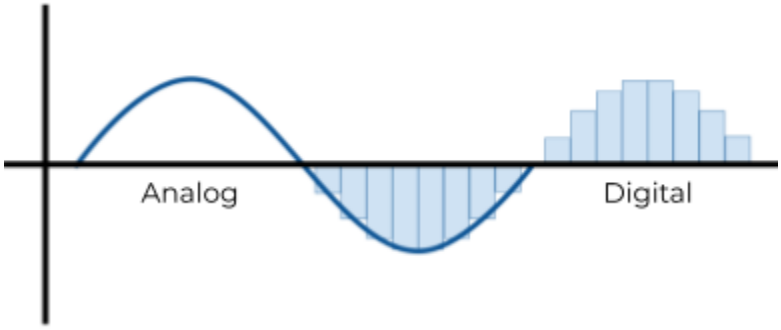
Analog vs. Digital Systems



Analog Systems

Represents data using **continuous values**. It is directly tied to physical phenomena, such as sound, light, or temperature. Key aspects of analog systems include:

- **Continuous Signals**:
    - Data is represented as continuous waveforms or signals.
    - Example: A sine wave representing sound intensity.
- **Advantages**:
    - High precision for natural signals (e.g., audio or video).
    - Smooth and continuous representation.
- **Disadvantages**:
    - Prone to noise and distortion.
    - Difficult to store and process with modern computers.
- Example: A traditional thermometer with a mercury column is an analog device, as the height of the column continuously represents the temperature.

Digital Systems

Represents data using **discrete values** (typically binary). It is the foundation of modern computing. Key aspects of digital systems include:

- **Discrete Signals**:
    - Data is represented as discrete levels.
    - Example: A digital signal encoding audio in binary.

- **Advantages**:
    - Resistant to noise and distortion.
    - Easy to store, replicate, and process.
    - Enables fast and reliable computations.
- **Disadvantages**:
    - Requires conversion for processing analog signals (e.g., via an ADC or DAC).
    - Can lose some precision compared to analog systems.
- Example: A digital thermometer with an LCD display is a digital device because it uses discrete numeric values to represent the temperature.

Summary

Aspect	Analog Systems	Digital Systems
Representation	Continuous waveforms or values.	Discrete numbers or binary signals.
Precision	High precision for natural signals.	Limited by sampling or quantization.
Noise Resistance	Susceptible to noise and interference.	Robust to noise and distortion.
Ease of Processing	Difficult to process and store.	Easy to process, store, and replicate.
Example	Vinyl record for music storage.	MP3 file for music storage.

Analog-to-Digital and Digital-to-Analog Conversion

Since most real-world data is analog (e.g., sound, light, temperature), it must often be converted to digital format for processing in modern systems. Similarly, digital data may need to be converted back to analog for human use.

- **Analog-to-Digital Conversion (ADC)**: Converts a continuous analog signal into a discrete digital signal.
    - Example: Sampling sound from a microphone to create an MP3 file.
- **Digital-to-Analog Conversion (DAC)**: Converts a discrete digital signal back into a continuous analog signal.
    - Example: A digital music player converting an MP3 file to analog audio for headphones.