PLC Programming Techniques – Part 1

PLC Programming Techniques 1

Lesson Objectives

- Introduction regarding basic PLC Texts and their advantages and limitations.
- Take a look at basic hardware configurations for moving equipment
- Build a simple program covering Automatic and Manual Modes
- Include ideas for Cycle Start and End of Cycle
- Discuss various Faults, their meaning and possible application.

PLC Programming Techniques 1

PLC Texts

- Many pages devoted to introduction to Binary Logic operations including AND, NAND, NOR and XOR gates (to name a few).
- Conversion and Binary Logic Simplification exercises
- Boolean Logic to Ladder Conversion

- Although good basic and introduction to Logical Systems, most of this has very little to do with Programming Machines or Automation on a Factory Floor.
- Some exercise are still very basic and do little to explain systematic approaches to controls.

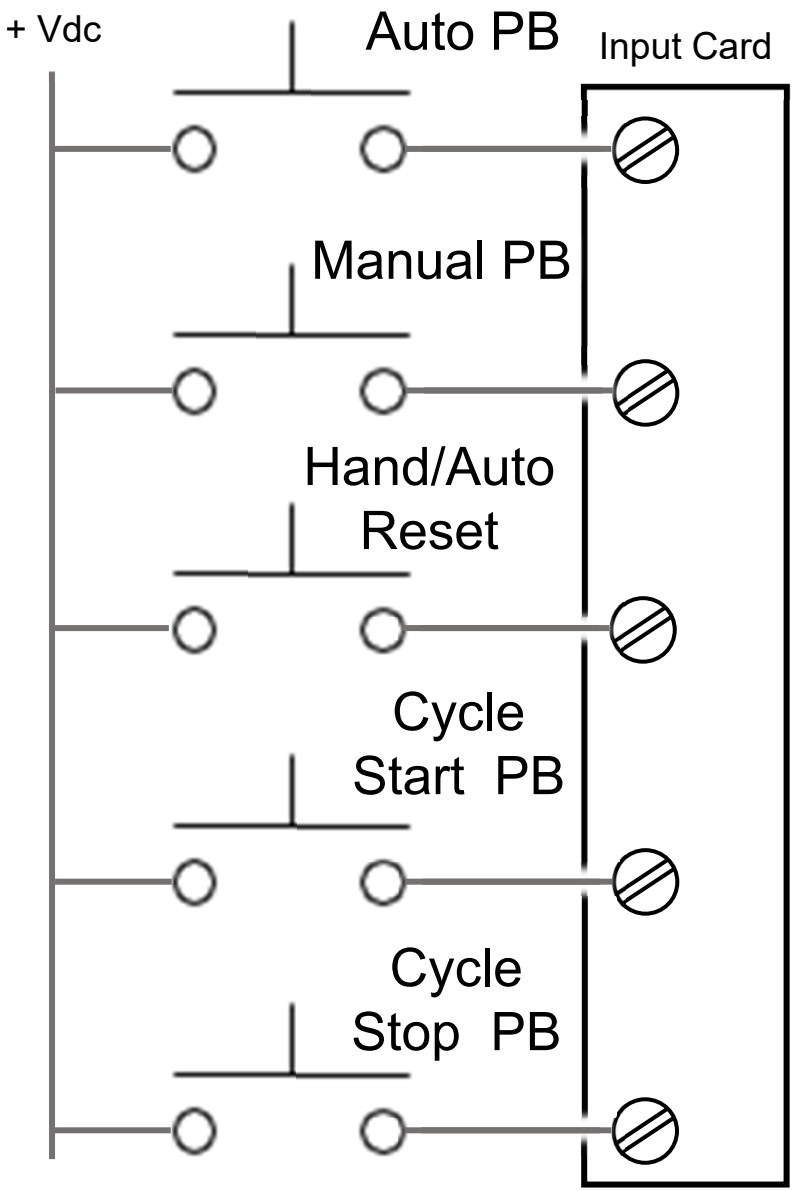
Challenge

To discuss system programming, we must start by defining the system being controlled and make some assumptions regarding its operation.

Example:

- Simple machine with a cylinder that must advance and return.
- Could be some events that precede the cylinder motion
- A Process is started once the Cylinder is the Advanced and held in Position.
- Solenoid type must be defined (see next slide).

PLC Programming Techniques 1



- Begin by defining some standard PLC inputs.
- All N.O. for simplicity (although there is typically a mixture of N.O. and N.C.
- Could be Physical PB or even inputs from HMI

