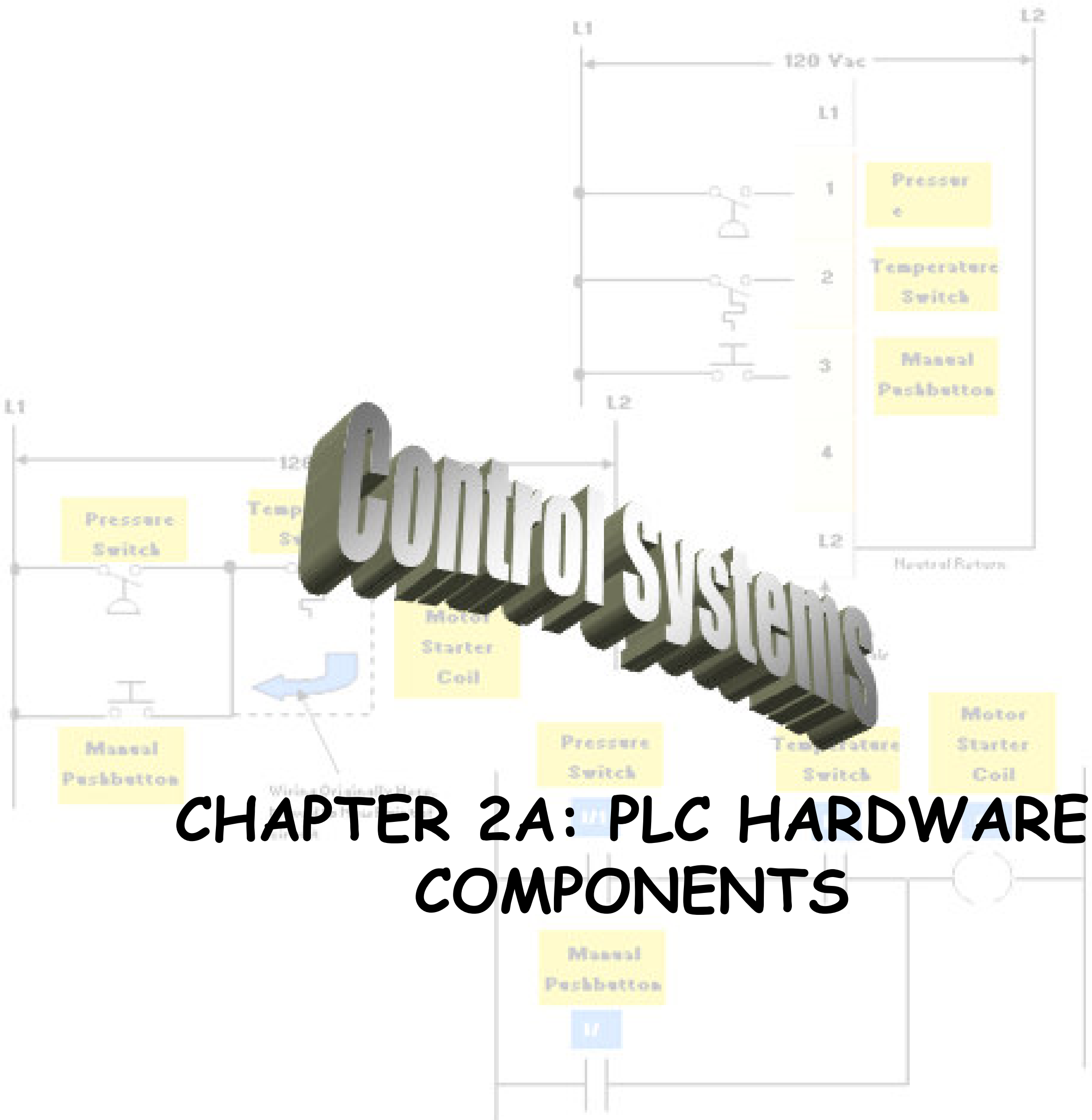
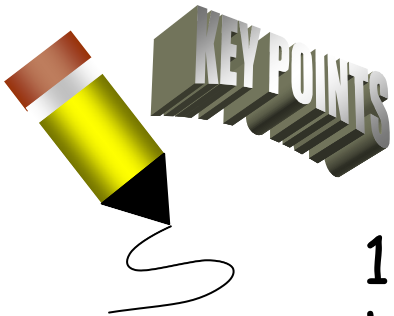


Control Systems

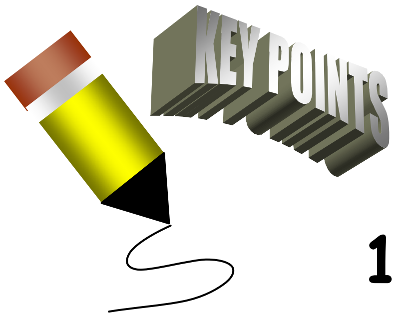
CHAPTER 2A: PLC HARDWARE COMPONENTS

D.Wilcher



CHAPTER OBJECTIVES

1. List and describe the function of the hardware components used in PLC systems.
2. Describe the basic circuitry and applications for discrete and analog I/O modules, and interpret typical I/O and CPU specifications.
3. Explain I/O addressing.
4. Describe the general classes and types of PLC memory devices.
5. List and describe the different types of PLC peripheral support device available.



THE I/O SECTION

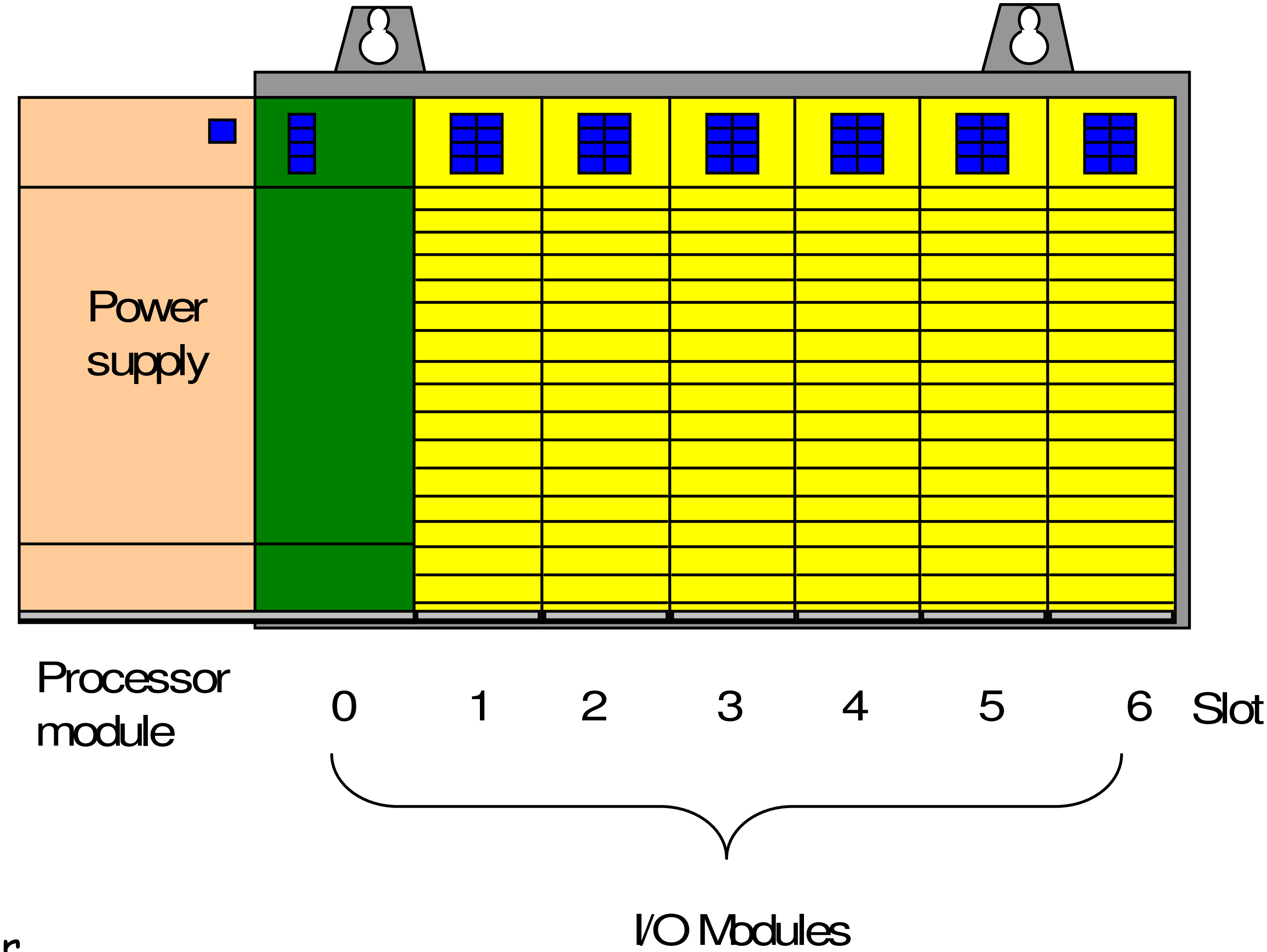
1. The I/O (Input & Output) interface modules provides the equivalents of "eyes","ears", and "tongue" to the brain of a PLC.

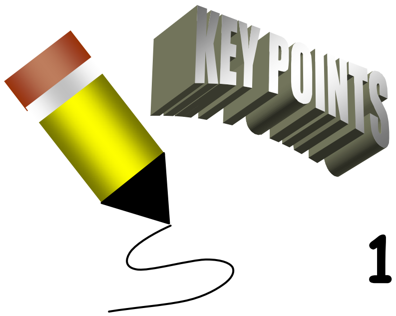
2. The I/O section consists of an I/O rack and individual I/O modules. (See **Figure 2-1**)

3. The I/O system provides an interface between the hardwired components in the field and the CPU.

4. The input interface allows status information regarding processes to be communicated to the CPU.

Figure 2-1:Typical I/O Section



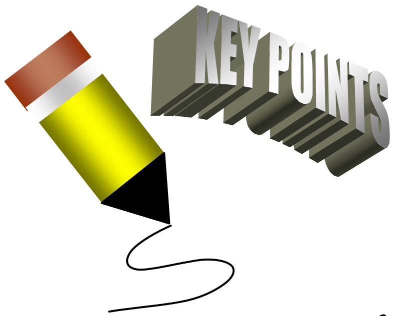


THE I/O SECTION…

1. The chassis is a physical hardware assembly that houses devices such as I/O modules, processor modules, and power supplies.

