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Role of Automation Tools in Industries

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ABSTRACT

This paper introduces Programmable Logic Controller (PLC), Supervisory Control and Data Acquisition (SCADA), Human-Machine Interface (HMI), Remote Terminal Unit (RTU), Programmable Automation Controller (PAC), Distributed Control System (DCS). This paper also discusses the role of PLC, SCADA, HMI, RTU, PAC and DCS in Automation & Instrumentation Engineering which is a cross sectional discipline that requires proportional knowledge in hardware and software development and their applications.

Keywords : PLC, Ladder Logic, I/Ps, O/Ps, Automation, SCADA, HMI, RTU, PAC, DCS

I. INTRODUCTION

This Systems and processes requiring "on/off" control abound in modern commerce and industry, but such control systems are rarely built from either electromechanical relays or discrete logic gates. Instead, digital computers fill the need, which may be programmed to do a variety of logical functions. The purpose of a PLC was to directly replace electromechanical relays as logic elements, substituting instead a solid-state digital computer with a stored program, able to emulate the interconnection of many relays to perform certain logical tasks. A Programmable Logic Controller, PLC or Programmable Controller is a digital computer used for automation of electromechanical processes. The Programmable Logic Controller (PLC) is basically a computer. Even the smallest PLC has a microprocessor, which qualifies it as a computer. PLCs are used in many industries and machines. Unlike general-purpose computers, the PLC is designed for multiple inputs and output arrangements, extended temperature ranges, immunity to electrical noise, and resistance to vibration and impact. A PLC has many "input" terminals, through which it interprets "high" and "low" logical states from sensors and switches. It also has many output terminals, through which it outputs "high" and "low" signals to power lights, solenoids, contactors, small motors, and other devices lending themselves to on/off control. In an effort to make PLCs easy to program, their programming language was designed to resemble ladder logic diagrams. Thus, an industrial electrician or electrical engineer accustomed to reading ladder logic schematics would feel comfortable programming a PLC to perform the same control functions. The following illustration shows a simple PLC, as it might appear from a front view. Two screw terminals provide connection to 120 volts AC for powering the PLC's internal circuitry, labelled L1 and L2. Six screw terminals on the left hand side provide connection to input devices, each terminal representing a different input "channel" with its own "X" label. The lower-left screw terminal is a "Common" connection, which is generally connected to L2 (neutral) of the 120 VAC power source.

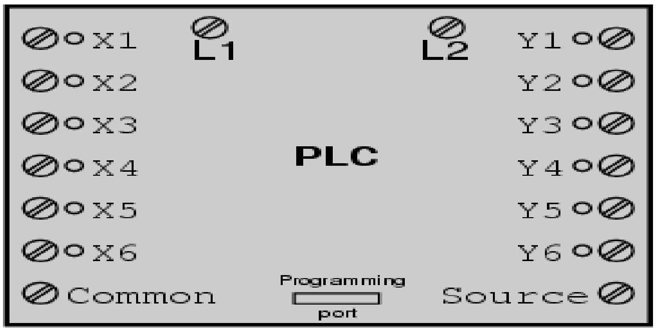

Figure 1. PLC Connection

The pin description of PLC shown in fig.2 has different types of input and output connections. Here there are 6 inputs & 4 outputs.

