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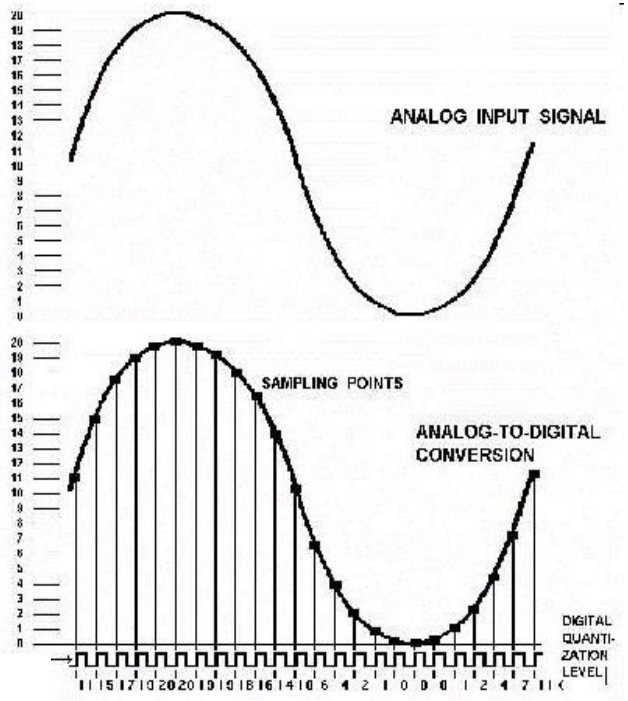
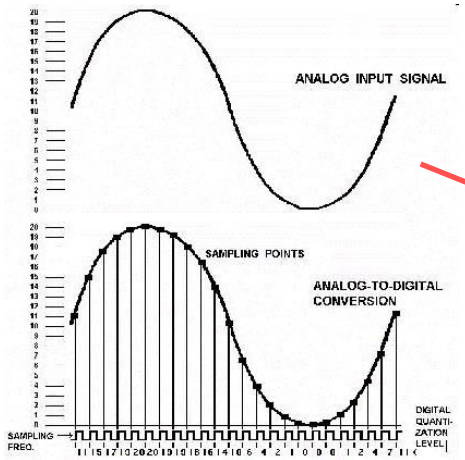
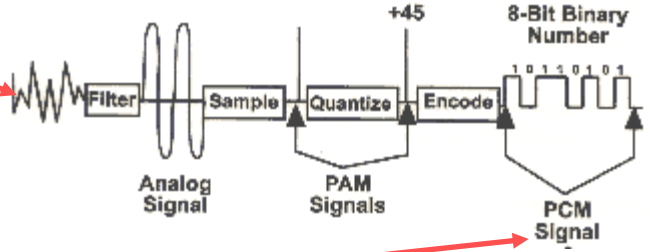
Analog to Digital (A/D) Converter

- In order to change an analog signal to digital, the input analog signal is sampled at a high rate of speed.
- The amplitude at each of those sampled moments is converted into a number equivalent – this is called quantization.
- These numbers are simply the combinations of the 0s and 1s used in computer language – this called encoding.

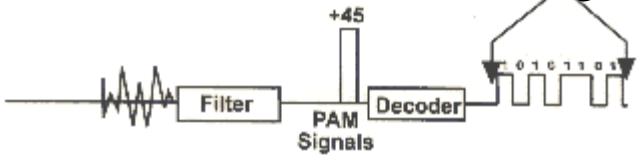






Modulation

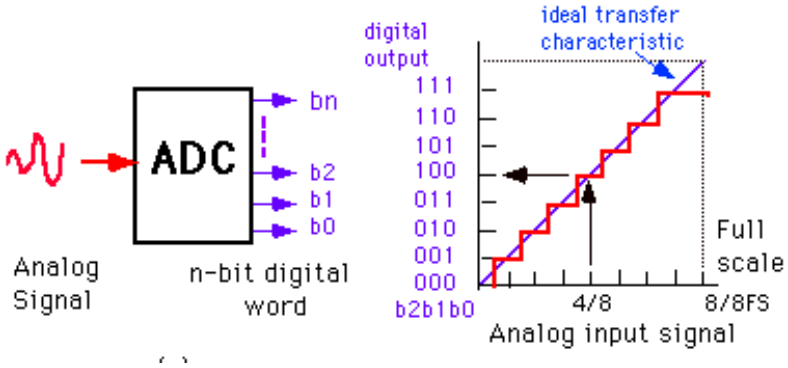
PCM Signal



Demodulation

Analog-to-Digital

- A simple hypothetical A/D converter circuit with one analog input signal and three digital output lines with eight possible binary combinations: 000 to 111
  - Shows the graph of digital output for FS V analog input
- The following points can be summarized in the above process:
  - Maximum value this quantization process reaches is **7/8** V for a 1 V analog signal; includes 1/8 V an inherent error
  - 1/8 V (an inherent error) is also equal to the value of the Least Significant Bit (LSB) = 001.
  - Resolution of a converter is defined in terms of the number of discrete values it can produce; also expressed in the number of bits used for conversion or as $1/2^n$ where n =number of bits
  - The value of the most significant bit (MSB) -100- is equal to ½ the voltage of the full-scale value of 1 V.
  - The value of the largest digital number 111 is equal to full-scale value minus the value of the LSB.
  - The quantization error can be reduced or the resolution can be improved by increasing the number of bits used for the conversion



A/D Conversion - Types

Can be classified in four groups:

1. Integrator:

- Charges a capacitor for a given amount of time using the analog signal.
- It discharges back to zero with a known voltage and the counter provides the value of the unknown signal.
- Provides slow conversion but low noise.
- Often used in monitoring devices (e.g., voltmeters)

2. Flash: uses multiple comparators in parallel.

- The known signal is connected to one side of the comparator and the analog signal to be converted to the other side of the comparator.
- The output of the comparators provides the digital value.
- This is a high-speed, high cost converter.

3. Successive approximation:

Includes a D/A (digital to analog) converter and a comparator. An internal analog signal is generated by turning on successive bits in the D/A converter.

4. Counter:

Similar to a successive approximation converter except that the internal analog signal is generated by a counter starting at zero and feeding it to the D/A converter.