2. Chassis come in different sizes according to the number of slots they contain.

3. In general, they can have 4, 8, 12, or 16 cells.



THE I/O SECTION…

1. A logical rack is an addressable unit consisting of 128 input points and 128 output points. (See **Figure 2-2**).

2. A rack uses 8 words in the input image table file and 8 words in the output image table. (See **Figure 2-3**)

3. A word in the output image and its corresponding word in the input image table file are called an I/O group.

4. A rack can contain a maximum of 8 I/O groups (numbered from 0 -7) for up to 128 discrete I/O.

Figure 2-2:Typical Logical Rack

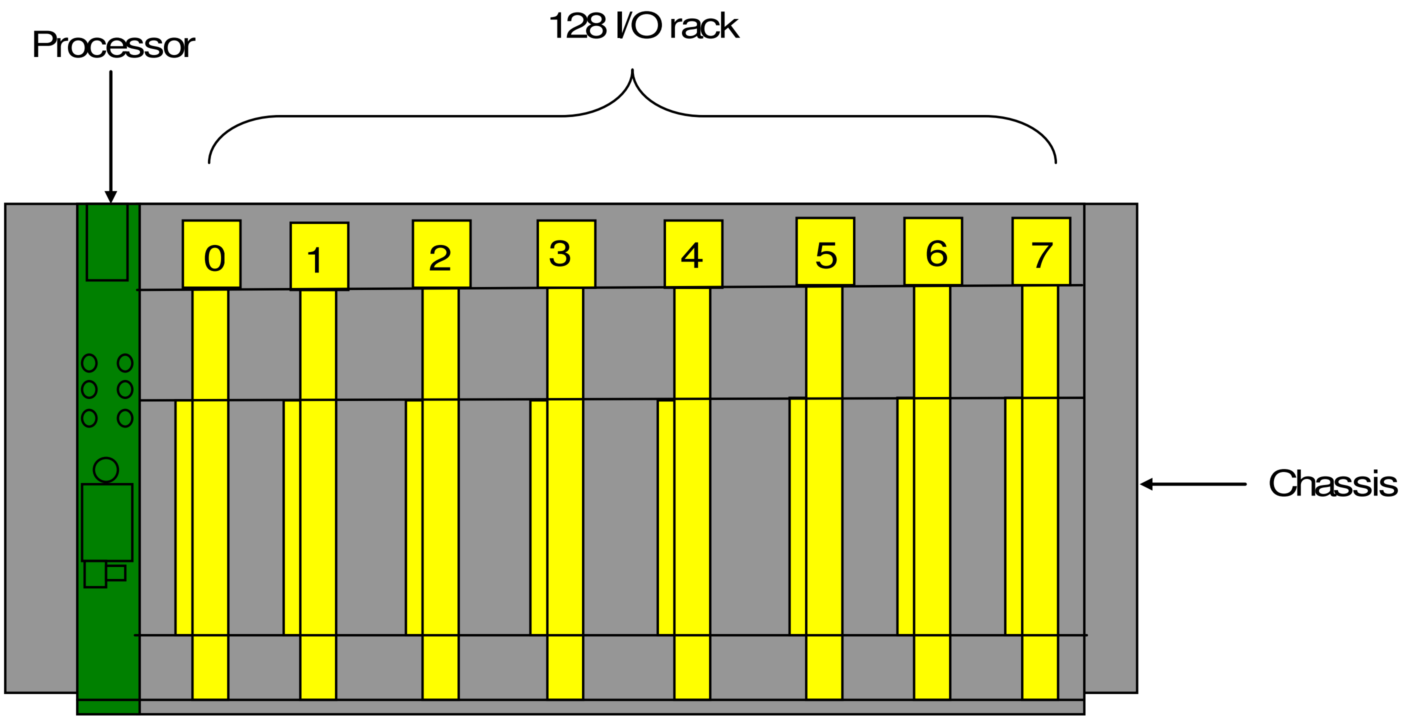


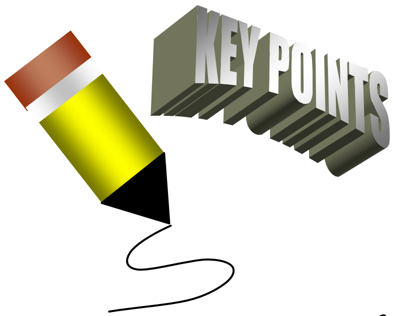
Figure 2-3:Typical I/O Image Tables

Output image table

Words																	
	O:00	0	1	2	3	4	5	6	7	10	11	12	13	14	15	16	17
	O:01	0	1	2	3	4	5	6	7	10	11	12	13	14	15	16	17
	O:02	0	1	2	3	4	5	6	7	10	11	12	13	14	15	16	17
	O:03	0	1	2	3	4	5	6	7	10	11	12	13	14	15	16	17
	O:04	0	1	2	3	4	5	6	7	10	11	12	13	14	15	16	17
	O:05	0	1	2	3	4	5	6	7	10	11	12	13	14	15	16	17
	O:06	0	1	2	3	4	5	6	7	10	11	12	13	14	15	16	17
	O:07	0	1	2	3	4	5	6	7	10	11	12	13	14	15	16	17

Input image table

Words																	
	I:00	0	1	2	3	4	5	6	7	10	11	12	13	14	15	16	17
	I:01	0	1	2	3	4	5	6	7	10	11	12	13	14	15	16	17
	I:02	0	1	2	3	4	5	6	7	10	11	12	13	14	15	16	17
	I:03	0	1	2	3	4	5	6	7	10	11	12	13	14	15	16	17
	I:04	0	1	2	3	4	5	6	7	10	11	12	13	14	15	16	17
	I:05	0	1	2	3	4	5	6	7	10	11	12	13	14	15	16	17
	I:06	0	1	2	3	4	5	6	7	10	11	12	13	14	15	16	17
	I:07	0	1	2	3	4	5	6	7	10	11	12	13	14	15	16	17



THE I/O SECTION…

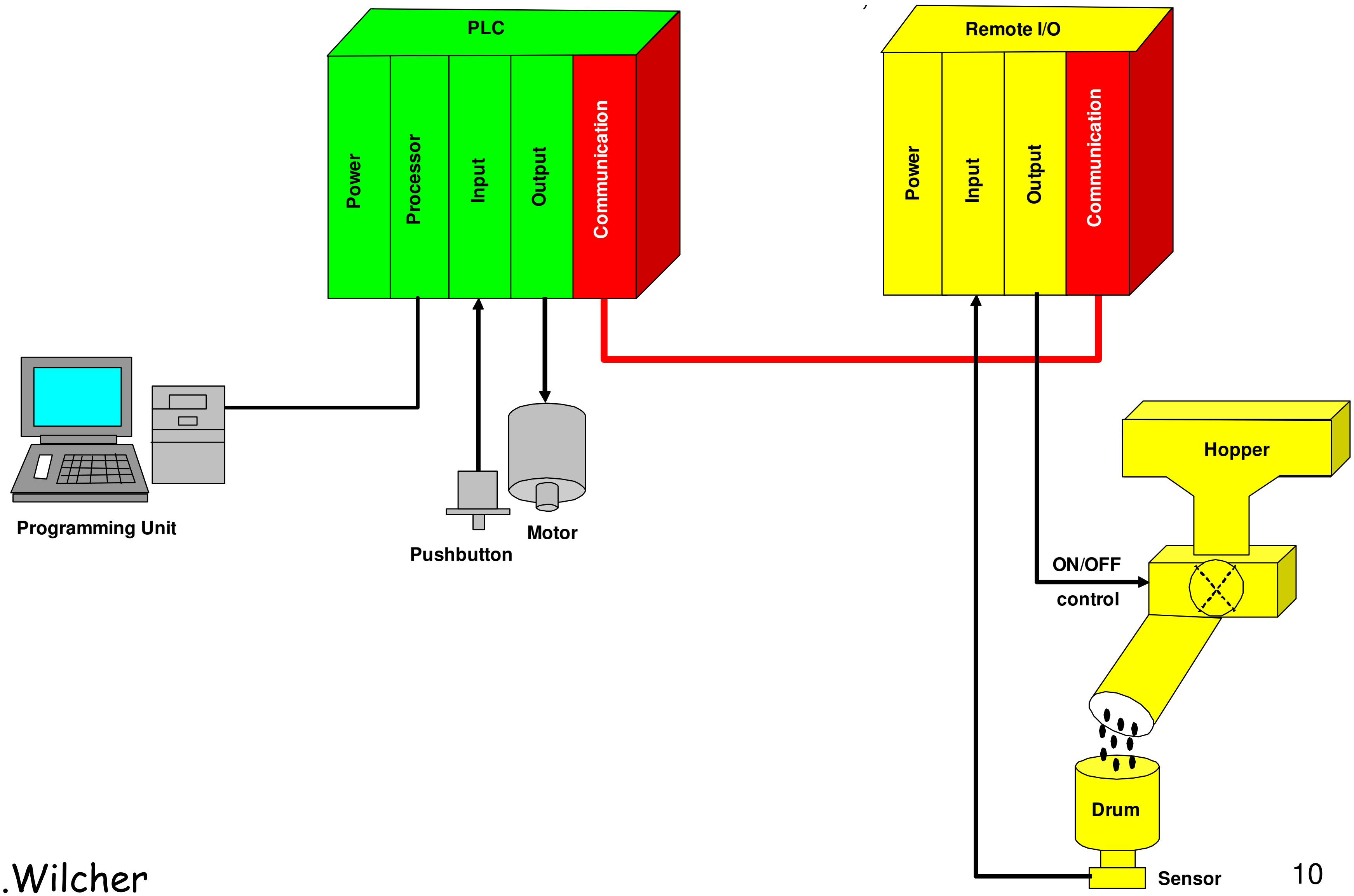
1.One benefit of a PLC system is the ability to locate the I/O modules near field devices. (minimize the amount of wiring required)

2. Remote Rack – located away from the processor module (See **Figure 2-4**)

3. To communicate with a remote rack, a special communications network is created.

4. Each remote rack requires a unique station number to distinguish one from another.

Figure 2-4:Remote I/O Rack



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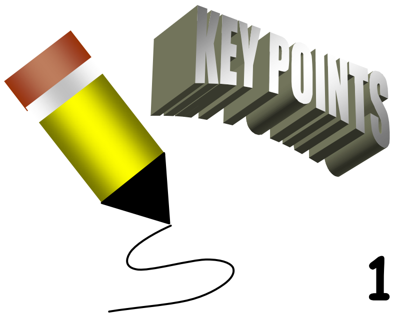


THE I/O SECTION…

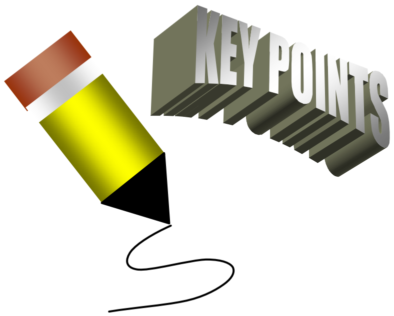
1. The remote racks are linked to the local rack through a communications module.

