Programmable Logic Controllers
Introduction
Part 1
History, Definitions, & Standards

PLC Industry Today

- PLC evolution began in 1968 when Dick Morley conceived the PLC concept
- Modicon - First PLC company, installed first PLC at General Motors and Landis Company in 1970
- PLCs
  - 6.5 billion dollar annual business
  - Annual growth at about 20 percent per year
  - Over 110 PLC vendors worldwide

PLC Definitions

- *PLCs*
  - *Special-purpose industrial computers*
  - *Specialized electronic devices*
  - *Based on one or more microprocessors*
  - *Used to control industrial machinery and automation systems*

General Characteristics

- PLCs are industrial computers that operate in harsh environments on the factory floor.
- PLC control applications vary from on/off control of a pump to control of a conveyor system sorting boxes based upon destination zip codes.
- PLCs use five standard programming languages

Programming Languages

- Ladder Diagrams (LD) - Not the ladder logic languages provided by PLC vendors like Allen Bradley.
- Function Block Diagrams (FBD)
- Structured Text (ST)
- Instruction List (IL)
- Sequential Function Charts (SFC)

Language Preferences

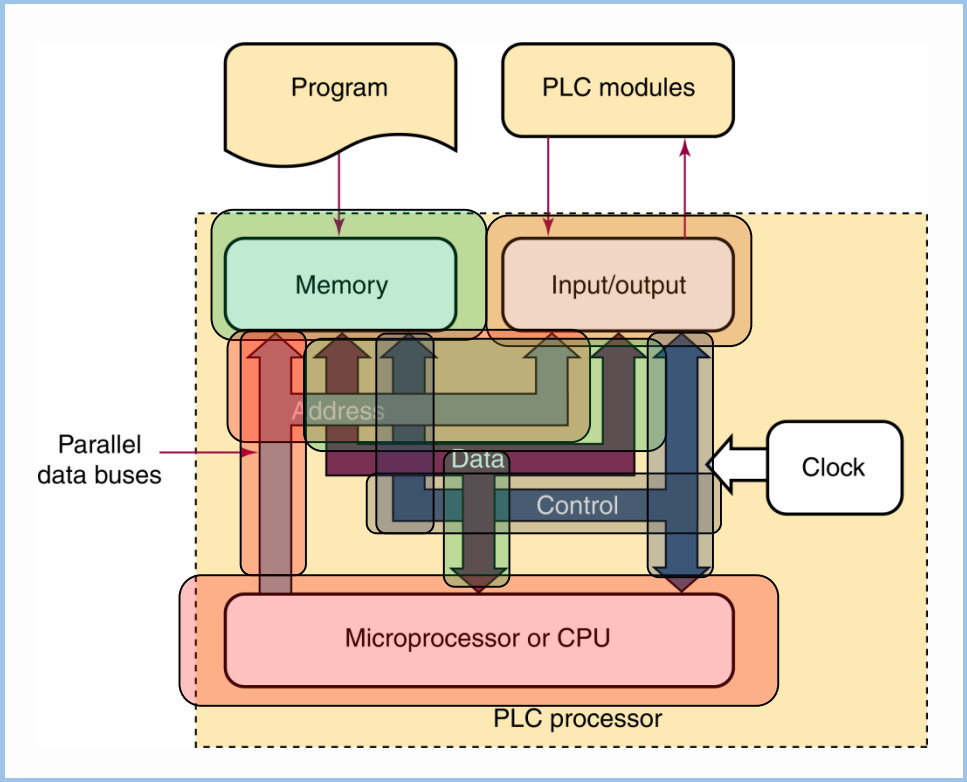
- U.S. production uses more ladder logic
- For process and motion control in the U.S. FBD is often used
- For sequential machine control the SFC language is often used

PLC versus PC

- Programmable Logic Controllers are called PLCs
- Personal Computers are called PCs.
- PLCs/PC similarities
  - Architecture
  - Motherboard
  - Processor
  - Solid state memory
  - Expansion slots
- PLC/PC differences: PLCs -
  - Have no disk drives
  - No monitors but often use human machine interface (HMI) flat screen display

