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Role of Controlling of Substation Using PLC And SCADA

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Abstract- An electrical substation is a subsidiary station of an electricity generation, transmission and distribution system. In electrical network there are always possibilities of faults. Hence the current and voltage to a substation require regular monitoring and control. This project proposes a novel solution to both the above requirements. In this project a SCADA systems will be designed using RS VIEW 32, using which all the parameters of a substation like current, voltage, temperature and flow of coolants in transformers etc can be monitored and automatically controlled from a distant location. These are connected to a PLC at the substation.

Keywords: SCADA, PLC, substation.

1. INTRODUCTION

This paper presents a sub-station automation system as an integrated system for the digital and analog automation of distribution sub-station, customers and user functions (engineers & technicians). Faults caused by over-current, earth leakage current and other disturbances create interruptions of electricity supply to the customers. The engineers and technicians have to manually locate the fault point and spend plenty of time and this tedious work may last for extend periods of time. After the introduction of fault management, the fault is detected by energizing section by section of distribution line until the protective relay trips the feeding circuit breaker of the fault zone. These operations are mostly based on manual and automatic operations. The advent of PLC and the introduction of numerical relays have improved the function of fault management system. Now it is possible to record the fault currents at the feeding distribution substations and the restoration process is also done automatically and is accelerated faster.

1.1 Programmable logic controller (PLC)

PLC or Programmable Logic Controller is a user friendly, microprocessor specialized computer that carries out control functions of many types and levels of complexity. Its purpose is to monitor crucial process parameters and adjust process operations accordingly. It can be programmed, controlled and operated by a person unskilled in operating computers. Essentially, a PLC's operator draws the lines and devices of ladder diagrams with a keyboard onto a display screen. The resulting drawing is converted into computer machine language and run as a user began in the 1970s, and has become the most common choice for manufacturing controls. Programmable Logic program.PLC will operate any system that has output devices that go on and off (Discrete, or Digital, outputs). It can also operate any system with variable (analog) outputs. The Control engineering has evolved over time. In the past humans A was the main method for controlling a system. More recently electricity has been used for control and early electrical control was based on

relays. These relays allow power to be switched on and off without a mechanical switch. It is common to use relays to make simple logical control decisions. The development of low cost computer has brought the most recent revolution, the Programmable Logic Controller (PLC). The advent of the PLC Control can be operated on the input side by ON/OFF devices or by variable (analog) input devices. The ubiquitous Programmable Logic Controllers (PLC) is now finding several applications in the management of assets in a substation. As most electrical equipment lend themselves to embedded devices acting as intelligent interfaces, PLCs are used in the substation to manage transformers, voltage regulation, automatic transfer schemes, custom/automatic reclosing schemes, automatic service restoration, remote control, system diagnostics maintenance

