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Implementation of Basic Gates and Compound Gates (AOI & OAI) using Ladder Diagram in Programmable Logic Controller (PLC)

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ABSTRACT: Programmable Logic Controllers or PLC, normally a digitized controller is fixed, rigid and industrial digital computer. Earlier days in industry, electromechanical relays, timers, counters and sequencers were widely used. The drawback of using these are many with respect to cost, wiring, and maintenance is more. The advancement in PLC came up to overcome all these factors. The question why PLC is the tool, which gives the control and hold in automation, it provides high gain, improved quality and accuracy, works flexible in criticized and hazardous situation, increase product rate, early time to market, low cost, and mainly since the automation helps in designing and changing over easily from one product to another. In this work, we have designed and simulated the basic gates and compound gates using ladder diagram in PLC, using Indraworks, Indralogic platform. This paper forms a basic for designing complex sequential circuits and helps in developing VLSI circuits. This paper gives a overview of AOI(And OR Inverter) and OAI(Or And Inverter) circuits designed and simulated through PLC with the help of ladder diagram.

KEYWORDS: PLC, Indralogic, Ladder diagram, NMEA, AOI, OAI.

I. INTRODUCTION

A formal definition of a PLC comes from the National Electrical Manufacturers Association (NMEA): [A Programmable Logic Controller is] a digitally operated electronic system, designed for use in an industrial environment, which uses a programmable memory for the internal storage of user-oriented instructions for implementing specific functions such as logic, sequencing, timing, counting, and arithmetic to control, through digital or analog input and outputs, various types of machine or process.

PLC Stands for programmable logic controller and can be classified as an solid state member of an computer family which is specially designed to control a process in an Hazardous industrial environment. in 1960's & 70's Electromechanical Relays, Timers , Counters and Sequencers were the standard components which were used in industries. Control system of a machine had a bunch of electromechanical devices interconnected wires of those ran into miles in case of system breakdown it would disturb the production and assembly lines which ended in huge loss maintenance cost, to keep panel operating cost ran extremely high. To replace conventional electromechanically operated device (Relays, Timers, Counters and Sequencers) Programmable logic controller came in to picture. It is an digitally operated electronic system to control a process(eg: machine for printing news paper , bagging plant to bag cement etc.) which can be able to withstand Rugged industrial Environment. PLC and its peripherals are designed so that they can be easily integrated to an industrial control system. The Hydramatic division of General Motors was the

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First to see the for a device what would be Known as Programmable logic Controller.

- Architecture:

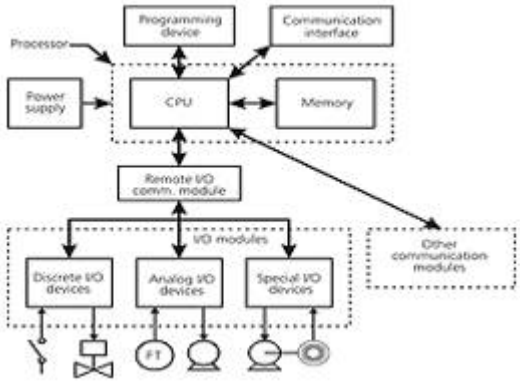

Figure 1 Basic PLC architecture [9]

The Figure 1 shows the basic architecture of PLC. A Programmable Controllers is made up of following Sections:

1. Processor / Central Processing Unit: This is the brain, or microprocessor, which controls or supervises a process according to the input CPU solves the user program and update the status of the outputs.
2. Programming Device: is the device where the programmer or operator can program or give instructions or data to the device to get desired output based on his application.
3. Input section: where the CPU gets the inputs from the devices such as, push button, limit switch or photoelectric sensors etc.
4. Output section: where the processed data from CPU to the devices such as lamp, motors conveyors etc. .
5. Communication Modules: it is an interface between CPU and I/O modules through which data flow from input to CPU, CPU to Output, and Output Filed devices flows such as RS232, Profibus, and Ethernet etc.

