

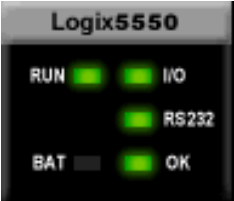
PLC Fundamentals – PLC System Components

MET 382
Controls & Instrumentation
for Automation

Spring '08
T.E. Kostek

Topics

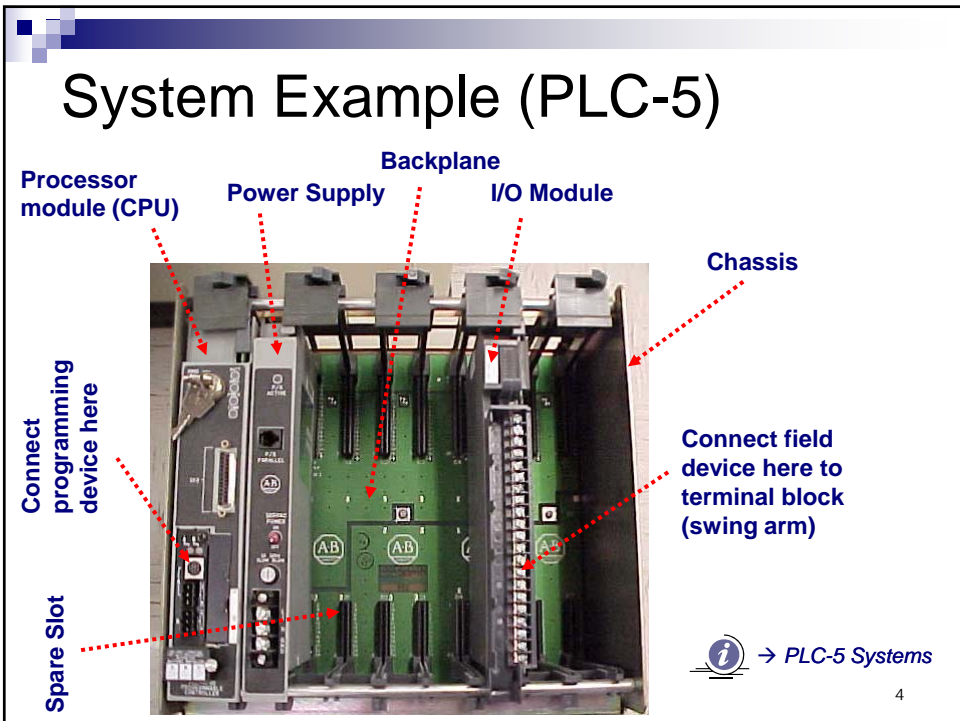
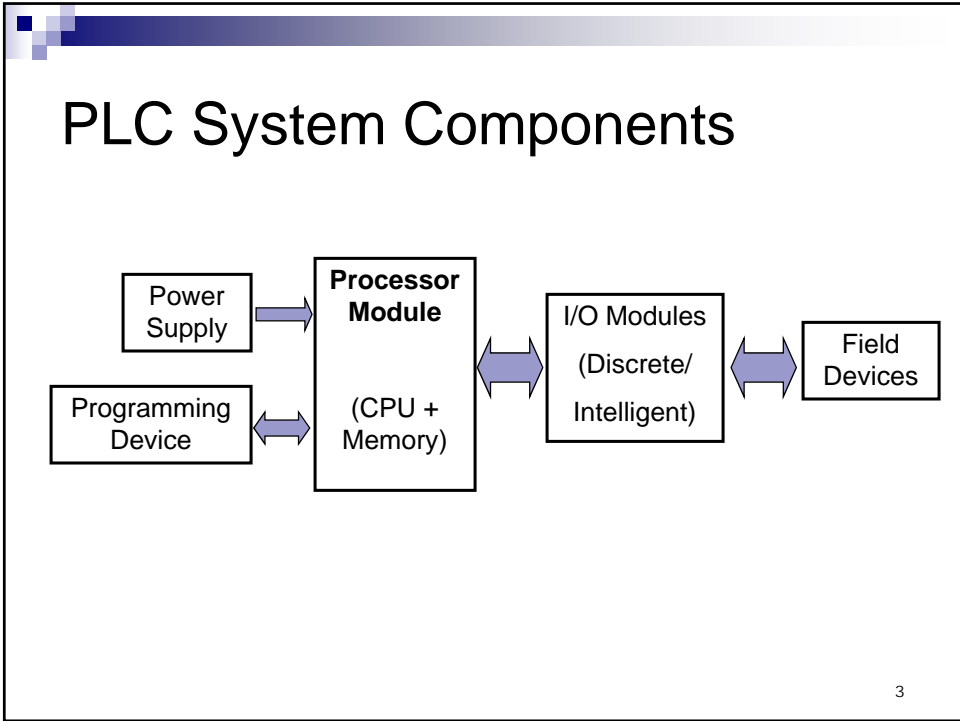
- Processor module – CPU
- Processor module – memory
- Power supply
- Programming device
- I/O Modules



