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Industrial Drives & Automation using PLC

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***Abstract*-- Automation devices such as controllers and data system and/or services system and methods are provided that receives statements or other unit of data interaction from an automation device ,provide the statements to an appropriate system or service for processing, and optionally return a response such as a result set. Programmable logic controller (PLC) or programmable controller is digital computer use for automation of electromechanical processes such as control of machinery or factory assembly lines, amusement rides or lighting fixtures. PLCs are used in many industries and machines. Unlike general purpose. The subject invention pertains facilitating communication between industrial computers; the PLC is designed for multiple inputs and output arrangements, extended temperature ranges, immunity to electrical noise, a resistance to vibration and impact. Programmes to control machine operation are typically stored in battery back or non-volatile memory. A PLC is an example of real time system since output results must be produced in response to input conditions within a bounded time, otherwise unintended operation will result.**

I. INTRODUCTION

Automation is the used of control systems such as numerical control, programmable logic controls and other industrial control systems, in concert with other application of **IT**(such as CAD,CAM,CAX),to control industrial machinery and processes, reducing the need for human intervention.in the scope of industrialization, automation is the step beyond mechanization. Whereas mechanization provided human operators with machinery to assist them with the muscular requirement of work, automation greatly reduces the need for human sensory and mental requirement as well. Processes and system can also be automated. Automation plays an increasingly important role in the global economy and in daily expenses. Engineers strive to combine automated devices with mathematical and organisational tools to create complex systems for applications and human activity. Many roles for human in industrial processes presently lie beyond the scope of automation. Human level pattern recognition and language production ability are well beyond capability of modern mechanical and computer systems. Tasks requiring subjective assessment or syntheses of complex sensory data such as sound as well as task such as strategy planning, currently require human expertise. Specialized harden computers, refer to as a programmable logic controllers (PLC), are frequently used to synchronised the flow of input from sensors and events. These leads to precisely controlled action that permit a tight control of any industrial processes.

II. HISTORY

The PLC was invented in response to needs of the American automotive industry. In 1968 GM Hydrometric (the automatic transmission division of general motors) issued a request for proposal for an electronic replacement for hard wired relay systems. The first PLC designated the 084 because it was Bedford Associates eighty-forth project was the result. Dickey Morley, who is considered to "father" of the PLC.

III. FEATURES OF PLC

The main difference from other computers is that PLCs are made for several conditions (such as dust, moisture, heat, cold) and have the facility for extensive input /output arrangements. These connect the PLC to sensors and actuators.PLCs read limit switches, analog processes variables (such as temperature and pressure), and the position of complex position in system. Some use machine vision. On the actuator side PLC operate electric motors, pneumatic and hydraulic cylinders, magnetic relays, solenoids or analog outputs. The input/output arrangements may be built into the simple PLCs or the PLC may have external IO attached to the computer networks that plugins into the PLC.

IV.PROGRAMMABLE LOGIC CONTROLLER COMPONENTS

A. DEFINITION

A Programmable controller is a solid state user programmable control system with functions to control logic, sequencing, timing, arithmetic data manipulation and counting capabilities. It can be viewed as an industrial computer that has a central processing unit, memory, input output interface and a programming device. The central processing unit provides the intelligence of the controller. It accepts data, status information from various sensing devices like limit switches, proximity switches, executes the user control program stored in the memory and give appropriate output commands to devices such as solenoid valves, switches etc.

Input output interface is the communication link between field devices and the controllers. Through these interfaces the processor can sense and measure physical quantities regarding a machine or process, such as proximity, position, motion, level, temperature, pressure etc. Based on status sensed, the CPU issues command to output devices such as valve, motors, alarm, etc. The programmer unit provide the man machine interface. It is used to enter the application program, which often uses simple user friendly logic.

