

IND121-Ind. Elect. II

Module 8

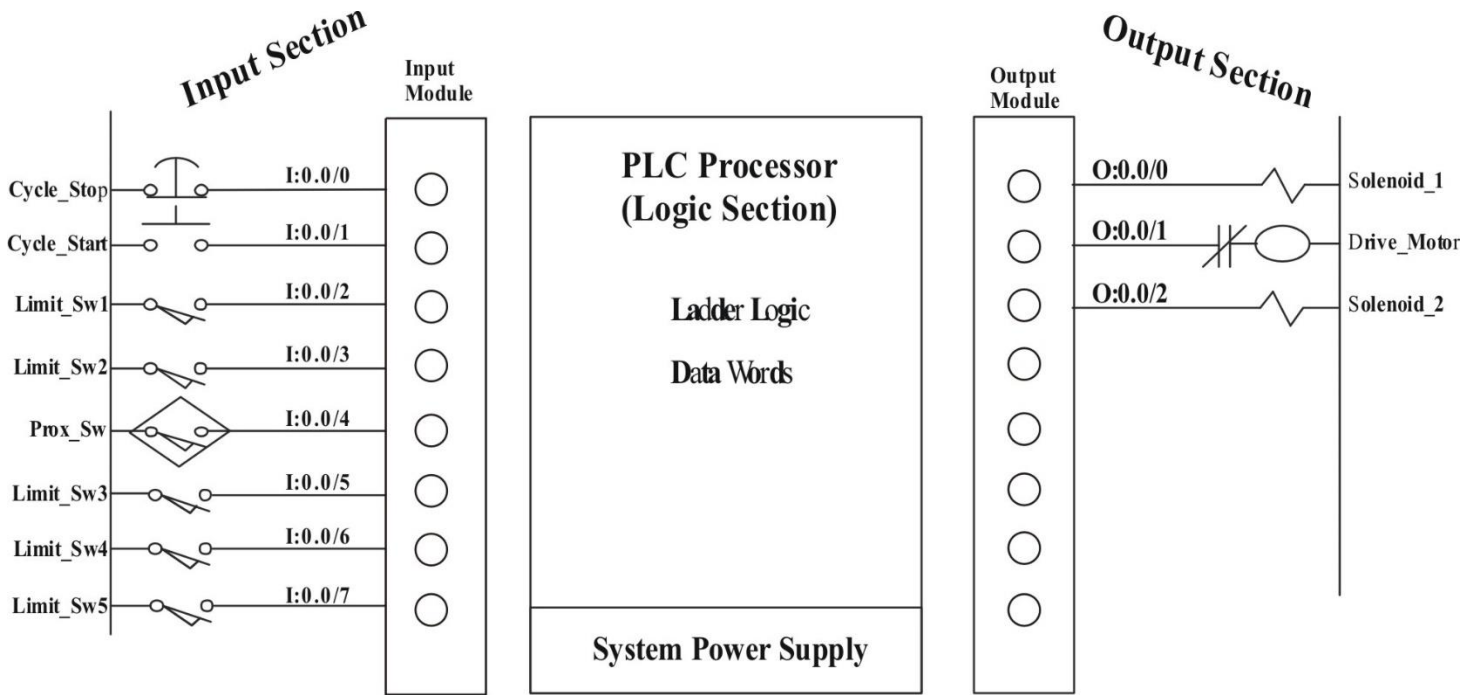
Basic PLC Operation

Created by Tom Wylie

On 11/23/16

Module Objectives:

- Explain the sections of a PLC system
- Explain the processor modes and how they affect the system
- Explain what turns on input and output indicator lights
- Explain the scan sequence of a PLC system
- Explain the addressing on a fixed I/O system (MicroLogix 1200)
- Interpret the I/O terminal definitions
- Explain the purpose of a Master Relay
- Explain the difference between a Triac and Relay type of output



Signals flow from the left to the right on a PLC system.

Signals come into the input modules from input devices, then the information comes into the processor, then the processor turns outputs on/off according to the program in the PLC.

Sections of a PLC:

A PLC system is made up of 4 parts: The PLC processor, PLC power supply, Input section and Output section.

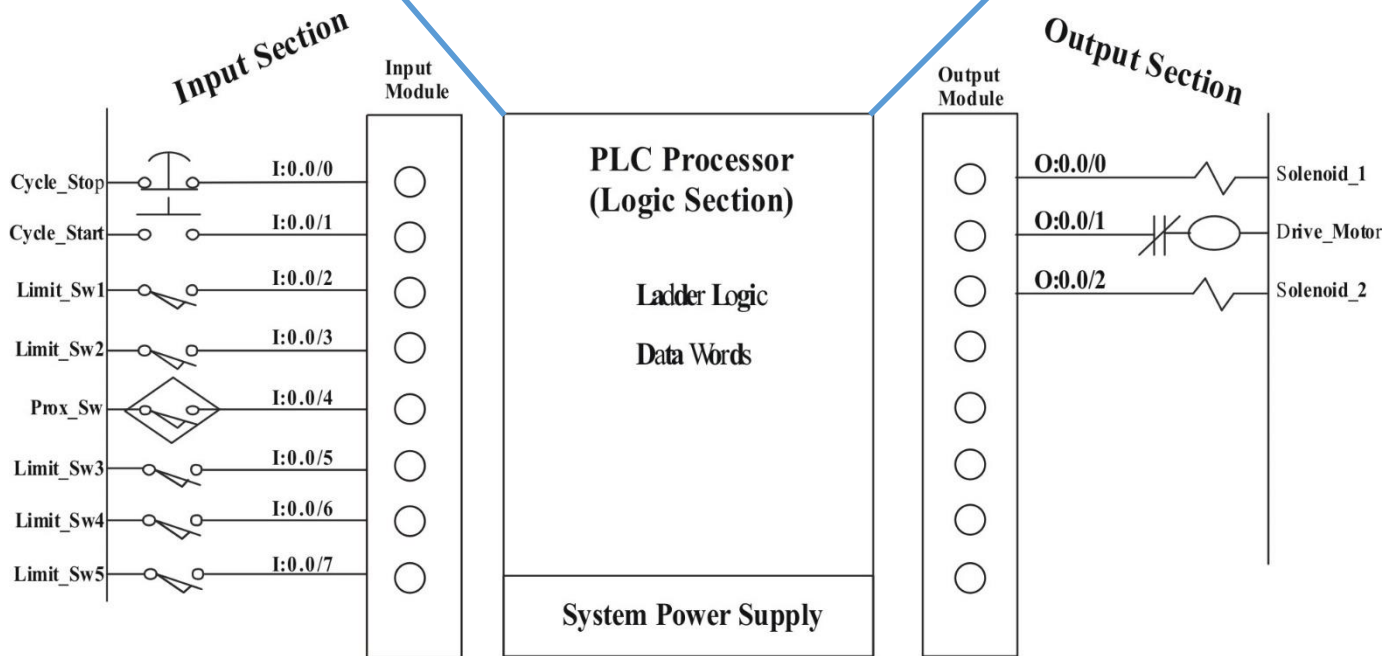
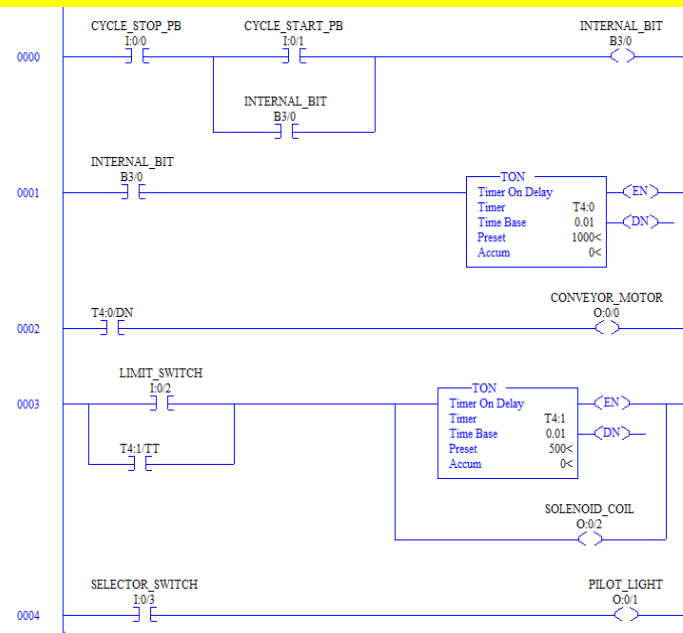
Input field devices (pushbuttons, etc.) are connected to the input section.

These signals are brought into the processor and compared with the PLC program. The PLC processor then sends the signals to the output section, turning output field devices based on the PLC program.

The PLC power supply powers the processor and the internal circuitry of the input and output sections.

In concept, the signals flow from the left to the right. It is important to understand signal flow when the Technician has to troubleshoot a faulty system.