Logix5550

RUN	■	I/O	■
		RS232	■
BAT	■	OK	■

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Processor Module - CPU

Processor Module

(CPU + Memory)

- Executes the user's program
- Generally, one processor module per chassis
 - ControlLogix systems support multiple *controllers* per chassis
- On many systems (such as PLC-5 and SLC-500s), the processor must be physically located in the left-most slot of the chassis
 - In a ControlLogix system, the controller (or controllers) can be located in any available slot!

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Processor Module - Memory

Processor Module

(CPU + Memory)

- Stores the user's program
- Memory Capacity
 - Memory capacity is usually specified in terms of K units $\rightarrow 1K = 2^{10} = 1,024$
 - Examples:
 - 1K bytes = 1,024 bytes
 - A PLC-5/30 has 32K words of memory:
 - 32K words = 32 x 1,024 = 32,768 words

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Processor Module - Memory

Processor Module

(CPU + Memory)

- Memory Capacity Details ...

Name	Abbr.	Size
Kilo	K	$2^{10} = 1,024$
Mega	M	$2^{20} = 1,048,576$
Giga	G	$2^{30} = 1,073,741,824$
Tera	T	$2^{40} = 1,099,511,627,776$
Peta	P	$2^{50} = 1,125,899,906,842,624$
Exa	E	$2^{60} = 1,152,921,504,606,846,976$
Zetta	Z	$2^{70} = 1,180,591,620,717,411,303,424$
Yotta	Y	$2^{80} = 1,208,925,819,614,629,174,706,176$

1 kilobyte (KB) = 1,024 bytes (about a thousand bytes)

1 megabyte (MB) = 1,048,576 bytes (about a million bytes)

1 gigabyte (GB) = 1,073,741,824 bytes (about a billion bytes)

Note: 15000 KB = 15 MB = 15 * 1,048,576 Bytes

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Processor Module - Memory (cont'd)

- General Memory Layout

Data Table

Program Area

Input Image Table
Output Image Table
Internal control relays
Registers (words)
Timers/Counters
User's Program

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Processor Module – Example

3 Position Key Switch (PROG, REM, RUN)

Status Indicators

Communication Ports (“Channels”)

Optional memory module slot

Battery

Channel 0: RS-232 Serial Port

Channel 1A: Data Highway Plus (Default)

Channel 1B: Remote I/O (Default)

→ PLC-5 Systems

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Power Supply

Power Supply

- The PLC power supply provides power (e.g., 5 volts DC) to all of the modules residing in the PLC chassis. These include:
 - Processor module
 - I/O modules
 - Communications modules
- Common form factors:
 - A separate module installed in the chassis
 - Chassis mounted (e.g., Allen-Bradley 1771-P7 Supply)
 - Integral to processor (CPU) module

→ DC control systems use an additional external power supply (e.g., 24 volts DC) to power DC field devices.