PLC Architecture

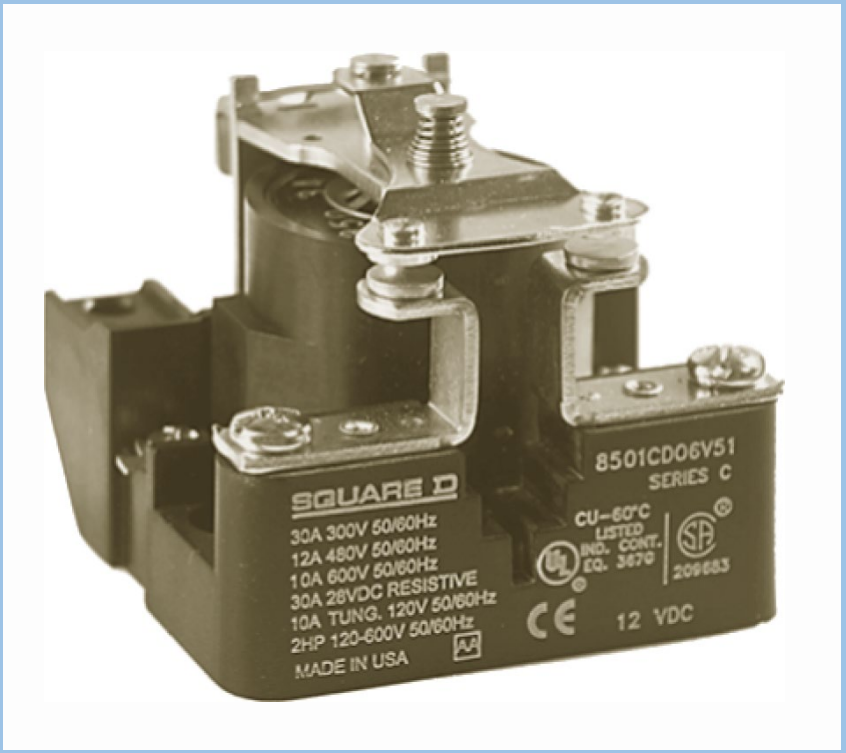
- PLC's CPU is a microprocessor(s)
- Memory and Input/Output (I/O) chips linked with parallel address, data, and control buses



