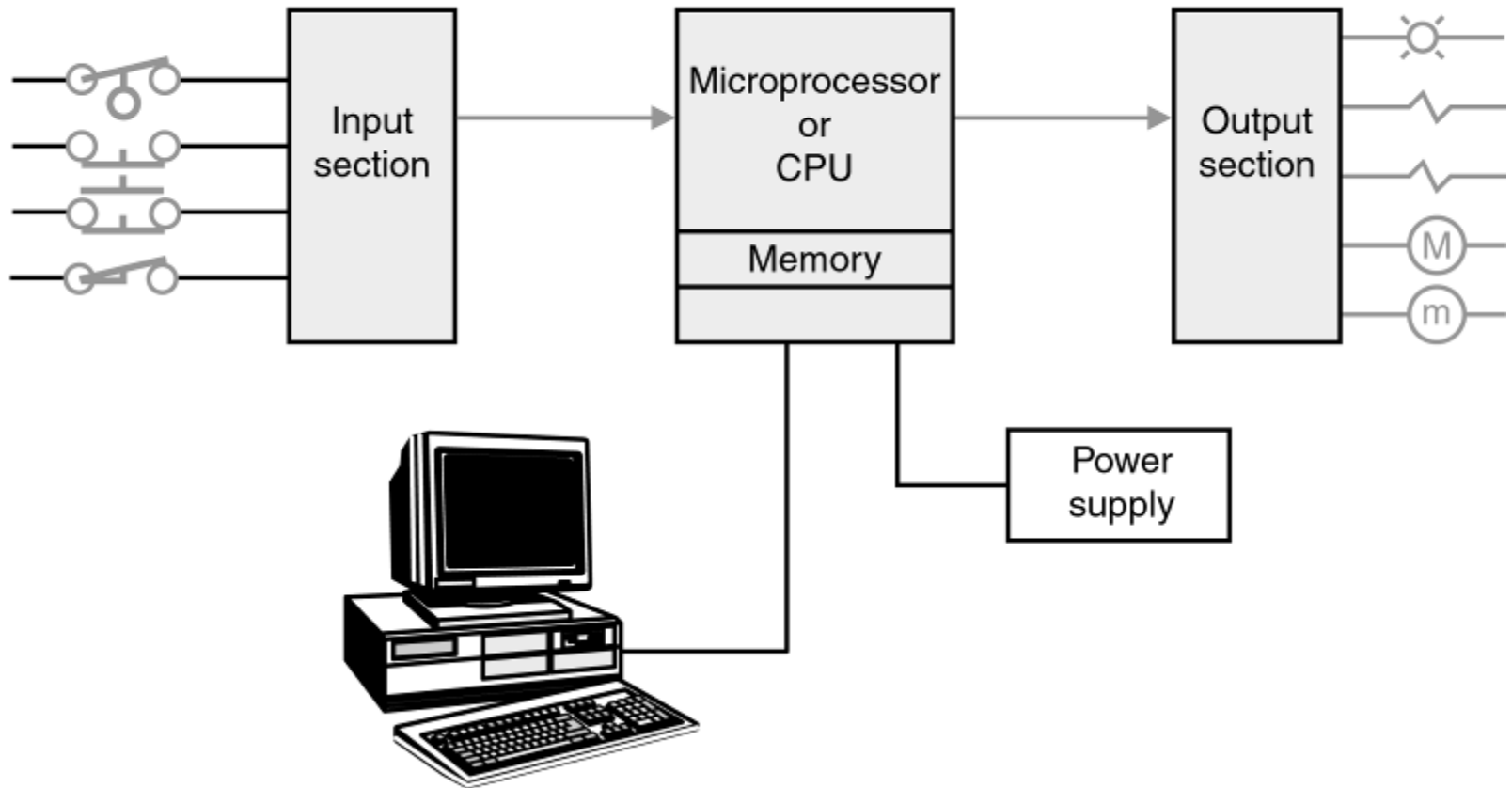


# INPUT / OUTPUT MODULES

# PLC Block Diagram



# Types of I/O Modules

- Discrete input and output
- Analog input and output
- Specialty I/O modules
- Communication modules

# Discrete Versus Analog Inputs

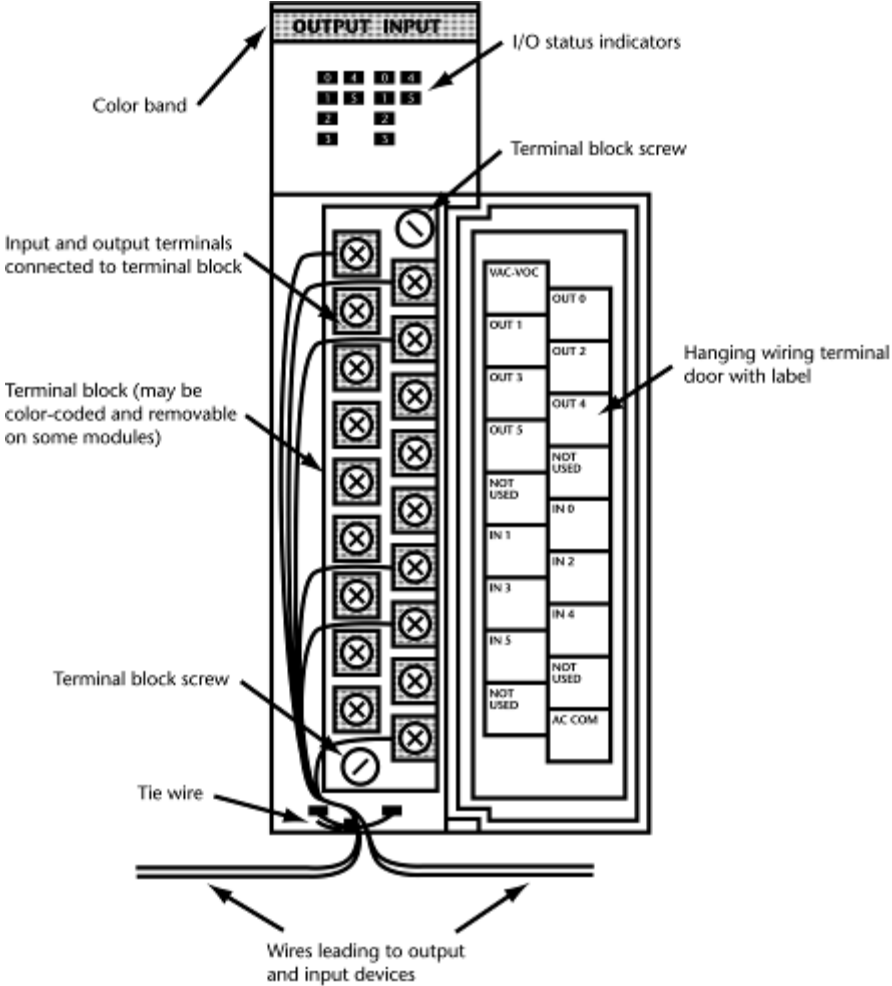
- Discrete or digital input signals are two-state signals:
  - Input ON or OFF, 1 or 0
- Analog input signals are values:
  - 0 to 10 volts DC
  - -10 to +10 volts DC
  - 4 to 20 milliamps