2. Cables connect the modules with each other.

3. If fiber optic cable is used between the CPU and I/O rack, its possible to operate I/O points from distances greater than 20 miles with no voltage drop(s).

4. Fiber optic cable will not pick up noise caused by adjacent high power lines or equipment normally found in an industrial environment. (Coaxial cable is more susceptible to this type of noise.)

5. Coaxial cable will allow remote I/O to be installed at distances greater than 2 miles.



THE I/O SECTION…

1. The location of a module within a rack and terminal number of a module to which an input or output device is connected will determine the device's address (See **Figure 2-5**).

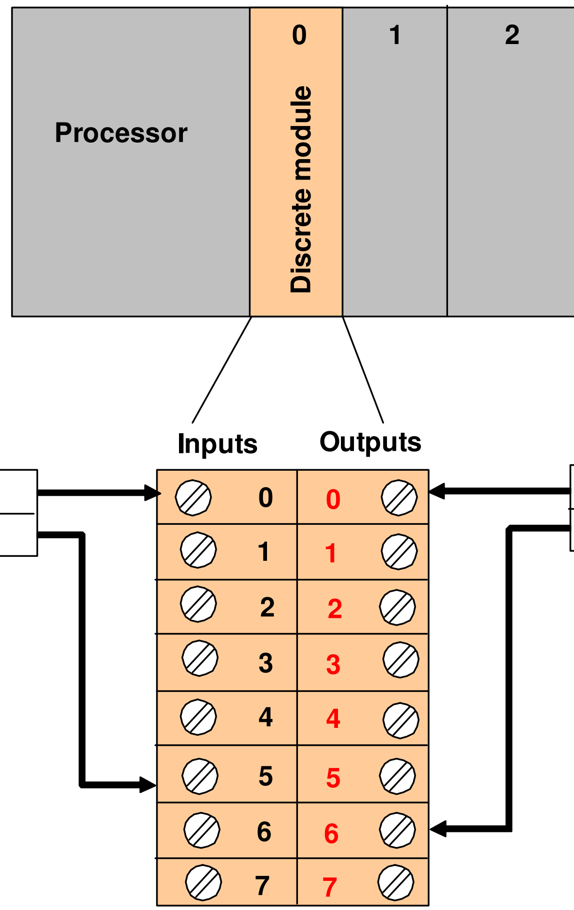
2. Each input and output device must have a specific address.

3. The processor uses this information to identify where the device is located to monitor or control.

4. Field wiring is easily connected to the I/O module housing as well as disconnecting to the PLC.

5. Indicator LEDs are added to the module for a quick ON or OFF status of each I/O circuit activated. Blown fuse indicators are available on some I/O modules.

