4.2 DAC/ADC SPECIFICATIONS

Both D/A and A/D converters are available with wide range of specifications specified by manufacturer.

RESOLUTION:

The resolution of a converter is the smallest change in voltage which may be produced at the output (or input) of the converter. For example, an 8-bit D/A converter has 2^8 -1=255 equal intervals.Hence the smallest change in output voltage is (1/255) of the full scale output range.

$$Resolution = \frac{V_{FS}}{2^n-1} = 1\text{LSB increment}$$

The resolution of an A/D converter is defined as the smallest change in analog input for a one bit change at the output.Example , the input range of an 8-bit A/D converter is divided into 255 intervals.The following table 4.2.1 shows the resolution for 6 to 16 bit DACs

S.No.	Bits	Intervals	LSB size (% of full-scale)	LSB size (For a 10 V full-scale)
1.	6	63	1.588	158.8 mV
2.	8	255	0.392	39.2 mV
3.	10	1023	0.0978	9.78 mV
4.	12	4095	0.0244	2.44 mV
5.	14	16383	0.0061	0.61 mV
6.	16	65535	0.0015	0.15 mV

Table4.2.1 Resolution for 6 to 16 bit DACs

[source:“Linear Integrated Circuits”by D.Roy Choudhry, Shail Bala Jain, Page-421]

LINEARITY:

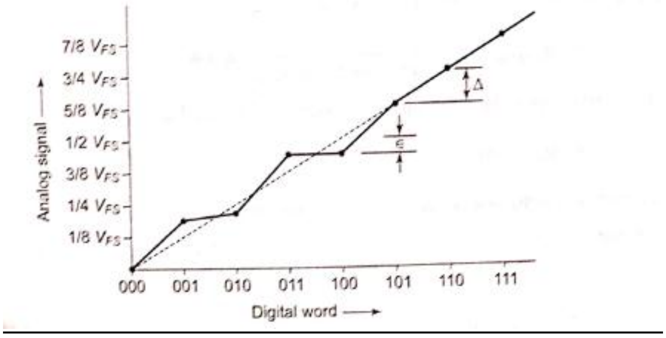

Figure 4.2.1 Linearity error of a 3-bit D/A converter

[source:“Linear Integrated Circuits”by D.Roy Choudhry, Shail Bala Jain, Page-421]

The linearity of an A/D or D/A converter is an important measure of its accuracy.In an ideal DAC ,equal increment in the digital input should produce equal increment in the analog output and the transfer curve should be linear.In an actual DAC, output voltages do not fall on a straight line because of gain and offset errors as shown by the solid line curve.The static performance of a DAC is determined by fitting a straight line through the measured output points. Linearity error of a 3-bit D/A converter is shown in fig 1.

The linearity error measures the deviation of the actual output from the fitted line and is given by ε/Δ.The error is usually expressed as a fraction of LSB increment or percentage of full scale voltage.A good converter exhibits a linearity error of less than ±(1/2)LSB.

ACCURACY :

Absolute accuracy is the maximum deviation between the actual converter output and the ideal converter output.Relative accuracy is the maximum deviation after gain and offset errors have been removed.

MONOTONICITY :

A monotonic DAC is the one whose analog output increases for an increase in digital input. A monotonic characteristic is essential in control applications; otherwise oscillations can result. If a DAC has to be monotonic, the error should be less than ±(1/2) LSB at each output level.

SETTLING TIME :

Settling time represents the time it takes for the output to settle within a specified band ±(1/2) LSB of its final value, after the change in digital input.It should be as small as possible.Settling time ranges from 100 ns to 10 μs depending on word length and type of circuit used.

STABILITY :

The performance of converter changes with temperature, age and power supply variations. So all the relevant parameters such as offset, gain, linearity error and monotonicity must be specified over the full temperature and power supply ranges.