➢Chapter 13
PLC Installation Practices,Editing, and Troubleshooting

❑PLC Enclosures

➢PLC system, if installed properly, should give years of trouble-free service.

➢The design of PLCs includes a number of rugged features that allow them to be installed in almost any industrial environment.

➢However, problems can occur if the system is not installed properly.

❑PLC Enclosures

➢Programmable logic controllers (PLCs) require protection against temperature extremes, humidity, dust, shock, and vibration or corrosive environments.

➢For these reasons, PLCs are generally mounted within a machine or in a separate *enclosure as shown in Figure.*

1. Power supply
2. PLC (programmable logic controller)
3. Digital input cards
4. Digital output cards
5. Analog input cards
6. Transient surge protectors
7. Circuit breakers
8. Relay switches
9. Operator interface terminal
10. NEMA 12 enclosure

❑PLC Enclosures

- An enclosure is the chief protection from atmospheric conditions.
- The National Electrical Manufacturers Association (NEMA) has defined enclosure types, based on the degree of protection an enclosure will provide.
- For most solid-state control devices, a NEMA 12 enclosure is recommended.
- This type of enclosure is for general purpose areas and is designed to be dust-tight.
- Typically, metal enclosures are used because metal enclosures provide shielding that helps minimize the effects of electromagnetic radiation that may be generated by surrounding equipment.

❑PLC Enclosures

- Every PLC installation will dissipate heat from its power supplies, local I/O racks, and processor.
- This heat accumulates in the enclosure and must be dissipated from it into the surrounding air.
- Excessive heat can cause erratic operation of the PLC or PLC failure.
- For many applications, normal convection cooling will keep the controller components within the specified temperature operating range.
- Proper spacing of components that provides adequate room within the enclosure is usually sufficient for heat dissipation.
- The temperature inside the enclosure must not exceed the maximum operating temperature of the controller (typically 60°C maximum).

❑PLC Enclosures

- Additional cooling provisions, such as a fan or blower, may be required where high internal or ambient temperatures are encountered.
- PLCs are always mounted horizontally with the name of the manufacturer facing out and right-side up, as illustrated in Figure .
- Vertical mounting is not recommended due to thermal considerations.

❑PLC Enclosures

➢A hardwired electromechanical *master control relay (MCR) is normally included as part of the wiring for a* PLC system.

➢ The master control relay provides a means of de-energizing the entire circuit that *is not dependent on* software.

➢The internally programmed MCR of a PLC is not sufficient to meet safety requirements.

➢The hardwired MCR is connected to interrupt power to the I/O rack in the event of an emergency, but still allow power to be maintained at the processor.

Figure 13-3 shows the typical wiring for an AC power distribution with a master control

❑PLC Enclosures

- Figure shows the typical wiring for an AC power distribution with a master Control
- A power disconnect switch is provided so that, when required, the PLC can be serviced with the power off.
- The step-down transformer provides Isolation from the main power distributior system and decreases the voltage to the 120 volts required for the controller power supplies and DC power supplies.
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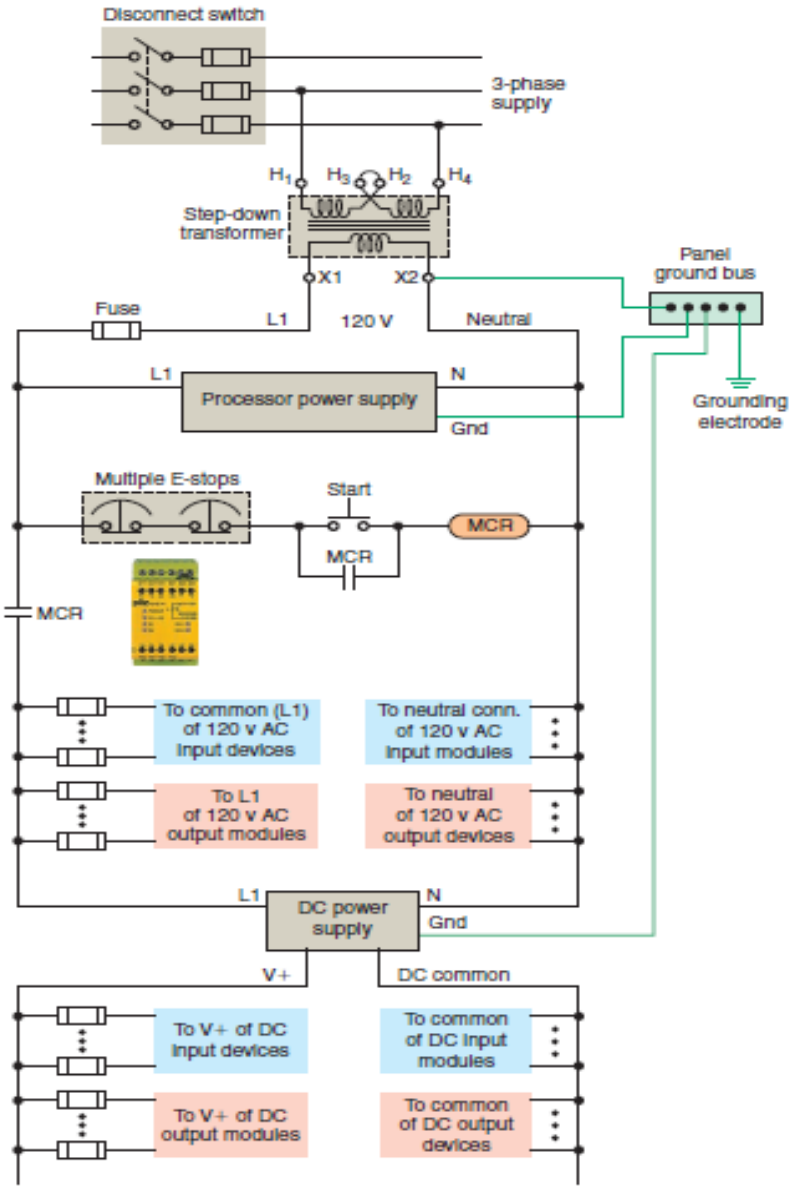
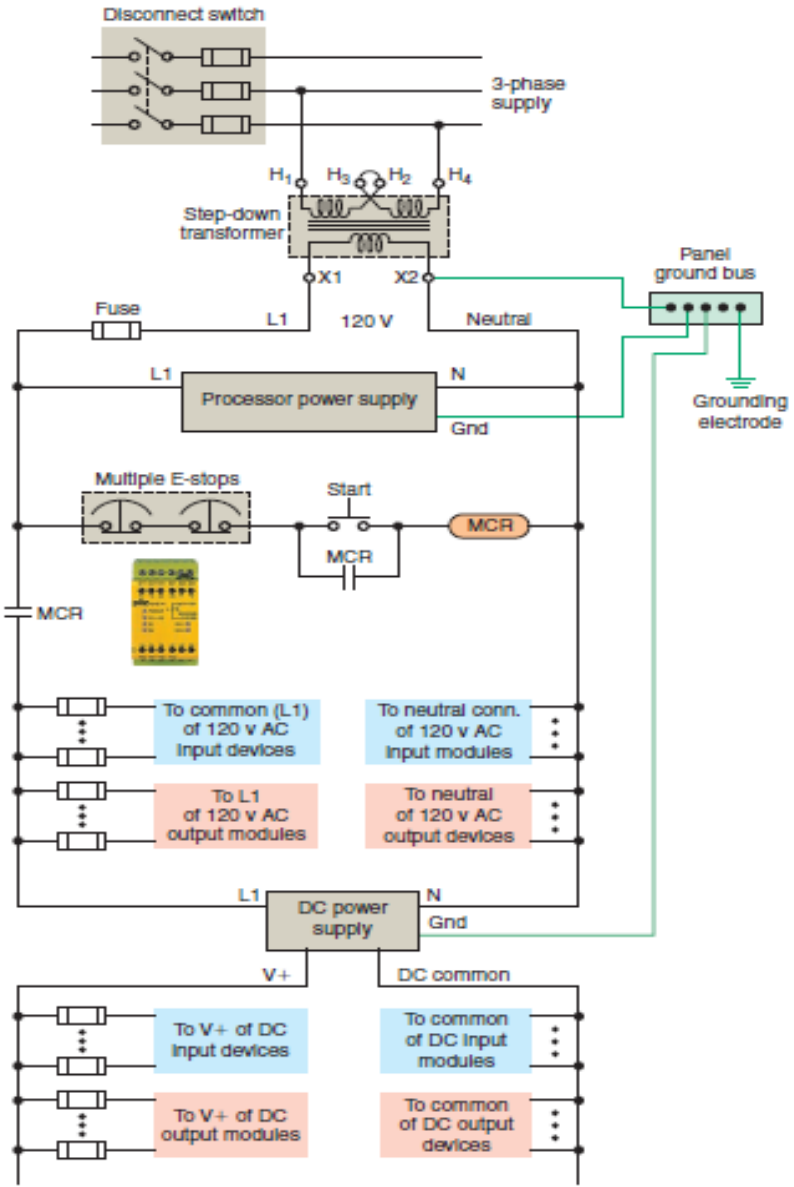


❑PLC Enclosures

- ➢ The momentary start button is pressed to energize the master control relay.
- ➢Pressing any one of the emergency-stop switches de-energizes the master control relay and thus de_energizesthe I/O device
- ➢Power to the processor of the PLC remains on so status LEDs can continue to provide up-to-date information.
- ➢Emergency stop buttons use normally Closed contacts wired in series for fail-safe operation.
- ➢In the event a wire is broken or comes off a terminal, the MCR relay is de-energiz and power is removed.



❑Electrical Noise

➢ Electrical noise, also called electromagnetic interference, or EMI, is unwanted electrical signals that produce undesirable effects and otherwise disrupt the control system circuits.

➢EMI may be either radiated or conducted.

➢*Radiated* noise originates from a source and travels through the air while *conducted noise travels on an actual conductor,* such as a power line

➢When the PLC is operated in a noise-polluted industrial environment, special consideration should be given to possible electrical interference.

➢To increase the operating noise margin, the controller should be located away from noise-generating devices such as large AC motors and high-frequency welders.

❑Electrical Noise

➢Malfunctions resulting from noise are temporary occurrences of operating errors that can result in hazardous machine operation in certain applications.