The PLC Program that runs a machine



The PLC Program

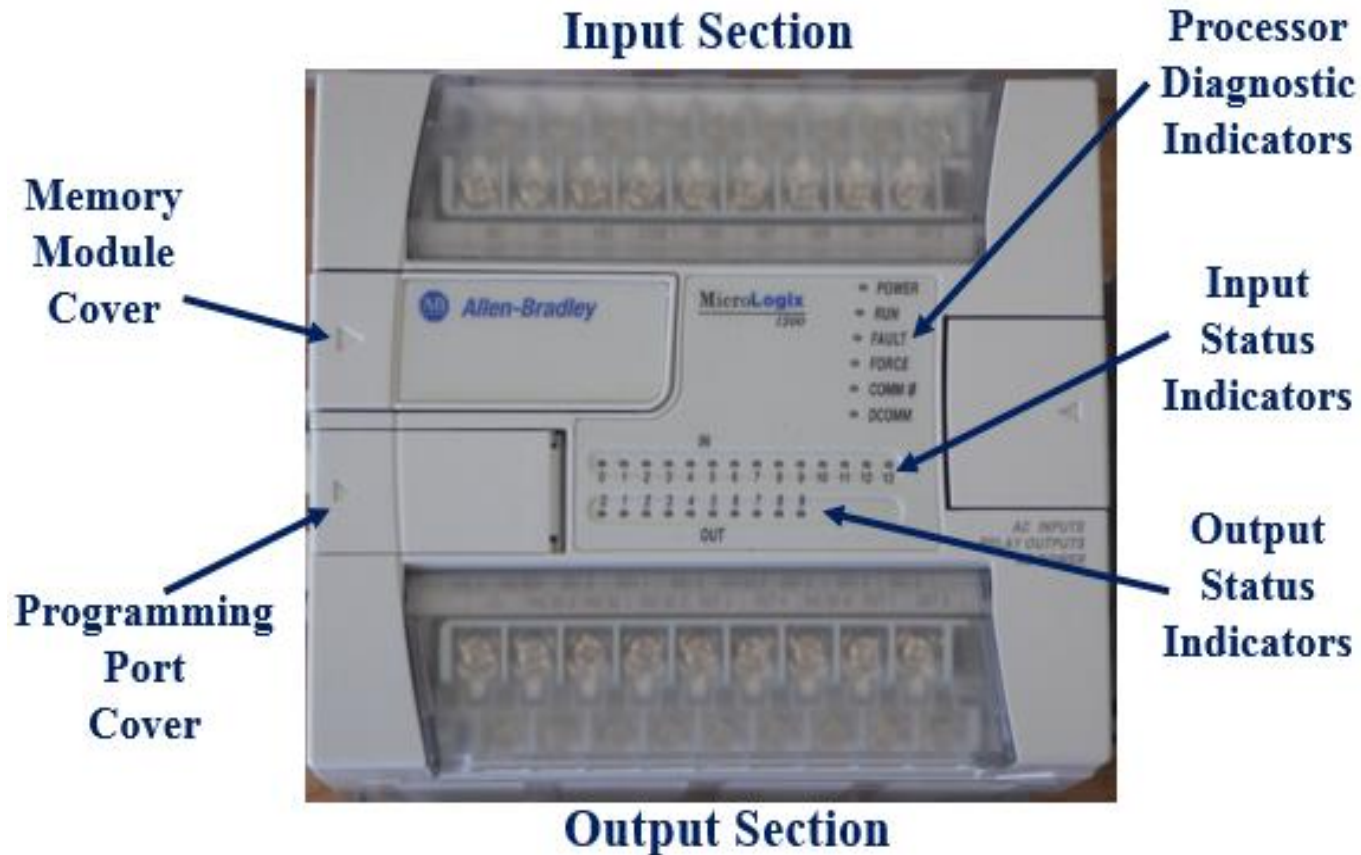
The PLC program does not come with the PLC if purchased by a distributor of the hardware. The PLC program is created by a Controls Engineer to control a machine in a certain sequence.

The PLC program is stored in the processor. When the processor is running, the program will control the machine.

The program is created using PLC programming software: RSLogix500.

Important: PLC programs do not go bad. The hardware goes bad. This could be the processor that holds the PLC program, or the field devices (Pushbuttons, solenoids, etc.), or the PLC I/O modules.

Input Section



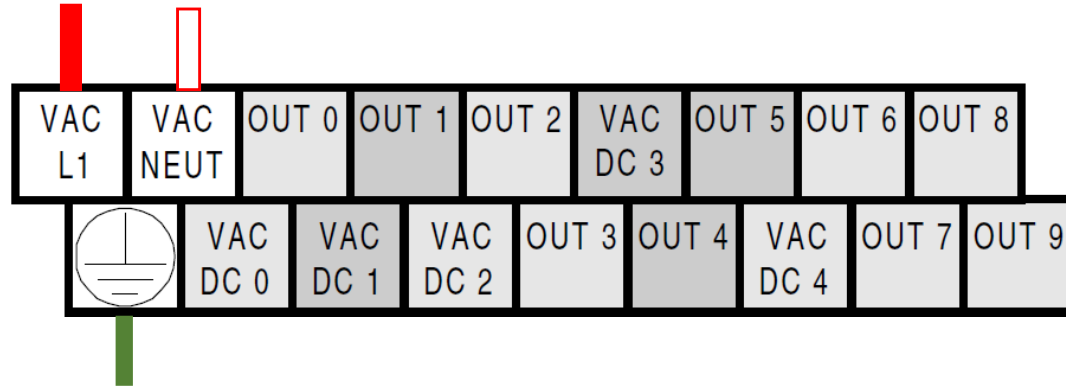
The MicroLogix1200 PLC

The PLC that will be used at NSCC for installation & wiring is the Allen Bradley MicroLogix1200. Some of the older wiring boards also have the MicroLogix1000 PLC. They are very similar.

This is small PLC that has the Power Supply, Processor, Input & Output sections all in the same unit. The user can add expansion I/O modules to increase the amount of I/O or get different types of I/O.

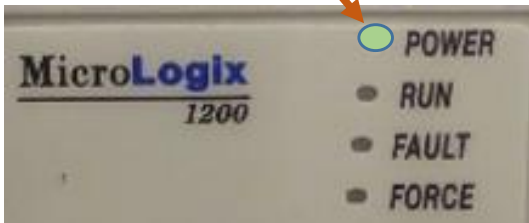
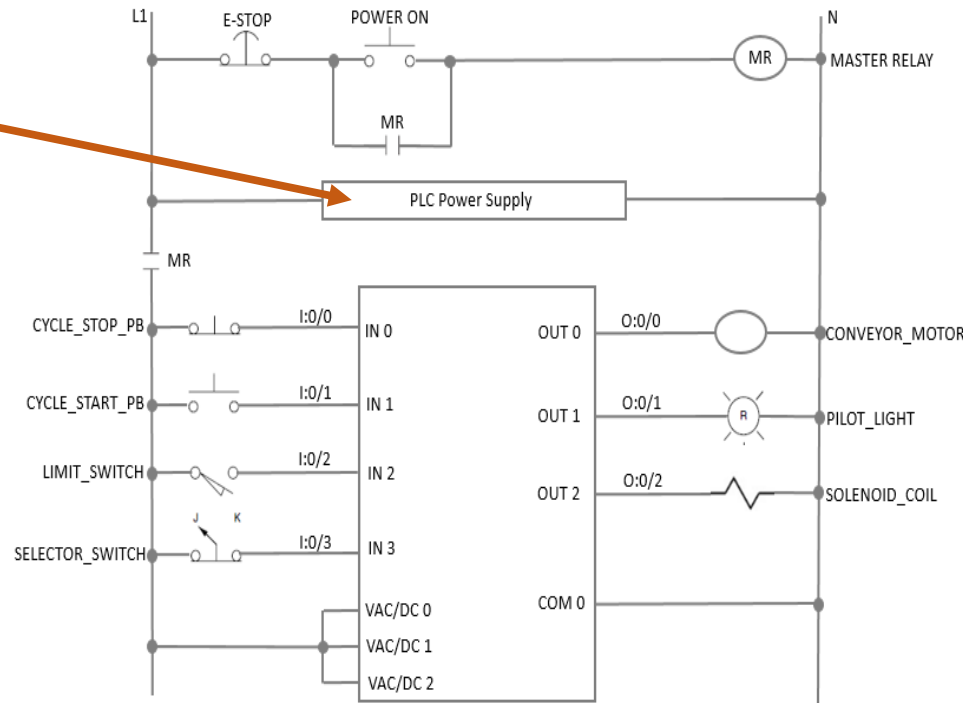
The user can add a memory module to backup the PLC program and load it on power up. There is also a programming port that will allow the connection of a computer so the user can use RSLinx and RSLogix500 to load a program or go online to the ML1200 for troubleshooting.

