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Automation of 11kv Substation using PLC and SCADA at GNDEC, Ludhiana: A Case Study

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***Abstract*-. The paper presents the use of SCADA (Supervisory Control and Data Acquisition) and PLC (programmable logic controller) in substation for the purpose of automation. At the substation the power is managed between the generator set and the main incomer supply. In the power management, the control of low voltage and turn on the generator set automatically which is installed at the substation in case of low voltage and monitors all electrical parameters on PC by using SCADA is done. PLC is a programmable logic controller which controls the voltage in substation. SCADA define as a centralized system that control and monitor the whole substation. SCADA system interact with PLC for the implementation of whole process. The application implemented in PLC is on ladder logic using unity pro software and SCADA software used is vijeo citect .**

Keywords— *SCADA and PLC.*

I. INTRODUCTION

Substations forms a very important node in the transmission and the distribution of electrical power system. Substation is the most important part of the power system, also needs automation. The main function of substation is to receive energy transmitted at high voltage from the generating station to a value appropriate for local distribution and provide facilities for switching. A substation is the convenient place for setting up the synchronous condenser at the end of transmission line for the purpose of power factor improvement. The combination of all the equipments which are used to change the characteristics (e.g. voltage, frequency, p.f, etc.) of electrical supply is known as substation.

Automation is the process of automatically controlling the process parameters in the plant with the help of automation devices. In the beginning, process at the plants was supervised manually based on the instrument installed in fields. This requires the plant supervisor to be placed in plant at all time. But the automation has helped to overcome this problem. Now, in global economy automation plays increasingly important role. Automation doesn't necessarily imply computerization, it can be pneumatic, mechanical, electronic or combination of all these. It is not only a part of industry today. The process in the substation includes the data acquisition, supervision of power system, and control of power system equipments. All these processes work collectively in a coordinated automatic mode. The signals or the message is produced automatically and then delivered in the same manner as the field supervisor provided commands.

Automation at the substation is done by the use of programmable logic controller (PLC) and supervisory control and data acquisition (SCADA) instead of electromechanical devices. As the technology advances the human involvement become less and degree of automation will correspondingly get greater. Now, in global economy automation employs an increasing important role in our daily life.

II. PLC AND SCADA

PLC is a solid state device stands for Programmable Logic Control. The function of the PLC is to performs the various logic function previously accomplished by the devices such as electromechanical relays, switches for the control and operation of equipment. It is control system designed for the automation. The PLC is real computer in which it is capable of receiving data via inputs their sending commands by its output Even though the electromechanical relay have served good for many generation, often under adverse condition, but the devolpment of modern technology equipments requires faster response, which electromechanical relays cannot offer. Most of the PLC programmed works on the "on" and "off" state and these corresponds to true or false in logical form and 0 and 1 in binary form. There are different types of PLC available in market such as Siemens, Schneider, Omron etc. we are using the Schneider PLC for the automation purposes because the simulation can be done without connecting the PLC but this is not possible in case of Siemens. PLC can transfer collected data to other devices and receive data and control commands from various devices by a serial port. There are also different types of the Schneider PLC which are as under:

a. Twido PLC
b. ZELIO PLC
c. M340 PLC

Among the different types of PLC we are using M340 PLC as it has many advantages over the Twido and ZELIO PLC. In the M340 PLC we can increase the number of input and output by increasing the number of racks. A PLC can be programmed to sense, control and activate various equipments. Thus, PLC includes a number of input output points which allow interfacing of electrical signals. First the input and output components are connected to PLC and then the control program is loaded onto PLC memory.

SCADA

SCADA is abbreviated as Supervisory Control and Data Acquisition. SCADA is defined as the system that gathers data or information from different devices located at, plant and then send this information to computer.SCADA is nothing but the graphical representation of automation. It is large scale control system for automated process. SCADA in the power system is defined as under:

Data Acquisition: Acquisition of data means to collect or gathering the information. The collected information is in type of measured values of current or voltage and the status of various equipments. The gathered information is being used locally or sent to another device for use by operator for the future planners.

Supervision: The operator or substation supervisor monitor and supervise the condition and the status of various electrical or substation equipment through this collected data. Substation supervisor engineers monitor the information on computer screens.

Control: Control means giving commands to various devices to perform operation on them. Traditional SCADA systems depend on supervisor to supervise the system and generate signals The devices in the substation can be controlled by the field supervisor through push buttons or a laptop computer.

