IJAREEIE

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

International Journal of Advanced Research

in Electrical, Electronics and Instrumentation Engineering

Volume 9, Issue 10, October 2020

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

Impact Factor: 7.122

9940 572 462 6381 907 438 ijareeie@gmail.com www.ijareeie.com

| e-ISSN: 2278 – 8875, p-ISSN: 2320 – 3765| www.ijareeie.com | Impact Factor: 7.122|

|| Volume 9, Issue 10, October 2020 ||

Digitalization and Automation of Grid-Substation Monitoring and Control System Using SCADA

Md.Mozammel Hossain[1], Zain Ahmed[2], Gazi Salauddin[3], Bappy Sarkar Bikalpo[4]

UG Student, Dept. of ECE, Presidency University, Dhaka, Bangladesh[1]

Lecturer, Dept. of ECE, Presidency University, Dhaka, Bangladesh[2]

UG Student, Dept. of ECE, Presidency University, Dhaka, Bangladesh[3]

UG Student, Dept. of ECE, Presidency University, Dhaka, Bangladesh[4]

ABSTRACT: The Digital control systems for substations have been installed in different parts of the world over the last few decades. Most of them use a Supervisory Control and Data Acquisition (SCADA) with Remote Terminal Unit (RTU) to monitor the metering devices for incoming and outgoing feeders. Digitalization and automation increase efficiency of a system by accurately detecting fault location to prevent false tripping and to minimize the area affected by the fault. We can also access data securely from any part of the world by point to point communication using internet. The main aim of this paper is to design a Supervisory Control and Data Acquisition (SCADA) system to monitor and control a grid from a remotely located control station. The paper also provides an analysis on architecture, technologies, communication protocols and software for automation of the grid and substation domain.

KEYWORDS: SCADA, RTU, MTU, PLC, Substation Automation

I. INTRODUCTION

Over the past 50 years, Supervisory Control and Data Acquisition (SCADA) systems have evolved significantly from standalone operations into network architectures that communicate across long distances. Moreover, their implementations have shifted from custom hardware and software to standard hardware and software platforms. These have led to a reduced operational, maintenance and development costs and helps management to plan, supervise, and make important decision by providing real-time information. SCADA systems are nowadays widely used in most industrial processes, power generation and distribution, and even facilities such as nuclear fusion. Power utilities around the world have increasingly adopted to the Automation of power systems to improve operational efficiency and provide a more reliable supply to its customers.

SCADA systems are used to monitor and control a plant or a grid. Data is transferred between a SCADA central host computer and a number of Remote Terminal Units (RTUs). A SCADA system collects data, transfers the information to a central site, then alerts the plant or grid if any fault occurs, carry out critical analysis, and also display the information in an organized way. These systems can be either relatively simple, or very complex. Nowadays, wireless technologies are widely deployed for purposes of monitoring, and more and more systems are monitored using the infrastructure of Local Area Network (LAN)/Wide Area Network (WAN).

Through substation automation reliability and performance of electrical protection is increased and event recording capabilities are gained. By monitoring and controlling the circuit-breakers operated on the site, the system can achieve data acquisition, parameter adjustment, and various signal alarms. In RTU automated substation, the power equipment, their communication and computers are interdependent. The data gathered from the equipment in the substation is communicated with the SCADA systems via RTU. The monitoring system supervises the real-time status of currents, voltages, pressures, temperatures, contacts, etc. This supervision is made possible with the help of digital equipment and special sensors which are installed in the field devices of the substation. The data are collected and processed in a data acquisition and control unit, then, using sent to a central computer located at the control building of the substation through a communication network such as cable, fiber, satellite, etc and later to the operation centers, hence allowing a remote supervision. Measured values reflect different time varying quantities, such as voltage, current, power, protection class trip, breaker fault and tap changer positions, which are collected from the grid. They are categorized into two basic types: analogue and digital. All analogue signals are converted to binary format through an A/D converter because they have to be normalized before storing. A collection of standard and/ or custom software, sometimes called Human Machine Interface (HMI) software or Man Machine Interface (MMI) software, are used to provide support to the SCADA central host and operator, support the communications system, and monitor and control remotely located field data interface devices.

II. SCADA SYSTEM MODEL

The overall model that is suggested to monitor and control a grid by digitalization and automation is described below.

A. Master Terminal Unit (MTU):

The master terminal unit or the central controller is formed by a server or/and group of sub servers connected directly or indirectly with main server, with the help of a communication link such as "Local Area Network (LAN) or/and Wide Area Network (WAN)". Human Machine Interface (HMI) is typically installed in Master Terminal Unit (MTU), which provide facility to observe information that is coming from remote terminal units. The information is displayed in the form of textual and graphical, that can be easily understood by SCADA user/operators during communication. So, each user terminals or sub terminals will be able to visualize associated information on display screen by getting connected with the main server. In SCADA system Master Terminal Unit (MTU) acts as heart of the system.

B. Remote Terminal Unit (RTU):

Substations or Remote Terminal Units (RTUs) act as slave stations in SCADA architecture. Typically, through actuators or sensors, Remote Terminal Units (RTUs) are connected with physical environment. Depending upon the request send from master station, RTU collect real time information from sensors and transmit back to master terminal station. In few cases, such as disaster, disaster recovery, actuators or sensors, malfunctioning and some other critical issues, remote terminal station can send request to master station. Remote Terminal Units (RTUs) are geographically distributed over different sites, and they collect and process real time information and send them to the master station using LAN/WAN (radio signals, telephone line, cable connection, satellite and micro waves media,). The data is either analog (real numbers), digital(on/off), or pulse data (e.g., counting the revolutions of a meter). Many remote terminal units hold the information that is stored in their memory and wait for the MTU to request to transmit the data. Some other advanced remote terminal units have microcomputers and programmable logic controllers (PLC) which can perform direct control over a remote site without the direction of the MTU. The central processing unit (CPU) within the RTU receives a data stream from the protocol which the communication equipment uses. The protocol may be open like Modbus, Transmission Control Protocol and Internet Protocol (TCP/IP) or a proprietary closed protocol. When the RTU sees its node, address embedded in the protocol, data is interpreted and the CPU directs the specified action to take.

