PLC Fundamentals – Common PLC Terminology

MET 382
Controls & Instrumentation
for Automation

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T.E. Kostek

Topics

- PLC vs. PC
- CPU
- Bits, bytes, and words
- Memory options
- PLC modules
- Slots
- Terminal blocks
- Fixed vs. modular systems
- Discrete vs. analog

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PLC vs. PC

- **PLC**: Programmable Logic Controller
- **PC**: Personal Computer or Programmable Controller

In this class, PC = Personal Computer

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CPU

- Every programmable device contains at least one CPU (Central Processing Unit)
- The CPU executes the user's program
- A microprocessor is a CPU implemented in the form of an integrated circuit (I.C.) or "chip"
- Every PLC processor module (or "controller") contains at least one CPU

Bits, Bytes, and Words

- Bit (**Bi**nary Digi**t**):
  - The smallest piece of information that can be stored in a programmable device
  - A bit's value is either 0 or 1
- Byte: 1 byte = 8 bits
- Word:
  - A word's size is machine dependent
  - Words are used to store numbers and codes
  - Words are also called registers

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Bits, Bytes, and Words (continued)

- With respect to Allen-Bradley PLC-5's and SLC-500's:
  - 1 Word = 16 bits
  - Examples:
    - Words → N7:0, B3:5
    - Bits → B3/0, N7:0/10, I:010/04, O:073/00

Note – The "/" generally means you are working at the bit level vs. the word level

→ *PLC-5 Systems*

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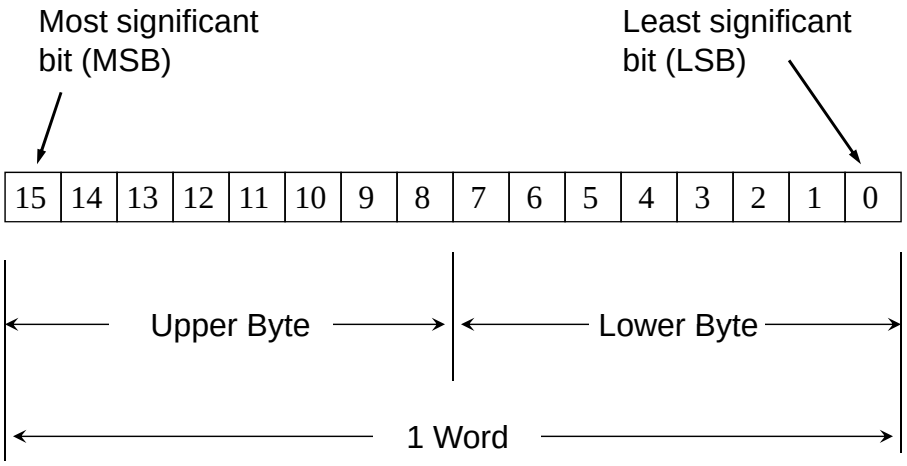
Bits, Bytes, and Words (continued)



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Bits, Bytes, and Words (continued)

- With respect to Allen-Bradley ControlLogix PLC's
  - 1 Word = 32 bits
  - DINT = 32 bits (Double Integer)
  - INT = 16 bits (Integer)
  - SINT = 8 bits (1 Byte)
  - BOOL = 1 bit (Boolean)

ControlLogix data types

→ ControlLogix Systems

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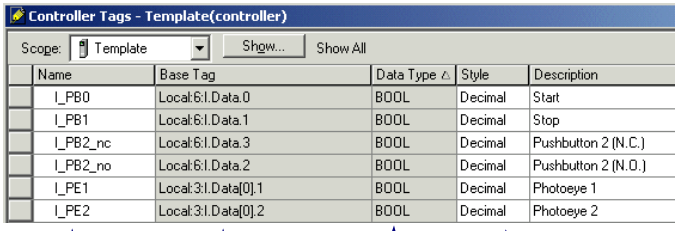
Bits, Bytes, and Words (continued)

Controller scoped tags (tag database):



Base address (real address)

Data type

Style (radix)

Alias tag (a pointer to a base address)