➢Noise usually enters through input, output, and power supply lines.

➢Noise may be coupled into these lines by an electrostatic field or through electromagnetic induction.

➢The following reduce the effect of electrical interference

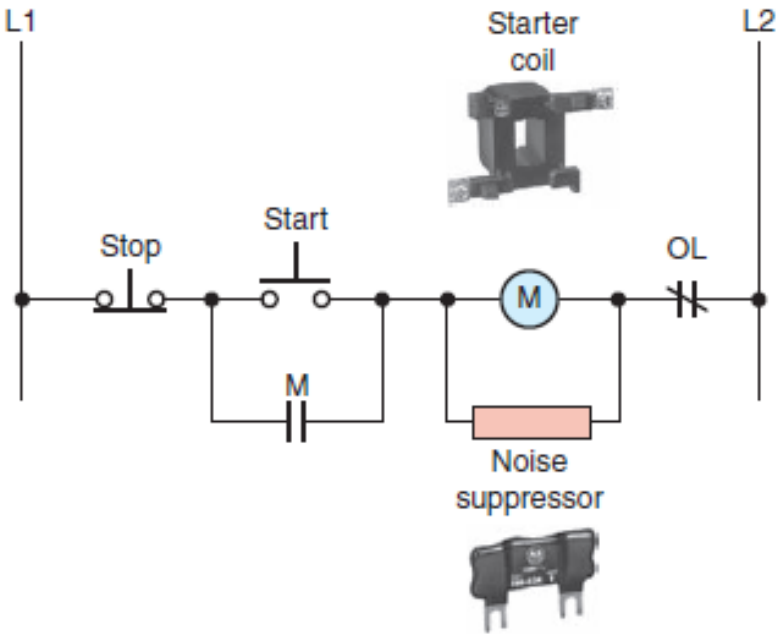
- Manufacturer design features
- Proper mounting of the controller within an enclosure
- Proper equipment grounding
- Proper routing of wiring
- Proper suppression added to noise-generating devices

❑Electrical Noise

➢Noise suppression is normally needed for inductive loads such as relays, solenoids, and motor starters when operated by hard contact devices such as pushbuttons or selector switches.

➢When inductive loads are switched off, high transient voltages are generated that if not suppressed can reach several thousand volts.

➢Figure illustrates a typical noise suppression circuit that is used to suppress the high voltage spikes generated when a motor starter coil is de-energized.



❑Electrical Noise

- Lack of surge suppression on inductive loads may contribute to processor faults and sporadic operation.
- RAM can be corrupted (lost), and I/O modules can appear faulty or can reset themselves.
- When inductive devices are energized or de-energized, they can cause an electrical pulse to be back-fed into the PLC system.
- The back-fed pulse, when entering the PLC system, can be mistaken by the PLC for a computer pulse.
- It takes only one false pulse to create a malfunction of the orderly flow of PLC operational sequences.

❑Electrical Noise

➢Proper routing of field power and signal wiring to the PLC enclosure as well as inside the enclosure helps to cut down on electrical noise.

➢The following are some general guidelines for PLC wire routing:

• Use the shortest possible wire runs for I/O signals.

• When possible, conductors that are run from the PLC enclosure to another location should be in ametal conduit as the metal can serve as a shield against EMI.

• *Never run signal wiring and power wiring in the* same conduit.

• Segregate I/O wiring by signal type. Route AC and DC I/O signal wires in separate wireways.

• Low-level signal conductors such as thermocouples and serial communications should be run as shielded twisted pair and routed separately.

• A fiber optic system, which is totally immune to all kinds of electrical interference, can also be used for signal wiring.

❑Electrical Noise

➢An important part of a PLC installation is clearly identifying each wire to be connected and the terminal to which it is connected.

➢A reliable labeling method, such as the heat-shrinkable wire identification sleeves shown in Figure , should be used to label each wire

❑Leaky Inputs and Outputs

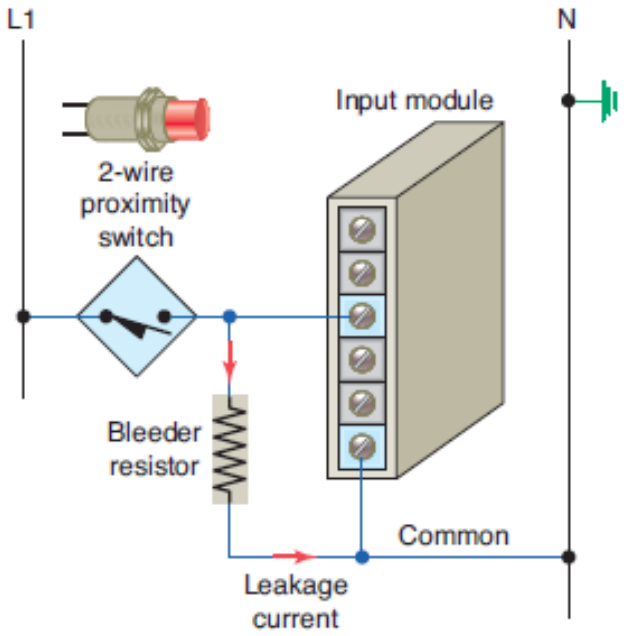
- Many electronic devices with transistor or triac outputs exhibit a small leakage current even when in the off state that may need to be considered when they are connected to PLC input modules.
- This so-called leakage is typically exhibited by two-wire proximity, photoelectric, and other such sensors.
- Often, the leaky input will only cause the module's input indicator to flicker.
- However, a large enough leakage current can activate the input circuit, creating a false input signal

❑Leaky Inputs and Outputs

➢A common solution to the problem of leaky input current is to connect a bleeder resistor across or in parallel with the input, as shown in Figure

➢The bleeder resistor acts as an additional lower resistance load, which allows the leakage current to flow through the lower resistance path.

➢Typically a 10 kΩ to 20 kΩ resistor is used to solve the problem.



❑Grounding

- Proper grounding is an important safety measure in all electrical installations.
- The authoritative source on grounding requirements for a PLC installation is the National Electrical Code.
- The NEC specifies the types of conductors, color codes, and connections necessary for safe grounding of electrical components.
- In addition, most manufacturers provide detailed information on the proper grounding methods to use in an enclosure.

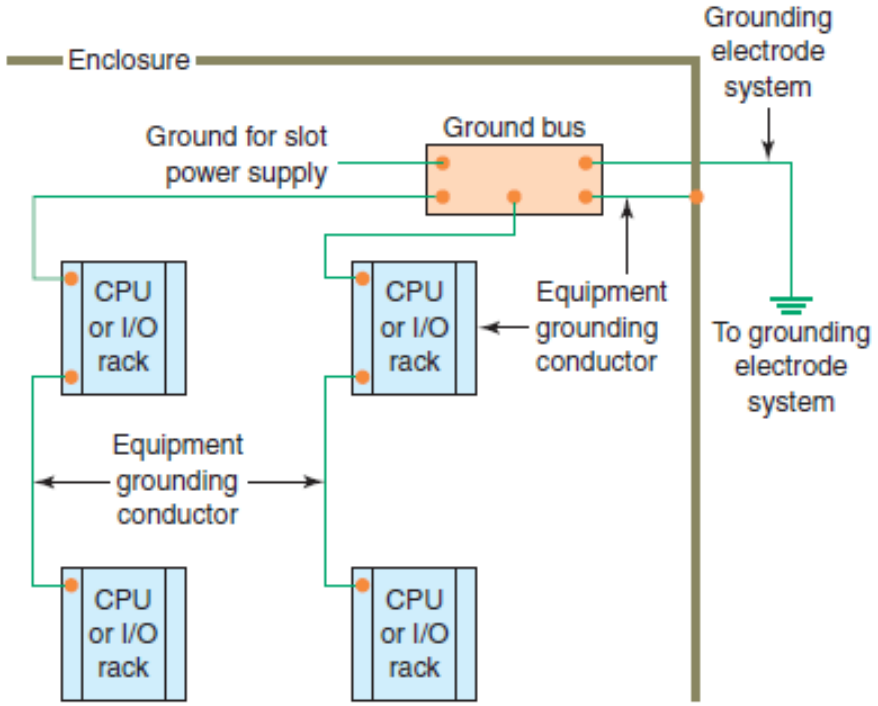
❑Grounding

➢Figure illustrates a PLC grounding system.

➢ A properly installed grounding system will provide a low impedance path to earth ground.

➢The complete PLC installation, including enclosures, CPU and I/O chassis, and power supplies are all connected to a single low impedance ground.

These connections should exhibit low DC resistance and low high- frequency impedance.

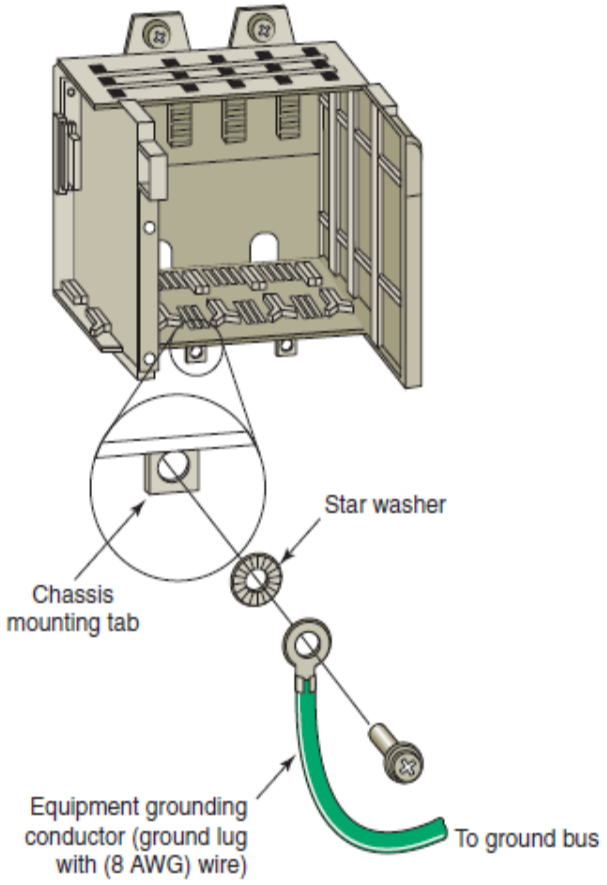


❑Grounding

➢the grounding path must be permanent (no solder), continuous, and able to conduct safely the ground-fault current in the system with minimal impedance.

