Shift Registers in Digital Electronics and Serial Input Serial Output Registers

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Introduction about Register

Flip-flop is a 1 bit memory cell which can be used for storing the digital data. To increase the storage capacity in terms of number of bits, we have to use a group of flip-flop. Such a group of flip-flop is known as a **Register**. The **n-bit register** will consist of **n** number of flip-flop and it is capable of storing an **n-bit** data

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Types of registers

The binary data in a register can be moved within the register from one flip-flop to another. The registers that allow such data transfers are called as **shift registers**. There are four mode of operations of a shift register.

Serial Input Serial Output (SISO)
Serial Input Parallel Output (SIPO)
Parallel Input Serial Output (PISO)
Parallel Input Parallel Output (PIPO)

The Clear/ input is an active-low asynchronous input which clears the register content to all 0's when asserted low, independent of the clock pulse.

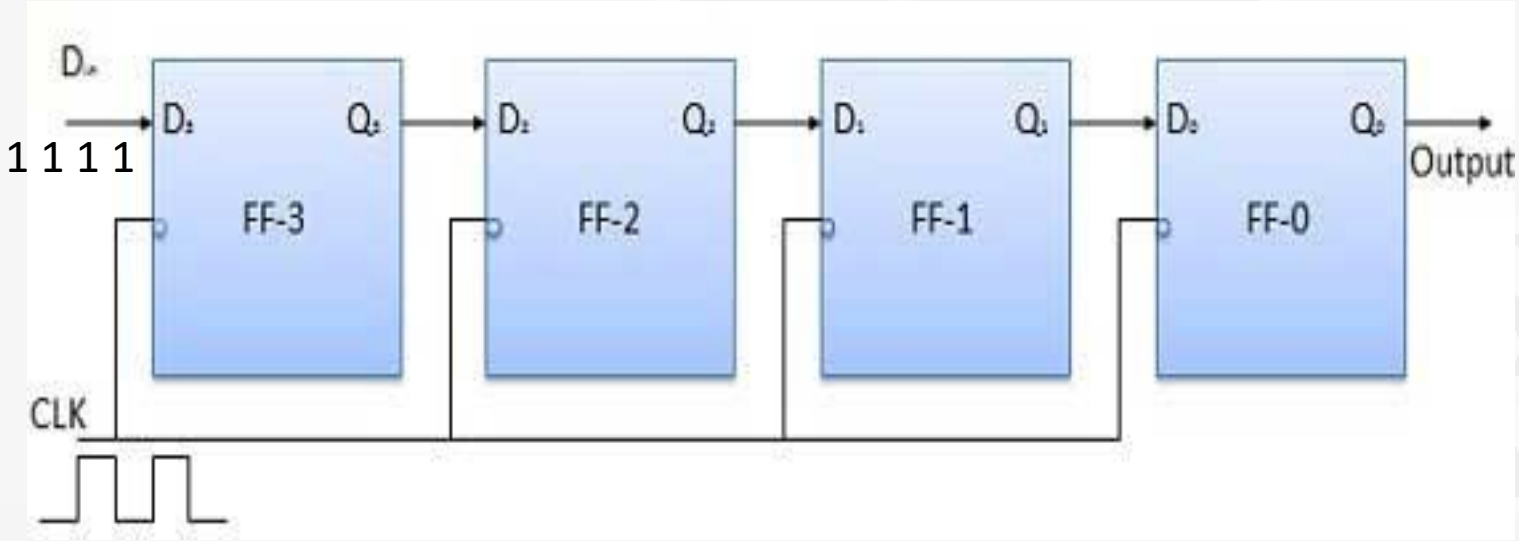
- During normal operation, Clear/ must be maintained at logic 1.
- The transfer of new information into a register is referred to as Loading
- The term Parallel Loading is used if all the input bits are transferred into the register simultaneously, with the common clock pulse.

In most digital systems, a master clock generator supplies clock pulses to all parts of the system, just as the heart that supplies a constant beat to all parts in the human system. Because of this fact, the input values in the register are loaded when a clock pulse arrives. This implies that, whenever a clock pulse arrives, it would load the register with new values, thus overwriting the previously stored register data.

