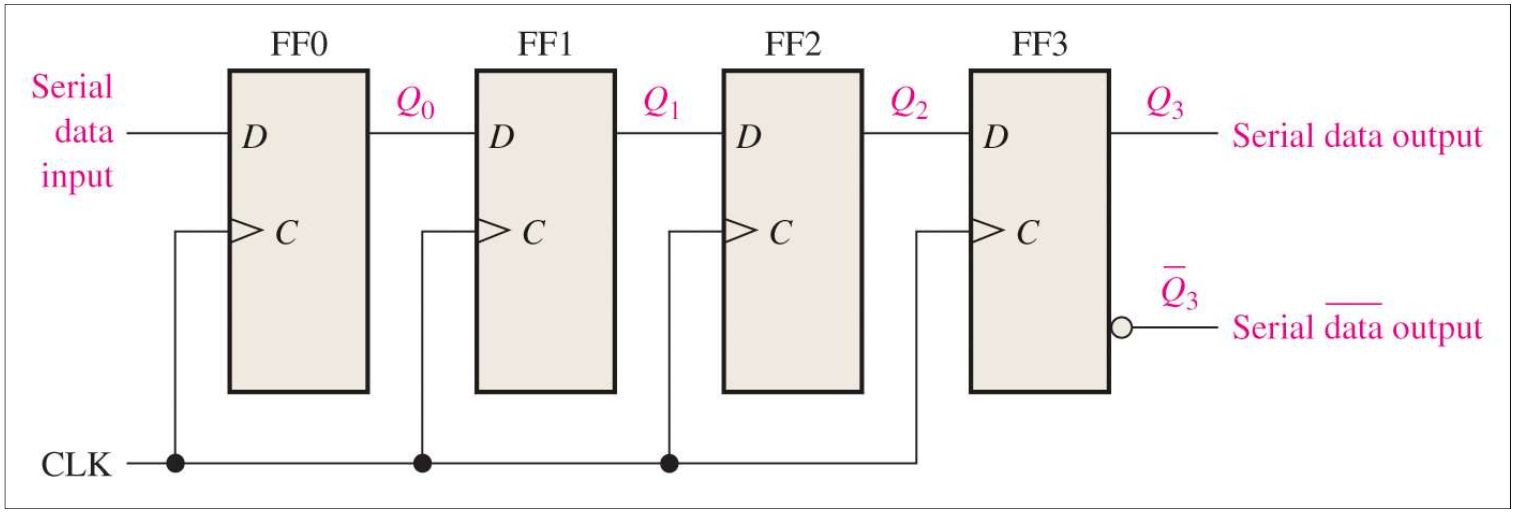
Basic Shift Register Operations

A **shift register** is a flip-flop circuit with important applications in the storage and movement of data. Some types of data movements are illustrated here.