# 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

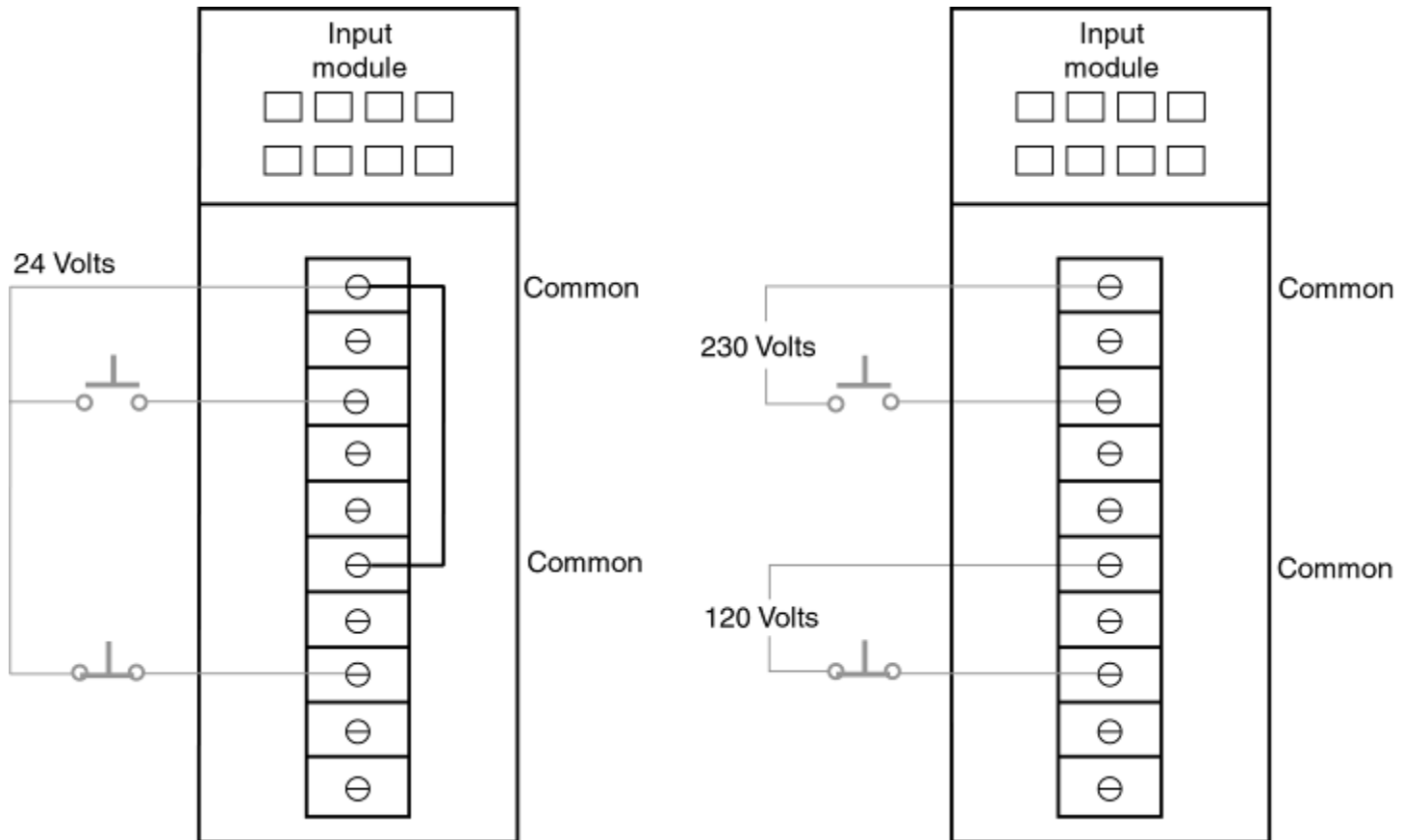
(1 of 2)



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

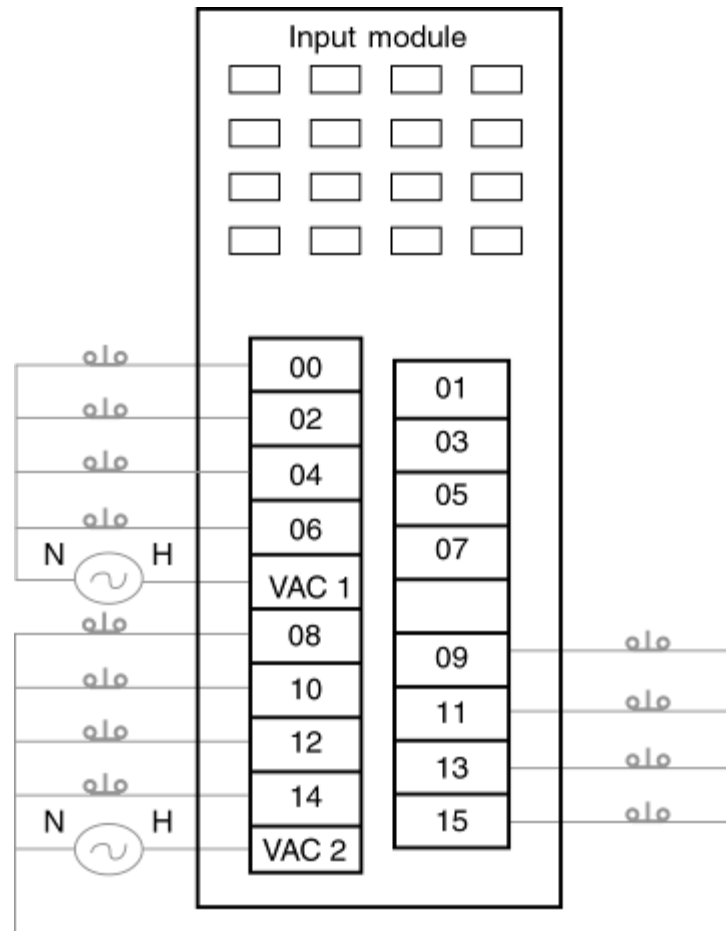
- Each screw terminal will have a unique identifier called an address.
- Each field device input screw terminal will correlate to a status indicator.
- Status indicator will be on when the input point sees an input signal.
- Status indicator will have same address identifier as input screw terminal.