C. Communication System:

Communication equipment is required for bi-directional communications between RTU and MTU. Using public transmission media or atmospheric means; data/message can be transmitted "between Master Terminal Unit (MTU) and Remote Terminal Units (RTUs). SCADA systems are capable of communicating using a wide variety of media, included radio signals, telephone line, cable connection, satellite and micro waves media. Cable connection is used for small types of networks usually, within industry or small industry, as this connection is inconvenient for large distance. With larger connectivity of SCADA nodes with LANs/WANs; powerful radio signals, satellite and microwaves media have been often used for SCADA communication. Usually, SCADA system uses "point to point (PTP), point to multipoint (PTM) and multipoint to multipoint (MTM) topologies and communication procedures includes half-duplex and full-duplex.

D. Software:

There are many software packages which enables engineers with moderate programming knowledge to build SCADA applications. SCADA server applications handle data archiving, alarm processing and events logging. OLE1 for Process Control (OPC) is an open standard designed to bridge process control hardware and software applications. An OPC server is simply a PLC device driver that helps programmers to communicate with PLC through a standard interface. SCADA systems include HMI that uses graphical interface to visualize the state of system variables, change set points, alerts operators of critical condition and generate data trends. There are many software packages that are used for designing HMI and SCADA. WINCC from SIEMENS, Complicity HMI from General Electric, and Lookout from National Instruments are popular for efficient commercial SCADA packages.

E. Database Server:

SCADA Database servers are very important for SCADA system. Most SCADA systems use SQL server from Microsoft Company as database server. OPC servers along with database servers deal together to manage SCADA

| e-ISSN: 2278 – 8875, p-ISSN: 2320 – 3765| www.ijareeie.com | Impact Factor: 7.122|

|| Volume 9, Issue 10, October 2020 ||

system data which includes Data Logging archiving, paging, alarm and authentication. All system data is stored in the database server. It is then maintained by the SCADA system designer to display the data to the operator simply and quickly using different ways of data management as alarms, SMS messages and reports.

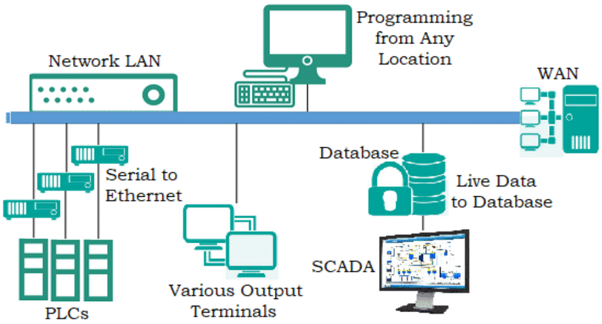


Fig. 1 SCADA System

III. SYSTEM COMPONETS AND WORKING PRINCIPLE

For this project, a gird at a remote location is being monitored. The main control room is proposed at the city center. RTU, PLC, MUX, sensors, etc. are installed at the grid location. At the control room, the computer system for the SCADA will be installed. This system consists of both hardware and software. For hardware we need main SCADA server, backup SCADA server, high definition computers, ethernet and LAN. Basic software that we need are OPC server, SQL server, network management software, HMI package. PLCs/RTUs, servers and workstations are then connected and communicated via different communication devices with each other. The main components that are used for this project are described below.

A. MiCOM C264 RTU:

For demanding electrical substations, Schneider Electric's has introduced MiCOM C264, which is a compact and modular Bay Controller & RTU. MiCOM C264 is perfect for smart management of electrical substations because of its high performance and ready for system integration. MiCOM C264 RTU has numerous benefits such as maximizing energy availability, improve security of operations in electrical networks, simplify the control and monitoring of electrical devices. The information capacity of the MiCOM C264 is designed in a way for controlling and operating switchgear units equipped with electrical check-back signaling located in medium voltage or high-voltage substations. External auxiliary devices are greatly eliminated by the integration and implementation of binary inputs and power outputs which are independent of auxiliary voltages, with the direct connection option for voltage and current transformers, and by the comprehensive interlocking capability. This makes it simple to handle bay protection and control technology from planning to station commissioning. During operation, by preventing non-permissible switching operations, the user-friendly interface makes it easy to set the unit and allows safe operation of the substation. A built-in liquid crystal display shows the switch gear settings, and can also measure data and monitor signals or indications. The bay is controlled interactively by using the control keys and the display.

Fig. 2 MiCOM C264 RTU

B. O9500R SDH Multiplexer:

The O9500R SDH MUX is an integrated solution supporting SDH/ PDH simultaneously on the same platform. It is designed in a way to support the DS0 access and PDH interfaces to be freely carried over SDH/SONET uplink. PDH stands for Asynchronous Digital Hierarchy and SDH stands for Synchronous Digital Hierarchy. Both PDH and SDH

| e-ISSN: 2278 – 8875, p-ISSN: 2320 – 3765| www.ijareeie.com | Impact Factor: 7.122|

|| Volume 9, Issue 10, October 2020 ||

are terminologies associated with digital multiplexers. The different hierarchies having different bit rates are combined. SDH/SONET uplink capability includes either STM-1/4/16 or OC-3/12/48. O9500R's connectivity is achieved via non-blocking cross-connection between HS tributary modules and LS tributary modules. O9500R offers service providers a versatile protection scheme including SNCP(UPSR) and MSP (1+1) protection for both ring and linear network topologies. O9500R can also work with Loop-O9100 and Loop-O9400R for SDH/SONET networking.
All interfaces of 09500R are fully compliant with ETSI standards and ITU recommendations. The O9500R SDH/SONET IMAP provides the facility of full operation, administration, maintenance and provisioning functionality. Users can easily operate the O9500R locally or remotely through Loop-iNET (EMS).

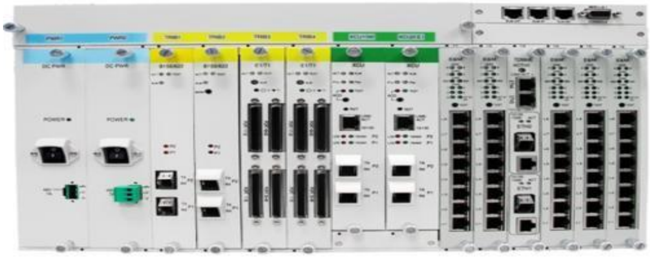


Fig. 3 O9500R SDH Multiplexer

C. Schneider PM 5500 Power and Energy Meter:

The PM5500 series power and energy meter offer great value for the demanding needs of energy monitoring and cost management applications. PM5500 meter features reliability, improved quality and affordability in a compact and easy to install format. The meter stores all accumulated active, reactive and apparent energy parameters in a non-volatile memory. Energy registers is automatically logged on a programmed schedule. All energy parameters indicate the total for all three phases. The meter also shows the present, last, predicted and peak demand, and a date or time when the peak demand occurred. Registers of peak demand can be manually (password protected) reset or it can be reset automatically on a programmed schedule. The meter provides highly accurate three phase voltage, three phase current, true power factor, displacement power factor, system frequency, voltage and current unbalance, total harmonic distortion, demand distortion. The meter also provides the status of the digital inputs and digital outputs. The I/O timer shows how long an input or output has been ON, the Operating timer shows how long a load has been powered and the load timer shows how long a load has been running.