B. PLC COMPONENTS

The PLC mainly consists of a CPU, memory areas, and appropriate circuits to receive input/output data. We can actually consider PLC to be a box full of hundreds or thousands of separate relays, counters, timers and data storage locations. They don't physically exist but rather they are simulated and can be considered software counters, timers, etc. Each component of a PLC has specific function:

- Input Relays (contacts)-These are connected to the outside world they physically exist and receive signals from switches, sensors, etc. typically they are not the relays but rather they are transistors.
- Internal Utility Relays- These do not receive signals from the outside world nor do they physically exist. They are simulated relays and are what enables a PLC to eliminate external relays. These are also some special relays that are dedicated to performing only one task. Some are always once during power-on and are typically used for initializing data that was stored.
- Counters-These are simulated counters and they can be programmed to count up, down or both up and down. Since they are simulated they are limited in their counting speeds. Some manufacturers also include high-speed counters that are hardware based. We think of these as physical existing.
- Timer-These come in varieties and increments. The most common type is an on-delay type. Others include off-delay and both retentive and non-retentive types. Increments vary from 1 millisecond through 1 second.
- Output Relays (coils) –These are connected to the outside world. These physically exist and send on/off signals to solenoids, lights etc. they can be transistors relays, or triacs depending upon the model chosen.
- Data Storage – Typically they are registers assigned to simply store data. They are usually used as temporary storage for math or data manipulation. They can also typically be used to store data when power is removed from the PLC. Upon power – up they will still have the same contents as before power was removed.

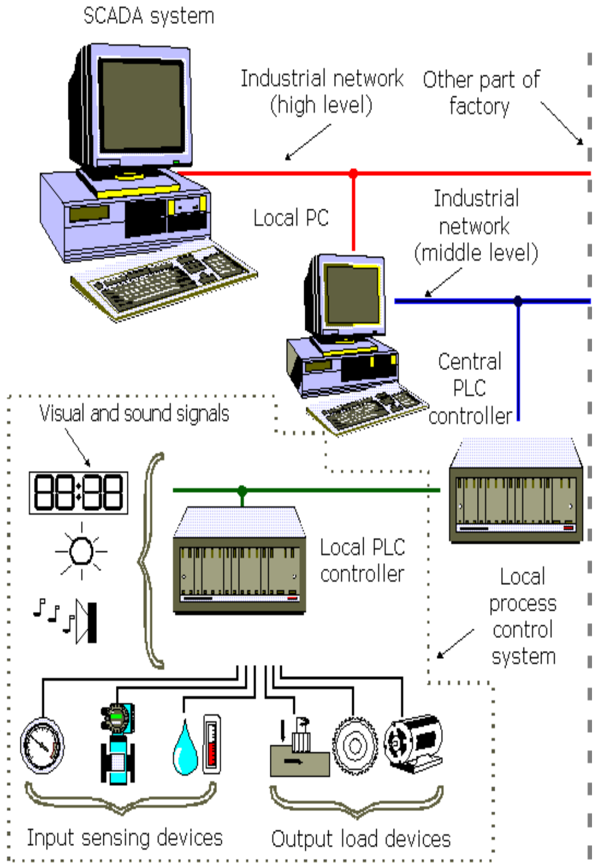
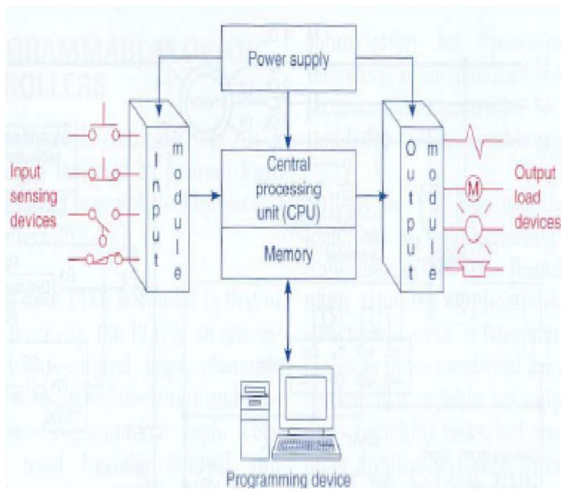


Figure: PLC Components Diagram

V. ARCHITECTURE OF PLC



A. PLC OPERATION

A PLC works by continually scanning a program. We can think of this scan cycle as consisting of 3 important steps. There are typically more than 3 but we can focus on the important part and not worry about others. Typically the others are checking the system and updating the current internal counter and timer values. The first type of scanning, as shown in the diagram below, is not as common as the type that will discussed second.