120VAC Power



PLC Power Supply
on an electrical
print

The Power Light
on the front of the
processor will
indicate that the
P/S is powered



The PLC Power Supply

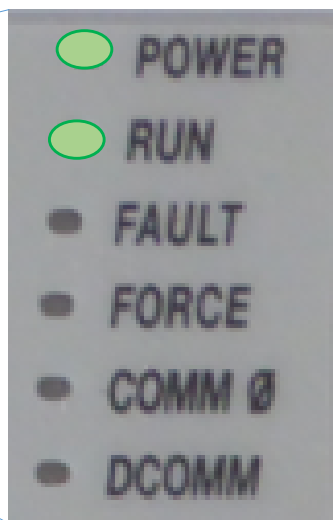
The power supply on a PLC system is powered by either 120VAC or 24VDC. In the illustration shown, it is powered with 120VAC.

The power supply voltage is stepped down to a lower DC voltage is powers the processor portion of the PLC, as well as the internal operation of the inputs and outputs on the ML1200.

The power supply protects the system from overvoltage, over current, and from transients (electrical spikes).

The middle diagram shows what PLC power supply looks like on a print.

A power indicator light on the front of the processor will indicate that the power supply is working correctly.



Processor Modes

The processor has primarily two modes of operation: Run mode and Program mode.

When the processor is in the Run mode it performs what is called a “Scan”, which means it scans through and interprets the PLC program and updates the I/O. More about the I/O in following slides.

The most important thing to understand now is that if the processor goes into the Program mode, the outputs of this type of controller is disabled, which means a machine will shut down.

There is a RUN diagnostic indicator on the front of the processor. When it is in the Run mode, this light will be on.

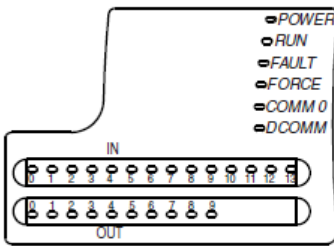
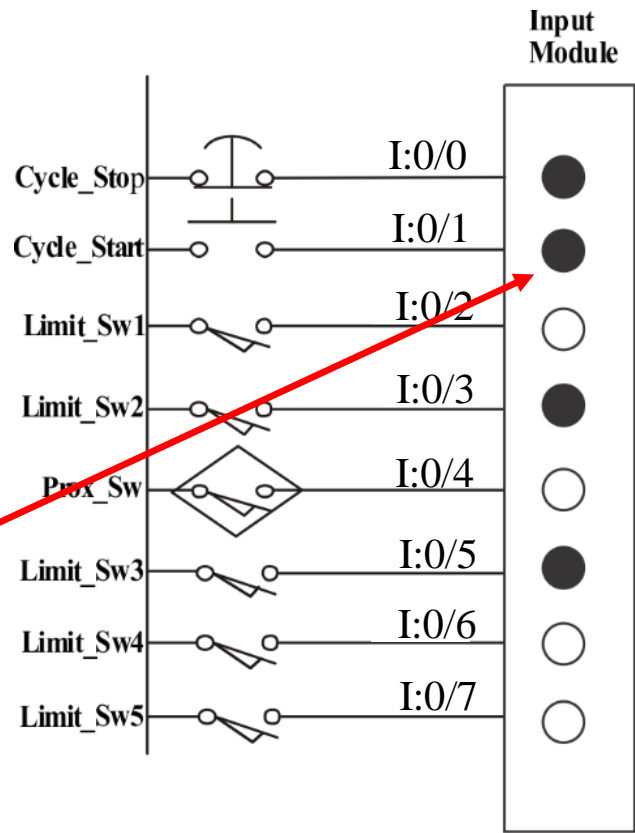


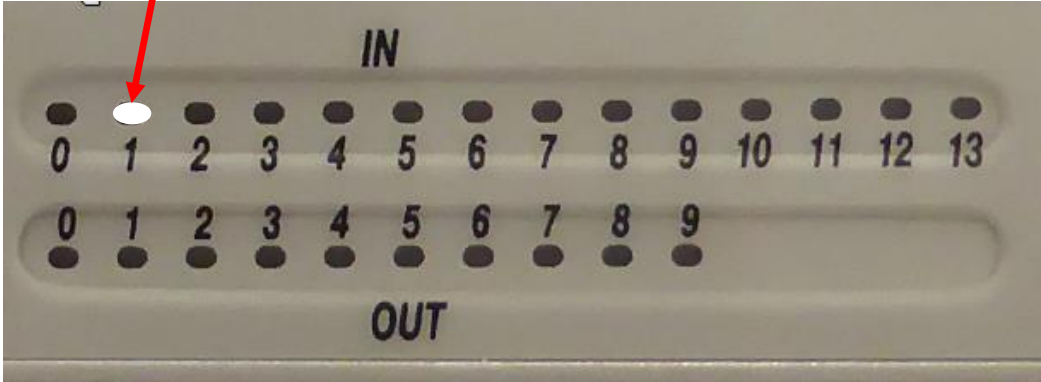
Table C.1 Controller LED Indicators

LED	Color	Indicates
POWER	off	No input power, or power error condition
	green	Power on
RUN	off	Not executing the user program
	green	Executing the user program in run mode
	green flashing	Memory module transfer occurring
FAULT	off	No fault detected
	red flashing	Application fault detected
	red	Controller hardware faulted
FORCE	off	No forces installed
	amber	Forces installed
COMM 0 ⁽¹⁾	off	Not transmitting via RS-232 port
	green	Transmitting via RS-232 port
DCOMM ⁽²⁾	off	Configured communications
	green	Default communications
INPUTS	off	Input is not energized
	amber	Input is energized (terminal status)
OUTPUTS	off	Output is not energized
	amber	Output is energized (logic status)

When the PB is pressed, it sends
A 120V signal into the input terminal,
Which turns on the input indicator
Light.



Input & Output Status Indicators on a ML1200



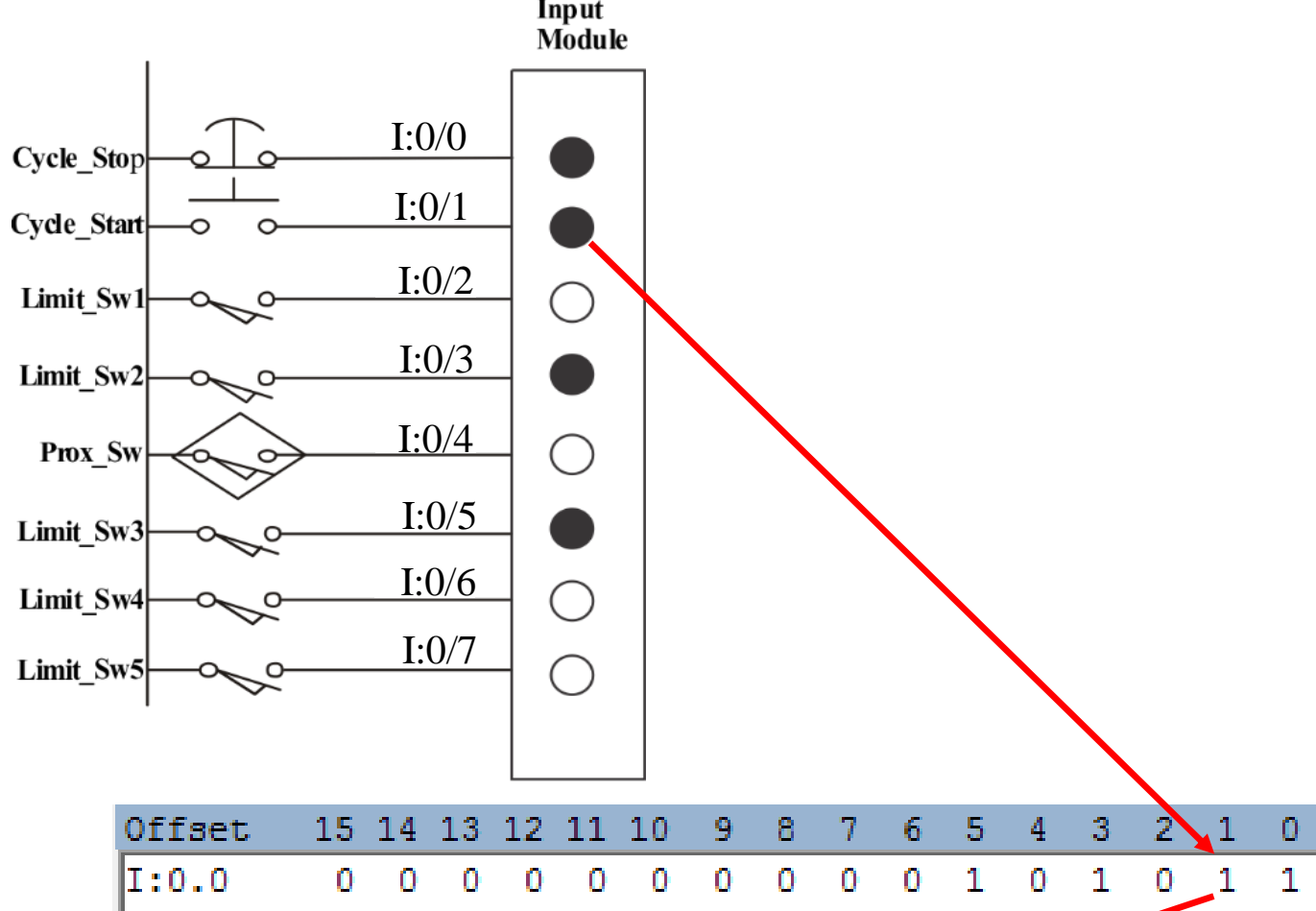
PLC Input Module

Discrete input devices (pushbuttons, limit switches, proximity switches, etc.) are wired to the terminals of an input module.