Fig. 4 Schneider PM 5500 Power and Energy Meter

D. RS485 System for Communication:

RS-485 is a standard defining the electrical characteristics of drivers and receivers for using in serial communications systems. In this standard, signaling is balanced, and it supports multipoint systems. Digital communications networks, those implement this standard can be used efficiently over long distances and in electrically noisy environments. In this type of network, multiple receivers can be connected in a linear, multidrop bus. These characteristics of RS-485 make it useful in industrial control systems and similar types of applications.
RS-485 allows multiple devices (up to 32) to communicate distances up to 1200 meters at half-duplex on a single pair of wires, and a ground wire. The length of the network and the number of nodes can be extended quite easily using a variety of repeater. Data is transmitted differentially on the two wires that are twisted together. High noise immunity and long-distance capabilities are gained through the properties of differential signals.

There is no such thing as a common zero as a signal reference in RS485. If the RS485 transmitter and receiver, several volts difference in the ground level does not create any problems. The RS485 signals are floating and each signal is transmitted over a Sig+ line and a Sig- line. Instead of the absolute voltage level on a signal line, the RS485 receiver compares the voltage difference between both lines. This is useful in preventing the existence of ground loops, a common source of communication problems. The best results are achieved when the Sig+ and Sig- lines are twisted.

E. Ethernet:

Ethernet is the traditional technology to connect devices in a wired local area network (LAN) or wide area network (WAN), and it enable them to communicate with each other via a protocol ,which is a set of rules or common network language. Ethernet describes how network devices can format and transmit data. With this help, other devices on the same local area or campus area network segment are able to recognize, receive and process the information. An Ethernet cable is the encased wiring over which data travels. Ethernet is likely used by connected devices accessing a geographically localized network with a cable -- that is, with a wired connection rather than wireless one. Compared to wireless technology, Ethernet offers a greater degree of network security and control since devices must be connected via physical cabling. This makes it quite impossible for outsiders to access network data from unsanctioned devices. Fast Ethernet or 100BASE-T provides transmission speeds up to 100 megabits per second and is used for LAN backbone systems, supporting workstations with 10BASE-T cards. On the other hand, Gigabit Ethernet provides an even higher level of backbone support at 1000 megabits per second. Moreover, 10-Gigabit Ethernet provides up to 10 billion bits per second. Since Ethernet networks are inexpensive and it is well understood, they are greatly used in data communication networks. Ethernet is designed to operate reliably under extreme harsh environment, which is typically found in utility applications for SCADA, substation and distribution automation.

F.iNET Software:

iNET is a set of intelligent network management software programs which can be taken as both Element Management Layer (EML) and Network Management Layer (NML) based on the Telecommunications Management Network (TMN) model. It provides the users with integrated network management over all of the Loop's products. This program is designed in a flexible way so that it can manage your network regardless of the size or complexity. Any component can be added or removed without affecting operations of the system. It provides a GUI (graphical user interface) to manage communications network, which contain CXR Telecom products. The network manager has great flexibility of work assignment because the workforce management is facilitated by the multiple levels of login security. It is highly scalable (up to 100,000 network elements) and can easily meet the needs of management, both large and small. iNET provides different facilities, such as alarm management, report& statistics, operation fault tolerance, and FCAPS (fault-management, configuration, accounting, performance and security) support. Most tasks are automated to save time of operators. Traffic can be diverted easily around network faults by just a single point and clicks. Maps and the reports can be printed as well as viewed directly from the iNET.

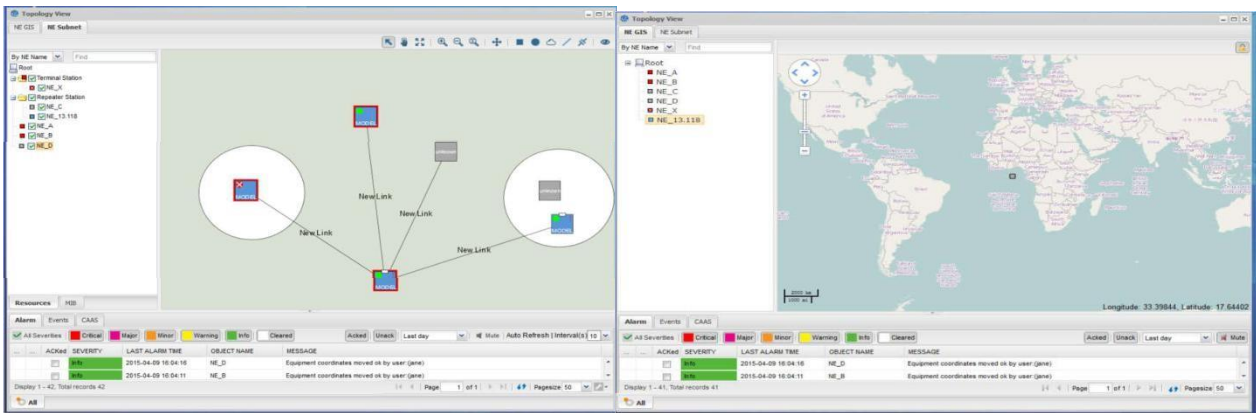


Fig. 5 (a) NE Subnet View. (b) NE GIS View.

G. Modbus Protocol:

Modbus is one of most important protocols used by SCADA system. It is an open standard that is described by the messaging structure. Modbus implementations uses RS485 because it allows longer distances, higher speeds and the possibility of a true multi drop network. As a result, it is easy for vendors to implement the Modbus messaging system in their devices and Modbus became the standard for industrial communication networks. The key advantage of Modbus standard is the flexibility. Intelligent devices like microcontrollers, PLCs etc. are able to communicate with Modbus very swiftly. In addition, for sending data to host system, many intelligent sensors are equipped with a Modbus interface too. The Modbus communication interface is built around messages. The format of these Modbus messages do not depend on the type of physical interface that is used. Regardless of the connection type, the same protocol can be used. As a result, Modbus gives the flexibility to upgrade the hardware structure of an industrial network quite easily, without the need for large changes in the software. Communication of a single device with several Modbus nodes at once is also possible without the need to use a different protocol for every connection, even if they are connected with different interface types. On interfaces likeRS485, the Modbus messages are sent in plain form over the network. For this case, the network is completely dedicated to Modbus. Even though the main message structure of the Modbus is peer-to peer, it is able to function on both point-to-point and multi drop networks. Each Modbus message uses the same structure. There are four basic elements that are present in each message. To make it simple, the sequence of these elements is the same for all messages. A master in the Modbus network always start the conversation. Depending of the contents of the message sent by the Master, a slave takes action and responds to it. is used to define Which device should respond to a message is defined by the addressing in the message header. If the address field doesn't match their own address, all other nodes on the Modbus network ignore the message.