# 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.

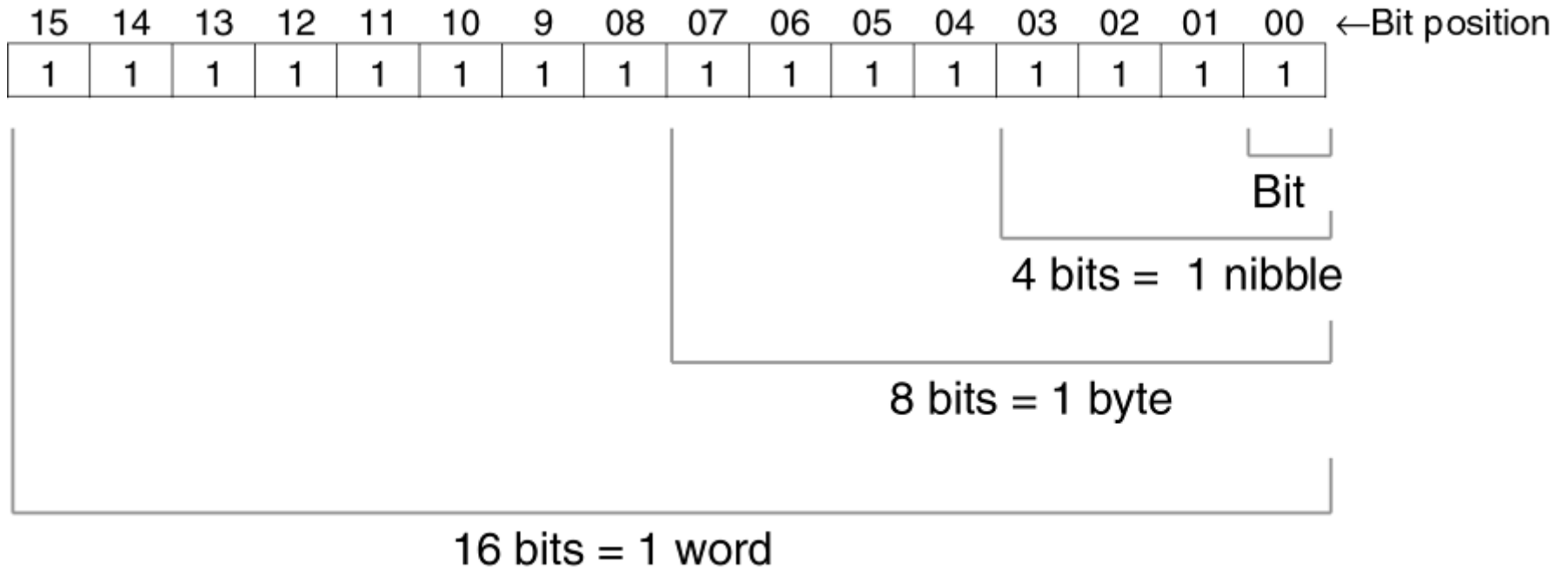
# PLC Words

- 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.

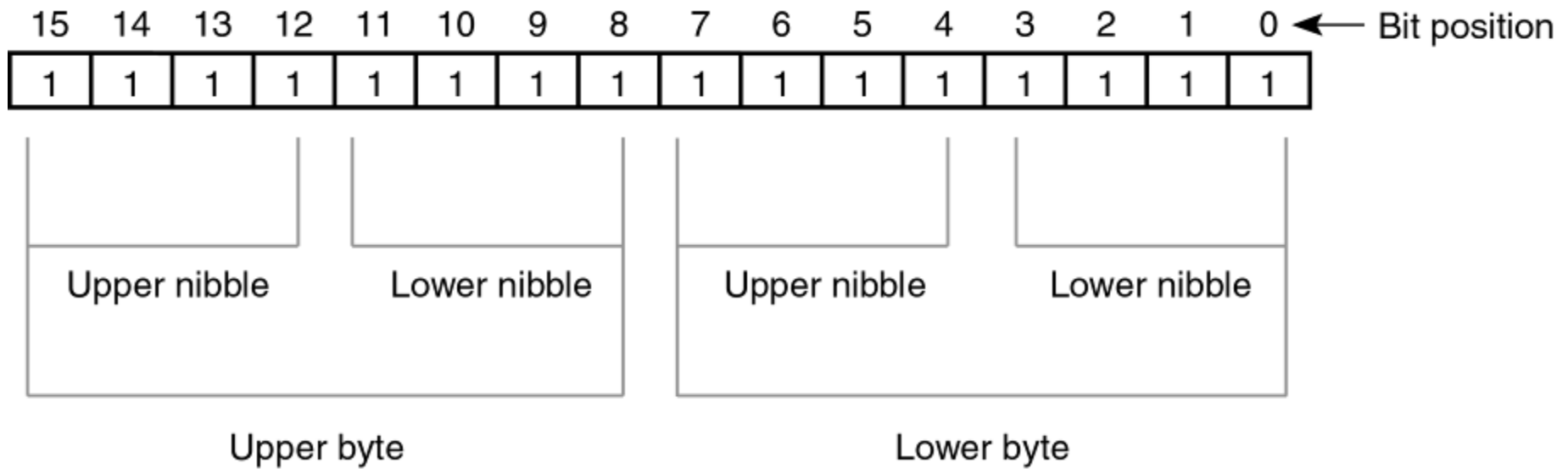
# Information Represented as Combinations of Bits