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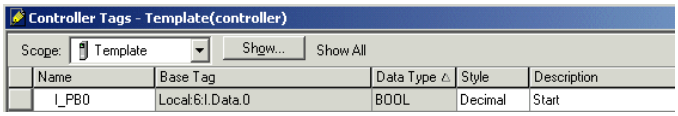
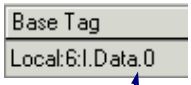
Bits, Bytes, and Words (continued)

Controller scoped tags (tag database):



This address represents a bit inside the PLCs memory (tag database)

Note – The 2nd "." in "Local:6:I.Data.0" generally means you are working at the bit level



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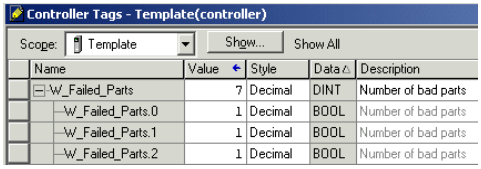
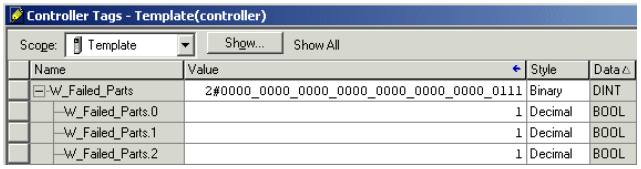
Bits, Bytes, and Words (continued)

The tag named “W_Failed_Parts” is a word (DINT):



Style set to “Decimal”



Style set to “Binary”

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Memory Options

- PLC systems use different types of memory technology, including:
  - RAM, Random Access Memory
  - ROM, Read Only Memory

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Memory Options (continued)

- RAM, Random Access Memory
  - RAM can be written to and read from
  - RAM Is volatile
    - Will lose memory contents when power is lost (if there is no battery backup)
  - PLC programs are typically stored in RAM

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Memory Options (continued)

- RAM, Random Access Memory (continued)
  - With respect to PLCs, RAM is usually battery backed using a lithium battery
  - Typical battery life is two to five years
  - Most PLCs use a capacitor to temporarily back up the RAM while the battery is being changed
    - In case there is a power failure while you are changing the battery!
    - Or the battery is only accessible by removing the processor module

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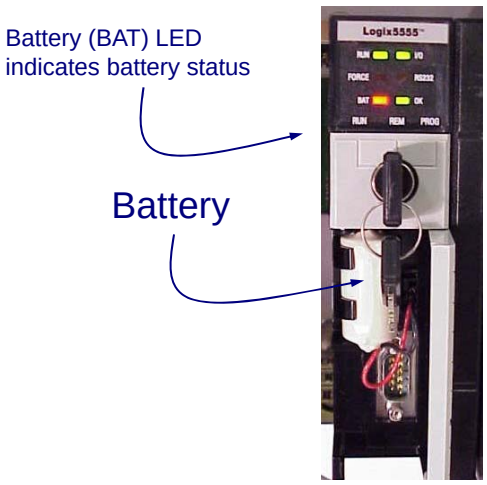
Memory Options (continued)



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Memory Options (continued)

- ROM, Read Only Memory
  - Is read only
  - Is nonvolatile
    - Will NOT lose memory contents when power is lost

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Memory Options (continued)

- ROM, Read Only Memory (continued)
  - Once programmed, a program stored in a ROM chip cannot be changed
  - The PLC manufacturer “burns” the PLC’s operating system (executive program) into ROM

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PLC Modules

- Most PLC systems are modular
- A module is a printed circuit board housed within an enclosure
- PLC modules slide into a chassis
- In general, you have to power down while inserting/removing modules from a chassis

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PLC Modules (continued)

- Be careful when handling modules:
  - Static electricity can damage sensitive circuits
  - Don't touch components or connector contacts
  - Store modules in anti-static bags

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PLC Modules (continued)

- Be careful when handling modules:

Electrostatic Discharge Damage

ATTENTION: Electrostatic discharge can damage integrated circuits or semiconductors if you touch backplane connector pins. Follow these guidelines when you handle the module:

- Touch a grounded object to discharge static potential
- Wear an approved wrist-strap grounding device
- Do not touch the backplane connector or connector pins
- Do not touch circuit components inside the module
- If available, use a static-safe work station
- When not in use, keep the module in its original static-shielded packaging

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PLC Modules (continued)

- PLC-5 System Example:

→ *PLC-5 Systems*

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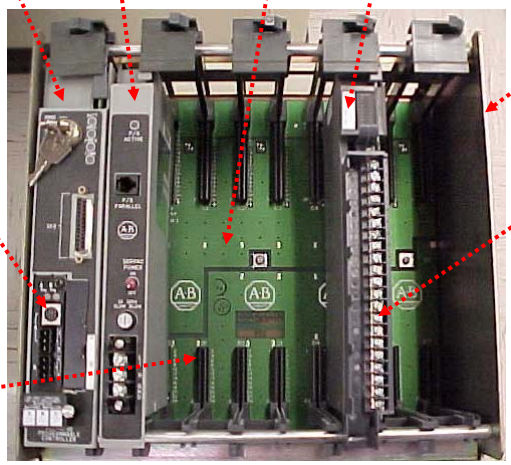
PLC Modules (continued)



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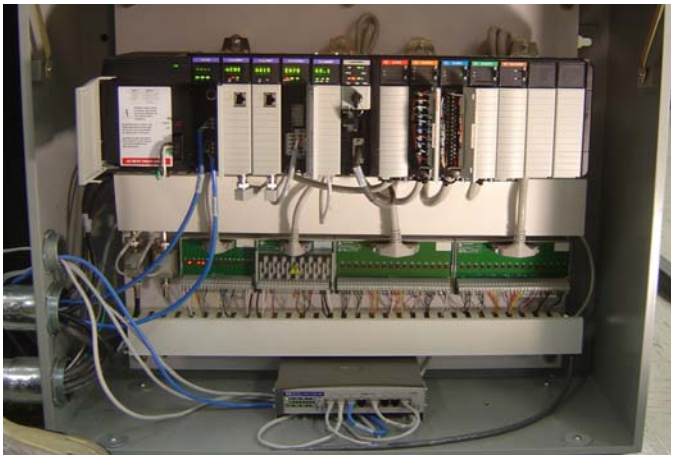
PLC Modules (continued)

- ControlLogix System Example



→ *ControlLogix Systems*

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PLC Modules (continued)

- ControlLogix Modules

→ *ControlLogix Systems*

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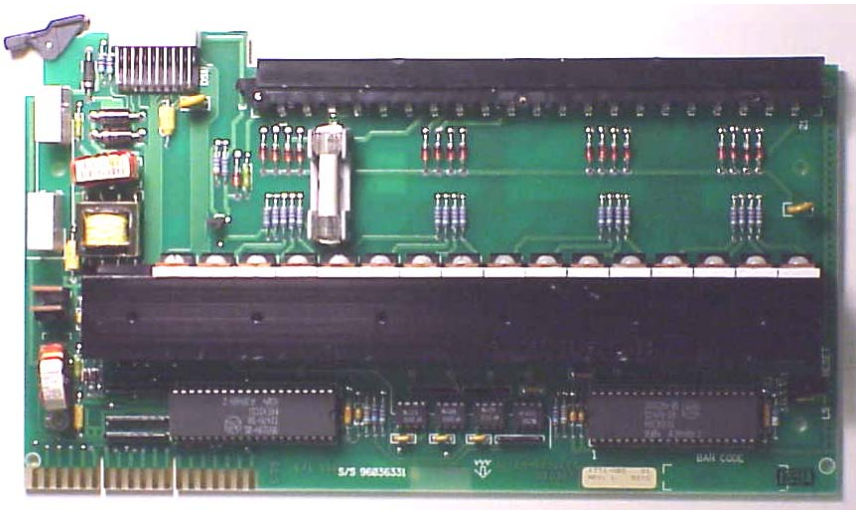
PLC Modules (continued)



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PLC Modules (continued)

- Advantages of modularity:
  - Modular systems are easier to troubleshoot and thus help minimize manufacturing downtime
  - Modular systems can be expanded if the system grows in the future
  - Modularity makes it more economical to upgrade the system (e.g., upgrade from a PLC-5/15 to a PLC-5/30 processor)

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Slots

- A PLC module slides into a slot
  - A slot is a connector that resides on the backplane.
- The backplane is part of the chassis
  - The backplane is a large printed circuit board containing the system data bus, address bus, power bus, and connectors (slots).
- Most PLC modules take up one slot
  - Some modules consume two slots

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Terminal Blocks

- A terminal block is a collection of screw terminals used to wire field devices to PLC input/output (I/O) modules.

