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Automation in Substation using Programmable Logic Controller (PLC)

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Abstract – *Power consumption and generation are increasing day by day as part of global growth. There is always some problem in network of power system, even though there is scheduled and skilled maintenance. It is not possible for the human being and repairs everything in power system in fraction of time. Due to this, automation is required in this particular area. This can be achieved by Programmable Logic Controller (PLC) and Supervisory Control and Data Acquisition System (SCADA). In this paper using indralogic PLC software, substation system has been made to operate automatically and handled fault correctly without any human intervention. In future it will be very helpful for independent electricity generators and users.*

***Key Words*:** *PLC, Substation, Indralogic software, Isolators, circuit breakers*

1. INTRODUCTION

As the power consumption increases globally, unpredicted challenges are being faced, which require modern, sophisticated methods to counter them. This calls for the use of automation in the power system. The PLC (Programmable Logic Controller) and SCADA (Supervisory Control and Data Acquisition System) are an answer to this. PLC on the other hand is like the brain of the system with the joint operation of the SCADA and the PLC, it is possible to control and operate the power system remotely. Tasks like opening of circuit breakers, changing transformer taps and managing the load demand can be carried out efficiently.

This type of an automatic network can manage load, maintain quality, and 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 cost of operation.

In this paper there is an intelligence switching and monitoring action like fault location, load management is performed.

Much attention is given to the use of PLCs in substation and distribution automation system in recent years. The manufacturers of PLCs have responded by developing new products that meet the unique requirements of the substation automation and SCADA applications. PLCs are very cost competitive with RTUs and have many benefits in substation automation applications. PLCs have an important place in substation automation and their use in substation application will grow.

As the use of PLCs in substation automation applications increases and the demand for substation and distribution automation increases. PLC programs are typically written in a special application on a personal computer, and then downloaded by a direct connection cable or over a network to the PLC. Automatic substations took leading concept in conservation of energy. Whenever there occurrence of fault there is automatic cutting of supply and by this we can prevent losses and damage to the loads.

2. PLC ARCHITECTURE:

According to the definition of NEMA (National Electrical Manufacturer's Association) standard IC S3-1978, a PLC is a digitally operated electronic device which uses a programmable memory for the internal storage of user oriented instructions for implementing specific functions such as, logic, sequencing, timing, counting, arithmetic to control through digital or analog modules, various types of machines or process. Typical Architecture of PLC is shown in fig 2.1.

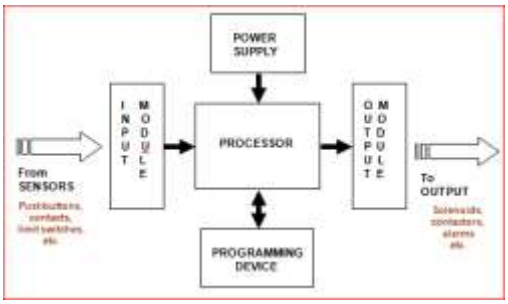

Fig2.1: Architecture of PLC

2.1 Major components of PLC:

Processor: It provides intelligence to command and govern the activities of the entire PLC systems. The processors (commonly called as CPU), as in the self contained unit, is generally specified according to memory required for the program to be implemented. The processor consists of the microprocessor, system memory, and serial communication ports for printer, PLC LAN link and external programming device.

I/O modules: It provides signal conversion and isolation between the internal logic level signals inside the PLC and the field's high level signal. Input and output modules are

specified according to the input and output signals associated with the particular application. Modules can be fall in to the categories of the discrete or analog. Discrete I/O modules are generally capable of handling 8 or 16 and, in some cases 32, on-off type inputs or outputs per module. The module can be specified as AC only, DC only or AC/DC along with the voltage values for which it is designed. Analog I/O modules are available and are specified according to the desired resolution and voltage or current range. Analog modules are also available which can directly accept thermocouple inputs for temperature measurement and monitoring by the PLC.

Power supply: Power supply provides voltage needed to run the primary PLC components. It depends on the manufacturer's PLC being utilized in the application. In some cases a power supply capable of delivering all required power for the system is furnished as part of the processor module. If the power supply is a separate module, it must be capable of delivering a current greater than the sum of the currents needed by other modules.

Programming device: Used to enter the desired program that determines the sequence of operation and control of process equipment or driven machine. The programming unit allows the engineer or technician to enter and edit the program to be executed. It can be a hand held device with a keypad for program entry and a display device (LED or LCD) for viewing program steps. More advanced systems employ a separate personal computer which allows the programmer to write, view, edit and download the program to the PLC, accomplished with the proprietary software available from the PLC manufacturer. Communication with the programmable controller with this system is via a cable connected to a special programming port on the controller.

3. CONNECTION DIAGRAM AND WORKING METHODOLOGY

Electrical substations usually have generators at generation side, isolators, circuit breakers, transformers, and loads at consumer side. As an when we are started utilizing the generated energy, there is a possibility of lot of disturbances like overvoltage, over current, thunderstorms and many things which may go beyond our control. Therefore, automatic controlling system is required, so that consumer can use energy without any intervention.