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

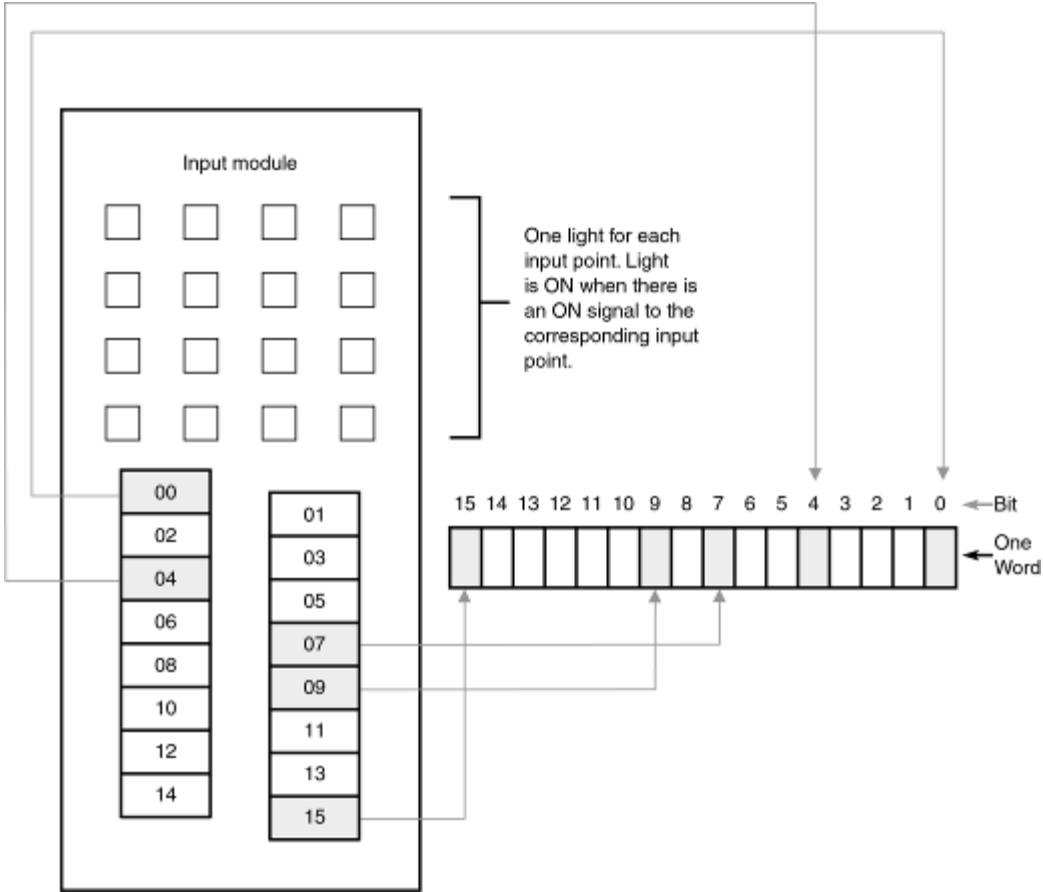
# Parts of a 16-Bit Word



# Bytes, Nibbles, and Bits

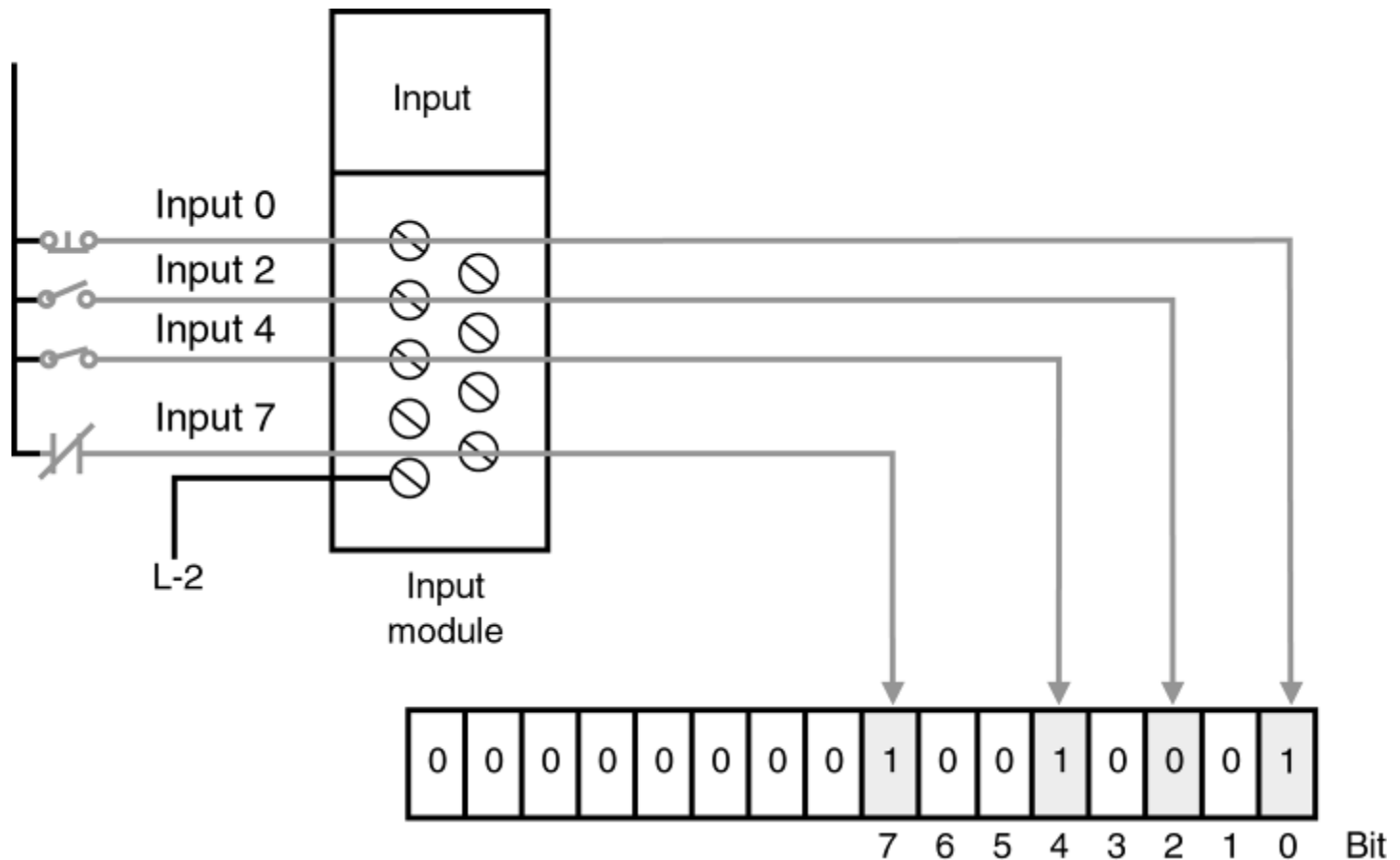


# 16-Point Module's I/O Points Represented in a Word

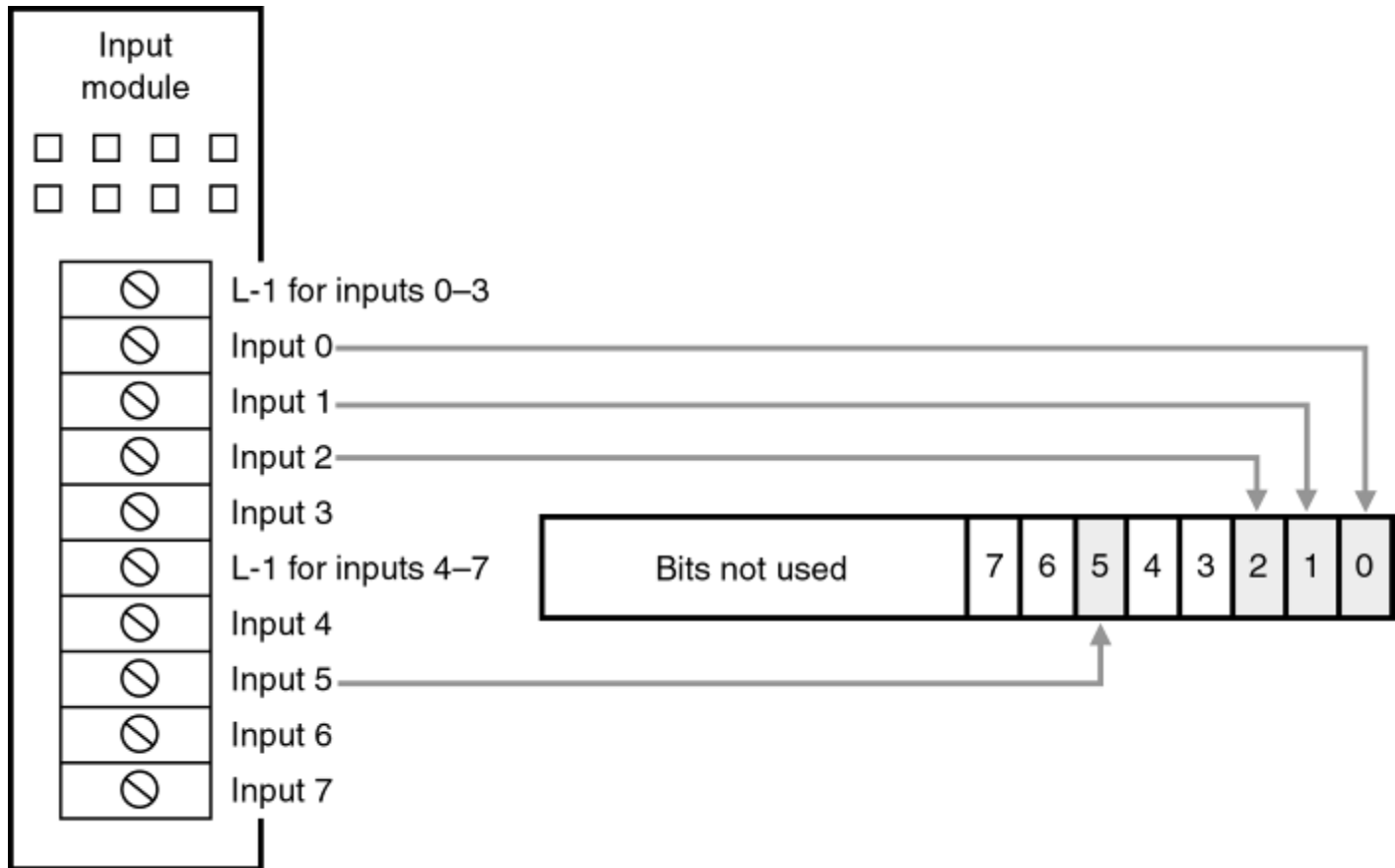




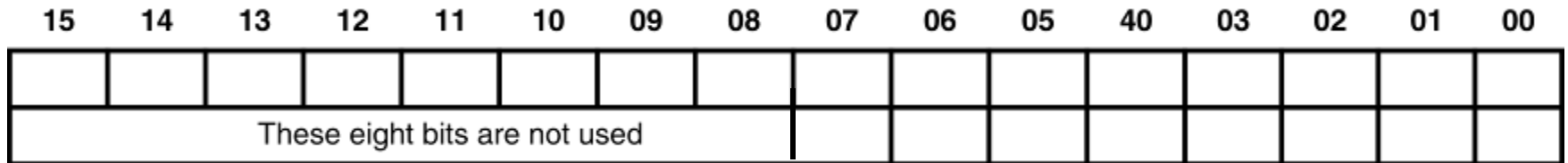
# Physical Input Conditions and the Corresponding Input Data Word



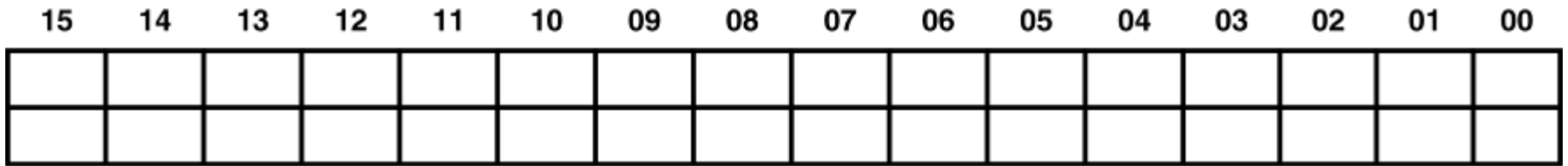
# 8-Point Input Module Represented in a Word



# 24-Point I/O Module Represented in Two Words



# Two Words Representing Inputs for a 32-Bit Module



# 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

15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
