

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 6, Issue 11, November 2017

Fault Diagnosis on Distribution System Using PLC & SCADA

Divyapradeepa T

Department of Electrical and Electronics, Rajalakshmi Engineering College, Chennai, India

ABSTRACT: This paper presents the FAULT DIAGNOSIS ON DISTRIBUTION SYSTEM USING PLC & SCADA which is used to monitor as well as diagnose condition of transformers, like load currents, transformer temperatures, voltages, oil level. The proposed on-line monitoring system integrates a solid state device named PLC (programmable logic controllers) and sensor packages. The suggested PLC monitoring system will help to detect the internal fault as well as external fault of transformer and also diagnose these faults with the help of desired range of parameters which is setting by programmer. A three phase line fault detection circuit provides visual indication and remote detection of the abnormal condition on electrical power distribution system. Whenever fault occurs on three phase line there is a need to detect the location, to reduce the patrolling time and clear the fault by communicating with area In-charge as soon as possible. This technology gives the exact location of fault and can able to isolate the damaged line. In this paper we describe a technique which is used to reach a strong conclusion about the power grid monitoring and controlling without manpower. It also describes the main purpose of monitoring switchyard and in power management of many relay and circuit breaker are used.the signal are given to the computer of the electricity board where there is electronic control unit with control sequence of disconnecting the load. SCADA the monitoring and control by computer is possible . If problem occurs, the relay will trip so we can easily identify the location and troubleshoot the problem through manpower and monitor the substation.

KEYWORDS: PLC, Schneider, SCADA, Transmission, distribution, faults, communication, substation, automation

I. INTRODUCTION

Most of power distribution or utility companies rely on manual labor to perform the distribution tasks like interrupting the power to loads & all parameter hourly checking .SCADA implementation in distribution reduce the manual labour operation & cost. The PLC & SCADA allows to detect the exact location of fault & without waiting SCADA gives an alarm system to the operators for identifying & prevent it. This technique is used to reach a strong conclusion of the power grid monitoring & controlling without manpower is SCADA. Much attention has been given to the use of PLCs (Programmable Logic Controllers) in substation and distribution automation applications in recent years. Innovative engineers and technicians have been actively seeking new applications for PLCs in substations and SCADA (Supervisory Control And Data Acquisition) systems. The manufacturers of PLCs have responded by developing new products that meet the unique requirements of substation automation and SCADA applications. PLCs are very cost competitive with traditional RTUs and have many benefits in substation automation applications. PLCs have an important place in substation automation and their use in substation applications will grow. As the use of PLCs in substation automation applications increases, and the demand for substation and distribution automation increases, utility engineers are seeking ways to implement applications. With deregulation, utilities are decreasing engineering staff levels. Utility engineers are required to field more projects with fewer available resources. The services of outside control system integrators, engineering firms or consultants are often called upon to meet the needs of the utilities. Selection of an outside firm is an important task of the utility engineer and the selection of the particular outside firm can determine the success or failure of a project.

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 6, Issue 11, November 2017

II. POWER SYSTEM

It is network of electrical components used supply transmit and distribute of electric power. Ex; grid (Supply Generate),Transmit (Terminate at load canters)& distribution system (feed to nearby home).Smaller power system we use in real like ups etc.

Generators: The device converts mechanical energy to electrical energy is called a generator. Synchronous machines can produce high power reliably with high efficiency, and therefore, are widely used as generators in power systems. A generator serves two basic functions. The first one is to produce active power (MW), and the second function, frequently forgotten, is to produce reactive power (MVAR).

Transmission Lines:The equipment connecting the generated electrical energy from the generation to the Distribution system is the transmission line. A transmission system is a massive interconnected network consists of mainly AC transmission lines with various high/extra high voltage levels. The main advantage of having higher voltage in transmission system is to reduce the losses in the grid. Electrical energy is transported from generating stations to their loads through overhead lines and cables. Overhead transmission lines are used for long distances in open county and rural areas, while cables are used for underground transmission in urban areas and for underwater crossings. Because the cost for cables is much more expensive than the overhead lines, cables are used in special situations where overhead lines can not be used. Since the majority of transmission lines are overhead lines, the discussion is limited to overhead lines only.