H. 42u Universal Server Rack:

42u Universal Server Rack is a structure that is designed specifically to store technical equipment. The mechanical machines include servers, routers and switches. The 42U Rack's door system has a four-point locking system. The door can be easily rotated and as a result it can be hinged from the left or right. The side panels have the options to be screwed on, locked in place, or hinged to give side door access. It has a strong frame structure and has the feature of multiple vendor equipment compatibility. The width follows EIA standard of 19″ Rack Rails, has external width of 23.6″ – 600mm, height of 78.74″ – 2,000mm, and depth of 39.37″ & 41.34″. It has accessories like Sidewalls, Split rear door, Baying Kits, Toolless Shelves, Casters, Bolt Down Kits, Cable Management and Power strips.

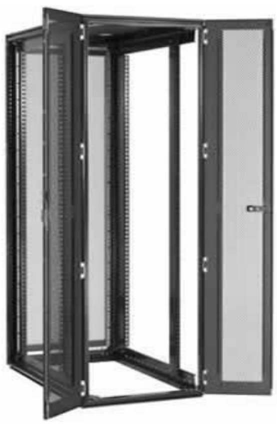


Fig. 6 42u Universal Server Rack

IV. SETTING PARAMETER AND SYSTEM DESIGN

In this paper, we designed a system with one grid and one control center. We will monitor and control that grid from the center. Let the Grid name be Grid A. Signal List for grid 'A' 132/33KV G/S is given bellow.

Analog Point

S. L	Bay Name	Analog	Signal Name
1	132 KV BUS -1	Hz	Frequency
2		KV	Volts BB
3	132 KV BUS -2	Hz	Frequency
4		KV	Volts BB

| e-ISSN: 2278 – 8875, p-ISSN: 2320 – 3765| www.ijareeie.com | Impact Factor: 7.122|

|| Volume 9, Issue 10, October 2020 ||

5	132 KV CKT - 1	KV	Volts BB
6		MW	Megawatts
7		MVAR	Megavars
8		AMP	Amperes
9	132 KV CKT - 2	KV	Volts BB
10		MW	Megawatts
11		MVAR	Megavars
12		AMP	Amperes
13	132/33 KV TR-1	KV	Volts TRFR LV side
14		MW	Megawatts TRFR LV SIDE
15		MVAR	Megavars TRFR LV SIDE
16		AMP	Amperes TRFR LV SIDE
17		TPI	Tap Position Indication (Analog)
18	132/33 KV TR-2	KV	Volts TRFR LV side
19		MW	Megawatts TRFR LV SIDE
20		MVAR	Megavars TRFR LV SIDE
21		AMP	Amperes TRFR LV SIDE
22		TPI	Tap Position Indication (Analog)
26		AMP	Amperes

Digital Input (Single)

S.L	Bay Name	Digital	Signal Name
1	132 KV BUS-1	P3	Protection Class 3 Trip
2		VS	Voltage Status
3	132 KV BUS-2	P3	Protection Class 3 Trip
4		VS	Voltage Status
5	132KV CKT-1	BRF	Breaker Fault
6		AR	CB Auto Reclose
7		ARO	Auto Reclose Block
8		LRCB	Local/Remote Switch for CB & BI
9		P1	Protection Class Trip 1
10		P2	Protection Class Trip 2
11		BF	Bay Fault
12	132KV CKT-2	BRF	Breaker Fault
13		AR	CB Auto Reclose
14		ARO	Auto Reclose Block
15		LRCB	Local/Remote Switch for CB & BI
16		P1	Protection Class Trip 1
17		P2	Protection Class Trip 2
18		BF	Bay Fault
19	132/33 KV TR-1	BRF	Breaker Fault
20		LRCB	Local/Remote Switch for CB & BI
21		P1	Protection Class Trip 1
22		P2	Protection Class Trip 2
23		BF	Bay Fault
24		TRA	Transformer Alarm

25		TRT	Transformer Trip
26		TEA	Transformer Temperature Alarm
27		TET	Transformer Temperature Trip
28		TCA	Tap Changer Alarm
29		TCT	Tap Changer Trip
30	132/33 KV TR-2	BRF	Breaker Fault
31		LRCB	Local/Remote Switch for CB & BI
32		P1	Protection Class Trip 1
33		P2	Protection Class Trip 2
34		BF	Bay Fault
35		TRA	Transformer Alarm
36		TRT	Transformer Trip
37		TEA	Transformer Temperature Alarm
38		TET	Transformer Temperature Trip
39		TCA	Tap Changer Alarm
40		TCT	Tap Changer Trip
41	132 KV BC	BRF	Breaker Fault
42		LRCB	Local/Remote Switch for CB & BI
43		P1	Protection Class Trip 1
44		P2	Protection Class Trip 2
45		BF	Bay Fault

Digital Input (Double)

S.L	Bay Name	Digital	Signal Name
1	132 KV CKT-1	STTS_CB	Circuit Breaker Open/Close
2		STTS_IS1	Isolator Switch 1 Open/Close
3		STTS_IS2	Isolator Switch 2 Open/Close
4		STTS_LI	Line Isolator Switch Open/close
5		STTS_EI	Earth Switch Open/Close
6	132 KV CKT-2	STTS_CB	Circuit Breaker Open/Close
7		STTS_IS1	Isolator Switch 1 Open/Close
8		STTS_IS2	Isolator Switch 2 Open/Close
9		STTS_LI	Line Isolator Switch Open/close
10		STTS_EI	Earth Switch Open/Close
11	132/33 KV TR-1	STTS_CB	Circuit Breaker Open/Close
12		STTS_IS1	Isolator Switch 1 Open/Close
13		STTS_IS2	Isolator Switch 2 Open/Close
14		STTS_LI	Line Isolator Switch Open/close
15		STTS_EI	Earth Switch Open/Close
16	132/33 KV TR-2	STTS_CB	Circuit Breaker Open/Close
17		STTS_IS1	Isolator Switch 1 Open/Close
18		STTS_IS2	Isolator Switch 2 Open/Close
19		STTS_LI	Line Isolator Switch Open/close
20		STTS_EI	Earth Switch Open/Close
21	132 KV BC	STTS_CB	Circuit Breaker Open/Close
22		STTS_IS1	Isolator Switch 1 Open/Close
23		STTS_IS2	Isolator Switch 2 Open/Close

| e-ISSN: 2278 – 8875, p-ISSN: 2320 – 3765| www.ijareeie.com | Impact Factor: 7.122|