1	1	1	0	0	1	1	1	1	1	1	1	1	1	1	1
1	1	1	0	0	0	0	0	0	0	1	0	0	0	0	1
0	0	0	1	1	1	1	0	1	0	1	1	1	0	1	1
0	0	0	1	1	0	1	0	1	1	1	0	1	0	1	1
1	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0
1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0
1	0	1	1	0	1	1	0	0	0	0	0	0	0	0	0
1	0	1	0	1	1	0	1	0	1	1	1	1	1	1	1
0	1	1	1	1	1	0	0	0	1	1	1	1	0	0	0

# Input Data File (1 of 2)

- 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

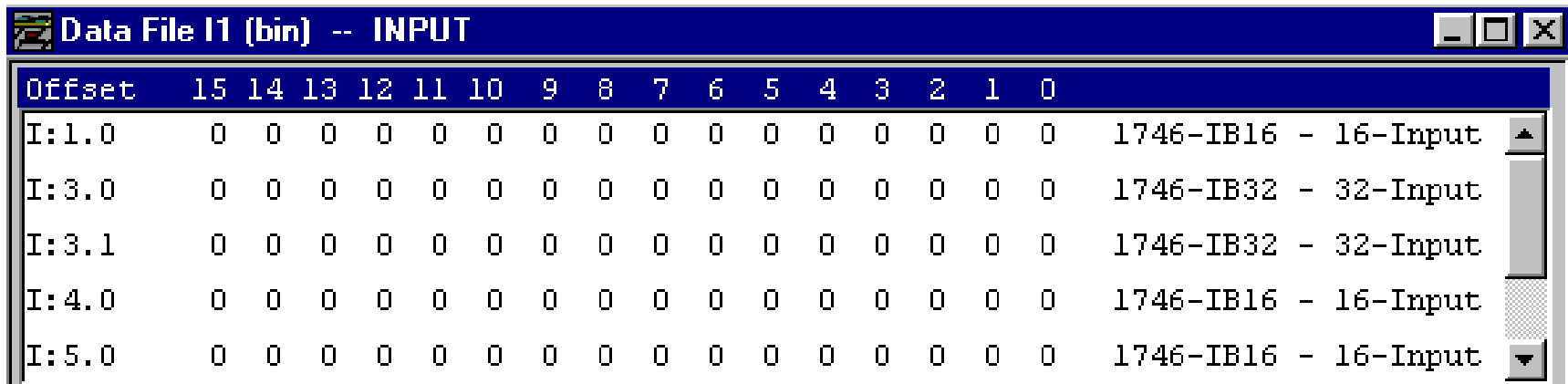
- 16-point discrete input modules are assigned one word in the input status table.
- A 16-point discrete input module residing in slot 3 would be addressed as I:3.0, bits 0 through 15.