Serial Input Serial Output (SISO) Register

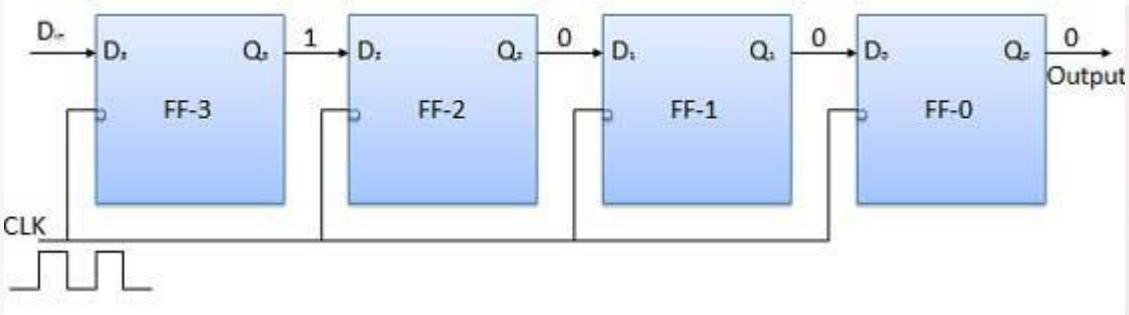
Let all the flip-flop be initially in the reset condition i.e. $Q_3 = Q_2 = Q_1 = Q_0 = 0$. If an entry of a four bit binary number 1 1 1 1 is made into the register, this number should be applied to **D_{in}** bit with the LSB bit applied first. The D input of FF-3 i.e. D_3 is connected to serial data input **D_{in}**. Output of FF-3 i.e. Q_3 is connected to the input of the next flip-flop i.e. D_2 and so on.

Block Diagram



Operation

Before application of clock signal, let $Q_3\ Q_2\ Q_1\ Q_0 = 0000$ and apply LSB bit of the number to be entered to D_{in}. So $D_{in} = D_3 = 1$. Apply the clock. On the first falling edge of clock, the FF-3 is set, and stored word in the register is $Q_3\ Q_2\ Q_1\ Q_0 = 1000$.

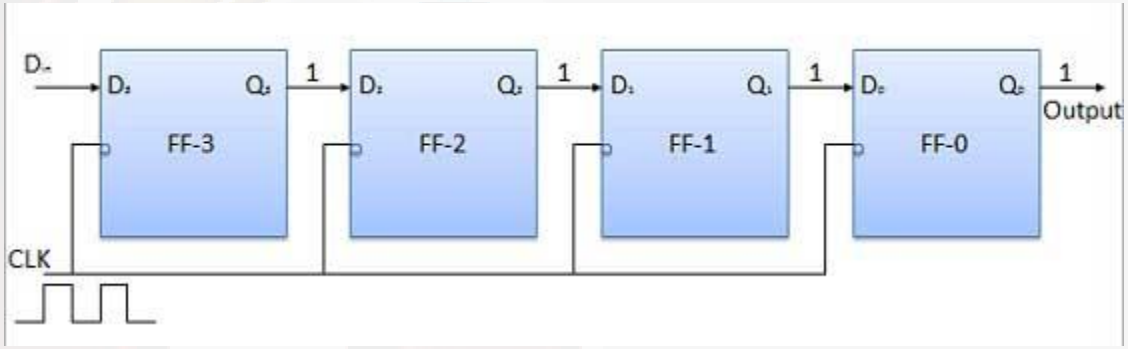


Apply the next bit to D_{in}. So $D_{in} = 1$. As soon as the next negative edge of the clock hits, FF-2 will set and the stored word change to $Q_3\ Q_2\ Q_1\ Q_0 = 1100$.

Apply the next bit to be stored i.e. 1 to D_{in}. Apply the clock pulse. As soon as the third negative clock edge hits, FF-1 will be set and output will be modified to $Q_3\ Q_2\ Q_1\ Q_0 = 1110$.

Operation

Similarly with $D_{in} = 1$ and with the fourth negative clock edge arriving, the stored word in the register is $Q_3\ Q_2\ Q_1\ Q_0 = 1111$