Devices in SCADA system are:

a) Human Machine Interface (HMI) or MMI (man machine interface) is the device by which the processed data is presented to the any person or operator. With the help of this processed data the person is monitor, control and interacts with the process. The PLC or the MMI can transfer and collected and receive data from various devices by the use of programming through serial port.
b) Remote terminal unit (RTU) is a device connected to the controlled process. With the help of RTU we can read inputs, make decision and produce output signal. Like PLC RTU also have the control capabilities in ladder logic in order to accomplished Boolean logic operations.
c) Communication infrastructure coupled the various components to SCADA system.

The main advantages of using SCADA are:

a. Real-time monitoring
b. Increased equipment life,
c. Easy faultfinding
d. Ease of maintenance

This paper consist of five sections. Section I gives the introduction. Section II deals with the PLC and SCADA. Section III deals with the problem formulation; section IV Deals with the methodology employed ; section V deals with results and section VI deals with conclusion.

III. PROBLEM FORMULATION

The literature review reveals that researches faced difficulty in the substation using conventional methods like manual supervision, hardwired control etc. Because in manual supervision of the equipment it required a supervisor to be placed in close locality of substation and turn on the generator manually when the incomer voltage to the substation is low. In manually supervision the chances of errors are more. Hardwired systems were too bulky to be designed. These difficulties are over come by using PLC and SCADA. At the substation major problems is that when the incoming voltage to the substation is low the existing system will not detect the low voltage and will not turn on the generator automatically as it leads to poor performance of various equipments. Main objective of the work:

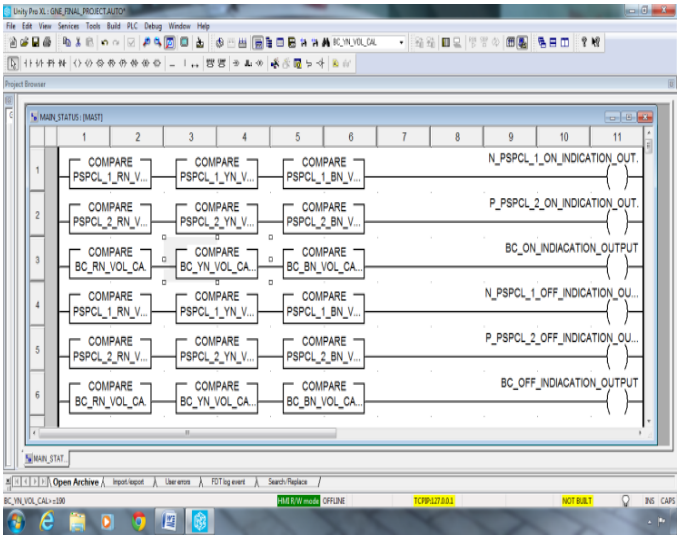
1. Automatic on the generator when the voltage is low.
2. Automatically monitoring all the electrical parameters of the substation like the phase to phase voltage, current, kilowatt hour consumption on PC.

IV. METHODOLOGY

First of all existing set up is to be studied The choice of PLC regarding its input and output is to be considered. The ratings of PLC is M340. The PLC is programmed according to the network. The ladder programming for PLC is being used for various operations and introduce in the thesis work. So the SCADA is studied in general and implemented for online monitoring of substation. Vijeo citect software is being used for the SCADA and unity pro software is used for PLC programming.

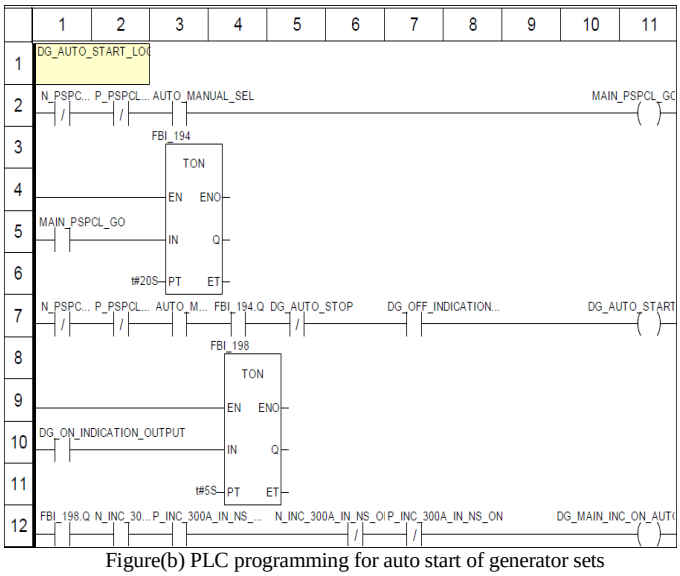
a. Simulation

After studied the different PLC we are using the M340. The PLC will work according to ladder diagram. The main features of M340 PLC is that online and offline modification can be done.