Figure 2-5:I/O Module addressing



Address

Type	Slot	Word	Bit
I	0	0	0
I	0	0	5

Address

Type	Slot	Word	Bit
O	0	0	0
O	0	0	6

Figure 2-5:I/O Module addressing…

AB (Allen Bradley) PLC 5 addressing format

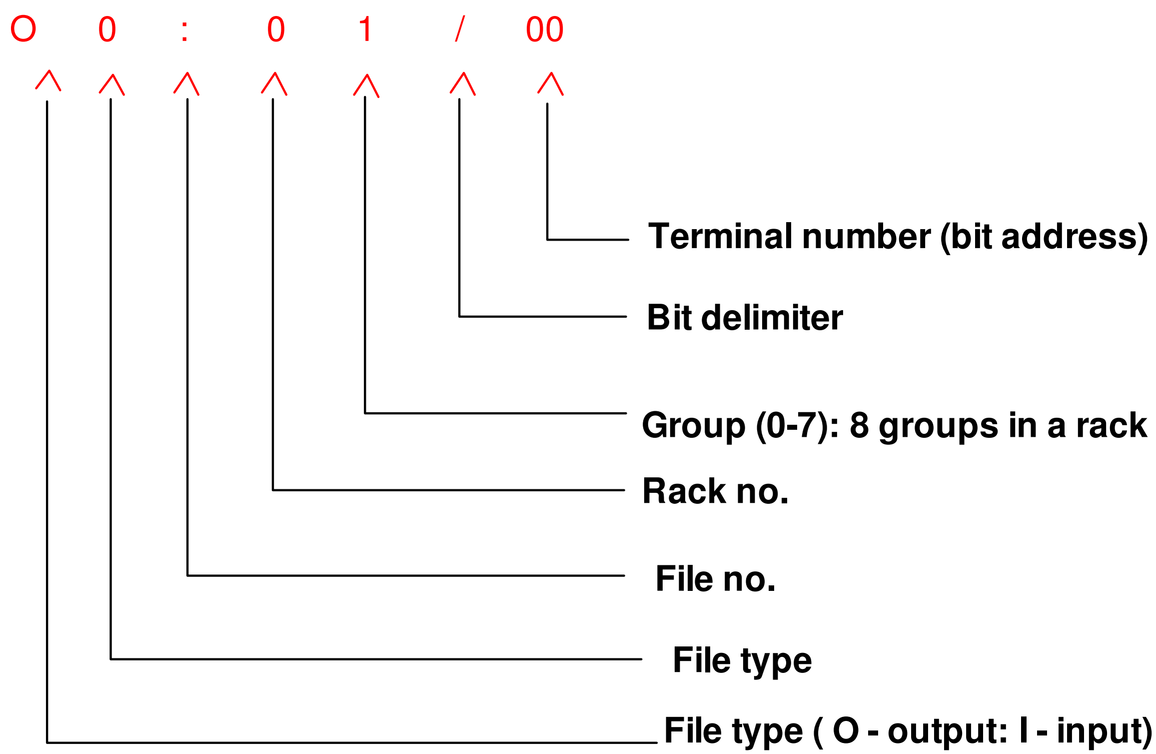


Figure 2-5:I/O Module addressing…

AB (Allen Bradley) SLC 500 addressing format

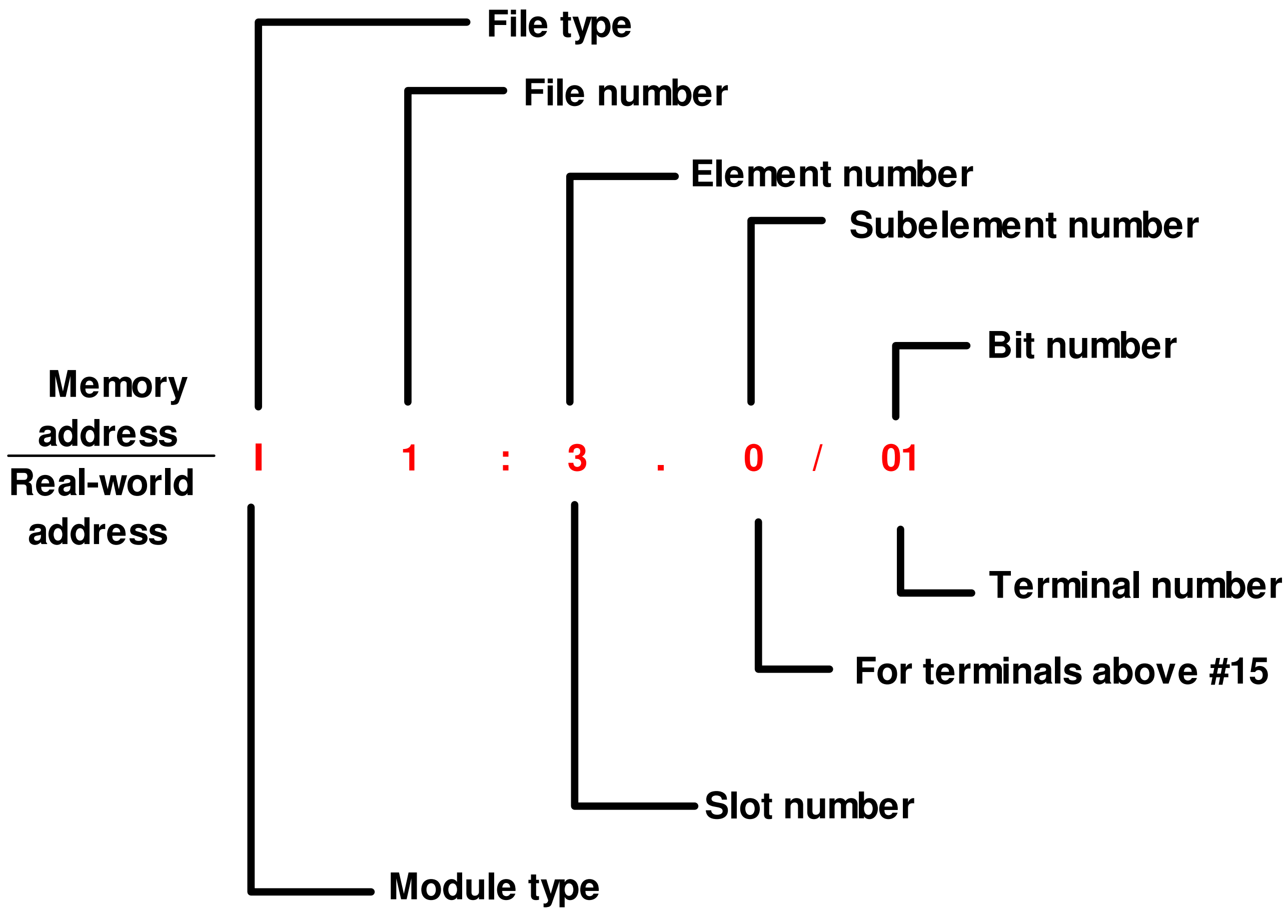
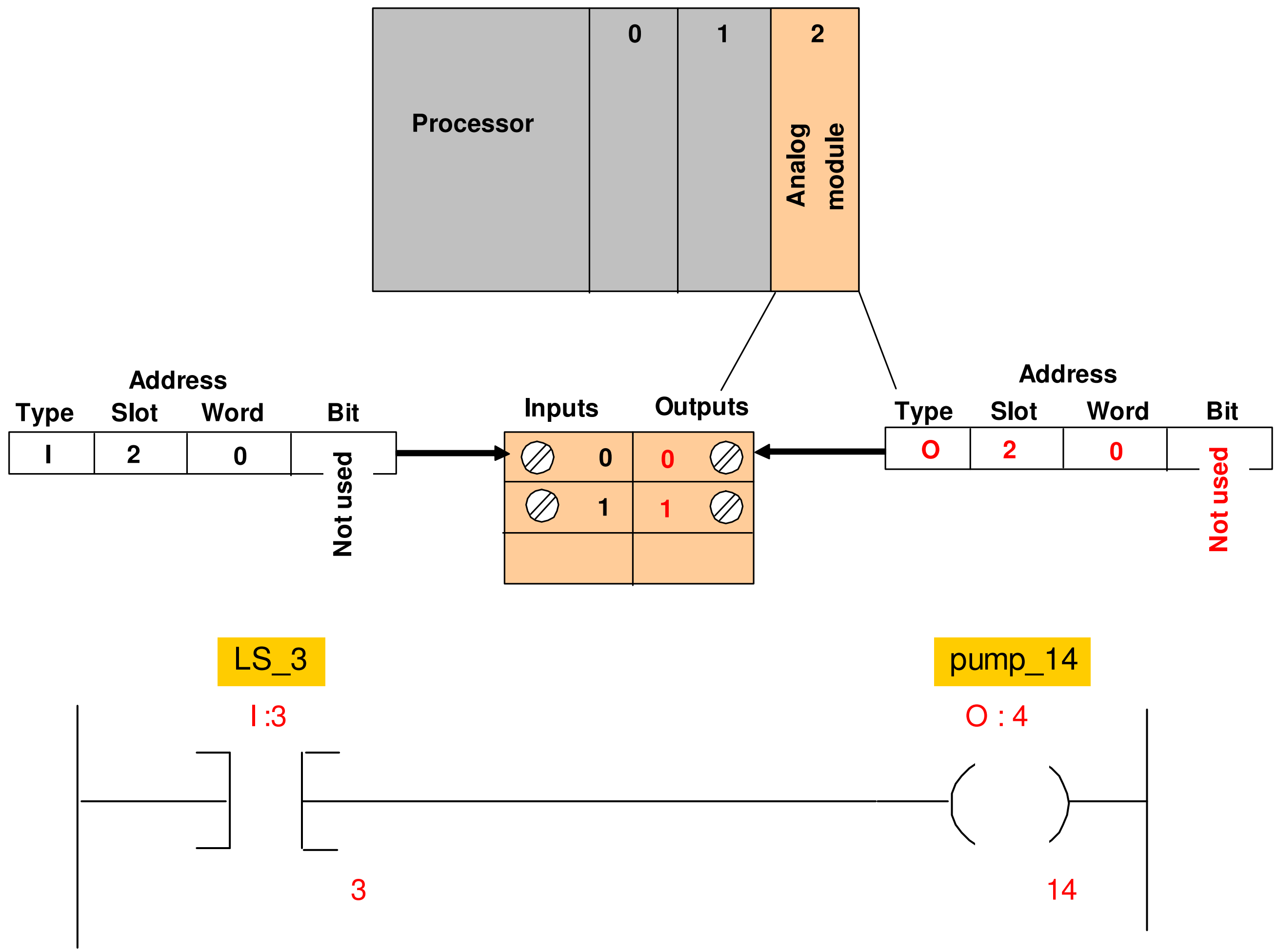
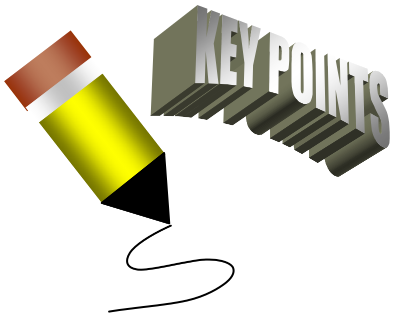


Figure 2-5:I/O Module addressing…

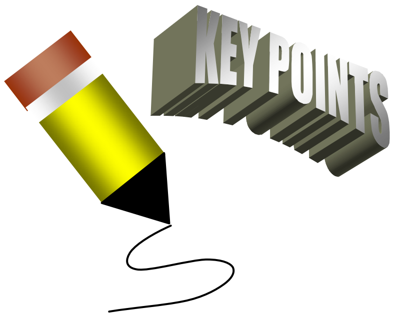




THE I/O SECTION…

Addressing Elements

1. **Type** –determines if an input or output is being addressed.
2. **Slot** – The physical location of the I/O module. NOTE: Maybe a combination of the rack number and the slot number when using expansion racks.
3. **Word and Bit**- Used to identify the actual terminal connection in a particular I/O module.
   a) A discrete module usually uses only 1 word.
   b) The design of a PLC determines whether the system is a capable of being addressed flexibly or its rigid in its addressing method.



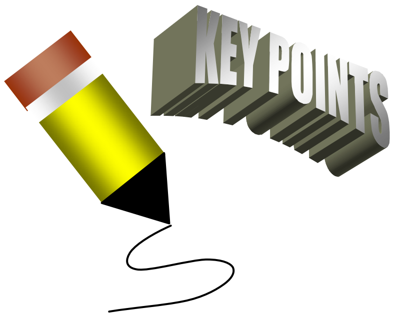
THE I/O SECTION…

What is a Flexible System?

1. Individual slot and point addresses are normally determined by the sequences in which the I/O racks are connected together.

2. In the case of some small PLCs, the system contains 1 rack and therefore has I/O addressing fixed by the manufacturer.

3. Actual address labeling varies greatly from manufacturer to manufacturer.



THE I/O SECTION…

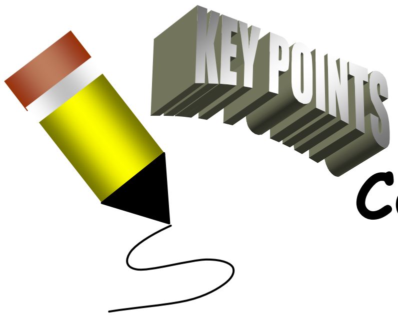
Construction of a Typical I/O Module

1.Consists of a printed circuit board (PCB) and terminal assembly. (See **Figure 2-6**)

2.The PCB contains the electronic circuitry used to interface the circuit of the processor with that of the input or output device .

3. It's designed to plug into a slot or connector in the I/O rack or directly into the processor.

4. The terminal assembly is attached to the front edge of the PCB and is used for making field-wiring connections.



THE I/O SECTION…

Construction of a Typical I/O Module...

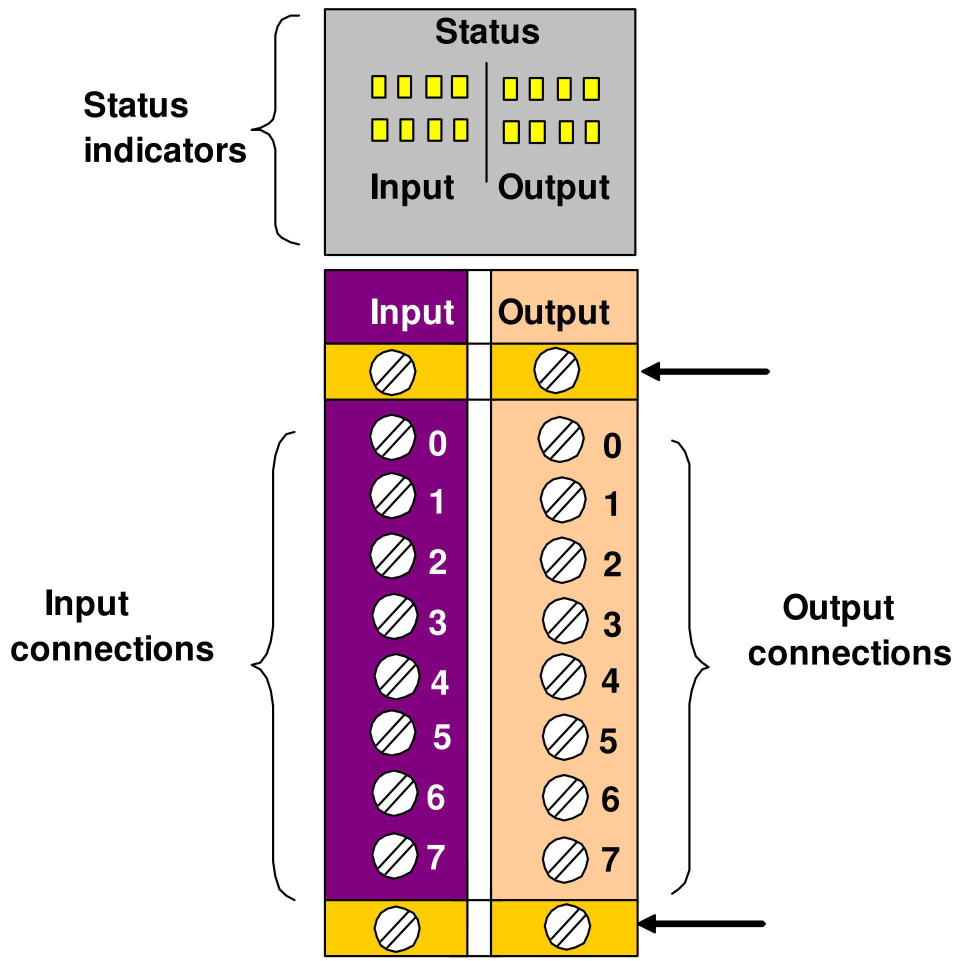
1. The module contains terminals for each I/O connection and to the power supply used to power the I/O.