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Power Supply (cont'd)

- Typical **inputs**: 120 VAC, 220 VAC, and 24 VDC
 - 120 VAC is the most common
- Typical (internal) **outputs**: 5 VDC
 - SLC-500 power supplies also provide 24 VDC (internal)
 - ControlLogix power supplies provide:
 - 5.1 VDC, 24 VDC, 3.3 VDC, and 1.2 VDC (internal)
- Some power supplies provide a 24 VDC external (user) output which can be used to power up a limited number of field devices

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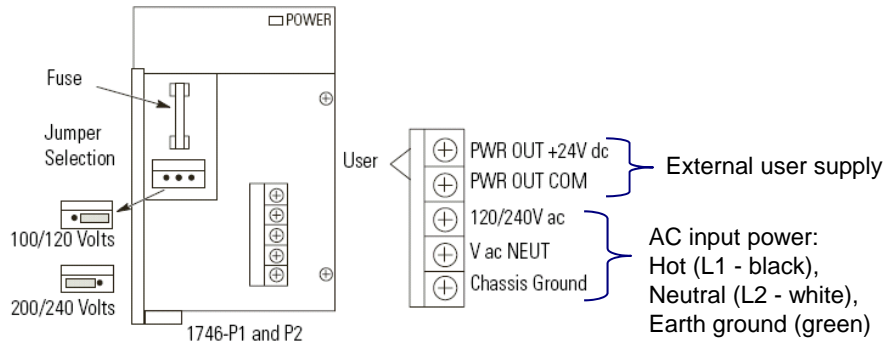
Power Supply (cont'd)

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 - 5.1 VDC, 24 VDC, 3.3 VDC, and 1.2 VDC
- Some power supplies provide a 24 VDC external (user) output which can be used to power up a limited number of field devices
 - Most user supplies do not provide enough current for medium to large applications
 - See example system on next slide ...

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Power Supply (cont'd)

- SLC-500 power supply which provides a 24 VDC external (user) output:



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Power Supply (cont'd)

- Never exceed the power supply's maximum current capacity!
 - Each module consumes a maximum amount of current from the supply
 - Use a spreadsheet to perform a "power budget" calculation
 - Build in extra capacity for future expansion
 - SLC-500 software (RSLogix500) calculates the amount of current used after you tell the software which module resides in each slot

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Power Supply (cont'd)

- Example – PLC-5 module power supply

Processor module must be placed in left most slot

LED status indicator

Connector for parallel supplies

On/off switch

Fuse

Incoming power (120v AC)
(L1 – Hot, L2 – Neutral,
GND – Earth ground)

→ PLC-5 Systems 15

Power Supply (cont'd)

- Example – PLC-5 chassis mount power supply

Incoming power (120v AC)

On/off switch

Fuse

110/220 VAC Selector switch


LED status indicator


→ PLC-5 Systems 16

Power Supply (cont'd)

- Example – PLC-5 chassis mount power supply

The 1771-P7 power supply attached to a 4 slot chassis →




 → PLC-5 Systems


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Power Supply (cont'd)


