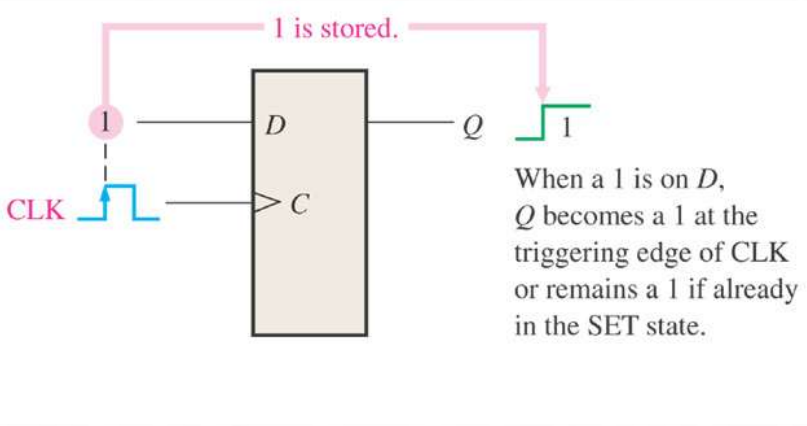
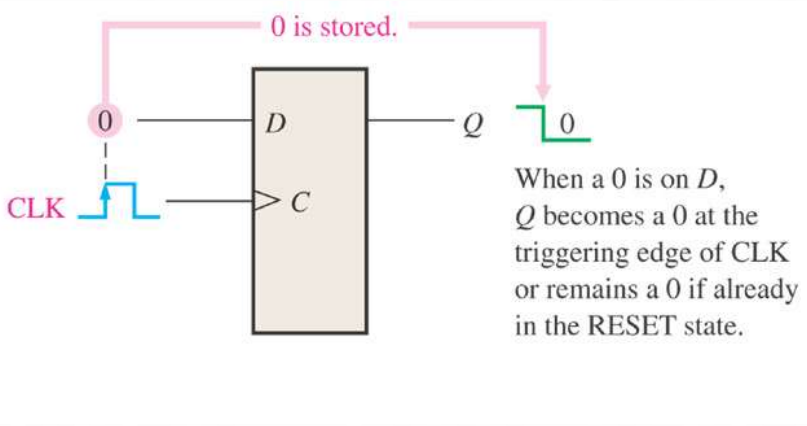
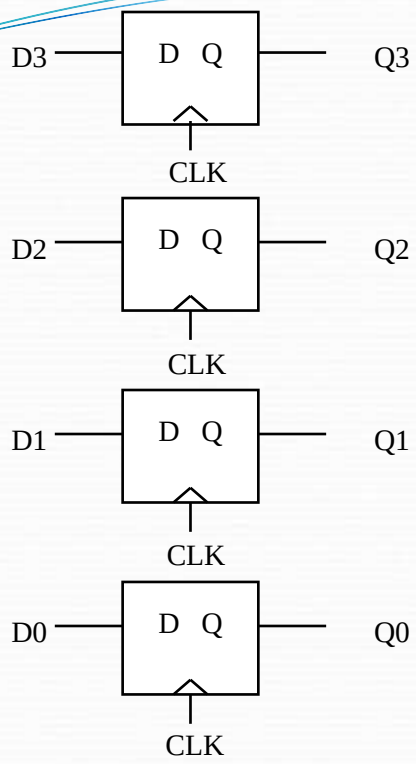
Chapter 9 Shift Register

9.0 Registers

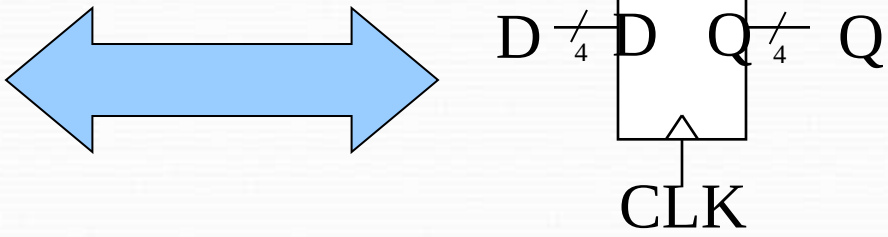
- One or more flip-flops used to store and shift data







A 4-Bit Register



Could be called a parallel-in/parallel-out register.

9.1 Basic Shift Register Functions

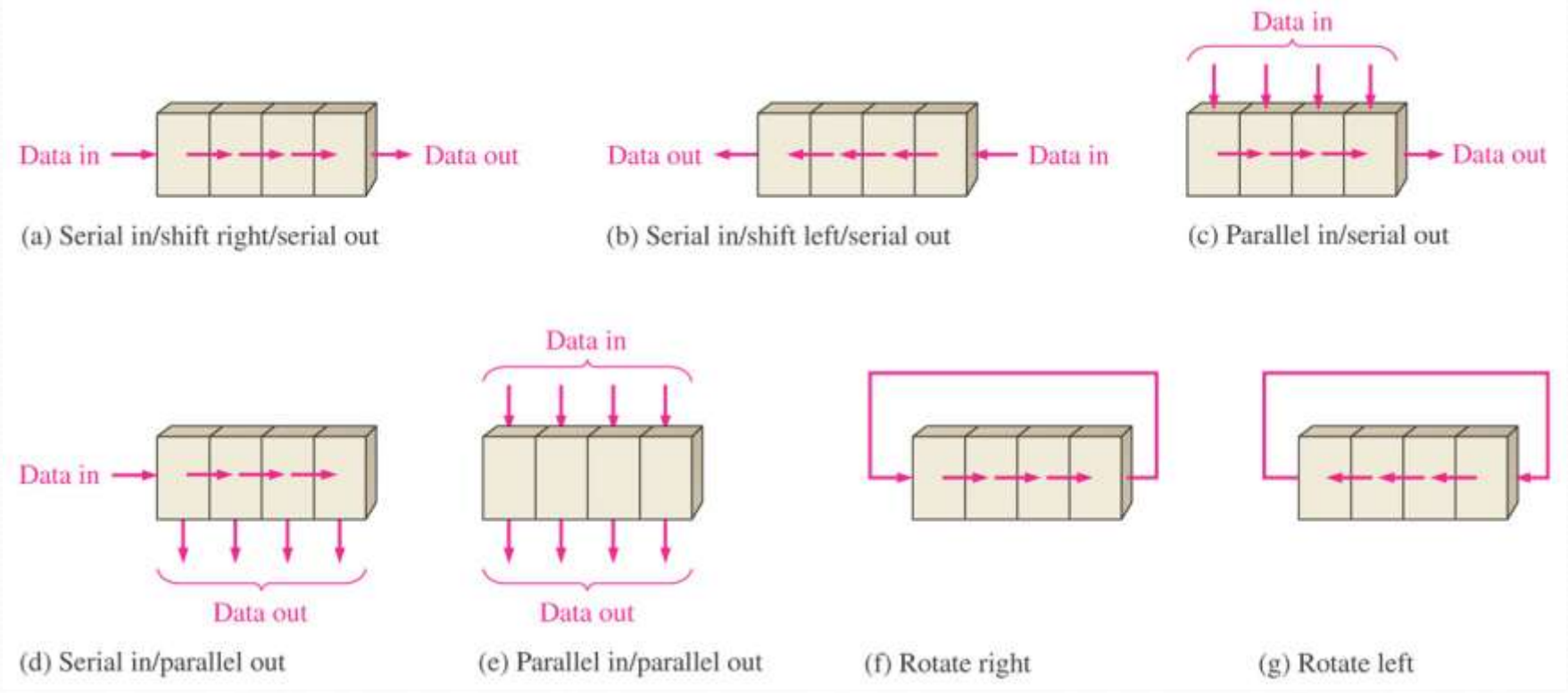
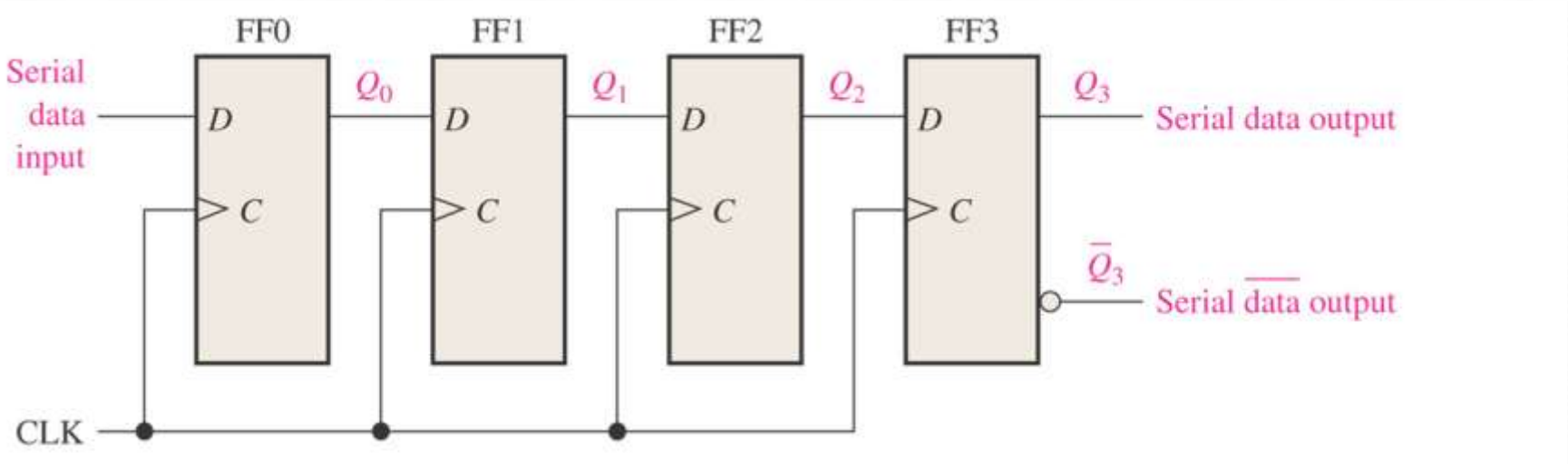


