ECEN 4856

Introduction to Programmable Logic Controllers (PLC)

Programmable Logic Controllers

- Industrial computer
  - Built-in OS
  - Programmed in Ladder Logic (function blocks)
  - Highly fault tolerant/Stable
  - Accepts variety of I/O
    - Analog, Digital, Counters
    - AC and DC voltages
- Uses
  - Factory automation
  - Process control
  - Manufacturing systems

PLC Operations

- Scan cycle
  - Standard PLC operation(differs slightly per manufacturer)
  - Consists of:
    - Overhead
    - Input scan
    - Logic execution
    - Output scan

(Note: once the output scan is complete the process repeats itself until the PLC is powered down or Fails.)

Scan Cycle

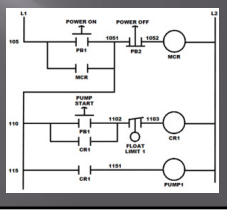
- Overhead
  - Test I/O module integrity
  - Verifying program logic hasn't changed
  - "Watchdog" (check PLC status)
  - Communications
    - PLC programmer port
    - Remote I/O
    - Other external devices
      - HMIs (Human Machine Interfaces)
      - Supervisor Computers

Scan Cycle cont.

- Input scan:
  - Records digital & analog values
  - Saves to input memory table
- Logic execution:
  - Program is scanned
    - Element by element, then rung by rung until the end
    - Resulting values written to output memory table
- Output scan
  - Output values written from the output memory table

Ladder Logic

- **Primary Programming Language for PLCs.**
- **Visual and Graphical language (not a high-level language, such as C, C++, Java…)**
- **Derived from relay logic diagrams**



Common Instructions

- Arithmetic (+ - * / COS SIN TAN)
- Binary (Mask, Shift)
- Boolean (AND,OR,NOT,XOR)
- Comparator (< > = CMP)
- Counter (CTD, CTU, CTUD)
- Data Conversion (ANY_TO_**)
- Process (PID, SCALER, more…)
- String (FIND REPLACE more)
- Time (TON,TOF,TONOFF)

Standard Data Types

- Bit Strings – (1's and 0's)
  - BOOL - 1 bit
  - BYTE - 8 bit
  - WORD - 16 bit
  - DWORD - 32 bit
  - LWORD - 64 bit
- INTEGER – whole number (1 byte = 8 bits)
  - SINT - signed short (1 byte)
  - INT - signed integer (2 byte)
  - DINT - double integer (4 byte)
  - LINT - long integer (8 byte)
- REAL - floating point
  - REAL - (4 byte)
  - LREAL - (8 byte)

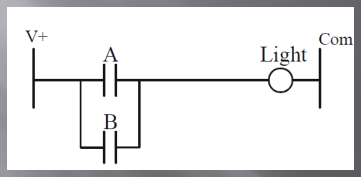
Variables

- Syntax and usage varies by manufacturer
- Attributes
  - Retained
  - Constant
- Types
  - Global
  - Direct (local)
  - Mapped - Input, Output, I/O
  - External
  - Temporary

Contacts and Outputs

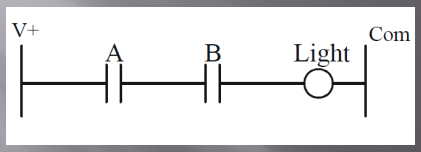
- Normally Open –[ ]–
  - Closed if its coil or input is energized
- Normally Closed –[\]–
  - Closed if its coil or input is not energized
- Coils
  - –( )– normal, energized if rung is closed
  - –(\ )– inverted coil, energized if rung is open
  - –(S)–set, once energized remains until reset
  - –(R)– reset, deenergizes a set coil

OR Operation



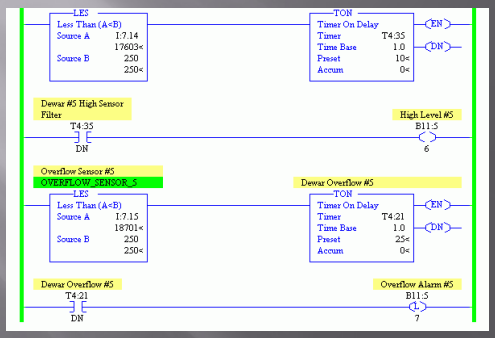
- A and B are inputs – either internal or wired
- Since they are connected in parallel they are logically OR'd
- Light is the output coil

AND Operation



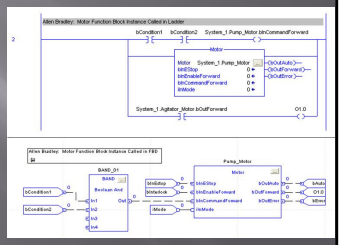
- A and B are inputs – either internal or wired
- Since they are connected in series they are logically AND'd
- Light is the output coil

Example Ladder Code

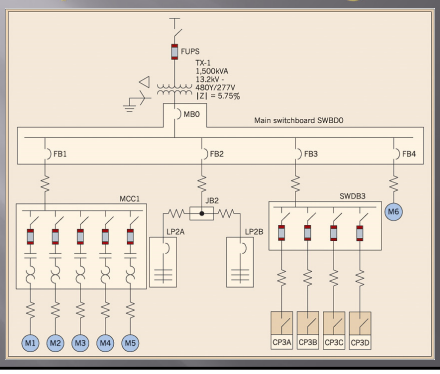


Function Block Diagrams

- Graphical language for PLC programming
- Inputs and Outputs of "Blocks" are tied together to perform functions
- Functions can be predefined or user created



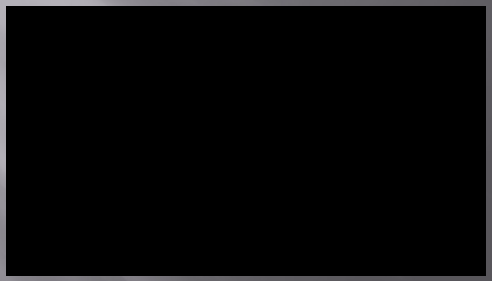
Example Electrical Single Line



YouTube Video

PART 1: https://www.youtube.com/watch?v=zvS_BuQlSXo

YouTube Video



PART2: https://www.youtube.com/watch?v=DXGKO_2Bw4g

Excellent Practice Resource

- Dr. M PLC Training Page
  - http://etidweb.tamu.edu/hsieh/Hsieh_VirtualPLC.html

References

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  http://en.wikibooks.org/wiki/Introductory_PLC_Programming
- Wikipedia
  http://en.wikipedia.org/wiki/IEC_61131-3
  http://en.wikipedia.org/wiki/Ladder_logic#Example_of_a_simple_ladder_logic_program
- Krootech
  http://www.kronotech.com/index.htm