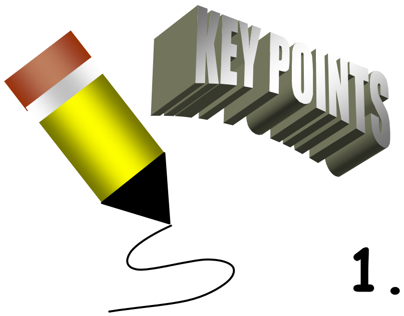
2. Most modules have plug-in wiring terminal strips.

3. If there is a problem with a module/ terminal strip, the entire unit is removed and replaced with a new one.

THE I/O SECTION…

Figure 2-6: Construction of a Typical I/O Module





THE I/O SECTION…

Construction of a Typical I/O Module...

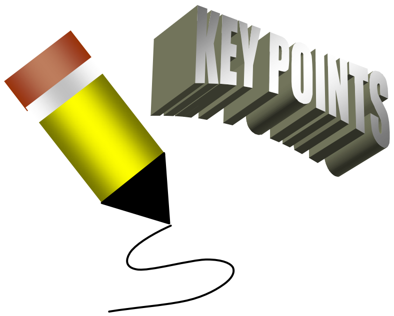
1.I/O module cards can be placed anywhere in the rack but are normally grouped together for ease of wiring.

2.I/O modules can be 8, 16,or 32 point cards .

3.The number refers to the number of I/O modules available.

4. The standard I/O module has 8 inputs or outputs.

5.A high-density module may have up to 32 I/O. **Advantage:** Possible to install 32 I/O in 1 slot for space savings.

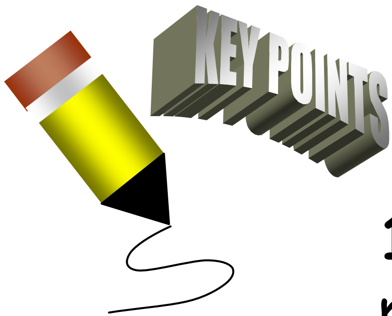


THE I/O SECTION…

Construction of a Typical I/O Module...

1.High density module disadvantage is not being able to handle much current per output.

2. High density module's 32 point cards usually have at least 4 common points .



DISCRETE I/O MODULES

1. The most common type of I/O interface module is the discrete type.

2. This type of interface connects field input devices of the ON/OFF nature. (Ex. Selector switches, pushbuttons, and limit switches)

3. Output control is limited to devices such as lights, small motor, solenoids, and motor starters that require ***simple*** ON/OFF switching.

4. The classification of discrete I/O covers bit oriented inputs and outputs.

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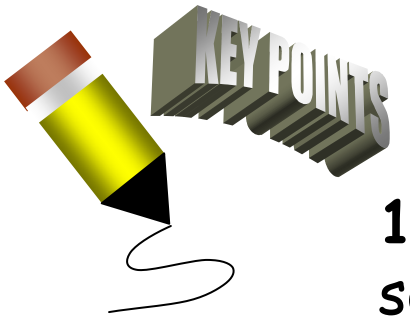


DISCRETE I/O MODULES…

1.Each discrete I/O module is powered by some field-supply voltage source.

2.Since these voltages can be of different magnitude or type, I/O modules are available at various ac and dc voltage ratings (See **Table 2-1**).

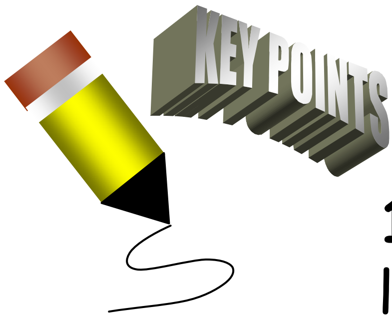
3. They receive their module voltage and current for proper operation from the backplane of the rack enclosure into which they are inserted.

4. Power from this supply is used to power the electronics, both active and passive, that reside on the I/O module PCB.

TABLE 2-1

COMMON RATINGS FOR DISCRETE I/O INTERFACE MODULES

Input Interfaces	Output Interfaces
12V ac/dc/24 Vac/dc	12 - 48 V ac
48V ac/dc	120V ac
120V ac/dc	230V ac
230V ac/dc	120V ac
5V dc (TTL level)	230V dc
	5V dc (TTL level)
	24V dc



DISCRETE I/O MODULES…

1. The relative higher currents required by the loads of an output module are supplied by user-supplied power.

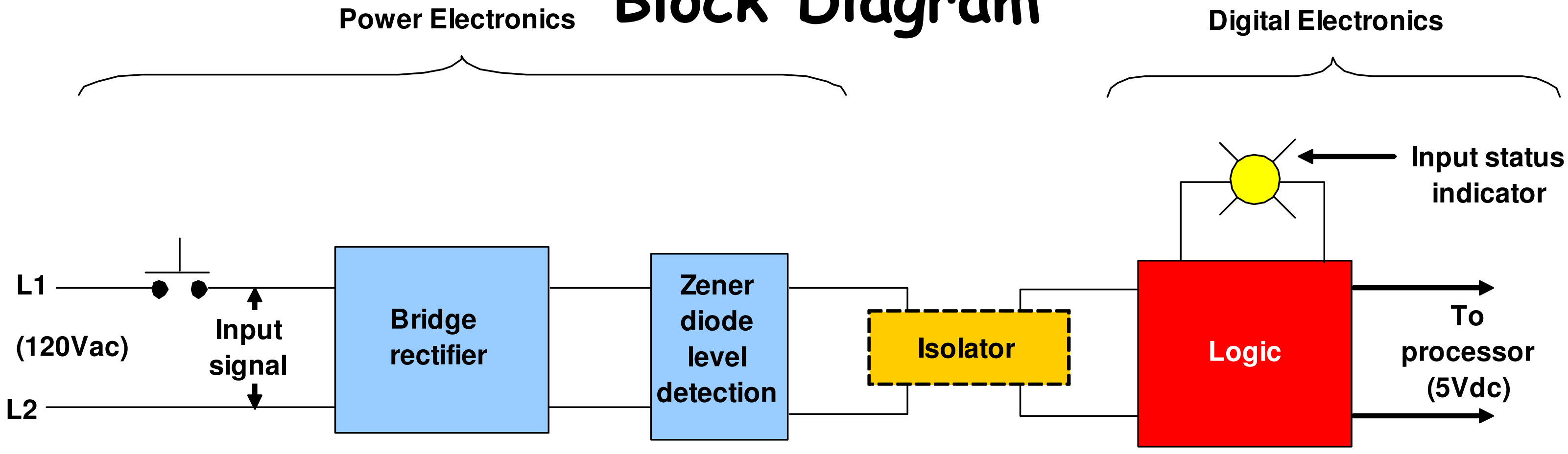
2. Module power supplies may be rated for 3A, 4A, 12A, or 16A depending on the type and number of modules used.

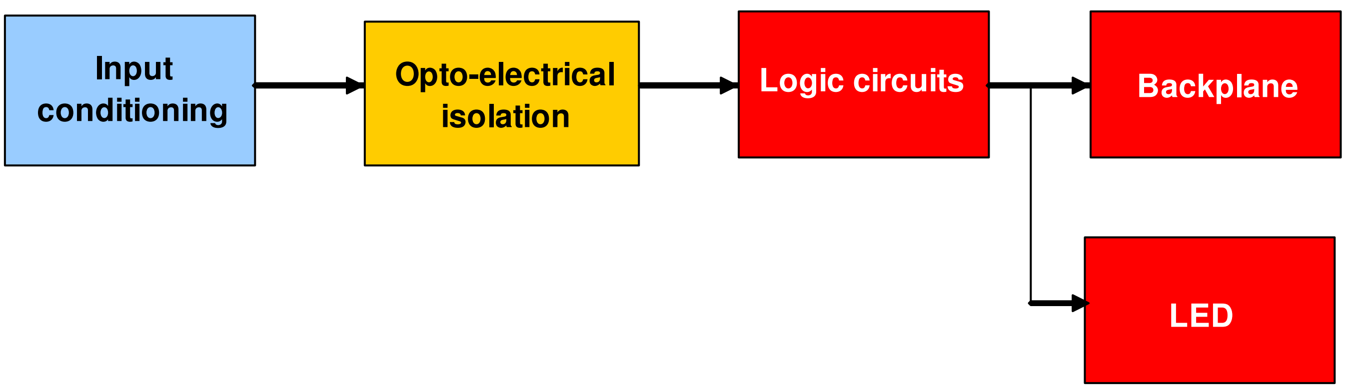
3. An AC discrete Input Module is built using both Analog Power and Digital Electronics. (See **Figure 2-7**)