- Indralogic:

The Indralogic is the part of PLC which is completely software based. It comprises of different set of function modules which are available to integrate the Control topologies. It uses the high speed system bus which helps in the smooth operation of the PLC. It also ensures the control processor for the high requirement of performance and functionality**.**

II. RELATED WORK

Paper [1] gives prior information about theoretical and practical applications of PLC, where it plays vital role in automated industry. Automation is the man focus of PLC. This paper gives information about necessary steps to learn PLC for programmers.This paper gives unique information about FPGA based PLC design. A hardware structure is designed and simultaneously execution is carried out. This FPGS based Nano-PLC works faster, gives good reliability, high performance and scanning time [2]. In this paper, PLC is used in home automation design. Both hardware and software is designed. This works gives more information like multilevel component, tolerance, on and off of the switch, voltage and power control. The hardware is designed in such a way that the new component can be added and programmed easily for good efficient working of home automation [3]. These above papers give us a brief idea of what is PLC and what are its future applications.

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III. SIMULATION RESULTS

- **AND:**

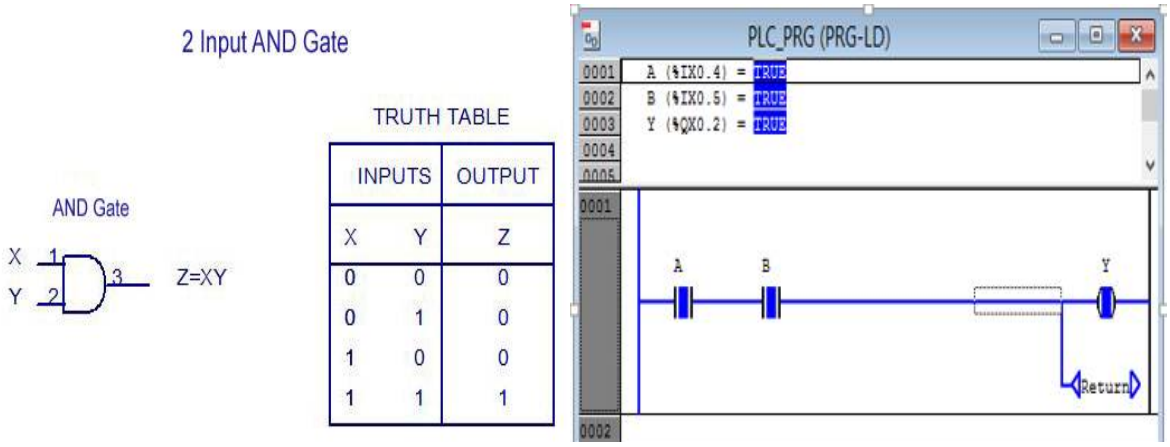

Figure 2: Symbol, Truth Table and simulation of AND gate.

Above circuit is designed using ladder diagram in PLC. The two input AND gate is designed by using two input and one output node. The symbol '| |' represents the input node. The input is normally closed for logic 1 operation and normally opened for logic 0 operation. The symbol '( )' represents the output node. The above circuit is tested for all the combinations of the AND gate and the simulation is shown for the fourth combination of the truth table as shown in the Figure 2.