Transformers The main functions of transformers are stepping up voltages from the lower generation levels to the higher transmission voltage levels and stepping down voltages from the higher transmission voltage levels to the lower distribution voltage levels. The main advantage of having higher voltage in transmission system is to reduce the losses in the grid. Since transformers operate at constant power, when the voltage is higher, then the current has a lower value. Therefore, the losses, a function of the current square, will be lower at a higher voltage.

Benefits of using PLCs in substation automation

Reliability, a large installed base, extensive support resources and low costs are some of the benefits of using PLCs as a basis for substation automation and SCADA systems. PLCs are extremely reliable. They have been developed for application in harsh industrial environments. They are designed to operate correctly over wide temperature ranges and in very high electromagnetic noise and high vibration environments. They can operate in dusty or humid environments as well. The number of PLCs (in the millions) which have been applied in various environments has allowed the designers of PLCs to perfect the resistance to the negative effects of harsh environments. The large installed base of PLCs offers the advantages of reduced costs, readily available and low cost spare parts and trained personnel to work on PLCs. The large installed base also allows the manufactures more opportunity to improve design and offer new products for more varied applications. PLCs have extensive support throughout the US and most of the world. PLC manufactures have extensive of field offices, distributors and authorized control system integrators. Most technical schools and colleges offer courses in PLC application, programming and maintenance. In many, if not all, applications PLCs offer lower cost solutions than traditional RTUs for SCADA systems. They offer lower cost solutions than traditional electromechanical control relay systems for automated substation applications. With the lower cost solutions PLC based systems offer in substation and distribution automation applications along with the other benefits, it is no surprise that there is so much interest in the application of PLCs in substation.

POWER GRID SYSTEM: An electrical grid is an interconnected network for delivering electricity from suppliers to consumers. It consists of generating stations that produce electrical power, high-voltage transmission lines that carry power from distant sources to demand centers , and distribution lines that connect individual customers. Power stations may be located near a fuel source, at a dam site, or to take advantage of renewable energy sources, and are often located away from heavily populated areas. The electric power which is generated is stepped up to a higher voltage at which it connects to the transmission network. A substation receives its power from the transmission network; the power is stepped down with a transformer and sent to a bus from which feeders fan out in all directions across the country side. These feeders carry three-phase power, and tend to follow the major streets near the substation. As the distance from the substation grows, the fan-out continues as smaller laterals spread out to cover areas missed by the feeders. This

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 6, Issue 11, November 2017

tree-like structure grows outward from the substation, but for reliability reasons, usually contains at least one unused backup connection to a near by substation. This connection can be enable in case of an emergency, so that a portion of substation service territory can be alternatively fed by another substation.

All power system have three major components: Generation , Load and Transmission .

Generator: Creates electrical power

Transmission: Transmits electric power from transmission line to load.

Load: Consumes electric power

FAULTS: Electrical fault is the deviation of voltages and currents from nominal values or states. Under normal operating conditions, power system equipment or lines carry normal voltages and currents which results in a safer operation of the system. But when fault occurs, it causes excessively high currents to flow which causes the damage to equipments and devices. Fault detection and analysis is necessary to select or design suitable switchgear equipments,, electromechanical relays, circuit breakers and other protection devices.

Types of faults: There are mainly two types of faults in the electrical power system. Those are as following:

- 1) symmetrical and
- 2) unsymmetrical faults.

Symmetrical faults: These are very severe faults and occur infrequently in the power systems. These are also called as balanced faults

There are mainly two types namely

- 1) line to line to line to ground (L-L-L-G) and
- 2) line to line to line (L-L-L).

Analysis of these fault is easy and usually carried by per phase basis. Three phase fault analysis or information is required for selecting set-phase relays, rupturing capacity of the circuit breakers and rating of the protective switchgear.

Unsymmetrical faults: These are very common and less severe than symmetrical faults. There are mainly three types namely

- 1) line to ground (L-G),
- 2) line to line (L-L) and
- 3) double line to ground (LL-G) faults.

