INTRODUCTION

First PLC is introduced by Bedford Associates founded by Richard Morley in 1968.

PLC was known as the Modular Digital Controller from which the MODICON company derived its name.

Programmable Logic Controllers were developed to provide a replacement for large relay based control panels.

These systems were inflexible requiring major rewiring or replacement whenever the control sequence was to be changed.
Contd...

- Maintainable by technicians and electrical personnel.

- To support this the programming language of Ladder Logic was developed.

- Ladder Logic is based on the relay and contact symbols technicians were used to through wiring diagrams of electrical control panels.
OVERVIEW

- What is a PLC?
  - Advantages
  - Disadvantages
  - Real world Relay Replacement
  - Example of a Motor Control

- How to program a PLC?
  - Ladder diagrams
  - Examples
  - Signal Processing
What is a Programmable Logic Controllers (PLC)?

A special computer for logic controls using ladder logic programming.
Contd…

- A digital computer used for industrial automation processes.
- PLC is designed for multiple inputs and output arrangements.
- Programs to control machine operation.
- PLC is an example of a real time system.
- Armored for severe conditions compared to PC’s.
- Relay logic replacement.
- Process Inputs and Outputs.
Advantages of PLC’s

- Easy to maintain
- Easy to program
- Reliable in industrial environment
- Compact
- Long lasting
- Scalable
Disadvantages of PLC’s

- Handling large amount of Data.
- Displaying Data.
- Handling Databases.
- Complex data handling.
MODICON 084, the first practical programmable controller (1969).

“Assembler” on manufacturer specific hardware. 6-12 keys for each instruction.

“Analog” I/O’s like +/-10V in addition to the digital I/O’s (Boolean variables).

Improved Communication: PLC ↔ PLC

Miniaturization

Improved Symbolic programming on PC’s

Soft PLC’s

Five standardized programming languages
IEC 1131-3
PLC a Real World Relay Replacement

- Real world Parts:
  - Switch
  - Bell
  - Relay

Switch controlling AC circuit or bell
Contd…

Relay Coil Symbol

Relay Normally open Contact Symbol

PLC Input Symbol

PLC Output Symbol
Example of a Motor Control

EQUIVALENT DIAGRAMS

Normally Open Contact

Normally Closed Contact
Basic PLC Components needed to replace relay control panels will be presented. These include:

- Isolated power supply.
- Digital Input and Output pins (DI/0).
- Micro-controller.
- Memory.

(Note: Advanced features such as Timers, Interrupts, Counters, etc. will be discussed latter)
PLC Execution

Sensors

Eingänge/Inputs:
E0.0 E0.1 E0.2 ..
1 0 1 ..

Check input status

I/O-List
- Inputvariables
- Outputvariables

Program
- Sequential logic

Update output status

Actors

Ausgänge/Outputs:
A0.0 A0.1 A0.2 ..
0 1 1 ..
How to program PLCs?

- Using a specialized Ladder Logic Software
  Allen-Bradley uses RsLogix 500 software to program SLC, Micrologix and so on.

- Omron uses Cx Programmer software for its SYSMAC PLCs.

- Other manufacturers has their own software.
LADDER LOGIC

- Ladder logic is a method of drawing electrical logic schematics.

- A graphical language popular for PLCs Controllers.

- Invented to describe logic made from relays.

- Language resemble ladders, with two vertical "rails" and a series of horizontal "rungs" between them.

- Rule-based language, rather than a procedural language.

- Executed sequentially by software, in a loop.
EXAMPLES

Relay Logic

Ladder Logic
PLC SIGNAL PROCESS

- **Inputs**: describe the status of the process to the controller (external).
- **States**: discrete modes the controller can be in (internal).
- **State transitions**: functions of the current state and the inputs.
- **Outputs**: actions initiated by the controller based on the current state (external).
Through inputs the PLC monitors sensors either digital or analog.

- Photo eye
- Proximity sensor
- Pressure switch

The output is to control processes either digital or analog.

- Motor
- Control a valve
- Light
CONCLUSION

- PLC’s are replacement of Relay based systems.

- Ladder Logic is develop to program this specialize devices using graphical symbols.

- Easy to maintain and program but does not handle complex data manipulation.

- Each manufacture has its own custom software to program PLC’s.

