DIGITAL ELECTRONICS

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COUNTERS

COUNTER

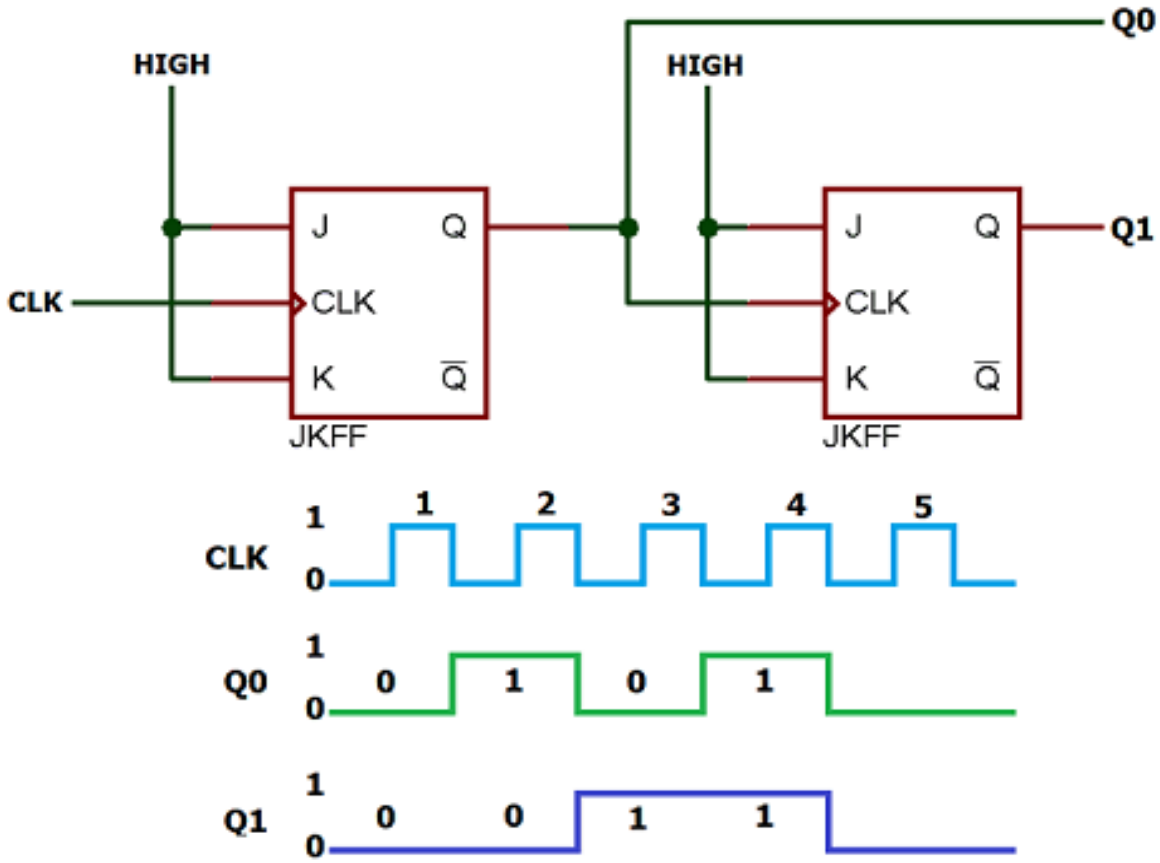
A counter is a sequential circuit consisting of a combination of flip-flops used for counting the pulses.

Depending upon the manner in which flip-flops of the counter are triggered, there are two types of counters:

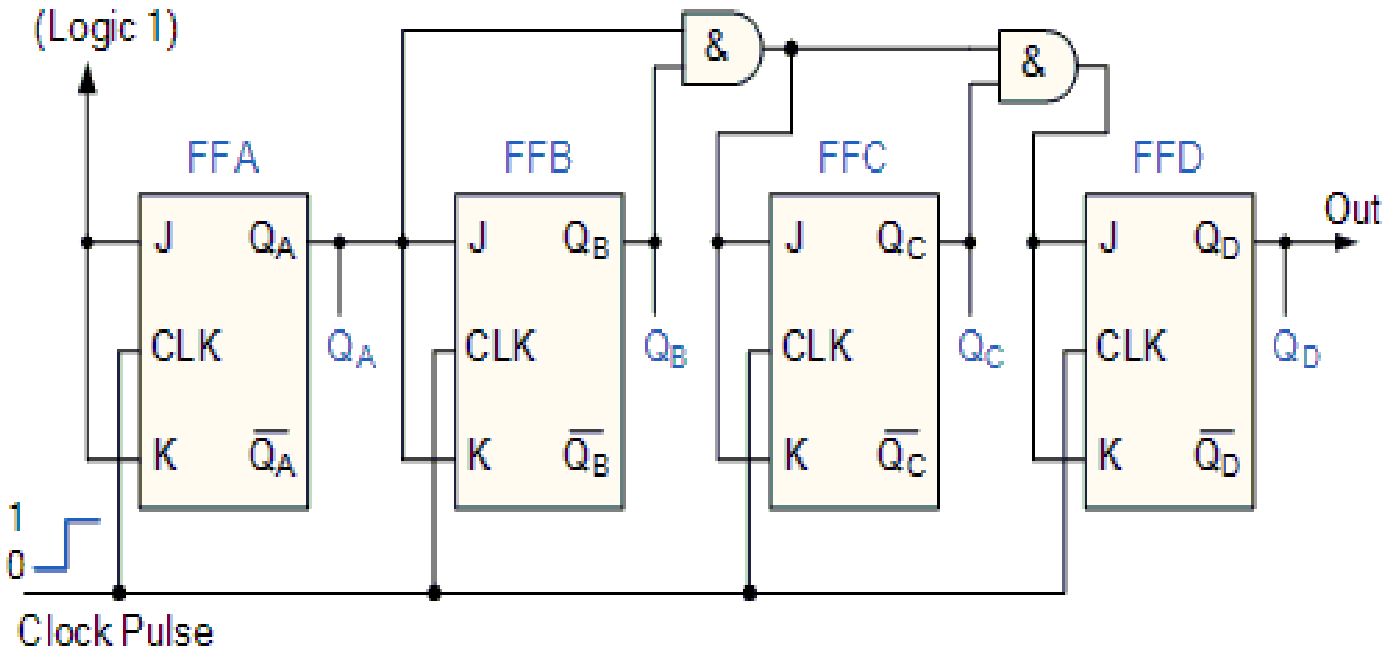
1. **Asynchronous counter:** If the flip-flops of a counter do not change their state at the same instant, then such counters are called asynchronous counters.

2. **Synchronous counters:** In the synchronous counter, clock input is given to all the flip-flops of the counter. So, in the synchronous counter, all flip-flops change their state at the same instant, that is why such type of counter is called synchronous counter.