- **OR:**

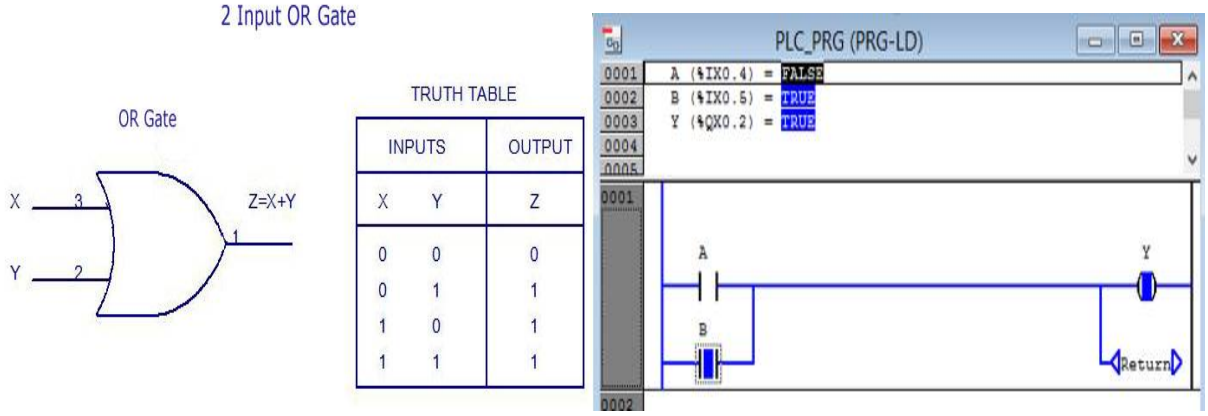

Figure 3: Symbol, Truth Table and simulation of OR gate.

The two input OR gate is designed by using two input and one output node. The above circuit is tested for all the combinations of the OR gate and the simulation is done for the second combination of the truth table as shown in the Figure 3.

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- **NAND:**

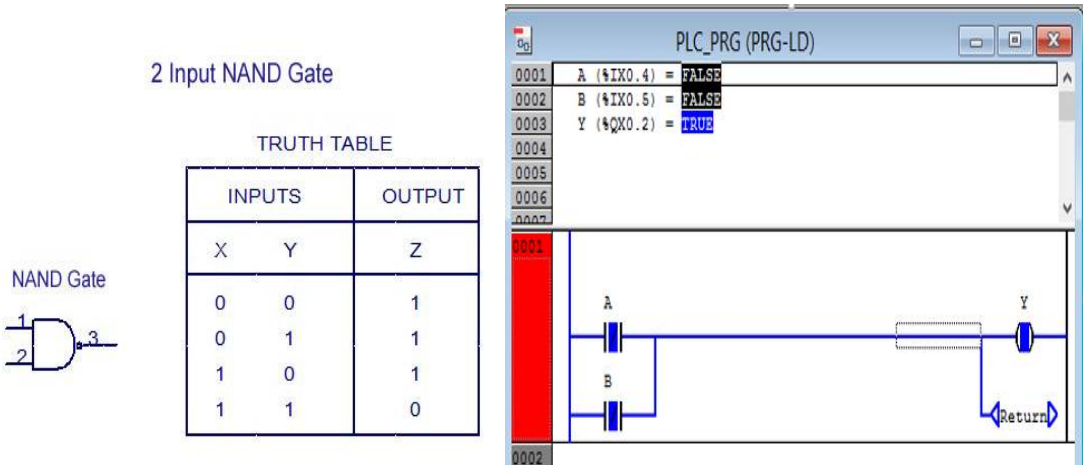

Figure 4: Symbol, Truth Table and simulation of NAND gate.

The two input NAND gate is designed by using two input and one output node. The above circuit is tested for all the combinations of the NAND gate and the simulation is done for the first combination of the truth table as shown in the above Figure 4.