Processor Architecture

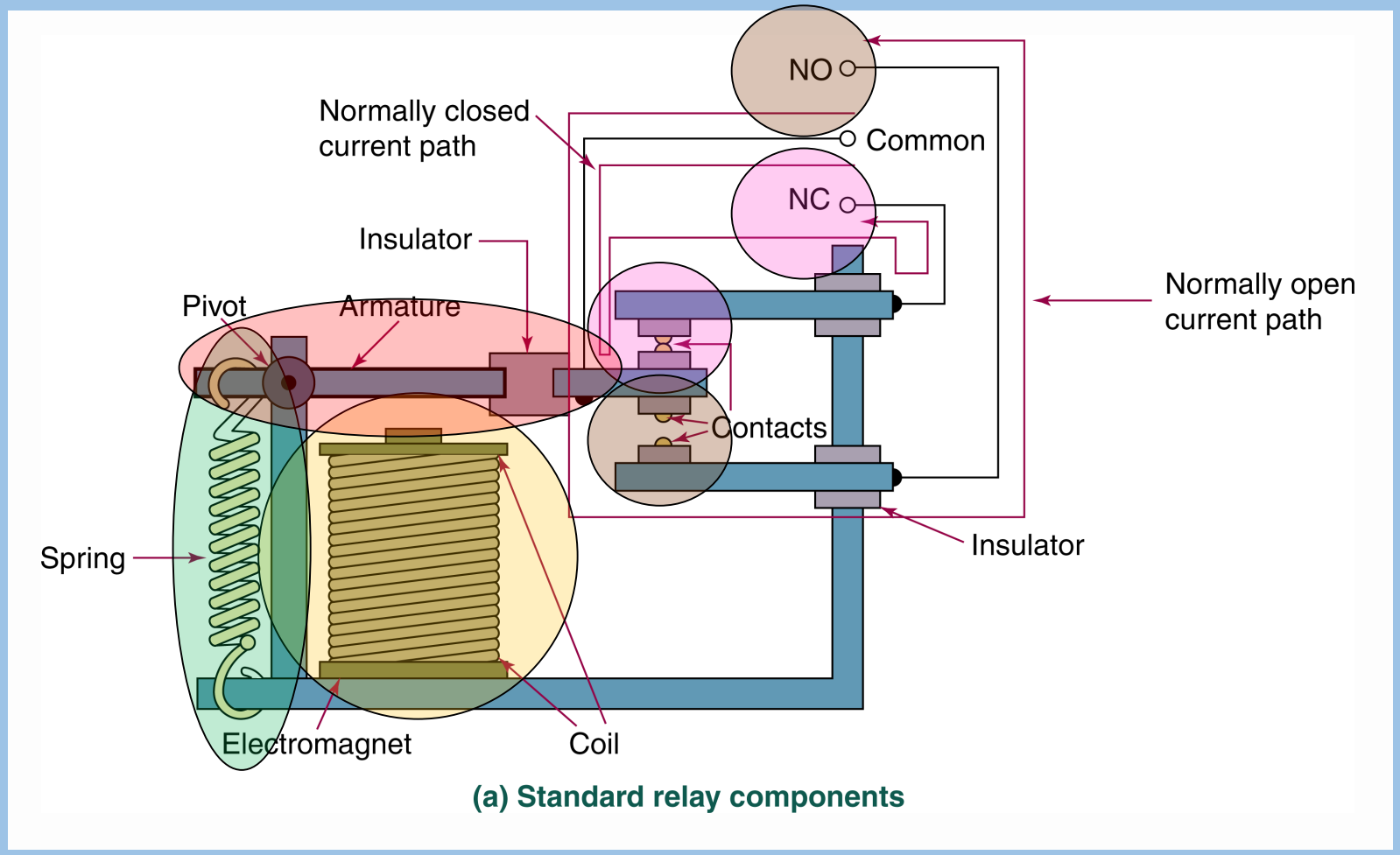
Early Machine Control

- Initially, relays were used to control the sequence of operations in machines
- These systems were called relay ladder logic (RLL)
- RLL were the control standard for industry
- PLCs eliminated much of the relay logic used for sequential control applications.