SLC-500 terminal block

→ *SLC-500 Systems*

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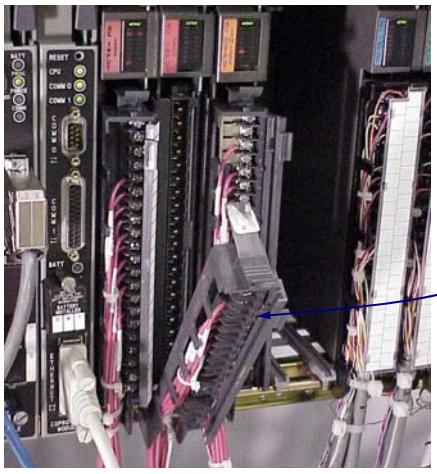
Terminal Blocks (continued)

- PLC-5 Swing Arm System:



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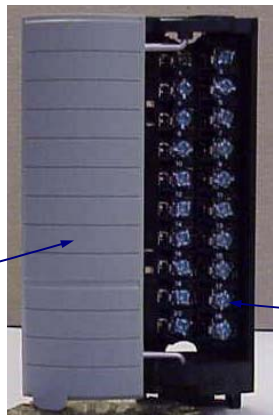
Terminal Blocks (continued)

- ControlLogix Removable Terminal Block (RTB)



→ *ControlLogix Systems*

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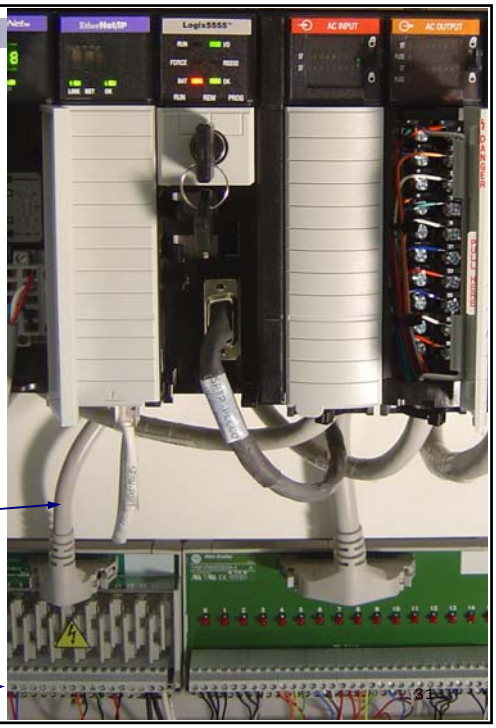
ControlLogix Removable Terminal Blocks (cont'd)



Pre-wired cable system

Screw Terminals for field devices

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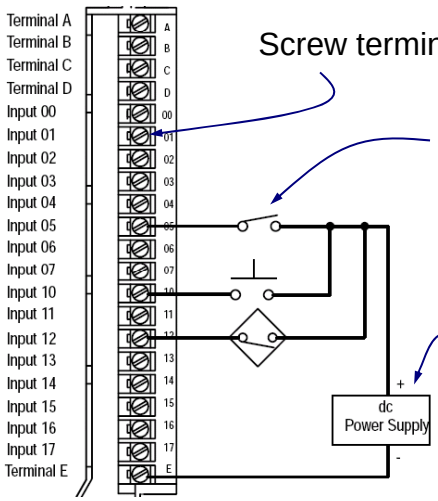
Terminal Blocks (continued)

- Wiring field devices to a PLC-5 terminal block:



Screw terminals

Field devices

Notes:

A 16 point DC input module is shown here

Terminals are numbered in Octal

An external DC power supply is required

→ *PLC-5 Systems*

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Fixed vs. Modular Systems

- Fixed systems:
  - Are not modular
    - The CPU, power supply, and inputs/outputs (I/O) are built into a single unit
  - Are typically used for simple applications that have limited amounts of I/O and future expansion is not anticipated
  - Are more difficult and time consuming to troubleshoot and repair
  - Are less expensive compared to modular systems

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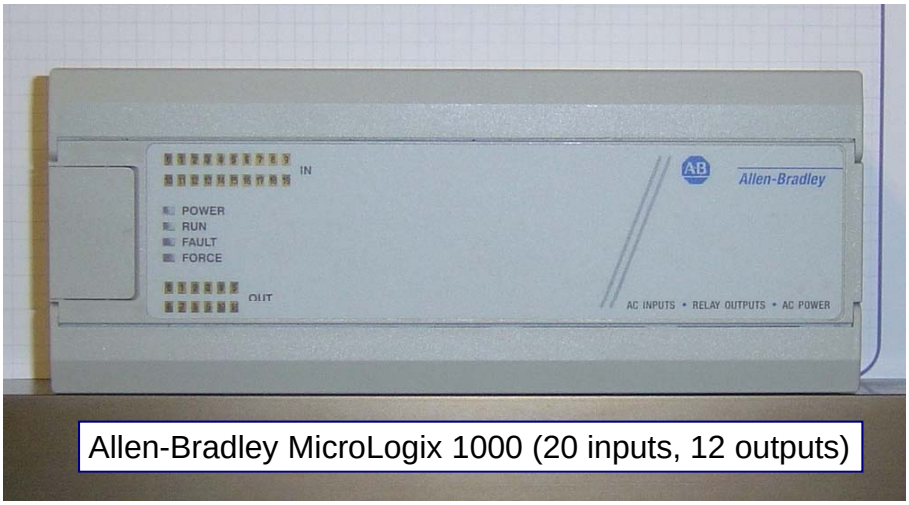
Fixed vs. Modular Systems (cont'd)

- Fixed PLC System Example:



Allen-Bradley MicroLogix 1000 (20 inputs, 12 outputs)

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Fixed vs. Modular Systems (cont'd)

- Fixed PLC System Example:

Allen-Bradley MicroLogix 1000 (20 inputs, 12 outputs)

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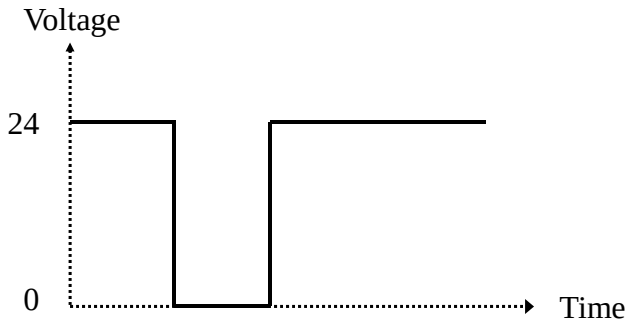
Discrete vs. Analog

- A discrete (also called "digital") input or output is either fully ON or fully OFF – only two states are possible.



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Discrete vs. Analog (continued)

- Discrete PLC inputs are commonly wired to:
  - Pushbuttons and selector switches
  - Thumbwheel switches
  - Mechanical limit switches
  - Photoelectric sensors
  - Inductive proximity sensors
  - Relay contacts
  - Discrete outputs from other programmable devices (PLCs, robot controllers, CNC controllers, etc.)
- Discrete PLC outputs are commonly wired to:
  - Pilot lights
  - Numeric displays
  - Solenoids
  - Relays (coil)
  - Motor starters (coil)
  - Discrete inputs of other programmable devices (PLCs, robot controllers, CNC controllers, etc.)