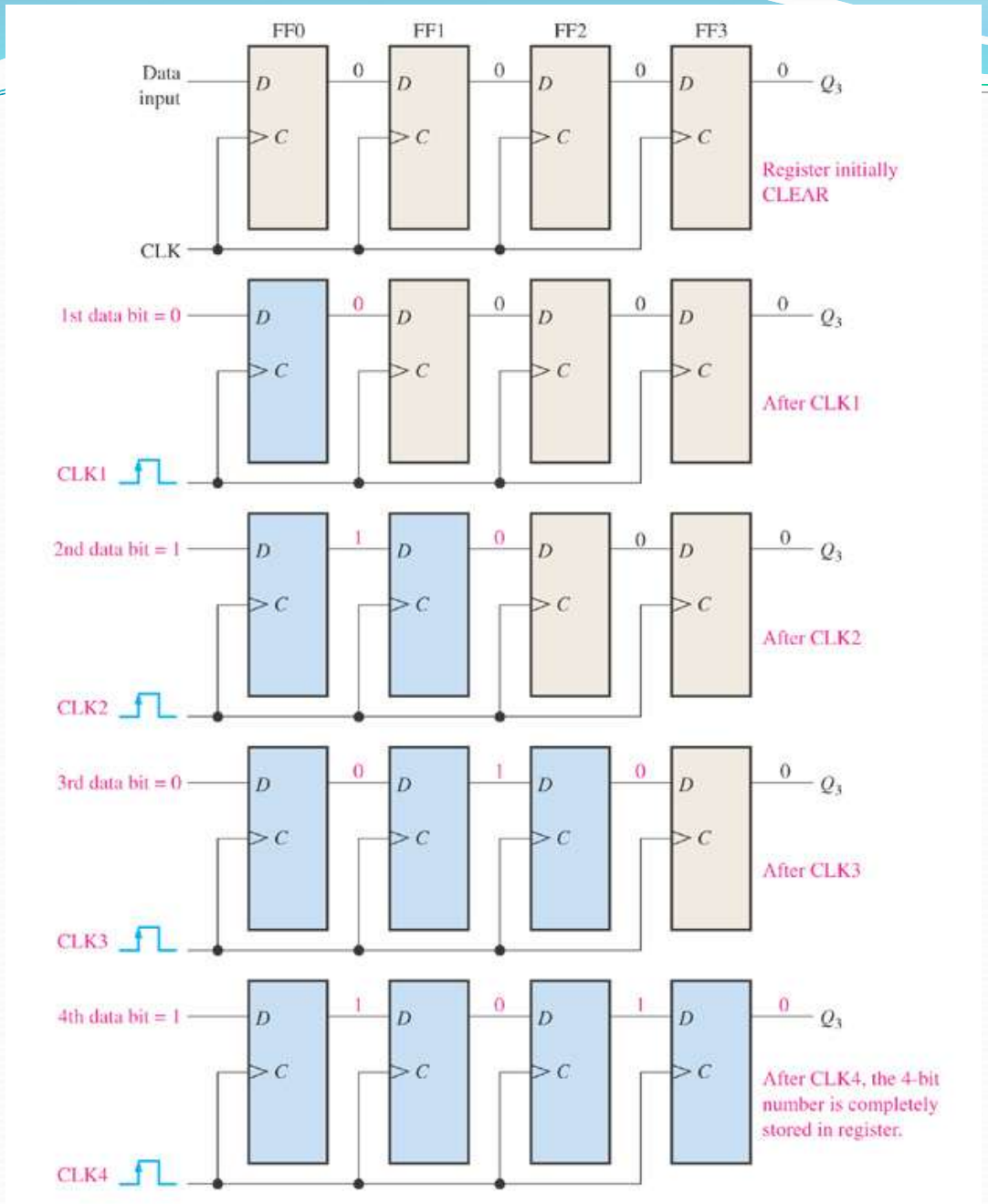
Figure 9–2 Basic data movement in shift registers. (Four bits are used for illustration. The bits move in the direction of the arrows.)

9.2 Serial IN/Serial OUT Shift Registers

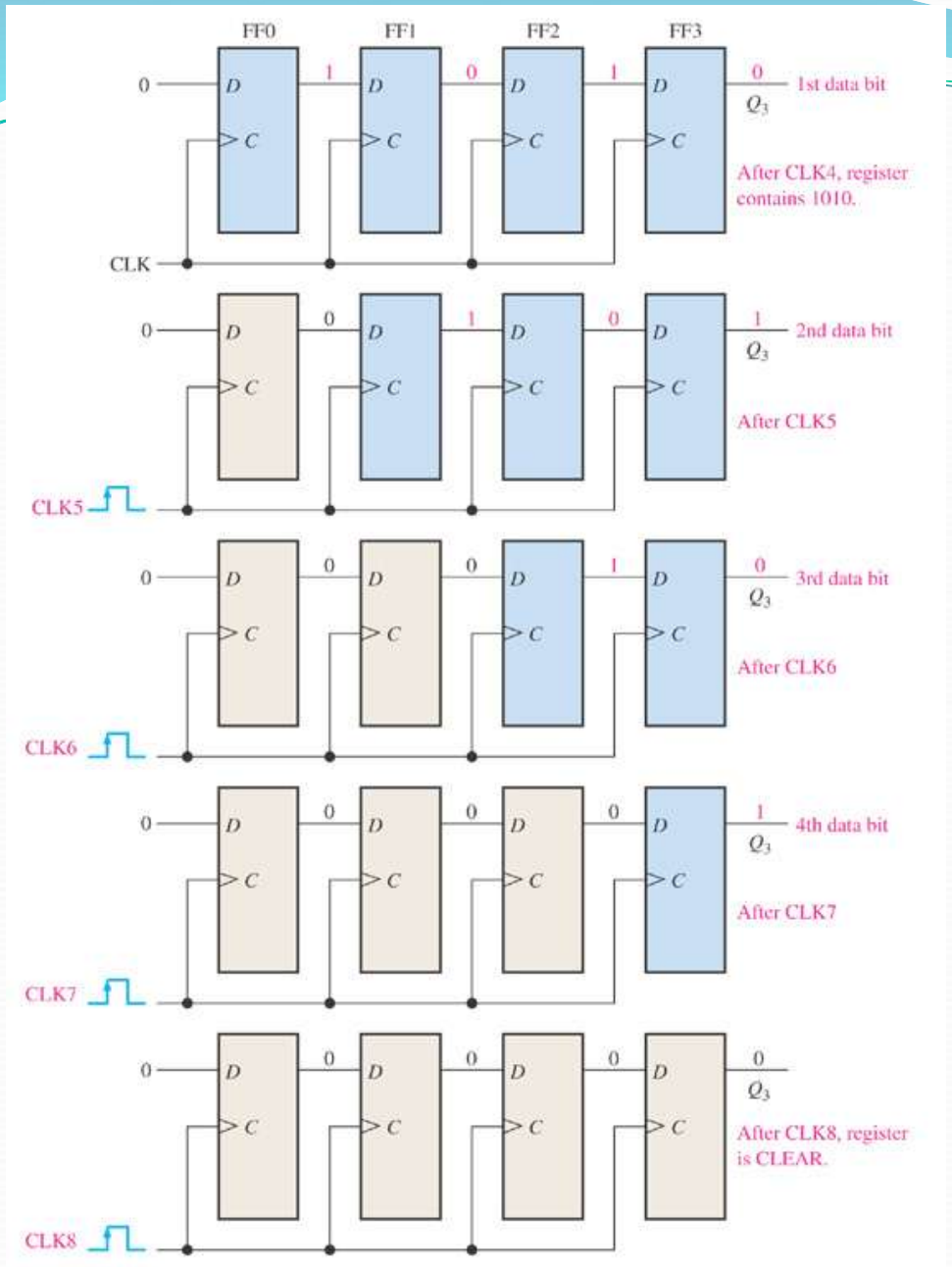
- Accepts data serially
  - One bit at a time on a single line
  - Produces the stored information on its output also in serial form

Figure 9–3 Serial in/serial out shift register.





Four bits (1010) being entered serially into the register



Four bits (1010) being serially shifted out of the register and replaced by all zeros

Example: Show the states of the 5-bit register in Fig. 9-6(a) for the specified data input and clock waveform. Assume that the register is initially cleared.

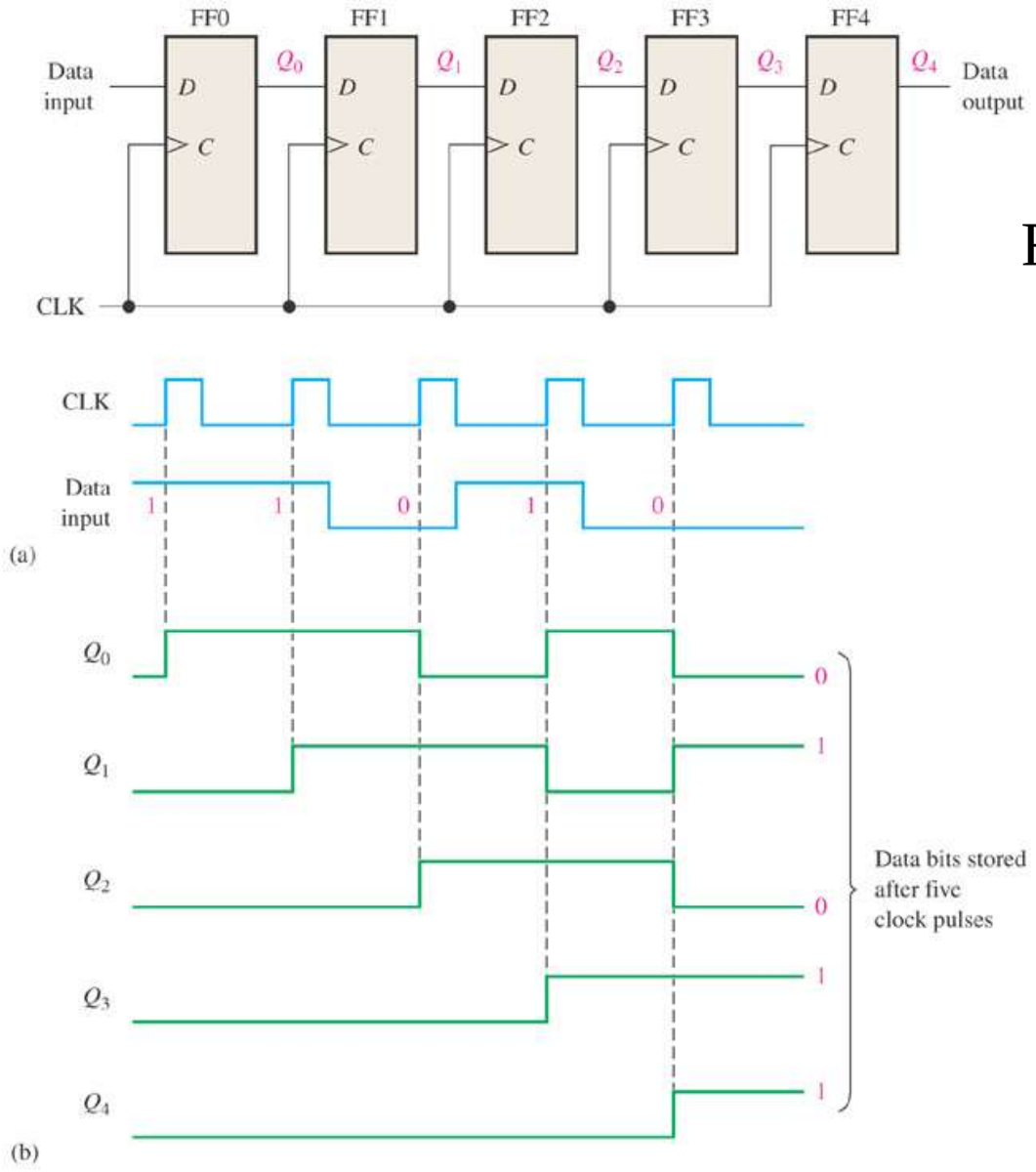


Fig. 9-6(a)

9.3 Serial IN/Parallel OUT Registers

- Data bits enter into registers serially
- Data bits are taken out of the registers in the parallel way