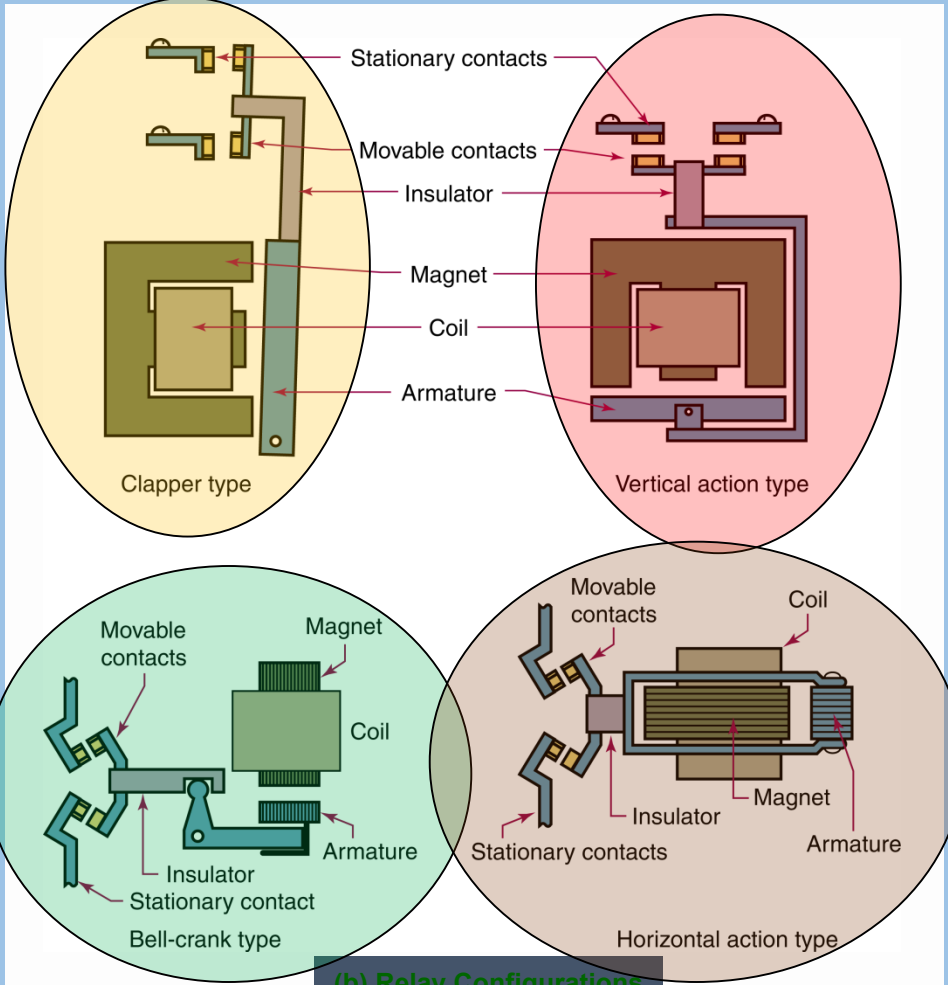
Electromagnetic Relay

Standard Relay Components



(a) Standard relay components

Relay Configurations



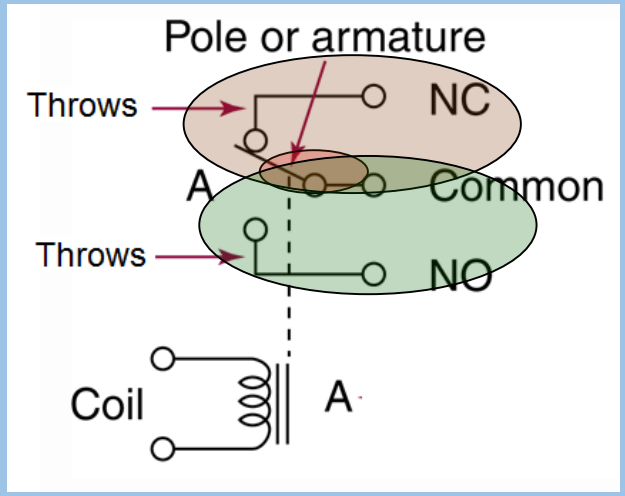
(b) Relay Configurations

Single Pole Double Throw Relay Operation