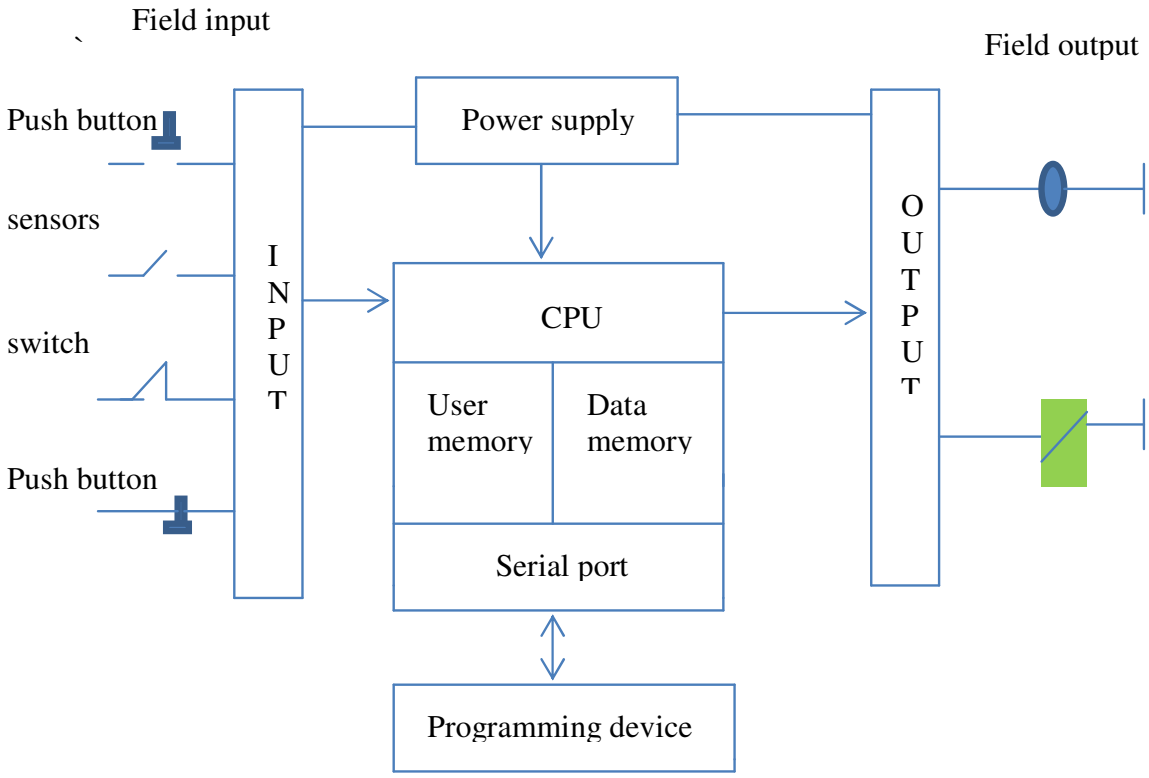

Fig. 1: Internal Block Diagram of PLC

1.2 Supervisory control and data acquisition (SCADA)

In recent years, the supervisory control and data acquisition (SCADA) system has been widely used in power system for power parameters recording, monitoring and switches control. The function of SCADA in power system application composes the recording and analysing of power measurements, operating status monitoring, and the execution of control action of switched equipment and load. In general, SCADA system consists of host in control station, communication network, and remote terminal unit in hardware as well as data base, control software, and application programs for software. With the advancement of programmable logic controller in communication and analog data treatment technology, more PLC based control systems are applied to power system to fulfil major functions of load control, on load transformer tab setting, data collection etc. in SCADA system.

Supervisory Control and Data Acquisition systems are computers, controllers, instruments; actuators, networks and interfaces that manage the control of automated industrial processes and allow analysis of those systems through data collection. They are used in all types of industries, from electrical distribution systems, to food processing, to facility

security alarms. Supervisory control and data acquisition is used to describe a system where both data acquisition and supervisory control are performed. Mobile Supervisory Control and Data Acquisition (referred to as Mobil SCADA) is the use of SCADA with the mobile phone network being used as the underlying communication medium. GSM is a wireless communication technology; most popular today for transmitting data anywhere in the world through SMS with the help of mobile phones. General Packet Radio Service (GPRS) is chosen as the specific mobile communication protocol to use as it provides an always on-line Inter connection without any time based charges. SMS is a globally accepted wireless service that enables the transmission of alphanumeric messages between mobile subscribers and external systems such as electronic mail, paging, and voice-mail systems. It is a store and forward way of transmitting messages to and from mobiles. SMS benefits includes the delivery of notifications and alerts, guaranteed message delivery, reliable and low cost communication mechanism for concise information, ability to screen messages and return calls in a selective way and increased subscriber productivity.