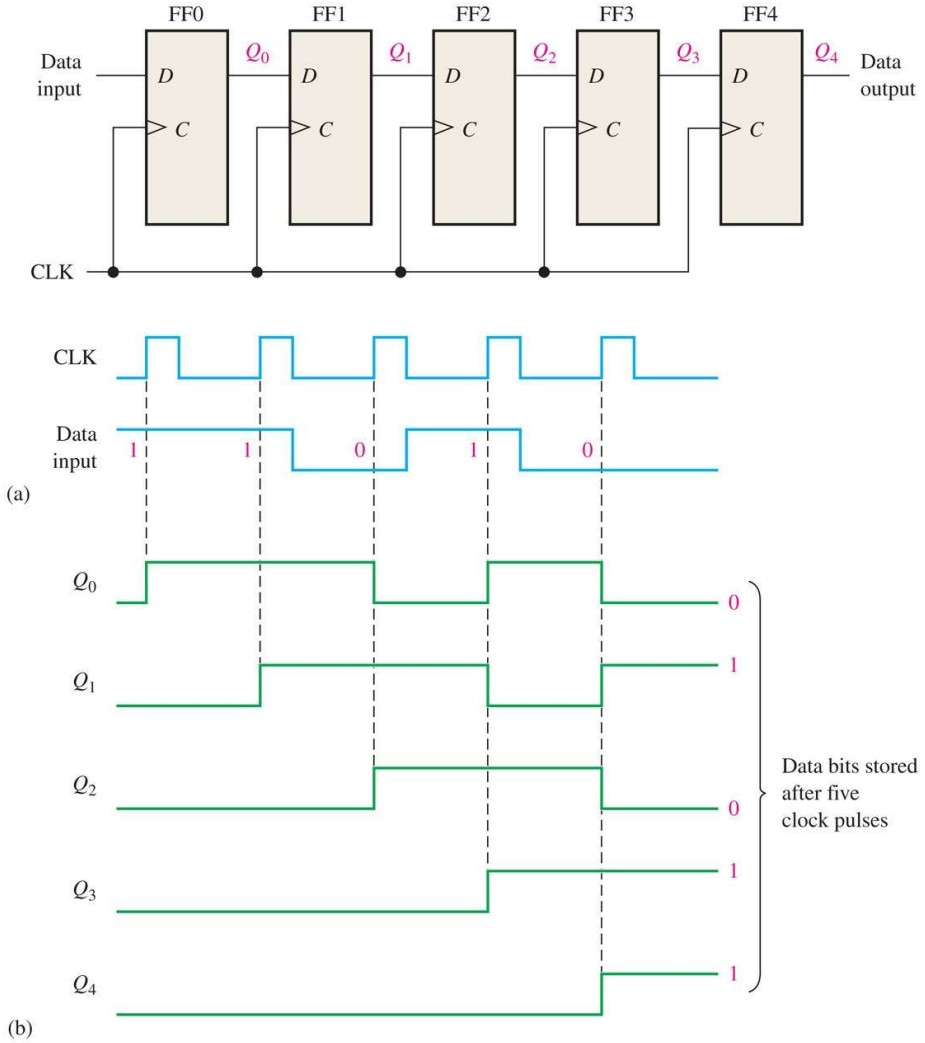
Serial-in/Serial out Shift Register

Shift registers are available in IC form or can be constructed from discrete flip-flops as is shown here with a five-bit serial-in serial-out register.



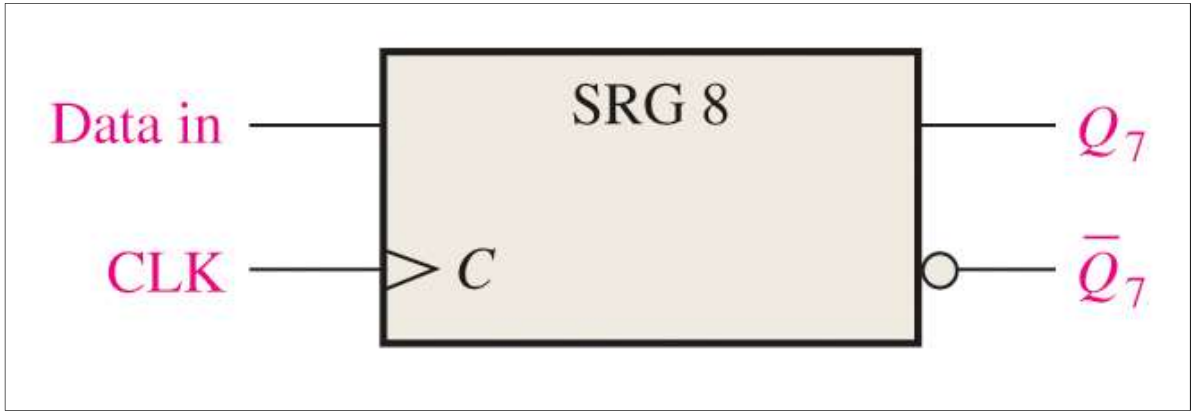
The data input is on the left. Each clock pulse will move the input bit to the next flip-flop. (Shifting occurs from left to right.)