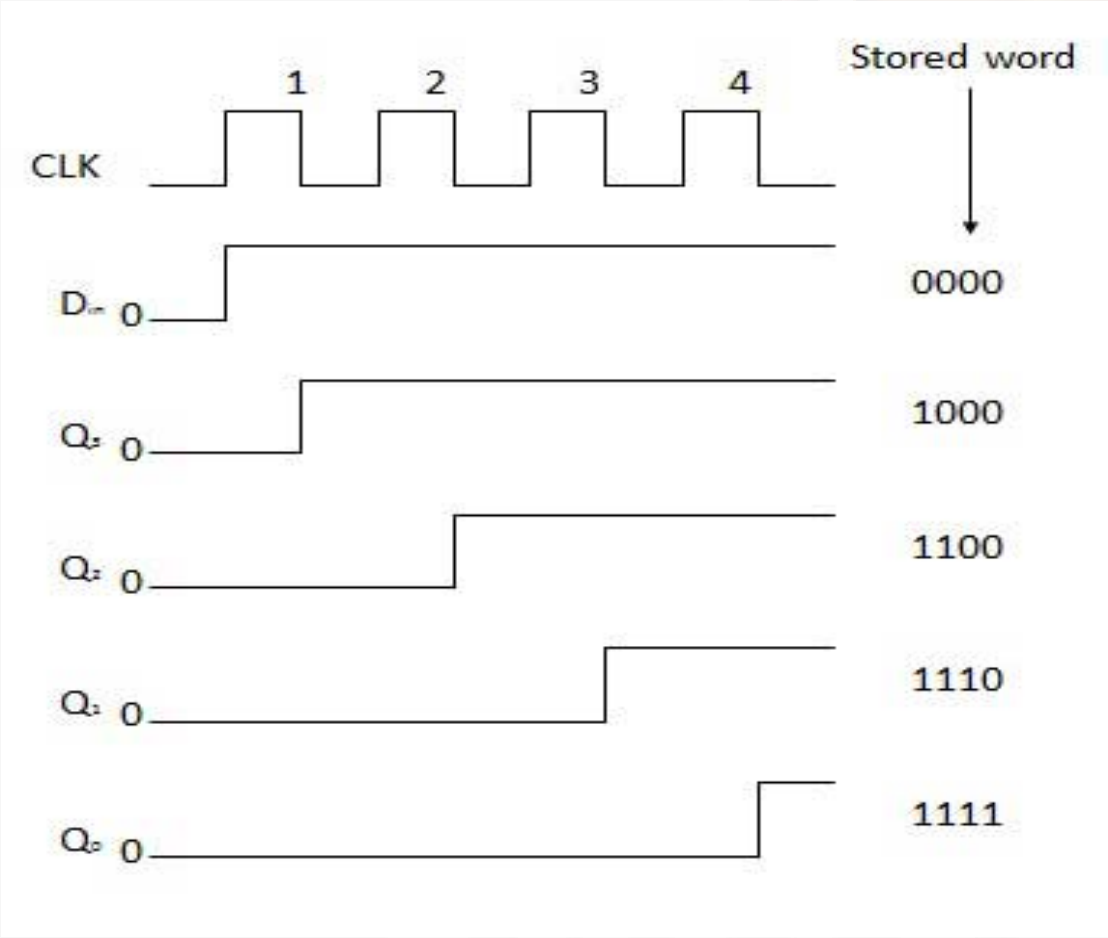


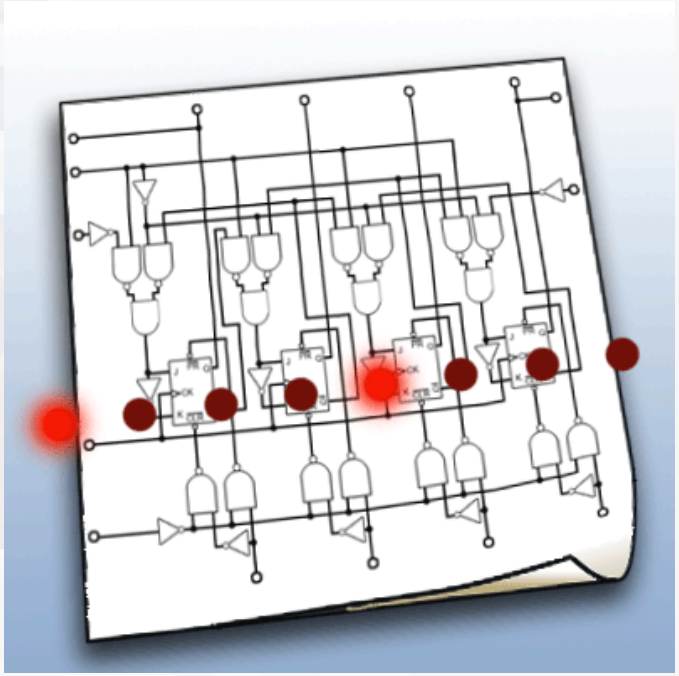
Truth Table

	CLK	$D_{in} = Q_3$	$Q_3 = D_2$	$Q_2 = D_1$	$Q_1 = D_0$	Q_0
Initially			0	0	0	0
(i)	↓	1	1	0	0	0
(ii)	↓	1	1	1	0	0
(iii)	↓	1	1	1	1	0
(iv)	↓	1	1	1	1	1