The Line to ground fault (L-G) is most common fault and 65-70 percent of faults are of this type. It causes the conductor to make contact with earth or ground. 15 to 20 percent of faults are double line to ground and causes the two conductors to make contact with ground. Line to line faults occur when two conductors make contact with each other mainly while swinging of lines due to winds and 5- 10 percent of the faults are of this type. These are also called unbalanced faults since their occurrence causes unbalance in the system. Unbalance of the system means that that impedance values are different in each phase causing unbalance current to flow in the phases. These are more difficult to analyze and are carried by per phase basis similar to three phase balanced faults.

Causes of Electrical Faults

• **Weather conditions:** It includes lighting strikes, heavy rains, heavy winds, salt deposition on overhead lines and conductors, snow and ice accumulation on transmission lines, etc. These environmental conditions interrupt the power supply and also damage electrical installations.

• **Equipment failures:** Various electrical equipments like generators, motors, transformers, reactors, switching devices, etc causes short circuit faults due to malfunctioning, ageing, insulation failure of cables and winding. These failures result in high current to flow through the devices or equipment which further damages it.

• **Human errors:** Electrical faults are also caused due to human errors such as selecting improper rating of equipment or devices, forgetting metallic or electrical conducting parts after servicing or maintenance, switching the circuit while it is under servicing, etc.

• **Smoke of fires:** Ionization of air, due to smoke particles, surrounding the overhead lines results in spark between the lines or between conductors to insulator. This flashover causes insulators to lose their insulating capacity due to high voltages.

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 6, Issue 11, November 2017

Effects of electrical faults

- **Over current flow:** When fault occurs it creates a very low impedance path for the current flow. This results in a very high current being drawn from the supply, causing tripping of relays, damaging insulation and components of the equipments.
- **Danger to operating personnel:** Fault occurrence can also cause shocks to individuals. Severity of the shock depends on the current and voltage at fault location and even may lead to death.
- **Loss of equipment:** Heavy current due to short circuit faults result in the components being burnt completely which leads to improper working of equipment or device. Sometimes heavy fire causes complete burnout of the equipments.
- **Disturbs interconnected active circuits:** Faults not only affect the location at which they occur but also disturbs the active interconnected circuits to the faulted line.
- **Electrical fires:** Short circuit causes flashovers and sparks due to the ionization of air between two conducting paths which further leads to fire as we often observe in news such as building and shopping complex fires.

Fault limiting devices

It is possible to minimize causes like human errors, but not environmental changes. Fault clearing is a crucial task in power system network. If we manage to disrupt or break the circuit when fault arises, it reduces the considerable damage to the equipments and also property. Some of these fault limiting devices include fuses, circuit breakers, relays, etc. and are discussed below.

- **Fuse:** It is the primary protecting device. It is a thin wire enclosed in a casing or glass which connects two metal parts. This wire melts when excessive current flows in circuit. Type of fuse depends on the voltage at which it is to operate. Manual replacement of wire is necessary once it blowout.
- **Circuit breaker:** It makes the circuit at normal as well as breaks at abnormal conditions. It causes automatic tripping of the circuit when fault occurs. It can be electromechanical circuit breaker like vacuum / oil circuit breakers etc, or ultrafast electronic circuit breaker.
- **Relay:** It is condition based operating switch. It consists of magnetic coil and normally open and closed contacts. Fault occurrence raises the current which energizes relay coil, resulting in the contacts to operate so the circuit is interrupted from flowing of current. Protective relays are of different types like impedance relays, mho relays, etc.
- **Lighting power protection devices:** These include lighting arrestors and grounding devices to protect the system against lightning and surge voltages.