Serial-in/Serial out Shift Register



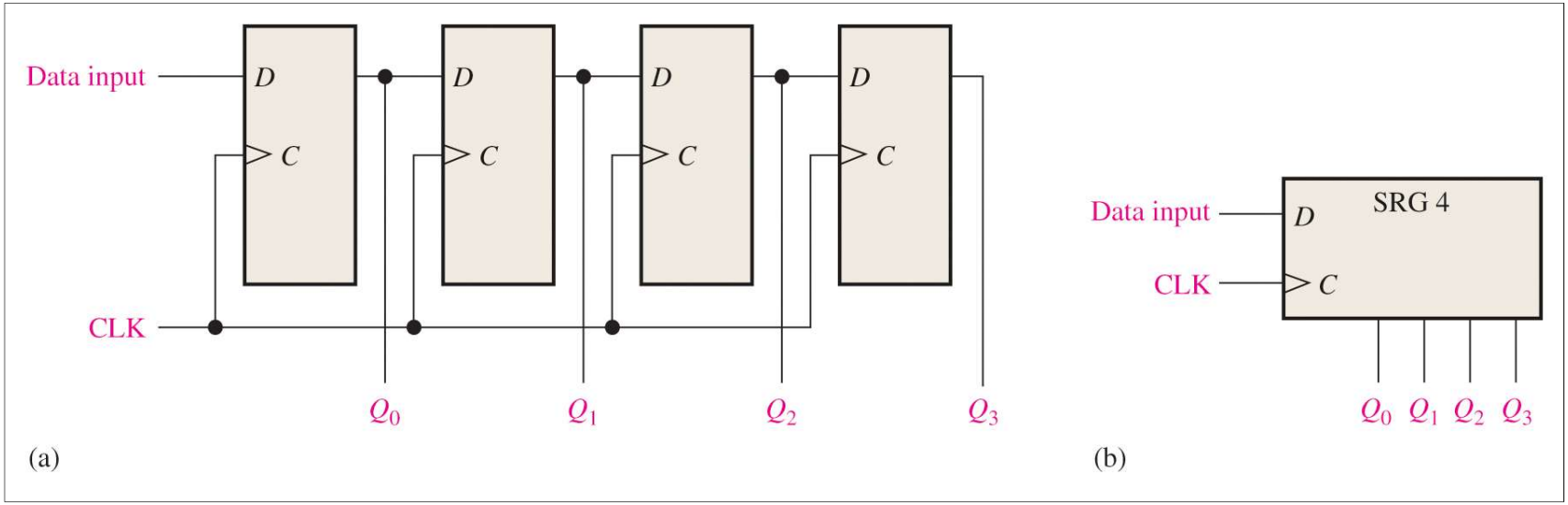
Serial-in/Serial out Shift Register

Shift registers are commonly presented as shown below. The “SRG 8” label indicates that the circuit is an 8-bit shift register.



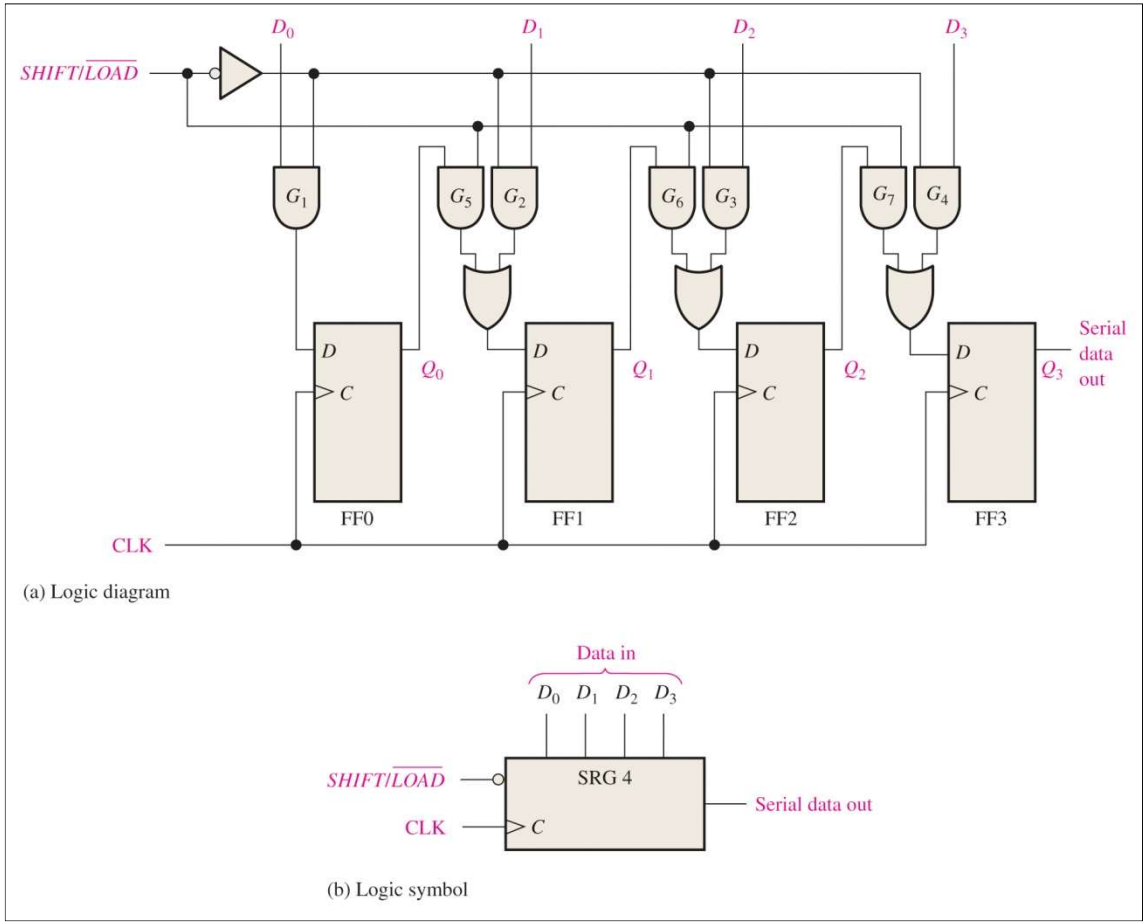
Serial-in/Parallel-out Shift Register

A **serial-in/parallel-out** shift register has a single data input and some number of parallel data outputs, as shown below.