1.3 ***Basic Structure of PLC and SCADA***

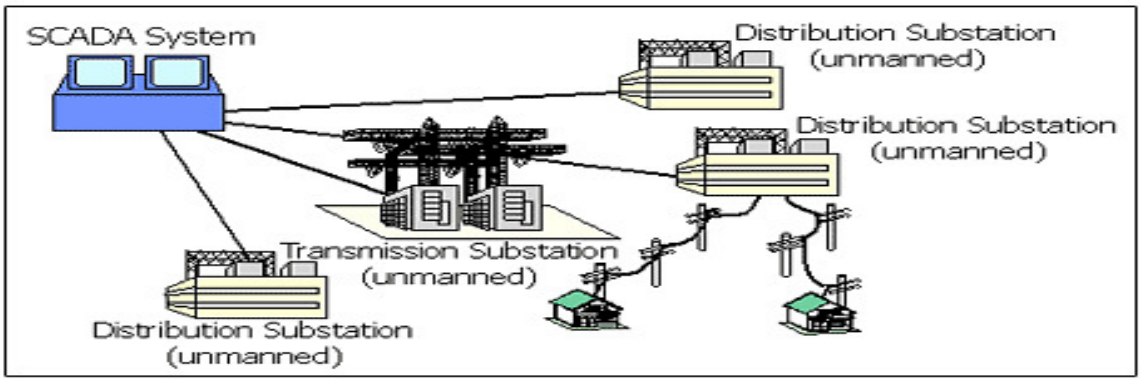

Fig. 2: Basic Structure of SCADA System

2. Methodology and Implementation

2.1. Block Diagram Explanation

Voltage from potential transformer and current from current transformer are given to the signal conditioning circuit where voltage and current signals are rectified and converted into required signal input for PLC Pressure and temperature signal from pressure sensor and temp sensor respectively are directly given to the PLC. The signals are compared in the PLC. & a connection from the PLC is given to the Relay which switches the circuit as per requirement.PLC is interfaced with a computer where the real time and history data is observed and stored.

3.1. Circuit Diagram

In the circuit diagram the two instrumentation transformer are used in which one is potential transformer (above) and another one is current transformer (below) on the left side of the programmable logic controller (PLC).which are used to step down voltage(230/9)V and current(3-4)A magnitude values of the single phase 50HZ alternating current supply.

Followed by the stepped down output of the instrumentation transformer are fed into the "bridge rectifier", where an alternating voltage and current are converting into the pulsating unidirectional direct current. And then the pulsating D.C is filtered using capacitor (63V, 1000µF for voltage & 25V, 1000µF for current) filter which are connected across the bridge rectifier. Here the ripple of the pulsating D.C is 80-90% is removed. Followed by the potentiometer are connected across the filter which can be used to vary or adjust the filtered one quantity. And then the small value capacitors (104µF) are used across the potentiometer to get smooth and noise free output. And then a zener diode are connected in reverse biased mode across the PLC input terminal, which protect the signal conditioning circuit from the reverse current. One another rectifier and signal conditioning circuit is used with the same function and circuit element, as explained above, to provide the working or biasing voltage (power) to temperature sensor (LM35) & relay circuit. The 9V batteries are used to provide biasing voltage to the pressure sensor (MP3V5050). The all four inputs such as current, voltage, pressure and temperature are fed into the PLC, where PLC compares the real time data of all the inputs with the predefined values, which are set in the ladder diagram program. And depending upon the programmed conditions the PLC generates the control output which is fed into the relay and relay trips it's coil(either closing or opening it's contact) in order to protect the devices(load, appliances) etc. which has to protect.