For this example, addressing is not necessary and will not be discussed

N.O. = Normally Open
N.C. = Normally Closed

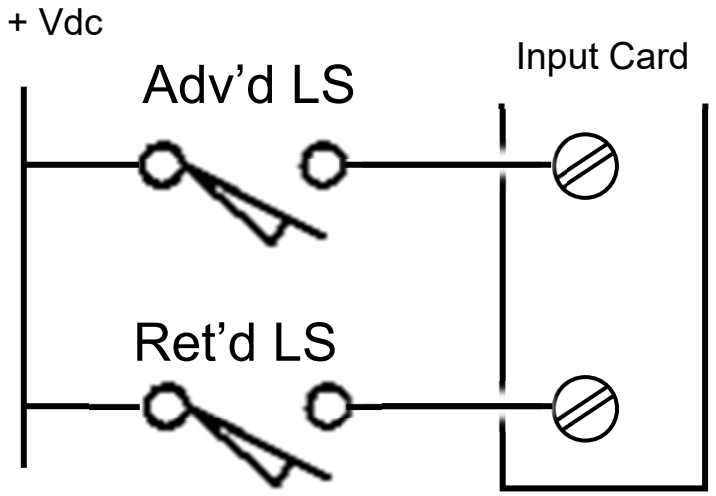
PLC Programming Techniques 1

Complication Factors not Addressed:

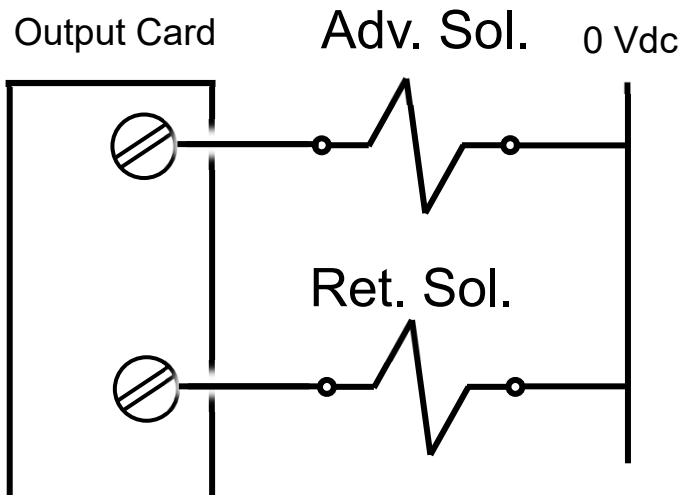
Programming Techniques is a very difficult subject to discuss since how the program is written will depend heavily on many other mitigating factors such as:

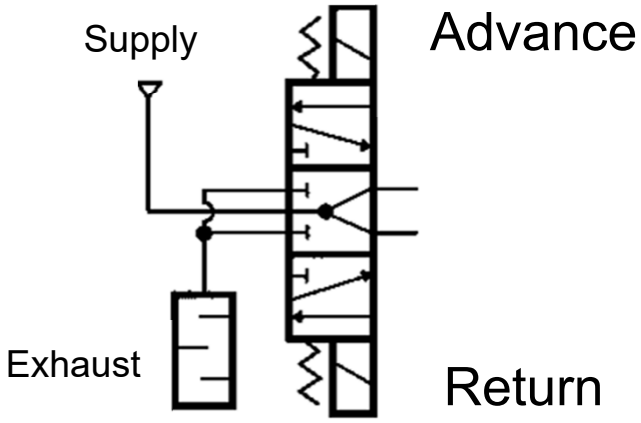
- Safety Issues related to valves (Estop energy release, moving a pneumatic cylinder without first being pressurized, need to hold in a position, speed and response of mechanical systems etc.).
- Pneumatic versus Hydraulic
- Single Sided Spring Return
- Double Sided - Detent versus Spring Return
- 3 Position versus 2 Position
- 3 Position Center Blocked
- 3 Position Center Vented or Return to Tank

PLC Programming Techniques 1

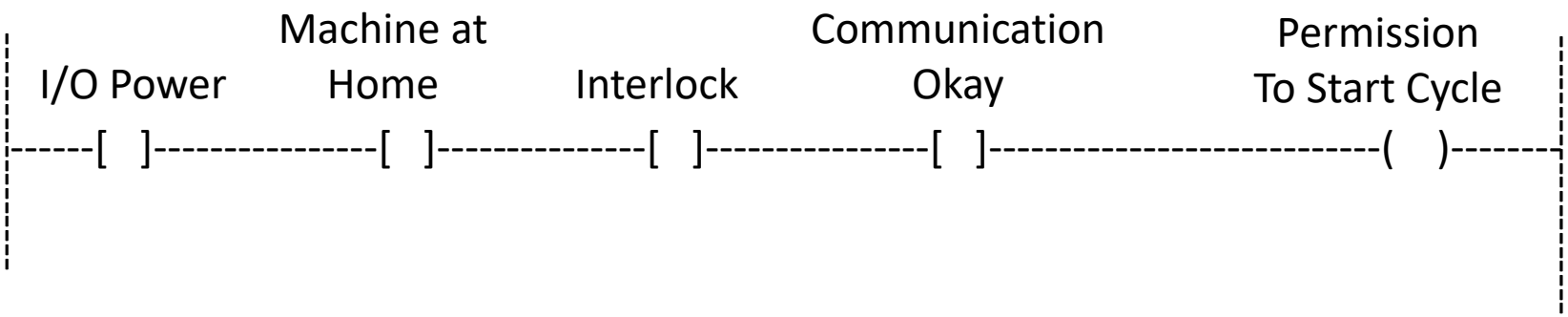


- Outputs move a pneumatic cylinder to an Advanced Position and then Return it (Home) again.
- Double sided, electrically held, spring return to center.
- Center position vents all energy but could also be blocked if necessary.