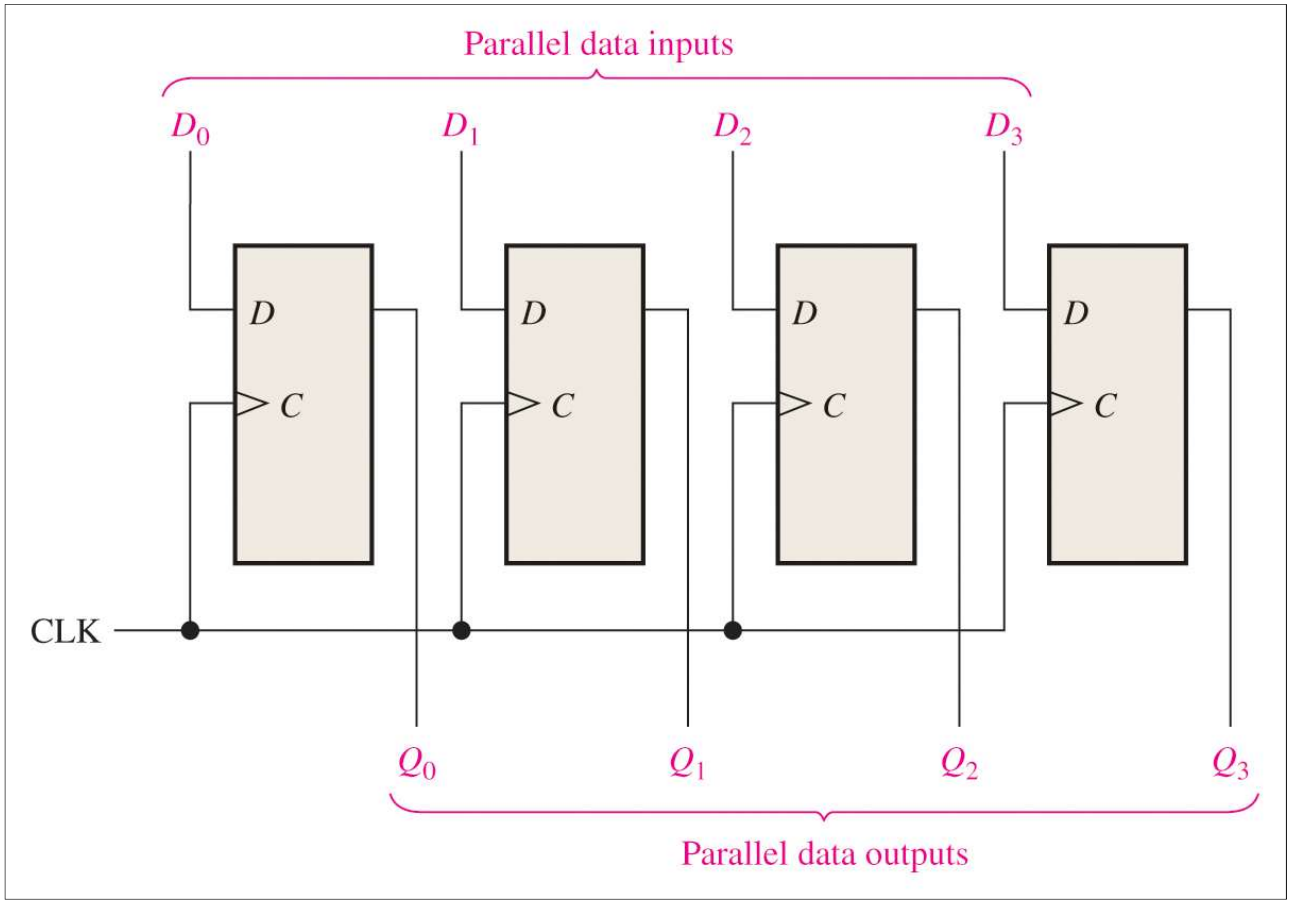


Parallel in/Serial out Shift Register

Shift registers can be used to convert parallel data to serial form, as shown.