- Single Pole Double Throw (SPDT) type relay

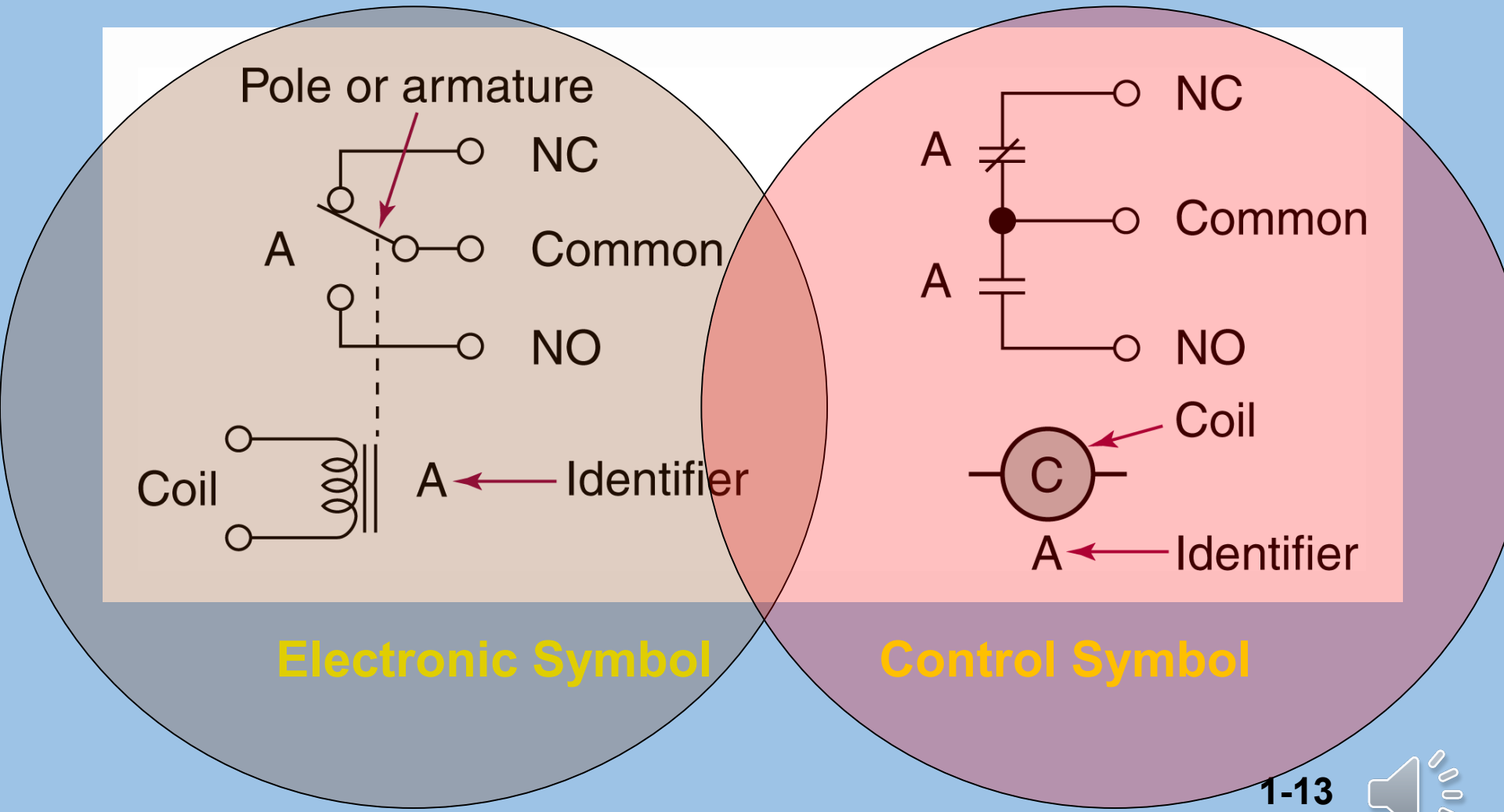
- SPDT relay has:
  - One common contact (single pole)
  - Two positions (NC and NO), which are called throws
  - Throws can also be thought of as potential paths for current flow