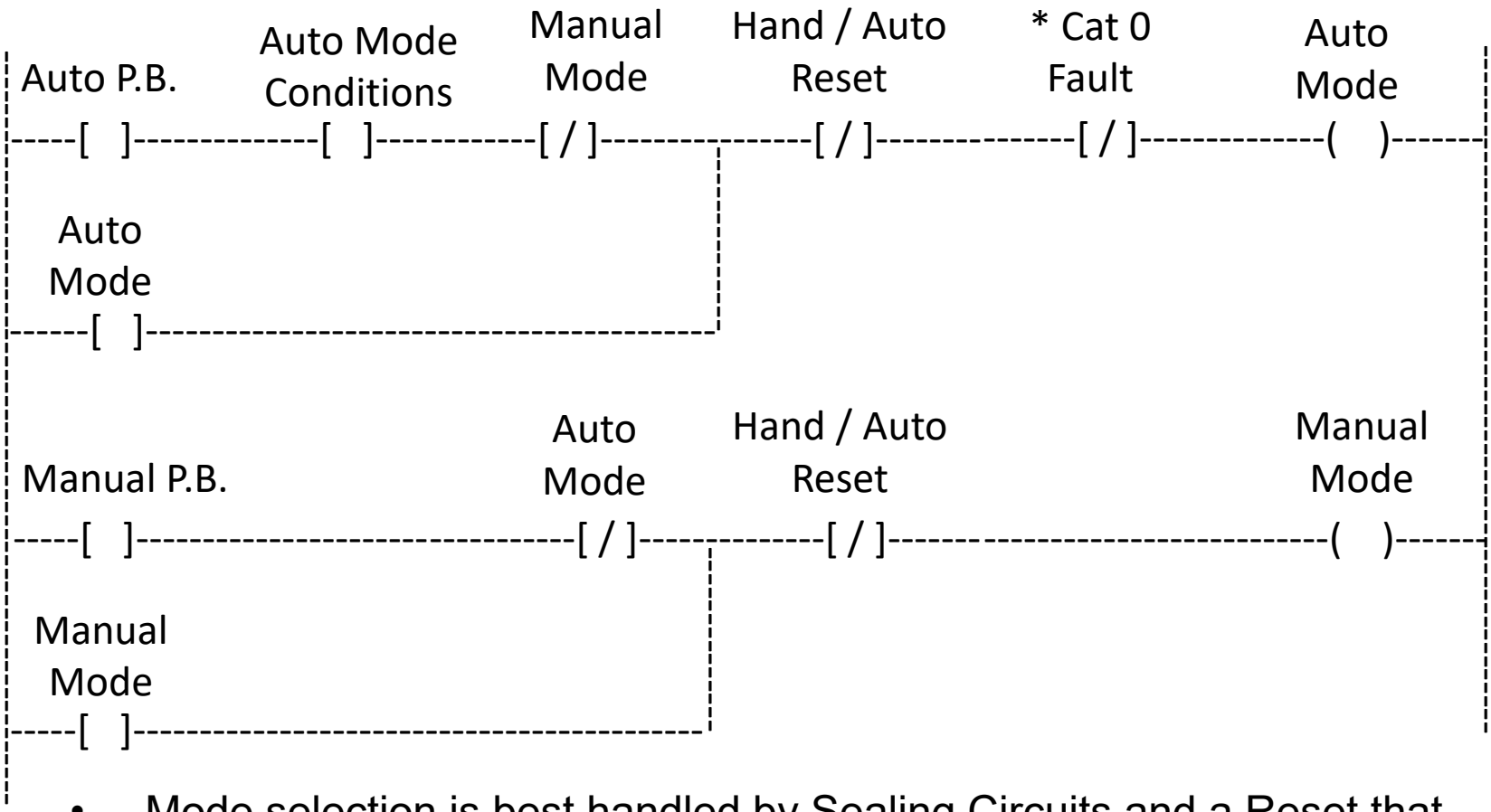


PLC Programming Techniques 1



- A typical machine, system or process will have conditions that are required for starting of the cycle.
- Permissions are particular to each machine, system or process with a few suggestions noted here.
- The next few slides show some samples of simple machine programming.
- For these examples, Latches --- (L) --- will not be used. Seals, it can be argued, are a better choice.