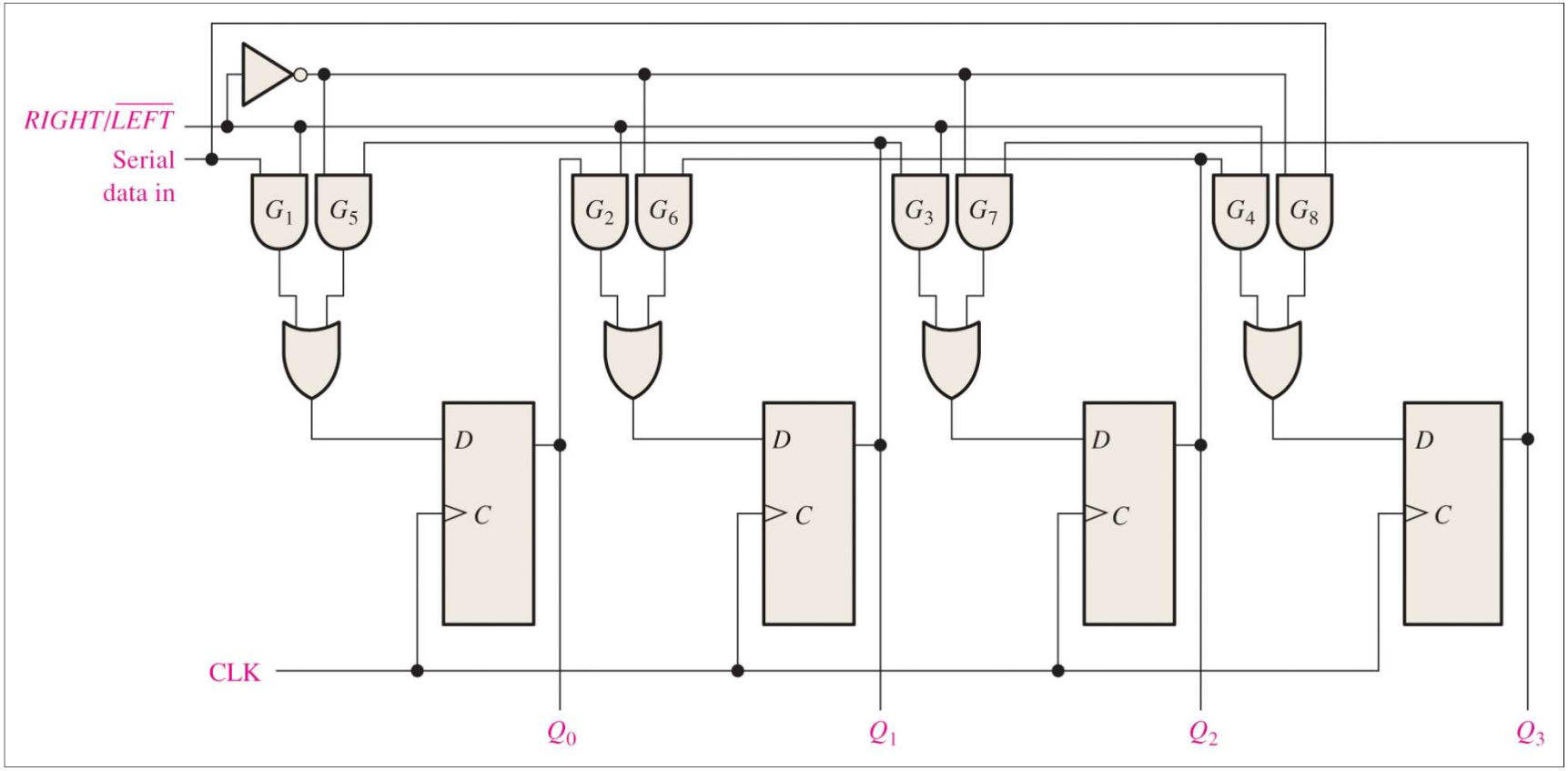


Parallel in/Parallel-out Shift Register



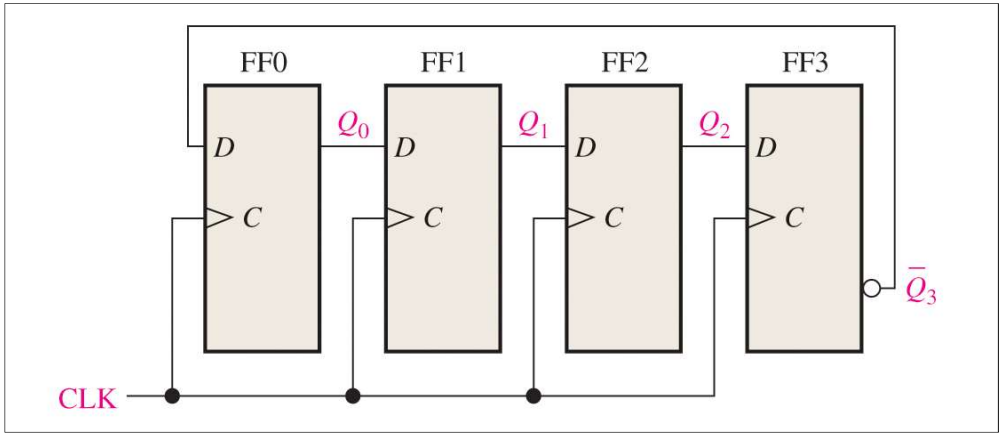
Ch.8 Summary

Four-Bit Bidirectional Shift Register



Shift Register Counters

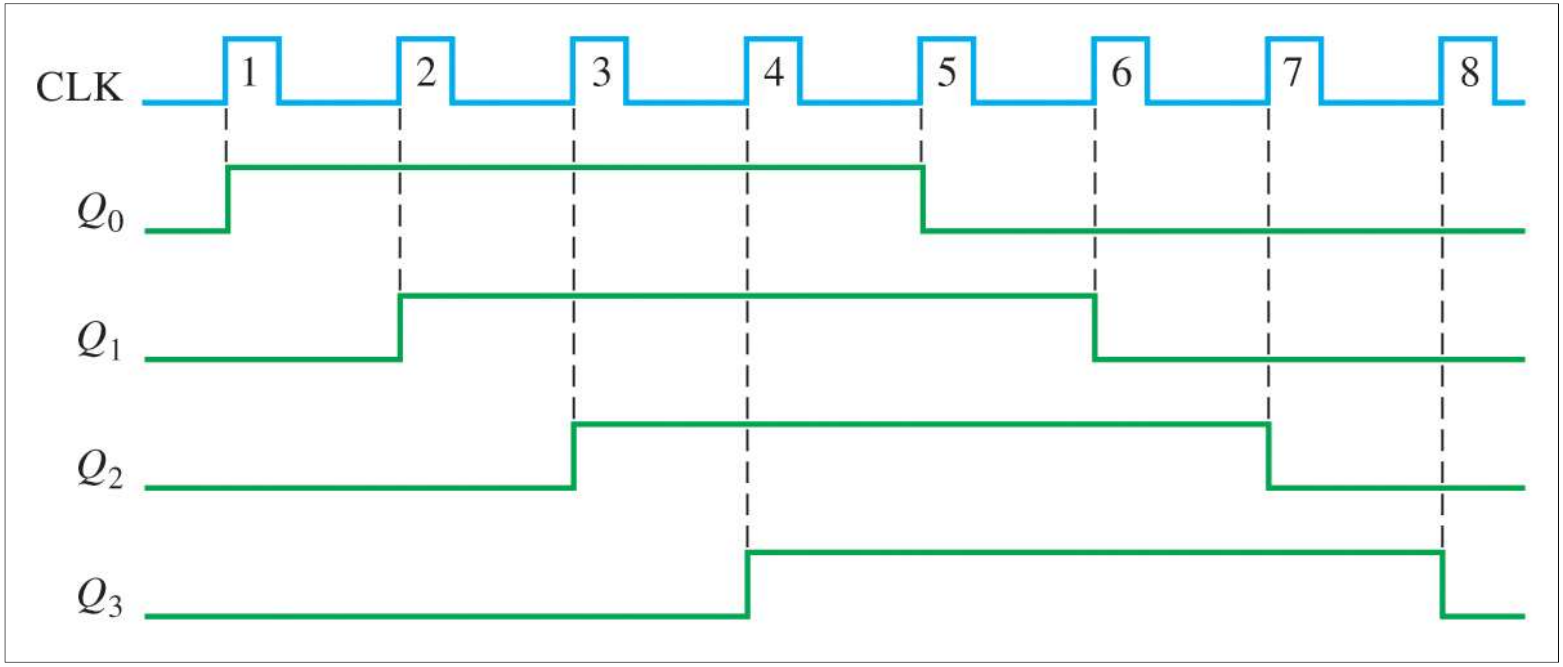
Shift registers can form useful counters by recirculating a pattern of 0's and 1's. A *Johnson counter* is an example of such a register.



A 4-bit Johnson counter can be constructed using a series of D flip-flops as shown.

