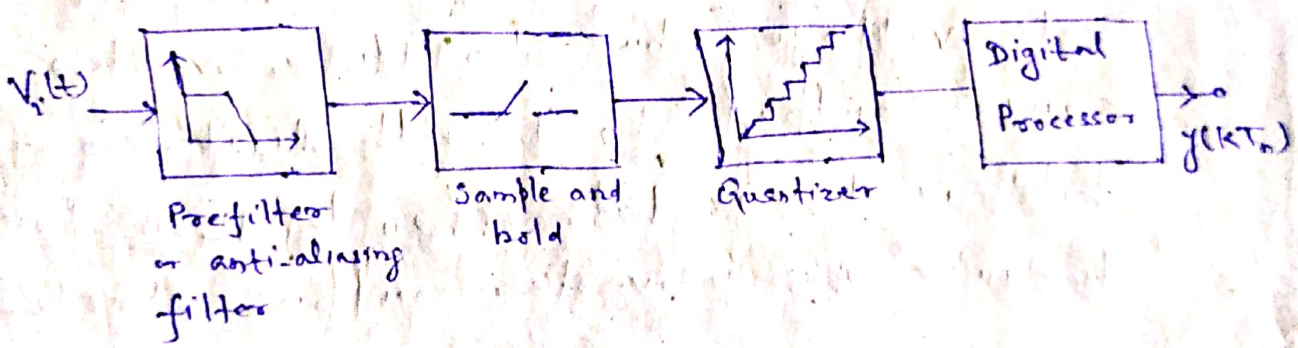
The analog-to-digital conversion process divides the analog input V_i into 2^n intervals. These intervals are called code range and all values of V_i falling within a code range are represented by particular code.

The general block diagram of Analog-to-Digital conversion process is shown in fig-2.



The above block diagram consist of a anti-aliasing or prefilter which function is to avoid the aliasing of high frequency signal. The sample and Hold circuit hold the analog input signal to A/D constant during conversion time. The quantizer segments the reference voltage signal into subranges. Typically, for n-bit digital output, 2^n subranges. The digital processor forms the encoder ckt which encodes the subrange into the corresponding digital bits.

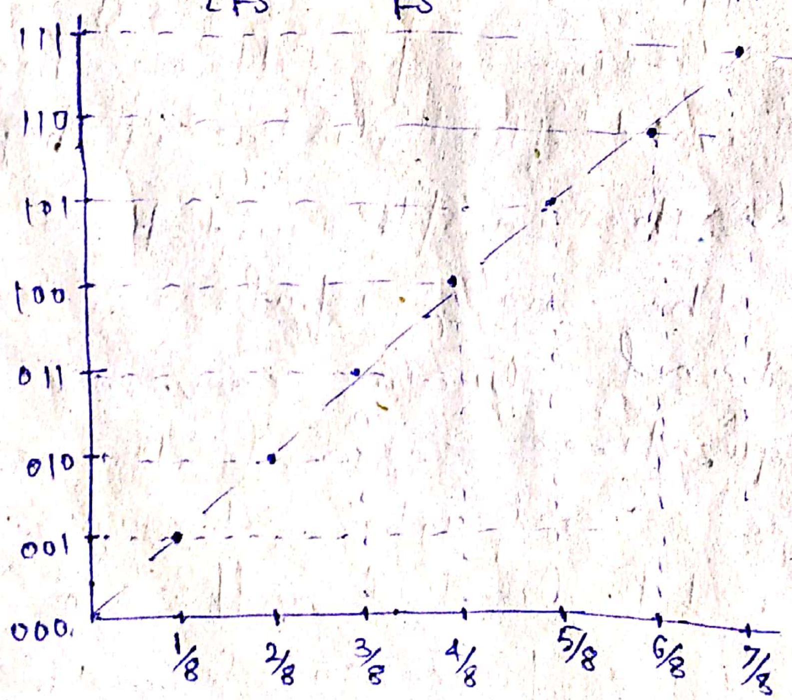
Resolution (for A/D) :- The finest minimum change in the input signal that is accepted for conversion is called Resolution. It is decided with number of bits.

