




PLC Fundamentals – Common PLC Terminology

MET 382
Controls & Instrumentation
for Automation

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Topics

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



Logix5550

RUN I/O

RS232

BAT OK

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PLC vs. PC

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



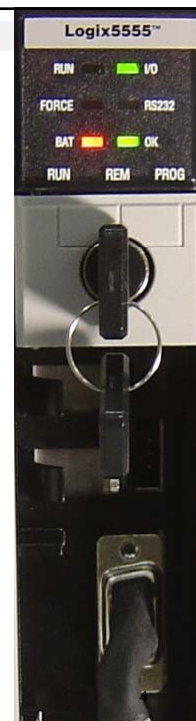
In this class, PC = Personal Computer



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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 (**B**inary **D**igit):
 - 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

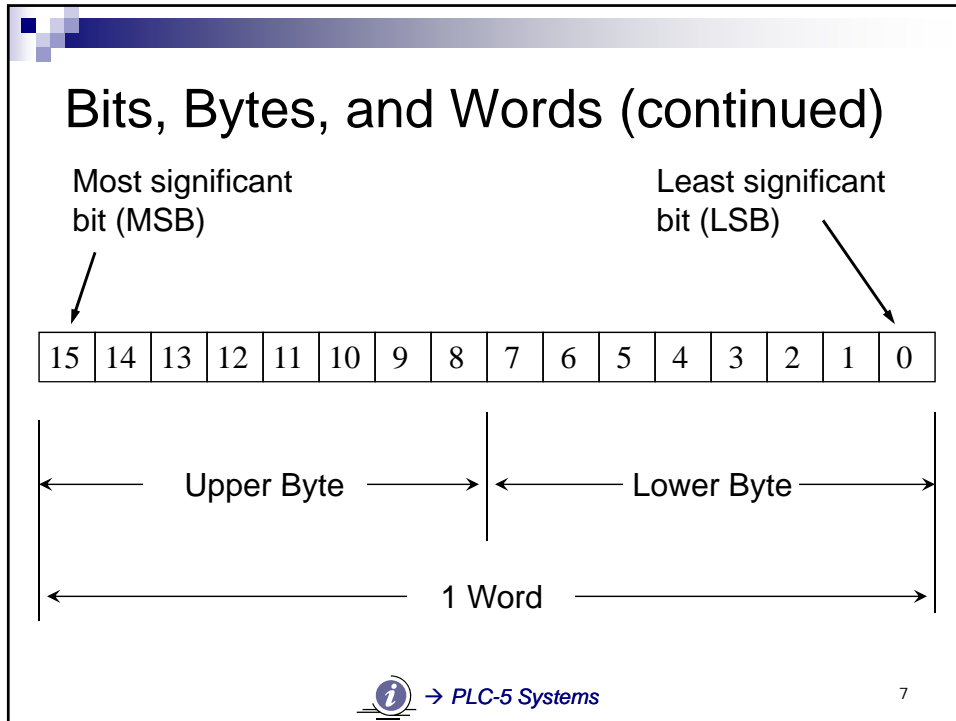


Note – The “/” generally means you are working at the bit level vs. the word level



→ PLC-5 Systems

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- ## Bits, Bytes, and Words (continued)
- 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
- 8

Bits, Bytes, and Words (continued)

Controller scoped tags (tag database):

Controller Tags - Template(controller)				
Scope: Template Shgw... Show All				
Name	Base Tag	Data Type	Style	Description
I_PB0	Local:6:I.Data.0	BOOL	Decimal	Start
I_PB1	Local:6:I.Data.1	BOOL	Decimal	Stop
I_PB2_nc	Local:6:I.Data.3	BOOL	Decimal	Pushbutton 2 (N.C.)
I_PB2_no	Local:6:I.Data.2	BOOL	Decimal	Pushbutton 2 (N.O.)
I_PE1	Local:3:I.Data[0].1	BOOL	Decimal	Photoeye 1
I_PE2	Local:3:I.Data[0].2	BOOL	Decimal	Photoeye 2

Bits, Bytes, and Words (continued)

Controller scoped tags (tag database):

Controller Tags - Template(controller)				
Scope: Template Shgw... Show All				
Name	Base Tag	Data Type	Style	Description
I_PB0	Local:6:I.Data.0	BOOL	Decimal	Start

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

Base Tag
Local:6:I.Data.0

Bits, Bytes, and Words (continued)

The tag named "W_Failed_Parts" is a word (DINT):

Controller Tags - Template(controller)				
Scope: Template		Show...	Show All	
Name	Value	Style	Data z.	Description
W_Failed_Parts	7	Decimal	DINT	Number of bad parts
W_Failed_Parts.0	1	Decimal	BOOL	Number of bad parts
W_Failed_Parts.1	1	Decimal	BOOL	Number of bad parts
W_Failed_Parts.2	1	Decimal	BOOL	Number of bad parts