Shift Register Counter Timing Diagram

The timing diagram for the 4-bit Johnson Counter (on the previous slide) is shown below.



4-bit Johnson Counter

TABLE 8–3

Four-bit Johnson sequence.

Clock Pulse	Q_0	Q_1	Q_2	Q_3
0	0	0	0	0
1	1	0	0	0
2	1	1	0	0
3	1	1	1	0
4	1	1	1	1
5	0	1	1	1
6	0	0	1	1
7	0	0	0	1

5-bit Johnson Counter

TABLE 8–4

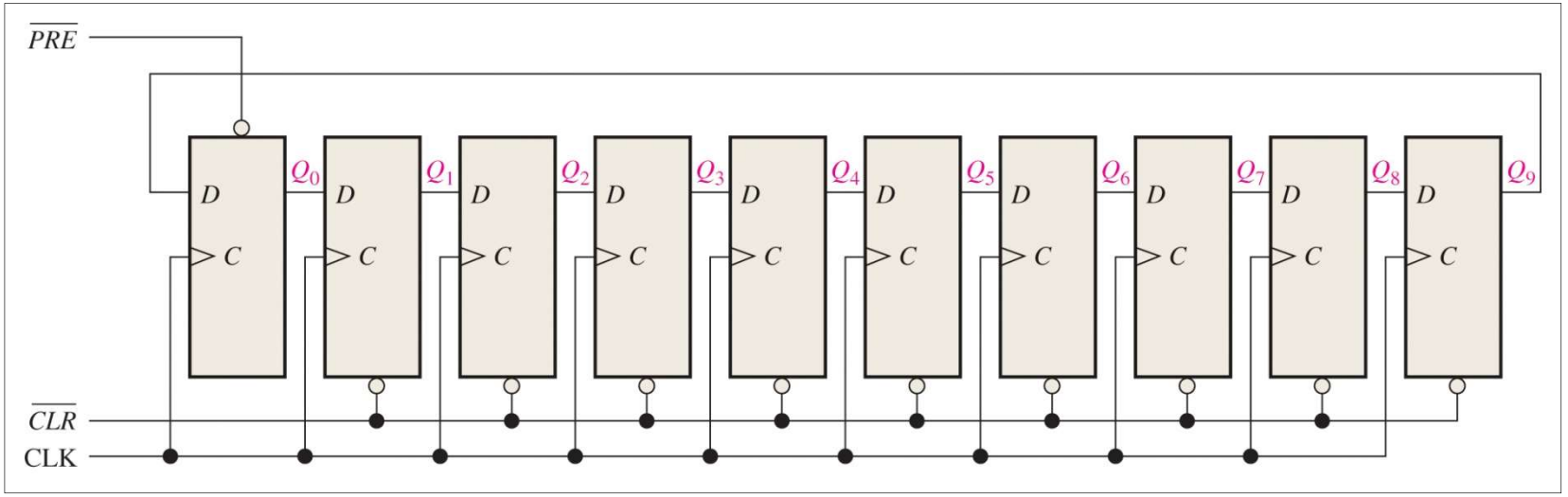
Five-bit Johnson sequence.