- Inputs are external signal from processes for the PLC to monitor. Ex: sensors

- Outputs are internal signal from PLC to control a particular process. Ex: motors.
How to start with PLC
Programmable Logic Controller
Overview

- What is PLC
- Allen Bradley PLC (How to work with RSLogix 500 software)
- Different functions & Ladder diagram
- Examples
- Tutorials
What is PLC

Definition

A programmable logic controller is a device which performs discrete or continuous logic in process plant or factory environment.
✓ Programmable logic controller (Programmable controller)

✓ Solid state system

✓ It was developed in late 1960’s or early 1970’s

✓ Designed to perform logic function
  ✓ It came to replace electromechanical relays.

✓ Early the I/O of PLC is digital value
Now a days analog I/O also possible with help of ADC/DAC inside PLC

schematic diagram of PLC
PLC History

MODICON 084, the first practical programmable controller (1969).

Improved Communication: PLC ↔ PLC

Miniaturization

Soft PLC’s

Hardware

1960

“Assembler” on manufacturer specific hardware. 6-12 keys for each instruction

1970

“Analog” I/O’s like +/-10V in addition to the digital I/O’s (Boolean variables)

1980

Symbolic programming on PC’s

1990

Five standardized programming languages IEC 1131-3
Some of the Advantage of PLC

- Low cost (relay cost is higher than PLC)
- High Reliability (generally solid state devices are more reliable)
- Maintenance easy than relay
- Flexibility
- Size is reduced
- Ease of programming
Types of Programming PLC

- Hand held device
- Dedicated desktop (keyboard with symbols)
- Computer
RSLogix 500 starter
Register used

- N7- integer (Ex: N7:0, N7:1……….)
- F8 - float (Ex: F8:0, F8:1…………..)
- T4 – timer (Ex: T4:0, T4:1………..)
- C5 – counter (Ex: C5:0, C5:1…………..)
How to address I/O’s

- Maximum 12- I/O is externally connect
- Software I/O more than 12
& Ladder diagram basics
Contacts & coils

- Rung branch
- Examine if close
- Examine if open
- Output energize
- Output latch
- Output unlatch
Some examples

AND LOGIC USING SIMPLE LD

Truth table

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<thead>
<tr>
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<th>B</th>
<th>AB</th>
</tr>
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<tr>
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Level application

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Dispensing oil from a tank

Diagram showing level application with high level, low level, fill motor, Drain, PLC, and END.
Program scan
Tank level control
Latch
Latch
Timer/ counter

- Timer On delay
- Timer OFF delay
- Retentive timer ON delay
- Up counter
- Down counter
- Reset
Some examples

ON delay
Reset

OFF delay
Compare

- **Equal**
  ```plaintext
  EQU
  Equal
  Source A  C5:0.ACC
  5≤
  Source B  5
  5≤
  ```

- **Limit test**
  ```plaintext
  LIM
  Limit Test  5
  5≤
  Low Lim    5
  5≤
  Test      C5:0.ACC
  0≤
  High Lim  ?
  7≤
  ```

- **Not equal**
  ```plaintext
  NEQ
  Not Equal
  Source A  ?
  Source B  ?
  ```
- Less than
- Greater than
- Less than or equal
- Greater than or equal
Some examples

Equal

Limit test
Not equal
Compute/math

- **Addition**

- **Subtraction**

- **Multiplication**

- **Division**

- **Square root**
Some examples

Addition

Register
Move / logic function

- **Move**
  - MOV
  - Move
  - Source
  - ?
  - Dest
  - ?

- **Masked move**
  - MVM
  - Masked Move
  - Source
  - N7:0
  - 2048<
  - Mask
  - N7:1
  - 0F00h<
  - Dest
  - N7:2
  - 2048<

- **AND logic**
  - AND
  - Bitwise AND
  - Source A
  - N7:0
  - ?
  - Source B
  - N7:1
  - ?
  - Dest
  - N7:2
  - ?

- **OR logic**
  - OR
  - Bitwise Inclusive OR
  - Source A
  - ?
  - ?
  - Source B
  - ?
  - ?
  - Dest
  - ?
X-OR logic

NOT

Clear
Some examples

Move

AND
Clear
Tutorials
Tabulate the logic truth table & Draw the ladder diagram for the following

1. XOR GATE

2. \[ Y = X_1 \text{ AND } X_2 \text{ AND } [\text{NOT } X_3] \text{ OR } [\text{NOT } X_4 \text{ AND } X_5] \]

3. \[ Y = (A+B)(C+E+FD) \]
THANK YOU

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References

• http://www.searcheng.co.uk/articles/plc/intro.html