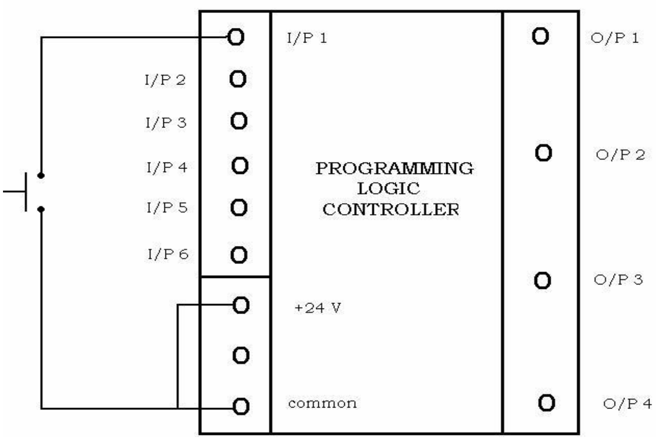

Figure 2. I/Ps & O/Ps Connections of PLC

II. PLC TOPICS

A. Features

The main difference from other computers is that PLCs are armored for severe conditions (such as dust, moisture, heat, cold) and have the facility for extensive input/output (I/O) arrangements. These connect the PLC to sensors and actuators PLCs read a set of digital and analog inputs, process logic statements, and generate analog and digital outputs to the industrial automation process. Control panel with PLC (grey elements in the centre). The unit consists of separate elements, from left to right; power supply, controller, relay units for in- and output.

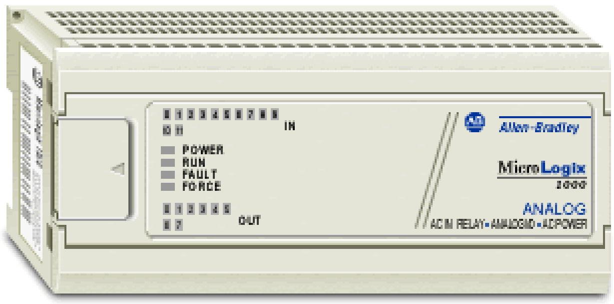

Figure 3. MicroLogix PLC

The MicroLogix 1000 (in fig. 3) family provides small, economical programmable controllers. They are available in configurations of 10 digital I/O (6 inputs and 4 outputs), 16 digital I/O (10 inputs and 6 outputs), 25 I/O (12 digital inputs, 4 analog inputs, 8 digital outputs, and 1 analog output), or 32 digital I/O (20 inputs and 12 outputs) in multiple electrical configurations of digital I/O. The I/O options and electrical configurations make them ideal for many applications.

B. Programming

PLCs are programmed using application software on personal computers. The computer is connected to the PLC through Ethernet, RS-232, RS-485 or RS-422 cabling. The programming software allows entry and editing of the ladder style logic. Ladder logic is a programming language that represents a program by a graphical diagram based on the circuit diagrams of relay logic hardware. It is primarily used to develop software for programmable logic controllers (PLCs) used in industrial control applications. 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. Here are a few examples of how the ladder logic program might look like. In real world applications, there may be hundreds or thousands of rungs. The above circuit shows two key switches that security guards might use to activate an electric motor on a bank vault door. When the normally open contacts of both switches close, electricity is able to flow to the motor which opens the door.

Ladder logic

Ladder Logic is a programming language that represents a program by a graphical diagram based on the circuit diagrams of relay-based logic hardware.

It is primarily used to develop software for Programmable Logic Controllers (PLCs) used in industrial control applications. 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. Ladder logic as shown in fig. 4 is widely used to program PLCs, where sequential control of a process or manufacturing operation is required. Ladder logic is useful for simple but critical control systems, or for reworking old hardwired relay circuits.

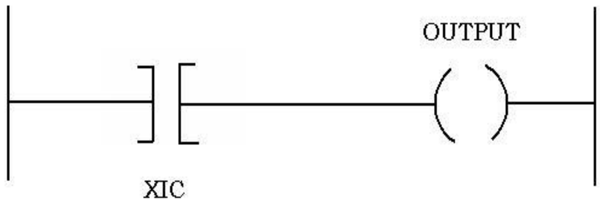

Figure 4. Simple ladder logic

Generally the software provides functions for debugging and troubleshooting the PLC software, for example, by highlighting portions of the logic to show current status during operation or via simulation. The software will upload and download the PLC program, for backup and restoration purposes. In some models of programmable controller, the program is transferred from a personal computer to the PLC through a programming board which writes the program into a removable chip such as an EEPROM or EPROM.

C. Scan time

A PLC performs a repetitive cycle of operations as shown in figure below. First, the PLC sequentially scans the input devices and updates a memory table indicating their status. Next, the PLC executes its control programming, or ladder logic. As it processes the ladder logic, the PLC updates a memory table which indicates whether output devices should be ON or OFF. Finally, the PLC uses the output table to actually change the condition of the output devices.

