Lesson 3 Lecture 5 - Analog & Digital
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What do we mean by Analog?

1. Analog means at it's basic level - an electrical signal (current or voltage) that is varying over time
    a. A voltage that varies at an inconsistent rate, but still varies is also an Analog signal
    b. An AC Current signal is an analog signal
    c. Analog signals vary in both voltage and current and Automation uses both
    d. Analog uses a continuous range of values in voltage or current to represent information
    e. Analog Signals over time are typically resembling a Sine Type Waveform
2. What are analog signals used for?
    a. Broadcast transmission
    b. Feedback in a process
    c. Distance detection in sensors
    d. Lighting and Indication
    e. Gauges and Meters
    f. Actuators – linear and rotary
    g. Communication & Signaling
    h. Ramping Motors speeds up and down, turning them on and off
3. How do Analog Signals work in Automation?
    a. Inputs
        i. An Ultrasonic, Inductive, or Photoelectric Sensor detecting distance
        ii. Using a Distance measurement to provide feedback to a system
        iii. Various types of feedback in process automation systems
        iv. RFID Systems
    b. Outputs
        i. Providing gauge, metered, or signal outputs
        ii. A Drive providing a Motor a ramp up or ramp down signal
        iii. Moving a part from point a to point b using an actuator
        iv. RFID Systems
        v. Provide Visual feedback on an HMI (OI)
4. Why do we need analog signals?
    a. We live in an Analog world
    b. We cannot see, hear, etc. in digital – we really aren't computers!
5. What are some issues with Analog
    a. Precision
    b. Noise
    c. Attenuation
    d. Computers think, listen, talk digitally

What do we mean by Digital?

1. Digital signals are typically referred to and measured by their voltage level and a digital signal is either one of two distinct levels: High or Low, On or Off, 1 or 0.
    a. Most Automation Systems today work on 24 VDC System so a High, On, or 1 value is approximately 24VDC where Low, Off, or 0 is close to Zero volts.
    b. Digital Signals operate in a Square Wave form over time.
    c. Digital signals do not necessarily vary over time
    d. It is easy to for digital signals into ways of communication such that computers and other devices can "talk"
        i. Ever dialed the number for someone's fax machine?
6. What are Digital signals used for?
    a. Inputs & Outputs
    b. Feedback in a process
    c. Distance detection in sensors
    d. Object detection in sensors
    e. Lighting and Indication
    f. Counters
    g. Encoders
    h. Communication & Signaling
    i. Turning motors on and off
    j. Coordination
7. How do Digital Signals work in Automation?
    a. Inputs
        i. An Ultrasonic, Inductive, or Photoelectric Sensor detecting distance or an object
            1. Sensor "Sees" it's target and turns ON (go's from 0 to 1, low to High)
            2. PLC or PC input "sees" the transition of the sensor output at it's input
            3. PLC make a decision based on how it is programmed to execute some operation or output based on that input
        ii. Some signals detect position, presence, and distance.
    b. Outputs
        i. Count, Light up an indicator, turn on a motor or advance a stepper motor, help coordinate processes, provide input to HMI
        ii. Communicate information on a network or in an RFID Application
8. Why do we need Digital Signals?
    a. We live in an Digital world
    b. Electronic Devices cannot see, hear, etc. in digital – they really are computers!
9. What are some issues with Digital
    a. Hard to vary an input or output - only have two levels
    b. When converting Digital to analog it is necessary to step these signals into a waveform

How do these signals compare:

	Analog	**Digital**
Signal	Analog signal is a continuous signal which represents physical measurements.	Digital signals are discrete time signals generated by digital modulation.
Waves	Denoted by sine waves	Denoted by square waves
Representation	Uses continuous range of values to represent information	Uses discrete or discontinuous values to represent information
Example	Human voice in air, analog electronic devices.	Computers, CDs, DVDs, and other digital electronic devices.
Technology	Analog technology records waveforms as they are.	Samples analog waveforms into a limited set of numbers and records them.
Data transmissions	Subjected to deterioration by noise during transmission and write/read cycle.	Can be noise-immune without deterioration during transmission and write/read cycle.
Response to Noise	More likely to get affected reducing accuracy	Less affected since noise response are analog in nature
Flexibility	Analog hardware is not flexible.	Digital hardware is flexible in implementation.
Uses	Can be used in analog devices only. Best suited for audio and video transmission.	Best suited for Computing and digital electronics.
Applications	Thermometer	PCs, PDAs
Bandwidth	Analog signal processing can be done in real time and consumes less bandwidth.	There is no guarantee that digital signal processing can be done in real time and consumes more bandwidth to carry out the same information.
Memory	Stored in the form of wave signal	Stored in the form of binary bit
Power	Analog instrument draws large power	Digital instrument draws only negligible power
Cost	Low cost and portable	Cost is high and not easily portable
Impedance	Low	High order of 100 mega ohm
Errors	Analog instruments usually have a scale which is cramped at lower end and give considerable observational errors.	Digital instruments are free from observational errors like parallax and approximation errors.

In Summary

1. Analog signals vary over time
2. Digital Signals are on or off
3. Analog signals are what we hear and see and feel
4. Digital signals are what computers and cell phone hear, see, and feel
5. We need both in Automation