IJAREEIE

e-ISSN: 2278-8875
p-ISSN: 2320-3765

International Journal of Advanced Research

in Electrical, Electronics and Instrumentation Engineering

Volume 11, Issue 5, May 2022

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

Impact Factor: 8.18

| e-ISSN: 2278 – 8875, p-ISSN: 2320 – 3765| www.ijareeie.com | Impact Factor: 8.18|

||Volume 11, Issue 5, May 2022||

|DOI:10.15662/IJAREEIE.2022.1105007 |

Remote Monitoring and Control of Electrical Substation Using Programmable Logic Controllers (PLC)

Ismail Abdullahi Ibrahim[1], Dr. C. Mohan[2]

M Tech, EECE, Sharda University, Greater Noida UP, India. [1]

Assistant Professor EECE, Sharda University, Greater Noida UP, India [2]

ABSTRACT: Being in the growing world, an engineer should promote technological advancement in every day. Monitoring and controlling system is one of the important field of the Electrical and Electronics Engineering for technological development. In this work, Beledweyn, Hiran-Somalia substation module has been taken for the technological development in automation. There are frequent blackouts in the region at the time of rainy seasons. The automation system makes the substation a sense of a good grid model. To do the automation development, PLC system has been used and the procedure of automation has been simulated using RS Logix software. Load calculation has been done before the development of automation. The load parameters have been implemented, simulated and verified with the software. In the simulation, one incoming HV feeder and four outgoing LV feeders have been considered for automation. The proposed automation system can solve the problems of Beledweyn Hiran-Somalia substation.

KEYWORDS: Automation, Single Line Diagram, PLC and Feeders.

1. INTRODUCTION

When considering whether or not to use distribution automation, several intangible benefits should be considered. After the regulatory and restructuring issues are handled, distribution automation operations should pick up. For a country's economic growth and development, power supply reliability and quality are crucial. Planning is frequently done before adding generation or expanding the transmission network. On the other side, the distribution system has evolved in an unplanned manner, resulting in significant technical and economic losses as well as poor power quality. [1]

Because of a lack of adequate and efficient past energy consumption data, a properly installed and monitored system can help almost any type of energy consumer by preventing power theft and inefficient power management, which has resulted in significant losses for power companies or unacceptably high electricity costs for customers. The output losses affect all consumers: industrial, commercial, and residential. Every customer has an energy consumption target in mind. However, there is no technology available at the consumer level to detect operating load and allow the service provider to calculate the load automatically. To meet customer needs, many new technologies have been implemented. [2]

Automation of distribution systems is a collection of software-based technologies that combine control, monitoring, switching, communications, and related intelligence in the energy distribution system, usually at the feeder level. It symbolizes one of the lines in the smart grids idea. The increased distribution automation suggests several aspects (ADA). [3]

II. LITERATURE REVIEW

The smart grid relies heavily on smart substations. Voltage conversion, power distribution, transmission, and distribution control and management are among its responsibilities. Intelligent substations provide the safe and reliable operation of the entire power system, which is essential for ensuring a consistent power supply. The SAS is responsible for assuring the safe and reliable execution of power transmission and distribution activities in the substation, including relay protection, monitoring, and remote control. An intelligent substation would not be complete without an intelligent electronic equipment (lED). Many IEDs are used in today's advanced substations. Substations are responsible for voltage conversion, power distribution, transmission and distribution control, and management in the power system.It's safe and trustworthy operation ensures the security and stability of the electricity grid. [4]

| e-ISSN: 2278 – 8875, p-ISSN: 2320 – 3765| www.ijareeie.com | Impact Factor: 8.18|

||Volume 11, Issue 5, May 2022||

|DOI:10.15662/IJAREEIE.2022.1105007 |

2.1 Introduction to Substation Automation

The power distribution network distributes electrical energy across the system by serving as a conduit between the high-voltage transmission grid and power users. Both neutral and arc suppression coil grounding are inadequate low current grounding systems in my country's power distribution network. The location of faults in the power distribution network has been the subject of power system research in the past. [14]