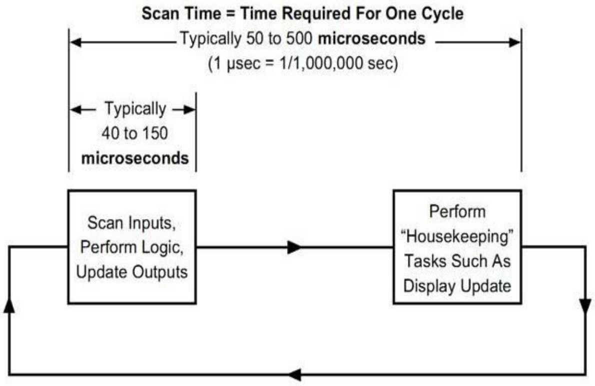

Figure 5. Scan Time

Engineers can now have numerical control over automated devices. The result has been a rapidly expanding range of applications and human activities. Information technology, together with industrial machinery and processes, can assist in the design, implementation, and monitoring of control systems. One example of an industrial control system is a programmable logic controller (PLC). PLCs are specialized hardened computers which are frequently used to synchronize the flow of inputs from (physical) sensors and events with the flow of outputs to actuators and events.

D. Advantages of PLC

Flexibility, Correcting Errors, Low Cost, Testing, Visual observation, Changes and error correction system made easier, operating speed, Simplifies the control system components, Documentation, Security, Changes by reprogramming.

This example of process automation creates the following benefits:

(a) Increased administrative control.

(b) Improved communication between different areas.

(c) Unnecessary emails reduced.

(d) Possibility of monitoring processes.

(e) Increased management capacity.

(f) Continuous improvement

III. SCADA

Supervisory control and data acquisition (SCADA) is a system of software and hardware elements that allows industrial organizations to: Control industrial processes locally or at remote locations. Monitor, gather, and process real-time data.

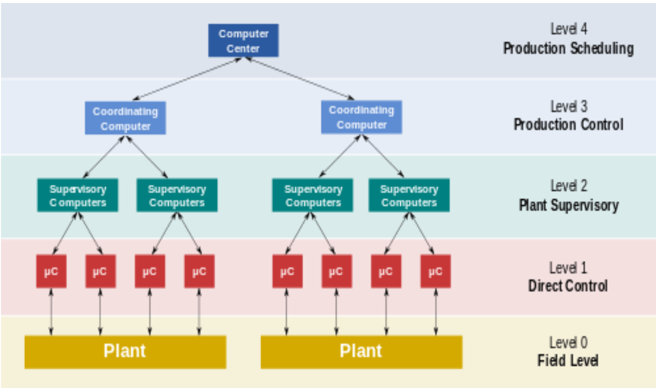

Figure 6. Functional levels of a manufacturing control operation

The accompanying diagram is a general model which shows functional manufacturing levels using computerized control.

- Level 0 contains the field devices such as flow and temperature sensors, and final control elements, such as control valves.
- Level 1 contains the industrialized input/output (I/O) modules, and their associated distributed electronic processors.
- Level 2 contains the supervisory computers, which collate information from processor nodes on the system, and provide the operator control screens.
- Level 3 is the production control level, which does not directly control the process, but is concerned with monitoring production and targets.
- Level 4 is the production scheduling level.

Level 1

Contains the programmable logic controllers (PLCs) or remote terminal units (RTUs).

Level 2

contains the SCADA software and computing platform. The SCADA software exists only at this supervisory level as control actions are performed automatically by RTUs or PLCs. SCADA 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 to a set point level, but the SCADA system software will allow operators to change the set points for the flow. The SCADA also enables alarm conditions, such as loss of flow or high temperature, to be displayed and recorded. A feedback control loop is directly controlled by the RTU or PLC, but the SCADA software monitors the overall performance of the loop.