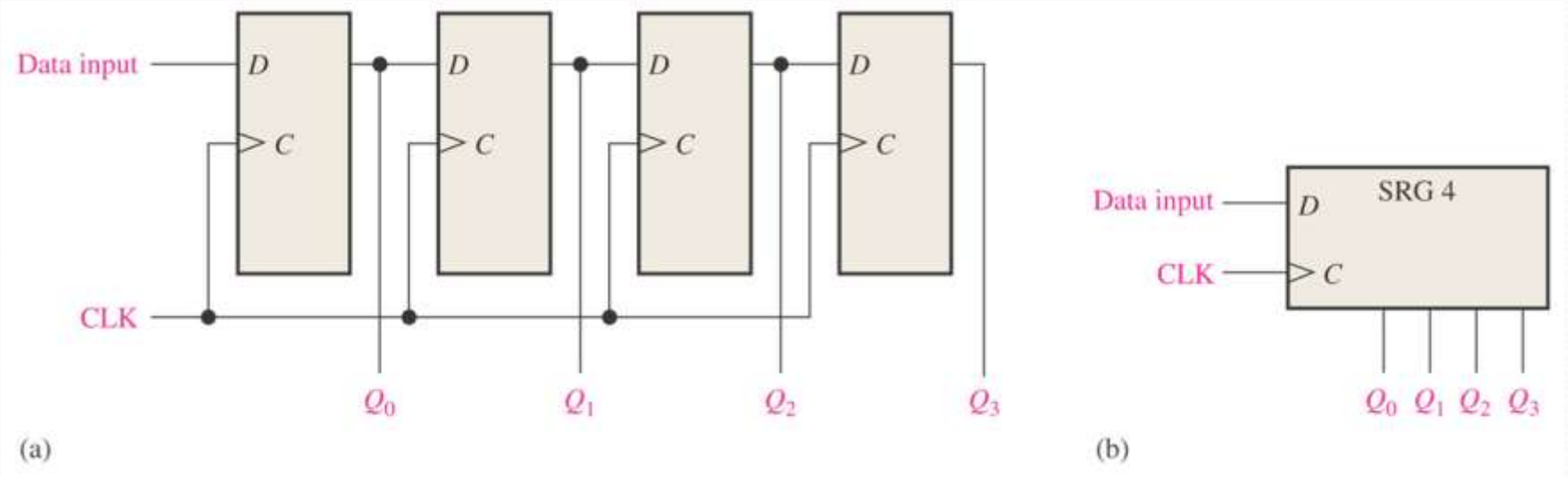
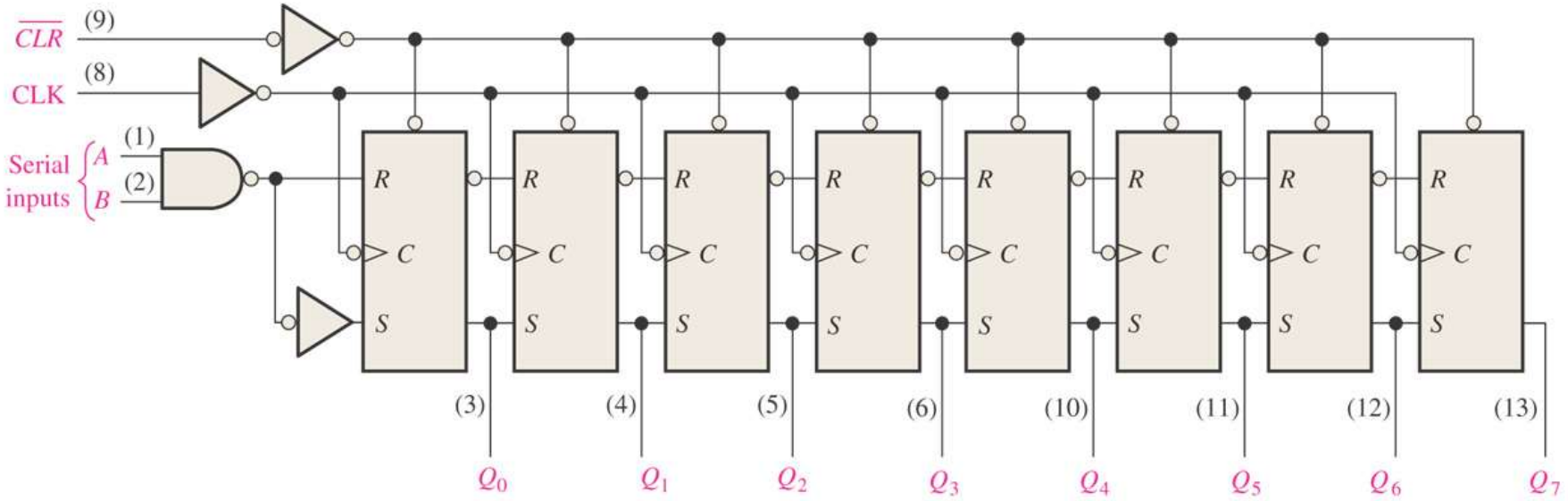
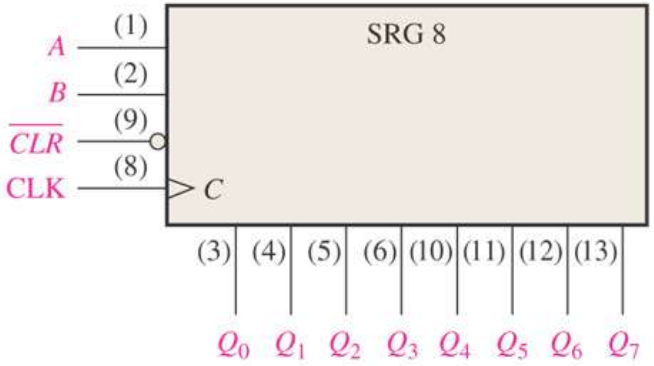


Figure 9–10 The 74HC164 8-bit serial in/parallel out shift register.