In actuality, a supervisory system must take into account the physiological and cognitive features of the supervisory operator. The purpose of power distribution automation is to provide electricity to consumers in a stable and efficient manner; automation is essential for maintaining power system stability, as modern power systems are operated under increasingly stressful conditions due to increased power demand. Power utilities use computer-assisted monitoring, control, and management of the electric power distribution system to provide improved service to customers. Distribution automation technologies allow utilities to improve distribution system dependability by streamlining operations. [6]

Integrated automated substation monitoring systems have gone a long way since the 1980s. As network, communication, and industrial automation technologies progress, the autonomous integrated monitoring system at the substation will become more dispersed and structured. In the early stages of the substation monitoring system, a bus network with a long delay was frequently utilized. Following that, Ethernet technology was developed. In the integrated development of the substation monitoring system, Ethernet was a critical technology. IEDs connect to the network from numerous locations, resulting in a communication network with a diverse set of functions and great performance. [7]

III. DEVELOPMENT OF AUTOMATION FOR BELEDWEYN SUBSTATION

3.1 Introduction

To update a human person, automation uses management systems such as computers or robots, as well as statistical technologies, to cope with specific techniques and machineries in an industry. It is the next step in the industrialisation process after mechanisation. It reaches far and wide, touching almost every aspect of existence. From the beginnings of agriculture through the space age, automation is a must. It is the transfer of human-management functions to technology equipment. The primary goal of automation is to reduce manufacturing costs, increase output, reduce labour costs, and produce high-quality products with fewer errors. Automation is the process through which a device accepts inputs that can be described and performs a set of operations in a predetermined order. Human stage sample repute and language production potential are well beyond the current mechanical and PC system's capabilities. [8]

3.2 Overview of PLC

A programmable logic controller, also known as a programmable controller, is a digital computer that is used to automate industrial electromechanical processes like factory assembly lines, amusement rides, and light fixtures. Many industries and machinery employ PLCs. Multiple analogue and digital inputs and outputs, wide temperature ranges, electrical noise immunity, and vibration and impact tolerance are all features of PLCs. Programs for controlling machine function are often stored in non-volatile or battery-backed memory. Sequential relay control, motion control, process control, distributed control systems, and networking are now all part of the PLC's capabilities. Some current PLCs have data handling, storage, processing power, and communication capabilities that are comparable to desktop computers.PLCs differ from other computers in that they are designed to withstand harsh environments (such as dust, moisture, heat, and cold) and have the ability to handle large amounts of data. [9]

3.3 Types of Software's Used in My Project

1. RS Logix Emulator
2. RS Logix Classic
3. RS Logix Micro starter Lite / RS Logix 500

3.3.1 RS Logix Emulator

What is RSLogix Emulate?

RS Logix Emulate is an Allen-Bradley PLC-5 and SLC-500 processor diagnostic and debugging tool. It runs your ladder logic programmes in your computer and updates their data tables to simulate what will happen when they are downloaded to physical PLC-5 processors.

| e-ISSN: 2278 – 8875, p-ISSN: 2320 – 3765| www.ijareeie.com | Impact Factor: 8.18|

||Volume 11, Issue 5, May 2022||

|DOI:10.15662/IJAREEIE.2022.1105007 |

While RS Logix Emulate is useful for verifying the integrity of your software, it should not be relied on alone for final programme verification. Due to differences in processor operation, final testing must be done with the actual CPU and I/O for your system (including variations based on processor series and revision).[10]

3.3.2 RS LOGIX CLASSIC

a) What is RSLinx Classic all about?

The RS Linx Classic for Rockwell Automation Networks and Devices industrial communication solution connects Allen-Bradley programmable controllers to a number of Rockwell Software and Allen-Bradley applications. Device programming and configuration software like RS Logix and RS NetWorx, as well as HMI (Human-Machine Interface) software like RSView32, FactoryTalk View SE (Site Edition), and FactoryTalk View ME (Machine Edition) and your own data acquisition applications written in Microsoft Office, web pages, or Visual Basic®, are examples of these applications. RS Linx Classic additionally includes diagnostics and strong data optimization tools. Custom apps are supported by the RS Linx Classic SDK's API (Application Programming Interface). DDE and OPC are supported by RS Linx Classic, a Data Access Server. [11]