Levels 3 and 4 are not strictly process control in the traditional sense, but are where production control and scheduling takes place.

A. SCADA BASICS

The block diagram of SCADA system shown in the figure which consists of different blocks, are the following:

- Human-machine Interface (HMI),
- Supervisory system,
- Remote terminal units,
- PLCs,
- Communication infrastructure and
- SCADA Programming

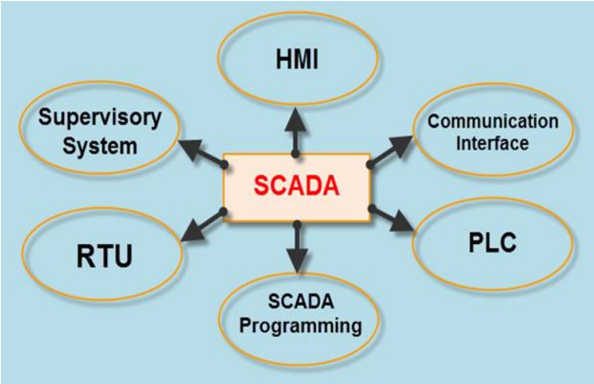

Figure 7. Basics of SCADA

IV. HUMAN-MACHINE INTERFACE (HMI)

It is an input-output device that presents the process data to be controlled by a human operator.

Figure 8. Human-Machine Interface

It is used by linking to the SCADA system's software programs and databases for providing the management information, including the scheduled maintenance procedures, detailed schematics, logistic information, trending and diagnostic data for a specific sensor or machine.

HMI systems facilitate the operating personnel to see the information graphically.

V. REMOTE TERMINAL UNIT

A remote terminal unit (RTU) is a microprocessor-controlled electronic device that interfaces objects in the physical world to a distributed control system or SCADA (supervisory control and data acquisition) system by transmitting telemetry data to a master system, and by using messages from the master supervisory system to control connected objects.

Other terms that may be used for RTU is remote telemetry unit or remote telecontrol unit.

Remote monitoring of functions and instrumentation for:

- Oil and gas (offshore platforms, onshore oil wells, pump stations on pipelines)
- Networks of pump stations (waste water collection, or for water supply)
- Environmental monitoring systems (pollution, air quality, emissions monitoring)
- Mine sites
- Air traffic equipment such as navigation aids (DVOR, DME, ILS and GP)

Remote monitoring and control of functions and instrumentation for:

- Hydro-graphic (water supply, reservoirs, sewage systems)
- Electrical power transmission networks and associated equipment
- Natural gas networks and associated equipment
- Outdoor warning sirens
-

VI. PAC (PROGRAMMABLE AUTOMATION CONTROLLER)

PAC is a compact controller that combines the features and capabilities of a PC-based control system with that of a typical PLC.

Figure 9. PAC

VII. DISTRIBUTED CONTROL SYSTEM (DCS)

DCS is a computerized control system for a process or plant usually with a large number of control loops, in which autonomous controllers are distributed throughout the system, but there is central operator supervisory control. This is in contrast to non-distributed control systems that use centralized controllers; either discrete controller located at a central control room or within a central computer.

The DCS concept increases reliability and reduces installation costs by localizing control functions near the process plant, with remote monitoring and supervision. Distributed control systems first emerged in large, high value, safety critical process industries, and were attractive because the DCS manufacturer would supply both the local control level and central supervisory equipment as an integrated package, thus reducing design integration risk.

Today the functionality of SCADA and DCS systems are very similar, but DCS tends to be used on large continuous process plants where high reliability and security is important, and the control room is not geographically remote.

VIII. CONCLUSION

Automated build tools such as Make can help us in a number of ways. They help us to automate repetitive commands and, so, save us time and reduce the risk of us making errors we might make if running these commands manually. They can also save time by ensuring that automatically-generated artifacts (such as data files or plots) are only recreated when the files that were used to create these have changed in some way. Through their notion of targets, dependencies and actions they serve as a form of documentation, recording dependencies between code, scripts, tools, configurations, raw data, derived data, plots and papers.

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