# 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

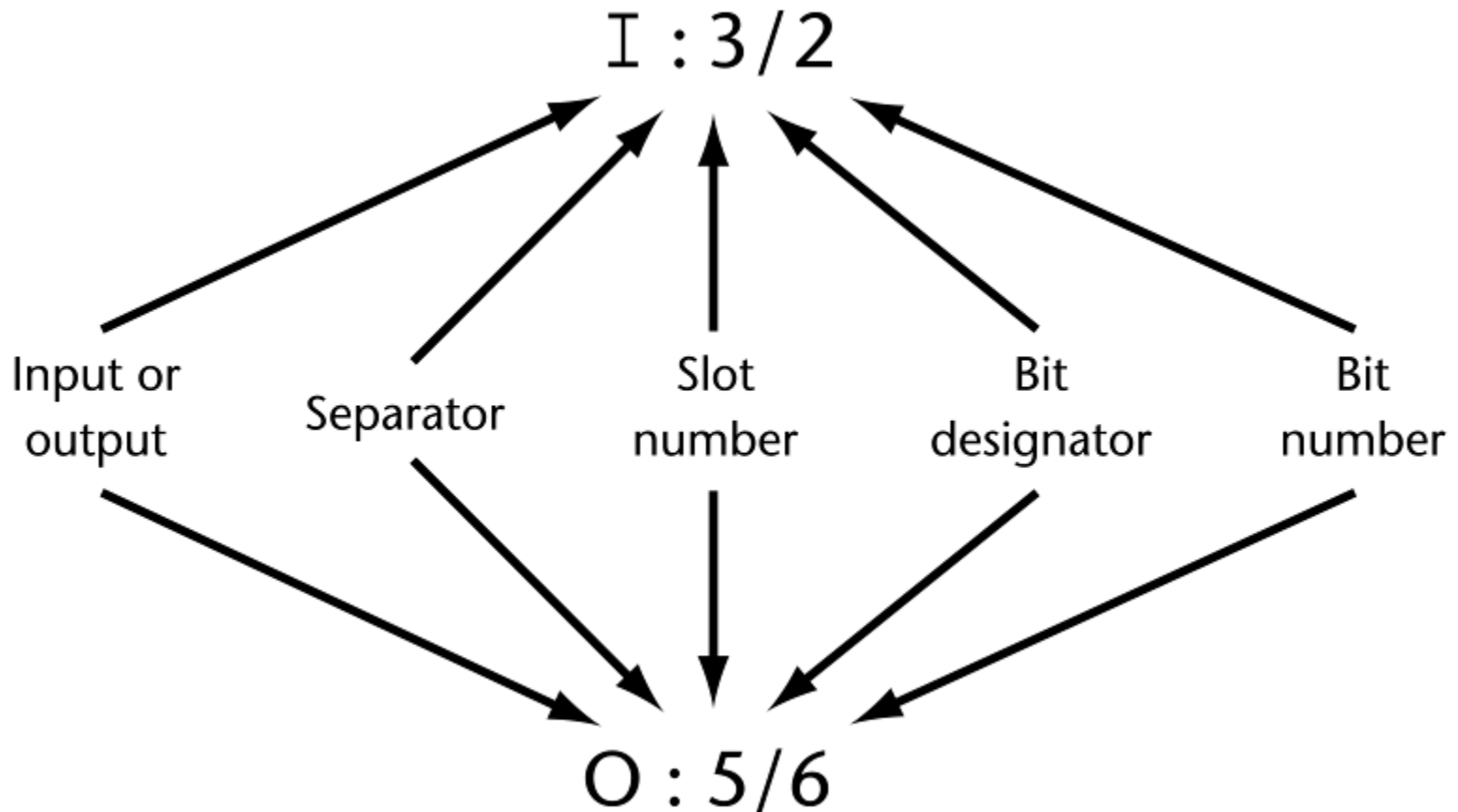


Offset	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
I:1.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1746-IB16 - 16-Input
I:3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1746-IB32 - 32-Input
I:3.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1746-IB32 - 32-Input
I:4.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1746-IB16 - 16-Input
I:5.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1746-IB16 - 16-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



# RSLogix 500 Software

## Input Status Table Screen View

Offset	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
I:1.0									0	0	0	0	0	0	0	0	1746-IB8 - 8-Input
I:3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1746-IB32 - 32-Input
I:3.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1746-IB32 - 32-Input
I:4.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1746-IB16 - 16-Input
I:6.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1746-IB16 - 16-Input

Address: I:7/1      Radix: Binary

Symbol:      Columns: 16

Desc:

I1      Properties      Usage      Forces      Help

# RSLogix 500 Software

## Output Status Table Screen View

Data File 00 (bin) -- OUTPUT

Offset	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
0:2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1746-0B16 - 16-Output
0:5.0								0	0	0	0	0	0	0	0	0	1746-0B8 - 8-Output

0:8/0 Radix: Binary Columns: 16

Symbol: Desc:

00 Properties Usage Forces Help



# 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

Data File I1 (bin) -- INPUT																	
Offset	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
I:1.0	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	0	1746-IB16 - 16-Input (SINK)
I:3.0	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	0	1746-NI8 - Analog 8 Channel
I:4.1	0	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	0	1746-NI8 - Analog 8 Channel
I:4.3	0	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	0	1746-NI8 - Analog 8 Channel
I:4.5	0	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	0	1746-NI8 - Analog 8 Channel
I:4.7	0	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	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.