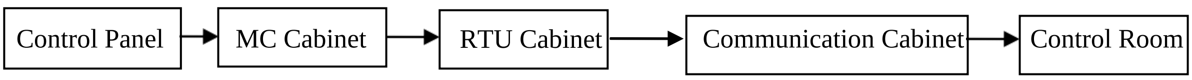
|| Volume 9, Issue 10, October 2020 ||

Digital Output (Double)

S.L	Bay Name	Digital	Signal Name
1	132 KV CKT-1	Control_CB	OPEN
2		Control_CB	CLOSE
3	132 KV CKT-2	Control_CB	OPEN
4		Control_CB	CLOSE
5	132/33 KV TR-1	Control_CB	OPEN
6		Control_CB	CLOSE
7	132/33 KV TR-2	Control_CB	OPEN
8		Control_CB	CLOSE
9	132 KV BC	Control_CB	OPEN
10		Control_CB	CLOSE

Signals are sent from the grid to the RTU in digital form, both single and double. In this system the grid has two 132 KV Bus, two 132 KV Circuit, two 132/33 KV Transformers, one 132 KV Bus Couplers. We can observe via the single digital input the protection trip and voltage status of the buses; protection class trip, circuit breaker condition, switch condition, bay fault of the two circuits; protection class trip, bay fault, transformer alarm, transformer trip, temperature alarm, temperature trip, tap changer alarm, tap changer trip for the transformers; switch condition, breaker fault, bay fault, protection class trip for the bus couplers. Also, by the double digital input we can observe circuit breaker condition, isolator switch condition, line isolator switch condition, earth switching condition for the two circuits, transformers and bus couplers. All these signals are sent to the control station from where they can be operated remotely.

For the signals to transfer from the grid to the control station we used three cabinets in one power grid.



According to the signal list we had, we used 3 Remote Terminal Units (RTU) because we need to have 30% spare space of the RTU card. The real time signals collected by the MiCOM C264 RTU is passed from the Central Processing Unit (CPU 270) of the RTU to the O9500R Multiplexer controller module. RTU is connected with the communication equipment (SDH/PDH) via patch cord. It is then sent to the Optical Distribution Frame (ODF) allocated core where it is combined with signal from other grids.

RTU is connected to the feeder via control cable, and feeder signal is sent to RTU through individual cord.

SDH/ PDH is connected to the server via optical fiber. The SDH/ PDH sends all the signals together at the server. There are two pooling servers at the master control station; the master server and the backup server. The feeder status can be visualized from the server using iNET software.

Figure 7 shows the Communication System Layout and figure 8 shows the System Architecture that we designed for this project.

In figure 9, 10 and 11 we showed the Digital Input, Digital Output connection of CKT-1, TR-1 and Bus Coupler with the RTU to monitor and control the parameter that we discussed previously. A marshalling cabinet is placed between the field instruments and RTU. Marshalling means grouping of I/O. Marshalling Panels provide cross wiring functionality between field instruments and the control system.