3.3.3 RS Logix 500

We are glad to welcome you to RS Logix 500. The SLC 500 and Micro Logix® processors employ the RS Logix 500 software, which is a 32-bit Windows ladder logic programming tool. SLC 500 and Micro Logix programmes produced in any Rockwell Software development package are compatible with RS Logix 500. The following features are included in the RS Logix 500 programme:

- ✓ When developing your programme, utilise a free-form ladder editor to focus on the application logic rather than syntax.
- ✓ Drag-and-drop editing lets you move data table components from one data file to the next, rungs from one subroutine or project to the next, and instructions from one rung to the next inside a project. [12]

3.4 Single Line Diagram of500VA Substation (SLD)

In my substation design I will be focusing an automation system in the distribution substation side of the consumers. In order to fully control the connected load for better reliability of power supply in the system, this system will assist the substations being monitored using PLC ladder Programming.

| e-ISSN: 2278 – 8875, p-ISSN: 2320 – 3765| www.ijareeie.com | Impact Factor: 8.18|

||Volume 11, Issue 5, May 2022||

|DOI:10.15662/IJAREEIE.2022.1105007 |

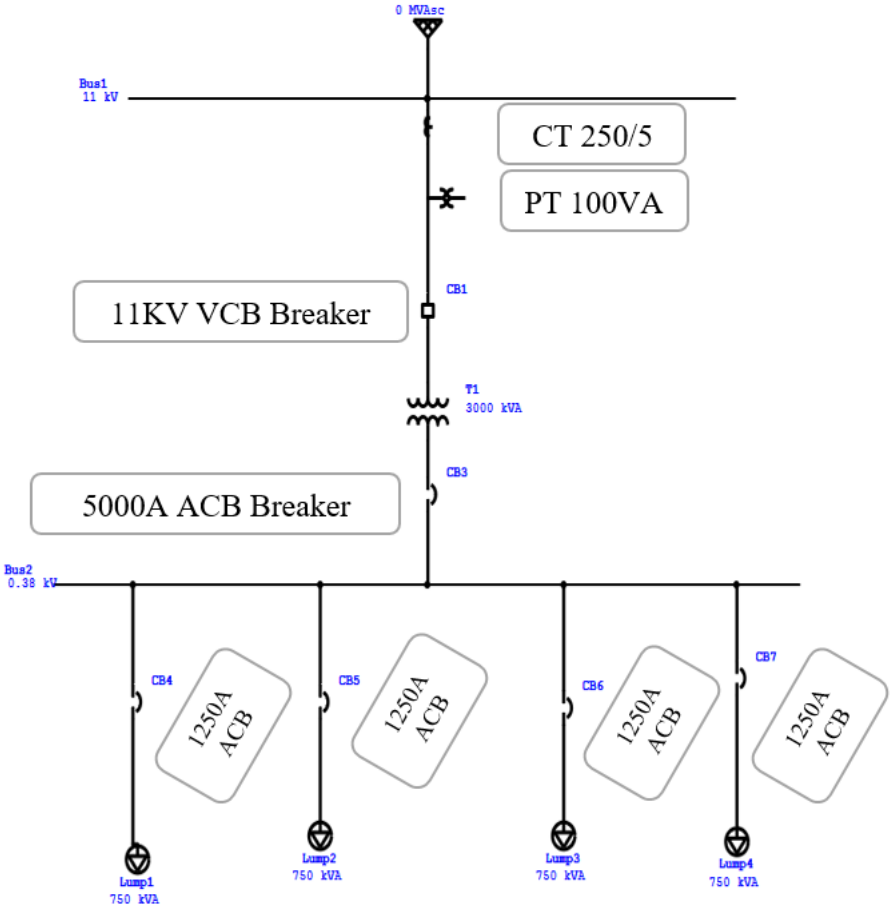


Figure 1 Description of 3000KVA distribution Substation

IV. SIMULATION WORK AND DISCUSSIONS

4.1 Introduction

This system will demonstrate an automation model for controlling a small distribution substation that shows how to control the substation in a control station based somewhere near to distribution substation.