- **NOR:**

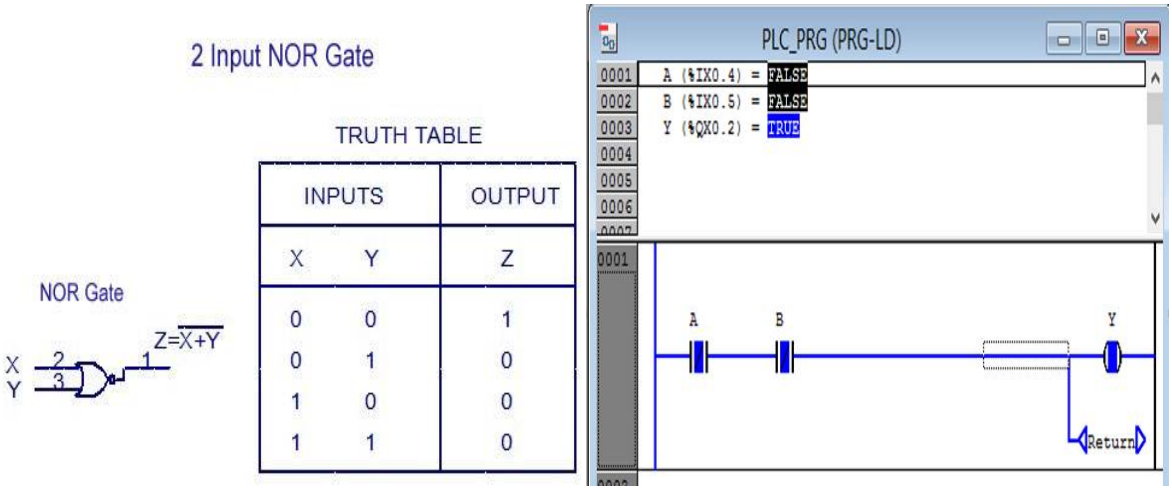

Figure 5: Symbol, Truth Table and simulation of NOR gate.

The two input NOR gate is designed by using two input and one output node. The above circuit is tested for all the combinations of the NOR gate and the simulation is done for the first combination of the truth table as shown in the Figure 5.

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- **XOR:**

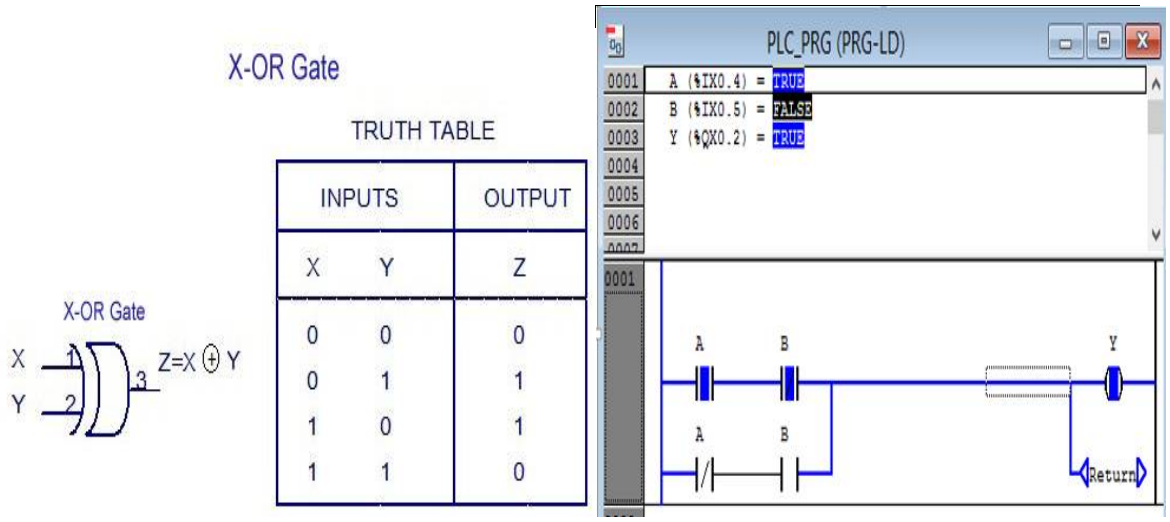

Figure 6: Symbol, Truth Table and simulation of XOR gate.

The two input XOR gate is designed by using two input and one output node. The above circuit is tested for all the combinations of the XOR gate and the simulation is done for the second combination of the truth table as shown in the Figure 6.