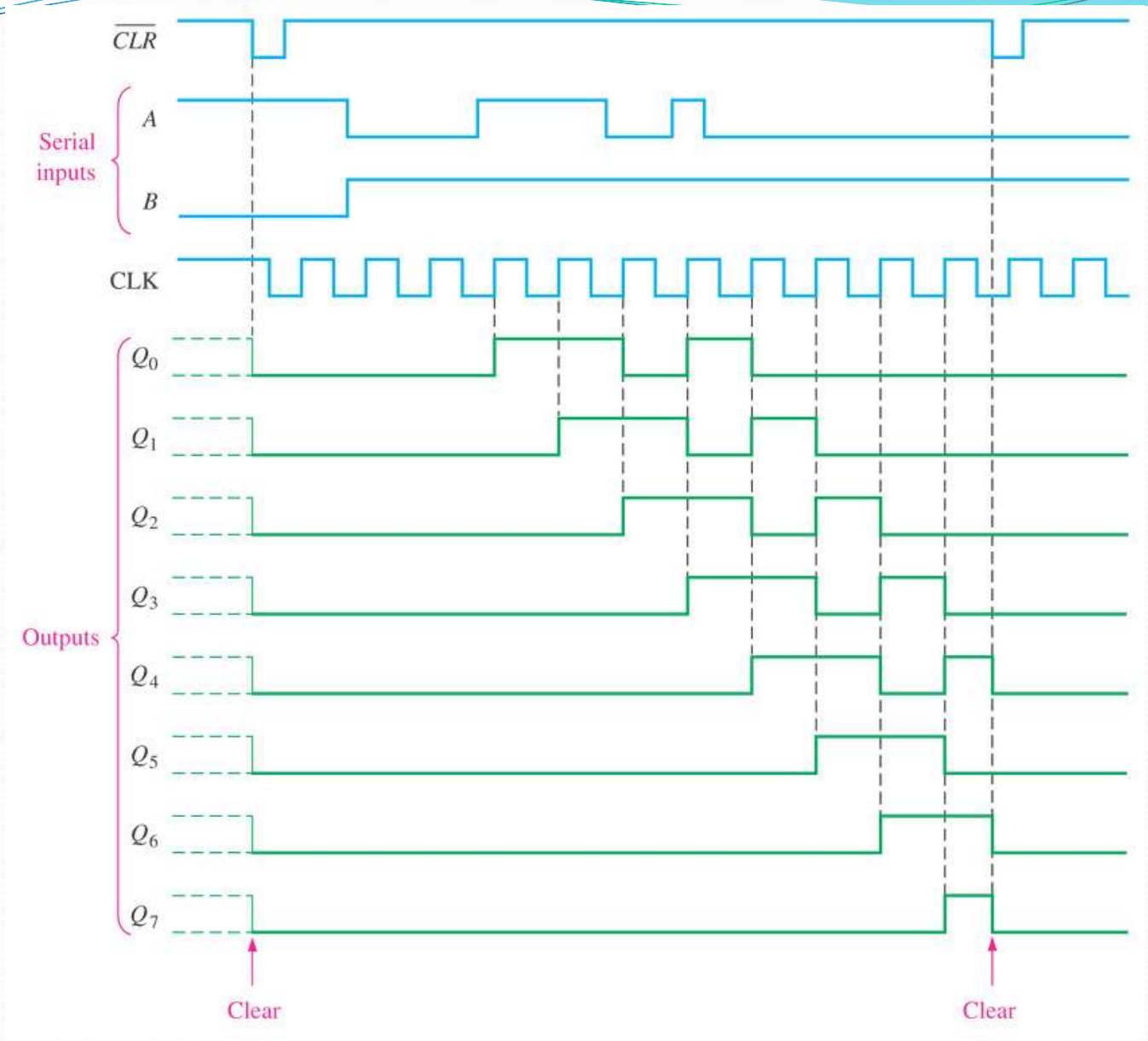


(a) Logic diagram



(b) Logic symbol

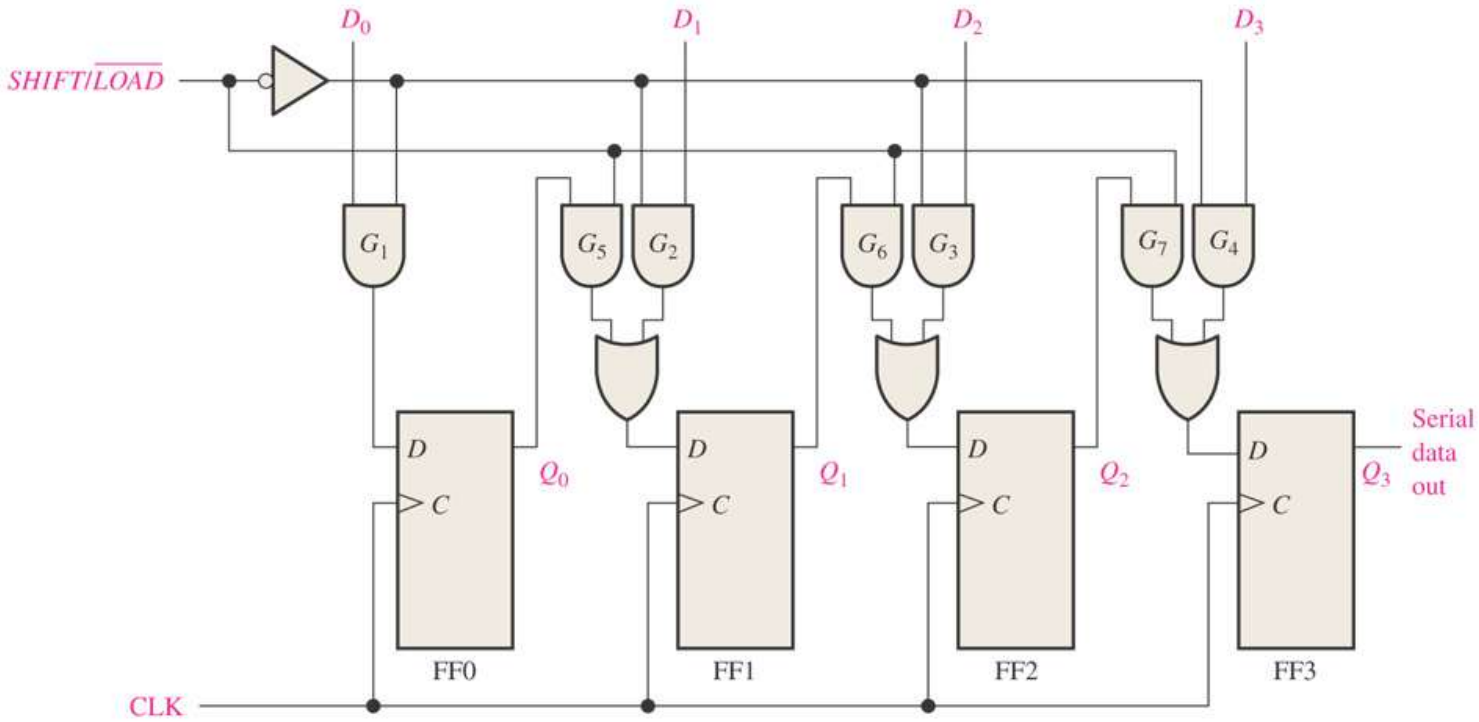
Figure 9–11 Sample timing diagram for a 74HC164 shift register.



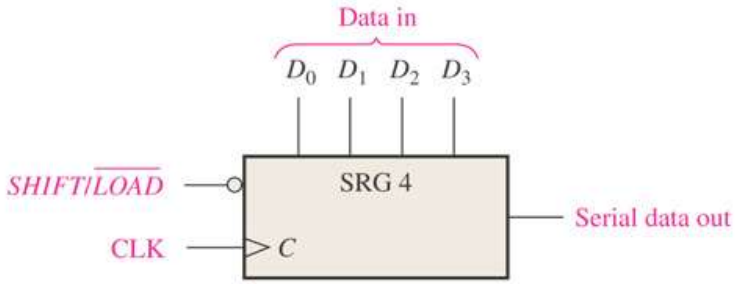
9.4 Parallel IN/Serial OUT Shift Registers

- Parallel inputs
- Serial outputs

Figure 9–12 A 4-bit parallel in/serial out shift register.

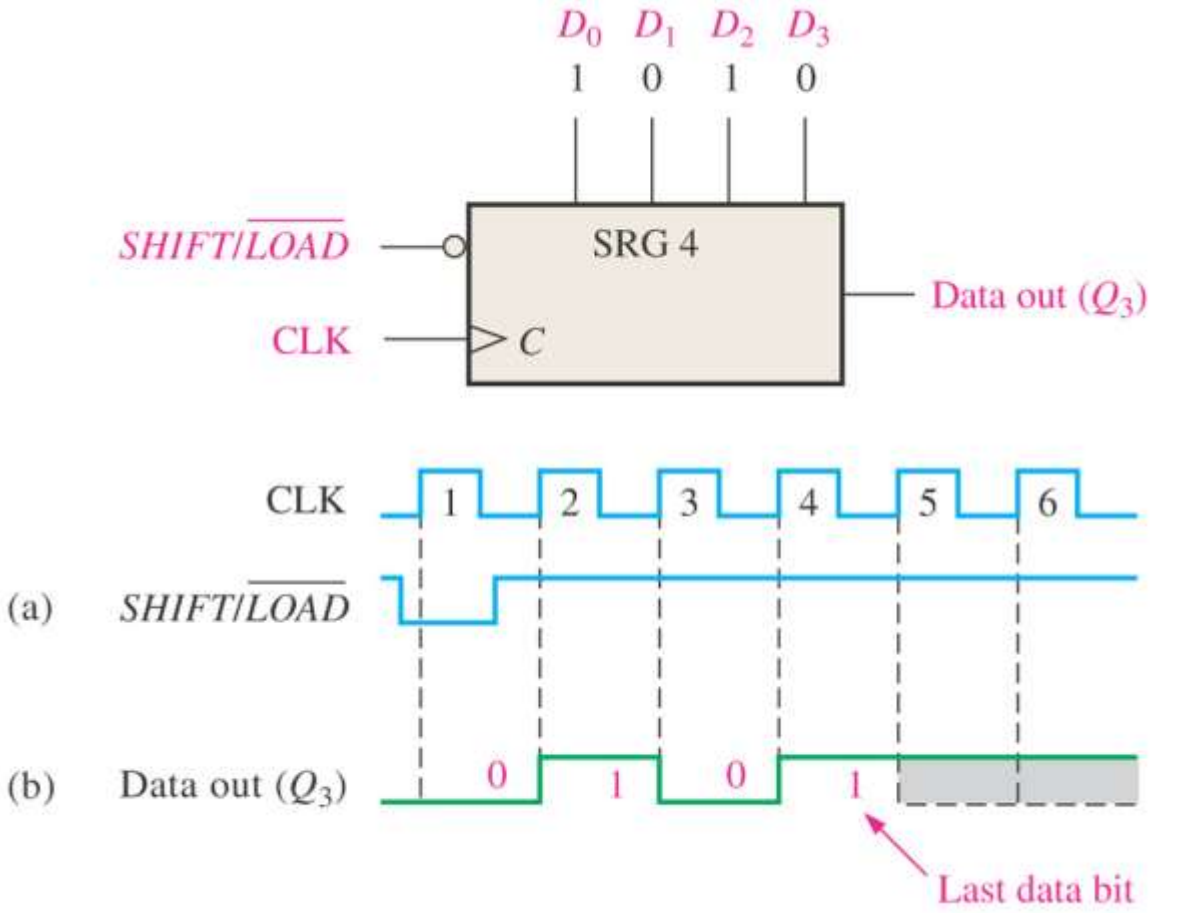


(a) Logic diagram

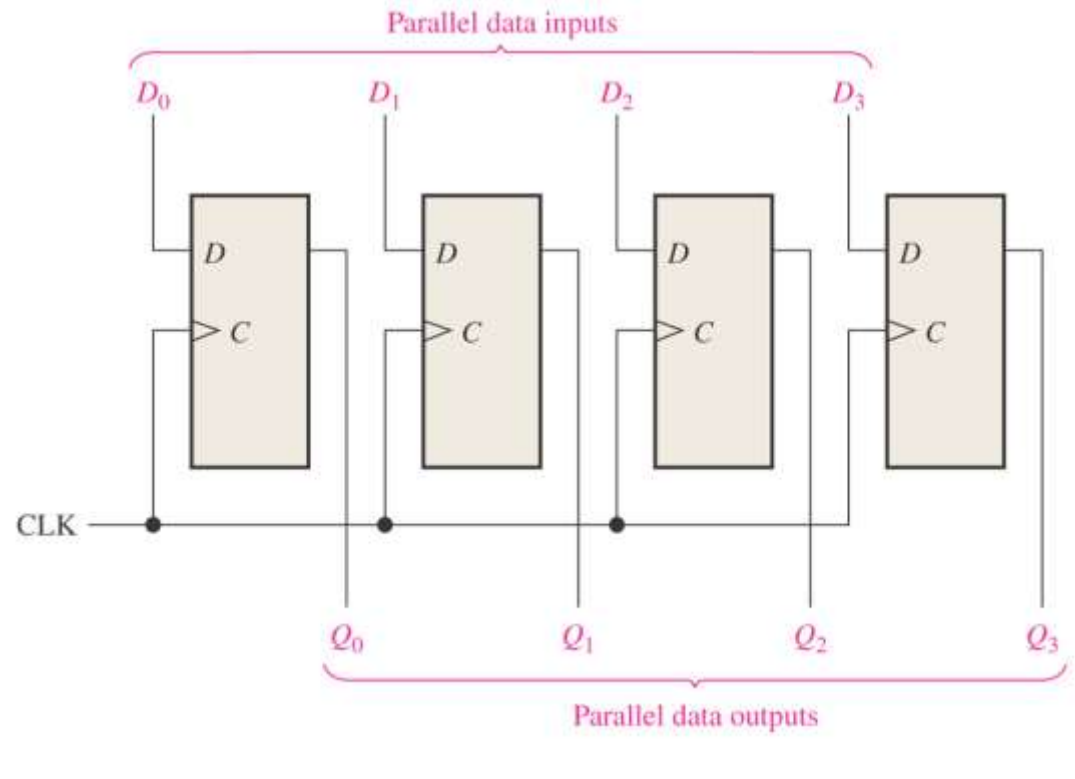


(b) Logic symbol

Example: Show the data-output waveform for a 4-bit register with the parallel input data and the clock and other control signal.