Style set to "Decimal"

Controller Tags - Template(controller)				
Scope: Template		Show...	Show All	
Name	Value	Style	Data z.	
W_Failed_Parts	2#0000_0000_0000_0000_0000_0000_0111	Binary	DINT	
W_Failed_Parts.0		1 Decimal	BOOL	
W_Failed_Parts.1		1 Decimal	BOOL	
W_Failed_Parts.2		1 Decimal	BOOL	

Style set to "Binary"



Memory Options

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

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

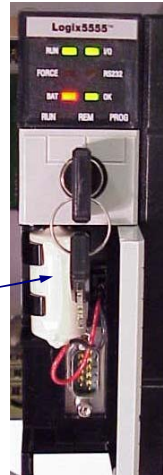
 - Most PLCs use a capacitor to temporarily back up the RAM while the battery is being changed
 - In case there is a power failure while you are changing the battery!
 - Or the battery is only accessible by removing the processor module

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Memory Options (continued)

Battery (BAT) LED
indicates battery status

Battery



 → ControlLogix Systems

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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)

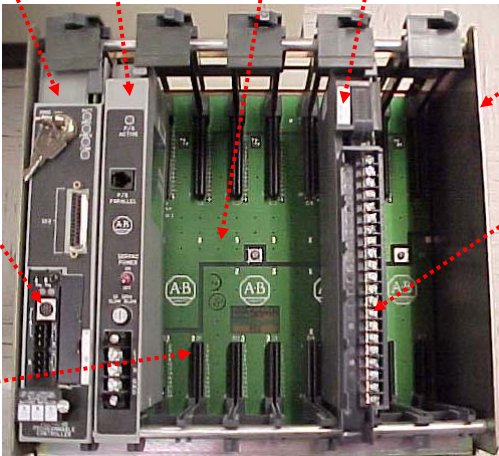
- PLC-5 System Example:



 → PLC-5 Systems

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PLC Modules (continued)




Processor module (CPU) Power Supply Backplane I/O Module

Chassis

Connect programming device here

Connect field device here to terminal block (swing arm)

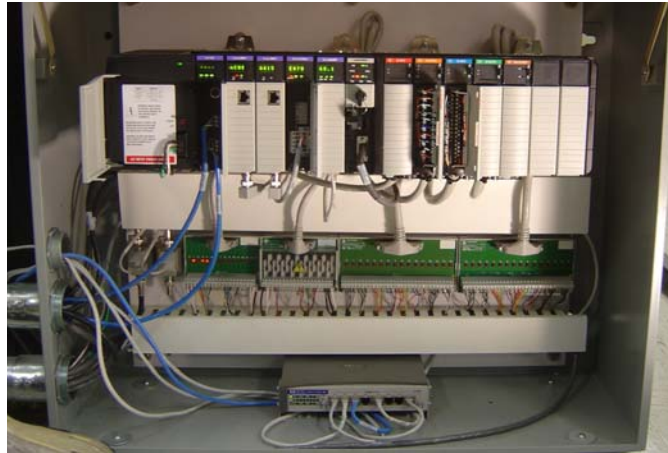
Spare Slot

 → PLC-5 Systems

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PLC Modules (continued)

- ControlLogix System Example



 → ControlLogix Systems

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PLC Modules (continued)

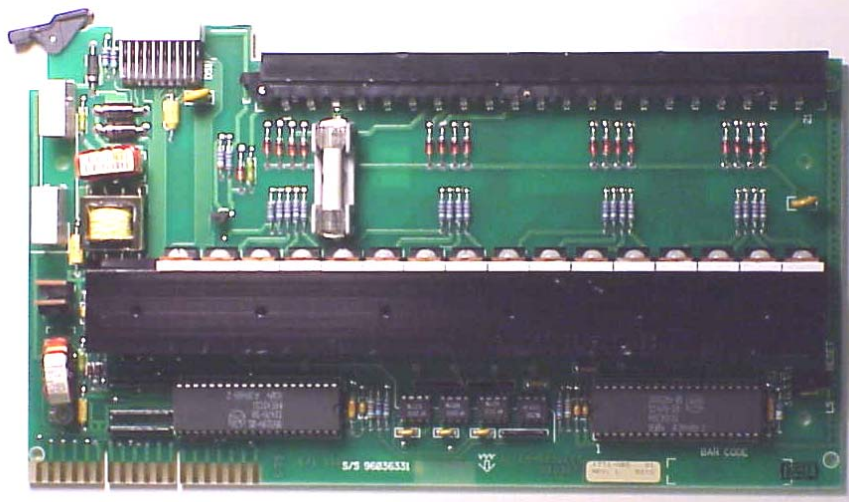
- ControlLogix Modules



 → ControlLogix Systems

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PLC Modules (continued)