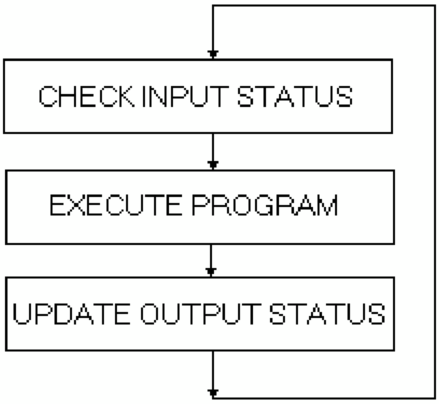


Figure: PLC Scan Diagram

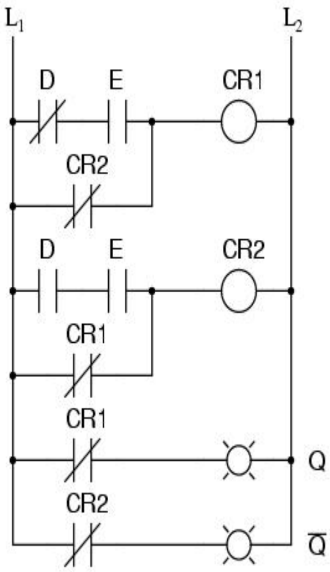
The first step is to check the input status. This step is therefore generally referred to as the "Check Input Status" stage. First the PLC takes a look at each to determine if it is on or off. In other words, is the sensor connected to the first input ? How about the second input? How about the third? This goes on and on through the entire program. It records this data into its memory to be used during the next step. Next step is to executes your program one instruction at time is called the "Execute Program"stage.For example ,if your program said that if the first input was on then it should turn on the first output. Since it already knows which inputs are on/off from the previous step it will be able to decide whether the first output should be turned on based on the state of the first input. It will store the execution results for use later during the next step.

Finally the PLC updates the status of the outputs. It updates the output based on which input was on during the first step and the results of executing your program during the second step. Based on the example in step 2 it would now turn on the first output because the first output was on and your program said to turn on the first output.

VI. LADDER LOGIC

A. DEFINATION

Ladder logic is one form of drawing electrical logic schematics, and is a graphical language very popular for programming Programmable Logic Controllers. Ladder logic was originally invented to describe logic made from relays. The name is based on the observation that programs in this language resemble ladders, with two vertical "rails "and a series of horizontal "rungs" between them. Figure below is very basic example of ladder logic used in a programmable logic controls program.



E	D	Q	$\overline{Q}$
0	0	latch	latch
0	1	latch	latch
1	0	0	1
1	1	1	0

Figure: Basic Ladder Logic Program

VII. LADDER LOGIC PROGRAMMING

A. INTRODUCTION

Ladder logic and ladder diagrams are the most common programming language used to program a PLC. Ladder logic was one of the first programming approaches used in PLCs because it borrowed from the relay diagrams that plant electricians already knew. The symbols used in relays ladder logic consist of a power rail to the left, a second power rail to the right, and individual circuits that connect the left power rail to the right. The logic of each circuit (or rung) is solved from left to right. A common mistake made by most people is trying to think of the diagram as having to have current across the rung for the output to function. This has many people trouble because of the fact that some inputs are "not" input, which will be true when there isn't current through this sensor. These concepts will be discussed more later. The symbols of these diagrams look like ladder – with two side rails and circuits that resemble rungs on a ladder.

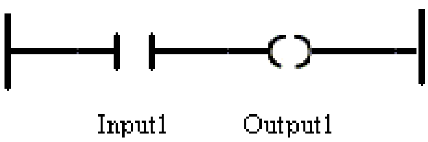


Figure: Simplified Logic Circuit

Figure shows a simplified ladder logic circuit with one input and one output. The logic of the rung above such:

- If Input1 is ON (or true) - power(logic) completes the circuit from the left rail to the right rail- and Output1 turns ON(or true).
- If Input1 is OFF (or false) - then the circuit is not completed and logic does not flow to the right-output 1 is OFF (or false).

There are many logic symbols are available in Ladder Logic- including timers, counters, math, and data moves such that any logical condition or control loop can be represented in ladder logic. With just a handful of basic symbols such as a normally closed coil, timer and counter most logical conditions can be represented.

Normally Open Contact

This can be used to represent any input to the control logic such as a switch or sensor, a contact from an output, or an internal output. When solved the referenced input is examined for a true (logical 1) condition. If it is true, the contact will close and allow logic to flow from left to right. If the status is FALSE (logical 0), the contact is open and logic will NOT flow left to right.

