

Review of Programmable Logic Controller and SCADA in Industrial Automation

Dr Sagar B Patel¹, Ami Lad²

¹ V.T Patel Department of Electronics and Communications
Chandubhai.S. Patel Institute of Technology, Charotar University of Science and Technology

² V.T Patel Department of Electronics and Communications
Chandubhai.S. Patel Institute of Technology, Charotar University of Science and Technology

Abstract—In any Industrial Automation there many instruments wired together in a network. In order to make them functioning Programmable Logic controllers (PLC) are used. Programmable Logic Controllers are industry based computers that are used to monitor inputs and control the output based on the logic state of the input. Sometimes the system is placed in remote locations and in order to control the functions of such systems. This is known as Supervisory Control and Data Acquisition System (SCADA). SCADA is system that enables to control, monitor and coordinate devices and components in real time from a remote location with acquisition of data for analysis and planning from one central location.

Keywords— Automation, PLC, SCADA, Application

I. INTRODUCTION

Automation is a Greek word which means self-derived. Automation helps in improving productivity and increasing work efficiency. It is a process in which a machine follows a predetermined sequence of operation with or without human interference in a manufacturing process. The main objective of Automation is to integrate manufacturing process, to increase safety level as well as improve work productivity, quality and efficiency and reduce labour cost. The basic automation processes are power source, suitable inputs and outputs, proper feedback and commands. At present the technology used in automation has been replaced by Programmable Logic Controller (PLC), Supervisory Control and Data Acquisition (SCADA) and Distributed Control System (DCS). Every method has a specific application and is chosen according to the problem [1]-[10]. Currently in the field of automation PLCs are used widely due to increased efficiency and profit. There are so many applications of I2C protocol in real time such as micro controller, wireless communication and many more [11] [12] [13].

II. BACKGROUND

This section highlights the background and history of PLC and SCADA in the automation industry.

HISTORY

Before the invention of PLC in 1968, in traditional Automation Hardwired Relay systems were used in the industries. PLC MODICON 084 was developed by Bedford Associates and now the current owners are Schneider Electric, French Company. Now the PLCs are most used by the automotive industry. PLC system is easy to maintain and flexible. If changes are to be made then they are changed only in the project file and not in the wiring. The physical structure of PLC reduced the space significantly taken by physical components such as relays and timers etc. The components that were used to in building large mechanical setup can be dragged and dropped in the computer interface which saves cost and long term maintenance [1]-[10]. SCADA was the term that was coined in mid 1970s which described the automated control and data acquisition. It is software developed to accomplish the assigned task in real time. The assigned task is accomplished on the basis of the information received from the remote locations [9].

III. LITERATURE

PROGRAMMABLE CONTROL SYSTEM

. This section consists of different components of Programmable Control System. There are four main components namely:

- Programming System
- Communications Network
- Controller
- I/O (Input/Output) System

A. Controller

Controller is similar to a computer but with user programmable memory and a central processor. A controller is responsible for performing the following functions:

- I/O Control
- Logic
- Timing
- Report Generation
- Communications
- Data Manipulation

B. I/O (Input/Output) System

An I/O system is responsible for sending and receiving of information between a controller and a process/machine.

An I/O System consists of two types of components:

- I/O modules which are part of Programmable Control System
- I/O devices which are part of the process/machine.

Input and Output Devices

- **Input Devices:** The device which supplies signals to an input module and controller. The devices such as Pushbutton, Pressure sensor, Switch, Temperature sensor and Photo electric sensor are a few examples of input devices
- **Output Devices:** The device which is actuated or energised by a controller. The devices such as Light, Motor starter, Alarm, Solenoid and Meter are a few examples of Output devices.

C. Programming System

The programming System is a system which is used to program and monitor the operation of a controller. It consists of a programming device such as personal computer, laptop or workstation and software

The PLCs support the following software languages:

- 1) Ladder Logic: Used mainly for non-continuous discrete control
- 2) Function Block: used mainly for process and loop control
- 3) Structured Text: a language that allows sophisticated constructs which are not duplicated easily in Ladder Logic or Function Block languages.
- 4) Sequential Function Block: a graphical structure for organizing blocks of code written in one of the given languages.
- 5) Statement List: similar to Structured text[6]

FLOW OF SYSTEM

In the system the controller is interfaced with the process, machine or device. Three actions are performed namely Evaluate, Control and Monitor.

- The system monitors information from process, machine or device.
- The controller evaluates the information based on the set of rules and then generates output information.
- This output information is used to control process, machine or device.[2]

PLC SCAN

The execution of the PLC program is a repetitive process referred to as scan.

- A PLC scan starts with CPU reading the input status.
- Once the program is complete the application program is executed using the status of inputs.
- The CPU performs internal diagnostics and communication tasks.
- In the end the outputs are updated indicating the end of cycle and the cycle starts over.

The time taken to perform each cycle varies according to the size of program, number of I/Os and the amount of communication required [5], [6].