➢Paint or other nonconductive material should be scraped away from the area where a chassis makes contact with the enclosure.

➢Ground connections should be made with a star washer between the grounding wire and lug and metal enclosure surface, as illustrated In Figure .



❑Voltage Variations and Surges

➢*Isolation transformers are used in some PLC systems* to isolate the PLC from electrical disturbances generated by other equipment connected to the distribution system

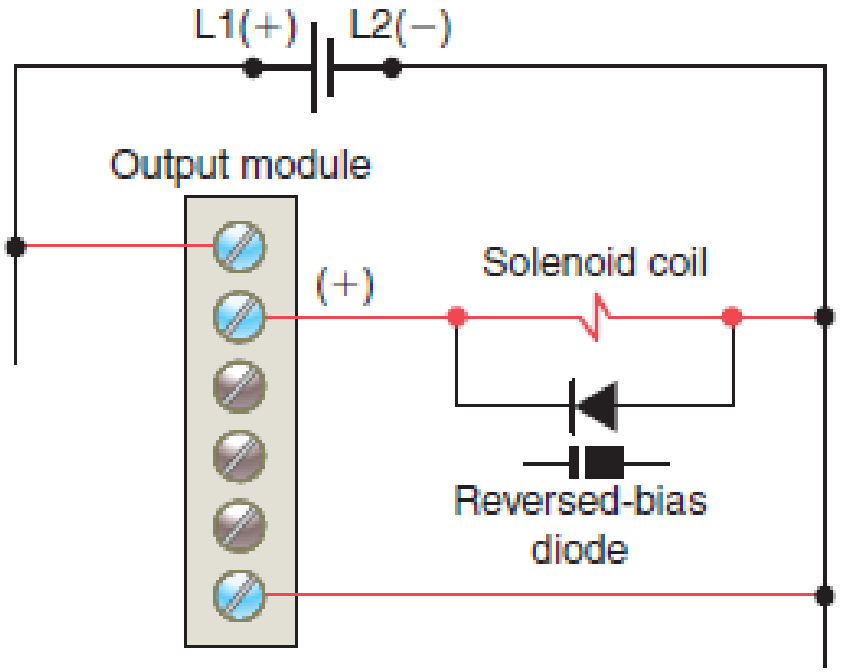
➢When current in an inductive load is interrupted or turned off, a very high voltage spike is generated.

➢This high voltage can be reduced or eliminated through suppression techniques which absorb the inductive induced voltage.

➢Generally, output modules designed to drive inductive loads include suppression networks built in as part of the module circuit.

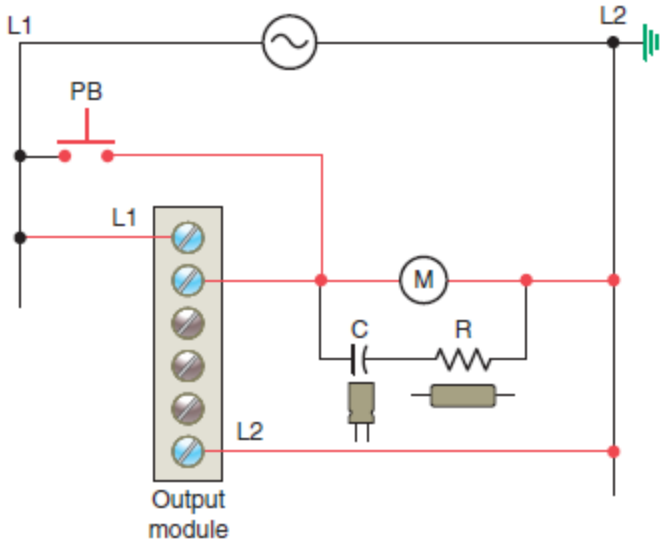
❑Voltage Variations and Surges

➢Figure illustrates how a diode is connected to suppress DC inductive



❑Voltage Variations and Surges

➢Figure illustrates how an RC (resistor/capacitor) snubber circuit is connected for suppressing AC load devices.



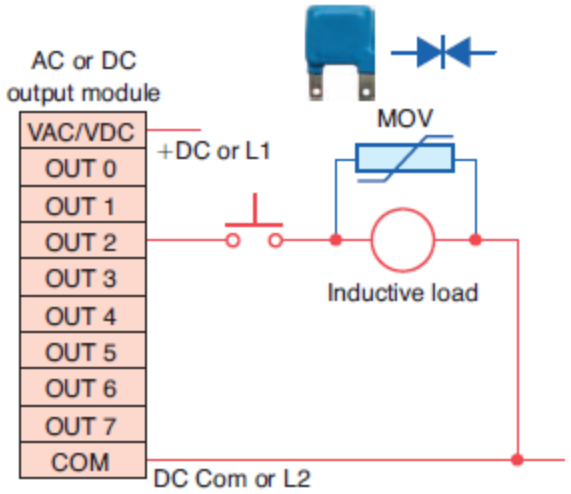
❑Voltage Variations and Surges

➢The *metal oxide varistor (MOV) surge suppressor,* shown in Figure , is the most popular surge protection device.

➢It functions in a manner similar to two zener diodes connected back-to-back

➢The device acts as an open circuit until the voltage across it in either direction exceeds its rated value.

• Any greater voltage peak instantly makes the device act like a short circuit that bypasses this voltage away from the rest of the circuit.



Program Editing and Commissioning

- *Editing is simply the ability to* make changes to an existing program through a variety of editing functions
- Preparing a control process for start-up, also called *commissioning, involves a series of tests to ensure that the* PLC, the ladder logic program, the I/O devices, and all associated wiring operate according to specifications.
- Before commissioning any control system, you should have a good understanding of how the control system operates and how the various components interact.

Program Editing and Commissioning

➢The following are general steps to be followed when commissioning a PLC system:

• Before applying power to the PLC or the input devices, disconnect or otherwise isolate any output device that could potentially cause damage or injury. Typically this precaution would pertain to outputs that cause movement such as starting a motor or operating a valve.

• Apply power to the PLC and input devices. Measure the voltage to verify that rated voltage is being applied.

• Examine the PLC's status indicator lights. If power is properly applied, the power indicator should be on, and there should be no fault indication. If the PLC does not power up properly, it may be faulty. PLCs rarely fail, but if they do fail, it usually happens immediately upon powering up.

Program Editing and Commissioning

➢The following are general steps to be followed when commissioning a PLC system:

• Verify that you have communication with the PLC via the programming device that is running the PLC programming software.

• Place the PLC in a mode that prevents it from energizing its output circuits. Depending on the make of the PLC, this mode may be called *disable, continuous test, or single-scan mode. This mode will allow* you to monitor input devices, execute the program, and update the output image file while keeping the output circuits de-energized.

• Manually activate each input device, one at a time, to verify that the PLC's input status lights turn on and off as expected. Monitor the associated condition instruction to verify that the input device corresponds to the correct program address and that the instruction turns true or false as expected.

Program Editing and Commissioning

➢The following are general steps to be followed when commissioning a PLC system:

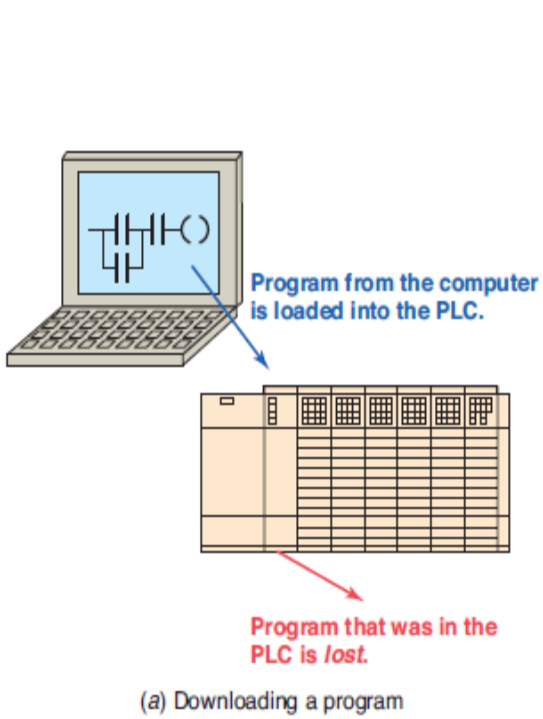
• Manually test each output. One way you can do this is by applying power to the terminal where the output device is wired. This test will check the output field device and its associated wiring.

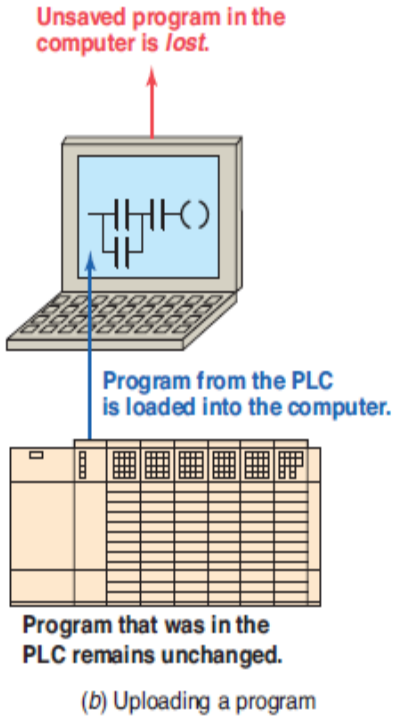
• After verifying all inputs, outputs, and program addresses, verify all preset values for counters, timers, and so on.

• Reconnect any output devices that may have been disconnected and place the PLC in the run mode. Test the operation of all emergency stop buttons and the total system operation.

Programming and Monitoring

- Figure illustrates how programs are downloaded and uploaded from and to the computer.
- With *online programming the program can be modifi*ed, the modifications can be tested, and finally they can be accepted or rejected while the PLC is running.
- However, offline programming is the safest manner in which to edit a program because additions, changes, and deletions do not affect the operation of the system until downloaded to the PLC.