Normally open Coil

This can be used to represent any discrete output from the control logic. When “solved” if the logic to the left of the coil is TRUE, the referenced output is TRUE (logical 1).

Normally Closed Contact

When solved the referenced input is examined for an OFF condition. If the status is OFF (logical 0) power (logic) will flow from left to right. If the status is ON, power will not flow.

Normally Closed Coil

When “solved” if the coil is a logical 0, power will be turned on the device. If the device is logical 1, power will be OFF.

B. RELAY LOGIC CIRCUIT

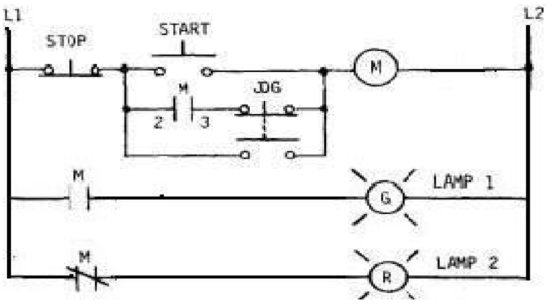


Figure: Relay circuit with Addition of status Indicators

Figure shows that same circuit with status Indicators added. These are used in control rooms to inform users of the status of their motors or other parts moving. Green is the generally accepted colour for a motor going, while red is stopped. The green light energized when the normally open contact energized by the moving motor, Closing it. The red light is energized whenever normally closed relay is closed, so it will turn off whenever the motor starts to run. One can see that with every component added, many wires need to connected as well. Depending on how far away these components are away from each other.

C. RELAY LOGIC CONVERSION TO PLC LADDER LOGIC

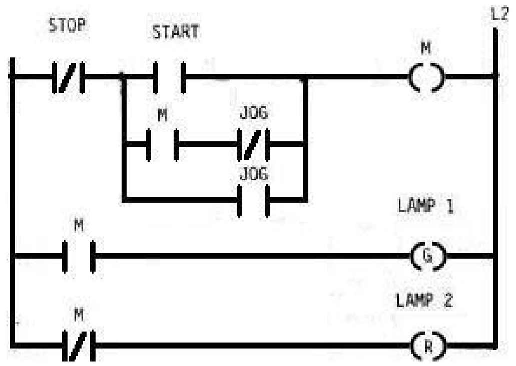
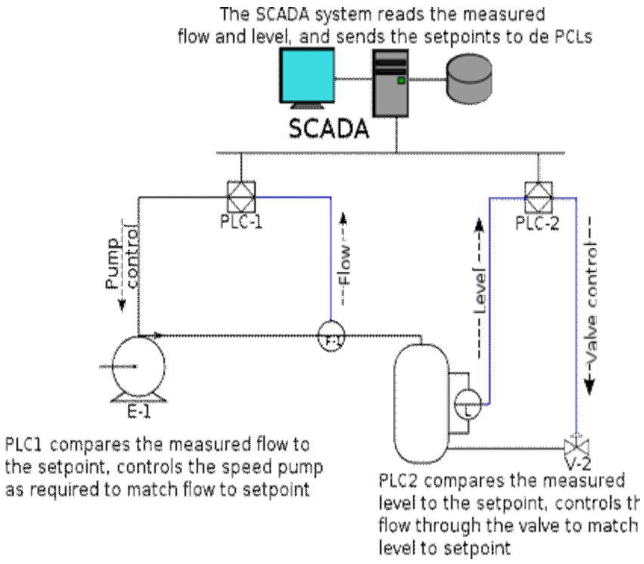


Figure: Relay logic diagram converted to PLC ladder Logic

Ladder logic seen here. If the PLC logic here was used then, adding the various component would’ve taken much less time than physically wiring each component.PLC ladder logic can differ from relay logic in that different components are used as well. In the relay diagrams, a single button double pole switch was used so that it could perform two different functions. In PLC ladder logic, just a single pole button is needed, because the computer can be asked to look for a on and off state. For the status lights, instead of running wires to the motor relays the PLC diagram just looks for a true or false state of the motor output.

