MET 487 Instrumentation and Automatic Control

Intro to Programmable Logic Controller

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Topics of Discussion

- Industrial Control using Relay Logics
- PLC Definition
- Evolution of PLC
- PLC System Components
- Brands of PLC
- PLC Programming Basic
- PLC Programming Examples
Industrial Control Using Relay Logic

- On-Off Control of a 3-Phase Induction Motor
  - Star the Motor
    - Push START button
    - M coil energized
    - M – Auxiliary contact closed: memorize the start action
    - M contact closed -Motor start and run
  - Stop the Motor

- Stop the Motor
  - Push STOP button
  - The M coil circuit is interrupted and the coil is deenergized
  - Both M main contact and Auxiliary contact are open
  - Motor stop
Evolution of the PLC

- Relay logic with wiring, relays, timers (cam timer, pneumatic system time delay), limit switches, and other component mounted on control panels (1960s)
- The first computer/PLC (late 1960s to 1970s)
  - MODICOM 084 – the world’s first commercial PLC
- The microprocessor-based PLC (1980s – now)
- Other new technology - possible replacement for PLC

Other new technology - possible replacement for PLC

Programmable Automation Controller
- www.opto22.com
- www.ni.com
- http://www.oldi.com/aw/

Embedded PC Control,
www.beckhoffautomation.com

Reference
- History of the PLC, by Jim Pinto,
  http://www.isa.org/Content/ContentGroups/News/2006/February
24/History_of_the_PLC.htm
Definition of PLC

- A real-time computer system for automation control of electromechanical processes such as control of machines on manufacturing floor or assembly lines.
- Typical inputs connected to the PLC are switches (user inputs), sensors (process controlled variables), and/or analog inputs.
- Typical output connected to the PLC are actuators such as magnetic relay coil, solenoids, or analog outputs which in term drive motors, pneumatic or hydraulic cylinders.
- Communication modules (including RS 232, RS 485, Fieldbus, Ethernet, Wireless, etc) are added for program download/upload and process data sharing.

PLC System Components

- PLC System Components
  - CPU and Memory
  - Input Modules
  - Output Modules
  - Power Supply
  - Programming Tools
  - Communication Module
Brands of PLC

- Rockwell Automation (Allen Bradley), http://www.ab.com/programmablecontrol/plc/
- Siemens
  - SIMATIC S7-1200 (HMI Basic Panel, Step 7 Basic engineering software), www.sea.siemens.com/s7-1200
Brands of PLC

  - EH-150 - Modular Mini PLC
  - EH-150 EHV – Modular High Speed Mini PLC
  - H Series – Large PLC for Plant Engineering
  - MICRO-EH
  - Webcontroller

- Fuji PLC, http://www.fujielectric.co.jp/fcs/eng/product/plc/

- Panasonic PLC,
PLC Programming Basic – Ladder Diagram

- Boolean Algebra
  - Logical AND
  - Logical OR
  - Logical NOT (Inverter)
  - Truth Table

```
AND Operation
M Coil ON = STOP (closed) AND START (ON)
OR
M Coil ON = STOP (closed) AND M Auxiliary Contact Closed

OR Operation
M Coil ON = SATRT (ON) OR M Auxiliary Contact Closed
```

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PLC Programming – Logical AND

```
Truth Table
Inputs    | Output
A  B  M
0  0  0
0  1  0
1  0  0
1  1  1

Boolean Equation
M = AB
```

---

Standard Digital AND Gate
PLC Programming – Logical OR

**OR Operation**

\[ M = A \text{ OR } B \]

<table>
<thead>
<tr>
<th>Inputs</th>
<th>Output</th>
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<tbody>
<tr>
<td>A</td>
<td>B</td>
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<tr>
<td>0</td>
<td>0</td>
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<td>0</td>
<td>1</td>
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**Truth Table**

**Boolean Equation**

\[ M = A+B \]

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PLC Programming – Logical NOT

**Standard Digital NOT Gate**

<table>
<thead>
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<tbody>
<tr>
<td>A</td>
<td>M</td>
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<td>0</td>
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</tbody>
</table>

**Truth Table**

**Boolean Equation**

\[ M = \text{NOT} A \]
PLC Programming – Boolean Equation

F = (AB) + C

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Boolean Equation
F = (AB) + C
F = (A AND B) OR C

PLC Programming

- Rungs - Each horizontal row is called a rung
- Rails - The two vertical lines is called rails
- Input
  - --| |-- Examine If Closed
  - — Examine if Open
- Output
  - symbol --( )—
- Addresses
  - Input: I:1/0 … I:1/15
  - Output: O:2/0 … O:2/15
PLC Programming

- Internal Relay
- Timer
- Counter
- Parallel Circuits
- Series Circuits

PLC Programming – Equivalent Ladder Diagram for $F = (AB) + C$