In order to get the ladder logic program for control and monitoring the substation parameters work properly First PLC works in having analog and digital inputs so the substation parameters that I will be controlling is based in analog since they are not constant and varying trough out the process in order to control and monitor through plc there is scaling parameter that is used to do that job and is known as Scale With Parameters (SCP).
Calculating substation parameter sizes.
Transformer = 3000kva

$$I = \frac{\mathrm{P}}{\sqrt{3}\,V}$$

$$I = \frac{3000 * 10^3}{\sqrt{3} * 380}$$

$$I = \frac{3000 * 10^3}{1.732 * 1380}$$

I = 4558 A ∴ FLA = 4558 A
∴ Main ACB Breaker = 5000 A

| e-ISSN: 2278 – 8875, p-ISSN: 2320 – 3765| www.ijareeie.com | Impact Factor: 8.18|

||Volume 11, Issue 5, May 2022||

|DOI:10.15662/IJAREEIE.2022.1105007 |

This substation has 4 outgoing feeders each of which has 750kvA or 600kw load and a circuit breaker of 1250A size.
For every outgoing feeder it has a load corresponding to 600 KW.
Total load for the 4 feeders = 4 * 600 KW = 2400 KW
Circuit Breaker sizing for every outgoing Feeder
Main Breaker = $\frac{5000}{4}$ = 1250 A

4.2 Ladder Logic Program for Scaling PT and CT

Explaining how to scale analog parameters using scale with parameters (SCP) in RS Logix from Rockwell automation the frontline company in today automation which is somehow easier to program ladder logic than other software's in terms of daily usage.

So in the coming rungs I will explain scaling PT and CT according to analog 10V scale which has value equivalent to 32767.

- Rung 0000

In this rungs first I have used an SCP to scale the Voltage in analog signal way that plc can understand, control and monitor during run mode.
As mentioned in my methodology section my overall PT size is:
PT = 100VA
Let 100VA = 5V plc
1 VA =?
So let PT works on the range of 1VA-100VA.
Analog voltage scale is in between the range of 0-10V corresponding to a scale value of 0-32767.
So 5V = 16384
1VA? X
5x = 16384
X = 3276.8

- Rung 00001

In this its being used a greater than > and less than < condition to check if the PT is in the range of scaled value after that the output being true will only display working condition.

- Rung 0002

In this rungs first I have used an SCP to scale the current of CT in terms of Voltage in analog signal way that plc can understand, control and monitor during run mode.
So as mentioned in my methodology section my CT has Size of:
CT = 200/5
So I will scaling the last ratio of 5 in the mentioned CT.
Let CT works on the range of 1A-5A in terms of voltage value scale.
Let 5A = 10 V = 32767
1A=? x
5x=32767
X= 6553.4

| e-ISSN: 2278 – 8875, p-ISSN: 2320 – 3765| www.ijareeie.com | Impact Factor: 8.18|