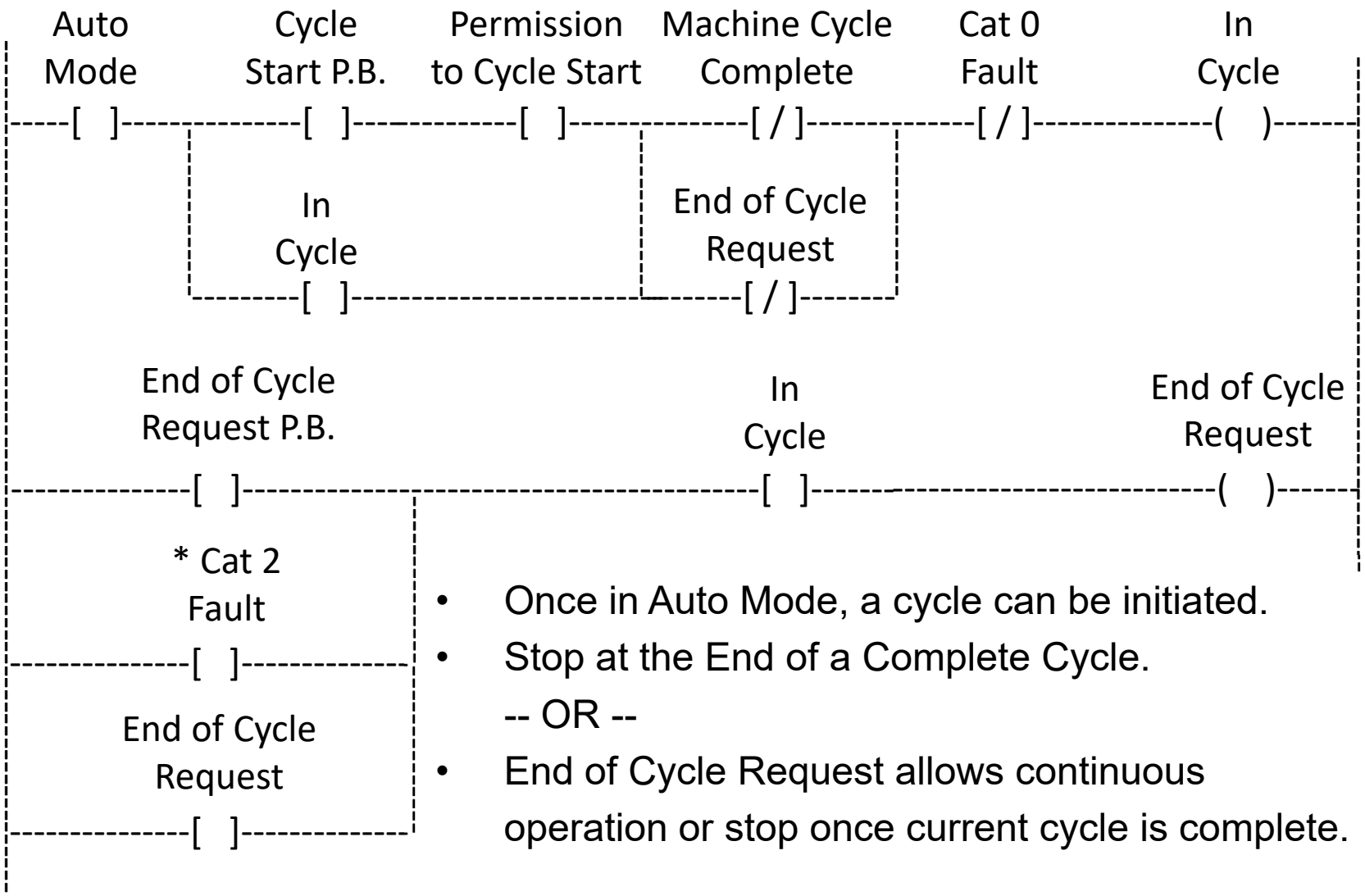
PLC Programming Techniques 1



- Mode selection is best handled by Sealing Circuits and a Reset that is required to switch Modes.
- There may be some additional conditions for Auto. Typically less conditions for Manual Mode.