- The combination of telemetry and data acquisition is referred as SCADA(Supervisory Control And Data Acquisition system). The SCADA encompasses the collecting of information via RTU(Remote Terminal Unit) relocating it back to central site carrying out decisive rehash and control and then displaying that information on a number of operating screens or displays. SCADA systems are highly distributed systems used to control geographically dispersed assets, often scattered over thousands of square kilo meters , where centralized data acquisition and control are critical to system operation. They are used in distribution systems such as water distribution and wastewater collection systems, oil and gas pipelines, electrical power grids, and railway transportation systems. A SCADA control centre performs centralized monitoring and control for field sites over long-distance communications networks, including monitoring alarms and processing status data. Based on information received from remote stations, automated or operator-driven supervisory commands can be pushed to remote station control devices, which are often referred to as field devices. Field devices control local operations such as opening and closing valves and breakers, collecting data from sensor systems, and monitoring the local environment for alarm conditions. A SCADA system gathers data from sensors and instruments located to remote sides. Then, it transmits data at a central site for controller monitoring process. Automation systems are used to increase the efficiency of process control by trading off high personnel costs for low computer system costs. These automation system are often referred to as process control system (PCS) or supervisory control and data acquisition (SCADA) systems, and the widespread use of such systems makes them critical to the safe, reliable, and efficient operation of many physical processes. The broad architecture of a SCADA involves physical equipment such as switches, pumps, and other devices able to be controlled by a Remote Telemetry Unit (RTU). The dual roles of the master computers are to provide the information such as meter readings and equipment status to human operators in a digestible form and to allow the operators to control the field equipment the master computers, and interface with the system using operator consoles which communicate with the master computers over a network.

- **PLC:** Programmable Logic Controller (PLC) or programmable controller is a digital computer used for automation of typically industrial electromechanical processes, such as control of machinery on factory assembly lines, amusement rides, or light fixtures. The Plc we used in this project is Schneider.

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 6, Issue 11, November 2017

SMPS: switched-mode power supply (switching-mode power supply, SMPS, switcher) is an electronic power supply that incorporates a switching regulator to convert electrical power efficiently. Like other power supplies, an SMPS transfers power from a source, like mains power, to a load, such as a personal computer, while converting voltage and current characteristics. Unlike a linear power supply, the pass transistor of a switching-mode supply continually switches between low-dissipation, full-on and full-off states, and spends very little time in the high dissipation transitions, which minimizes wasted energy. Ideally, a switched mode power supply dissipates no power. Voltage regulation is achieved by varying the ratio of on-to-off time. In contrast, a linear power supply regulates the output voltage by continually dissipating power in the pass transistor. This higher power conversion efficiency is an important advantage of a switched-mode power supply. Switched-mode power supplies may also be substantially smaller and lighter than a linear supply due to the smaller transformer size and weight. Switching regulators are used as replacements for linear regulators when higher efficiency, smaller size or lighter weight are required. They are, however, more complicated; their switching currents can cause electrical noise problems if not carefully suppressed, and simple designs may have a poor power factor.

SCADA and PLC COMMUNICATION

“PLC and SCADA Based Power Distribution Monitoring” the name itself says that the electrical parameters (voltage, current and power factor) can be monitored in Computer (PC) by using SCADA Software. In this paper the PLC works as a mediator between L.T. power distribution and PC at second level. PLC will collect data related to electrical power and build a link with the consumer side i.e. the Windows OS based PC then it gives the continuous power monitoring according to the used load on SCADA. PLCs are used in many industries and machines. PLCs are designed for multiple analogue and digital inputs and output arrangements, extended temperature ranges, immunity to electrical noise, and resistance to vibration and impact. Programs to control machine operation are typically stored in battery-backed-up or non-volatile memory. The functionality of the PLC has evolved over the years to include sequential relay control, motion control, process control, distributed control systems and networking. The data handling, storage, processing power and communication capabilities of some modern PLCs are approximately equivalent to desktop computers. 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.

Programming of PLC

Ladder logic

Ladder logic was originally a written method to document the design and construction of relay racks as used in manufacturing and process control. Each device in the relay rack would be represented by a symbol on the ladder diagram with connections between those devices shown. In addition, other items external to the relay rack such as pumps, heaters, and so forth would also be shown on the ladder diagram. See relay logic. Ladder logic has evolved into a programming language that represents a program by a graphical diagram based on the circuit diagrams of relay logic hardware. Ladder logic is 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. While ladder diagrams were once the only available notation for recording programmable controller programs, today other forms are standardized in IEC 61131-3

Experimental Results and Discussion: A considerable amount of effort is necessary to maintain an electric power supply within the requirements of various types of consumers without failure of system.