||Volume 11, Issue 5, May 2022||

|DOI:10.15662/IJAREEIE.2022.1105007 |

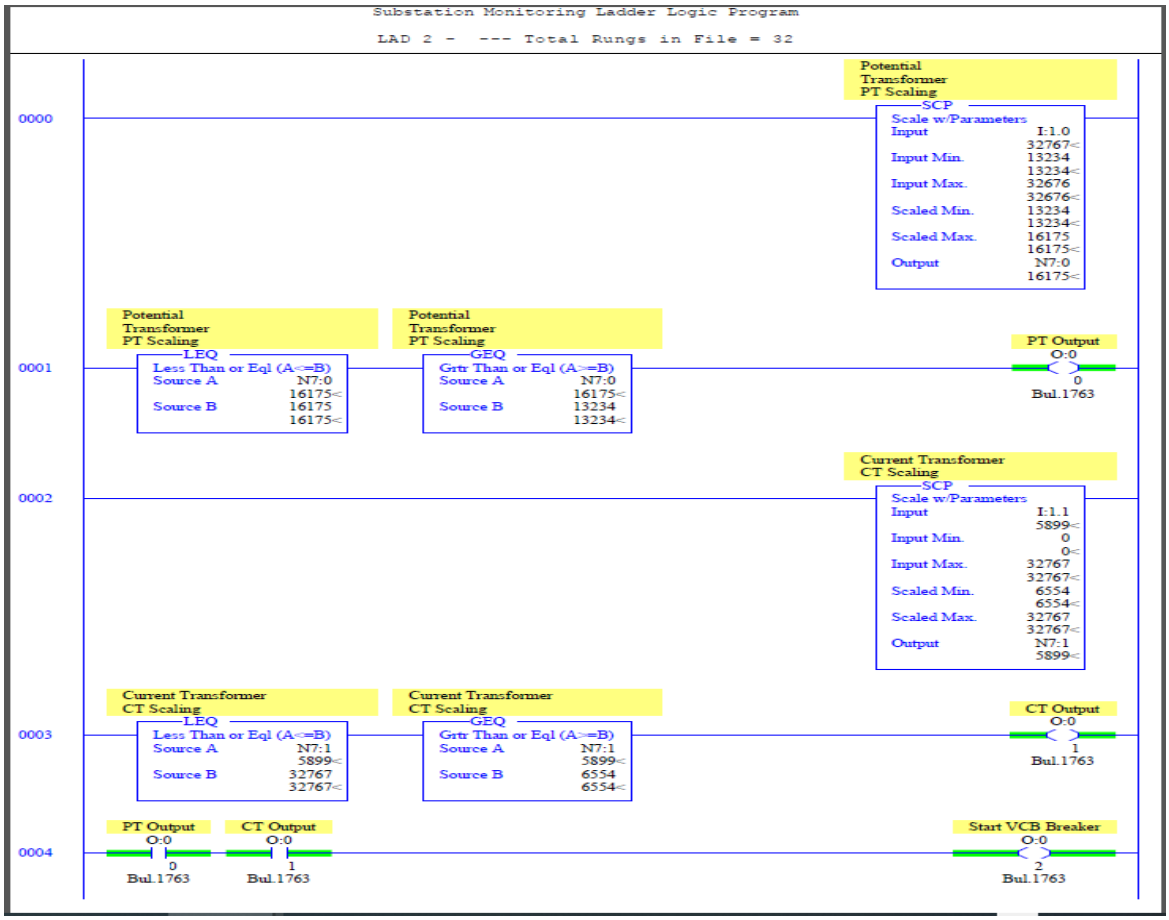


Figure 0.1 Ladder Program for Current and Voltage

In the last rungs I have simulated that the substation to get triped off if it gets beyond the limit that I assigned in all of the 4 outgoing feeders in order to avoid overloading of the substaion and also used divide for reducing the values as low value because my maximum scaling is 32767 even for all outgoing feeders main breaker shouldn't exceed this value. So I have a DIV(division) to reduce it and then ADD(addition) to add all the 4 outgoing feeders values aslo before it get tripped it shows an alarm that the system is experiencing an overcurrent values after alarming you if you don't take step towards it and it continues then it will get tripped.

- Rung 0027

From this rung it uses division in order that the main brekaer to trip if the current crosses more than alarm condition in all 4 feeders. So I have used a low value to the all feeders in order not to be > 32767 of the scaled value so I have added N7:6 & N7:7 of Hawotako + Bundaweyn feeders and stored into destination of N7:10.

- Rung 0028

From this rung it uses division in order that the main brekaer to trip if the current crosses more than alarm condition in all 4 feeders. So I have used a low value to the all feeders in order not to be > 32767 of the scaled value so I have added N7:8 & N7:9 of Koshin + Holwadag feeders and stored into destination of N7:11.

- Rung 0029

From this rung it uses division in order that the main brekaer to trip if the current crosses more than alarm condition in all 4 feeders. So I have used a low value to the all feeders in order not to be > 32767 of the scaled value so I have added N7:10 & N7:11 of Hawotako + Bundaweyn feeders and stored into destination of N7:12.

| e-ISSN: 2278 – 8875, p-ISSN: 2320 – 3765| www.ijareeie.com | Impact Factor: 8.18|

||Volume 11, Issue 5, May 2022||

|DOI:10.15662/IJAREEIE.2022.1105007 |

- Rung 0030

In this rung I have used a greater than > condition to check so that the final low value of all the feeders should not get more than the scaling maximum value which is 32767.