APPLICATIONS OF PLC

PLCs can be used in a variety of applications ranging from simple and repetitive tasks to sophisticated manufacturing and process control. Following are the few applications of PLCs

Industry	Application	Tasks
Rubber and plastic	Tire Manufacturing	• Storing Information • Alerts during Malfunctions • Sequencing the tire press/cure
Chemical	Chemical Batching	• Setting mixture ratios • Determining discharge rates • Recording inventory
Power Generation	Plant power systems	• Distribution regulation • Monitoring usage
Manufacturing & Machining	Material handling	• Storing • Retrieving • Warehousing • Transporting

LADDER LOGIC

Ladder logic is the most basic programming language of Programmable Logic Controllers. Since the PLCs were invented in order to replace relay logic control systems thus it was natural that the language initially developed closely resembled the diagrams used to document relay logic. There are three approaches to ladder logic programming namely empirical approach, Pseudo approach and I/O mapping. Empirical approach is well suited for the small applications. Pseudo approach is also known as Sequential Function Charts. It requires extensive planning and development time for programming and as a result implementation and troubleshooting of programming problems reduces significantly. In I/O mapping the inputs and the outputs are diagrammed separately. Then a link is developed between the inputs and the outputs they affect. Finally a Boolean expression is developed for each output which enables easier translation into programming rungs. In this method the quality and efficiency in problem solving improves [8].

SCADA

SCADA performs the main function of collecting data and control at supervisory level. SCADA system uses different types of software; some are used only for data acquisition and not for data control. Supervisory control is a system which provides control on the process that is external to SCADA system which means that the system does not control the process in real time instead a separate automated control system is present that responds to the changes in the process quickly with no change in time. SCADA consists of Output signal hardware, controllers, Human Machine Interface (HMI), networks, databases, communications and software. Most of the control actions performed by SCADA are performed automatically by Remote Terminal Units (RTUs) or by Programmable Logic Controllers (PLCs). For example, PLC might control the dryer section of the process but SCADA allows one to vary the set points as per the requirement [10].

IV. CONCLUSIONS

PLC and SCADA have become an integral part of industrial automation sector. Due to its characteristics such as robustness and withstanding in the harsh environments, it is more preferable in the factories where the human effort is not enough for the working of heavy machinery. On the other hand SCADA is a system that helps in the working of devices that are placed in remote location. PLC is an industry wide tool that will enhance the value of control education with a more holistic approach.

V. REFERENCES

- [1] International Electrotechnical Commission. IEC 61131-3: Programmable Controllers — Part 3 Programming languages. International Electrotechnical Commission, Geneva, Switzerland, 1993.
- [2] L.A. Bryan, E.A. Bryan, Programmable Controllers: Theory and Implementation, IL, Chicago: Industrial Text, 1988.
- [3] A. J. Crispin, Programmable Logic Controllers and their Engineering Applications, New York: McGraw Hill, 1990.
- [4] J. D. Otter, Programmable Logic Controllers; Operation Interfacing and Programming, NJ, Englewood Cliffs: Prentice-Hall, pp. 75-77, 1988.
- [5] Helen Maria Sabu, Aravind V.B, Apurva Sullerey and Binson VA, "Online Monitoring of PLC Based Pressure Control System" *International Journal of Research and Innovations in Science and Technology*, Vol 2, no 2, pp 47-50, 2015.
- [6] Richa Netto, Aditya Bagri, "Programmable Logic Controllers" *International Journal of Computer Applications*, Vol\77, No.11, pp 27- 31, 2013.
- [7] Maha M. Lashin, "Different Applications of Programmable Logic Controller (PLC)" *International Journal of Computer Science, Engineering and Information Technology (IJCSEIT)*, Vol. 4, No. 1, pp 27-32, 2014.
- [8] REHG, J. A. Structured PLC programming with sequential function charts. *Proceedings of the 2001 ASEE Annual Conference & Exposition* (2001)
- [9] National Communications System, "Supervisory control and data acquisition (SCADA) systems," Technical Information Bulletin 04-1, 2004.
- [10] "Botnets, cybercrime, and cyberterrorism: vulnerabilities and policy issues for congress," CRC Report RL32114, 2008.
- [11] S Patel, VV Dwivedi, YP Kosta, "A Parametric Characterization and Comparative Study of Okumura and Hata Propagation-loss-prediction Models for Wireless Environment", *International Journal of Electronic Engineering Research*, Vol. 2, No. 4, 2010
- [12] Sagar Patel, Rahul Patel and Jaymin Bhalani, "Performance Analysis & Implementation of different Modulation Techniques in Alamouti MIMO Scheme with Rayleigh Channel", *International Conference on Recent Trends in computing and Communication Engineering*, April 2013
- [13] Jigar Kumar, Arpita Patel and Sagar Patel, "Multiuser – MIMO Broadcast Channel Techniques", *International Research Journal of Engineering and Technology*, Vol. 3, No. 2, Feb. 2016