→ Direction of data travel

Waveforms





Applications

sometimes it's necessary to send or receive data serially, or one bit at a time. Some examples include:

- Input devices such as keyboards and mice
- Output devices like printers
- Any serial port, USB or Firewire device transfers data serially
- Recent switch from Parallel ATA to Serial ATA in hard drives

To receive serial data using a shift register:

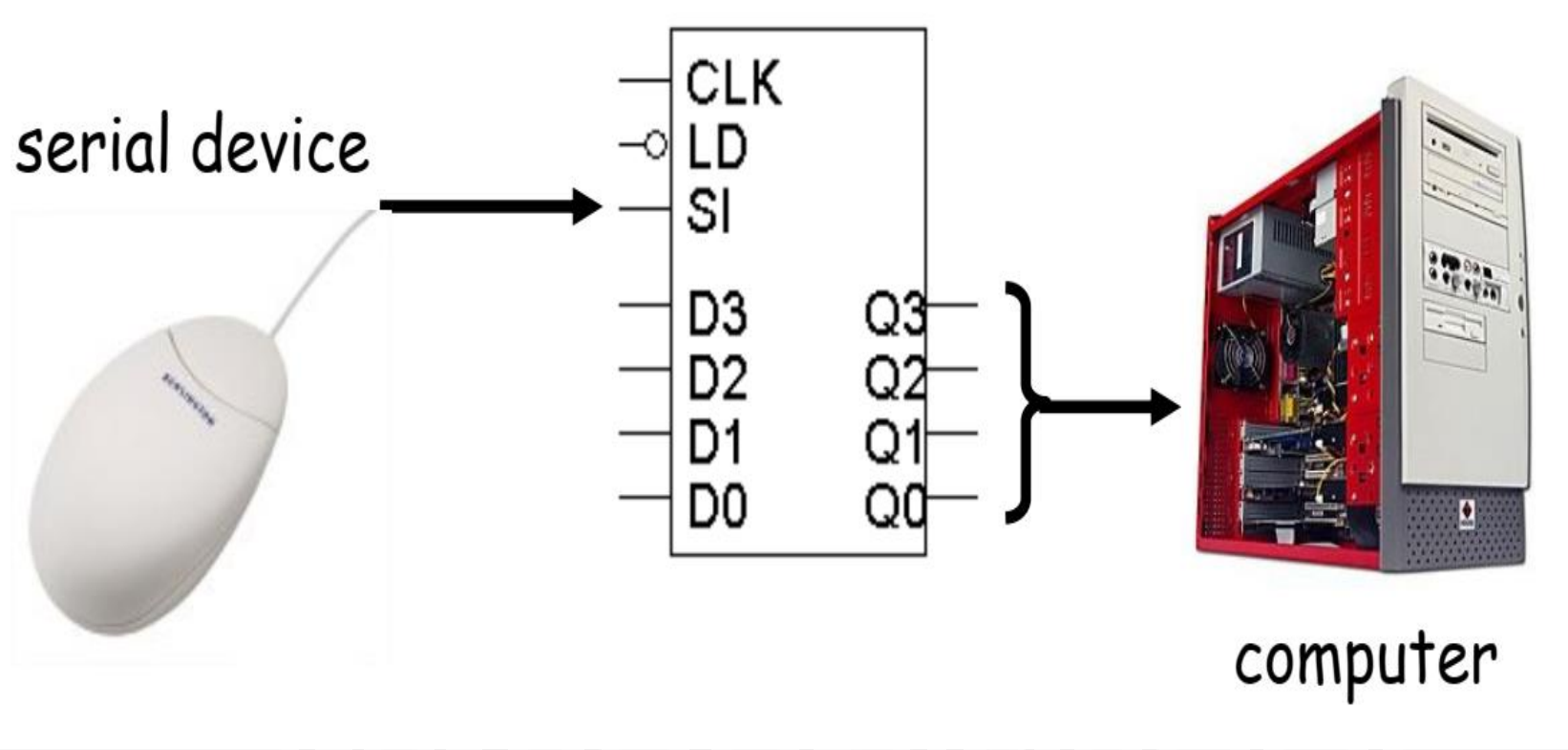
- The serial device is connected to the register's SI input
- The shift register outputs Q3-Q0 are connected to the computer

• The serial device transmits one bit of data per clock cycle

- These bits go into the SI input of the shift register
- After four clock cycles, the shift register will hold a four-bit word

• The computer then reads all four bits at once from the Q3-Q0 outputs.

Applications



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- Digital Fundamentals, Thomas L. Floyd, 11th Ed., 2015, Pearson Education Limited
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