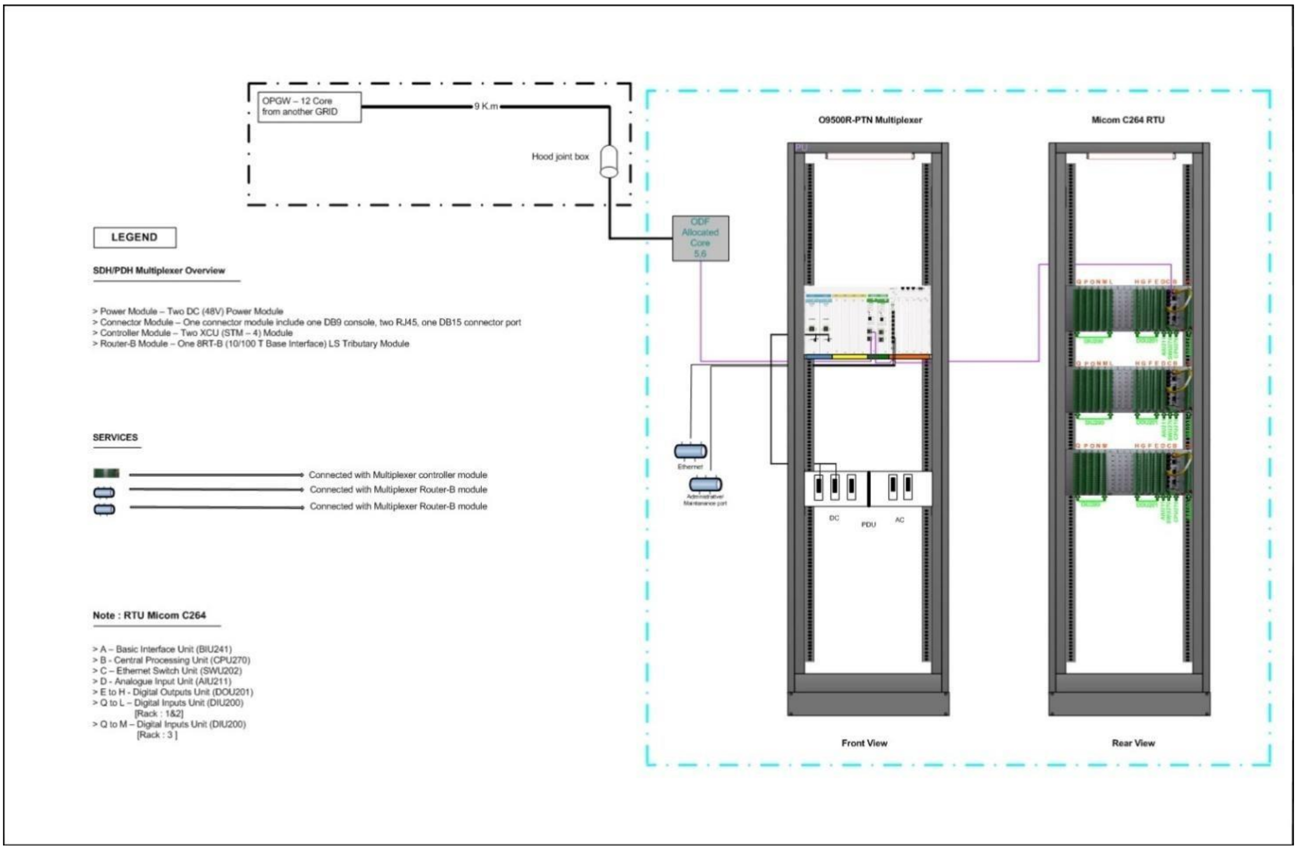


Fig. 7 Communication System Layout

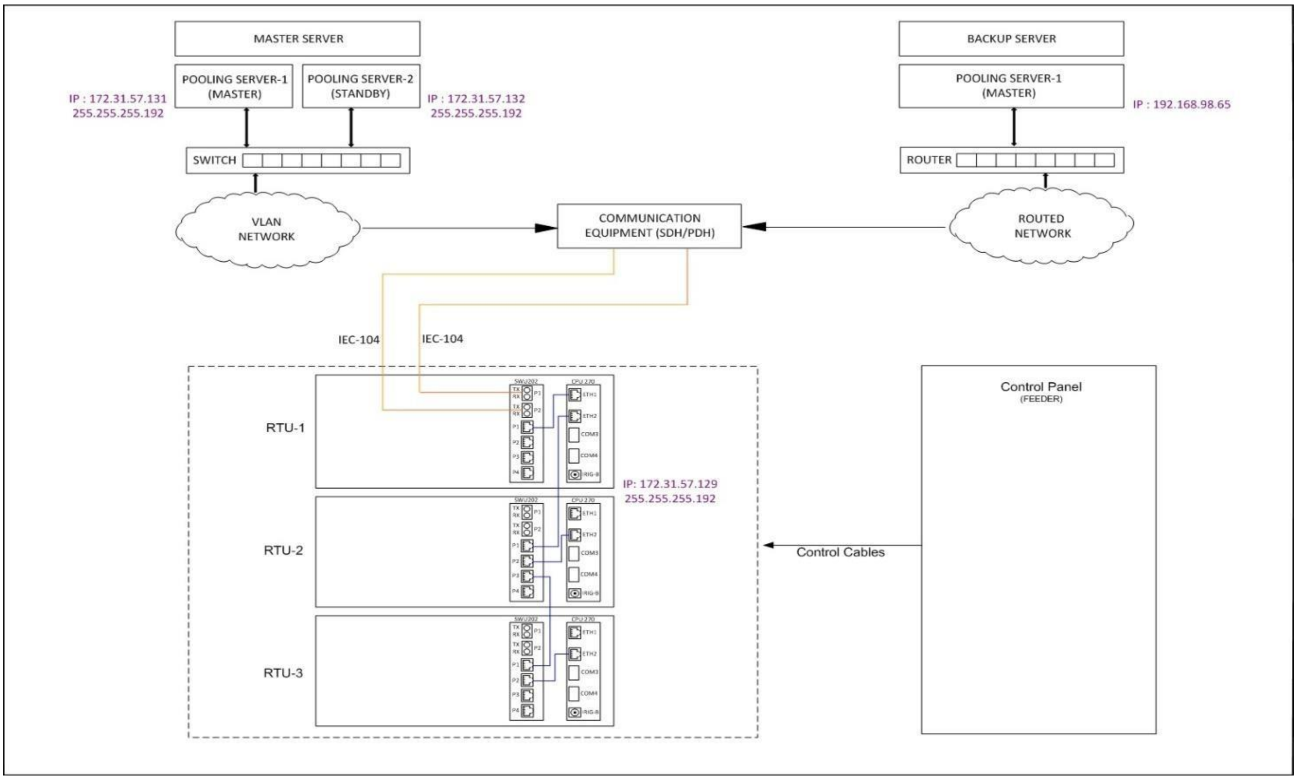


Fig. 8 System Architecture

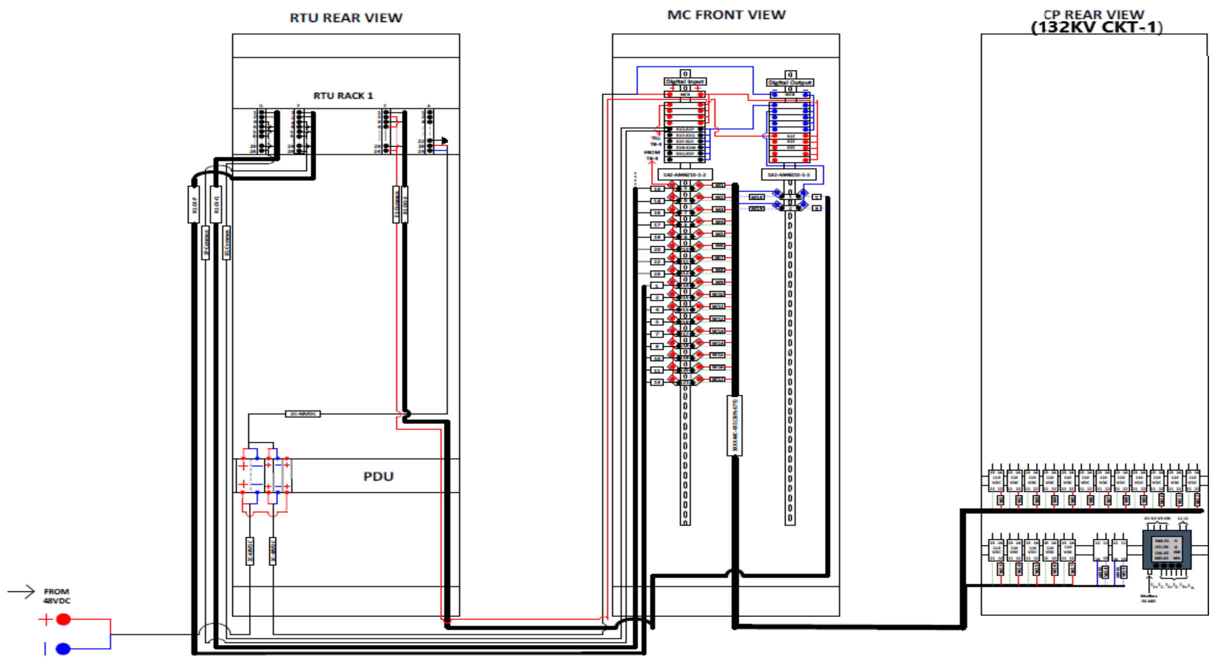


Fig 9. RTU-MC-CP DI DO CONNECTION (132 KV CKT-1)