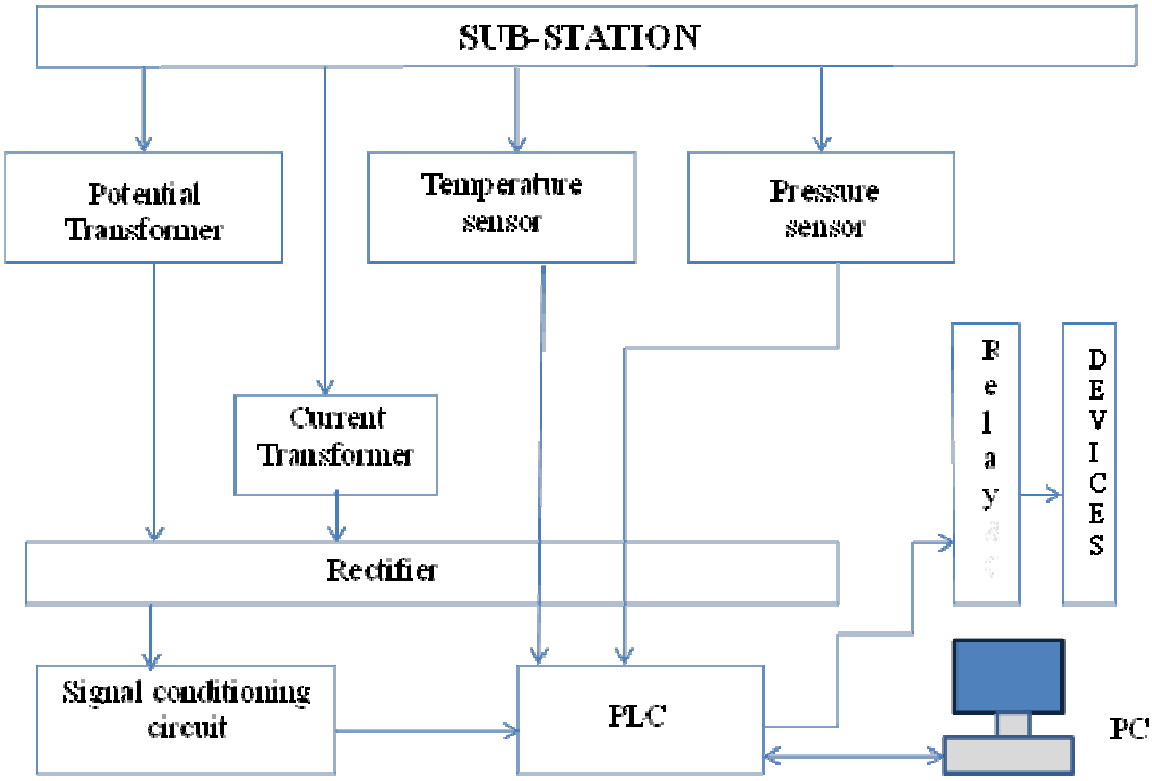

Fig.3: Block Diagram of Automation of the Sub-Station

3. Implementation

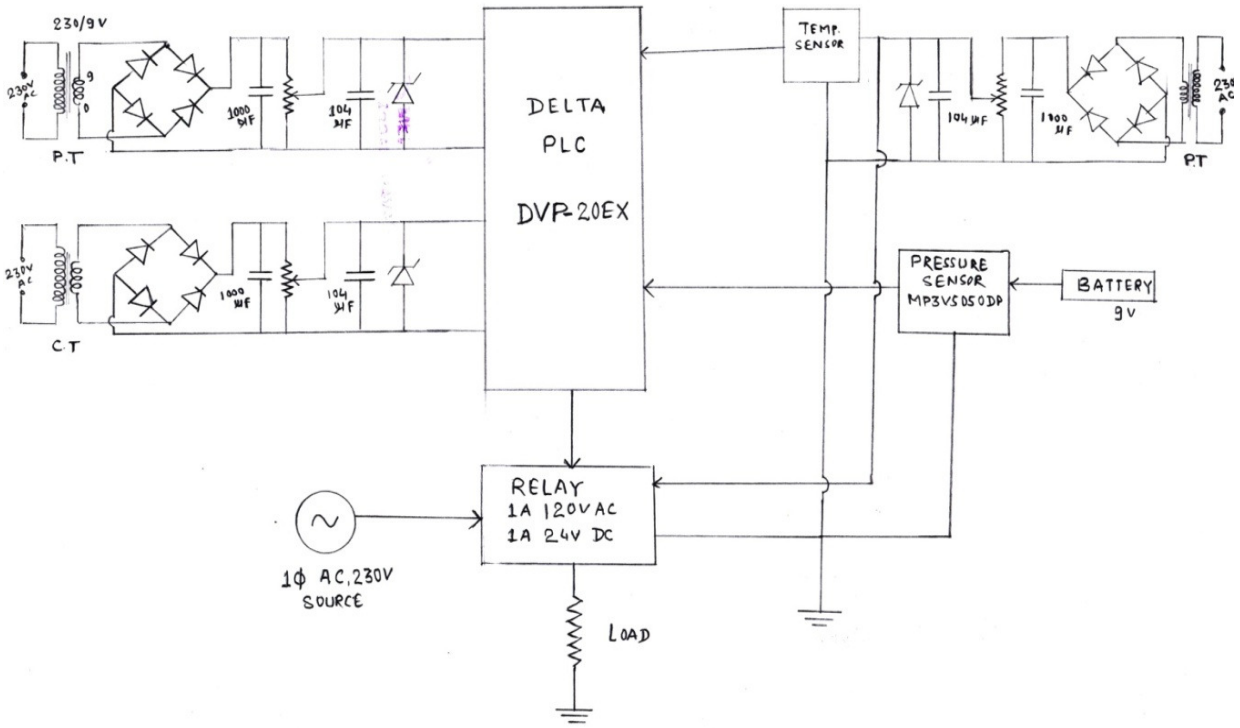

Fig.4: Circuit diagram of Automation of the Sub-Station

4. PLC HARDWARE

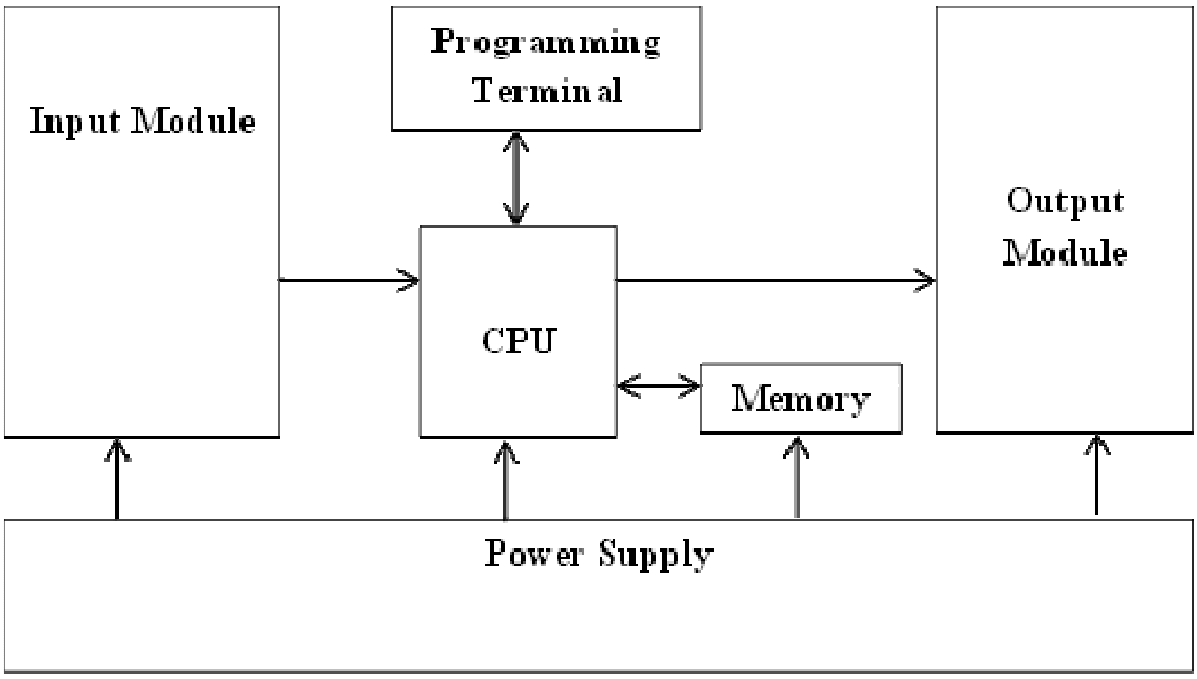

Fig.5: PLC Hardware Block Diagram

4.1. WORKING OF PLC: Bringing input signal status to the internal memory of CPU

- The field signals are connected to the I/P module. At the output of I/P module the field status converted into the voltage level required by the CPU is always available.
- At the beginning of each cycle the CPU brings in all the field I/P signals from I/P module & stores into its internal memory called as "PII", meaning process image input.
- The programmable controller operates cyclically meaning when complete program has been scanned; it starts again at the beginning of the program.