In this example the module is 120VAC input module. When an input device is activated, it will send 120V into the input terminal, which will turn on the input indicator light.

When the input indicator light is on, the module sends a signal into the PLC memory. Actually it sends a value of “1” into the bit in the PLC memory, that matches it’s input address.

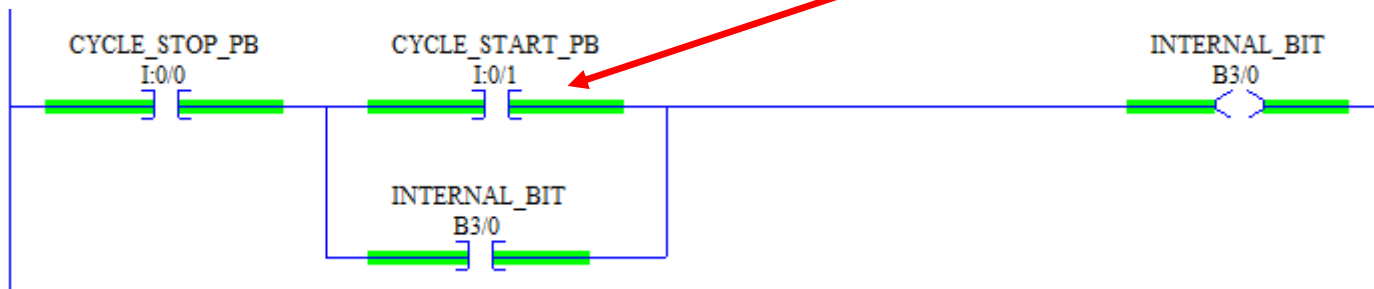
Notice that each input has a unique address. If it is an input, the address starts with an “I”.



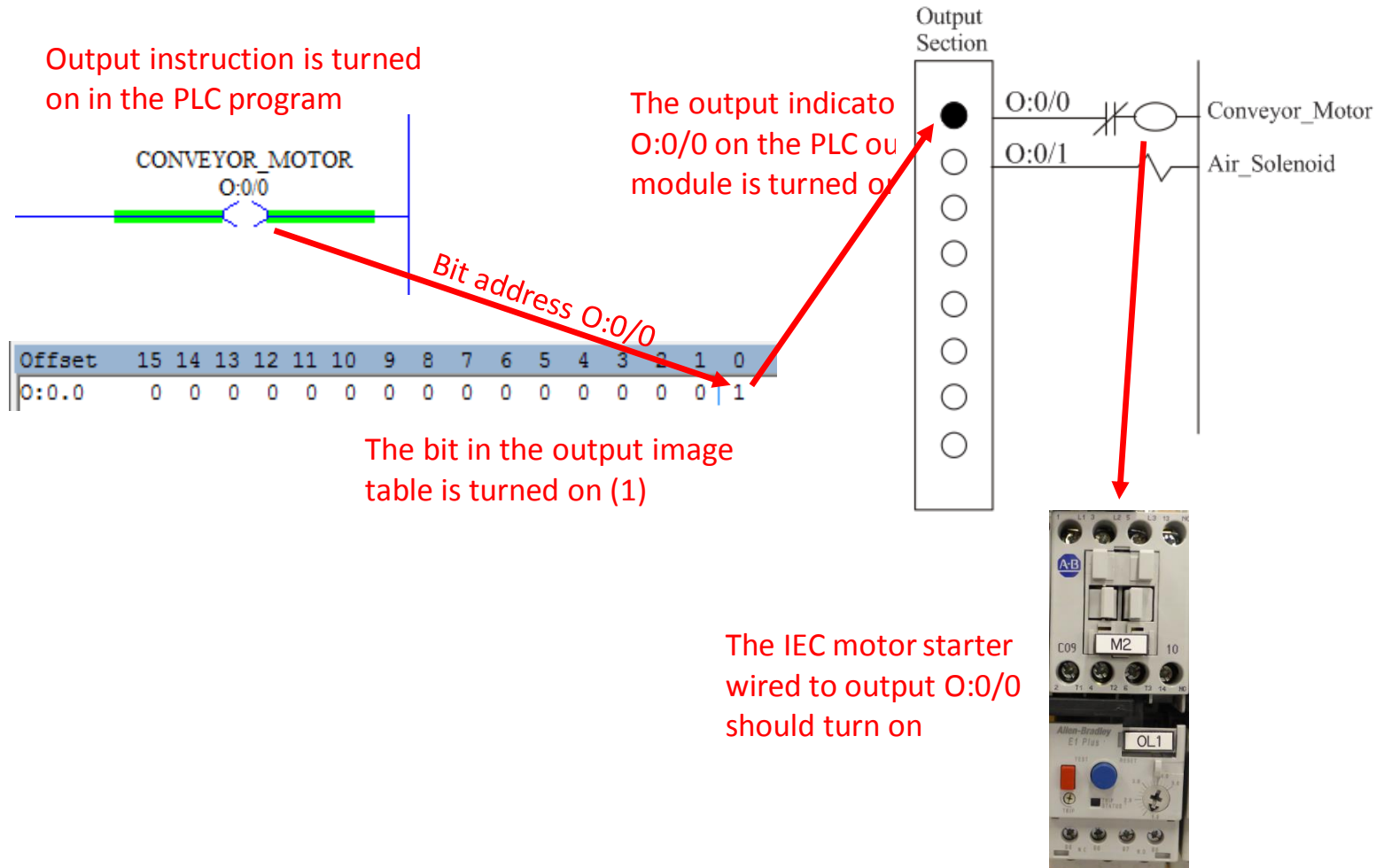
PLC Input Module cont.

A little more explanation on how the input module sends signals. When the Cycle_Start button (input I:0/1) is pushed, it send 120V signal into the input and turns on the input indicator light. If the processor is in the Run mode, during the Scan I/O update, it writes the status of the lights (on or off) into the input image table as 1s or 0s.

The status of the input will determine if an input instruction in the PLC program will highlight (get continuity). In this case, I:0/0 is a “1”, thus it highlights the N.O. instructions in the PLC program.



Important: A high voltage (120V) at the input terminal will turn on the indicator light. Use these lights to troubleshoot the input devices. If you activate an input device and the light comes on, then the device is working correctly.