2-BIT ASYNCHRONOUS COUNTER



4-BIT ASYNCHRONOUS COUNTER

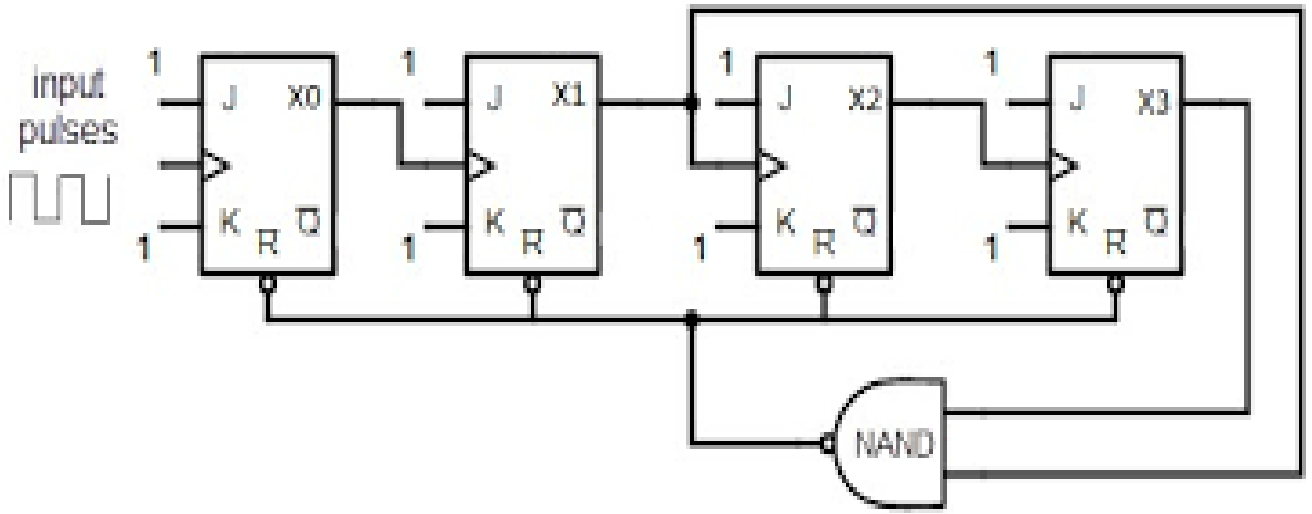


MODULUS COUNTER

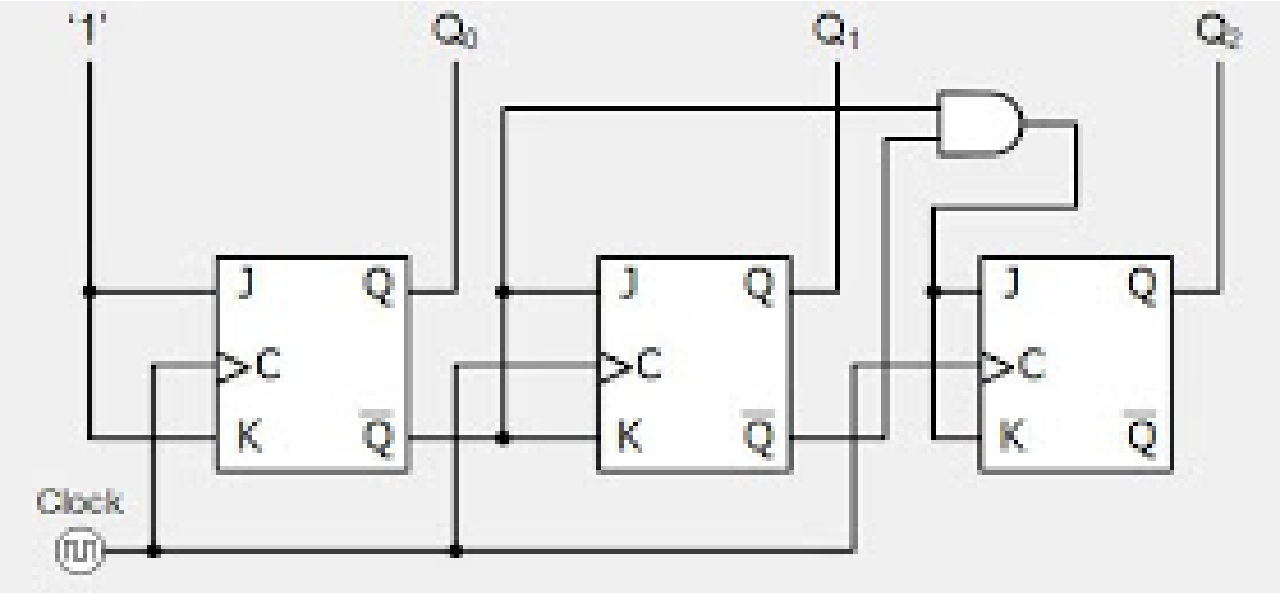
- The **modulus** (or just **modulo**) is the number of states the **counter** counts and is the dividing number of the **counter**. **Modulus Counters**, or simply MOD **counters**, are defined based on the number of states that the **counter** will sequence through before returning back to its original value.
- A MOD-N counter can be used to divide the input clock frequency by N as the frequency of the output of last flip-flop will be one by-N of the input clock frequency. So a MOD-N counter is also called Divide by N counter.

DECADE COUNTER

- A **decade counter** is one that counts in decimal digits, rather than binary. It counts from 0 to 9 and then resets to zero. The **counter** output can be set to zero by pulsing the reset line low. The **count** then increments on each clock pulse until it reaches 1001 (decimal 9).



3 BIT SYNCHRONOUS COUNTER



APPLICATIONS OF COUNTERS

- Frequency **counters**.
- Digital clocks.
- Analog to digital convertors.
- With some changes in their design, **counters** can be used as frequency divider circuits.
- In time measurement.
- We can design digital triangular wave generator by using **counters**.

SHIFT REGISTERS

SHIFT REGISTER

- Shift register is a combination of flip-flops and primarily used to store the data and shifting the data in a digital system..
- It has no specified sequence of states.
- Data are entered in the form of 0 and 1 by some external source.
- The shifting capability of shift register means the movement of data from one flip-flop to next flip-flop with the application of clock input.