Sr. No	Component	Rating/Size	No. of Units
1	PLC	24 V DC	1
2	SMPS	240 AC/24DC	1
3	Indicator LED	24V DC	15
4	Toggle Switch	5A	15
5	Panel Board	2*2.5 ft ²	1

*Table 1: Components required

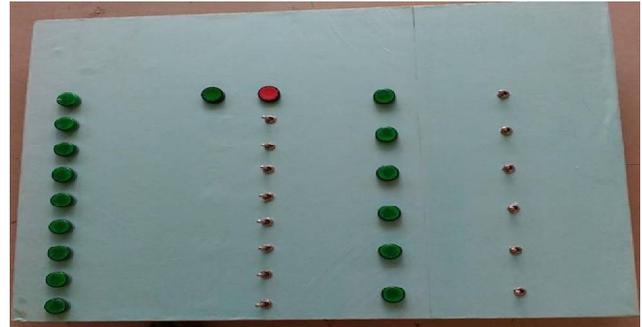
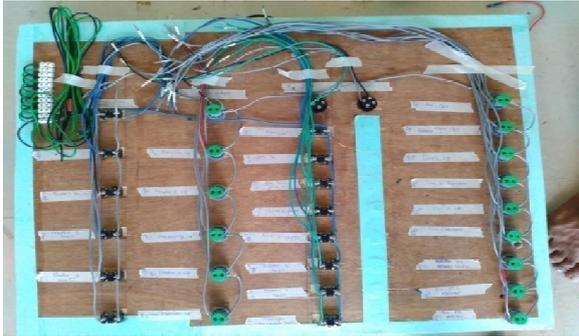
International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 6, Issue 11, November 2017

*Fig 1: Hardware connection:



Proper voltage: One important requirement of a distribution system is that voltage variations at consumer's terminals should be as low as possible. The changes in voltage are generally caused due to the variation of load on the system. Low voltage causes loss of revenue, inefficient lighting and possible burning out of motors. High voltage causes lamps to burn out permanently and may cause failure of other appliances. Therefore, a good distribution system should ensure that the voltage variations at consumers terminals are within permissible limits. The statutory limit of voltage variations is $\pm 6\%$ of the rated value at the consumer's terminals. Thus, if the declared voltage is 230 V, then the highest voltage of the consumer should not exceed 244 V while the lowest voltage of the consumer should not be less than 216 V.

Availability of power on demand: Power must be available to the consumers in any amount that they may require from time to time. For example, motors may be started or shut down, lights may be turned on or off, without advance warning to the electric supply company. As electrical energy cannot be stored, therefore, the distribution system must be capable of supplying load demands of the consumers. This necessitates that operating staff must continuously study load patterns to predict in advance those major load changes that follow the known schedules.

Reliability: Modern industry is almost dependent on electric power for its operation. Homes and office buildings are lighted, heated, cooled and ventilated by electric power. This calls for reliable service. Unfortunately, electric power, like everything else that is man-made, can never be absolutely reliable. However, the reliability can be improved to a considerable extent by interconnected system, reliable automatic control system, providing additional reserve facilities. The use of PLCs (Programmable Logic Controllers) in substation and distribution automation applications has grown in recent years. The economics of PLC based solutions mean that substation automation and SCADA solutions can be applied even more widely. This will help the utilities respond to the challenges presented by deregulation. As the use of PLCs in substations increases, the criteria for selection of control system integrators, engineering firms and consultants will become an extremely important factor in the success of PLC substation automation and SCADA projects. One of the most important criteria is that the control system integrator, the engineering firm or the consultant has sound business practices in place. They should also have a project management methodology in place to assure the success of these projects [9] This type of an automatic network can manage load, maintain quality, detect theft of electricity and tempering of meters. It gives the operator an overall view of the entire network. Also, flow of power can be closely scrutinized and Pilferage points can be located. Human errors leading to tripping can be eliminated. This directly increases the reliability and lowers the operating cost. In short our project is an integration of network monitoring functions with geographical mapping, fault location, load management and intelligent meter.