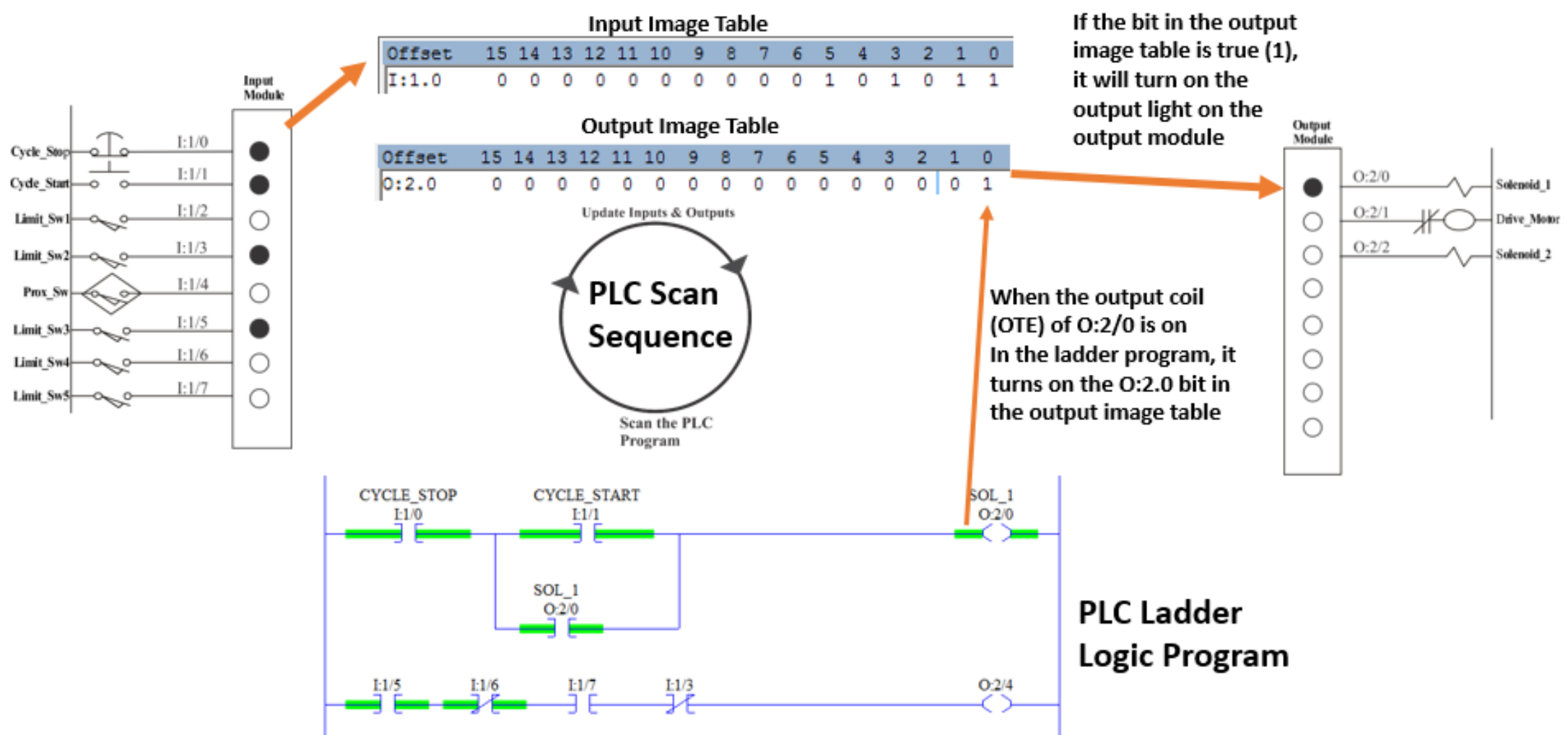
PLC Output Module

Discrete output devices (solenoid coils, pilot lights, starter & contactor coils) are wired to the terminals of an output module.

If coil O:0/0 (Conveyor_Motor) is on (highlighted) in the PLC program, it writes a “1” into the corresponding address in the output image table. When the scan updates the I/O, it writes the ones and zeros out to the outputs. This turns on the output indicator light for that address, then it should turn on the physical output device.

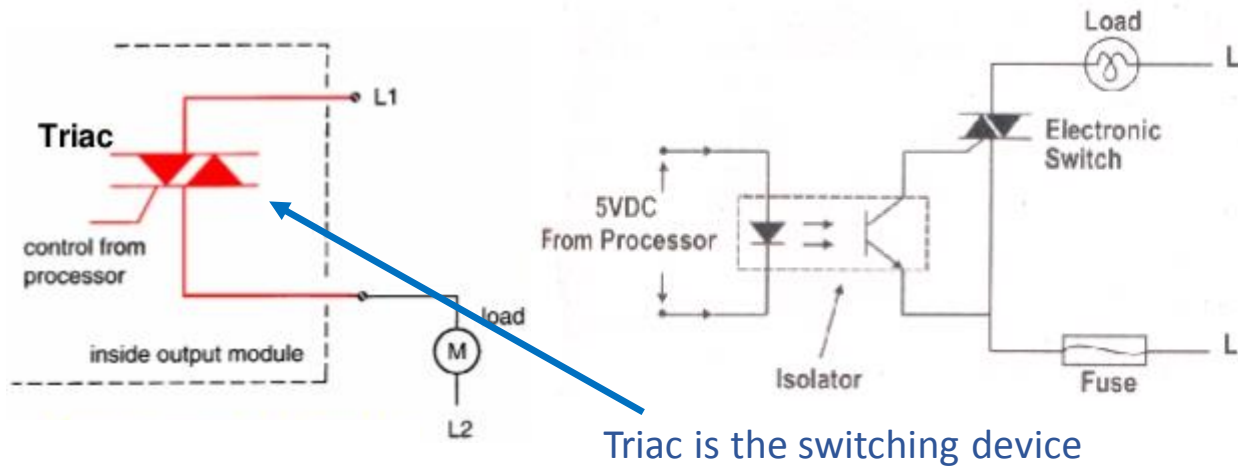
In this example, an IEC motor starter coil is wired to output O:0/0. When the output indicator light is turned on, the output device should turn on.

Important: The PLC program/output image table is what turns on a PLC output indicator light.



PLC Scan Sequence

This is graphic of the full operation of a PLC. Notice the PLC scan sequence circle (middle). During the scan the processor updates the I/O (writes 1s in the input image table based on the input indicator lights, then writes the 1s and 0s from the output image table to the output module). The processor then scans the PLC program. Notice the highlight (green) means continuity or power flow. The PLC scan is fast. It is usually around 4 milli-seconds per 1K of memory.



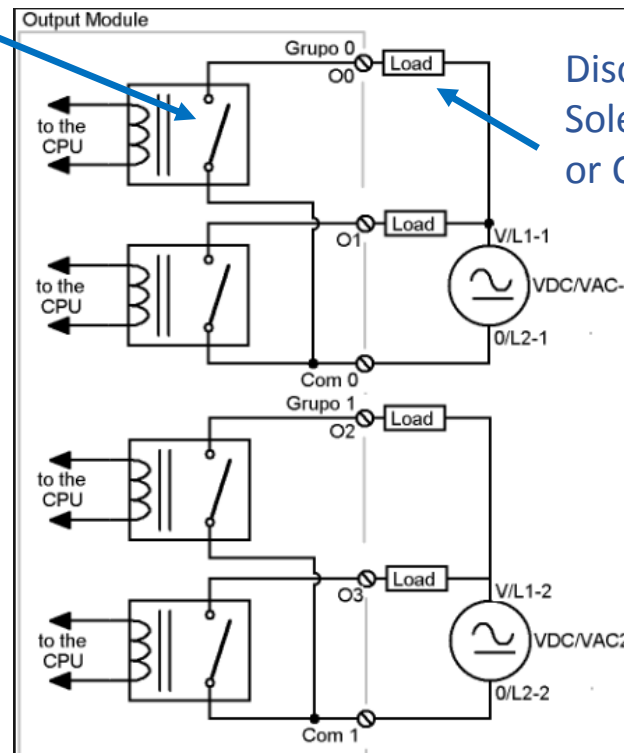
Triac versus Relay Outputs

There are two types of output switching devices found in PLC output modules/points: Solid-State and Relay type of output switching.

In an AC output there are Triac type of output points. Triacs are solid state switching devices. The advantage of these devices is that there is no contact wear. The disadvantage is that they are sensitive to heat and spikes.

Physical Relay Contact in the Output

Data from the Processor

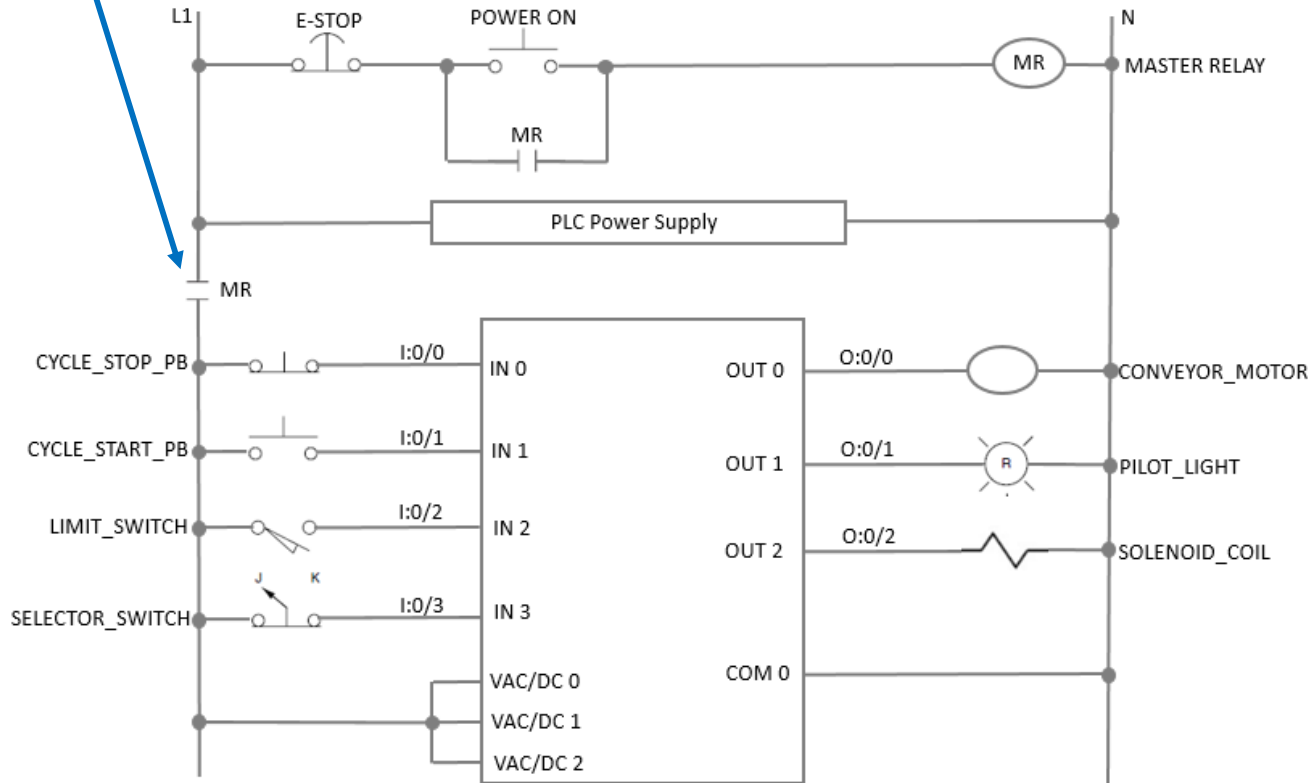


Discrete output device:
Solenoid, Pilot Light, MS
or Contactor Coil

The other type of switching device is a relay contact. There are actual relays in the output. The disadvantage of these devices is the wear of switching a load, and they are rated at a low current.

