INPUT / OUTPUT MODULES
PLC Block Diagram

Input section → Microprocessor or CPU → Output section

Memory

Power supply
Types of I/O Modules

• Discrete input and output
• Analog input and output
• Specialty I/O modules
• Communication modules
Discrete Versus Analog Inputs

• Discrete or digital input signals are two-state signals:
  – Input ON or OFF, 1 or 0
• Analog input signals are values:
  – 0 to 10 volts DC
  – -10 to +10 volts DC
  – 4 to 20 milliamps
Module Features

• Identifier as to type of module:
  – Input
  – Output
  – Combination input or output

• Status indicators

• Screw terminals for connecting field devices

• Removable terminal blocks
SLC 500 Combination I/O Module

(1 of 2)
SLC 500 Combination I/O Module (2 of 2)

• Each screw terminal will have a unique identifier called an address.
• Each field device input screw terminal will correlate to a status indicator.
• Status indicator will be on when the input point sees an input signal.
• Status indicator will have same address identifier as input screw terminal.
Typical Wiring of Input Signals
16-Point Input Module with 8 Points Per Common
Binary Data Representation

• We communicate to others using groups of letters arranged into words.
• The PLC uses groups of bits called words.
• Different bit patterns represent different information.
Bits

• Unlike English, computers have only two characters available – 1 or 0.
• Each 1 or 0 is called a binary digit or bit.
• Binary is base or radix 2.
• A single bit is the smallest unit of computer data.
One measure of a computer’s capabilities is the length of the data words on which it can operate.

- Current PLCs use 16-bit words.
- Newer PLCs use 32-bit words.
- SLC 500 family PLCs are 16-bit computers.
Information Represented as Combinations of Bits
Parts of a 16-Bit Word

16 bits = 1 word

4 bits = 1 nibble

8 bits = 1 byte
Bytes, Nibbles, and Bits

15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0

Upper nibble  Lower nibble  Upper nibble  Lower nibble

Upper byte    Lower byte
16-Point Module’s
I/O Points Represented in a Word

One light for each input point. Light is ON when there is an ON signal to the corresponding input point.
Physical Input Conditions and the Corresponding Input Data Word
8-Point Input Module Represented in a Word
24-Point I/O Module
Represented in Two Words

These eight bits are not used
Two Words Representing Inputs for a 32-Bit Module

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Data Table Format

• Words are 16 bits.
  – Bits 0 through bit 15
• First word or bit is always 0.
• SLC 500 data tables can contain up to 256 words (0 to 255).
Words Arranged in a Data Table

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</table>
• Each input screw terminal has one memory location to store on or off status.
• Input data is stored in the input data file.
  – Also called the input status file
• Input status file holds input status information, which is used to solve ladder program.
Input Data File (2 of 2)

• Identified as an I-type data file
• Only one input status file allowed per project
• Only has words created for actual modules in system
Discrete Input
Status Table Word

• 16-point discrete input modules are assigned one word in the input status table.
• A 16-point discrete input module residing in slot 3 would be addressed as I:3.0, bits 0 through 15.
## Input Status Table

<table>
<thead>
<tr>
<th>Offset</th>
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</table>
Discrete I/O Module With 32 Points

- Because input status word is 16 bits wide, there are 16 bits available for up to 16 I/O screw terminals.

- A 32-point I/O module will require two 16-bit words to accommodate all I/O points.

- For a 32-point input module in slot 3, two words, I:3.0 and I:3.1 will be created as part of the I/O configuration.
32-Point Input Module

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1746-IB16 - 16-Input
1746-IB32 - 32-Input
Input Addressing for Upper 16 Bits

- Screw terminal 16 address would be I:3.1/0.
- Screw terminal 17 address would be I:3.1/1.
- Screw terminal 18 address would be I:3.1/2.
- Screw terminal 31 address would be I:3.1/15.
  - Can be entered on ladder as I:3/31, will display as set up in properties
I/O Address Format for SLC 500 Family of PLCs

**Diagram:**

- **Input or output**
- **Separator**
- **Slot number**
- **Bit designator**
- **Bit number**

**Example Address:**

- **I : 3/2**
- **O : 5/6**
RSLogix 500 Software
Input Status Table Screen View
RSLogix 500 Software
Output Status Table Screen View
Analog Inputs

- Typical analog signals come from temperature, pressure, position, and motor speed.
- Analog input modules convert analog signals to digital words.
- Analog input signals are current or voltage.
Typical Analog Inputs

- Analog input signals
  - 0 to 10 volts DC
  - -10 to +10 volts DC
  - 0 to 5 or 1 to 5 volts DC
  - 4 to 20 milliamps
  - 0 to 20 milliamps
  - -20 to +20 milliamps
Analog Module Configurations

• Analog input information comes in as an input channel.

• Analog modules are
  – All inputs
  – All outputs
  – Combination of input and output channels
Analog Input Signals

Represent Values

• A potentiometer supplying a 0- to 10-V DC input signal to an analog input module could send a converted signal of 0 to 32767 into PLC memory.

• Analog data format is determined by module and module configuration.
Local Versus Remote I/O

• Local analog modules in a SLC 500 system automatically send the converted signal into the input status table.