 → PLC-5 Systems

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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

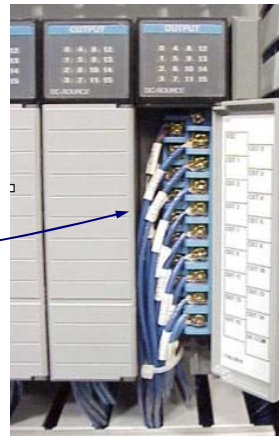
- A PLC module slides into a slot
 - A slot is a connector that resides on the backplane.
- The backplane is part of the chassis
 - The backplane is a large printed circuit board containing the system data bus, address bus, power bus, and connectors (slots).
- Most PLC modules take up one slot
 - Some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



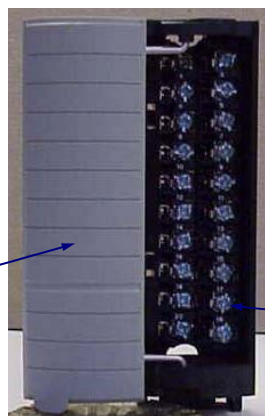
Swing arm

 → PLC-5 Systems

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Terminal Blocks (continued)

- ControlLogix Removable Terminal Block (RTB)



Handle

Screw Terminals


 → ControlLogix Systems


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ControlLogix Removable Terminal Blocks (cont'd)

Pre-wired cable system

Screw Terminals for field devices

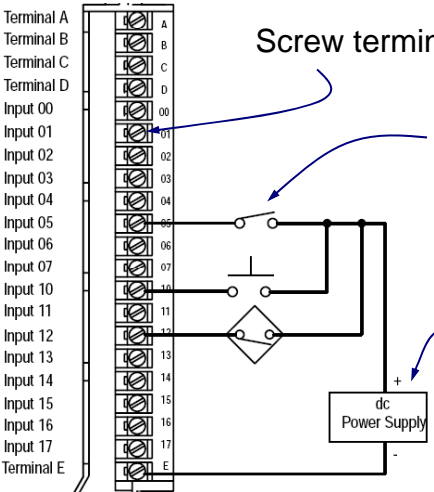


 → ControlLogix Systems

Detailed description: This slide shows a photograph of a ControlLogix terminal block assembly. The top part of the image shows a rack-mounted terminal block with several white pre-wired cables plugged into it. Below this, a close-up view shows the screw terminals on a green PCB, with a yellow warning triangle indicating high voltage. The text 'Pre-wired cable system' has a blue arrow pointing to the top part of the assembly, and 'Screw Terminals for field devices' has a blue arrow pointing to the bottom part.

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 32

Detailed description: This slide contains a wiring diagram for a PLC-5 terminal block. The terminal block is shown vertically with terminals labeled from Terminal A to Terminal E, and Input 00 to Input 17. A circuit diagram is overlaid on the terminals, showing a switch connected to Input 01 and Input 02, and a diode connected to Input 11 and Input 12. A DC power supply is connected to the terminals, with the positive terminal (+) connected to Input 14 and the negative terminal (-) connected to Terminal E. The text 'Screw terminals' has a blue arrow pointing to the terminal block, and 'Field devices' has a blue arrow pointing to the switch and diode symbols. The 'Notes' section provides additional information about the module and power requirements.

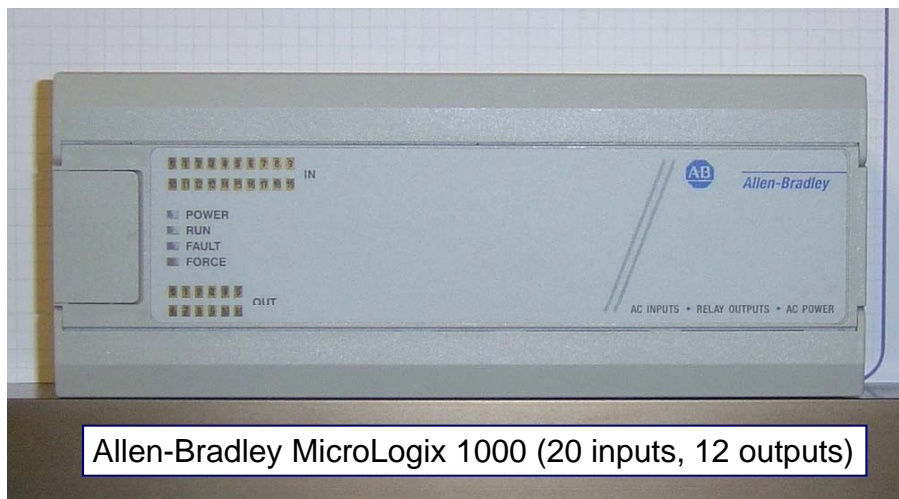
Fixed vs. Modular Systems

- 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:

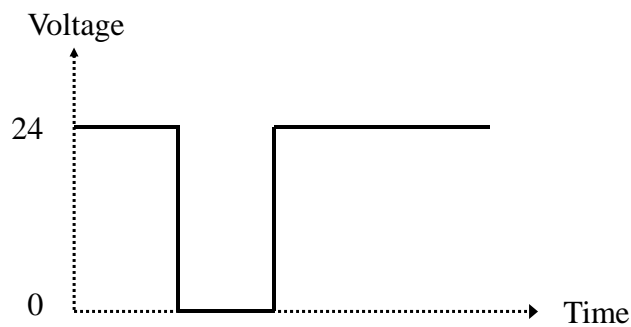


Allen-Bradley MicroLogix 1000 (20 inputs, 12 outputs)

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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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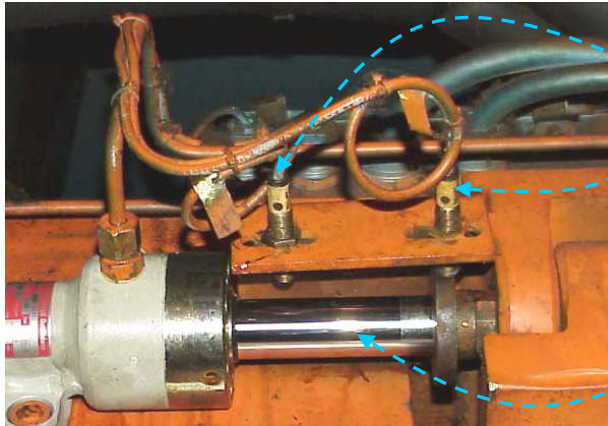
Discrete vs. Analog (continued)

- 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:



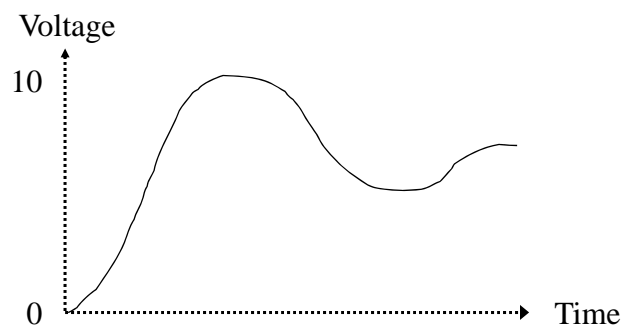
Inductive proximity switches

Hydraulic Cylinder

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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)

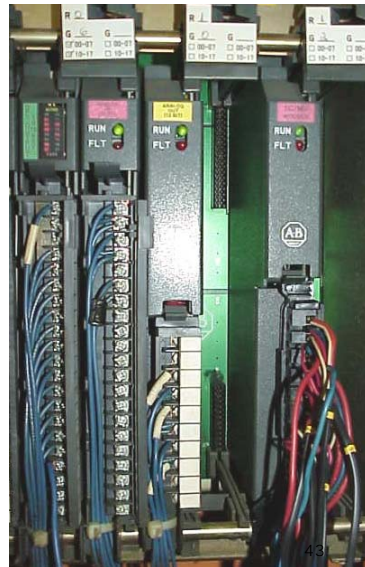
- Typical PLC analog outputs:
 - Hydraulic servo valves (proportional valves)
 - The analog voltage is wired to an amplifier. The amplifier controls the valve.
 - Variable frequency drives (control the speed of an electric motor)
 - Analog meters (for display purposes)

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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

Discrete vs. Analog (continued)

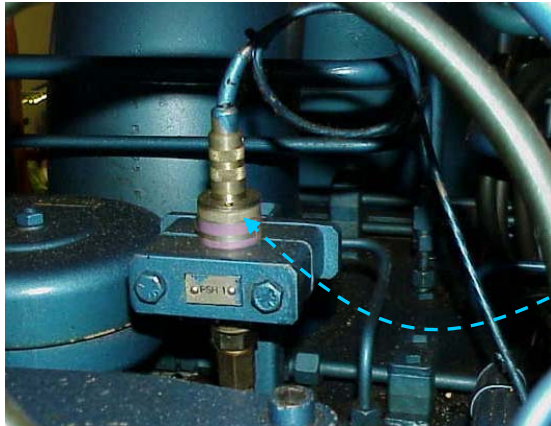
■ Analog Example:

- 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:



Pressure
transducer

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