9.5 Parallel IN/Parallel OUT Registers



9.6 Bidirectional Shift Registers

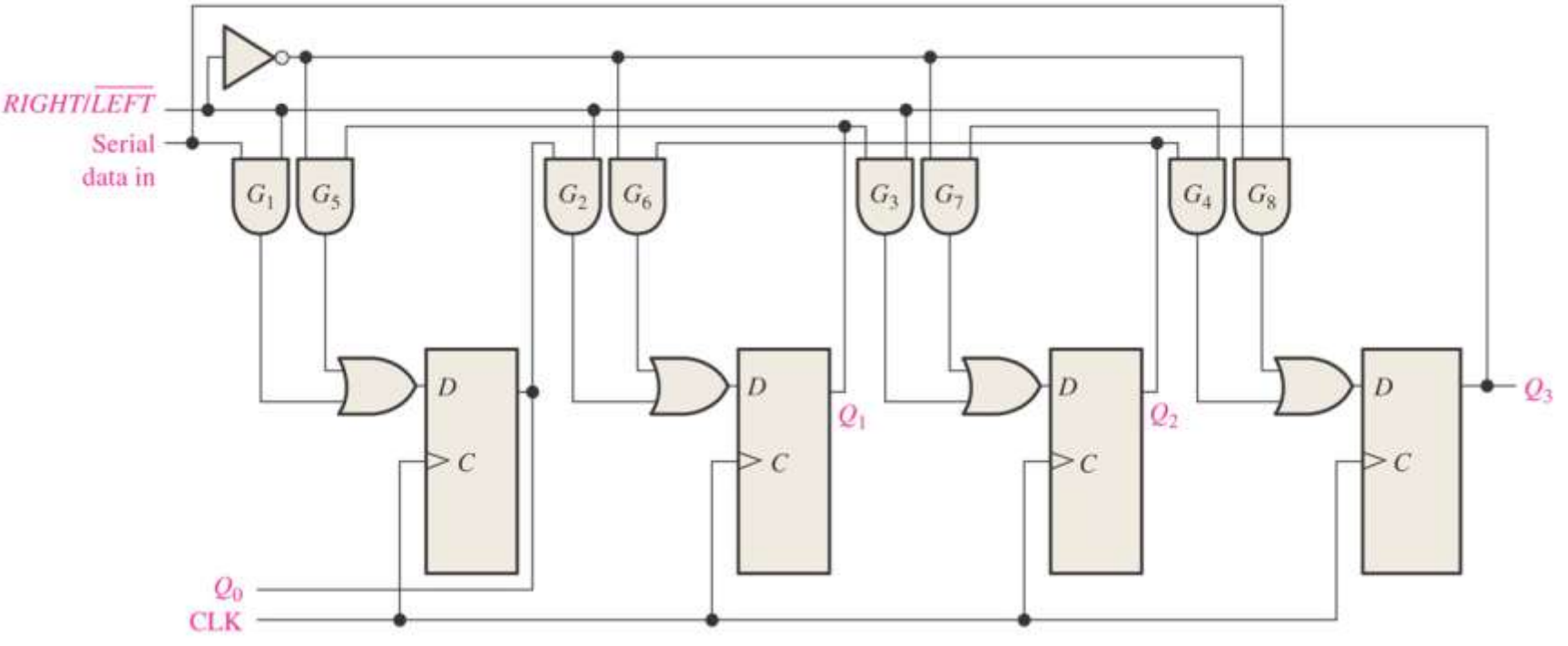
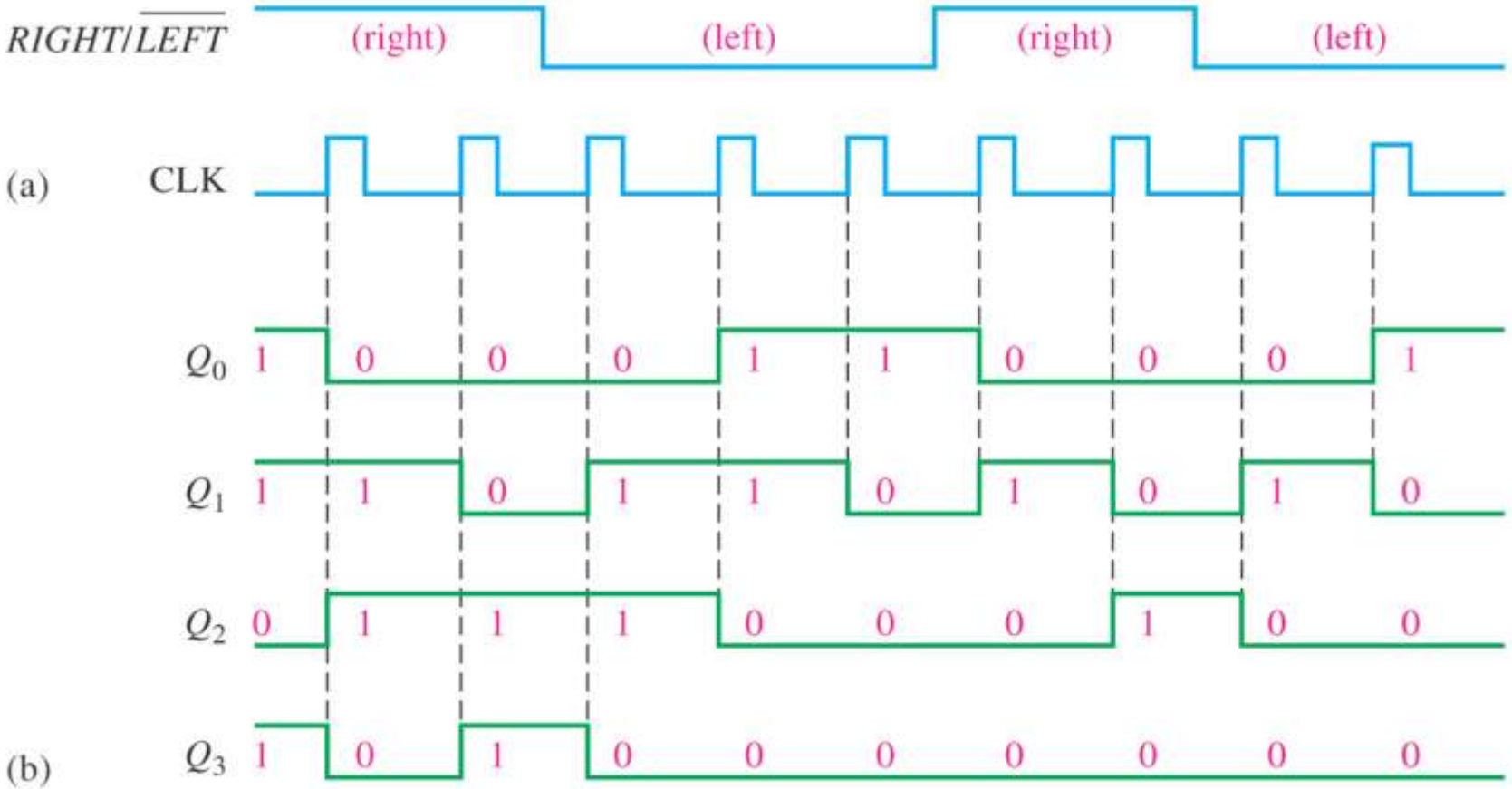
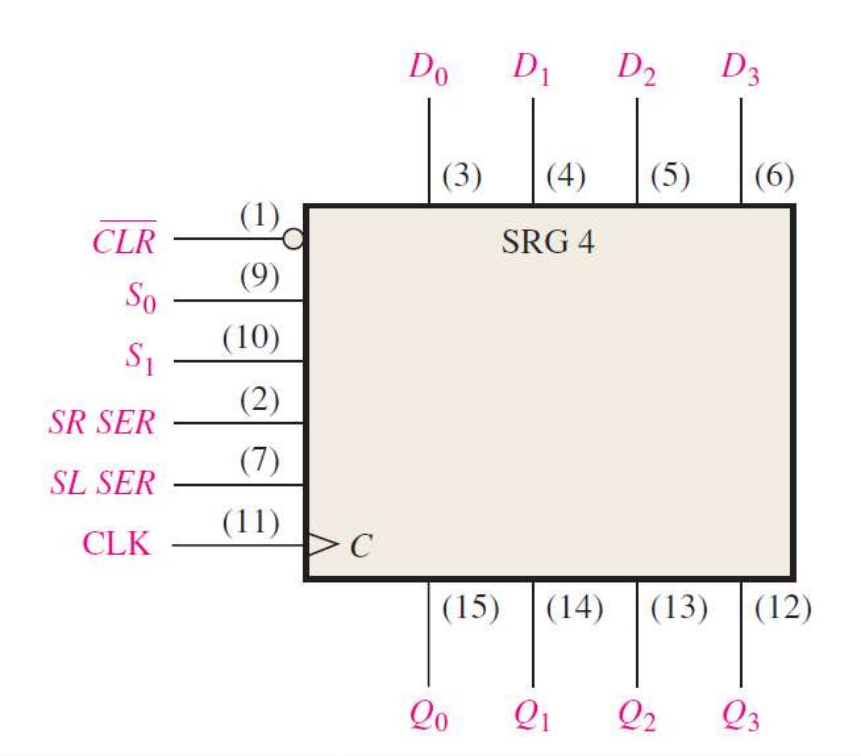


Fig. 9-19 Four-bit bidirectional shift register

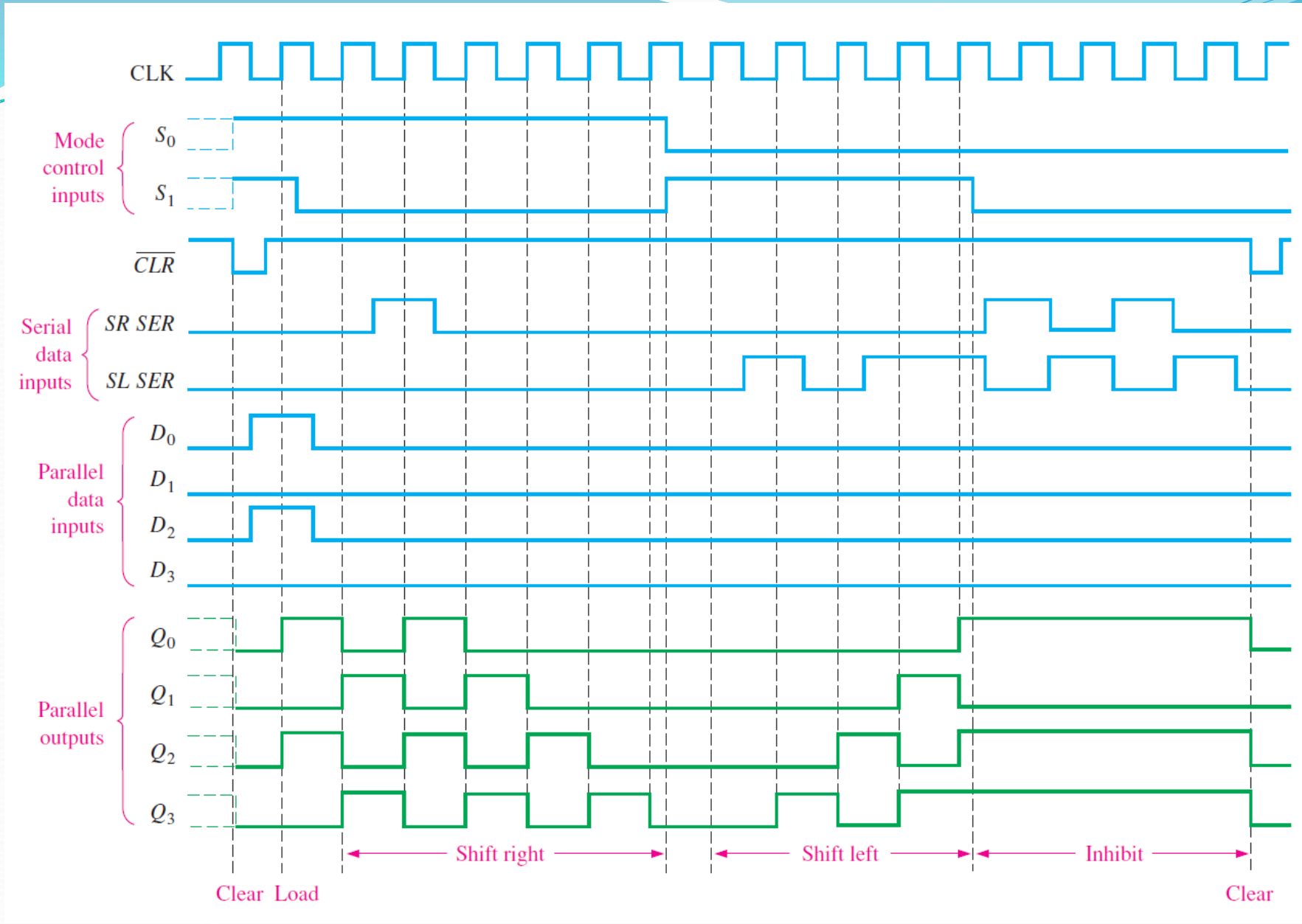
Example: Determine the state of the shift register of Fig. 9-19 after each clock pulse for the given control signals. Assume that the serial data-input line is LOW.