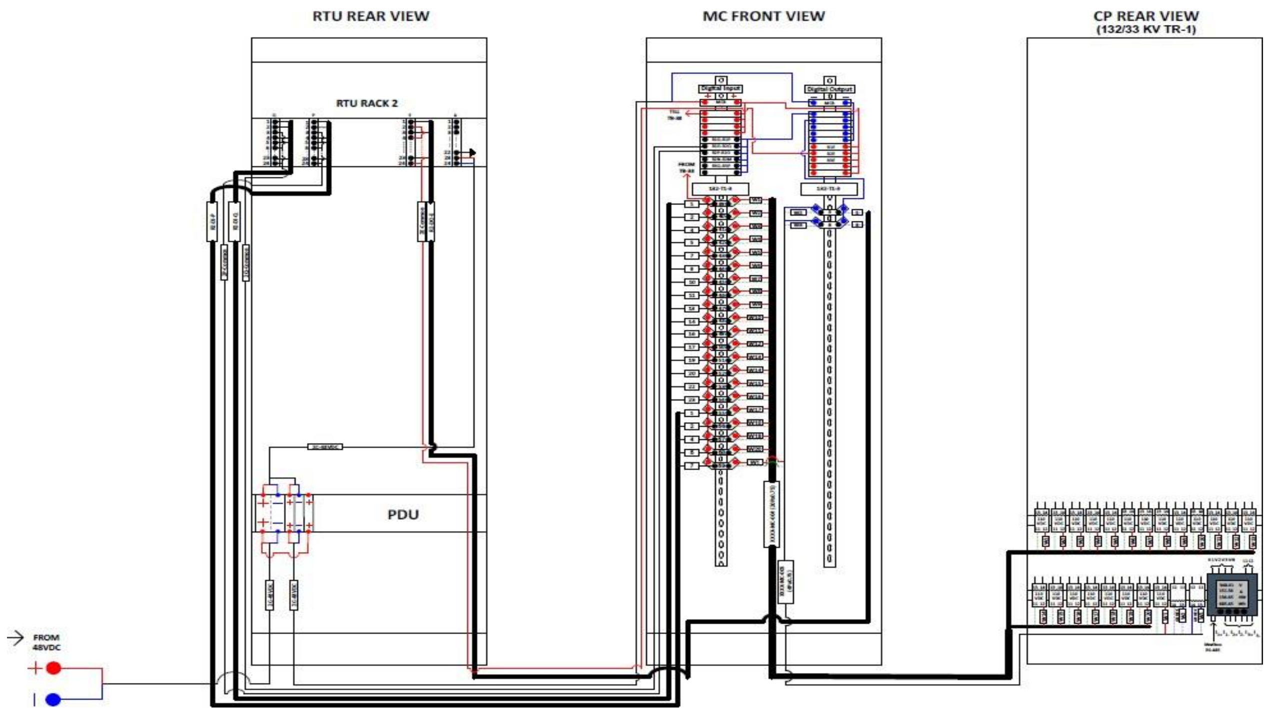


Fig 10. RTU-MC-CP DI DO CONNECTION (132/33 KV TR-1)

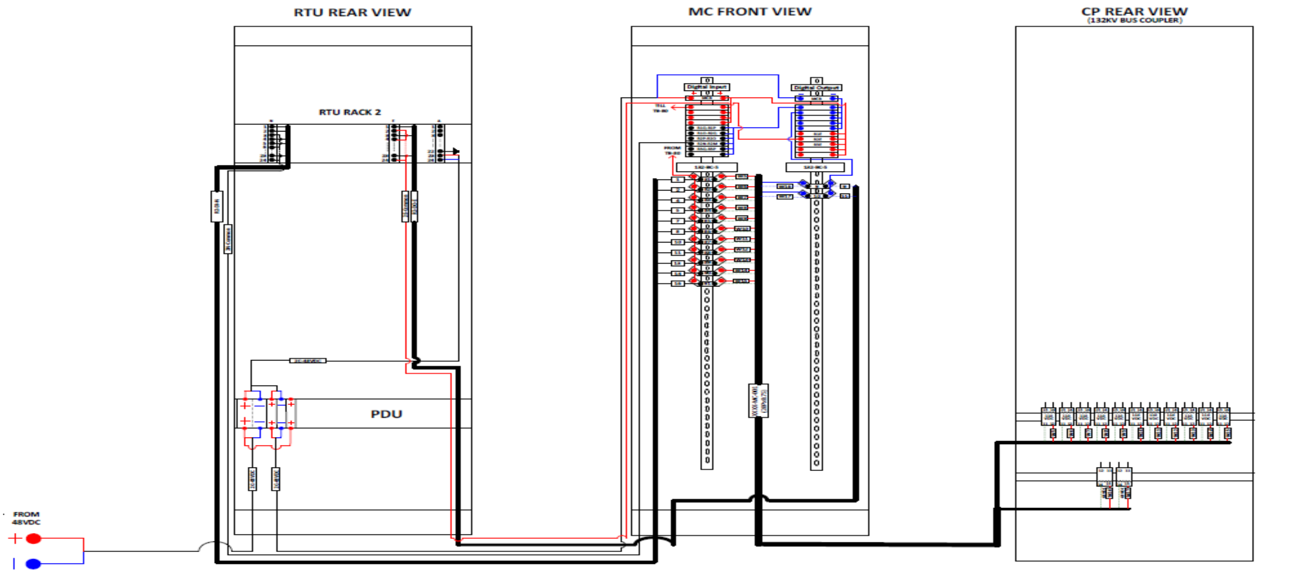


Fig 11. RTU-MC-CP DI DO CONNECTION (132 KV BC)

V. CONCLUSION

The importance of power in our region pushes us to try to use the new world technology in controlling our little resources of power supply. One of main parts of this research is an experimental platform comprises four well plant modules which are equipped with HDS-PDS &RTU. Several experiments were presented to test, evaluate and demonstrate several communication scenarios between the SCADA server and these plants using different configurations, and all results were acceptable. The other part of the research presents a framework for building a SCADA system to control Power stations. The final recommendations are upgrading of the present system depending on adding new components that are needed for the SCADA system with keeping the previous control system components, so the upgraded system will have the ability to run the new control system with all its original options. Wireless communication system can be a suitable option because it has no cost for infrastructure, no running cost charges and the connection and monitoring can be online for 24 hours.