The minm change in input signal voltage to an A/D for n-bit, that ~~given by~~ causes to change 1 LSB in output is given by

$$\boxed{\Delta v_i = \frac{V_{FS}}{2^n}}$$

Larger is the number of bits, better is the resolution. The maximum full scale voltage input to A/D converter that causes output to be all digital output bits as 1, is less than by 1LSB from V_{FS} because A/D converter output startes from 0

i.e $V_{iFS} = V_{FS} - 1$ LSB voltage.



$V_{iFS} = 1 - \frac{1}{2^3} = \frac{7}{8}$

Quantization and Quantization error :-

In D/A converter, the number of digital inputs are fixed. For example if there is a 3-bit D/A converter then total possible number of inputs is 8. But, on the other hand, in A/D converter, the input analog signal can have any value in a range but the digital output can have only 2^n discrete value for an n-bit A/D converter.

Thus, we see that the entire analog input voltage is to be divided into 2^n interval suitably. This process is called quantization. When each interval of thus divided analog input is assigned to a corresponding n-bit binary code, this is referred to as encoding.

The above fact can be understood in better way by taking an example. Let us consider, an analog voltage ranging 0 volt to V volt is to be converted in 3-bit digital output. Let the whole voltage is divided into 8-interval with each interval size $\frac{V}{8}$ as shown in below —

Analog voltage	Digital value
0	000
$\frac{1}{8}$	001
$\frac{2}{8}$	010
$\frac{3}{8}$	011
$\frac{4}{8}$	100
$\frac{5}{8}$	101
$\frac{6}{8}$	110
$\frac{7}{8}$	111

Here each interval is assigned to 3-bit digital output or digital binary number. From above table, we observe that, the whole range of analog voltage in an interval is represented by only one digital value [i.e., example $3/8 < V_{an} < 4/8$ the $D = 011$]. This ~~sea~~ results an error which is termed as Quantization error.

Classification of A/D converter

A/D converters are classified based on their features —

Type:-I i> **Programmed A/D converter:-** The A/D ~~g~~ converter in which conversion is made in a fixed number of steps with equal time interval is known as programmed A/D converter. Successive approximation type A/D converter is an example of programmed A/D converter.

ii> **Non-programmed A/D converter:-**

The A/D converter which requires a sequence of steps initially, and time interval of Sequence depends only on the response time of conversion circuitry is called non-programmed. Integrating type A/D converter is an example of non-programmed A/D converter.

Type:-II. i> **Closed-loop or feedback type**

The A/D converter in

which analog voltage generated internally as a function of digital input is fedback to one input of the comparator is called closed loop A/D converter.

ii> Open-loop A/D converter :-

The A/D converter in which the input analog voltage is directly compared with a reference voltage is termed as open-loop A/D converter. The flash type A/D converter is an example of open-loop A/D converter.

Type:- III. i> Capacitor charging type A/D Conv

The A/D converter which operates on the principle of charging the capacitor at a rate proportio to input voltage, while simultaneously pulling out discrete charge packets out of the capacitor at a rate such that the net charge flow is zero

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The capacitor balancing ~~type~~ integrating type A/D converter belongs to the category of capacitor charging A/D converter. Dual ~~slo~~ slope A/D converter is charge-balancing type converter.

ii) Discrete voltage comparission type A/D:-

This type of A/D converter is based on the principle of generation of discrete voltage whose levels are equivalent to digital words. The comparision of these voltage levels are then made with the input voltage to determine the equivalent digital ~~word~~ word.

Type:-IV i) Direct A/D Converter :-

The A/D converter which compares the given analog signal with an internally generated equivalent analog signal is called direct A/D converter. Flash type A/D, Counter type A/D, Successive approximation, Tracking or Servo operated A/D converters are fall in this category.

iii> Indirect A/D converter :- The A/D converter in which conversion takes place in an indirect manner is called indirect A/D converter. The integrating A/D converter is an indirect type A/D converter. It is a special class of Analog-to-digital converter which uses either a reference voltage or which integrates the signal during conversion process. Therefore they do not need sample-and-Hold ckt. The process of integrating the signal also improves the signal-to-noise ratio. The integrating A/D converters are suitable for very low frequency. The charge balancing type and dual slope A/D convertes are indirect analog-to-digital converter.