Programming and Monitoring

- Many manufacturers provide a *continuous test mode* that causes the processor to operate from the user program without energizing any outputs.
- This mode allows the control program to be executed and debugged while the outputs are disabled.
- A check of each rung can be done by monitoring the corresponding output rung on the programming device.
- A *single-scan test mode may also* be available for debugging the control logic.
- This mode causes the processor to complete a single scan of the user program each time the single-scan key is pressed with no outputs being energized

Programming and Monitoring

- Two useful monitoring tools provided with PLC programming packages are data monitor and cross reference.
- *Data monitoring functions allow you to monitor and/or* modify specified program variables.
- The *cross reference* function allows you to search each instance of a particular address.
- The data monitor feature allows you to display data from any place in the data table.

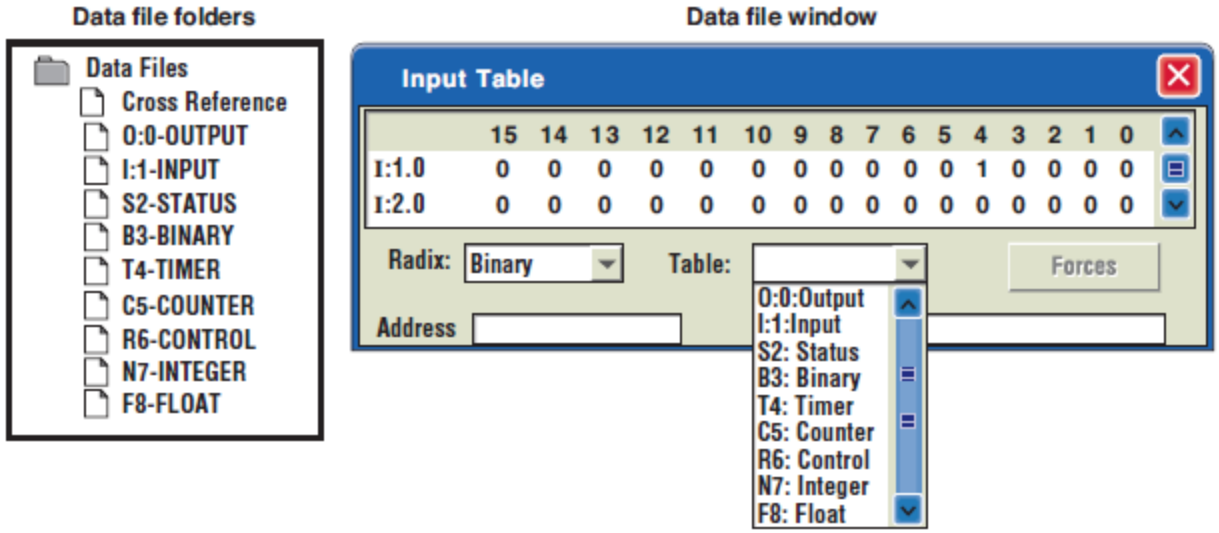
Programming and Monitoring

➢Depending on the PLC, the data monitor function can be used to do the following

- View data within an instruction
- Store data or values for an instruction prior to use
- Set or reset values and/or bits during a debug operation for control purposes
- Change the radix or data format

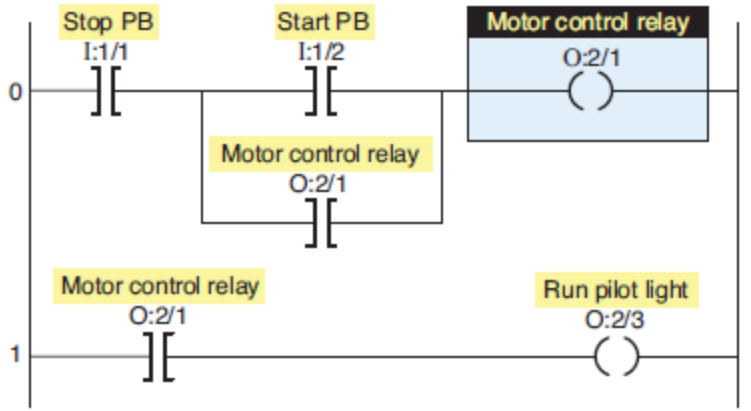
Programming and Monitoring

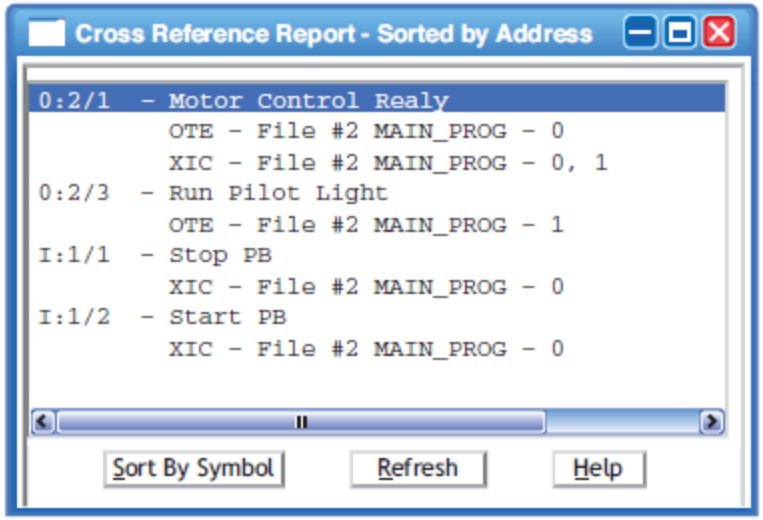
- Figure shows the data file folder and window for the Allen-Bradley SLC 500 PLC and its associated RSLogix software.
- The data file folder allows the user to determine the status of I/O files as well as the status fi e (S2), binary file (B3), timer file (T4), counter file (C5), control file (R6), integer file (N7), and the floating-point file (F8).
- Always be careful when manipulating data using the data monitor function.
- Changing data could affect the program and turn output devices on or off.



Programming and Monitoring

- When troubleshooting a PLC, it may be necessary to locate each instance of a particular address in the ladder program.
- The cross reference function searches all program files to locate each instance of the selected address.
- A user can then trace the operation by finding all the places where a particular output coil or contact with the same address is used in the program.
- Figure shows a sample cross reference report for the Allen-Bradley SLC 500 PLC and its associated RSLogix software.





Programming and Monitoring

➢ Its contents can be summarized as follows:

- The report contains all the addresses used in the program.
- Addresses are displayed in the same order as the data table files.
- The address that the search was performed for (O:2/1) is highlighted.
- The description for each address is displayed.
- Listing includes the instruction type, program file, and rung number for each address.
- Each occurrence of the address is displayed, starting with program file 2 and rung 0.

Preventive Maintenance

➢ The following preventive maintenance tasks should be carried out during these short shutdown periods:

• Any filters that have been installed in enclosures should be cleaned or replaced to ensure that clear air circulation is present inside the enclosure.

• Dust or dirt accumulated on PLC circuit boards should be cleaned. If dust is allowed to build up on heat sinks and electronic circuitry, an obstruction of heat dissipation could occur and cause circuit malfunction.

• Furthermore, if conductive dust reaches the electronic boards, a short circuit could result and cause permanent damage to the circuit board.

• Ensuring that the enclosure door is kept closed will prevent the rapid build-up of these contaminants.

Preventive Maintenance

➢ The following preventive maintenance tasks should be carried out during these short shutdown periods:

• Connections to the I/O modules should be checked for tightness to ensure that all plugs, sockets, terminal strips, and module connections are making connections and that the module is installed securely.

✓Loose connections may result not only in improper function of the controller but also in damage to the components of the system.

• All field I/O devices should be inspected to ensure that they are adjusted properly. Circuit boards dealing with process control analogs should be calibrated every 6 months. Other devices, such as sensors, should be serviced on a monthly basis.

✓Field devices in the environment, which have to translate mechanical signals into electrical, may gum up, get dirty, crack, or break—and then they will no longer trip at the correct setting.

Preventive Maintenance

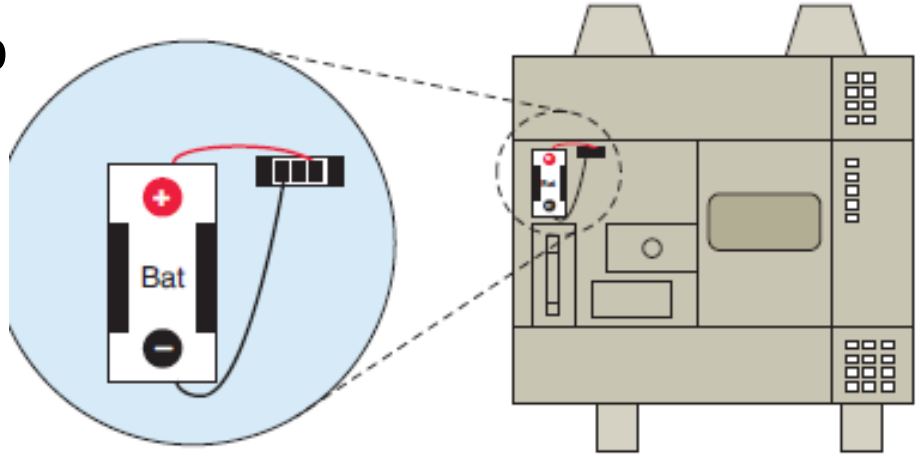
➢ The following preventive maintenance tasks should be carried out during these short shutdown periods:

• Care should be taken to ensure that heavy noise- or heat-generating equipment is not moved too close to the PLC.

• Check the condition of the battery that backs up the RAM memory in the CPU (Figure).

• Stock commonly needed spare parts. Input and output modules are the PLC components that fail most often

• Keep a master copy of operating p



Preventive Maintenance

- To avoid injury to personnel and to prevent equipment damage, connections should always be checked with power removed from the system.
- In addition to disconnecting electrical power, all other sources of power (pneumatic and hydraulic) should be de-energized before someone works on a machine or process controlled by a PLC

Troubleshooting

- In the event of a PLC fault, you should employ a careful and systematic approach to troubleshoot the system to resolve the problem.
- PLCs are relatively easy to troubleshoot because the control program can be displayed on a monitor and watched in real time as it executes.
- If a control system has been operating, you can be fairly confident of the accuracy of the program logic.
- For a system that has never worked or is just being commissioned, programming errors should be considered.
- When a problem occurs, the first step in the troubleshooting procedure is to identify the problem and its source.
- The source of a problem can generally be narrowed down to the processor module, I/O hardware, wiring, machine inputs or outputs, or ladder logic program.