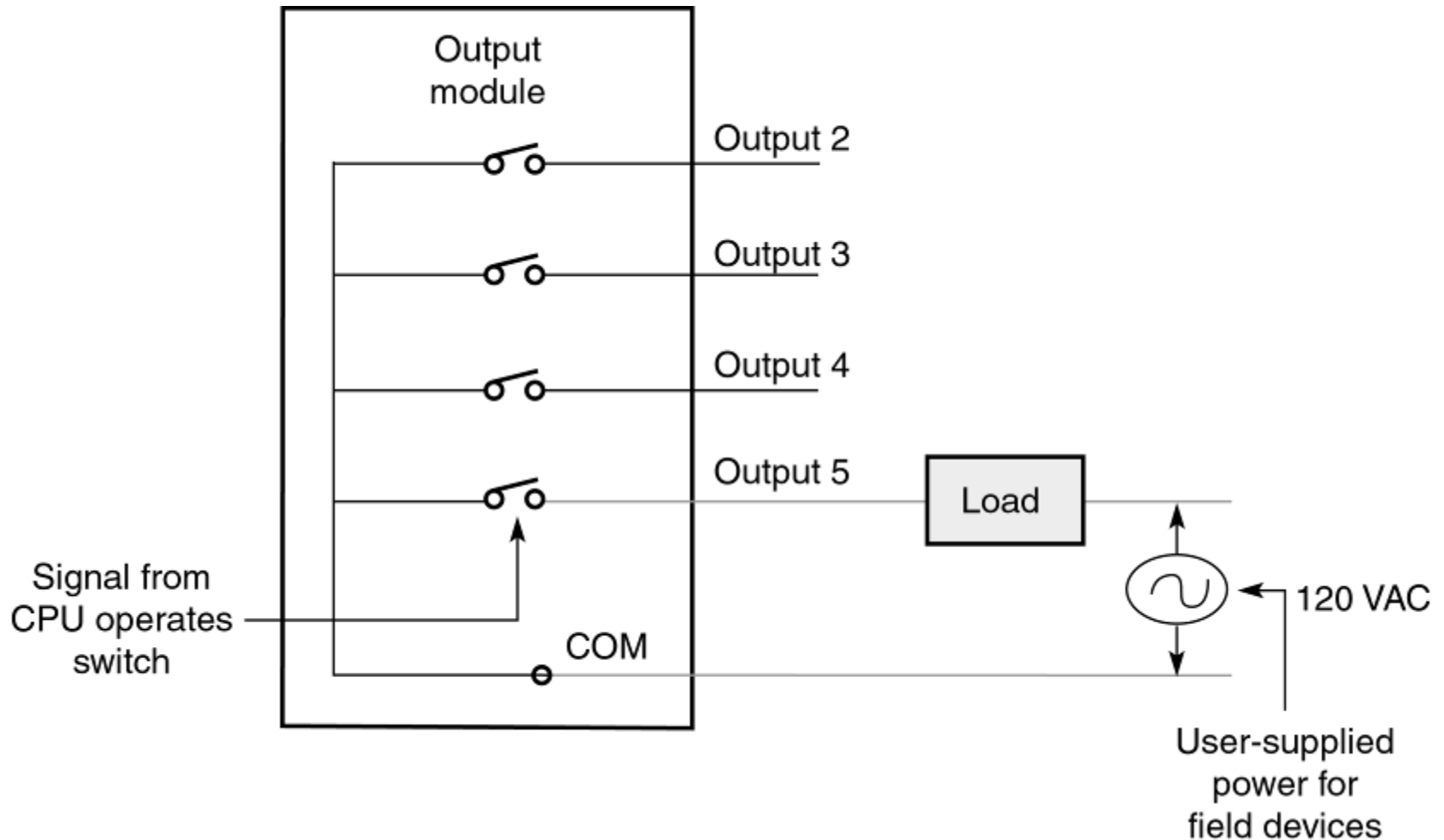
# Operating Characteristics (2 of 2)