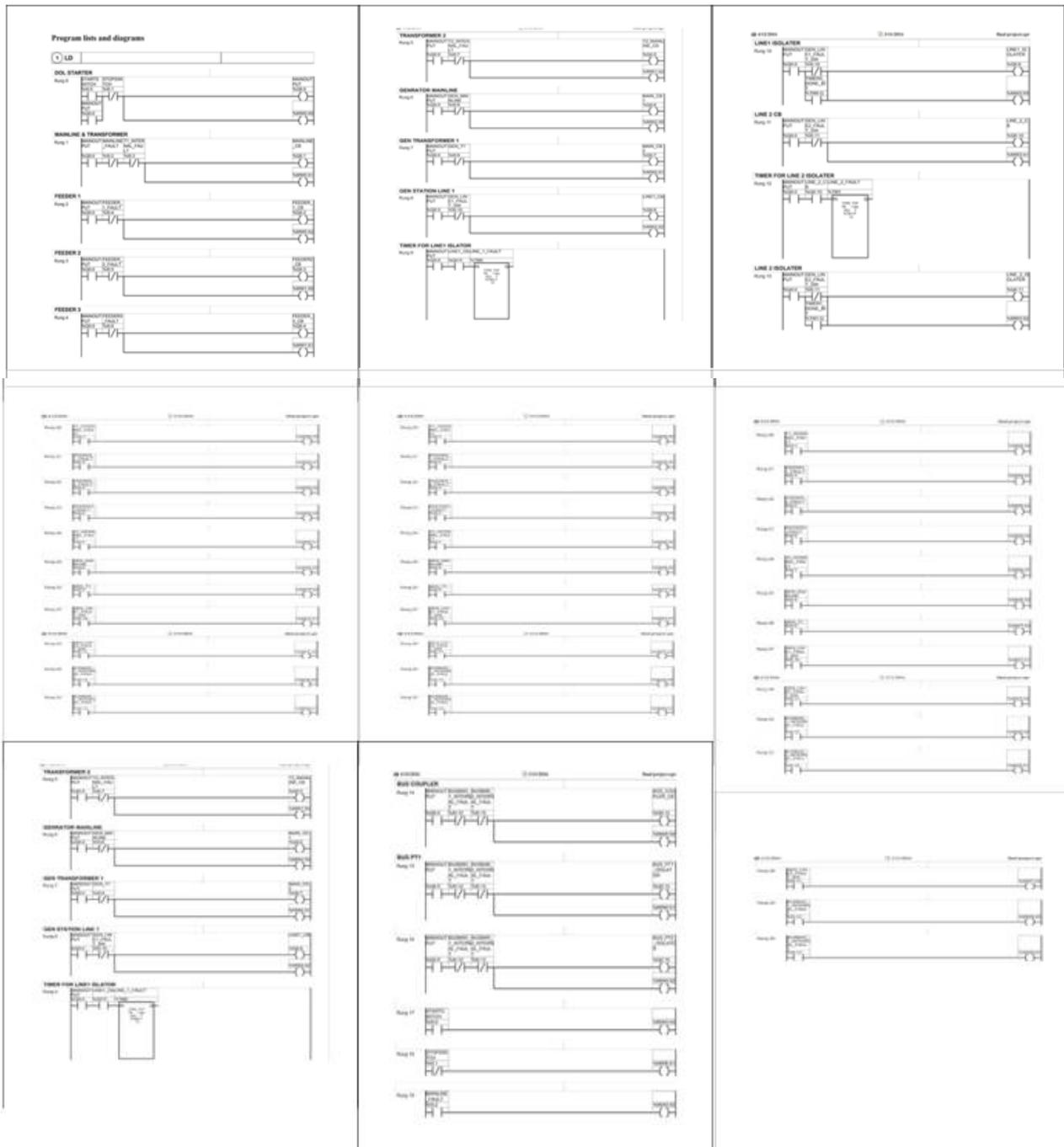
International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 6, Issue 11, November 2017