- **XNOR:**

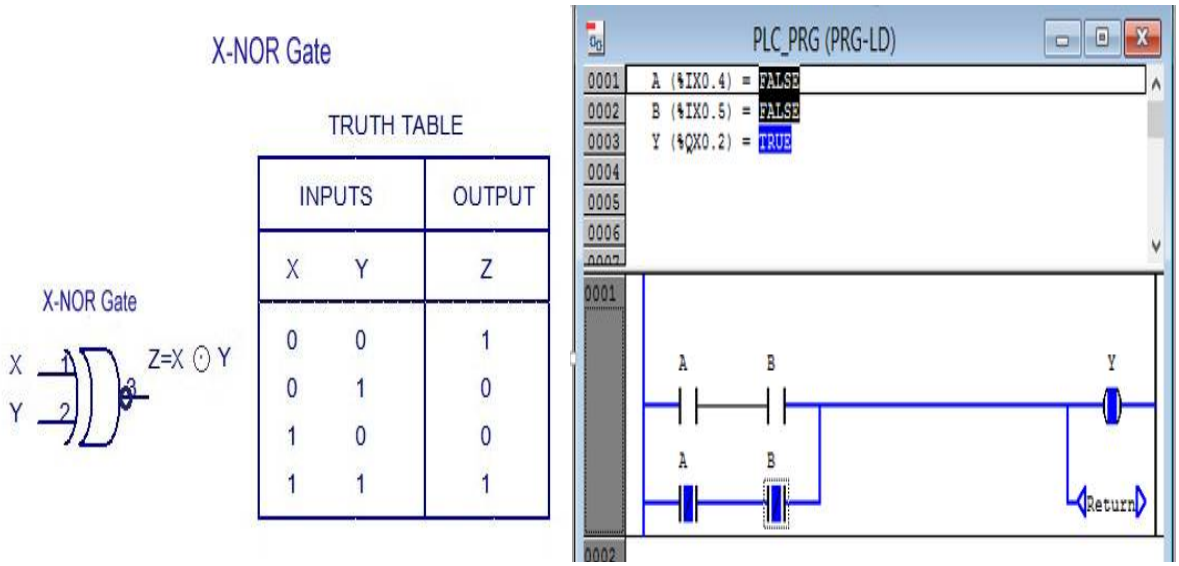

Figure 7: Symbol, Truth Table and simulation of XNOR gate.

The two input XNOR gate is designed by using two input and one output node. The above circuit is tested for all the combinations of the XNOR gate and the simulation is done for the first combination of the truth table as shown in the Figure 7.

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- **AND-OR-INVERT (AOI) and OR-AND-INVERT (OAI):**