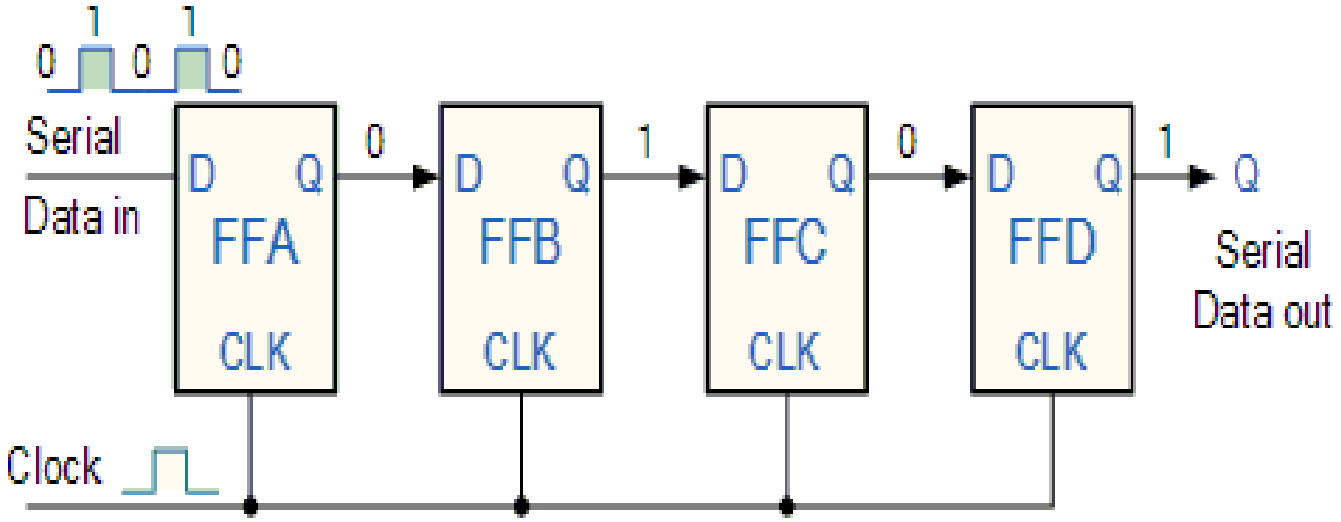
TYPES OF SHIFT REGISTER

Depending upon the manner by mean of which data are loaded or data are retrieved , there are four types of shift register:

1. Serial in serial out shift register.
2. Serial in parallel out shift register.
3. Parallel in serial out shift register.
4. Parallel in parallel out shift register.