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Discrete vs. Analog (continued)

- Discrete Example:
  - Suppose an inductive proximity switch is wired to a discrete PLC DC input module
  - The output of the proximity switch is either on or off
  - The PLC input is either switched to COM or switched to +24 VDC

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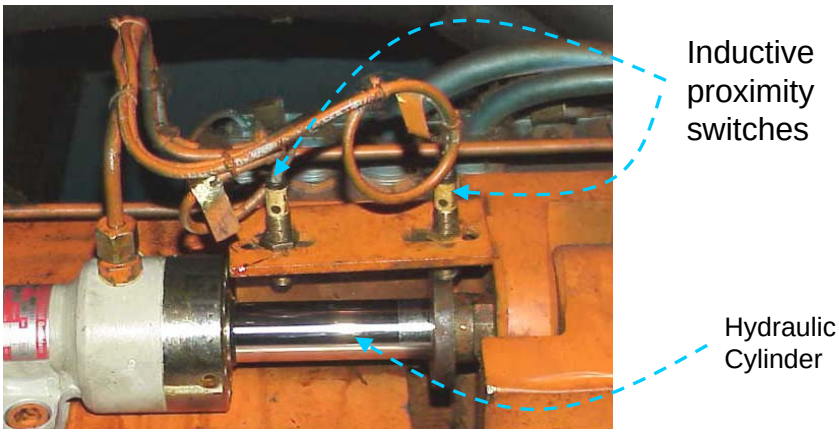
Discrete vs. Analog (continued)

- Discrete Example Continued:



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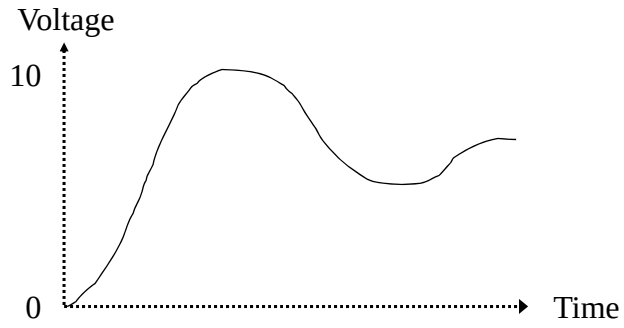
Discrete vs. Analog (continued)

- An analog (continuous) input or output can take on ANY value, usually within a fixed range of values.



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Discrete vs. Analog (continued)

- Typical PLC analog inputs:
  - Pressure transducers
  - Flow transducers
  - Position transducers
  - Temperature transducers
  - etc.

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Discrete vs. Analog (continued)

- Typical PLC analog outputs:
  - Hydraulic servo valves (proportional valves)
    - The analog voltage is wired to an amplifier. The amplifier controls the valve.
  - Variable frequency drives (control the speed of an electric motor)
  - Analog meters (for display purposes)

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Discrete vs. Analog (continued)

- Common analog ranges:
  - 0 to 5 v,
  - 0 to 10 v,
  - -10 to +10 v,
  - 4 to 20 ma

→ *PLC-5 Systems*

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Discrete vs. Analog (continued)

- Analog Example:
  - A pressure transducer (sensor) measures pressures ranging from 0 to 1000 psi. The transducer generates a corresponding analog output of 0 to 5 volts dc.
  - The output of the transducer is linear – there is a straight line relationship between the pressure and the output voltage.

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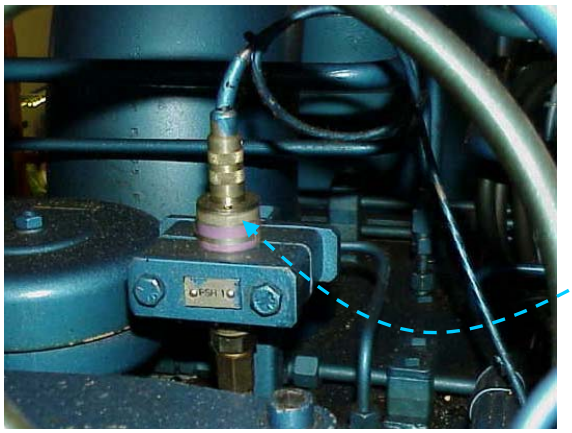
Discrete vs. Analog (continued)

- Analog Example Continued:



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