Chapter 4: Input/Output Modules and Installation
Input/Output Modules
Learning objectives

- Understand
  - Wiring of typical sensors and actuators to PLC I/O modules
  - Surge protection for certain types of devices
  - Typical control cabinet layout
  - Typical installation wiring
Input/Output Modules

Overview

- **Input/Output (I/O) Modules** provide Physical Interface between
  - PLC Processor and
  - Field Devices:
    - Switches, Lamps, Valves etc...

- **Common Characteristics of I/O Modules**
  - **Removable Terminal Blocks** (Retractable)
    - Wiring is connected to the terminal block
    - Terminal block is plugged into the module
  - **Isolation**
    - Isolates field wiring from the PLC internal circuitry
      - PLC power supply provides low-voltage power unlike a typical field wiring
  - **Diagnostic Indicators**
    - Discrete Input modules display an indicator for each input channel that is on
    - Discrete Output modules display an indicator for each output channel that is on
I/O modules provide isolation between field wiring and PLC internal circuitry:
- Ground loops
- Noisy electrical signals
- Fault on I/O wiring

Isolation prevents events from interfering with the PLC and causing a module failure.
Input/Output Modules

Sinking & Sourcing

- What is Sinking and Sourcing?
  - The flow of current (power) when the I/O device is active

- An Output Device is designated as Sourcing if current flows OUT when the output device is active

- An Output Device is designated as Sinking if current flows IN when the output device is active
Input/Output Modules
Sinking & Sourcing

- What is Sinking and Sourcing?
  - The flow of current (power) when the I/O device is active

- An Input Device is designated as Sourcing if current flows OUT when the output device is active

- An Input Device is designated as Sinking if current flows IN when the output device is active
A Sourcing field Sensor is usually connected to a PLC input why?

- **Sourcing Field Sensor** connected to **Sinking PLC Input**
- **Sinking Field Sensor** connected to **Sourcing PLC Input**

- **Sourcing PLC Output** connected to **Sinking Field Device**
- **Sinking PLC Output** connected to **Sourcing Field Device**

Arrows indicate the direction of the current flow.
Input/Output Modules

Focus

- Primarily concern with sinking PLC inputs and sourcing PLC outputs since that is the majority of types of connections.

- Note that most discrete sensors can be purchased in either a sinking or sourcing configuration. Make sure you specify the correct one!!
Discrete Input Modules

A Discrete Input module senses status of devices with only **two states**
- on/off, open/closed, running/stopped

- **Types of discrete inputs**
  - Switches - many kinds
    - Pushbutton
    - Limit
    - Level
  - Proximity
  - Relay contacts
Discrete Input Modules

Standard Discrete Input Voltages

- 120 v AC/DC (can handle either)
- 220 v AC/DC
- \( \approx 10 - 30 \) v DC
- \( \approx 10 - 30 \) v AC
- \( \approx 20 - 60 \) v DC
Discrete Input Modules

Discrete Input Module Block Diagram

Threshold detector

- Senses when input device is on
- When input device voltage > minimum-on-state voltage → devised is sensed to be on
- When device voltage < maximum-off state voltage → devised is sensed to be off
Discrete Input Modules

Discrete Input Module Block Diagram

- **Input Signal**
  - Bridge Rectifier
  - Noise and Disturbance
  - Threshold Detector
  - Opto-Isolation

- **Powered from the field**
  - AC Types Only
  - Electrical Isolation

- **Powered from PLC**

**Optical Isolator**

- Provides electrical isolation between field wiring and the PLC internal circuitry
  - Light-Emitting Diode & Photoelectric transistor
    - Switch Closed → Current flow through LED → Generates Light → Light Triggers current flow thru Photoelectric transistor → Sensed by PLC digital logic

- Circuitry to the LHS of isolator powered from the field
- Circuitry to the RHS powered from internal PLC voltage source
Discrete Input Modules

Noise and Disturbance
- Capacitors and Resistors are typically used to form simple noise filter

Bridge Rectifier
- Converts AC to full-wave rectified DC
Discrete Input Modules

AC Inputs

- Power flows into the Input Module when the field device is on
  - Hence the Input Module is characterized as a Sinking Module
- There is a least one common per module. Some modules have a common for every 4 input channels
- Why would you need more than one common?
Discrete Output Modules

Discrete Output Modules:
- Used to turn real-world output devices either on or off
- Can be used to control any two-state device
- Available in AC and DC versions
- Available in various voltage ranges and current capabilities

Examples of Discrete Devices Controlled by PLC
- Indicator Lamps, Alarm Lamps
- Motor Starters, Electric Valves, Electric Fans
- Control Relays, Heater Relay
Discrete Output Modules

Standard Discrete Output Voltages

- 120 v AC
- 220 v AC
- ≈12 - 48 v AC
- 120 v DC
- 220 v DC
- ≈12 - 48 v DC

- AC Discrete Output Modules handle only Ac Signals
- DC Discrete Output Modules handle only DC Signals
- Relay output Modules handle both Ac and DC signals
Discrete Output Modules
Block Diagram

![Block Diagram of Optical Isolator](image.png)

**Optical Isolator**

- Provides electrical isolation between PLC and internal circuitry and field wiring
- Circuitry on LHS of Optical Isolator powered by internal PLC voltage
- Circuitry on RHS of Optical Isolator powered from the field
Discrete Output Modules

AC Outputs

AC Signals

- Output Modules that handle Ac signals are Sourcing Modules
  - Power flows out of the Module when the Switch ("Triac") is ON
Input/Output Modules

Wiring

- Best to sketch the diagram on a piece of paper before wiring
  - Easier to visualize the whole picture
- Suppose you have many inputs to wire?
  - Start the sketch with one input first
    - If you figure out the first, the rest will follow
  - Next simply add second input
  - third input etc…
Input/Output Modules

Sinking Input Module Wiring

- **Suppose:**

![Diagram of a simple circuit with one input, a power supply, and wiring terminals labeled Input 0, Input 1, Input 2, Input 3, and Common]

Wire this simple circuit
Input/Output Modules

Wiring in a Simple Circuit

Diagram of a simple circuit with inputs labeled as Input 0, Input 1, Input 2, and Input 3, and a common connection.
Input/Output Modules

Wiring Additional Input Device

Wiring an additional input device
Input/Output Modules

Wiring three-wire Sensor

- Connect 3-wire sourcing sensor
  - Sourcing Sensor → output is positive
Input/Output Modules

Three-wire Sensor Wiring

- Complete Wired Circuit

![Diagram of three-wire sensor wiring](image-url)