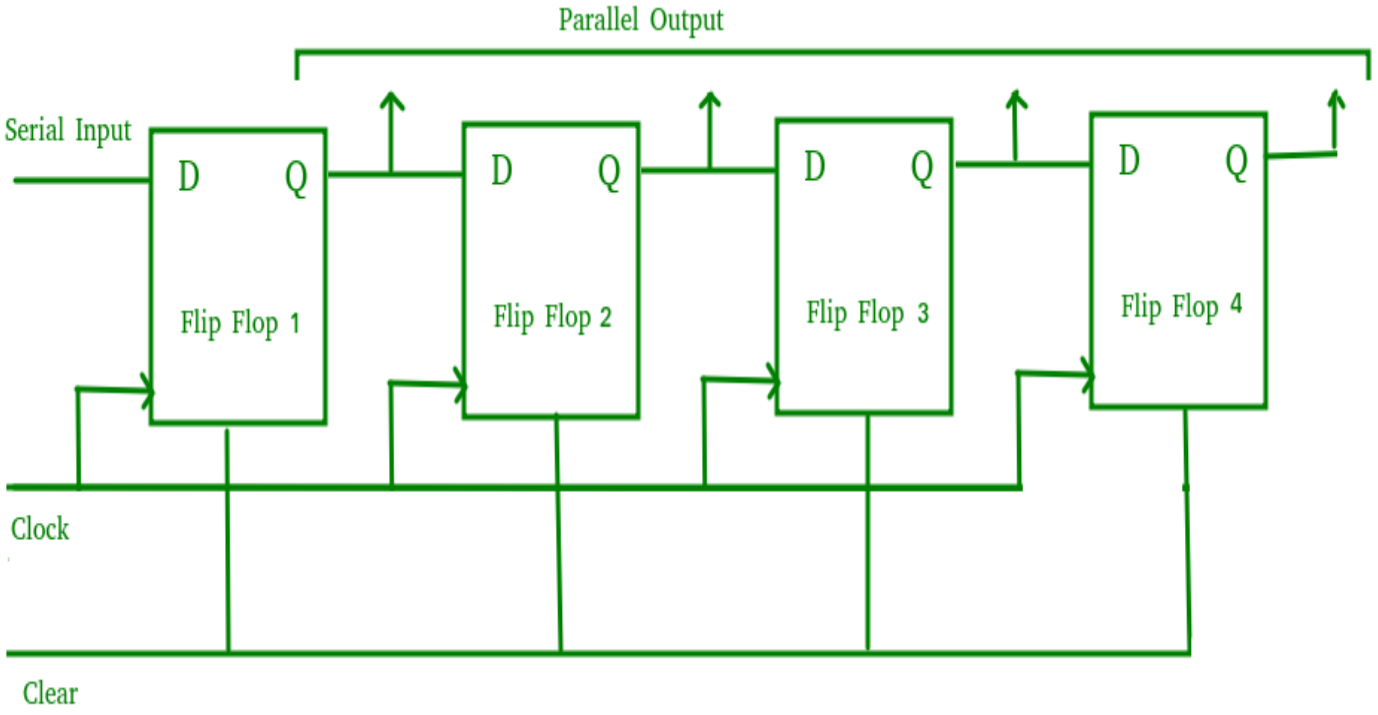
SERIAL IN SERIAL OUT SHIFT REGISTER

- **Serial In Serial Out** (SISO) **shift** registers are a kind of **shift** registers where both data loading as well as data retrieval to/from the **shift register** occurs in **serial**-mode.



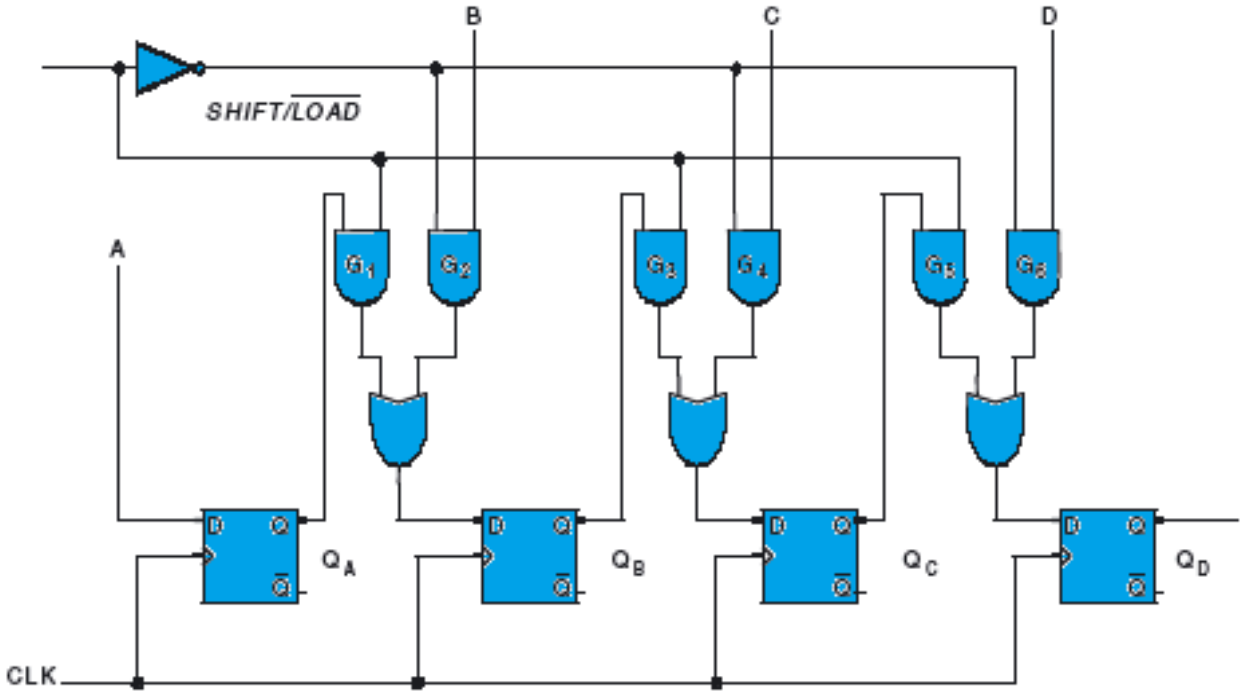
SERIAL IN PARALLEL OUT SHIFT REGISTER

- In **Serial In Parallel Out** (SIPO) **shift** registers, the data is stored into the register serially while it is retrieved from it in **parallel-**fashion**.**