A DC PLC output will use either a transistor for solid-state switching, or a relay contact.

MR contact control power going to the PLC I/O



Master Relay (Safety Relay)

Every PLC installation should have a master relay for safety. There are exceptions to this with new technology Safety PLCs.

A Master Relay is powered by a Power On pushbutton, and will also have an E-Stop to shut it off.

When the Master Relay is off, it shuts off power to the PLC I/O. The PLC I/O circuits have solid state devices which can fail shorted. If they fail shorted, the PLC program cannot shut them off.

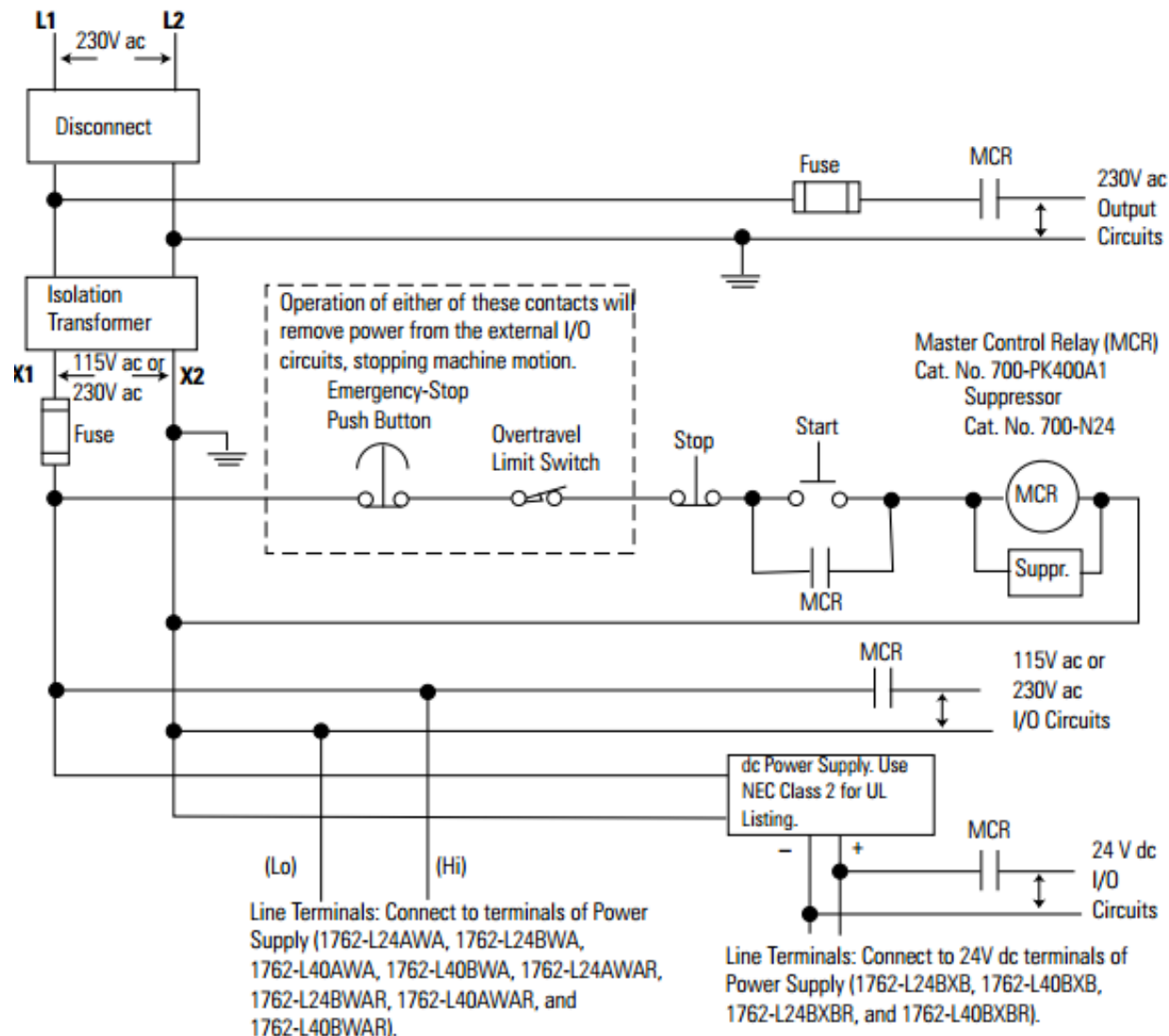
When the MR is powered, it will send power down to the PLC I/O to enable the operation. Being able to shut off inputs are not as critical as being able to shut off outputs.

Notice that the PLC power supply is not shut off with the MR. When the PLC P/S is shut off, there is a chance of losing the PLC program, which would require a reload, which is downtime.

Master Relay continued

This is a diagram from the Allen Bradley installation manual that shows a larger scope of what a Master Relay will control. Notice that the contacts from the MR are found in all the extension circuits.

The user needs to realize that the National Fire Protection Association requires that the with one hit of the Emergency Stop pushbutton will stop all motion on a machine. Everything involving motion to actuators must be controlled by the Master Relay.



MicroLogix 1200 I/O Addressing

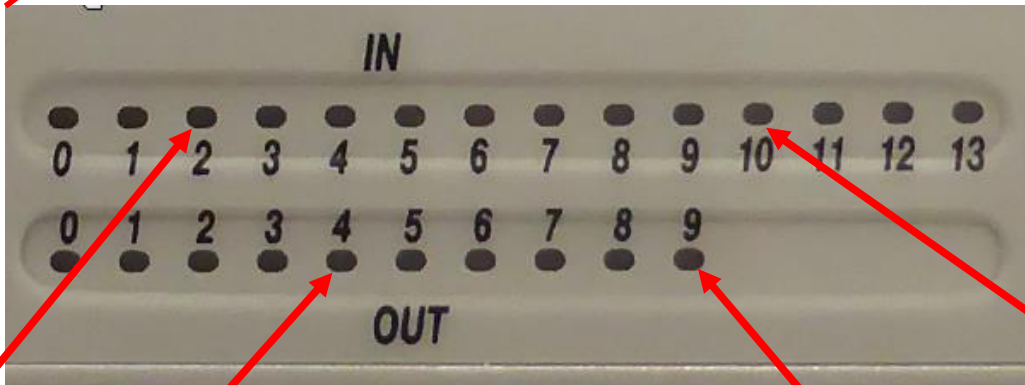
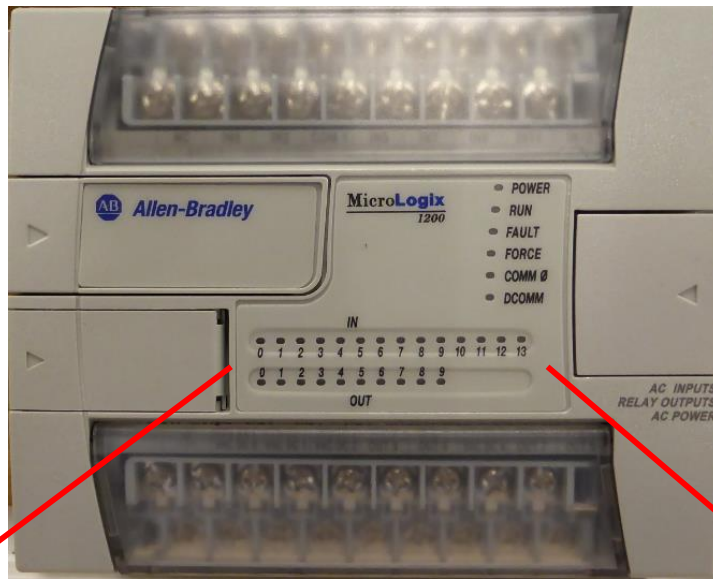
The Micrologix 1200 fixed I/O unit has the same operating system as an SLC-500.