*Cat 0 Fault: See last slide

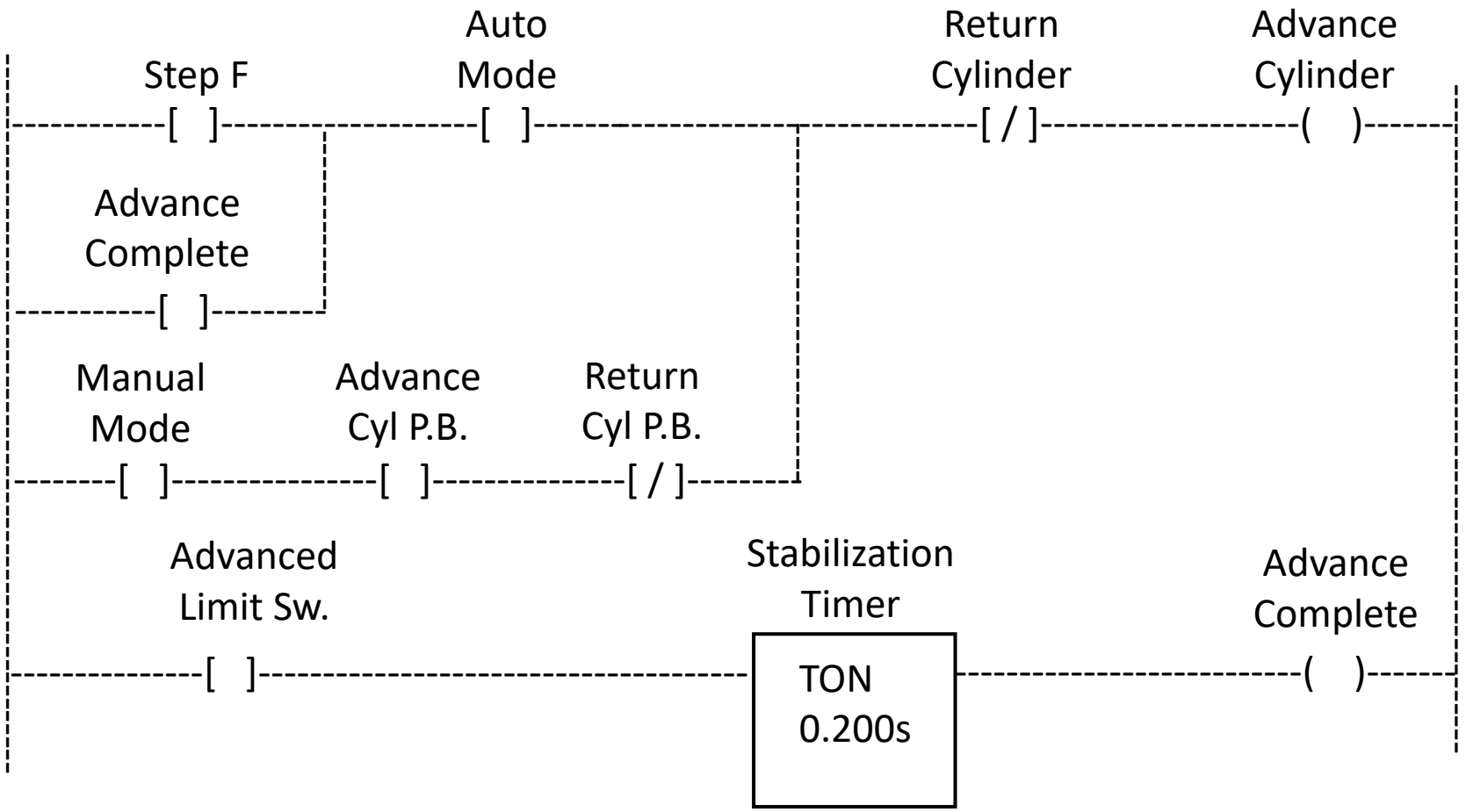
PLC Programming Techniques 1



- Once in Auto Mode, a cycle can be initiated.
- Stop at the End of a Complete Cycle.
  -- OR --
- End of Cycle Request allows continuous operation or stop once current cycle is complete.