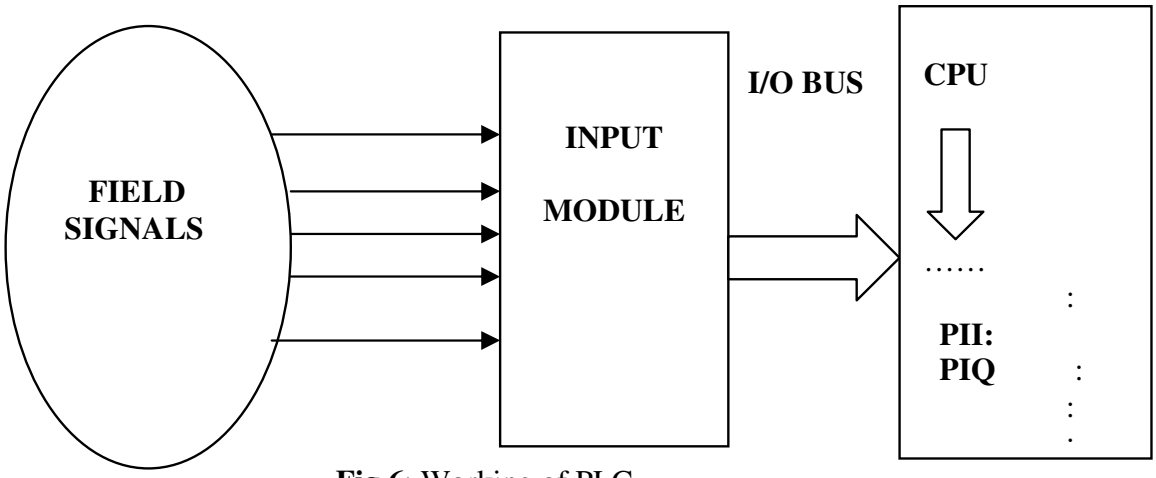

Fig.6: Working of PLC

A PLC works by continually scanning a program. We can think of this scan cycle as consisting of 3 important steps. There are typically more than 3 but we can focus on the important parts and not worry about the others. Step 1-Check Input Status-First the PLC takes a look at each input to determine if it is on or off. In other words, is the sensor connected to the first input on? How about the second input? How about the third... It records this data into its memory to be used during the next step. Step 2-Execute Program-Next the PLC executes your program one instruction at a time. Maybe your program said that if the first input was on then it should turn on the first output. Since it already knows which inputs are on/off from the previous step it will be able to decide whether the first output should be turned on based on the state of the first input. It will store the execution results for use later during the next step. Step 3-Update Output Status-Finally the PLC updates the status of the outputs. It updates the outputs based on which inputs were on during the first step and the results of executing your program during the second step.

5. SUMMARY OF THE PAPER

The following tables give summary of the paper as: 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. Therefore, controlling and monitoring of parameters like current, voltage, temperature, pressure etc could be done effectively. The process could be carried out with low voltage (upto 24v) with several system benefits, such as uninterrupted power supply, reduced man power, data storing & accuracy, and even more. Though the PLCs are developed to work out frequently in even harsh environments. They are designed to operate correctly over wide temperature ranges and in very high electromagnetic noise and high vibration condition. They can operate in dusty or humid environments as well. The number of PLCs which have been applied in various functional

areas has allowed the designers of PLCs to create the resistance to the negative effects of harsh environments and workout it's function accurately.

5.1 By Placement and Coordination of FACTS controllers in multi-machine power systems

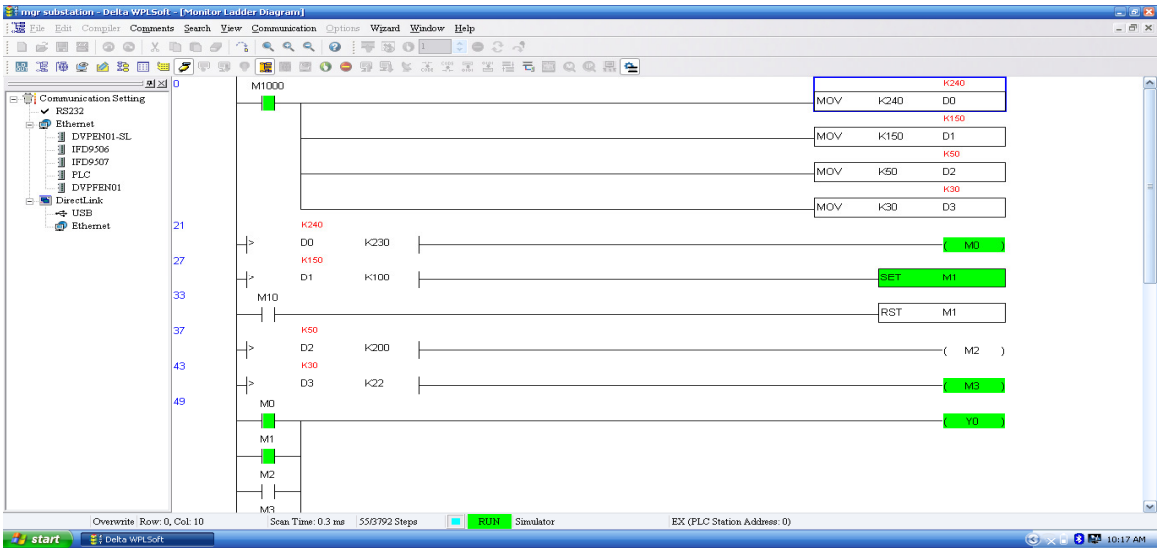

Figure 1 By placement and coordination of FACTS controllers in multi-machine power systems

6. CONCLUSIONS

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.

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