PARALLEL IN SERIAL OUT SHIFT REGISTER

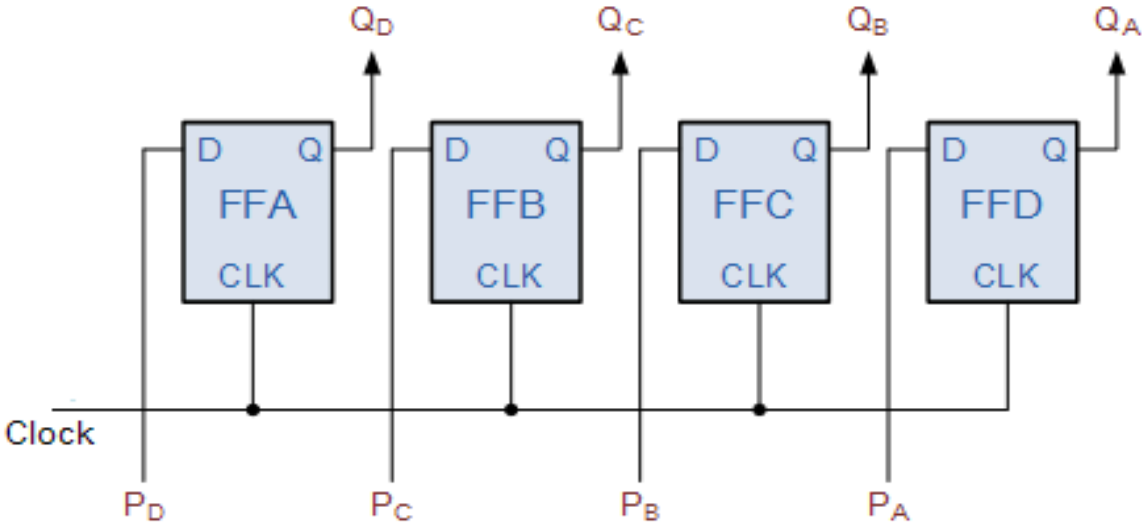
In **Parallel In Serial Out** (PISO) **shift** registers, the data is loaded onto the **register** in **parallel** format while it is retrieved from it serially.



A 4-bit parallel-in–serial-out shift register.

PARALLEL IN PARALLEL OUT SHIFT REGISTER

Parallel In Parallel Out (PIPO) shift registers are the type of storage devices in which both data loading as well as data retrieval processes occur in parallel mode.



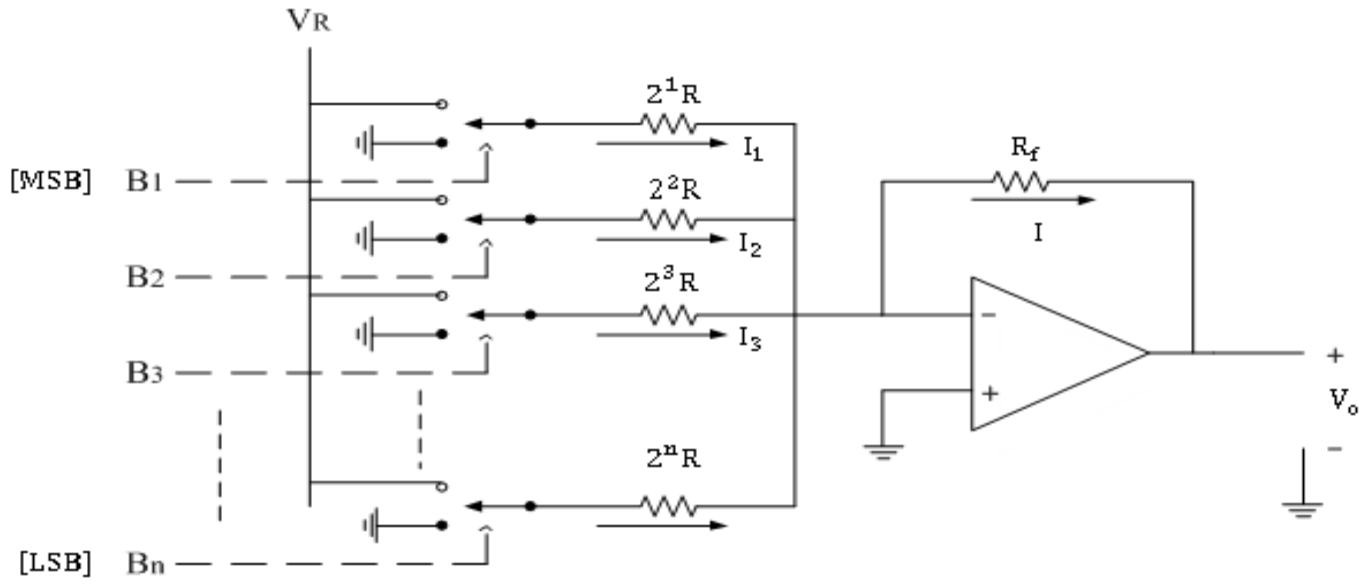
ANALOG TO DIGITAL AND DIGITAL TO ANALOG CONVERTOR