4. Power from this supply is used to power the electronics, both active and passive, that reside on the I/O module PCB.

DISCRETE I/O MODULES…

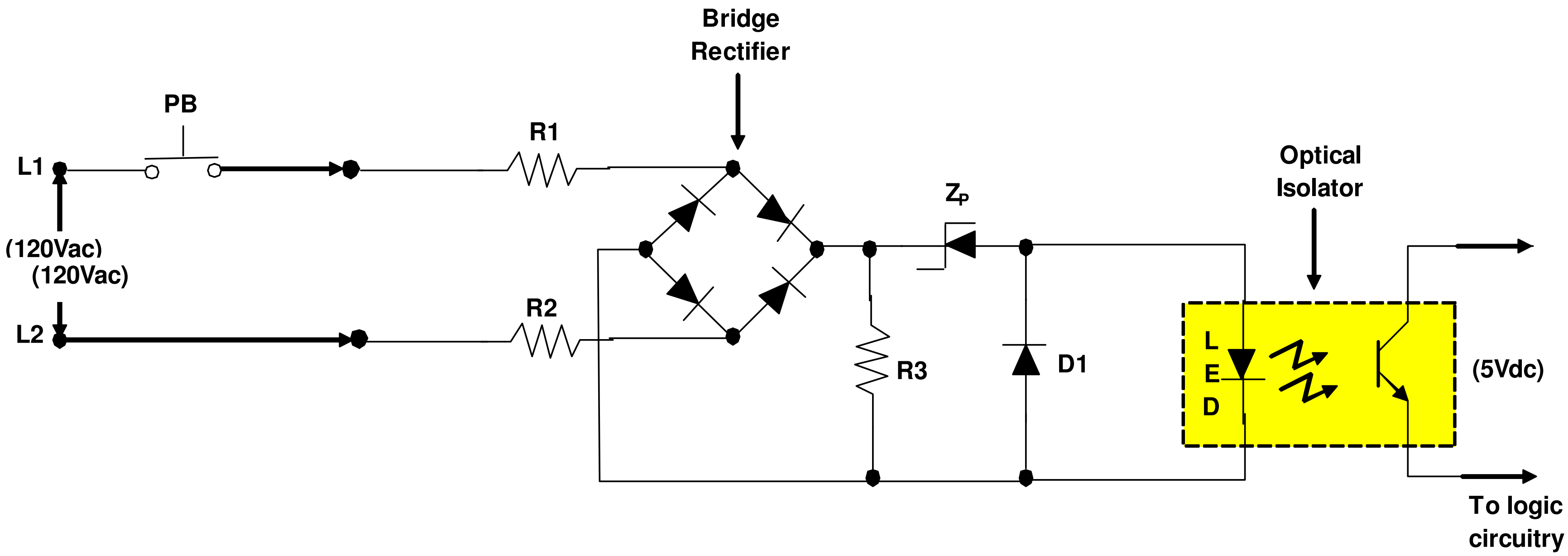
Figure 2-7:AC Input Module System Block Diagram