• Remote I/O analog signals require block transfers.
Analog Input Modules and the Input Status Table

- Each analog channel will be represented by a entire word in the input status table.
- A two-channel analog input module will have two words in the input status table to represent the binary representation of the analog voltage or current.
Analog Data Is Represented as Whole Word Data

- Analog signals are not digital signals represented as 1s and 0s.
- Analog information is represented as a 16-bit signed integer in the data table.
- Each channel will require one word.
- Data table will reserve one word for each channel.
- This is part of the I/O configuration process.
Input Word Assignment

• 1746-NI8 is an 8-channel analog input module.
• Eight words will be assigned to the input status table as part of the I/O configuration.
• Module in slot 4 will have words I:4.0 through I:4.7, one for each channel.
## 1746-NI8

### Input Status Table Words

| Offset | 15 | 14 | 13 | 12 | 11 | 10 | 9  | 8  | 7  | 6  | 5  | 4  | 3  | 2  | 1  | 0  | Status/Channel                  |
|--------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|------------------|
| I:1.0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1746-IB16 - 16-Input (SINK)    |
| I:2.0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1746-IB16 - 16-Input (SINK)    |
| I:3.0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1746-IB16 - 16-Input (SINK)    |
| I:4.0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1746-NI8 - Analog 8 Channel    |
| I:4.1  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1746-NI8 - Analog 8 Channel    |
| I:4.2  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1746-NI8 - Analog 8 Channel    |
| I:4.3  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1746-NI8 - Analog 8 Channel    |
| I:4.4  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1746-NI8 - Analog 8 Channel    |
| I:4.5  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1746-NI8 - Analog 8 Channel    |
| I:4.6  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1746-NI8 - Analog 8 Channel    |
| I:4.7  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1746-NI8 - Analog 8 Channel    |
| I:5.0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1746-IB16 - 16-Input (SINK)    |
PLC Output Section

• The output section of a PLC system is the physical connection between the processor and the outside world.
Output Classifications

• Output modules fall into three classifications.
  – Discrete
  – Analog
  – Specialty
Discrete Outputs

- Motor starter coils
- Pilot lights
- Solenoids
- Alarms
- Valves
- Fans
- Control relays
- Start pushbuttons
- Stop pushbuttons
- Horns
- Start / stop signals to variable speed drives
Operating Characteristics (1 of 2)

• Discrete output modules are simply switching devices that carry out commands from the processor.
• They receive their operating power from the PLC’s power supply.
• Power output point switches to control field devices are provided by the user.
Operating Characteristics (2 of 2)

• Each output point contains a switching device, which is located inside the module.
• The switching device is turned on or off according to the bit value residing in that particular output module’s status table address.
Three Basic Types of Output Modules

• Solid-state (triac) switching for AC loads
• MOSFET for DC loads
• Mechanical relay
Basic Wiring for a 120 VAC

Output module

- Output 2
- Output 3
- Output 4
- Output 5

Load

Signal from CPU operates switch

User-supplied power for field devices

120 VAC
Relay Output Module Variations

• Combination input and relay output module
• Isolated relay outputs
• 8 or 16 outputs with shared commons
Combination 120 VAC Input and Relay Output Module
8-Point Relay Output Module
AC Isolated Output Module
Interposing Relays

• Most output modules switch between one-half and four amps.
• To switch higher current loads, a mechanical relay called an interposing relay is placed between the output point and the load.
• Output module switches the relay.
• Relay switches the load.
Interposing Relay Switches Load That Exceeds Module Capability
Analog Output Modules

• They accept a 16-bit output status word, which the module converts to an analog value through a digital-to-analog converter.

• Analog output modules send out a varying current or voltage signal.
Typical Analog Field Devices

• Temperature
• Pressure
• Position
• Valves
• Variable frequency drives
• Meters
Typical Analog Outputs

- Analog output signals
  - 0 to 10 volts DC
  - -10 to +10 volts DC
  - 0 to 5 or 1 to 5 volts DC
  - 4 to 20 milliamps
  - 0 to 20 milliamps
  - -20 to +20 milliamps
Analog Module Configurations

- Analog output information is sent to the field device by way of an output channel.
- Analog modules are
  - All inputs
  - All outputs
  - Combination of input and output channels
Analog Output Signals
Represent Values

• A binary output signal from 0 to 32767 from the output status table could be converted to a 0 to 10 V DC output signal to control an analog field device.

• Analog data format is determined by module and module configuration.
Local Versus Remote I/O

• Local analog modules in an SLC 500 system automatically receive the binary value from the output status table.

• Remote I/O analog signals require block transfers.
Analog Input Modules and the Output Status Table

• Each analog channel will be represented by an entire word in the output status table.

• A two-channel analog output module will have two words in the output status table to represent the binary representation of the analog voltage or current.
Analog Data Is Represented as Whole Word Data

- Analog signals are not digital signals represented as 1s and 0s.
- Analog information is represented as a 16-bit signed integer in the data table.
- Each channel will require one word.
- Data table will reserve one word for each channel.
- This is part of the I/O configuration process.
Output Word Assignment

• 1746-NO4V is a four-channel analog voltage output module.

• Four words will be assigned to the output status table as part of the I/O configuration.

• Module in slot 4 will have words O:4.0 through O:4.3, one for each channel.
### 1746-NO4V Input Status Table Words

![Data File 00 (bin) -- OUTPUT table]

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