DIGITAL TO ANALOG CONVERTOR

- The device which converts digital quantity to analog quantity is known as digital to analog (D/A) convertor.
- In most of the electronics equipment, processing of the signal is done in digital form and after processing, these signals are converted in analog form.
- There are two different types of D/A convertor:
  1. Binary weighted D/A convertor
  2. R/2R ladder D/A convertor.

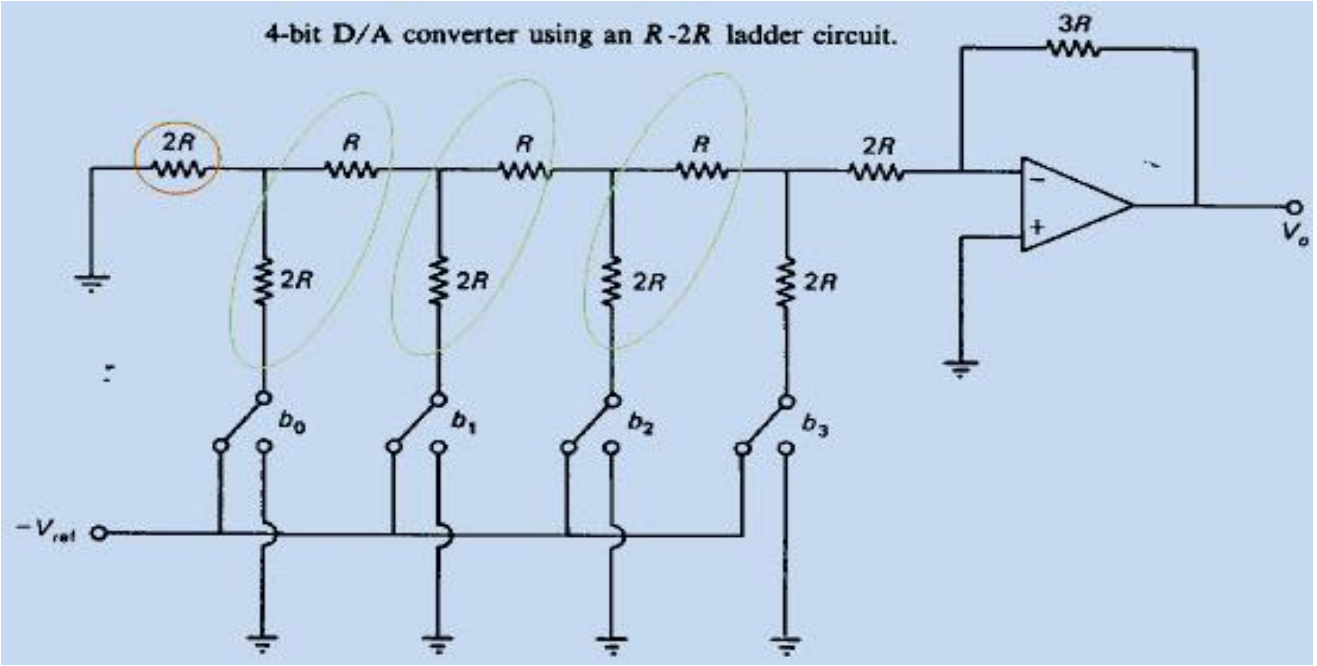
BINARY WEIGHTED D/A CONVERTOR

This D/A convertor involve a resistive network and an operational amplifier. Each resistor of the network represent the binary weight of the input bits of the digital code. The operational amplifier provides a very high input impedance and connected in inverting mode.