- 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

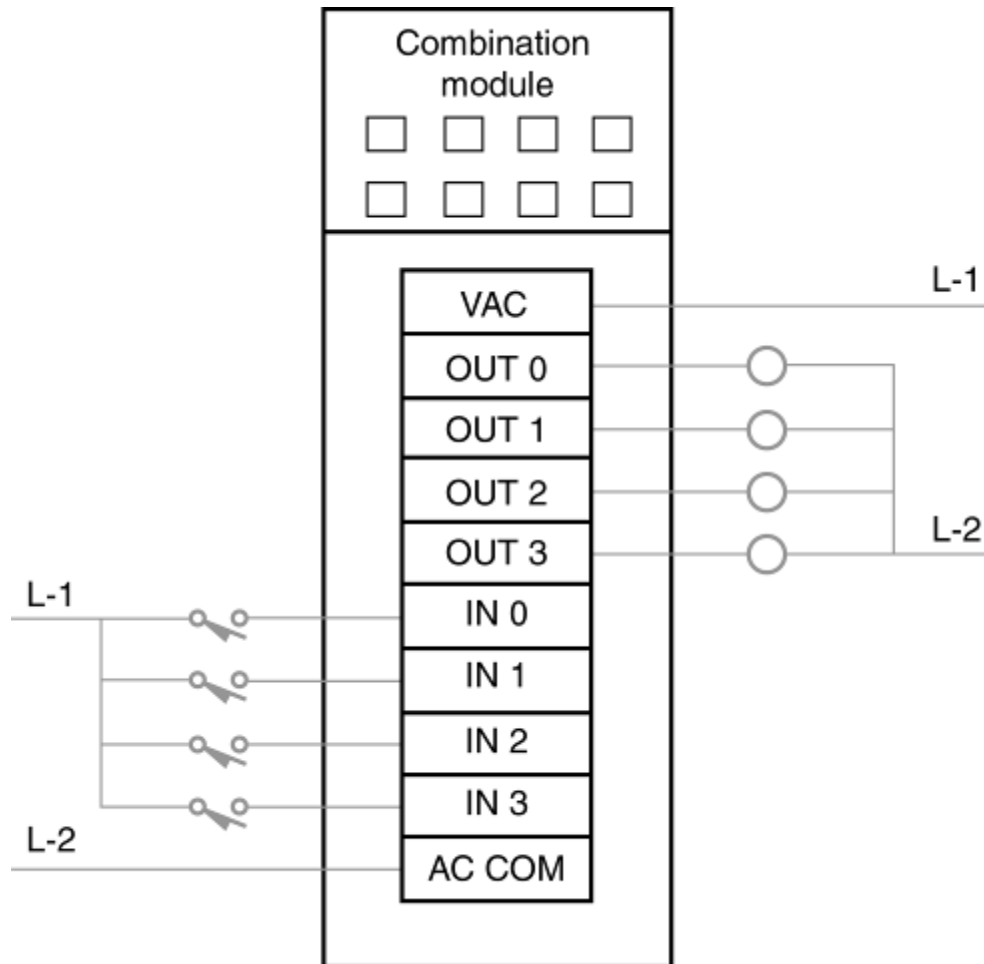




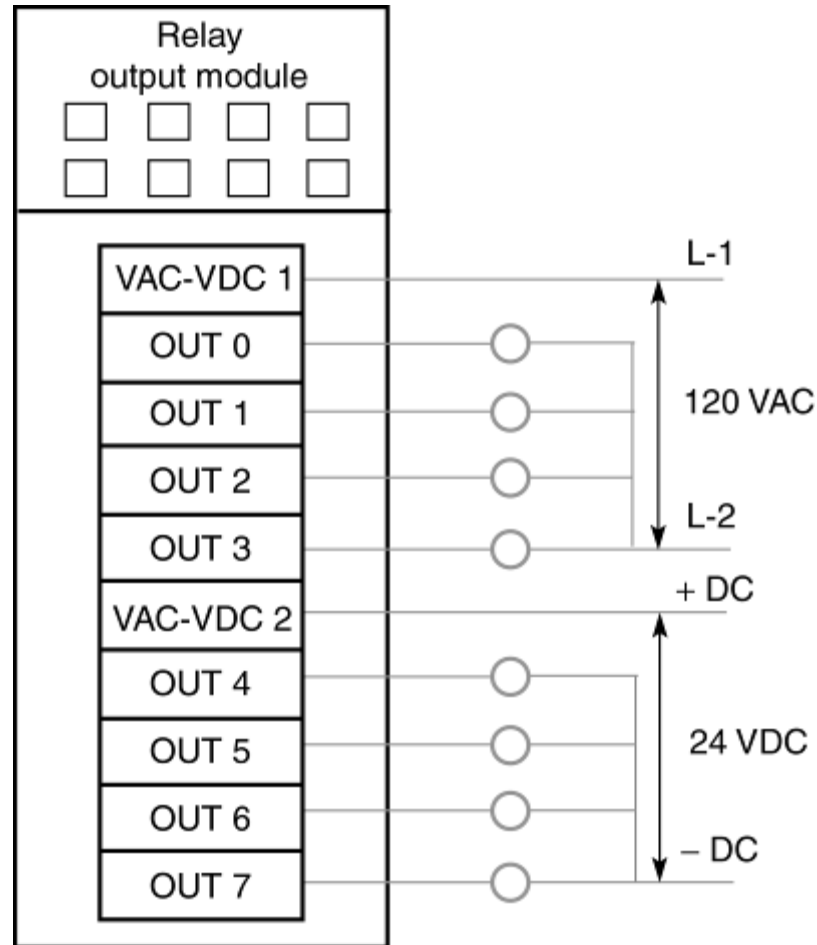
# Relay Output Module Variations

- Combination input and relay output module
- Isolated relay outputs
- 8 or 16 outputs with shared commons

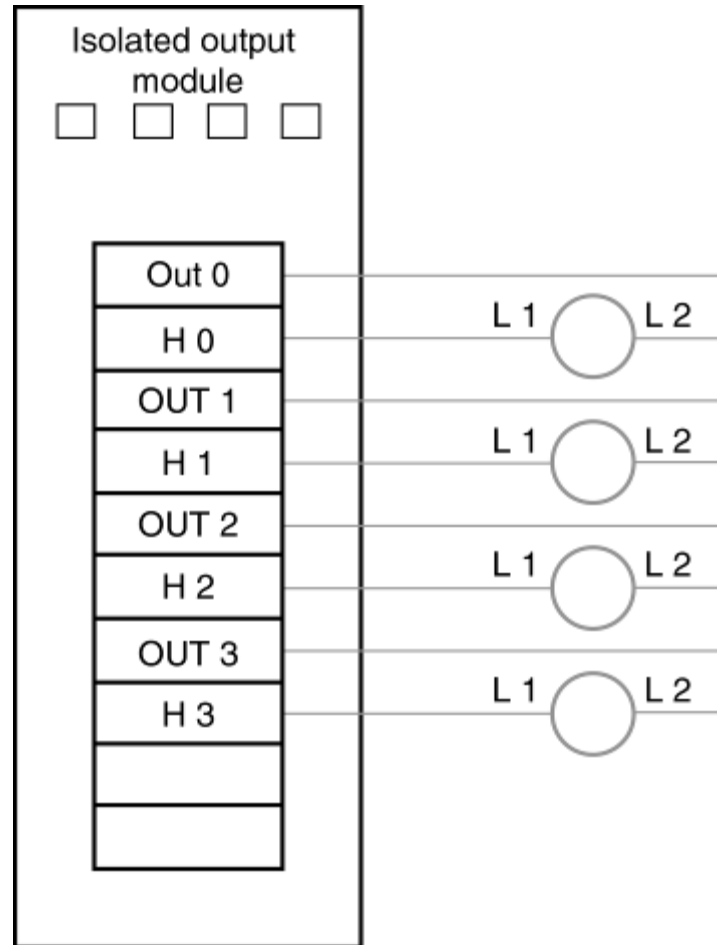
# Combination 120 VAC Input and Relay Output Module



# 8-Point Relay Output Module



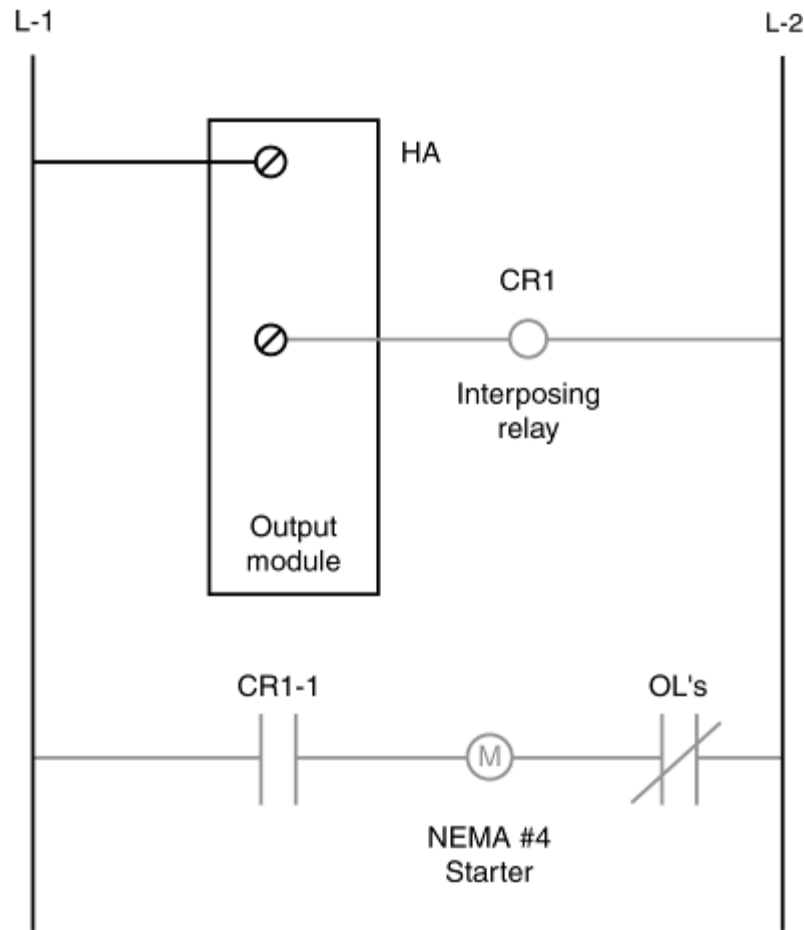
# AC Isolated Output Module



# 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.