Clock Pulse	Q_0	Q_1	Q_2	Q_3	Q_4
0	0	0	0	0	0
1	1	0	0	0	0
2	1	1	0	0	0
3	1	1	1	0	0
4	1	1	1	1	0
5	1	1	1	1	1
6	0	1	1	1	1
7	0	0	1	1	1
8	0	0	0	1	1
9	0	0	0	0	1

Ring Counter

A **ring counter** shifts a single “1” output from each flip-flop to the next.

Initial state is required. No decoding is needed!

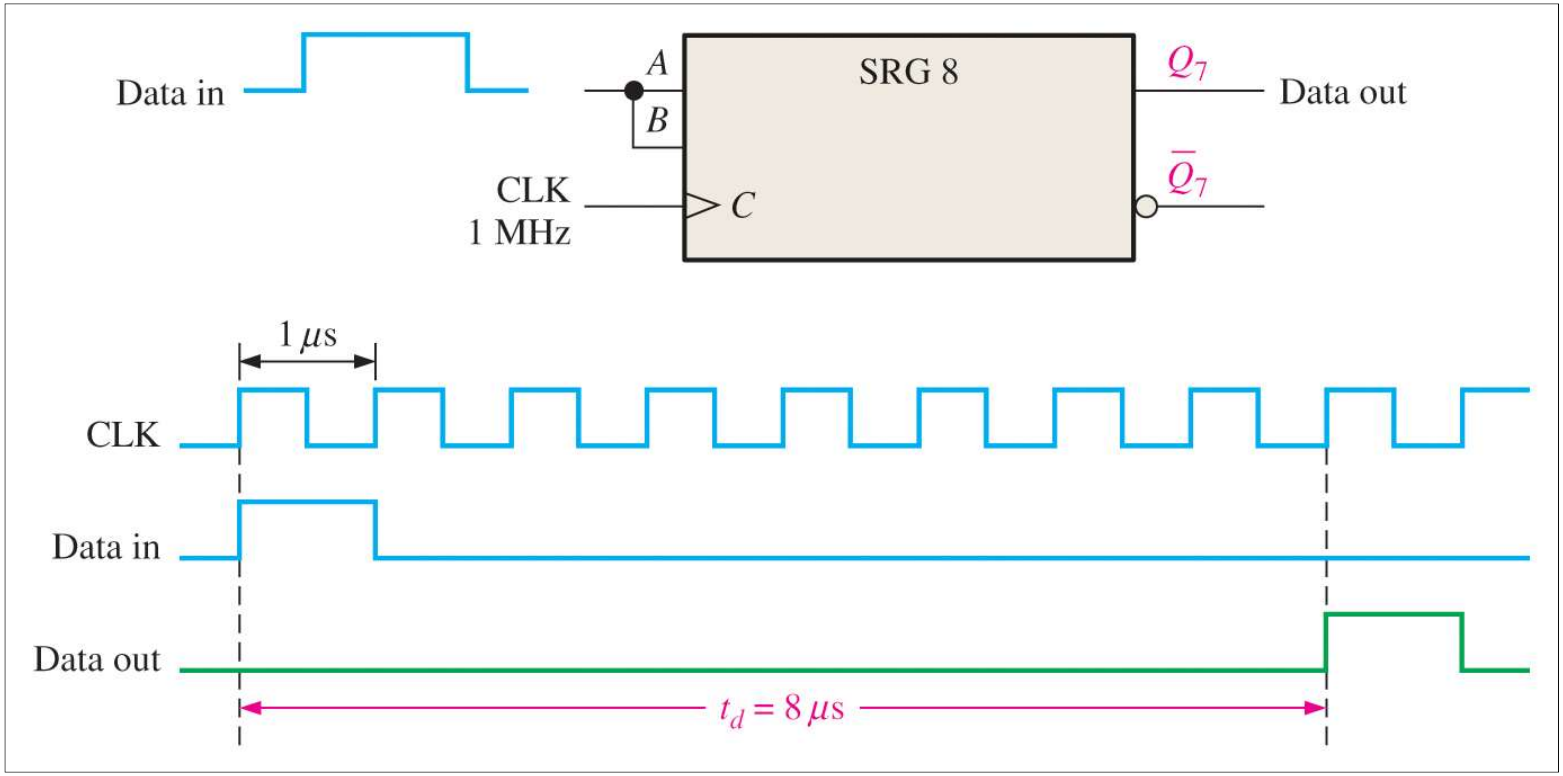


Ring Counter Output Sequence

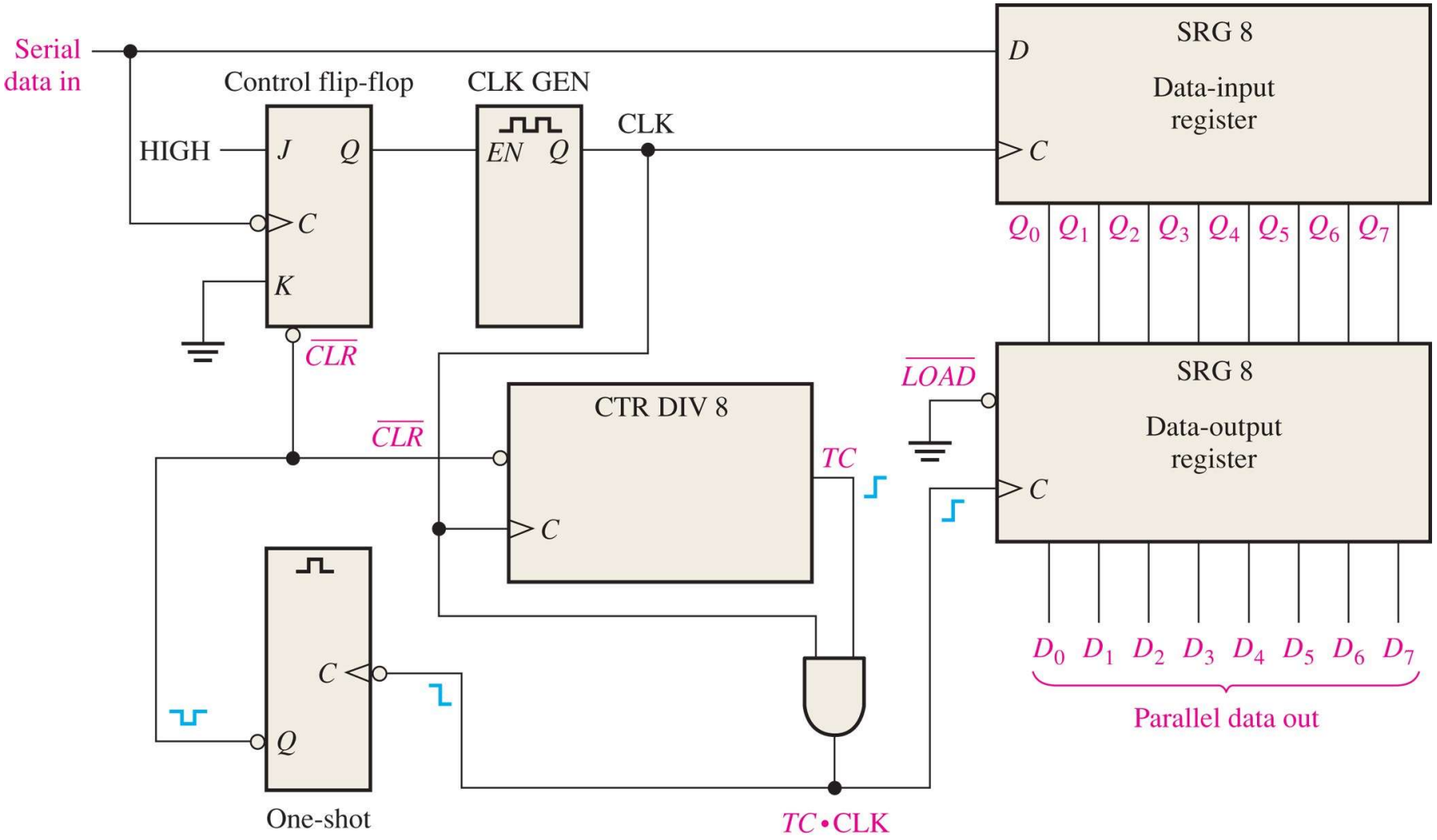
TABLE 7–5 • Ten-bit ring counter sequence.

CLOCK PULSE	Q_0	Q_1	Q_2	Q_3	Q_4	Q_5	Q_6	Q_7	Q_8	Q_9
0	1	0	0	0	0	0	0	0	0	0
1	0	1	0	0	0	0	0	0	0	0
2	0	0	1	0	0	0	0	0	0	0
3	0	0	0	1	0	0	0	0	0	0
4	0	0	0	0	1	0	0	0	0	0
5	0	0	0	0	0	1	0	0	0	0
6	0	0	0	0	0	0	1	0	0	0
7	0	0	0	0	0	0	0	1	0	0
8	0	0	0	0	0	0	0	0	1	0
9	0	0	0	0	0	0	0	0	0	1

Serial-in/Serial-out Shift Register Application: Time Delay Circuit



Serial-to-Parallel Data Converter



Serial-to-Parallel Data Converter