Troubleshooting

- In The following sections will deal with troubleshooting these potential problem areas.

Processor Module

- The processor is responsible for the *self-detection of potential* problems.
- It performs error checks during its operation and sends status information to indicators that are normally located on the front of the processor module.
- You can diagnose processor faults or obtain more detailed information about the processor by accessing the processor status through programming software.

Troubleshooting

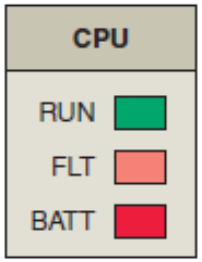
➢In The following sections will deal with troubleshooting these potential problem areas.

Processor Module

➢Figure shows sample diagnostics LEDs found on a processor module. What they indicate can be summarized as follows:

RUN (Green)

- **On steady indicates that the process is in the RUN mode.**
- **Flashing during operation indicates that the process is transferring a program from RAM to the memory module.**
- **Off indicates that processor is in a mode other than RUN.**



Troubleshooting

➢In The following sections will deal with troubleshooting these potential problem areas.

Processor Module

➢Figure shows sample diagnostics LEDs found on a processor module. What they indicate can be summarized as follows:

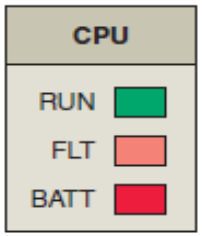
FLT (Red)

• Flashing at power-up indicates that the processor has not been configured.

• Flashing during operation indicates a major error either in the processor, chassis, or memory.

• On steady indicates that a fatal error is present (no communications).

• Off indicates there are no errors.



Troubleshooting

➢In The following sections will deal with troubleshooting these potential problem areas.

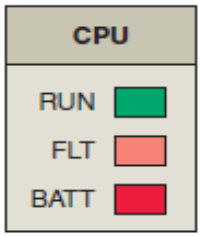
Processor Module

➢Figure shows sample diagnostics LEDs found on a processor module. What they indicate can be summarized as follows:

BATT (Red)

• On steady indicates the battery voltage has fallen below a threshold level, or the battery is missing or not connected.

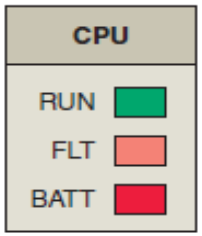
• Off indicates that the battery is functional.



Troubleshooting

Processor Module

- The processor then monitors itself continually for any problems that might cause the controller to execute the user program improperly.
- Depending on the controller, a set of fault relay contacts may be available.
- The fault relay is controlled by the processor and is activated when one or more specific fault conditions occur.
- The fault relay contacts are used to disable the outputs and signal a failure.
- Most PLCs incorporate a *watchdog timer to monitor* the scan process of the system.



Troubleshooting

Processor Module

- The watchdog timer is usually a separate timing circuit that must be set and reset by the processor within a predetermined period.
- The watchdog timer circuit monitors how long it takes the CPU to complete a scan.
- If the CPU scan takes too long, a watchdog major error will be declared.
- PLC user manuals will show how to apply this function.
- The PLC processor hardware is not likely to fail because today's microprocessors and microcomputer hardware are very reliable when operated within the stated limits of temperature, moisture, and so on. The PLC processor chassis is typically designed to withstand harsh environments.

Troubleshooting

Input Malfunctions

➢If the controller is operating in the RUN mode but output devices do not operate as programmed, the faults could be associated with any of the following:

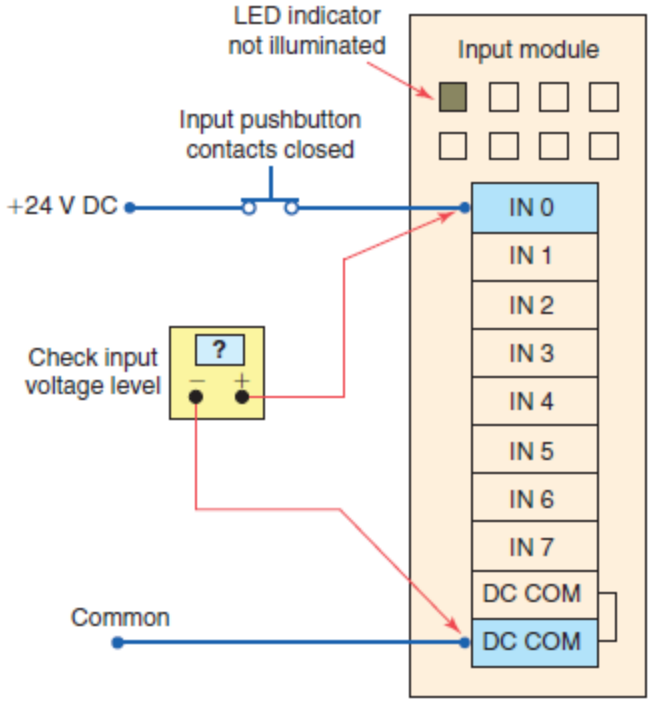
- Input and output wiring between field devices and modules
- Field device or module power supplies
- Input sensing devices
- Output actuators
- PLC I/O modules
- PLC processor

Narrowing down the problem source can usually be accomplished by comparing the actual status of the suspect I/O with controller status indicators.

Troubleshooting

Input Malfunctions

- Usually each input or output device has at least two status indicators. One of these indicators is on the I/O module; the other indicator is provided by the programming device monitor.
- The circuit of Figure illustrates how to check for discrete input malfunctions



Troubleshooting

Input Malfunctions

The steps taken can be summarized as follows:

- When input hardware is suspected to be the source of a problem, the first check is to see if the status indicator on the input module illuminates when it is receiving power from its corresponding input device (e.g., pushbutton, limit switch).
- If the status indicator on the input module does *not* illuminate when the input device is on, take a voltage measurement across the input terminal to check for the proper voltage level.
- If the voltage level is correct, then the input module should be replaced.
- If the voltage level is not correct, power supply, wiring, or input device may be faulty.

Troubleshooting

Input Malfunctions

- If the programming device monitor does not show the correct status indication for a condition instruction, the input module may not be converting the input signal properly to the logic level voltage required by the processor module. In this case, the input module should be replaced.
- If a replacement module does not eliminate the problem and wiring is assumed to be correct, then the I/O rack, communication cable, or processor should be suspected.

Troubleshooting

Input Malfunctions

➢Figure shows a typical input device troubleshooting guide. This guide reviews condition instructions and how their true/false status relates to external input devices.

Input device troubleshooting guide

Input device condition	Input module status indicator	Monitor display status indicator		Possible fault(s)
Closed — ON 24 V DC input	ON	True	False	None - correct indications
Open — OFF 0 V DC input	OFF	False	True	None - correct indications
Closed — ON 24 V DC input	ON	False	True	Sensor condition, input voltage, status indicator are correct. Ladder instructions have incorrect indications. Input module or processor fault.
Closed — ON 0 V DC input	OFF	False	True	Status indicator and instructions agree but not with the sensor condition. Open field device or wiring.
Open — OFF 0 V DC input	OFF	True	False	Sensor condition, input voltage, status indicator are correct. Ladder instructions have incorrect indications. Input module or processor fault.
Open — OFF 24 V DC input	ON	True	False	Input voltage, status indicator, and ladder instructions agree but not with sensor condition. Short circuit in the field device or wiring.

Troubleshooting

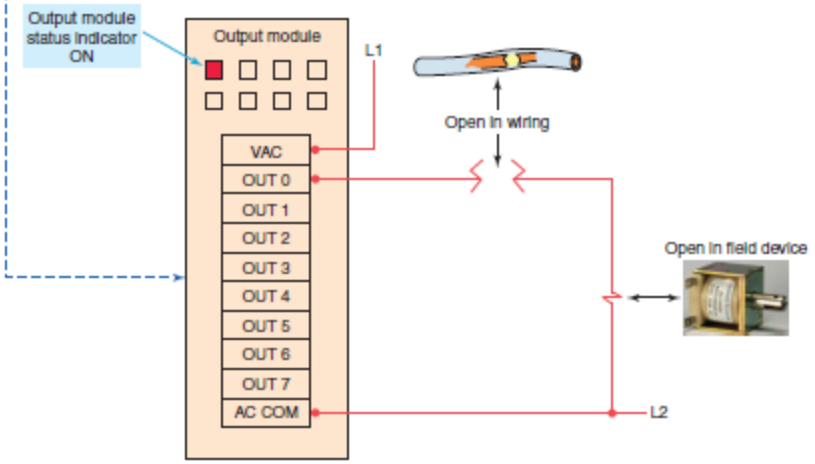
Output Malfunctions modules:

- If the blown fuse indicator is not illuminated (fuse OK), then check to see if the output device is responding to the LED status indicator.
- An output module's logic status indicat functions similarly to an input module's status indicator.

When it is on, the status LED indicates that the module's logic circuitry has recognized a command from the processor to turn on.

Output device troubleshooting guide

Output device condition	Output module status indicator	Monitor display status indicator	Fault(s)
Energized — ON	ON	True	None - correct indication
De-energized — OFF	OFF	False	None - correct indication
De-energized — OFF	ON	True	Output instruction and status indicator agree but the field device does not. Open field device or wiring. Module circuit or fuse.
De-energized — OFF	OFF	True	Field device status and status indicator agree but the output condition does not. Module circuit or fuse.