- The armature has insulators used to isolate electrical switching contacts from the rest of the relay components



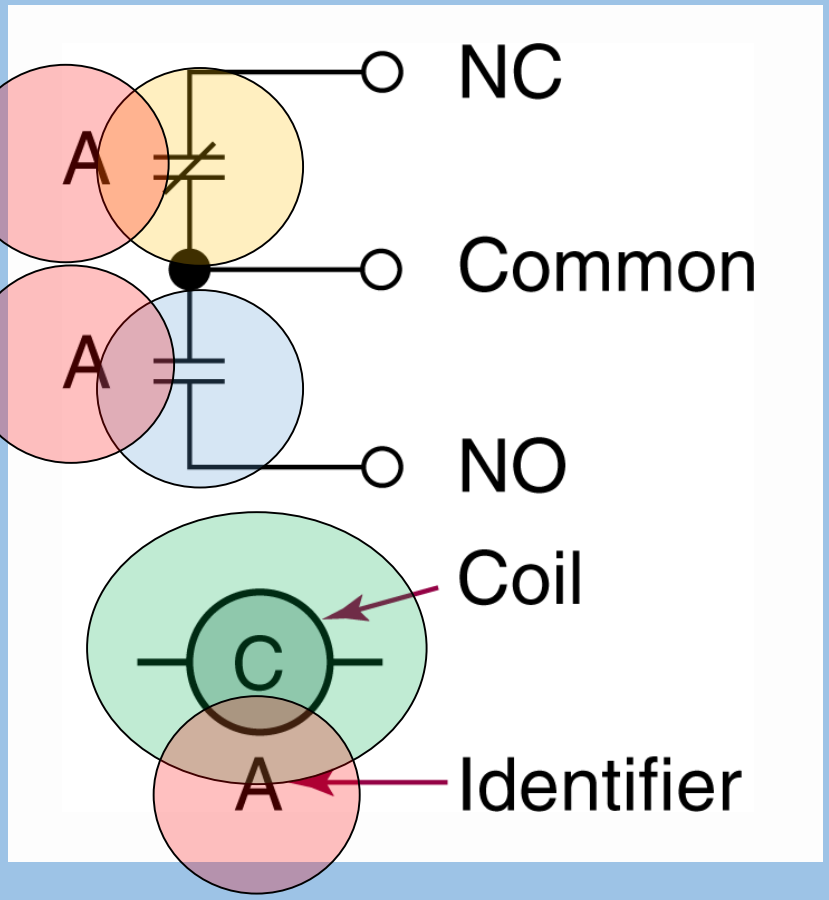
Standard Relay Symbols

SPDT



Control Schematic Symbol

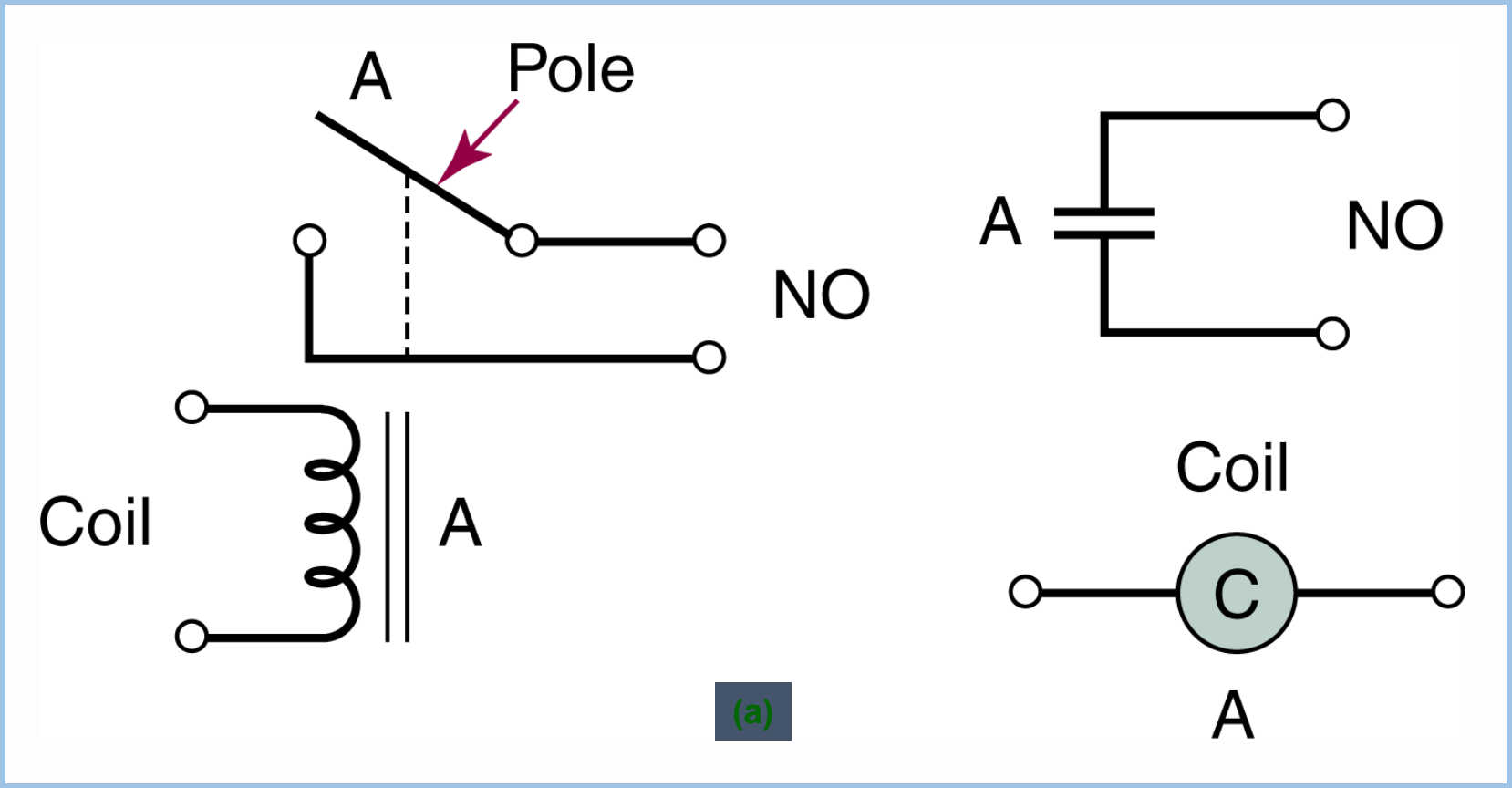
- NO contact
  - Symbol has two parallel lines to indicate normally open (NO) contacts
- NC contact
  - Symbol has same two parallel lines with a diagonal line across them to indicate normally closed (NC) contacts
- The electromagnetic coil is indicated by a circle with a C