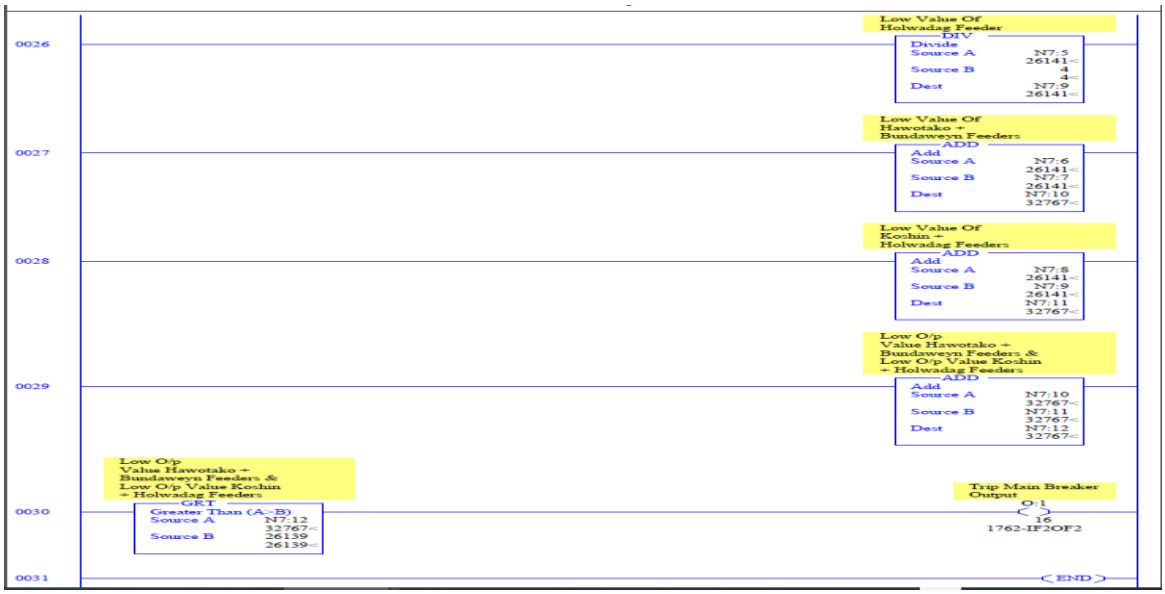


Figure 0.2 Adding of low values of every feeder Current

V. CONCLUSION

5.1 Introduction

Electric power distribution networks deliver power to customers from substations. Distribution systems must prioritise service reliability and efficient delivery. Extreme occurrences like Superstorm Sandy and derecho put distribution system reliability at risk and cost the economy billions of dollars, with Superstorm Sandy alone costing $52 billion. Hurricanes, winter storms, and other extreme weather events may pose a higher danger to distribution system reliability as a result of global climate change. To lessen the impact of these occurrences on dependable power delivery, governments and utilities are pursuing smart distribution systems (SDSs) through grid upgrading. [13]

5.2 Future scope of the Project

This project is being analysed and demonstrated in a research way so in order to benefit from the automation system in a software manner to monitor and control the substation parameters e.g voltage and current of the connected feeders.
This project is being carried out a software known as RS Logix 500, RS Logix Emulate and RS Logix Classic each them having different functions and works in combined way one or two can't work it should be started all the 3 software's at same time.

- RS Logix 500 is the software's that allows you to write your program ladder logic in numerical rungs starting from rung 0000 up to last rung of your required program instructions.
- RS Logix Emulate is the software's that allows you handle the ladder logic in a processor way so it processes to the program that has being written in the RS Logix 500.
- RS Logix Classic is the software's that allows you to make a communications between your RS Logix Emulate (processor) and RS Logix 500 (Program ladder logic).