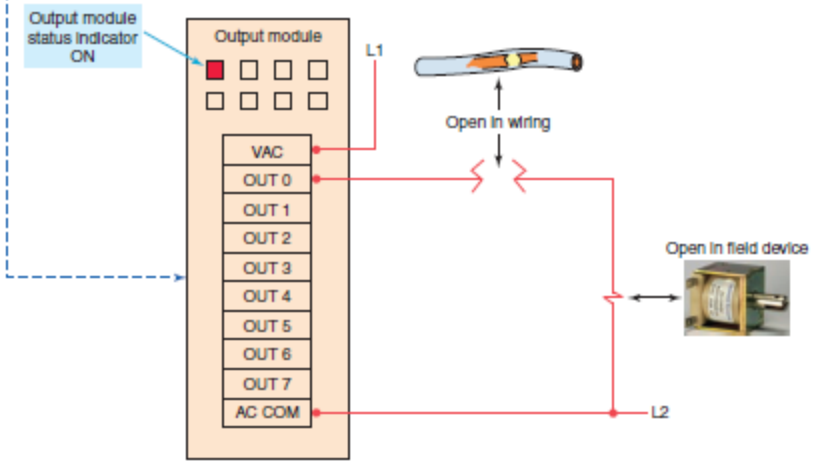


Troubleshooting

Output Malfunctions modules:

- If an output rung is energized, the module status indicator is on, and the output device is not responding, then the wiring to the output device or the output device itself should be suspected

Output device troubleshooting guide			
Output device condition	Output module status indicator	Monitor display status indicator	Fault(s)
Energized — ON	ON	True	None - correct indication
De-energized — OFF	OFF	False	None - correct indication
De-energized — OFF	ON	True	Output instruction and status indicator agree but the field device does not. Open field device or wiring. Module circuit or fuse.
De-energized — OFF	OFF	True	Field device status and status indicator agree but the output condition does not. Module circuit or fuse.



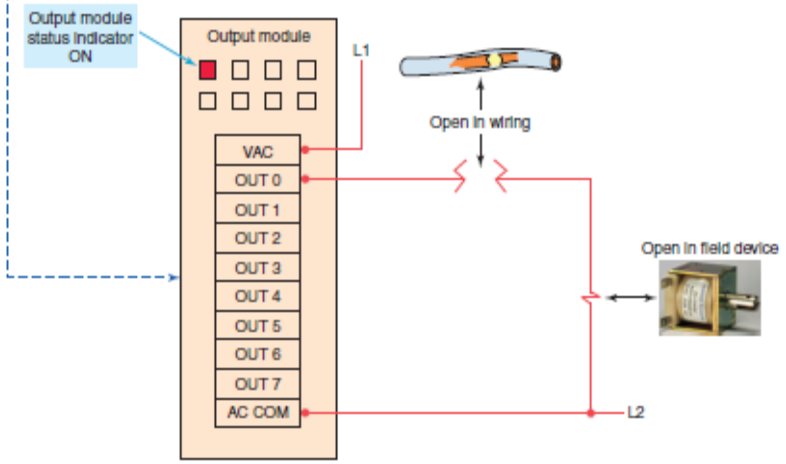
Troubleshooting

Output Malfunctions modules:

- If an output rung is energized, the module status indicator is on, and the output device is not responding, then the wiring to the output device or the output device itself should be suspected.
- If, according to the programming device monitor, an output device is commanded to turn on but the status indicator is off, then the output module or processors may be at fault.
- Check voltage at output; if incorrect, power supply, wiring, or output device may be faulty.

Output device troubleshooting guide

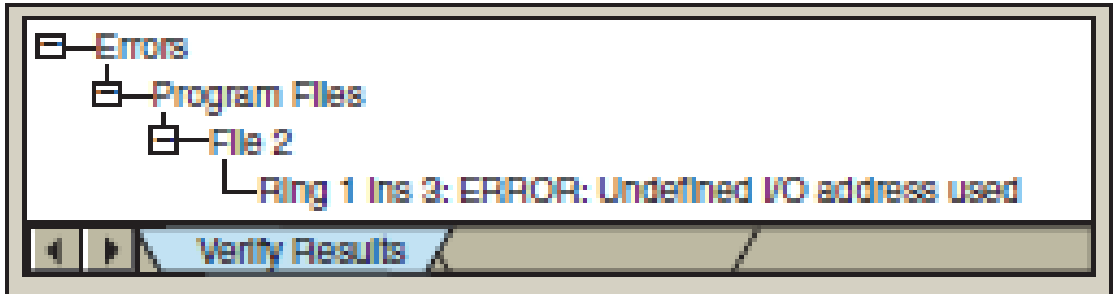
Output device condition	Output module status indicator	Monitor display status indicator	Fault(s)
Energized — ON	ON	True	None - correct indication
De-energized — OFF	OFF	False	None - correct indication
De-energized — OFF	ON	True	Output instruction and status indicator agree but the field device does not. Open field device or wiring. Module circuit or fuse.
De-energized — OFF	OFF	True	Field device status and status indicator agree but the output condition does not. Module circuit or fuse.



Troubleshooting

Ladder Logic Program

- Many PLC software programs offer various software checks used to verify program logic. Figure shows a sample of verifying program errors using RSLogix 500 software. Selecting **edit then verify project will check** the program for errors. The sample shows what the error message might look like.



Troubleshooting

Ladder Logic Program

- The ladder logic program itself is not likely to fail, assuming that the program was at one time working correctly.
- A hardware fault in the memory IC that holds the ladder logic program could alter the program, but this is a PLC hardware failure.
- If all other possible sources of trouble have been eliminated, the ladder logic program should be reloaded into the PLC from the master copy of the program.
- Make sure the master copy of the program is up to date before you download it to the PLC.
- Start program troubleshooting by identifying which outputs operate properly and which outputs do not.
- program

Troubleshooting

- Then trace back from the output on the nonfunctioning rung and examine the logic to determine what may be preventing the output from energizing. Common logic errors include:
- Programming an examine if closed instruction instead of an examine if open (or vice versa)
- Using an incorrect address in the program

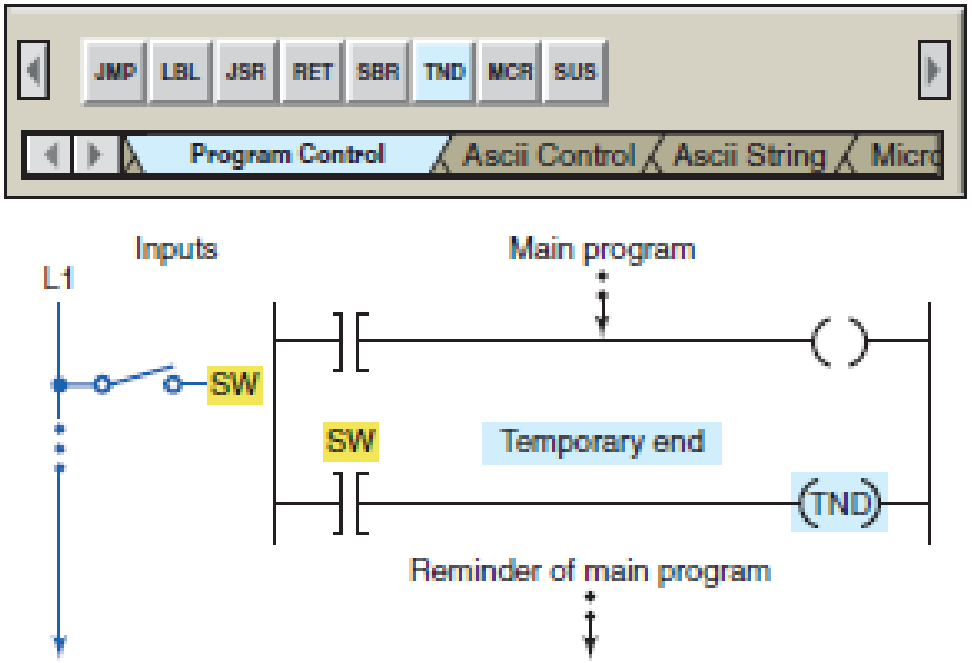
Troubleshooting

- The force on and force off instructions allow you to turn specific bits on or off for testing purposes.
- Figure illustrates how forces are identified as being enabled or disabled in RSLogix 500 software.
- Forcing lets you simulate operation or control an output device.
- For example, forcing a solenoid valve on will tell you immediately whether the solenoid is functional when the program is bypassed.
- If it is, the problem must be related to the software and not the hardware.
- If the output fails to respond when forced, either the actual output module is causing the problem or the solenoid itself is malfunctioning.

Troubleshooting

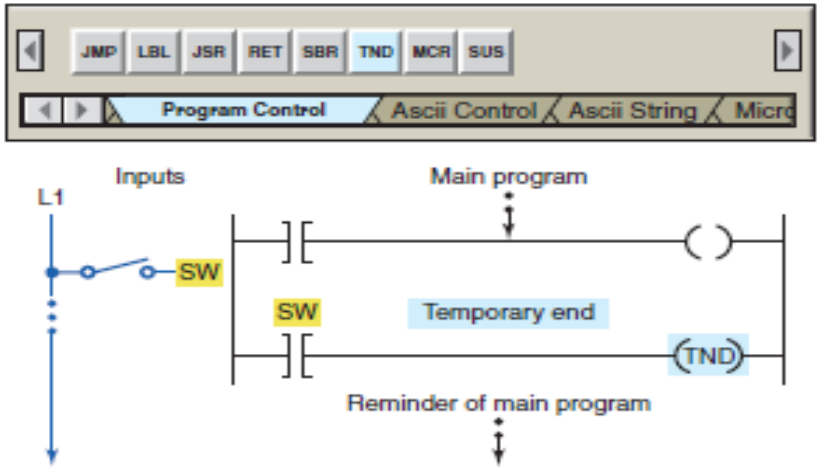
• Certain diagnostic instructions may be included as part of a PLC's instruction set for troubleshooting purposes.

• The *temporary end (TND) instruction, shown in Figure* , is used when you want to change the amount of logic scanned to progressively debug your program.



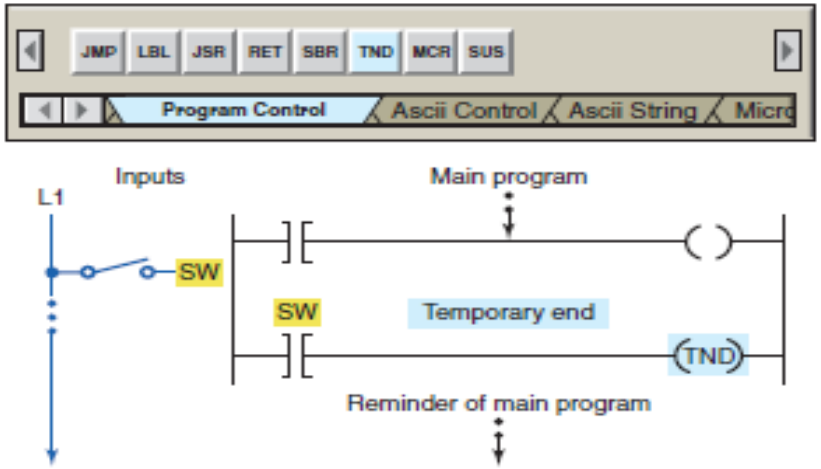
Troubleshooting

- The instruction operates only when its rung conditions are true and stops the processor from scanning any logic beyond the TND instruction.
- When the processor encounters a true TND rung, it resets the watchdog timer (to 0), performs an I/O update, and begins running the ladder program at the first instruction in the main program.
- If the TND rung is false, the processor continues the scan until the next TND instruction or the END statement.