- Example – ControlLogix power supply

ControlLogix power supply in a 13 slot chassis



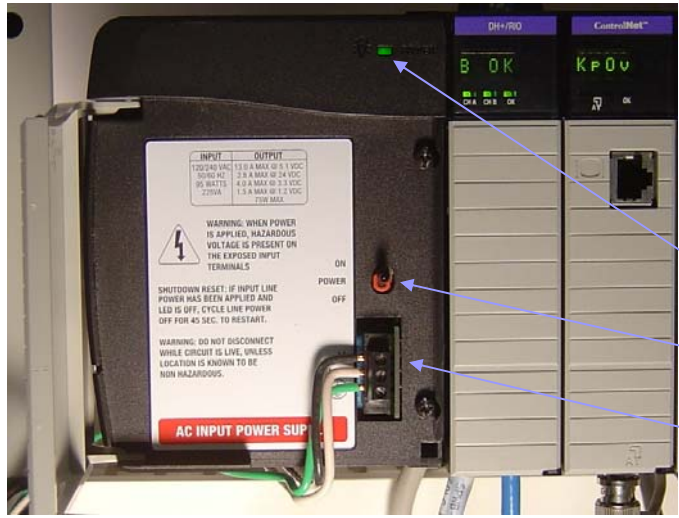
 → ControlLogix Systems

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 → ControlLogix Systems

Power Supply (cont'd)

- Example – ControlLogix power supply



The image shows a ControlLogix power supply unit. On the left, there is a white label with technical specifications and safety warnings. The specifications table is as follows:

INPUT	OUTPUT
120/240 VAC 1.5 A MAX @ 50/60 VDC	2.8 A MAX @ 24 VDC
300 WATT	4.0 A MAX @ 12 VDC
270 WATT	1.5 A MAX @ 15 VDC
	7.50 A MAX

Below the table, there are several warning sections:

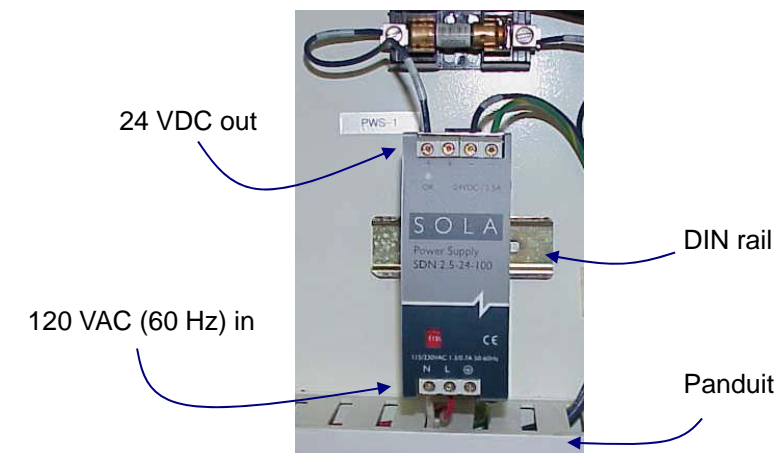
- WARNING:** WHEN POWER IS APPLIED, HAZARDOUS VOLTAGE IS PRESENT ON THE EXPOSED INPUT TERMINALS.
- SHUTDOWN RESET:** IF INPUT LINE POWER HAS BEEN APPLIED AND LED IS OFF, CYCLE LINE POWER OFF FOR 45 SEC. TO RESTART.
- WARNING:** DO NOT DISCONNECT WHILE CIRCUIT IS LIVE, UNLESS LOCATION IS KNOWN TO BE NON HAZARDOUS.

On the right side of the unit, there is a green LED status indicator, a red on/off switch, and a terminal block for incoming power. Labels with arrows point to these components: "LED status indicator", "On/off switch", and "Incoming power (120v AC)".

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Power Supply (cont'd)

- Example – 24 VDC DIN rail mountable power supply for field devices:



The image shows a SOLA 24 VDC DIN rail mountable power supply. It is a blue and silver unit mounted on a DIN rail. Labels with arrows point to various parts: "24 VDC out" points to the output terminals at the top; "120 VAC (60 Hz) in" points to the input terminals at the bottom; "DIN rail" points to the mounting rail; and "Panduit" points to the base of the unit. The unit is labeled "PWS-1" and "SOLA Power Supply SDN 2.5-24-100".

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Programming Device

Programming Device

- The programming device is used to:
 - Create PLC programs (offline and online)
 - Download PLC programs
 - Upload PLC programs
 - Monitor PLC programs and CPU diagnostics
 - Edit existing programs
 - Comment PLC programs
 - Print PLC programs
 - Troubleshoot the system
 - And more ...