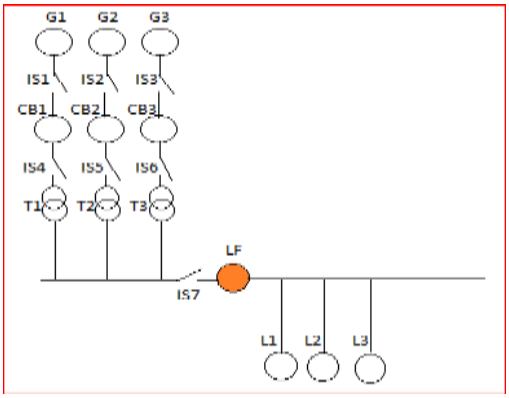

Fig.3.1 Connection diagram of sample substation

The single line diagram of the proposed system has shown in Fig.3.1 as shown above. Here three generators are connected to three circuit breakers through isolators. Circuit breakers are then connected to transformers through isolators to protect the transformers. All transformers are connected in parallel. IS7 is isolator which is connected to fault indication lamp. Other end of circuit is connected to the light loads of consumers. Whenever there is occurrence of fault, LF will glow and make IS7 to open to protect the transformers. Another case is, if fault occurs on generation side, with the help of sensors, isolators and circuit breakers will get opened to protect the healthy part of the substation. The entire operation is fully automated using PLC.

3.1 LADDER DIAGRAM:

The IndraLogic ladder diagram for the sequential operation of the system has to be built and through Ethernet cable, it is connected to PLC kit. The conditions for the working operation of this projects are, first supply should be ON and circuit run by default condition. Initially all isolators are connected and G1, CB1 will simultaneously gets ON. Switch ON T1 then L1 will ON. Switch ON T2 then L2, G2, CB2 will simultaneously ON. Switch ON T3 then L3, G3, CB3 will simultaneously ON. Switch ON TF then LF, buzzer ON and all circuit breakers are turned OFF. In the case of T1 and T2 or T1 and T3 or T2 and T3 are ON then from G1 or G2 or G3 there will be two either G1 and G2 or G1 and G3 or G2 and G3 will operate at the same time respectively.

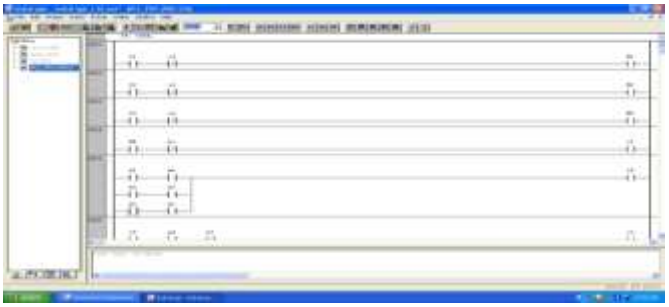

Fig.3.2 : Before running mode

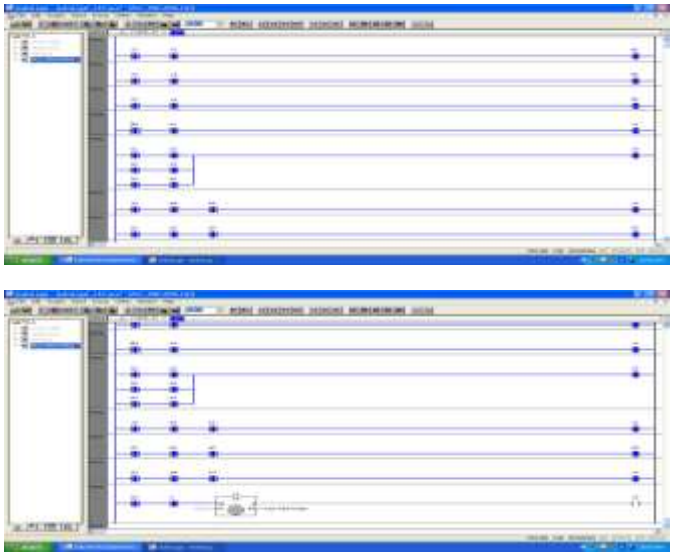

Fig 3.3: In running mode

Fig 3.4: Fault condition

4. CONCLUSION

Now a day's automation is in leading area which can be utilized in most of the areas and one of the most important areas is substation. In substation whenever there is occurrence of fault during transmission the direct effect will be on loads, i.e. damages to the load. To open the circuit breakers manually it needs some time and lot of energy is wasted. To overcome these problems automation in substation will bring improvements in transmission and distribution system. Using Indralogic PLC software we can programmed and tested by assuming all possible modes and conditions

5. REFERENCES

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6. BIOGRAPH

Miss. Savita C. Kundargi was born on 20th June 1993 in Arakeri, Bagalkot district, Karnataka, India. She has completed B.E in Electrical and Electronics Engineering from "Basaveshwar Engineering College (Autonomous)", Bagalkot in 2015. She completed M.Tech in Power and Energy Systems from the same college in 2017. She served as Assistant Professor in SECAB Institute of Engineering and Technology, Vijayapura, Karnataka, India from 2017 to 2019. Currently she is working as a lecturer in B.V.V.S Polytechnic (Autonomous), Bagalkot, Karnataka, India. Her areas of interests are power and energy systems, Renewable energy sources, SCADA and PLC.