The fixed I/O units have the processor and inputs & outputs built into one unit. Any I/O on a fixed Allen Bradley unit is considered to be Slot 0.

An input would be addressed as I:0/2, or I:0.0/3. Inputs start with an "I".

An output would be addressed as O:0/4 or O:0.0/4. Outputs start with an "O".

If there are more than 16 input points, such as a 30 I/O unit: 18 inputs and 12 outputs, the first 16 inputs would be I:0/0-I:0/15. The next bit could be addressed as I:0/16, or I:0.1/0. The one indicates word 1. The first 16 bits were in word 0.

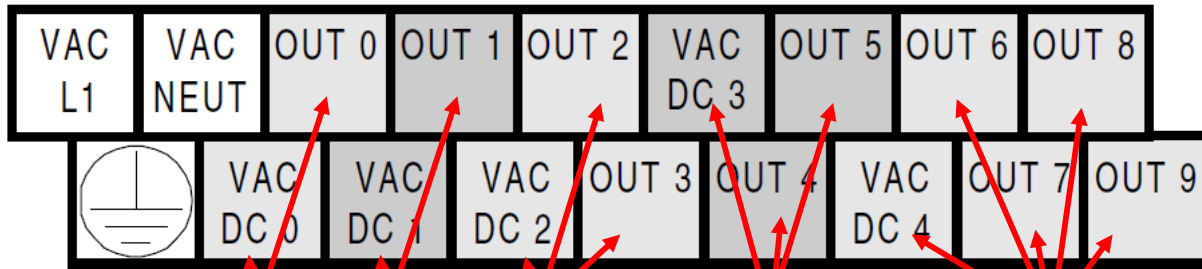


I:0/2

O:0/4

O:0/9

I:0/10



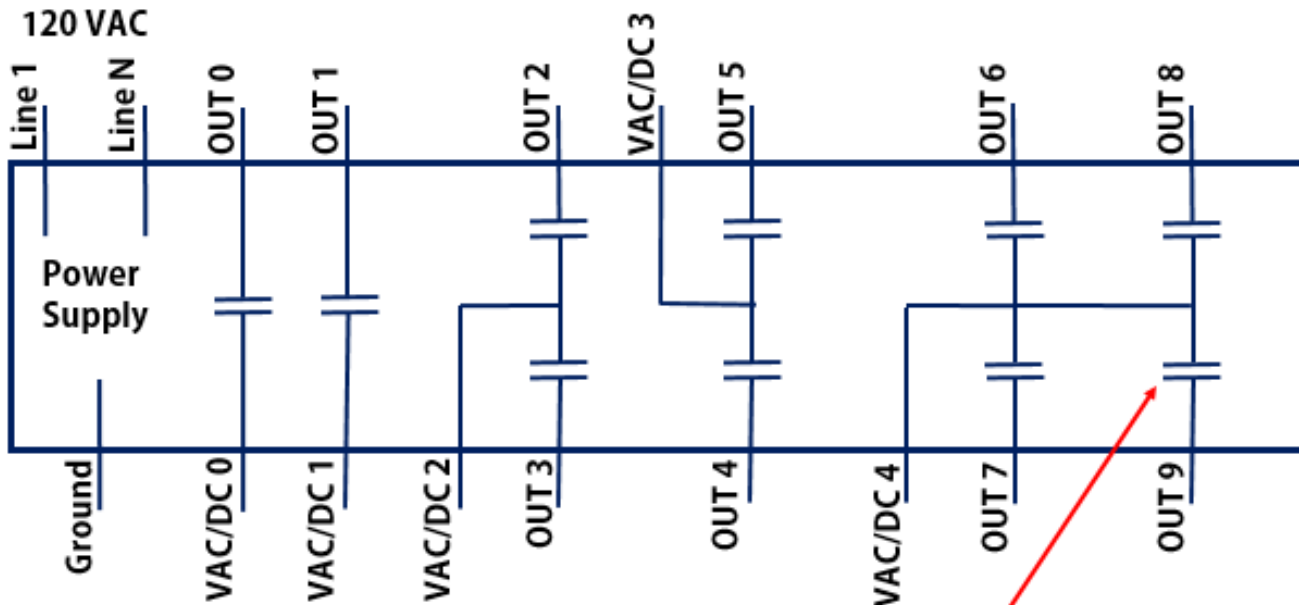
Group 0

Group 1

Group 2

Group 3

Group 4



Discrete Output Relay Contact

Output Groups

The output terminals strips on the ML1200 can be sort of confusing. The unit has isolated output groups. This way the user can use for different applications. Group 0 could enable a variable frequency drive, while Group 1 could enable a Fanuc robot, while Group 2 control solenoid valves.

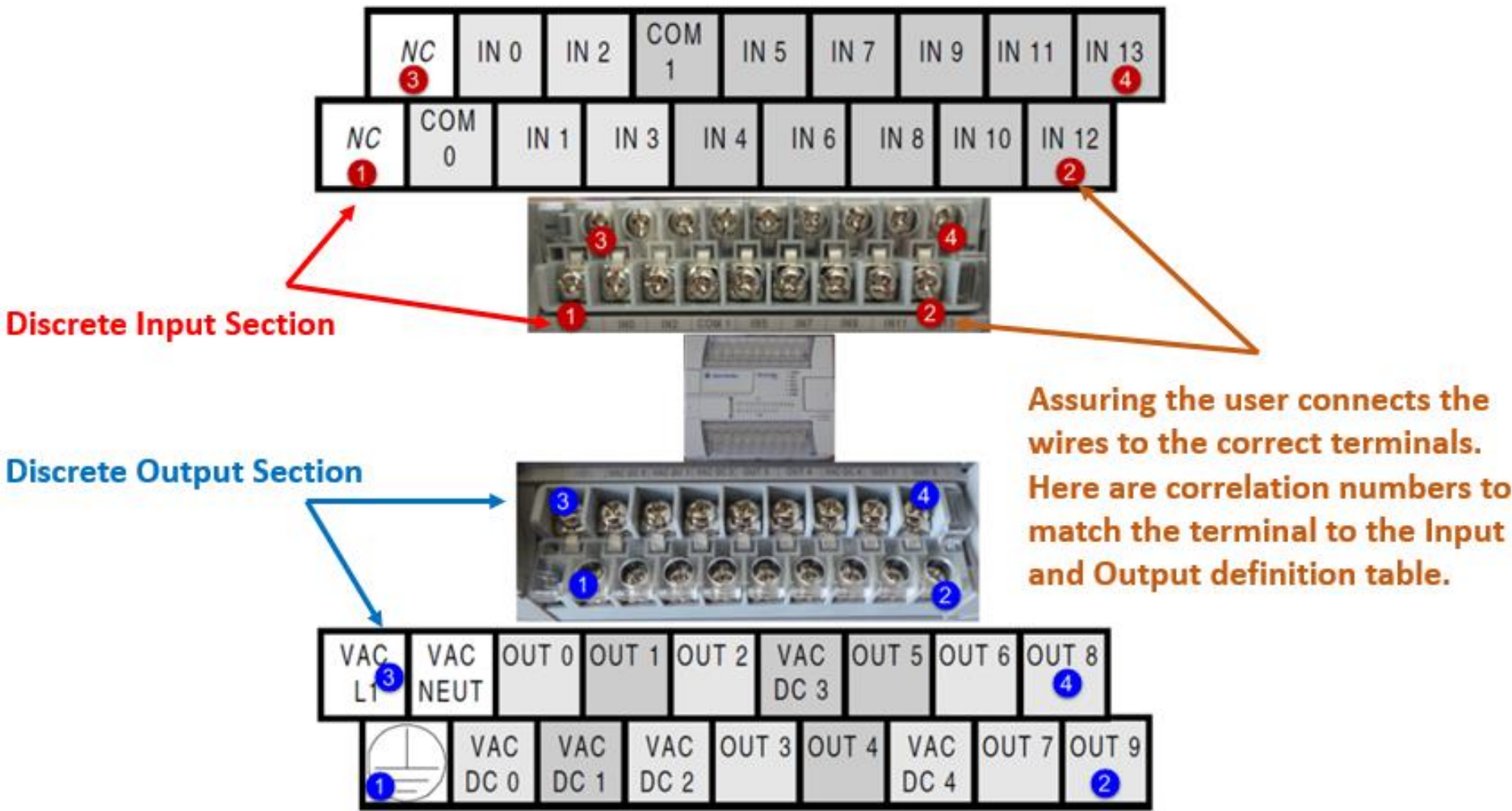
This illustration shows the terminals laid out by Groups. The manufacturer has shaded sections on their diagram to show the groups.