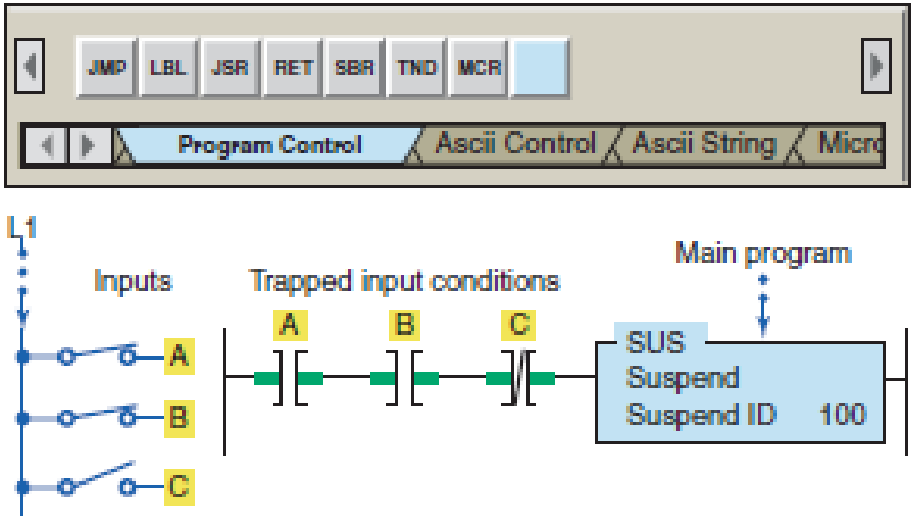
Troubleshooting

- By inserting the TND instruction at different locations in the program you can test parts of the program sequentially until the entire program has been tested.
- Once the troubleshooting process has been completed,any remaining TND instructions are removed from the program..



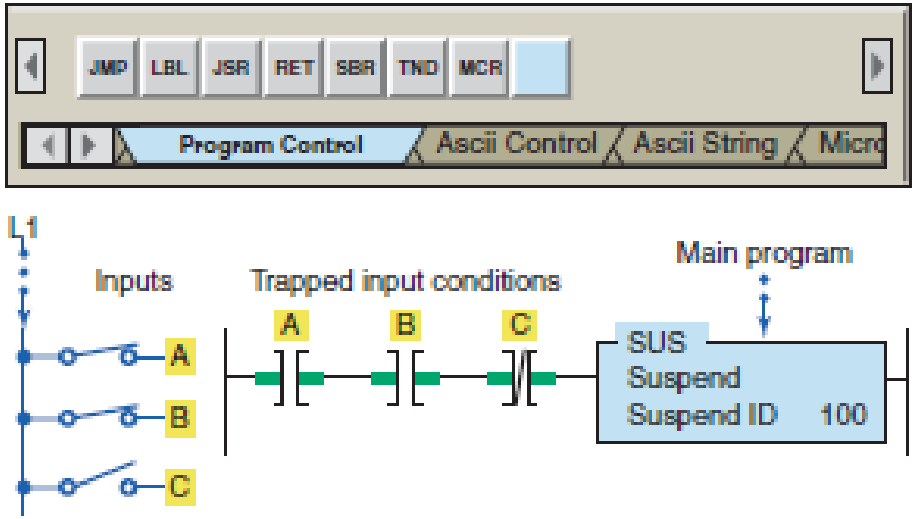
Troubleshooting

- The *suspend (SUS) instruction, shown in Figure ,* is used to trap and identify specific conditions for program debugging and system troubleshooting.



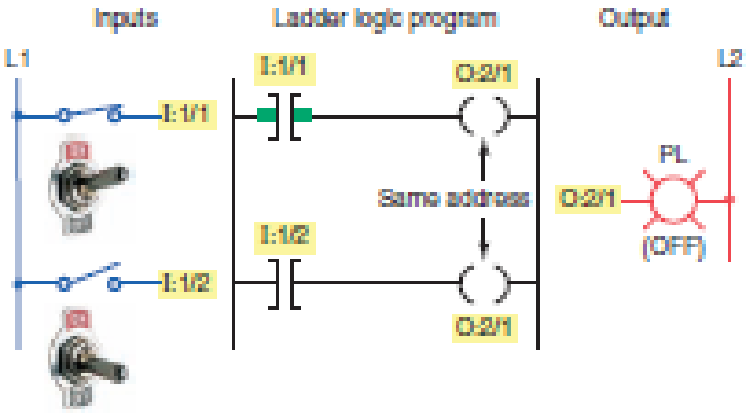
Troubleshooting

- When the rung is true, this instruction places the controller in the *suspend or idle mode* .
- The suspend ID, in this case 100, must be selected by the programmer and entered in the instruction.
- When the SUS instruction executes, the ID number 100 is written in word 7 (S:7) of the status file.
- If multiple suspend instructions are present, then this will indicate which SUS instruction was active.



Troubleshooting

- When an instruction does not seem to be working correctly, the problem may be an addressing conflict caused by the *same address being used for two or more coil instructions* in the same program.
- As a result, multiple rung conditions can control the same output coil, making troubleshooting more difficult.
- In the case of duplicate outputs, the monitored rung may be true; but if a rung farther down in the ladder diagram is false, the PLC will keep the output off. The program of Figure 13-28 illustrates what



Troubleshooting

• The program of Figure illustrates happens when the same address is used for two coils. The resulting problem scenario can be summarized as follows:

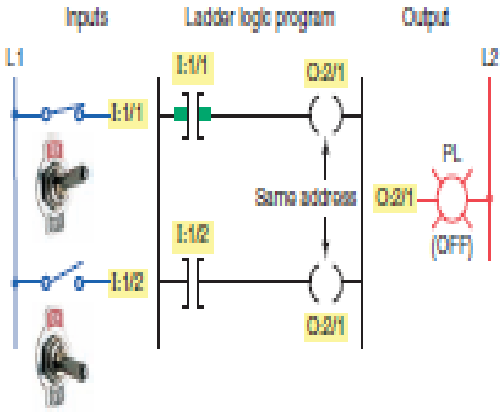
• The problem is turning input switch I:1/1 on *will not turn on PL output O:2/1 as it appears to be* programmed.

• The root of the problem lies in the fact that the PLC scans the program from left to right and top to bottom.

• Whenever input switch I:1/1 is true (closed) and input switch I:1/2 is false (open) output O:2/1 will be off.

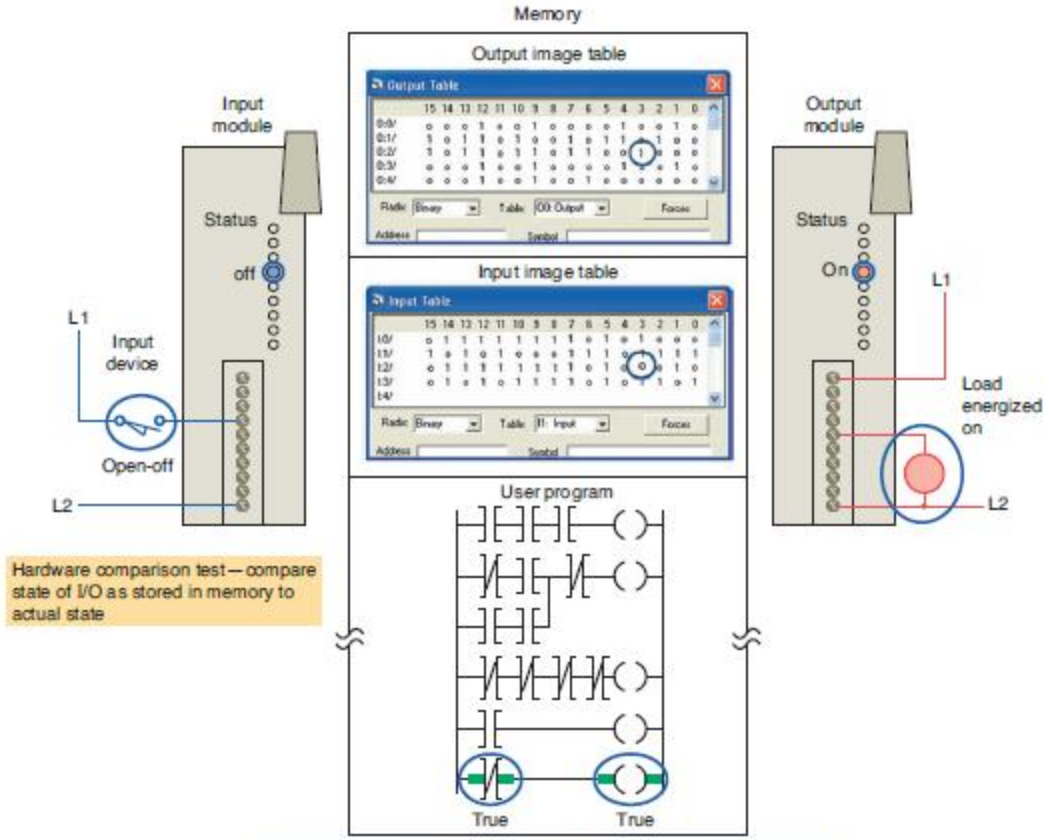
• This is because when the PLC updates the outputs it does so based on the status of input I:1/2.

• Regardless of whether input I:1/1 is open or closed the output reacts only to the status of input switch I:1/2.