The 74HC194 4-bit bidirectional universal shift register



- S0=S1=1: Data Preset
- S0=1， S1=0：Shift Right，Input from SR SER
- S0=0，S1=1： Shift Left，Input from SL SER
- S0=S1=0：Inhibit

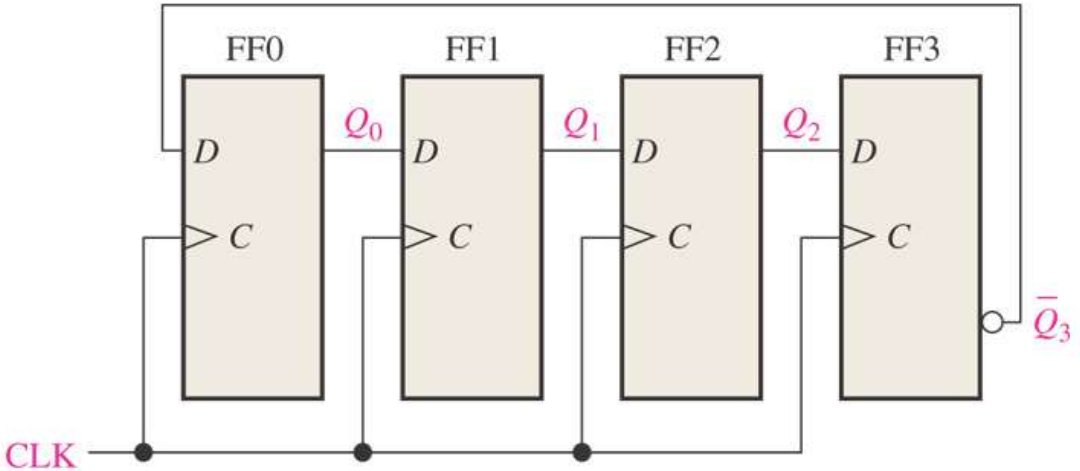


Sample timing diagram for a 74HC194 shift register

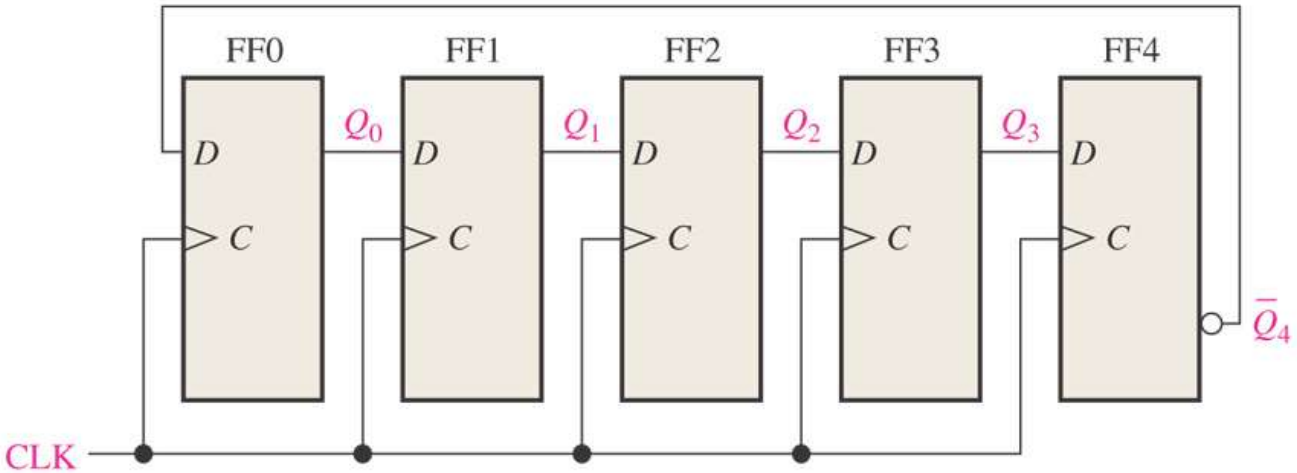
9.7 Shift Register Counters

- The Johnson Counter
- The Ring Counter

Figure 9–23 Four-bit and 5-bit Johnson counters.



(a) Four-bit Johnson counter



(b) Five-bit Johnson counter

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

M=2N

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

Figure 9–24 Timing sequence for a 4-bit Johnson counter.

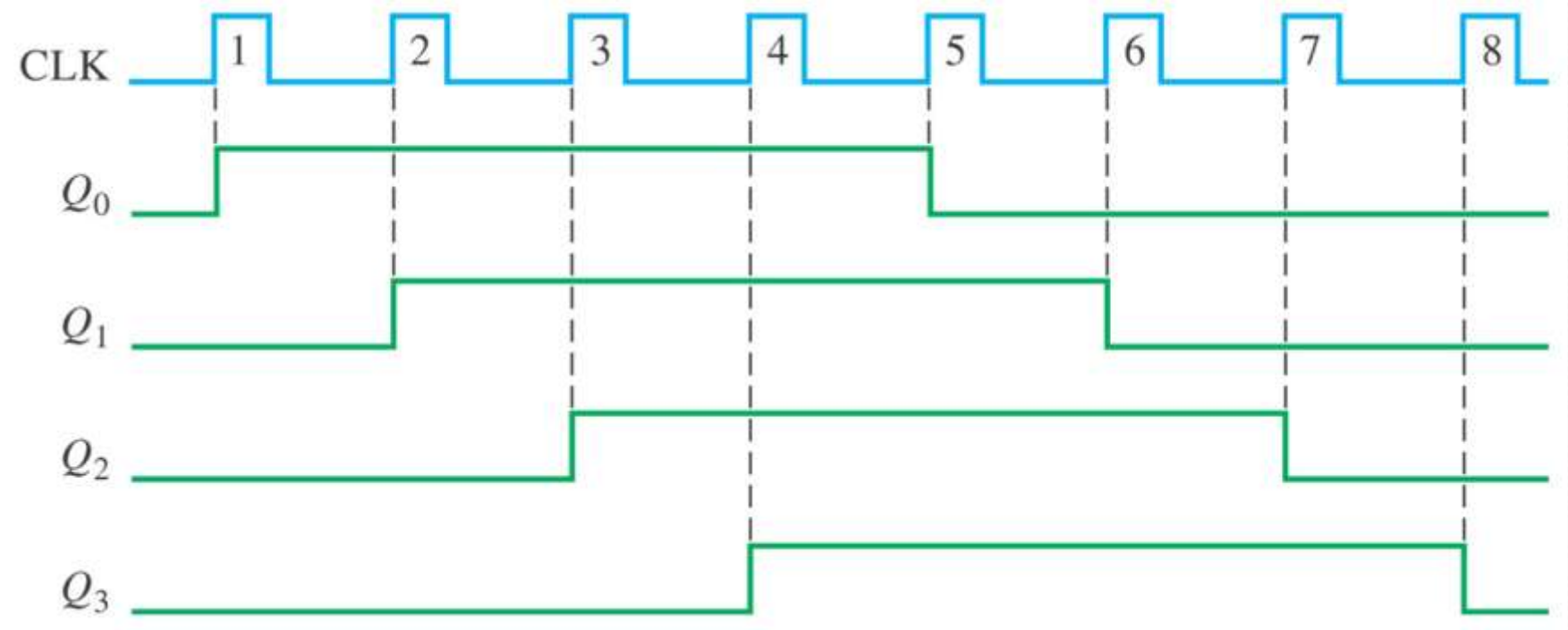


Figure 9–25 Timing sequence for a 5-bit Johnson counter.

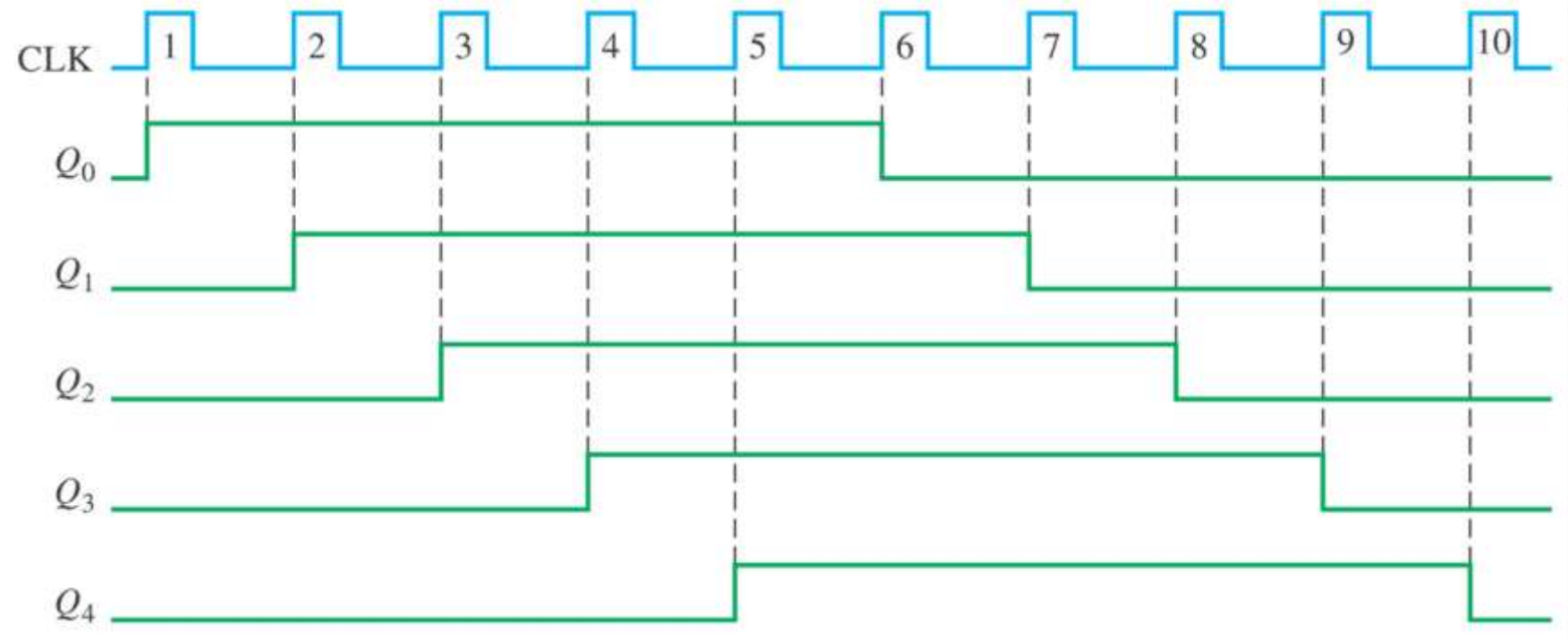
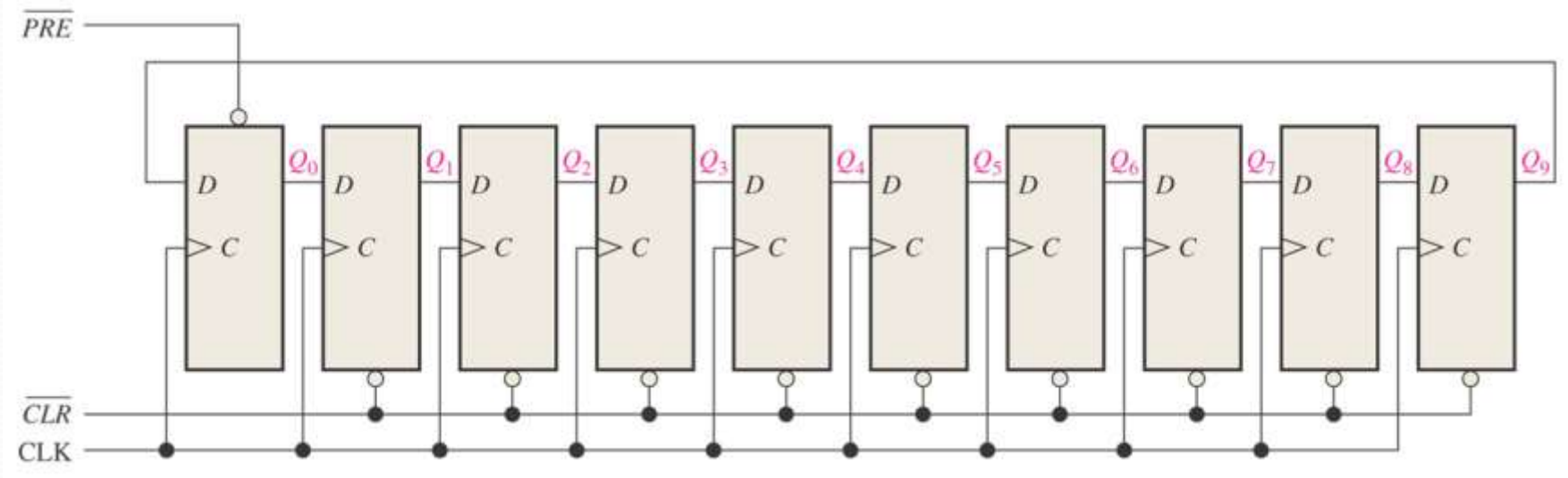