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Programming Device (cont'd)

- Programming device options:
 - Dedicated industrial terminals
 - Allen-Bradley T3
 - Small hand-held devices
 - Allen-Bradley 1747-PT1 Hand-Held Terminal (HHT)
 - Can be used with some SLC-500 processors

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Programming Device (cont'd)

- Programming device options (continued):
 - Personal computers with proprietary PLC programming software
 - DOS-based software
 - Allen-Bradley's APS software (for SLC-500's)
 - Allen-Bradley's 6200 series software (for PLC-5's)
 - A.I. Series Programming Software

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Programming Device (cont'd)

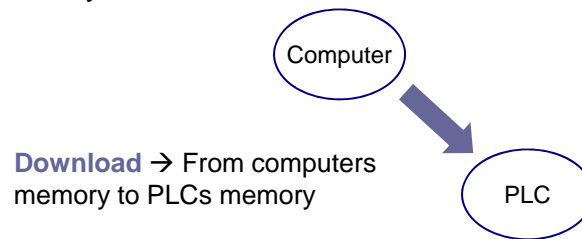
- Programming device options (continued)
 - Windows-based software
 - Allen-Bradley's **RSLogix 5** (for PLC-5's)
 - Allen-Bradley's **RSLogix 500** (for SLC-500's and MicroLogix processors)
 - Allen-Bradley's **RSLogix 5000** (for ControlLogix processors)

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Programming Device (cont'd)

■ Download vs. Upload

- Using a programming device, a PLC program can be **downloaded** (copied) from the computers memory to the PLCs memory.



Note: In our laboratory, the program is downloaded to the Logix 5555 controller residing in slot #5.

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Programming Device (cont'd)

■ During the download process:

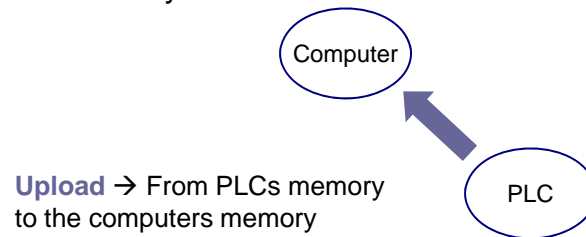
- The program currently loaded in the PLCs memory will be erased!
- The PLC will be placed in the program mode (generally, all outputs are switched OFF).
 - The line or machine controlled by the PLC shuts down!
- Only the ladder rungs are generally downloaded.
 - Program documentation (such as descriptions, rung comments, etc.) is not downloaded. Documentation is only stored on disk.

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Programming Device (cont'd)

■ Download vs. Upload

- Using a programming device, a PLC program can be **uploaded** (copied) from the PLCs memory to the computers memory.



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Programming Device (cont'd)

■ During the upload process:

- The PLC program remains unchanged and can remain in the run mode.
- The PLC program is copied into the PCs memory + hard disk.

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Programming Device (cont'd)

■ Online vs. Offline

□ Offline programming:

- A programming device (for example, a computer running the RSLogix 5000 software) is considered **offline** when it is not communicating with a PLC.
- In the offline mode, the computer may or may not be connected to the PLC via a communications cable.
- Offline programming can be accomplished anywhere you can use your computer.
- Programs created offline are stored on the computers hard drive.

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Programming Device (cont'd)

■ Online vs. Offline

□ Online programming:

- A programming device (for example, a computer running the RSLogix 5000 software) is considered **online** when it is communicating with a PLC.
- In the online mode, the computer must be connected to the PLC via a communications cable.
- Online programming is used to troubleshoot (monitor) a PLC program and/or edit (change) the PLC program while it is running.
- While online, the PLC can be placed in the run mode or the program mode.