Troubleshooting

•Compare the logic status of the hardwired inputs and outputs to their actual state, as illustrated in Figure . Any disagreements indicate malfunctions as well as their approximate location

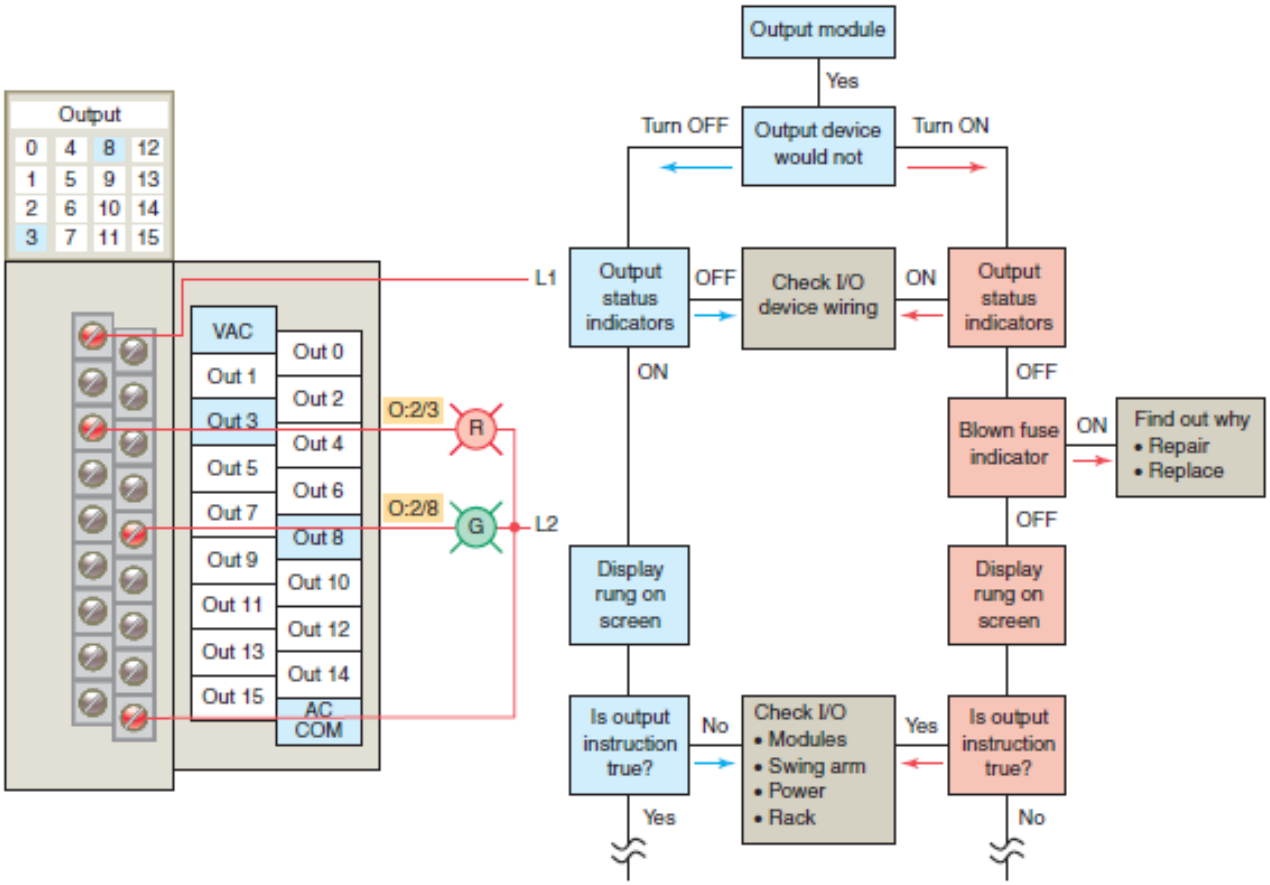


Troubleshooting

- Some of your troubleshooting can be accomplished by interpreting the status indicators on the I/O modules.
- The key is to know whether the status indicators are telling you that there is a fault or that the system is normal.
- Often PLC manufacturers supply a troubleshooting guide, map, or tree that presents a list of observed problems and their possible sources.

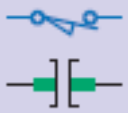
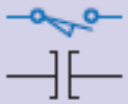
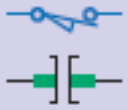
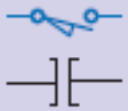
Troubleshooting

✓ Figure shows a sample troubleshooting tree for a discrete output module.



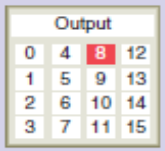
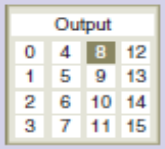
Troubleshooting

✓Figures 13-31 is a sample of input and output troubleshooting guides.

If Your Input Circuit LED Is . . .	And Your Input Device Is . . .	And	Probable Cause
ON Input: 0 4 8 12 / 1 5 9 13 / **2** 6 10 14 / 3 7 11 15	On/Closed/Activated 	Your input device will not turn off.	Device is shorted or damaged.
		Your program operates as though it is off.	Input circuit wiring or module.
			Input is forced off in program.
	Off/Open/Deactivated 	Your program operates as though it is on and/or the input circuit will not turn off.	Input device off-state leakage current exceeds input circuit specification.
			Input device is shorted or damaged.
			Input circuit wiring or module.
OFF Input: 0 4 8 12 / 1 5 9 13 / **2** 6 10 14 / 3 7 11 15	On/Closed/Activated 	Your program operates as though it is off and/or the input circuit will not turn on.	Input circuit is incompatible.
			Low voltage across the input.
			Input circuit wiring or module.
			Input signal turn-on time too fast for input circuit.
	Off/Open/Deactivated 	Your input device will not turn on.	Input device is shorted or damaged.
		Your program operates as though it is on.	Input is forced on in program.
			Input circuit wiring or module.

Troubleshooting

✓Figures is a sample of input and output troubleshooting guides.

If Your Output Circuit LED Is . . .	And Your Output Device Is . . .	And	Probable Cause
ON 	On/Energized 	Your program indicates that the output circuit is off or the output circuit will not turn off. 	Programming problem: - Check for duplicate outputs and addresses. - If using subroutines, outputs are left in their last state when not executing subroutines. - Use the force function to force output off. If this does not force the output off, output circuit is damaged. If the output does force off, then check again for logic/programming problem.
			Output is forced on in program.
			Output circuit wiring or module.
	Off/De-energized 	Your output device will not turn on and the program indicates that it is on. 	Low or no voltage across the load.
			Output device is incompatible: check specifications and sink/source compatibility (if dc output).
			Output circuit wiring or module.
OFF 	On/Energized 	Your output device will not turn off and the program indicates that it is off. 	Output device is incompatible.
			Output circuit off-state leakage current may exceed output device specification.
			Output circuit wiring or module.
			Output device is shorted or damaged.
	Off/De-energized 	Your program indicates that the output circuit is on or the output circuit will not turn on. 	Programming problem: - Check for duplicate outputs and addresses. - If using subroutines, outputs are left in their last state when not executing subroutines. - Use the force function to force output on. If this does not force the output on, output circuit is damaged. If the output does force on, then check again for logic/programming problem.
			Output is forced off in program.
			Output circuit wiring or module.

Troubleshooting

✓**PLC Programming Software**

✓You must establish a way for your personal computer (PC) software to communicate with the programmable logic controller (PLC) processor.

✓Making this connection is known as *configuring the communications.*

✓*The method* used to configure the communications varies with each brand of controller.

✓In Allen-Bradley controllers, *RSLogix* software is required to develop and edit ladder programs.

✓A second software package, *RSLinx, is needed to monitor* PLC activity, download a program from your PC to your PLC, and upload a program from your PLC into your PC.

✓You cannot download multiple projects to the PLC and then run them when required

Troubleshooting

✓PLC Programming Software

➢The PLC will accept only one program at a time, but the program can consist of multiple subroutine files which can be conditionally called from the main program RSLinx software is available in multiple packages to meet the demand for a variety of cost and functionality requirements.

➢This software package is used as the driver between your PC and PLC processor.

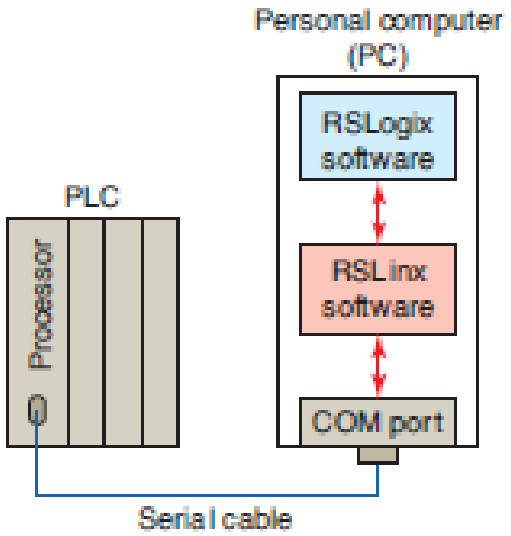
➢A *driver is a computer* program that controls a device.

For example, you must have the correct printer driver installed in your PCin order to be able to print a word-processing document created on your PC. RSLinx works much like the printer driver for RSLogix software. The RSLinx program must be opened and drivers configured before communications can be established between a PC and a PLC that is using.

Troubleshooting

✓PLC Programming Software

- RSLinx works much like the printer driver for RSLogix software.
- The RSLinx program must be opened and drivers configured before communications can be established between a PC and a PLC that is using RSLogix software.
- RSLinx allows RSLogix to communicate through an interface cable to the PLC processor.
- The simplest connection between a PC and a PLC is a point-to-point direct connection through the computer serial port, as illustrated in Figure .



Troubleshooting

✓PLC Programming Software

- A serial cable is used to connect to your PC's COM 1 or COM 2 port and to the PLC processor's serial communications port.
- With RSLinx software you can auto-configure the serial connection and thus automatically find the proper serial port configuration.
- Two important aspects of the communication link must be considered, namely, the RS-232 standard and the communications protocol.
- The *RS-232 standard specifi*es a function for each of the wires inside the standard communications cable and their associated pins.
- *Communications protocol is a standardized method for transmitting* data and/or establishing communications between different devices.

Troubleshooting

✓PLC Programming Software

➢ Minimum configuration for two-way communications requires the use of only three connected wires, as shown in Figure .

➢For ease of connection, the RS-232 standard specifies that computer devices have male connectors and that peripheral equipment have female connectors.

➢Direct communication between two computers, such as a PC and a PLC, does not involve intermediate peripheral equipment.

Therefore, a serial null-modem type cable must be used for the connection becaus(both the PC and the PLC processor use pin 2 for data output and pin 3 for data input