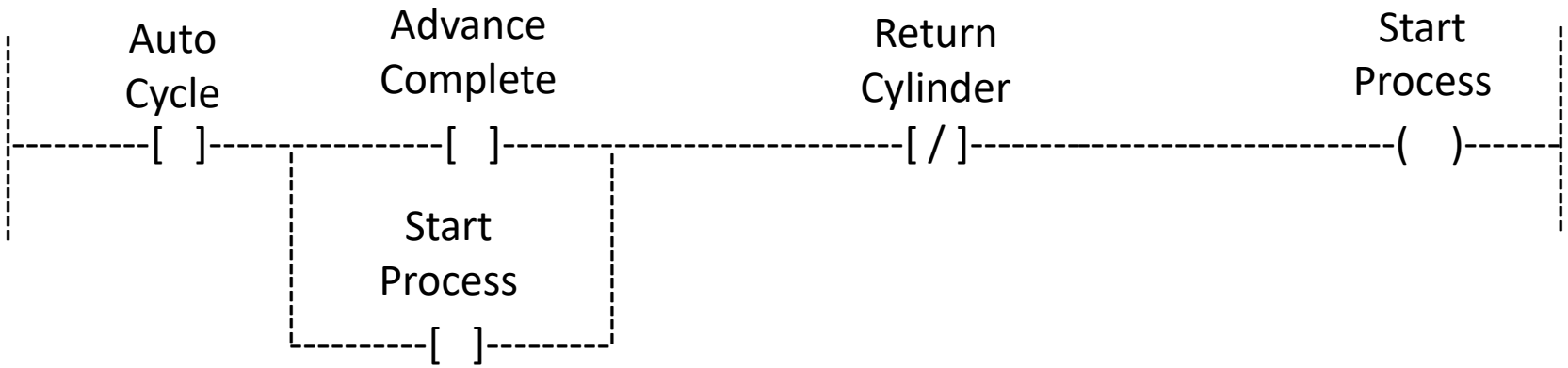
*Cat 2 Fault: See last slide

PLC Programming Techniques 1



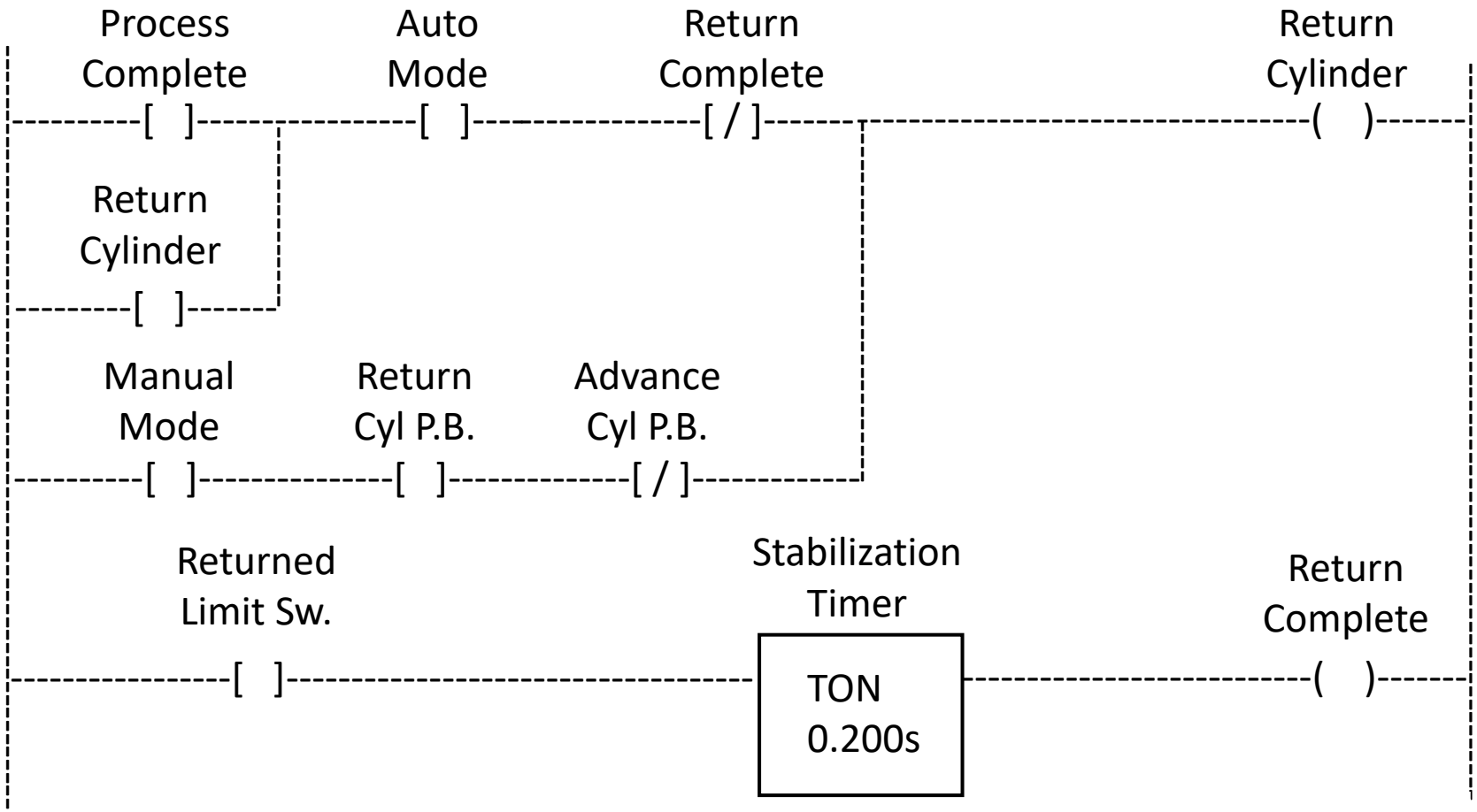
- In Automatic Mode the cylinder advances when Step 7 Activates.
- In this example Step 7 contains the necessary permissions to Advance.
- A 200ms debounce or stabilization time is used.

PLC Programming Techniques 1



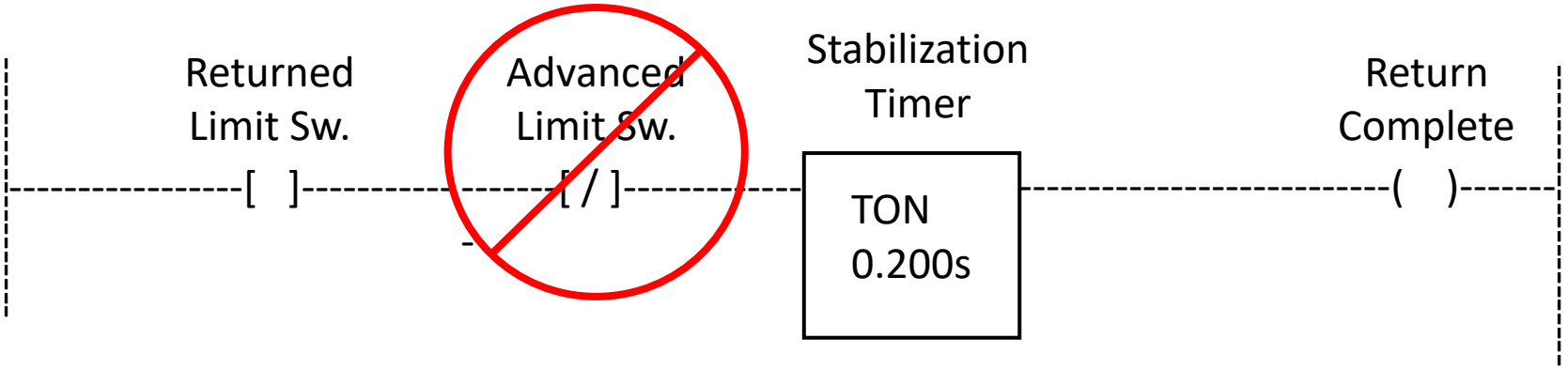
- Advance Complete is not mode dependent so Auto Cycle is required for the Process to Start.
- Start Process is used to seal around Advance Complete.
- Seal may not be required but if the Advance Proximity “flickers” due to the Process (ie: Press moving the part slightly), the Operation will not be interrupted.
- Fault logic should hand abnormal conditions.