Control Symbol

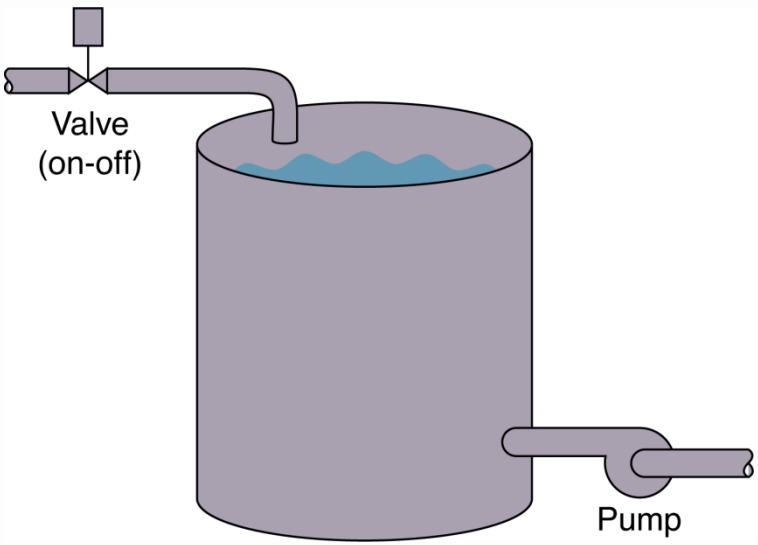
Poles and Throws

SPST



Machine Control Systems
Tank Liquid Level Control

- Tank filled with an electrically operated valve and emptied by a motor-driven pump
- Control must satisfy the following logic:
  - Pump operates only when the valve is open
  - Valve can open at any time

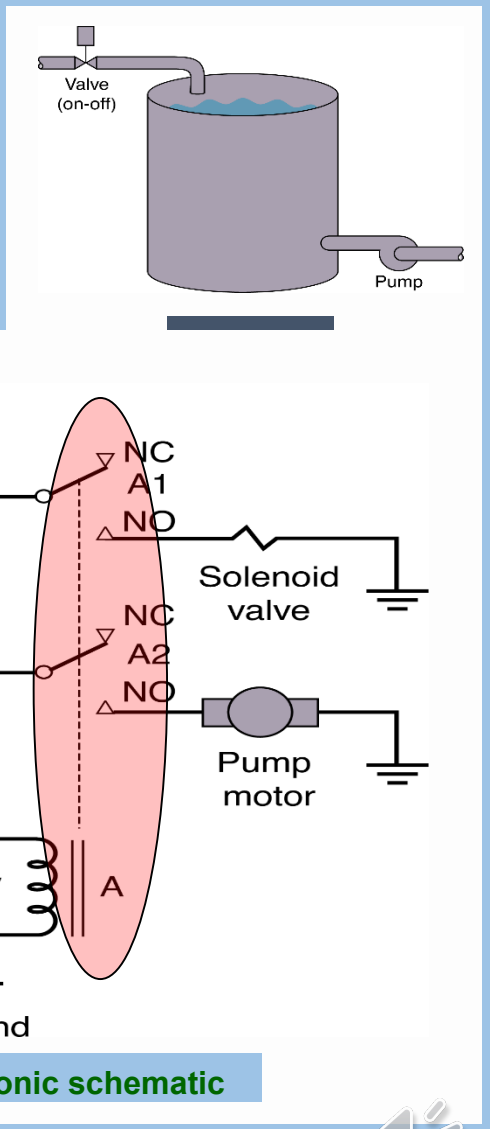


(a) Process Tank

Machine Control Systems
Electronic Schematic

Operation:

1. Manually closing S1causes relay A to be energized
2. A1 and A2 close NO contacts
3. Input valve is energized - tank fills
4. A2 - no immediate action as it is waiting for switch S2 to be closed



(b) Electronic schematic

Machine Control Systems

Control Ladder Diagram