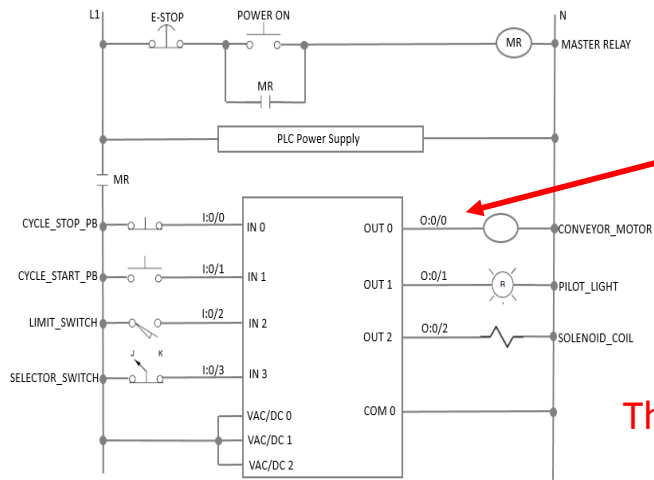
The lower graphic shows the actual diagram with contacts for a different visual for the user. Remember that the output is just a switching device. A hot line has to be brought into one side of the switch, and other side of the switch has the load.

***Input & Output Terminals
on the ML1200***

The input and output terminals on the ML1200 can be quite confusing. The primary reason for this confusion is that not all the terminals are marked, and the markings that are on the terminal strip are for the lower terminal strip.

This diagram will show what terminals correlate to the manufacturer I/O terminal strip graphic. First, make sure you are looking directly at the ML1200 upright. You can see the correlation by the numbers put on the graphic by the author of this power point.





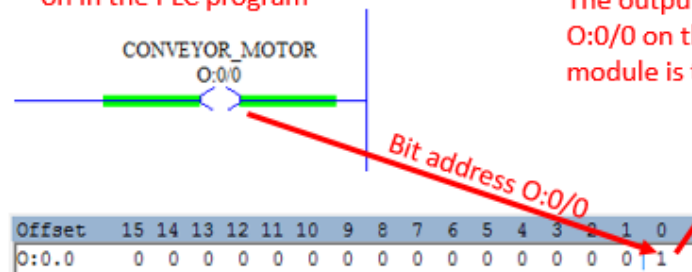
Electrical Print to find out the output address.

The output light is on

Measure the output voltage on the output terminal

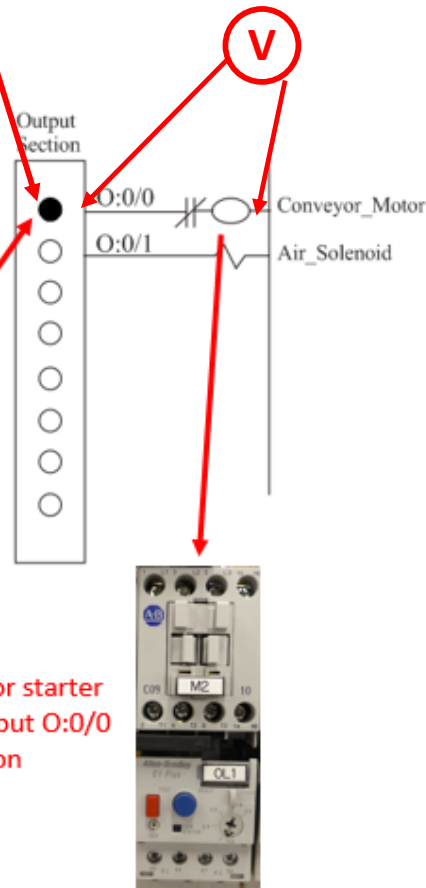
Output instruction is turned on in the PLC program

The output indicator O:0/0 on the PLC output module is turned on



The bit in the output image table is turned on (1)

The IEC motor starter wired to output O:0/0 should turn on

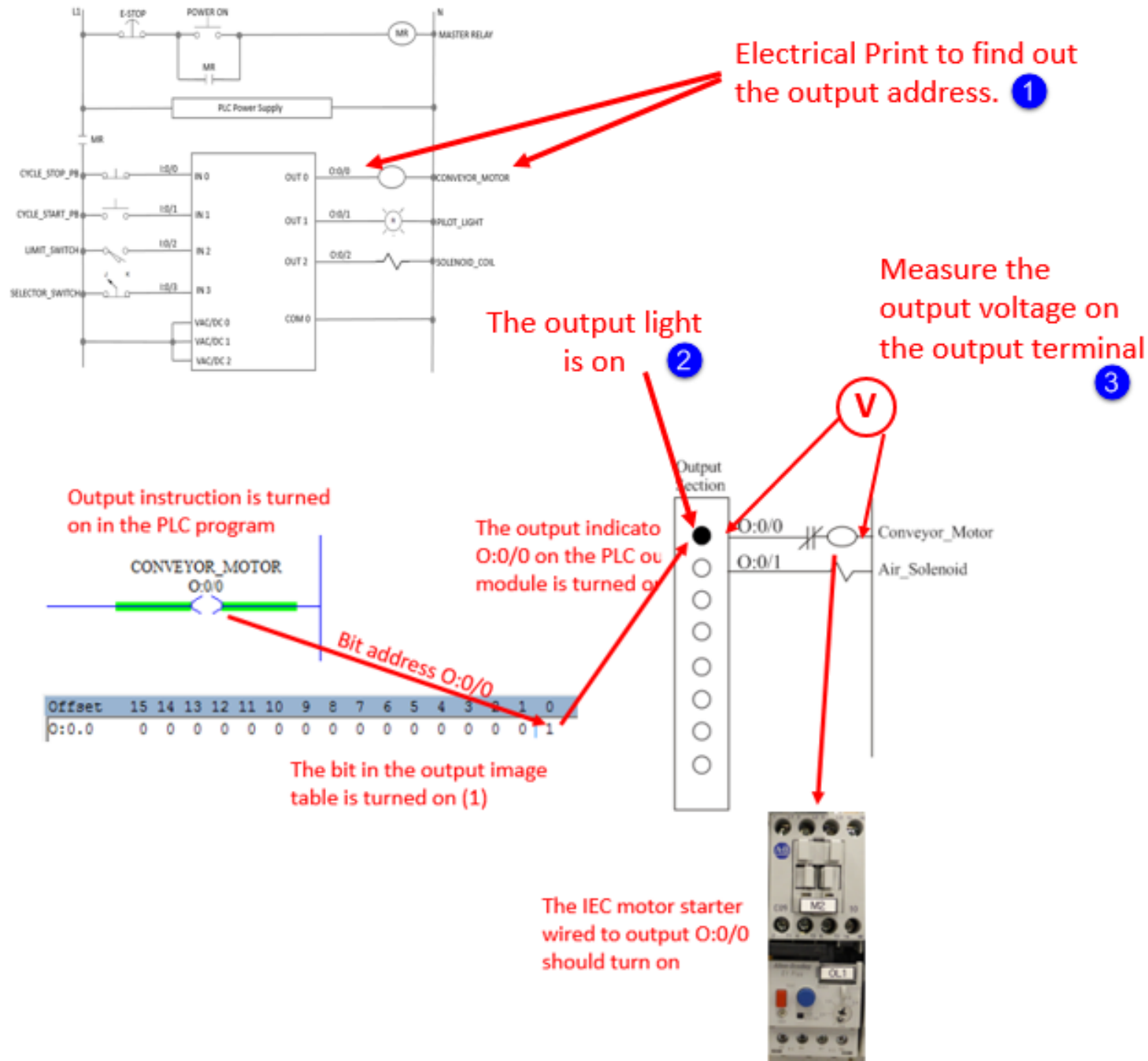


Troubleshooting an Output

If a discrete output has failed, the Technician must first find the output address of the failed output. In this example, the Conveyor Motor is not working.

The first step is to get the electrical print to determine that the address for this motor is: O:0/0. Find the name: CONVEYOR_MOTOR, then look at the address.

Next go to the output section of the PLC to see if the output indicator light is turned on.



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Next go to the output section of the PLC to see if the output indicator light is turned on. If it is on, then measure the voltage at the output terminal to make sure it has the voltage to turn on the output device. If the light is on, but there is no voltage coming out, the output may be bad, and may need replacing (with a ML1200, the full unit would have to be replaced). If the PLC output light is not on, then the problem may be in one of the inputs. Check the PLC program to see what inputs are turning on this output. More on troubleshooting in PLC200.

PLC Terms & Definitions

- Bit- Stands for binary digit (a “1” or a “0”)
- Discrete I/O-Sometimes called digital I/O are I/O that have two states (on and off)
- SCAN-The term used to define the processor servicing the I/O and analyzing the PLC program to determine what should be turned on or off
- Input & Output address-The address assigned to an input or output. This is typically determined by the location of the module the input or output is wired to on the I/O chassis
- Bit address-This is the address assigned to a bit. This could be either internal, such as a B3/2, or an I/O, such as I:0/1 or O:0/3
- Input and output image table-The memory locations in the processor that stores the status of the input module lights(input image). The output image will store the status of what outputs are turned on by the PLC program
- Highlight, logic power flow-This is simply the terms used for an input instruction that has continuity and will pass power flow. If all the input instructions on a rung are highlighted, the output instruction will receive power flow



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