VIII. SCADA

The term SCADA usually refers to centralised system which monitor and control entire sites, or complexes system spread out over large areas(anything between an industrial plant and country) .Most control actions are performed automatically by remote terminal units (“RTUs”) or by Programmable logic controllers(“PLCs”). Host control functions are usually restricted to basic overriding or supervisory level intervention. For example, a PLC may control the flow of cooling water through part of an industrial process, but the SCADA system may allow operators to change the set point for the flow, and enable the alarm conditions, such as loss of flow and high temperature, to be displayed and recorded. The feedback control loop passes through RTU or PLC while the SCADA system monitors the overall performance of the loop.



IX. ADVANTAGES

The main advantages of automation are:

- Replacing human operators in tedious task.
- Replacing humans in tasks that should be done in dangerous environment (i.e. fire, space, volcanoes, nuclear facilities, under the water, etc.).
- Making tasks that are beyond the human capabilities such as handling too heavy loads, too large objects, too hot or too cold substances or the requirement to make things too fast or too slow.
- Economy improvement. Sometimes and some kinds of automation implies improves in economy of enterprises, society or most of humankind. For example, when an enterprise that has invested in automation technology recovers its investment; when a state or country increases its income due to automation like Germany or Japan in the 20th Century or when the humankind can use the internet which in turn use satellites and other automated engines.

X. DISADVANTAGES

- Technology limits. Current technology is unable to automate all desired tasks.
- Unpredictable development costs. The research and development cost of automating a process is difficult to predict accurately beforehand. Since this cost can have a large impact on profitability, it's possible to finish automating a process only to discover that there's no economic advantage in doing so.
- Initial costs are relatively high. The automation of a new product required a huge initial investments in comparison with the unit cost of automation is spread in many product batches. The automation of a plant required a great initial investment too, although this cost is spread in the products to be produced.

XI. APPLICATIONS

- PLCs may need to intact with people for the purpose of configuration, alarm reporting or everyday control.
- Most modern PLCs can communicate over a network to some other system, such as a computer running a SCADA (Supervisory Control and Data Acquisition) system or web browser.
- Use of PLC in storing water.

  A facility needs to store in water tank. The water is drawn from the tank by another system, as needed, and our example system must manage the water level in the tank.
  Using only digital signal, the PLC has two digital inputs from float switches (low level and high level). When the water level above the switch it closes the contact and passes the signal to the input. The PLC used as digital output to open and close the inlet value into the tank.
  And water level drops enough so the low-level float switches off, the PLC will open the valve to let more water in it.so that high level switches on, the PLC will shut the inlet will stop the water from overflowing. This rung is an example of seal in logic. The output is seal in until some condition breaks the circuit.

```
|
|
|     Low  Level            High  Level
Fill  Valve          |
|-------[/]------|------[/]-------
-----------------(OUT)----------|
|                                     |
|
|                                     |
|
|                                     |
|
|             Fill     Valve          |
|
|------[                    ]------|
|
|
|
|
```

An analog system might use water pressure sensor and or load cell, and adjustable dripping out of the tank, the value adjust to slowly drip water back into the tank. In this system, to avoid 'flutter' adjustments that can wear out the valve, many PLCs incorporate "hysteresis" which essentially creates a dead band of activity. A technician adjusts this dead band so the valve moves only for a significant rate. Backup and maintenance method can make real system very complicated.

XII. CONCLUSIONS

A. *SUMMARY*

This report has discussed the role that programmable Logic controllers have in the efficient design and control of mechanical processes. Also discussed waste understanding of ladder logic and the programming involved with it. Finally, the report has discussed relay logic and the evolution that logic made from it. Four areas in regards to programmable logic controllers were addressed:

1. Programmable Logic History and advancement of controls technology, with a comparison of programmable logic controllers and hard-wired relays
2. PLC components: This section defined what programmable logic is and described all hardware associated with it.
3. Ladder Logic: This section covered ladder logic and its general progression from relay logic.
4. Ladder Logic Programming: this section covered basic programming techniques and their implementation.

B. *CLOSING COMMENTS*

With the speed of changing technology today it is easy to lose sight or knowledge of the basic theory or operation of programmable logic. Most people simply use the hardware to produce the results they desire. Hopefully, this report has given the reader a deeper insight into the inner workings of programmable logic is very simple to understand, but it is the complex programs that run in the ladder diagrams that make them difficult for the common user to fully understand. Hopefully this has alleviated some of that confusion.

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