PLC Programming Techniques 1



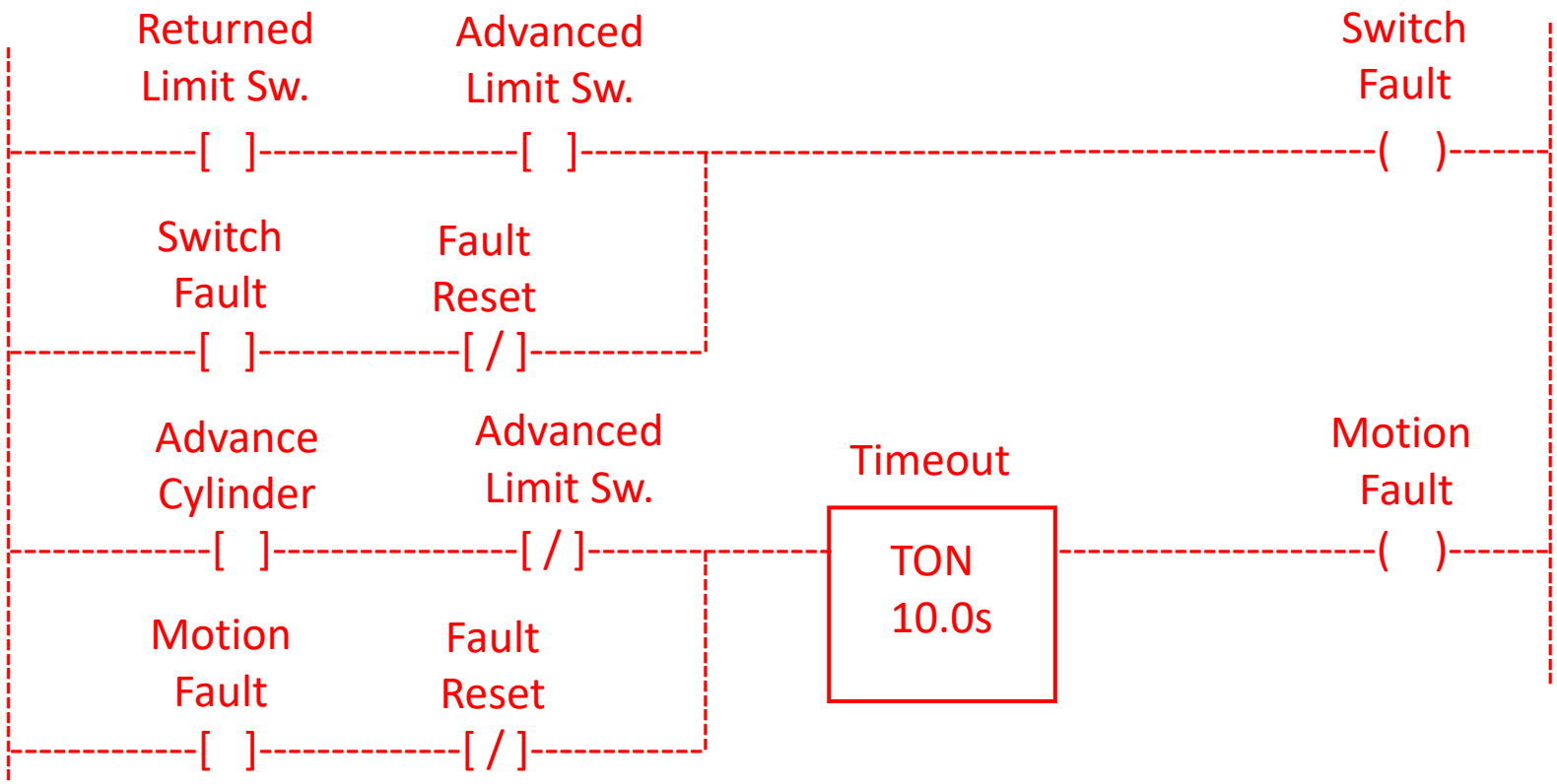
- In Automatic Mode the Cylinder returns after the Process is complete.
- A 200ms debounce or stabilization time is used to ensure the cylinder has Returned Completely.
- The Return Seal is broken once Stabilization is complete.