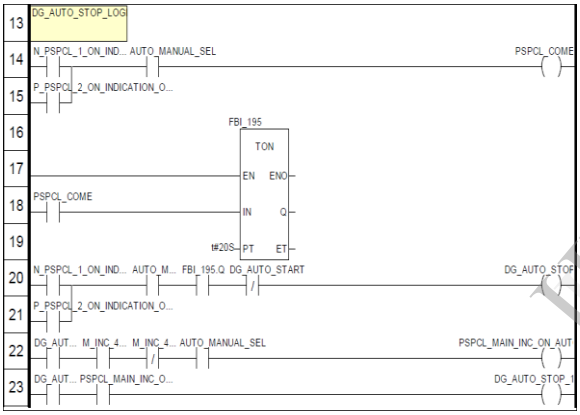


FIGURE(a) PLC programming for the detection of low Voltage

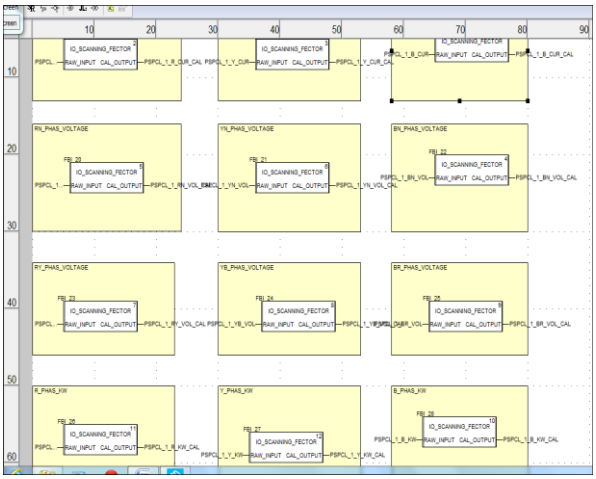
In the figure (a) the programming is done to compare the voltage between the different phases.



Figure(b) PLC programming for auto start of generator sets



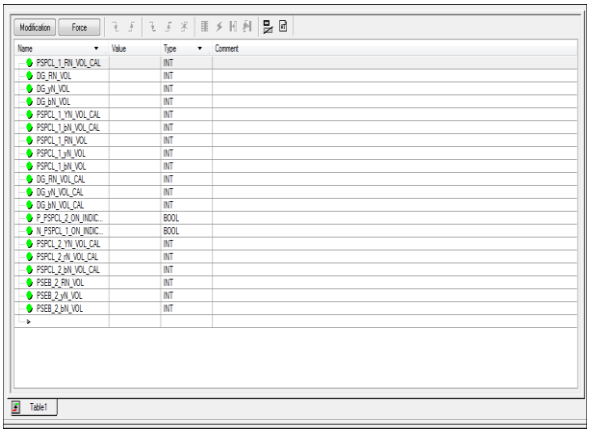
Figure(c) PLC programming for auto stop of generator sets.



Figure(d) programming for the monitoring of electrical parameters

Animation Tables

The animation table is used to display the values of the variables used in the programming. To run the program without connecting the PLC, the values of various parameters are forced into the animation table. With the help of these values we can run the project in the software part. The values of all the variables or the parameters are of integer type or bool type values.



b. SCADA SCREEN

Vijeo citect software of SCADA is used for the online monitoring and control of various electrical parameters. Window overview of SCADA Software:

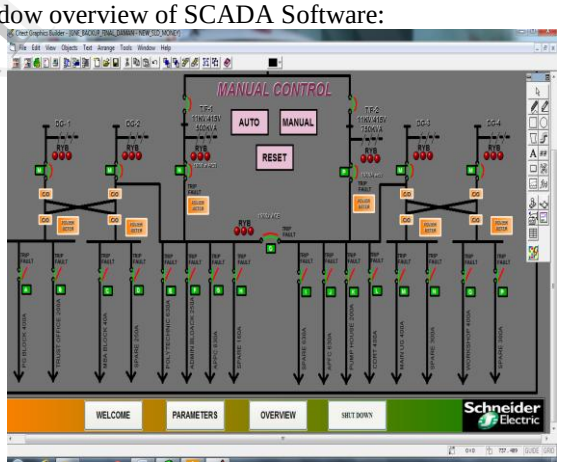
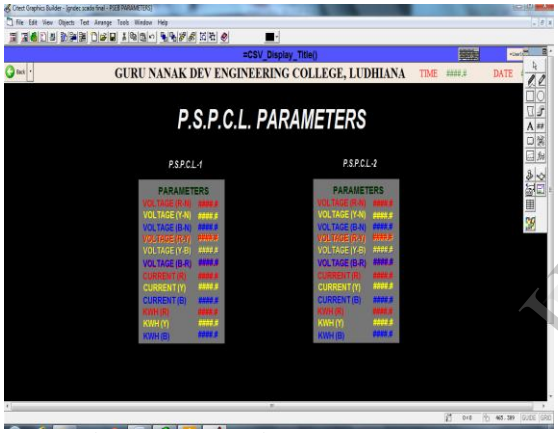


Figure (e) SCADA screen of substation

In figure(e) When we select auto mode automatic mode the whole operation i.e. control and monitoring of substation equipments starts working in the automatic mode. This auto mode shows the various equipment installed at the substation. From this the auto and the manual operation is set down for the equipments. The fig (e) shows the power management system in which generator will operate automatically after the mains failure. The system is controlled & monitored by operator using SCADA. The substation is running on PSPCL's main supply which is continuously being monitored by its meter. After the mains power failure, ACB of PSPCL supply goes off automatically. If the meter's value is zero or is less than 150v, the generator set will automatically gets on. Each generator set will have 2 change overs viz; 1 for PSPCL (position 1) and 1 for generator set (Position 2). After the

mains failure or when it detects the low voltage the change over at position 1 will goes off and the change over at position 2 will be on. By this the generator set will operate automatically & the electricity will be supplied to their destination point's. As the whole process is in automation so it takes a few seconds to power up the appliances after the mains failure. Voltage readings of the generator sets will be shown on their individual meters. The Change over are used to switch the light from PSPCL to generator sets & vice versa. When the PSPCL supply is back, DG sets will check for fluctuations for 10 seconds, and then compares the voltage between the phases and then the ACB of the generator set goes off & after another 5 seconds the generator set will go off & the PSPCL supply will operate the whole process. In this, we are using 4 generator sets. Operation of all generator will be same. By this our power is managed between PSPCL & generator set's supply. You can easily operate the breakers & can visualize the status on SCADA screen. You need not to control the whole process manually. We can easily check the voltages & loads of different phases as all the parameters of the energy meters will be displayed on the SCADA screen.



Figure(f) SCADA screen of incoming supply voltage

In figure (f) the readings of the meters like phase to phase voltage, cureent values ,kwh consumption are shown on SCADA screen.

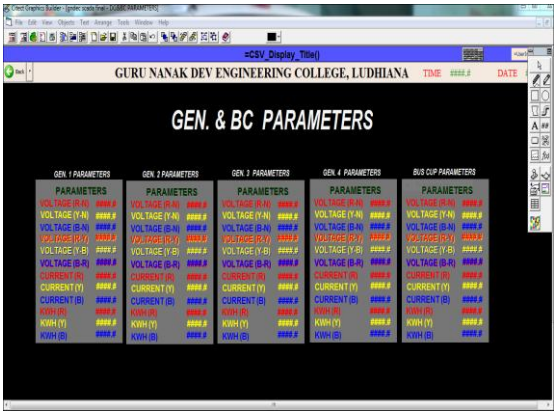


Figure (g) SCADA screen of generator and bus coupler parameters

From the above figure we can read the values of voltage , current etc. The values which are displayed on the SCADA screen is only of the generator which is ON.

RESULTS:

The proposed system is designed for the management of the voltage between the generator set and main incomer supply and automatic detection of low voltage at the substation, so that we can reduce poor performance of lights, fans, computers etc and for the online monitoring of the various electrical parameters.

CONCLUSIONS

1. Automatic or the manual control is possible.
2. The substation automation approach is very reliable, user friendly using PLC and SCADA. The traditional approach towards this concept posed various problems and it requires the substation supervisor to be placed in the closed vicinity of the substation. The automatic control overcomes all these difficulties.
3. Only pressing a single switch on the control panel the whole substation will operate automatically.
4. Speed of the operation of the equipments also increases.
5. Fault tracing in any part become quite easy.
6. Ease of maintenance.
7. The unity pro software uses ladder language which can be easy understood by any person.

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