Figure 9–26 A 10-bit ring counter.



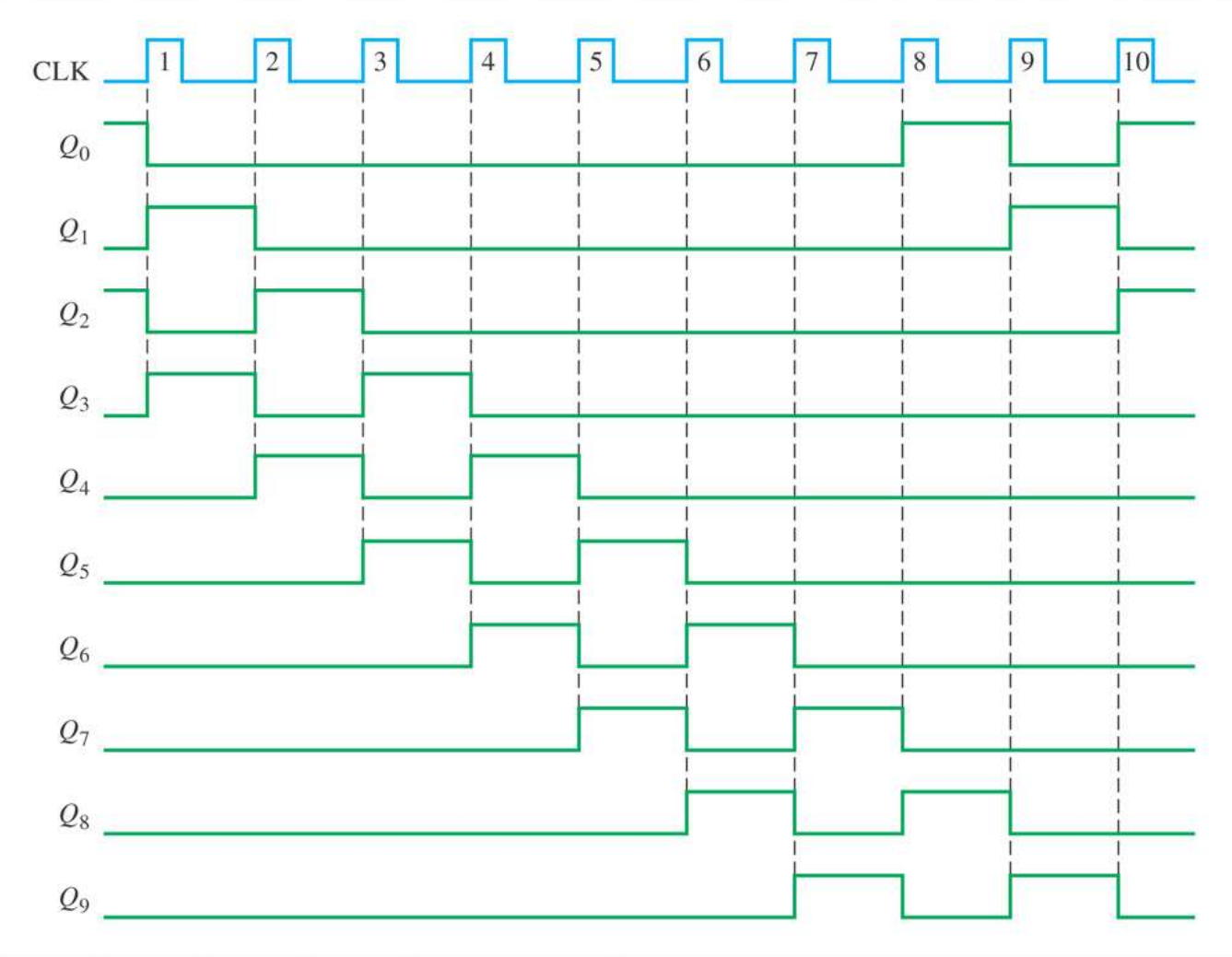
When the counter is initially set to 1000000000:

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

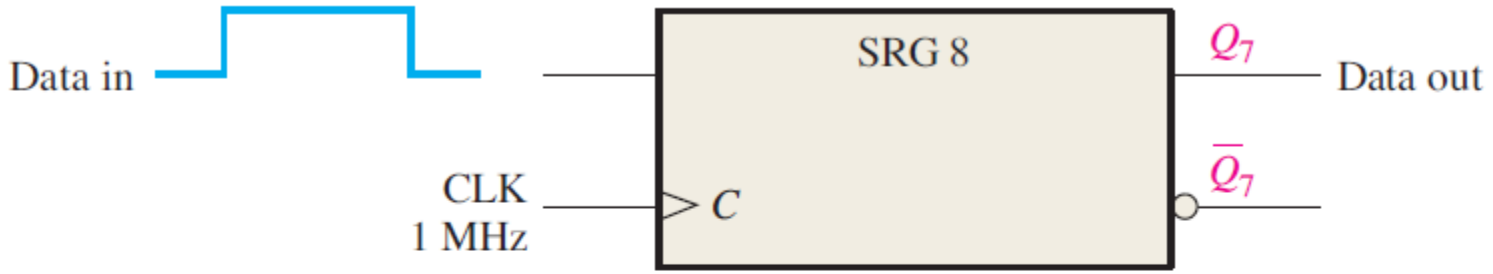
M=N

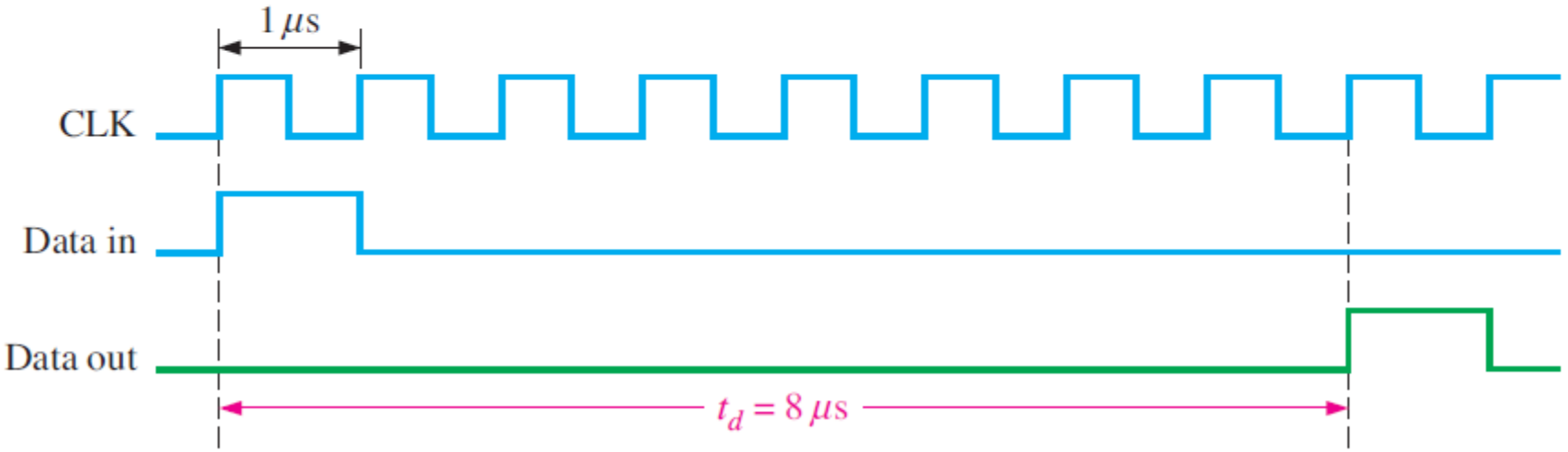
When the counter is initially set to 0000000101:



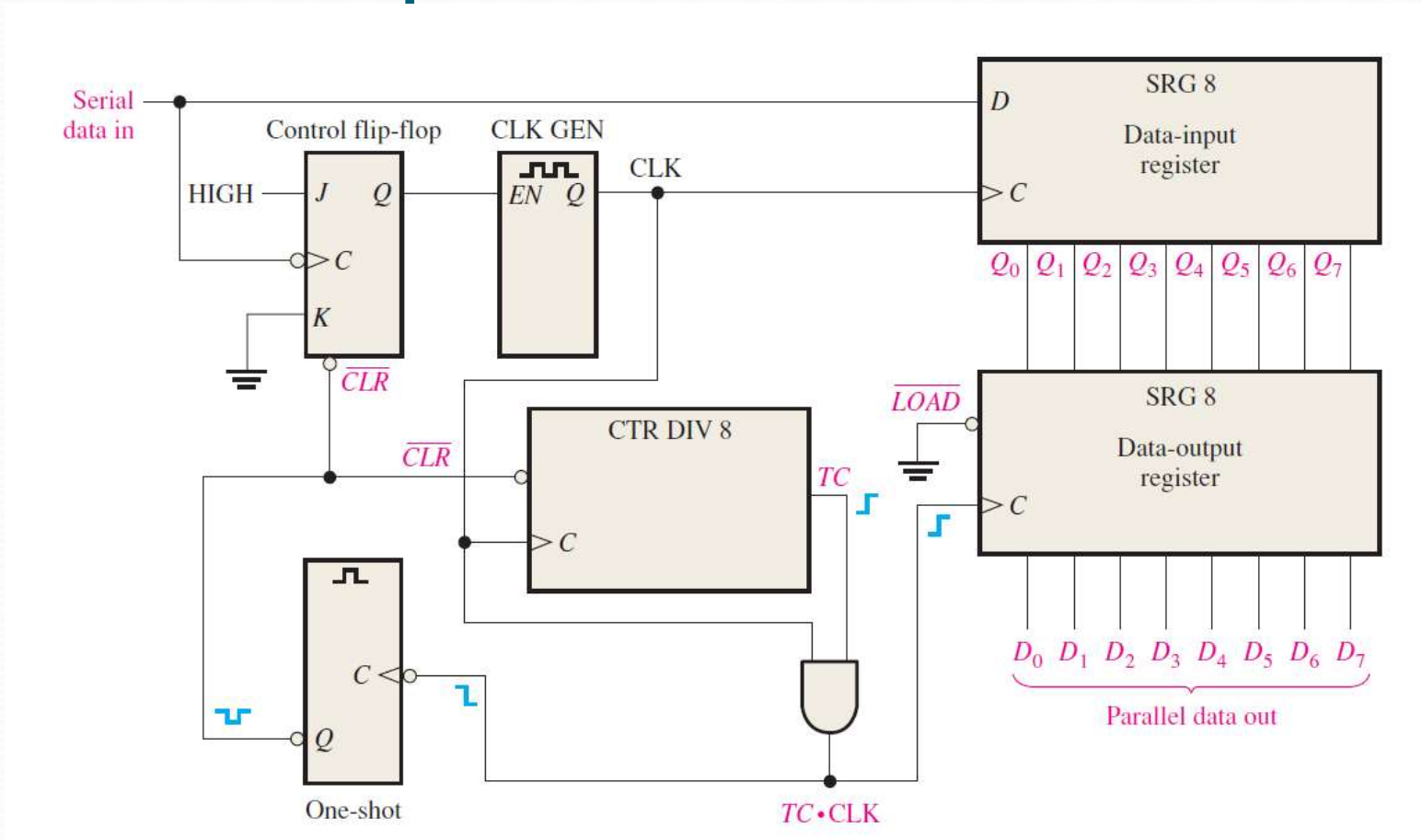
9.8 Shift Register Applications

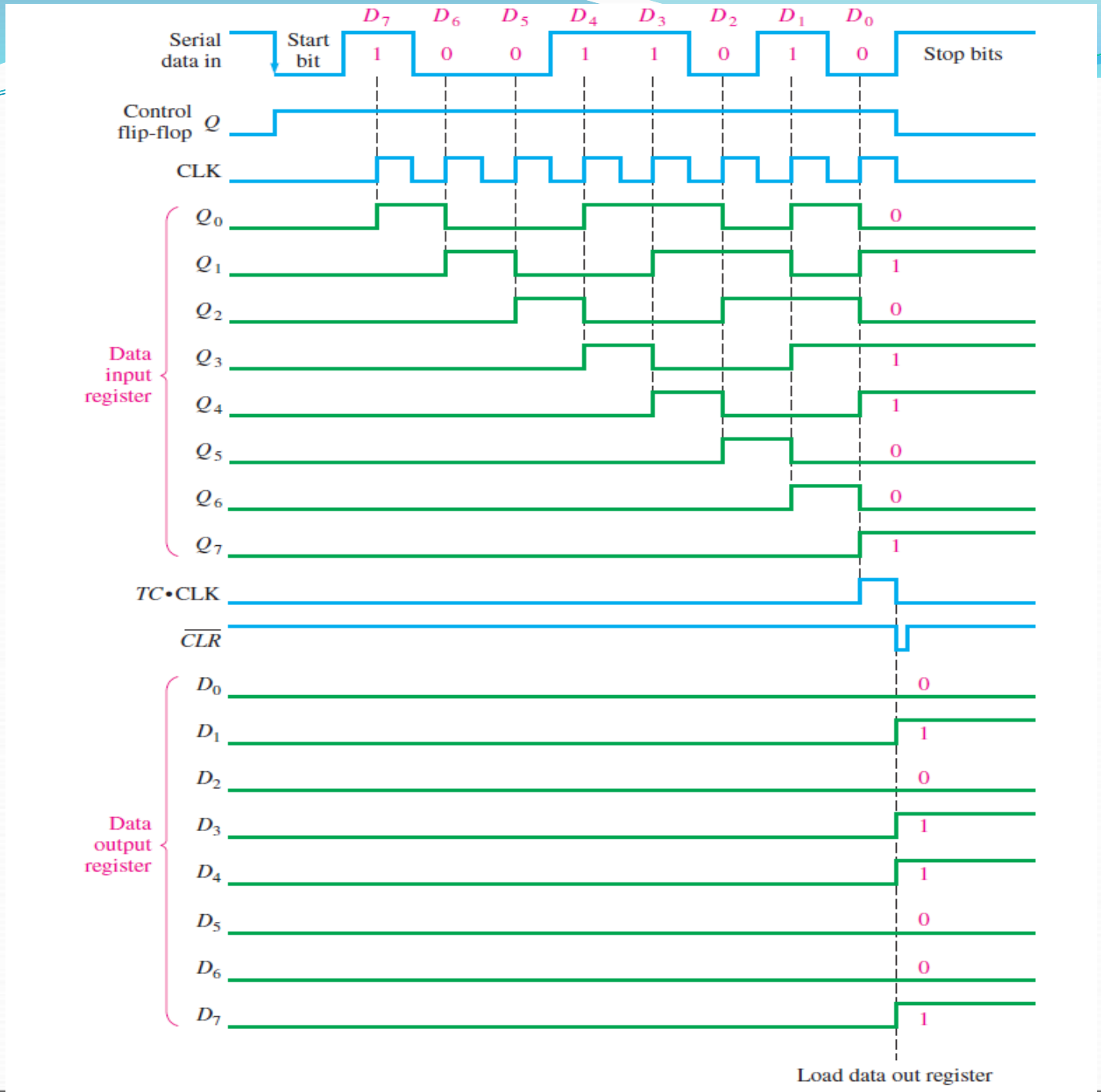
- Time delay



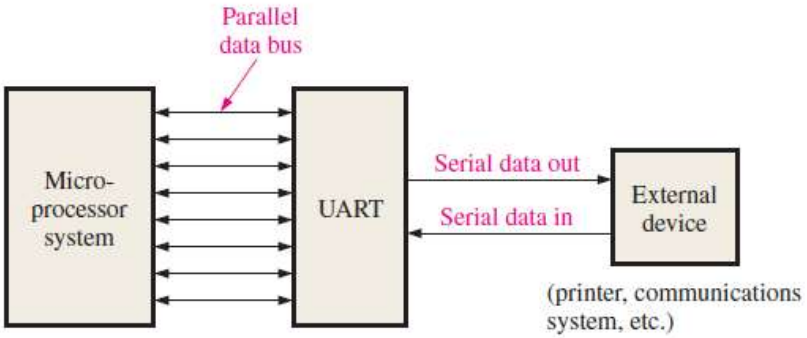


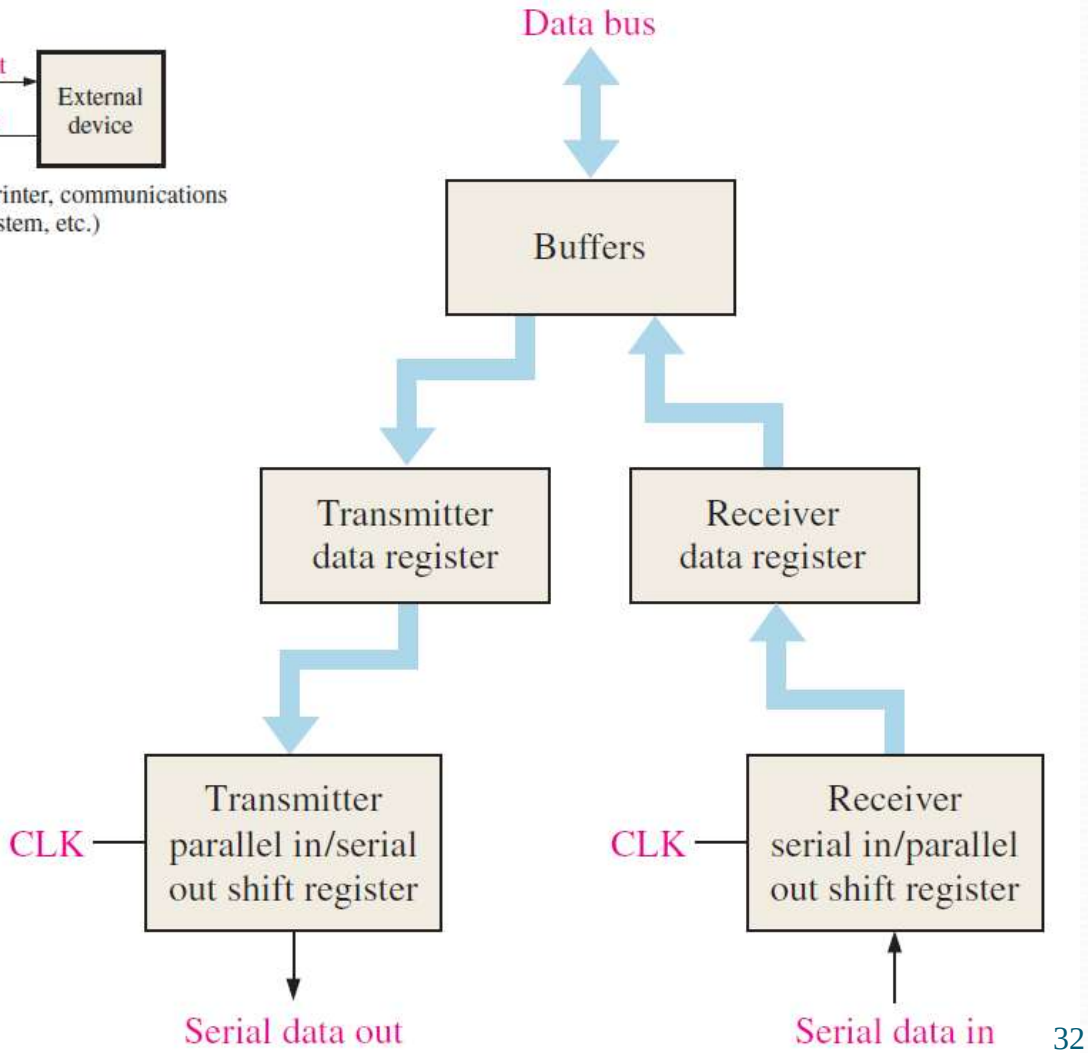
Serial to parallel data converter




Serial data in
Start bit
D_7 D_6 D_5 D_4 D_3 D_2 D_1 D_0
1 0 0 1 1 0 1 0
Stop bits
Control flip-flop Q
CLK
Data input register
Q_0 Q_1 Q_2 Q_3 Q_4 Q_5 Q_6 Q_7
0 1 0 1 1 0 0 1
$TC \bullet CLK$
$\overline{CLR}$
Data output register
D_0 D_1 D_2 D_3 D_4 D_5 D_6 D_7
0 1 0 1 1 0 0 1
Load data out register

Universal Asynchronous Receiver Transmitter (UART)





Summary

- The concept of shift register
- Some kinds of shift register
  - Serial In/Serial Out
  - Serial In/parallel Out
  - Parallel In/Serial Out
  - Parallel In/Parallel Out
  - Bidirectional Shift
- Shift register counters
- Applications

Assignments

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