R/2R LADDER D/A CONVERTOR

This type of D/A convertor involve only two resistor values, R and 2R for any number of data input bits. So the problem of wide range of resistor value in case of binary weighted D/A is overcome in this type of D/A convertor.



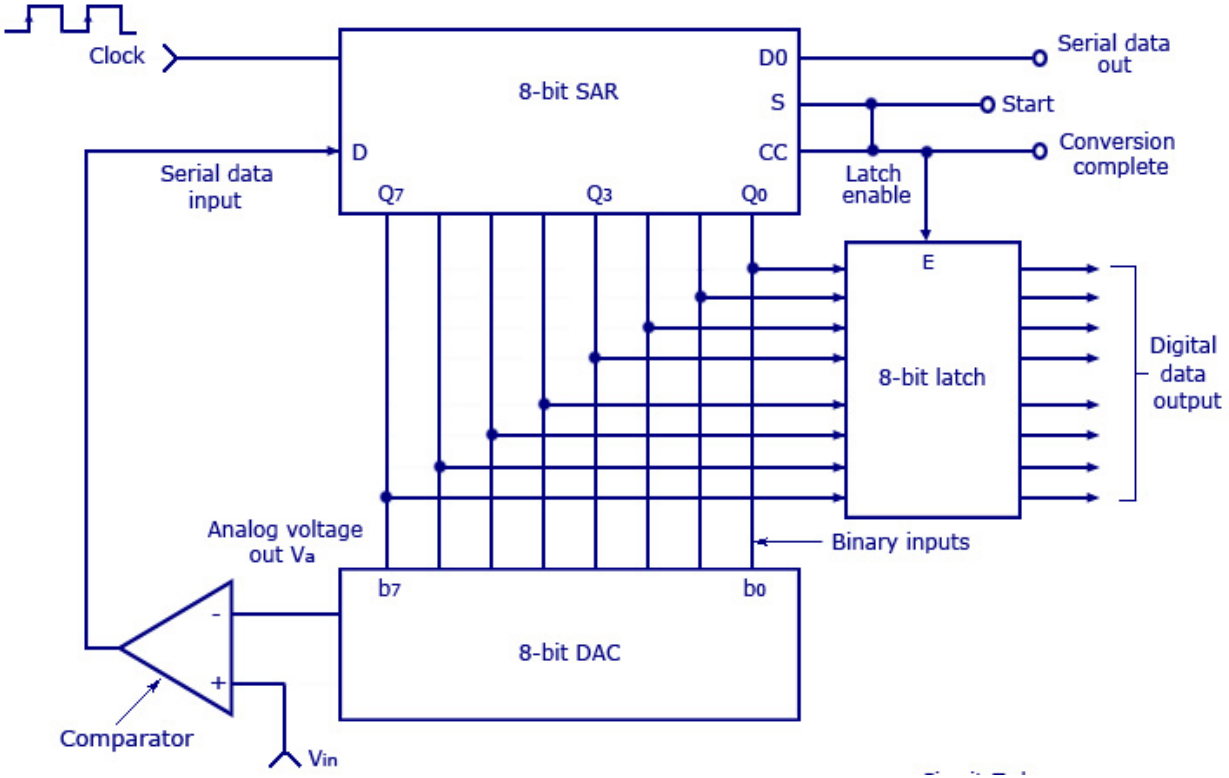
ANALOG TO DIGITAL CONVERTOR

In the analog to digital (A/D) convertor, the analog quantity is converted in to digital form. There are different types of analog to digital convertor:

1. Flash A/D convertor
2. Stair step ramp A/D convertor
3. Single slope A/D convertor
4. Dual slope A/D convertor
5. Successive approximation A/D convertor

SUCCESSIVE APPROXIMATION A/D CONVERTOR

A successive approximation A/D converter consists of a comparator, a successive approximation register (SAR), output latches, and a D/A converter.



DUAL SLOPE A/D CONVERTOR

In **dual slope** type **ADC**, the integrator generates two different ramps, one with the known analog input voltage VA and another with a known reference voltage –Vref. Hence it is called a **dual slope** A to D converter.