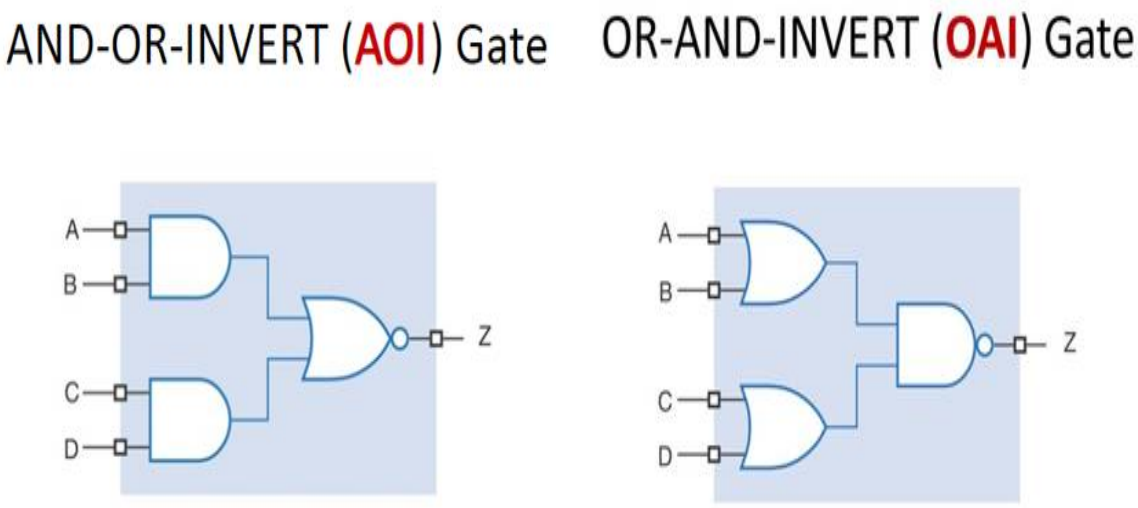

Figure 8: Symbol of AOI and OAI gate.

AND-OR-INVERT(AOI)/OR-AND-INVERT (OAI) gate belongs to Complex gates, It is designed by using combination of three basic gates AND, OR and NOT (Inverter) gates. Figure 8 depicts the symbol of AOI and OAI gates. AOI/OAI gate has many advantages instead of using individual gates. Since AOI/OAI is the combination of gates it greatly reduces area and power. The major advantage of using these gates is that the speed will be more and good efficiency and accuracy. The number of transistors used to design AOI/OAI will be less and hence it is used in low area and low power applications in VLSI.

- **Simulation of AOI:**

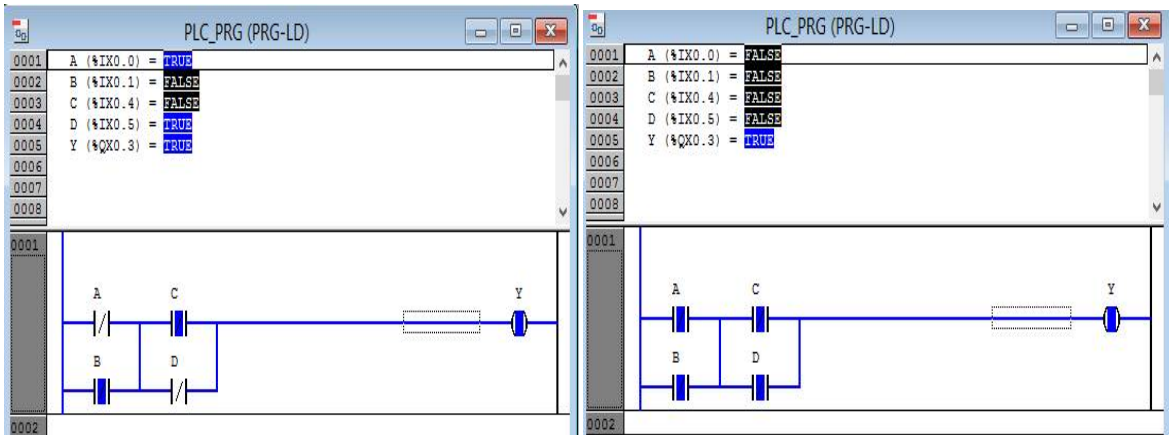

Figure 9: Simulation of AOI gate.

The 2-2 AOI gate is designed by using four input and one output node. The above circuit is tested for all the sixteen combinations of the AOI gate. Figure 9 shows the simulation of AOI gate for two combinations The first figure is shown for 1001 combination with output as 1 and second figure for the combination of 0000 with output as 1.