III. EXPERIMENTAL RESULT

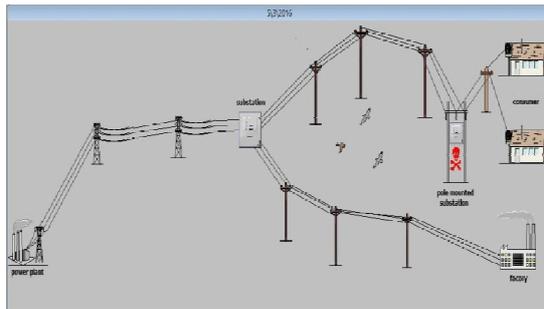


International Journal of Innovative Research in Science, Engineering and Technology

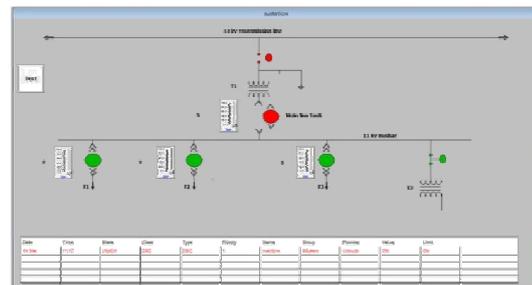
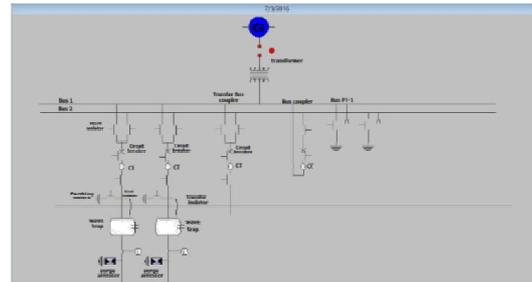
(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 6, Issue 11, November 2017



*Fig 2: Programming using ladder logic(screen shot of programming) Animation result:



*Fig 3: Animation using SCADA

IV. CONCLUSION

The use of PLCs (Programmable Logic Controllers) in substation and distribution automation application has grown in recent years. The economics of plc based solution mean that substation automation and SCADA solution can be applied even more widely. This will help the utility respond to the challenge present by deregulation. As the use of PLCs in substation increase, the criteria for selection of control system integrators, engineering firms consultant will become an extremely important factor in the success of plc substation automation and SCADA project. One of the most important criteria is that the control system integrator, the engineering firm or the consultant has sound business practice in place. They should also have a project management methodology in place to assure the success of these projects.

REFERENCES

- [1] Bhalija, B., R.P. Maheshwari. And N.G Chothani.
- [2] Protection and Switchgear', Oxford presss, 2012 p.p 160
- [3] Bakshi U.A., Bakshi M.v Protection and Switchgear', Technical Publication, Pune.
- [4] R.P singh, _Switchgear and Power System Protection, PHI learning pvt. Ltd, New Delhi,2009,.
- [5] Protective Relaying and Power Quality IEEE PSRC Working Group Report.



ISSN(Online): 2319-8753
ISSN (Print): 2347-6710

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 6, Issue 11, November 2017

- [6] Under voltage protection- definition, Available: <http://www.merriamwebster.com/dictionary/undervoltage%20protectin>
- [7] Book of Protection & Switch Gear by Bhavesh Bhalja  Wikipedia  Asian Journal of Scientific Research
- [8] International Journal of Scientific Research and Management studies(IJSRMS)ISSN: 2349-3771
- [9] NERC System protection and control subcommittee, power plant and transmission system protection coordination, July 2010
- [10]Hemant Ahuja, Arikha Singh, Saubhagya Tandon, Shreya shrivastav, Sandeep Patil, “ Automatic Filling Management System For Industries’’ IJETAE, Vol. 4, Special Issue 1, February – 2014
- [11]. Nabil Shaukat, “A PLC Based Automatic Liquid Filling Process”, IEEE, publication page No. 226-233, 2002.
- [12]. Ahmed ulla Abu Saeed, Md. Al-mamun, A.H.M. Zaidul Karim, “ Industrial Application Of PLCs in Bangladesh’’ IJSER, Vol. 3, Issue 6, June 2012
- [13]. Gray Dunning, “Introduction to programmable Logic Controllers,” Delmar ThomsonLearning1998.