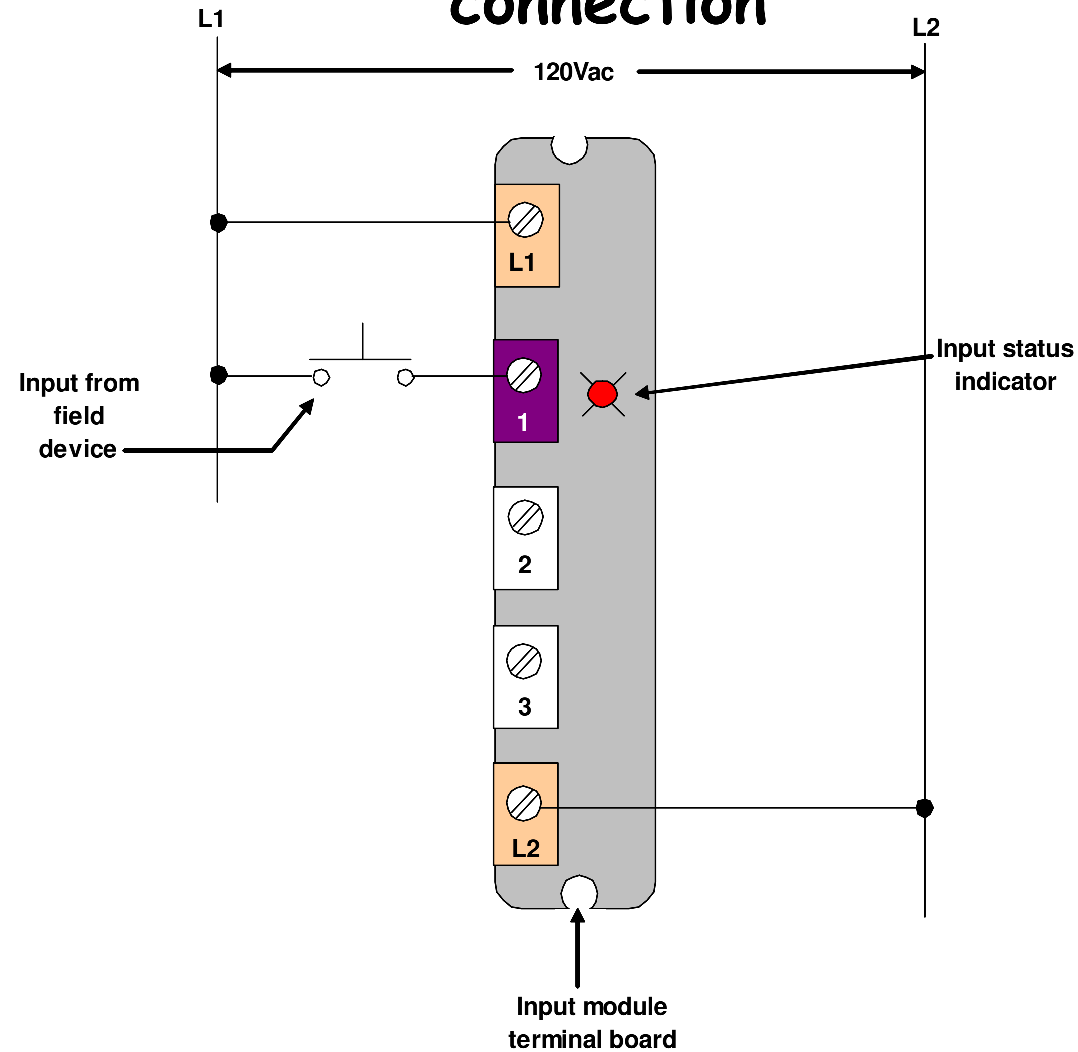
DISCRETE I/O MODULES…

Figure 2-8:Simplified Subcircuit Schematic Diagram of an AC Input Module



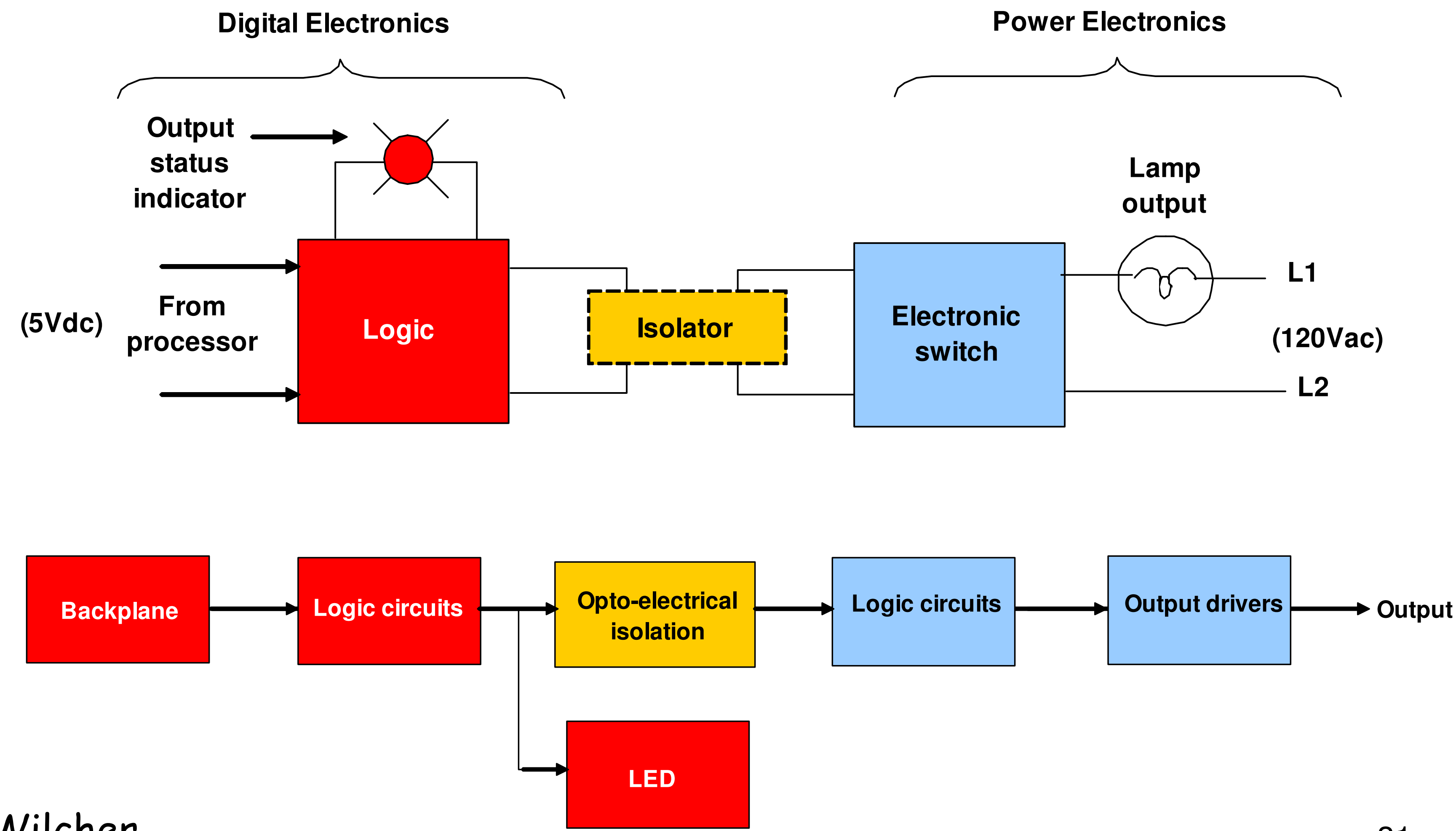
DISCRETE I/O MODULES…

Figure 2-9: Typical input module wiring connection



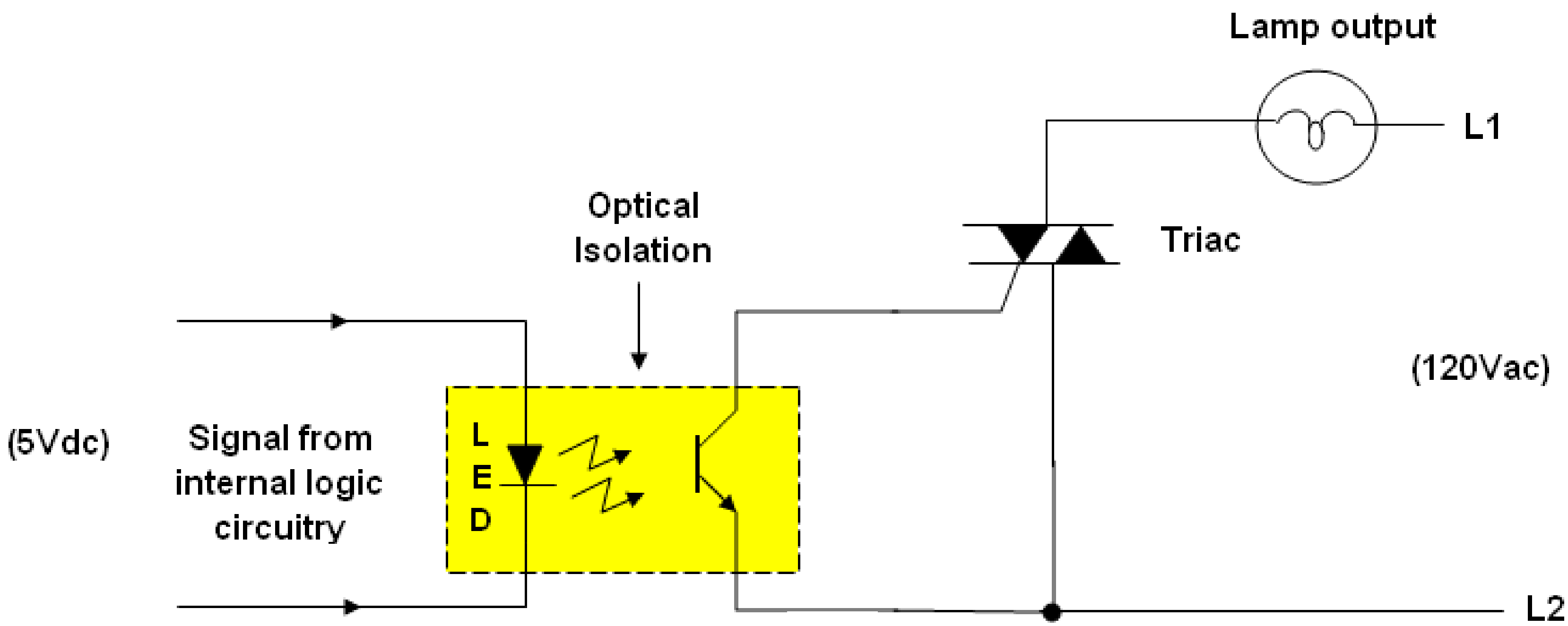
DISCRETE I/O MODULES…

Figure 2-10: AC Output Module System Block Diagram



DISCRETE I/O MODULES…

Figure 2-11: AC Output Module Driver Subcircuit Diagram



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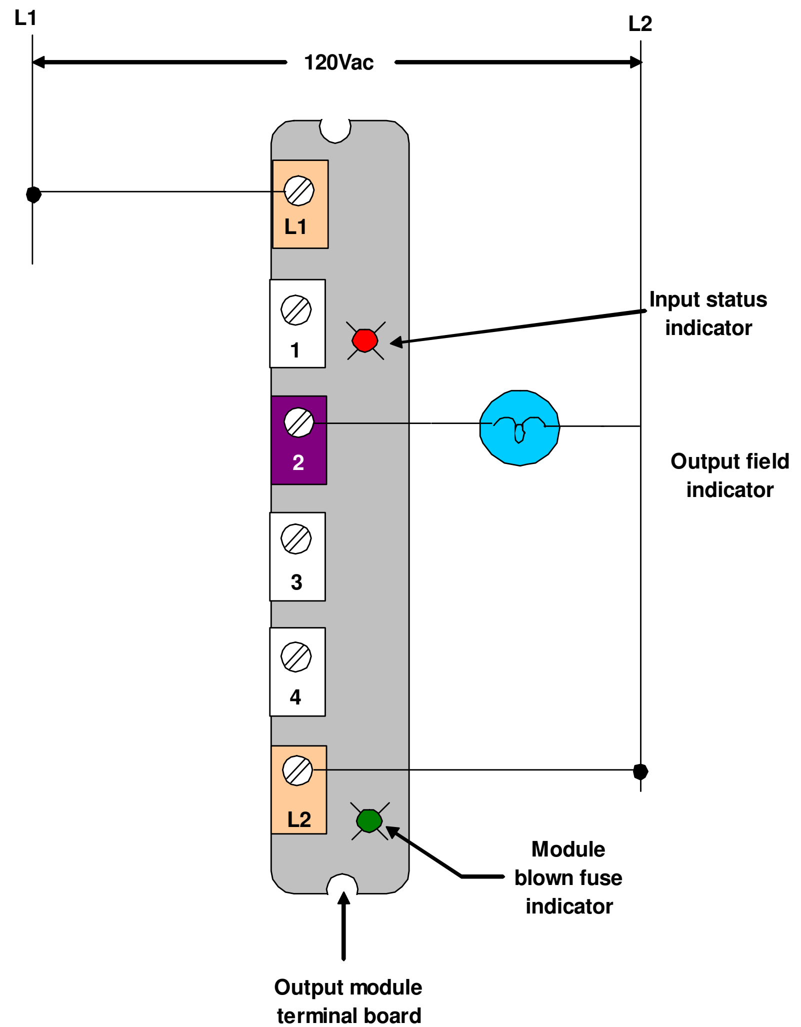
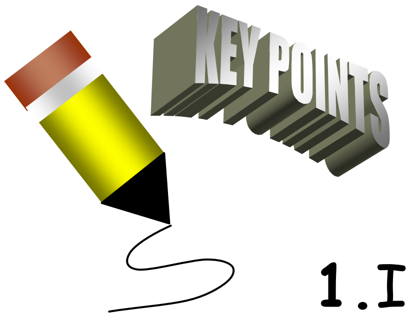
DISCRETE I/O MODULES…

Figure 2-12:Typical output module wiring connection





DISCRETE I/O MODULES…

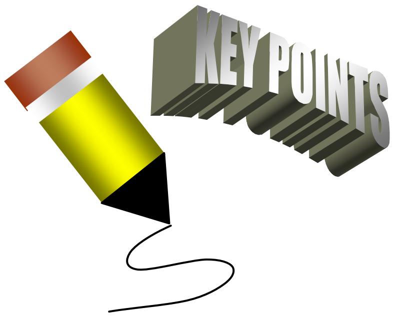
AC output module

1.Individual ac outputs are usually limited by the size of the triac to 1A or 2A.

2.The maximum current load for any 1 module is also specified.

3. To protect the output module circuits, specified current ratings should not be exceeded.

4. For controlling larger loads such as large motors, a standard control relay is connected to the output module.



DISCRETE I/O MODULES…

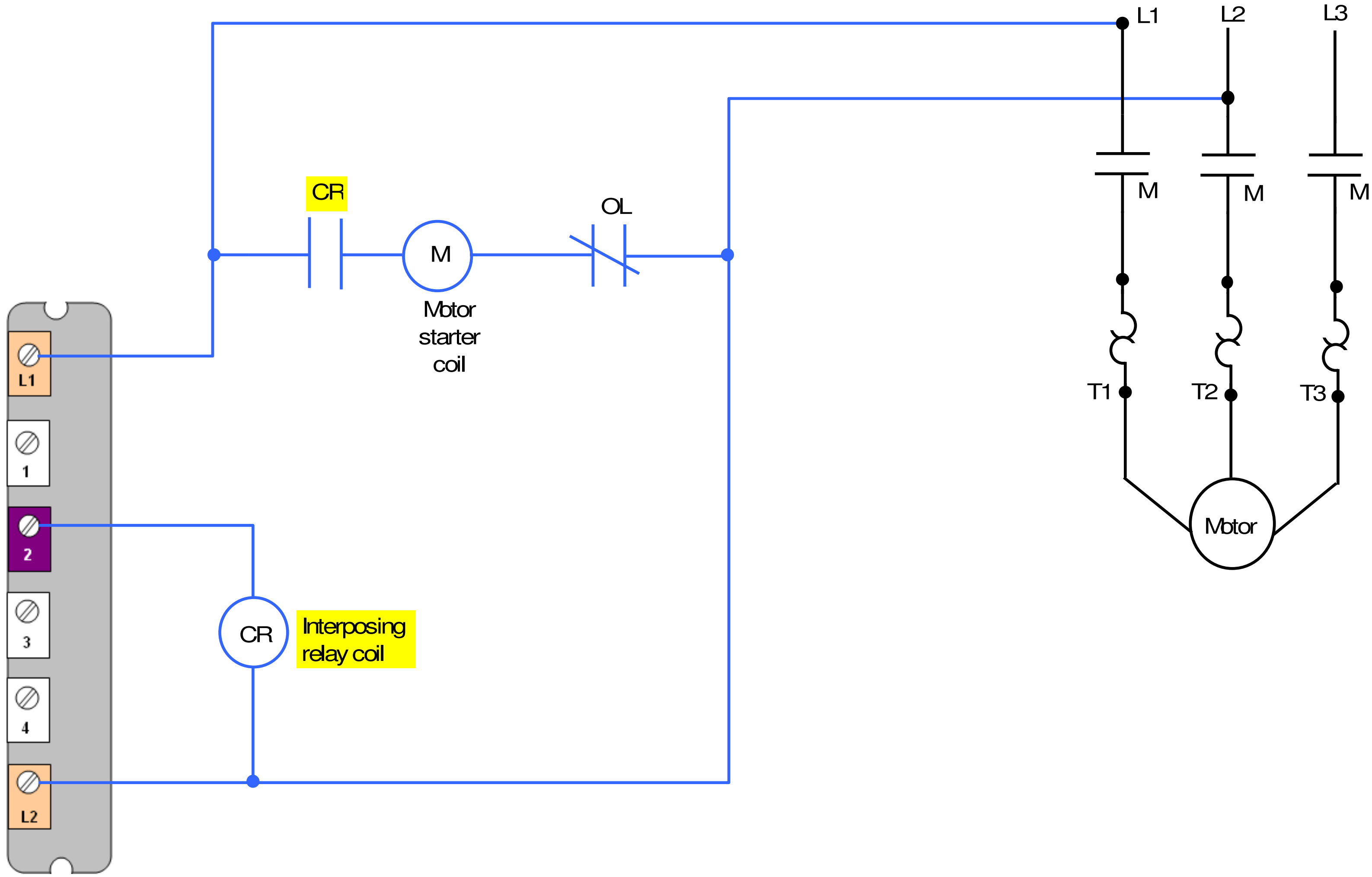
AC output module

1. The contacts of the relay can then be used to control larger load or motor starter.

2. When a control relay is used in this manner, it is called an ***interposing relay***. (See **Figure 2-13**)

DISCRETE I/O MODULES…

Figure 2-13:Interposing relay connection



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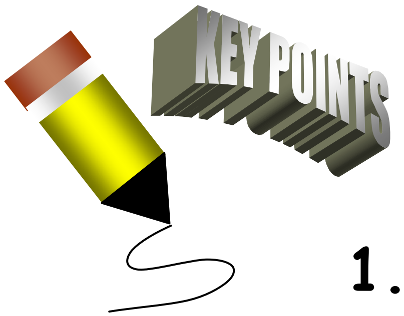