The research outcome will going to be a systematic model program that is meant for controlling the substation that is being designed in this research work in order to benefit from the advancement of technology. This system will demonstrate an automation model for controlling a distribution substation that shows how to control the substation in a control station based some near to distribution substation.

| e-ISSN: 2278 – 8875, p-ISSN: 2320 – 3765| www.ijareeie.com | Impact Factor: 8.18|

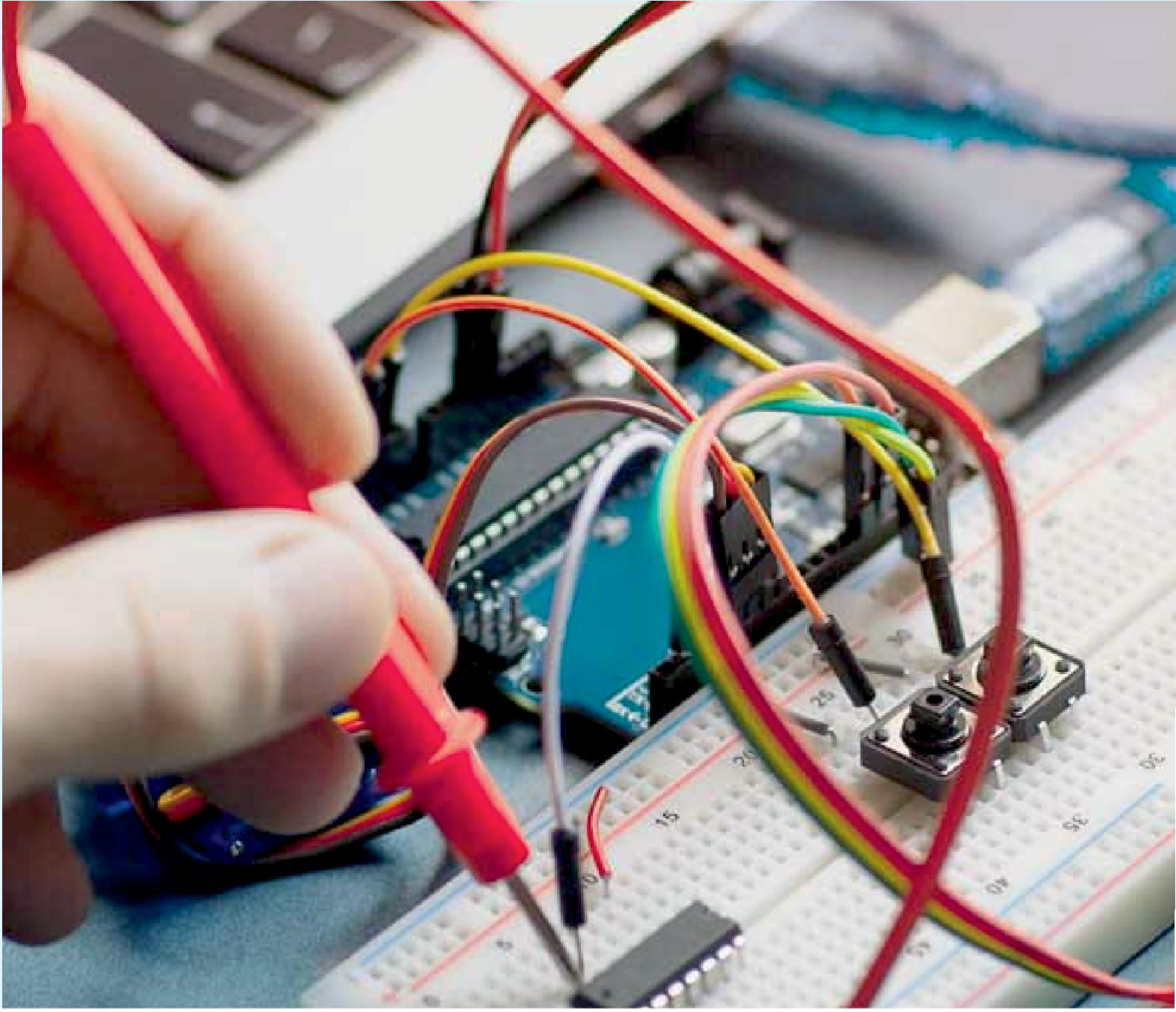
||Volume 11, Issue 5, May 2022||

|DOI:10.15662/IJAREEIE.2022.1105007 |

In the future time this project can be added or connected to Supervisory Control and Data Acquisition (SCADA) in order to fully control and monitor through a graphical manner or screen for clear displaying in it. This system simulation will contribute to a better to be a smart grid city if the automation is being benefited from its advantages.