REFERENCES

[1] Aye Min Zaw, HlaMyoTun (2014), 'Design and Implementation of SCADA System Based Power Distribution for Primary Substation (Monitoring System)', International Journal of Science, Engineering and Technology Research (IJSETR), Volume 3, Issue 5, ISSN: 2278 – 7798.

[2] Hari Kumar, and K. Thanushkodi (2009), 'The Era of Global Standard for SCADA Substation Automation', International Journal of Electronic Engineering Research ISSN 0975 - 6450 Volume 1 Number 3 pp. 245–257.

[3] A.Daneels and W.Salter, "*What is SCADA?",* International Conference on Accelerator and Large Experimental Physics Control Systems, Italy,(1999).

[4] Boyer, Stuart A. (2010),'SCADA Supervisory Control and Data Acquisition.' USA: ISA -International Society of Automation. p. 179. ISBN 978-1-936007-09-7.

[5] Li D, Serizawa Y, Kiuchi M. (2002), 'Concept design for a web-based supervisory control and data acquisition (SCADA) system.' Transmission and Distribution Conference and Exhibition2002: Asia Pacific. IEEE/PES; Vol. 1; p. 32–36.

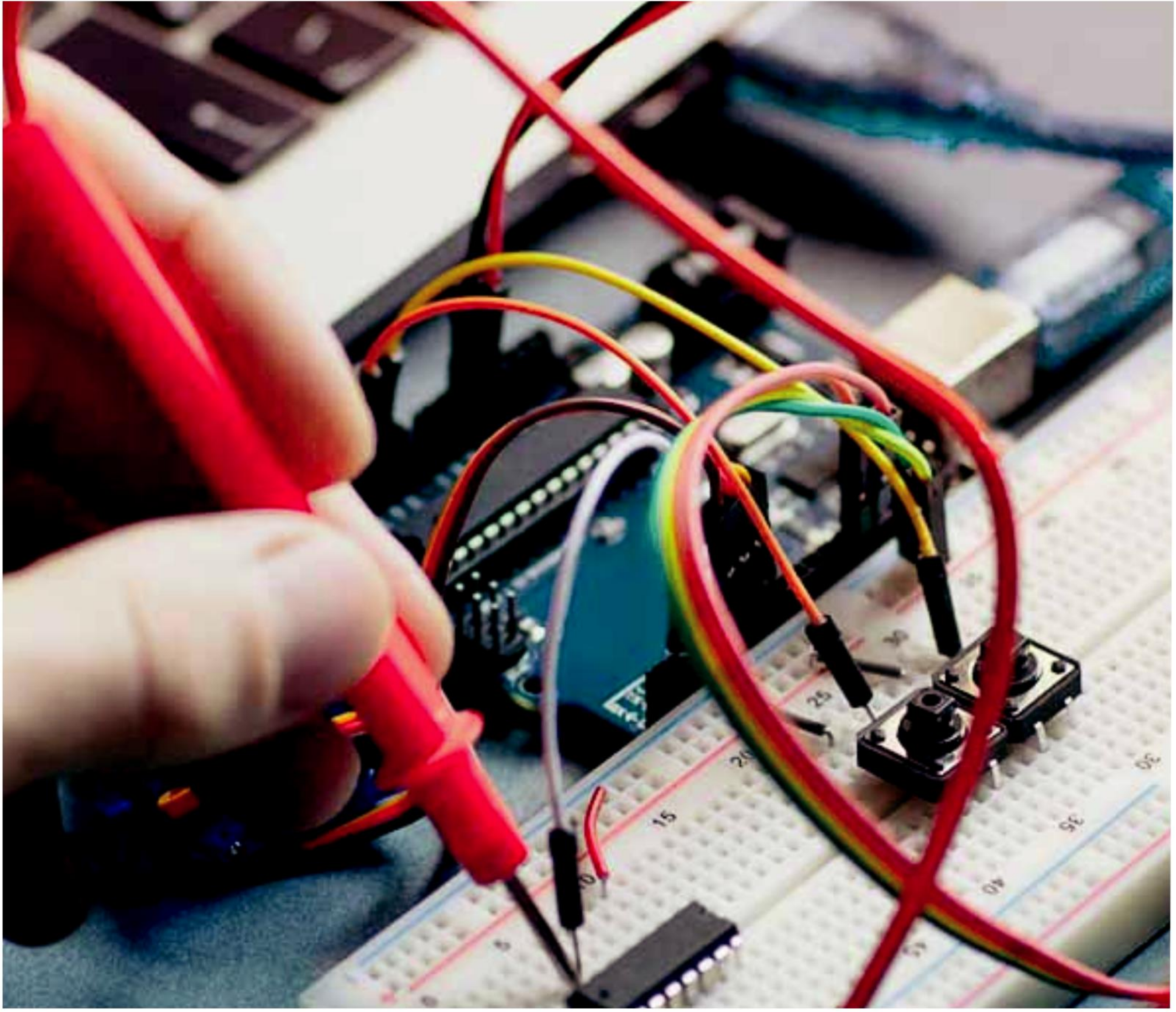
[6] M. K. Choi, R. J. Robles, E. S. Cho, B. J. Park, S. S. Kim, G. C. Park and T. H. Kim (2010), "A Proposed Architecture for SCADA System with Mobile Sensors", Journal of Korean Institute of Information Technology, vol. 8, no. 5, pp. 13-20.

[7] Jogi Jose, Christy P Varghese, Akhil Jo Abraham, Justin Joy, A.Koilraj (2017), 'Substation Automation System for Energy Monitoring and Control Using SCADA', International Journal of Recent Trends in Engineering & Research (IJRTER), Volume 03, Issue 04, ISSN: 2455-1457.

[8] MiCOM C264 RTU, https://www.se.com/ww/en/product-range-presentation/60784-micom-c264/.

[9] O9500R SDH Multiplexer, https://www.looptelecom.com/en/product/SDH-SONET-MSTP-Multiplexer/SDH-SONET-Multiservice-Access-Multiplexer-IMAP-O9500R .

[10] Schneider PM 5500 Power and Energy Meter, https://www.se.com/ww/en/product-range-presentation/61281-powerlogic-pm5000-series/.



International Journal of Advanced Research

in Electrical, Electronics and Instrumentation Engineering

9940 572 462 6381 907 438 ijareeie@gmail.com