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I/O Modules

I/O Modules
(Discrete/
Intelligent)

- I/O modules interface input and output field devices to the PLC
- I/O modules can be classified into:
 - Discrete I/O modules
 - Intelligent I/O modules
 - Sometimes called “Special” modules

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I/O Modules - Discrete **Input** Options

- Number of input points (density):
 - 8, 16, or 32
- Type of electrical input:
 - AC (24v, 110v, & 220v)
 - DC
 - Voltage ranges: (12, 24, 48, up to 125 v)
 - Sinking or Sourcing

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I/O Modules - Discrete Output Options

- Number of output points (density):
 - 8, 16, or 32
- Type of electrical output:
 - Relay (contact outputs)
 - AC (triac)
 - (24v, 110v, & 220v)
 - DC (transistor)
 - Voltage ranges: (12, 24, 48, up to 125 v)
 - Sinking or Sourcing

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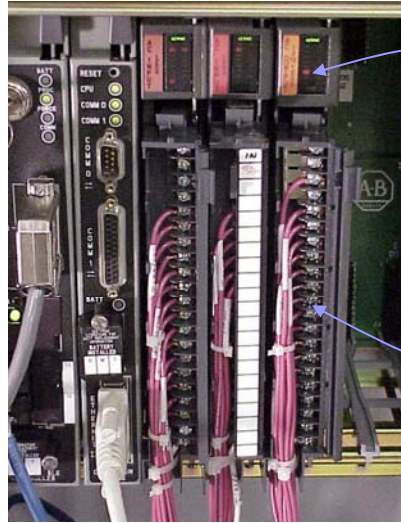
I/O Modules - Discrete Output Options (cont'd)

- Relay output modules:
 - (+) Switch DC or AC (versatile)
 - (+) Handle higher load currents
 - (-) Are slower (electromechanical device)
 - (-) Less reliable than a solid state switch (transistor)
 - (-) Shorter life expectancy

(+) Advantage, (-) Disadvantage

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Discrete I/O Modules – PLC-5 Example



LED status indicators

Swing arm with screw terminals

 → PLC-5 Systems

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Discrete I/O Modules – ControlLogix Example

 → ControlLogix Systems

LED status indicators

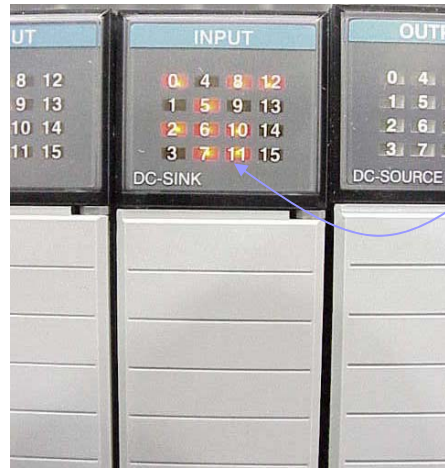
Module lock

Removable terminal block



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Discrete I/O Modules – SLC-500 Example



LED status indicators on a SLC-500 DC input module.

This module supports up to 16 inputs which are numbered 0 through 15 (not 1 through 16!)

 → SLC-500 Systems

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I/O Modules – Intelligent I/O Modules

- Used for special signals and special applications which are beyond the scope of discrete I/O modules
- Generally have their own CPU & memory
- Are typically more expensive than discrete modules
- 5 volt power supply consumption is usually higher compared to discrete modules

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I/O Modules – Intelligent I/O Module Examples

- Analog input modules (1771-IFE)
- Analog output modules (1771-OFE)
- Thermocouple input modules (1771-IXE)
- BASIC modules (1771-DB)
- High speed counter modules (1771-VHSC)
- etc.



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I/O Modules – Producer/Consumer Model

- In a ControlLogix PLC system, I/O modules communicate with the Logix controller using the producer/consumer model.
- **Input** modules produce data for the controller to consume.
- **Output** modules consume data produced by the controller.



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I/O Modules – Producer/Consumer Model