DISCRETE I/O MODULES…

Discrete output module

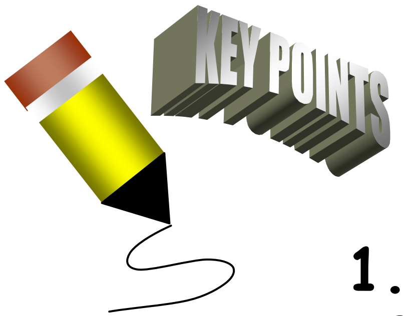
1.Discrete output modules are used to turn real world output devices either ON or OFF.

2.These modules can be used to control any 2-state device: Available in ac or dc versions.

3. They are made in various voltage ranges and current ratings.

4.Output modules can be purchased with transistor, triac, or relay devices.

5. Triac outputs can be used only for control of ac devices.



DISCRETE I/O MODULES…

Discrete output module

1.Transistor outputs can be used for control of dc devices.

2.Relay outputs can be used with ac or dc devices.

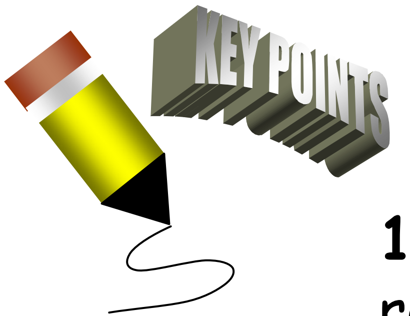
3.Switching response of relays are slower than solid state outputs (triac or transistor) because of the mechanical resistance of the spring used to return the contacts to their original position.

4.Allen Bradley (AB) modules are color coded for each identification (See **Table 2-2**).

Table 2-2:

AB Module Color Code Identification

Color	Type of I/O
Red	ac inputs/outputs
Blue	dc inputs/outputs
Orange	Relay outputs
Green	Specialty modules



DISCRETE I/O MODULES…

DC Field Devices

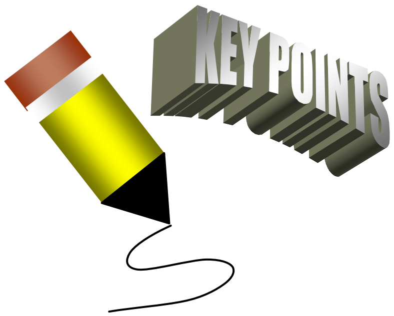
1. The design of dc field devices typically requires a specific ***sinking*** or ***sourcing*** circuit.

2. Depends on the internal circuits of the device.

3. Sinking and sourcing references are terms used to describe a current flow relationship between field input and output devices in a control system.

4. Sourcing I/O circuits (source) current to sinking field devices.

5. Sinking I/O circuits (receive) sink current from sourcing field devices



DISCRETE I/O MODULES…

DC Field Devices…

1.Another common name used for Sinking circuit is "Low Side" driver.

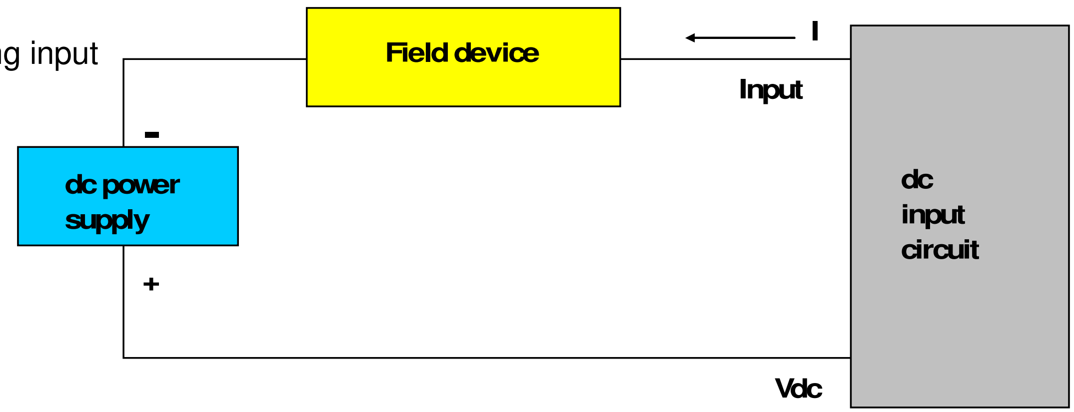
2.Another common name used for Sourcing circuit is "High Side" driver.

3.Sinking and sourcing references are terms used to describe a current flow relationship between field input and output devices in a control system.

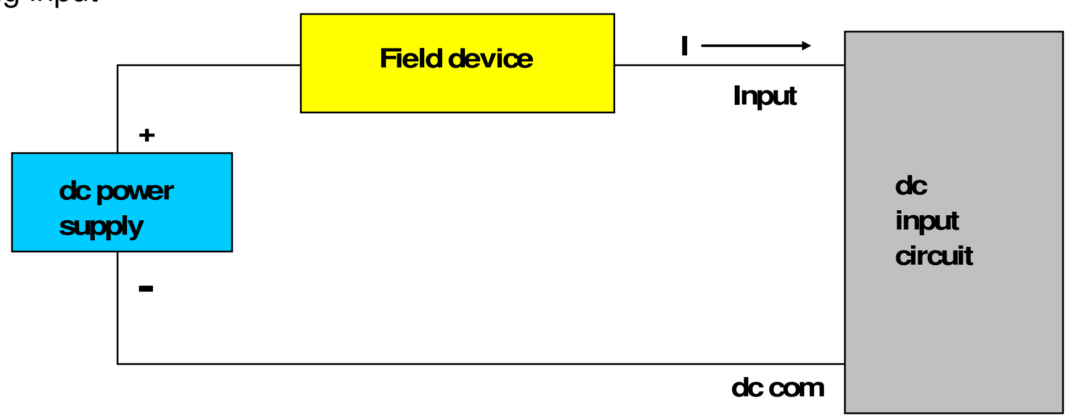
DISCRETE I/O MODULES…

Figure 2-14: Sinking and Sourcing Input devices

Sinking device with sourcing input module circuit



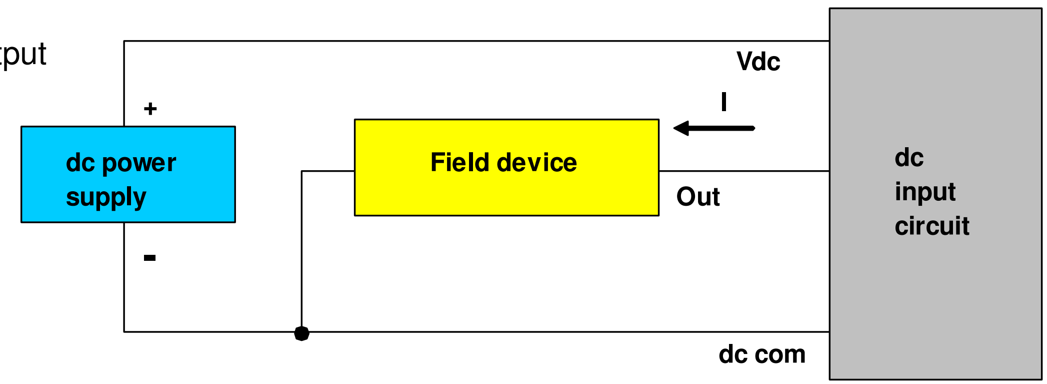
Sourcing device with sinking input module circuit



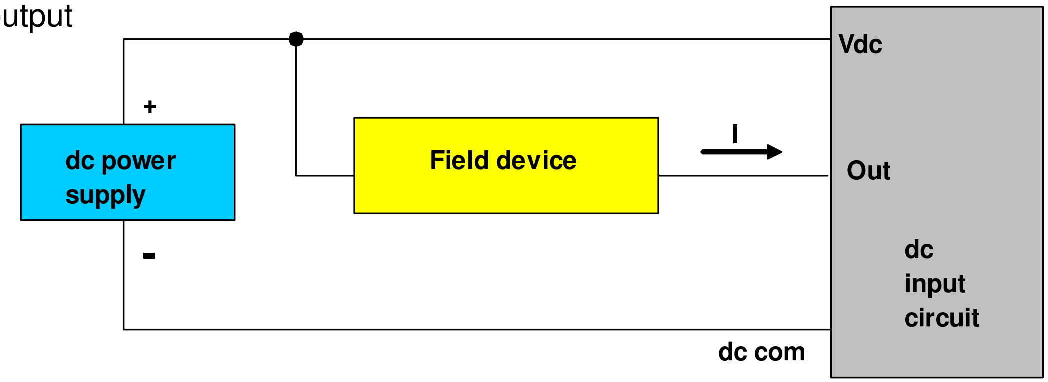
DISCRETE I/O MODULES…

Figure 2-15: Sinking and Sourcing Output devices

Sinking device with sourcing output module circuit



Sourcing device with sinking output module circuit



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