Programmable Logic Controllers

* Relay Ladder Logic (RLL) is "hard-wired" by the interconnection of the relays, limit switches, timers, counters, etc.
* Changing the "program" requires **s** the wires from the relays and limit switches. – not terribly easy or convenient!

Programmable Controllers

* Programmable Logic Controllers (PLC) were developed in the early 60's to overcome the deficiencies of RLL – uses
* Programming can still be done in ladder logic, just like hard-wired RLL
* Electricians and technicians can readily adapt to this familiar type of programming.

PLC Station

PLC Direct DL205

Simple Hydraulic System

Relay Ladder Logic (RLL) Control System

Hydraulic System
Start-up Configuration

• Press the PB-1 pushbutton
• Contacts X1 turn ON

• Output relay C5 turned ON
• Inputs C5 read as ON

• Output relay Y2 turned ON
• Valve solenoid shifts spool
• Pushbutton released
• Contact X1 turned OFF

Pneumatic System

\[ Y_2 \]
\[ \text{LS-1} \]

\[ +24VDC \]
\[ \text{PB-1} \]
\[ \text{LS-1} \]

\[ \text{Inputs} \quad \text{Outputs} \]
\[ X_1 \quad Y_2 \]
\[ X_2 \]

PLC "Ladder" Logic

\[ C_5 \quad X_1 \quad C_5 \quad X_2 \]
\[ Y_2 \]

Pneumatic System

\[ \text{PB-1} \]
\[ \text{LS-1} \]

\[ +24VDC \]
\[ \text{Sol-A} \]

\[ \text{Inputs} \quad \text{Outputs} \]
\[ X_1 \quad Y_2 \]
\[ X_2 \]

PLC Wiring Diagram

• LS-1 is activated
• Contact X2 turned ON

Pneumatic System

\[ Y_2 \]
\[ \text{LS-1} \]

\[ +24VDC \]
\[ \text{PB-1} \]
\[ \text{LS-1} \]

\[ \text{Inputs} \quad \text{Outputs} \]
\[ X_1 \quad Y_2 \]
\[ X_2 \]

PLC "Ladder" Logic

\[ C_5 \quad X_1 \quad C_5 \quad X_2 \]
\[ Y_2 \]

Pneumatic System

\[ \text{PB-1} \]
\[ \text{LS-1} \]

\[ +24VDC \]
\[ \text{Sol-A} \]

\[ \text{Inputs} \quad \text{Outputs} \]
\[ X_1 \quad Y_2 \]
\[ X_2 \]

PLC Wiring Diagram

• Hold is "broken"
• Output relay C5 turned OFF

Pneumatic System

\[ Y_2 \]
\[ \text{LS-1} \]

\[ +24VDC \]
\[ \text{PB-1} \]
\[ \text{LS-1} \]

\[ \text{Inputs} \quad \text{Outputs} \]
\[ X_1 \quad Y_2 \]
\[ X_2 \]

PLC "Ladder" Logic

\[ C_5 \quad X_1 \quad C_5 \quad X_2 \]
\[ Y_2 \]

Pneumatic System

\[ \text{PB-1} \]
\[ \text{LS-1} \]

\[ +24VDC \]
\[ \text{Sol-A} \]

\[ \text{Inputs} \quad \text{Outputs} \]
\[ X_1 \quad Y_2 \]
\[ X_2 \]

PLC Wiring Diagram

• Contacts C5 turned OFF

Pneumatic System

\[ Y_2 \]
\[ \text{LS-1} \]

\[ +24VDC \]
\[ \text{PB-1} \]
\[ \text{LS-1} \]

\[ \text{Inputs} \quad \text{Outputs} \]
\[ X_1 \quad Y_2 \]
\[ X_2 \]

PLC "Ladder" Logic

\[ C_5 \quad X_1 \quad C_5 \quad X_2 \]
\[ Y_2 \]

Pneumatic System

\[ \text{PB-1} \]
\[ \text{LS-1} \]

\[ +24VDC \]
\[ \text{Sol-A} \]

\[ \text{Inputs} \quad \text{Outputs} \]
\[ X_1 \quad Y_2 \]
\[ X_2 \]

PLC Wiring Diagram

• Output Y2 turned OFF
• Solenoid Y2 turned OFF

Pneumatic System

\[ Y_2 \]
\[ \text{LS-1} \]

\[ +24VDC \]
\[ \text{PB-1} \]
\[ \text{LS-1} \]

\[ \text{Inputs} \quad \text{Outputs} \]
\[ X_1 \quad Y_2 \]
\[ X_2 \]

PLC "Ladder" Logic

\[ C_5 \quad X_1 \quad C_5 \quad X_2 \]
\[ Y_2 \]

Pneumatic System

\[ \text{PB-1} \]
\[ \text{LS-1} \]

\[ +24VDC \]
\[ \text{Sol-A} \]

\[ \text{Inputs} \quad \text{Outputs} \]
\[ X_1 \quad Y_2 \]
\[ X_2 \]

PLC Wiring Diagram

• Valve spool shifts to left
• Cylinder begins to retract

Pneumatic System

\[ Y_2 \]
\[ \text{LS-1} \]

\[ +24VDC \]
\[ \text{PB-1} \]
\[ \text{LS-1} \]

\[ \text{Inputs} \quad \text{Outputs} \]
\[ X_1 \quad Y_2 \]
\[ X_2 \]

PLC "Ladder" Logic

\[ C_5 \quad X_1 \quad C_5 \quad X_2 \]
\[ Y_2 \]
Programmable Logic Controllers

Pneumatic System

• Limit switch LS-1 released
• Input X2 goes OFF

PLC “Ladder” Logic

X1
X2
C5
C5

Opposite of X2

Y2

LS-1

Pneumatic System

• Cylinder fully retracts to initial start configuration

PLC Wiring Diagram

Inputs Outputs
X1
X2
Y2

PLC “Ladder” Logic

Inputs Outputs
X1
X2
Y2

OFF
ON

OFF
ON

Pneumatic System

PB-1
LS-1

+24VDC

PLC Memory

• Digital memory consists of individual “bits” (either “on” or “off”, “1” or “0”)
• Bits can be written to or read from
• Organized in groups of 8 bits = 1 byte

C17 C16 C15 C14 C13 C12 C11 C10

1 0 0 1 0 1 0 1

PLC External Output - NPN

PLC Output (simplified)

“0” = off
“1” = on

External Load (solenoid coil)

Typically +24V

PLC “Building Blocks”

Internal N.O. Contacts
(C0 - C1777)

Internal N.C. Contacts
(C0 - C1777)

External N.O. Inputs
(X0 - X17)

External N.C. Outputs
(X9 - X17)

PLC “Building Blocks”

Internal Control Relays
(C0 - C1777)

External Outputs
(Y0 - Y17)
Control circuit for a “one shot”

Simplified control circuit for a “one shot”

Timers (T0 - T377)
- When contacts C6 close, timer T1 will count for 2.5 seconds (K25 = 25 tenths)
- After 2.5 sec, contacts T1 will close (and stay closed until C6 opens and turns timer off)

Simplified control circuit for a “one shot”

IF (X1 is true)
OR { (Y2 is true) AND (not X2 is true) }
THEN (Y2 will be set true)
ELSE (Y2 will be set false)

Counters (CT0 - CT177)
- Each time contacts X0 close, counter increments by 1
- When counter reaches 6 (K6 = 6 counts), counter output CT2 closes

Counters (CT0 - CT177)
- When contacts C9 close, counter will reset to zero (and the contacts CT2 will open)