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- **Simulation of OAI:**

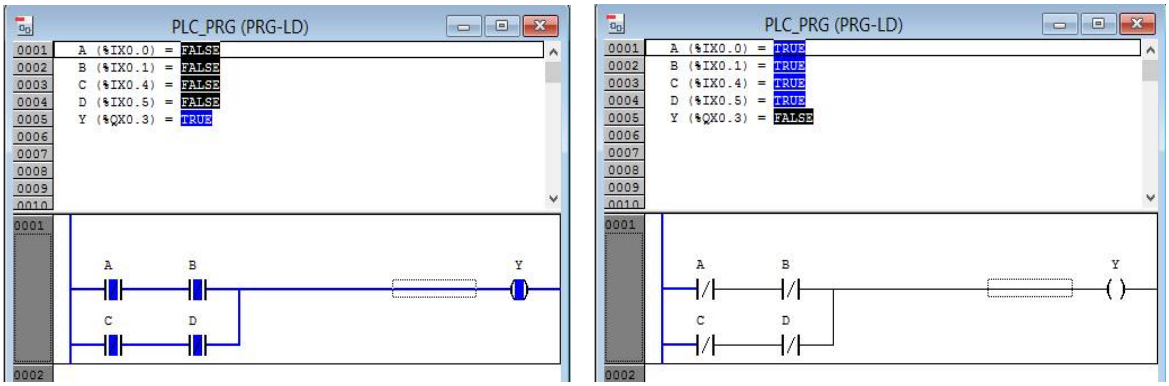

Figure 10: Simulation of OAI gate.

The 2-2 OAI gate is designed by using four input and one output node. The above circuit is tested for all the sixteen combinations of the OAI gate truth table. Figure 10 shows the simulation of OAI gate for two combinations. The first figure is shown for 0000 combination with output as 1 and second figure for the combination of 1111 with output as 0.

IV. CONCLUSION AND FUTURE SCOPE

In this work, we have simulated all the basic gates and complex gates using ladder diagram. Further work can be carried out using these basic gates in higher levels and can be implemented using ladder diagram. Different set of combinational circuits and sequential circuits can be implemented through ladder diagram. In future the digital circuits can be implemented with help of PLC through ladder diagrams.

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REFERENCES

1. Dr. Wai Phyo Aung, “Guidelines for Approching Steps of Learning Programmable Logic Controllers in Automation, International journal of Trend in Scientific research and development, ISSN 2456-6470/vol-2/Issue – 4
2. Dhruthi ane, etc..”Implentation of PLC using FPGA”, International of Journal of Scientific Engineering an Research, ISSN : 2347-3878
3. M. Hudedmani, R. Umayal, S. Kabberalli, and R. Hittalamani, “Programmable Logic Controller (PLC) in Automation”, *Advance Journal of Grad, Res*, vol. 2, no. 1, pp. 37-45, May 2017.
4. Avvaru Ravi Kiran, B.Venkat Sundeep, Ch. Sree Vardhan, Neel Mathews, “The Principle of Programmable Logic Controller Automation”. International Journal of Engineering Trends and Technology- Volume4 Issue 36 pp 65-72.
5. Camel Yilmaz, “Implementation of PLC – Based Home automation”, Journal of Applied sciences, ISSN:1812-5654
6. L. A. Bryan, E. A. Bryan, “Programmable controllers: theory and Implementation”, 2nd ed., ISBN 0-944107-32-X, Industrial Text Company, 1997..
7. W. Bolton, “ Programmable Logic Controllers”, Fourth Edition,Elsevier Newness, ISBN-10: 0-7506-81128, 2006
8. Hackworth FD Jr. Programmable Logic Controllers: Pro-gramming Methods and Applications.
9. Operating and Programming Guide. Rexroth IndraLogic 1.0, R911305036. 1st ed.
10. "Programmable Logic Controllers (PLCs)." © 2002 Keyence Corporation: http://world.keyence.com/products/programmable_logic_controllers/plc.html
11. Oyebola, Blessed. (2015). Automated Process Control through Programmable Logic Controller (PLC) for National Economic Development.
12. Barry Wilkinson, The Essence of Digital Design, Prentice Hall Europe, a Pearson Education Company-1997.
13. John F. Wakerly, Digital Design:Principles and practices-Prentice Hall Inc., a Pearson Education Company, 2000.