REFERENCES

1. Keda Ahire, B., Shankar Bhagvat, S., Kishor Akole, P., & Tanaji Pagar, T. (n.d.),(2018). *INTERNATIONAL JOURNAL OF RESEARCH IN ELECTRONICS AND COMPUTER ENGINEERING Substation Fault Monitoring and Controlling using PLC and HMI*. *6*.
2. Borse, N., Mandale, D., & Lashkare, A. (2020). CONSUMER LOAD MONITORING AND CONTROLLING SYSTEM BASED ON PLC AND SCADA. *International Research Journal of Engineering and Technology*. www.irjet.net
3. Sakai, R. T., Almeida, C. F. M., Rosa, L. H. L., Kagan, N., Pereira, D. de S., Medeiros, T. S., Kagan, H., Cruz, M. R. da, Júnior, J. A. A., Gemignani, M. M. F., Silva, G. T. A. da, & Brito, J. A. S. (2022). Architecture Deployment for Application of Advanced Distribution Automation Functionalities in Smart Grids. *Journal of Control, Automation and Electrical Systems*, *33*(1), 219–228. https://doi.org/10.1007/s40313-021-00799-6
4. Wu, S., Su, W., Chen, X., & Liu, T. (2022). *An authentication design of intelligent substation based on identity password*. 35–39. https://doi.org/10.1109/icesit53460.2021.9696800
5. Beigi AM, Maroosi A (2018) Parameter identification for solar cells and module using a hybrid firefly and pattern search algorithms. Sol Energy 171(4):435–446
6. Bassey Ngang, N., Lordson Amana, A., & Author, C. (2021). A Simplified Approach for Using PLC and SCADA System in 330 kV distribution Substations in Nigeria. *InInternational Journal of Sciences & Applied Research www.ijsar.in* (Vol. 8, Issue 6). www.ijsar.in
7. Jingxia Liu, Xuerang Zhang, Fuquan Zhang (2020).Research on Communication Network Configuration and Simulation of Smart Substation Based on Ethernet. *Energy and Power Engineering*, *12*(04), 14–24. https://doi.org/10.4236/epe.2020.124b002
8. Patel, Dr. K., Jogani, V., Bhajiyawala, P., Modi, A., & Panchal, P. (2021). Technological revolution in Industrial Automation using PLC. *International Journal of Scientific Research in Computer Science, Engineering and Information Technology*, 514–519. https://doi.org/10.32628/cseit2172136
9. Angayarkanni, S., Aruna, L., Aswini, R., Deepa, C., & Kowsalya, J. (n.d.) 2018. PLC AND SCADA BASED DISTRIBUTION AND SUBSTATION AUTOMATION. *International Research Journal of Engineering and Technology*. Volume: 05 Issue: 03 | www.irjet.net
10. Rockwell Automation June, P. L. (2005). *Getting Results Guide*. *June*. https://literature.rockwellautomation.com/idc/groups/literature/documents/rm/1747rm001_-en-p.pdf
11. Automation, R. (2022). *RSLinx Classic Getting Results Guide*. *March*, 65.
12. Automation, R. (n.d.), November 2008. SLC 500 Instruction Set Reference Manual. http://www.literature.rockwellautomation.com
13. Systems, S. D. (2016). *Smart Distribution Systems*. https://doi.org/10.3390/en9040297
14. Buksh Narejo, G., Shahyan Pervez Bharucha, E., & Engr Danny Zarir Pohwala, P. (2015). Remote Microcontroller Based Monitoring of Substation and Control System through GSM Modem. *International Journal of Scientific & Engineering Research*, *6*(1). http://www.ijser.org



INNO SPACE
SJIF Scientific Journal Impact Factor

doi cross ref

ISSN INTERNATIONAL STANDARD SERIAL NUMBER INDIA

निस्केयर NISCAIR

Impact Factor: 8.18

International Journal of Advanced Research

in Electrical, Electronics and Instrumentation Engineering

9940 572 462 6381 907 438 ijareeie@gmail.com

www.ijareeie.com

Scan to save the contact details