PLC Programming Techniques 1



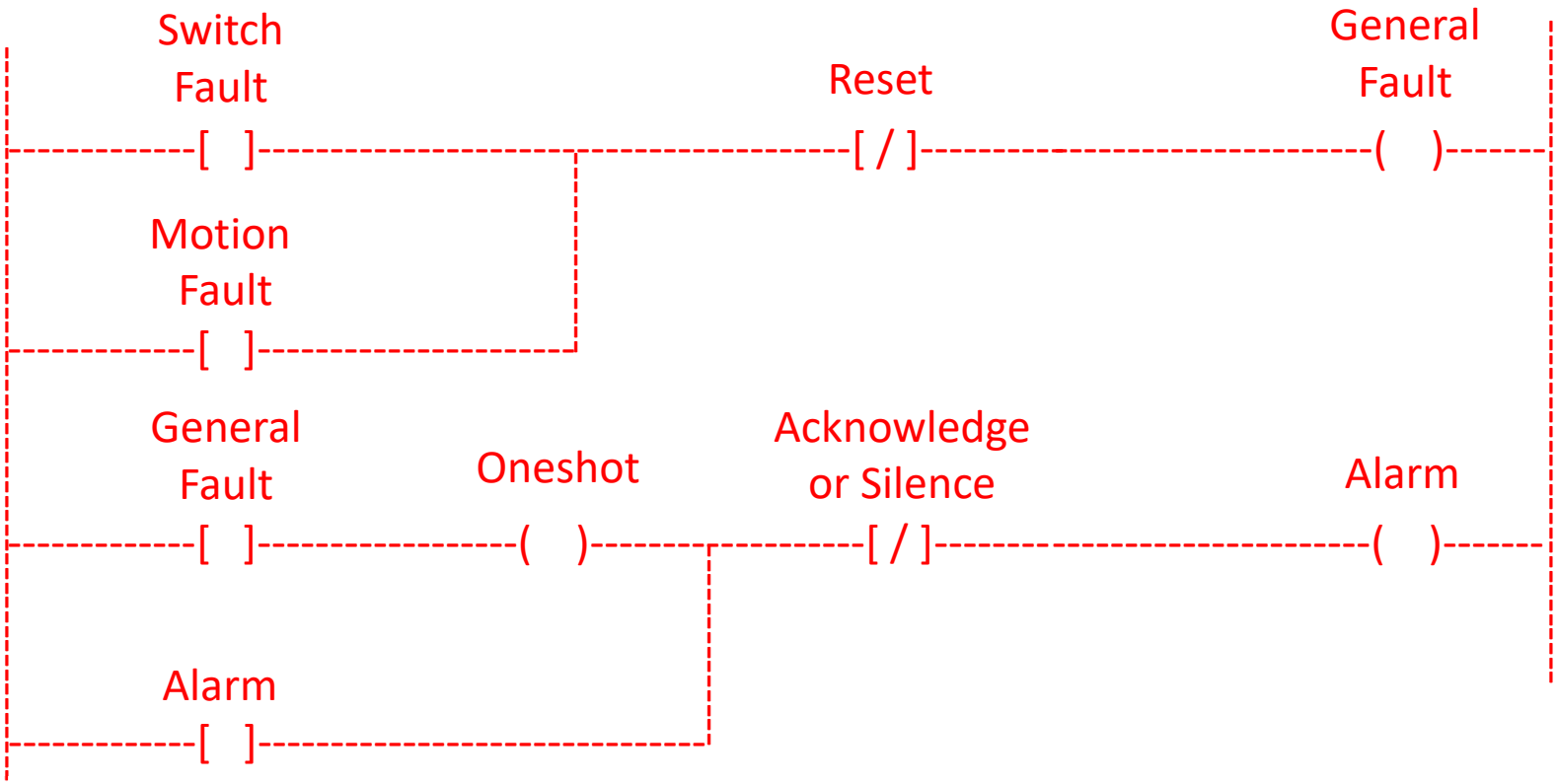
- Resist the temptation to add additional conditions.
- Use fault logic to detect and act on anomalies.
- If, in this case, the Advance Switch were to stick Closed, the program would now fail to detect that the Cylinder has Returned possibly creating erroneous fault states and limit recovery options

PLC Programming Techniques 1



- Fault logic can be tricky without a clearly defined fault detection strategy. For example, will the machine execute an Immediate or End of Cycle Stop?
- It is a good practice to hold Fault Bits on until Explicitly Reset to aid in Diagnosing the Root Cause.
- Note that resetting may seem to clear a motion fault but then see a reoccurrence at the next cycle.

PLC Programming Techniques 1



- Some simple logic to trigger a Fault Bit and also an Alarm Bit for Annunciation.
- In this example, Alarms can be Acknowledged or Silenced; however, if a Fault still exists when the Reset Button is Pressed, the Alarm Annunciation will be re-triggered.
- Depending on the number of expected faults, this method might not be optimal.

PLC Programming Techniques 1

Category Definitions

Cat 0: Stopping by immediate removal of power to the machine actuators (i.e., an uncontrolled stop). Traditional E-stop.

Cat 1: A controlled stop with power available to the machine actuators to achieve the stop and then removal of power when the stop is achieved.

Cat 2: A controlled stop with power left available to the machine actuators. Traditional End of Cycle Stop

Wording varies depending on the specification
(IEC 60204-1, NFPA 79, CSA C22.2 No. 301)