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Design of Electrical SCADA System for 11KV Substation

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Abstract : *In Substation it is difficult to monitor and control the different parameters such as voltage, current, power factor etc. which affect the reliability of the power. As the demand for reliable electric power is become important therefore the technology "Supervisory Control and Data Acquisition system "or SCADA is developed. SCADA system provide better monitoring, control and maintain the reliability of power, it can also extend the life of substations and related equipment by providing current data for troubleshooting small problems before they escalate. This paper evaluates the SCADA system has also provide the difference between the "Numerical Relay" and "Electromechanical Relay".*

Keywords : *Intelligent Electronic Device (IED), Remote Terminal Unit (RTU), Human Machine Interface (HMI), Distribution Control System (DCS, Engineer Work Station (EWS), Operators Work Station (OWS)*

I. Introduction

SCADA stands for (Supervisory Control and Data Acquisition system). The first 'SCADA' systems use data acquisition by means of panels of meters, lights and strip chart recorders. The operator manually operates various control knobs and performs supervisory control. It is a system which consists of computers for monitoring and controlling process. It is used in industry, factories and power stations. This can range from a meters to thousands of kilometers. Telemetry is used to connect the equipment and system by large distance in manufacturing process, public utilities, mining industry etc. The command, programs delivered by the telemetry and it also receive information from the remote location. SCADA consist of collecting information; perform necessary analysis, transferring information to the central site and then the required control actions are then sending back to the process.

In early days, the relay logic was used for controlling. Now a days due to advancement in technology the digital, electronic or the electronic device based relay logic equipment are used. The PLC or programmable logic controller is one of the most widely used control systems in industry. As need to monitor and control more devices, the PLCs were distributed in the system and the systems became more intelligent and smaller in size.

As the requirement for smaller and smarter systems, sensors were designed with the intelligence of PLC and DCS. Intelligence of PLC and DCS are known as "intelligent electronic device (IED)". The IEDs are connected on a fieldbus, such as Profibus, Device-net or Foundation Fieldbus to the PC. They include enough intelligence to collect data, communicate to other devices, and hold their part of the overall program. Each of these super smart sensors has more than one sensor on-board. Commonly, an IED could combine an analog input sensor, analog output, PID control, and communication system and program memory in one device.

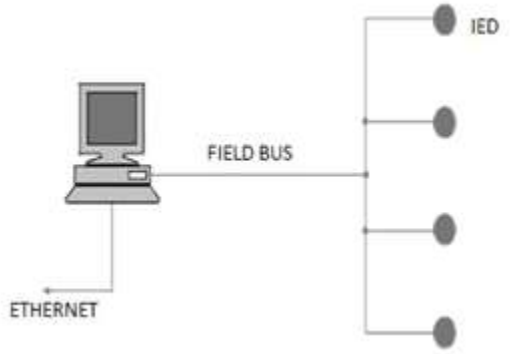

Fig.1 Modern Structure of SCADA

Substation communication plays a important role in power system operation. As the demand for reliable electric power became important "Supervisory Control and Data Acquisition" were developed, which would allow remote monitoring and control of system parameters. In the conventional systems, electromechanical relays are used for protection of substation equipment. In medium voltage substation, existing control and relay panels use electromechanical type of relays which require high amount of energy for their operation.

These relays posses a high burden on the voltage and current transformers and several manufacturers have stopped producing these relays due to the non-availability of parts and an increase in manufacturing cost. Introduction of Microprocessor based multi-functional numerical relay provides important advantages, like single solution to complex protection functions with automatic self-testing and improved reliability at optimal cost.

II. Architecture

Human Machine Interface (HMI) is the principal user interface and normally takes the form of a computer. The software which is required for the control of CB is a part of the HMI computer s/w. The term SCADA introduces centralized systems which monitor and control entire sites over large areas. The control over a given set of RTUs is done by the SCADA system. The HMI of a SCADA system consists of a number of remote points to be monitored/controlled in which communications are expected to be operated by a human operator. Various communication protocols are developed for SCADA and numerical relays. One such protocol is MODBUS protocol, which is used because of its fast and reliable communication. As it is simple to implement, it has been adopted by many manufacturers. And in today's world, MODBUS has become the most widely used protocol for communication purpose. The main uses of MODBUS communication in a substation are:

i. Data acquisition of AC voltages and currents, power factor (PF) value for metering, scaling and indication supervision.
ii. Controls for circuit breaker ON/OFF and reporting the status of relay contact points.
iii. Alarm handling in case of limit violation, acknowledgement facilities and control supervision.

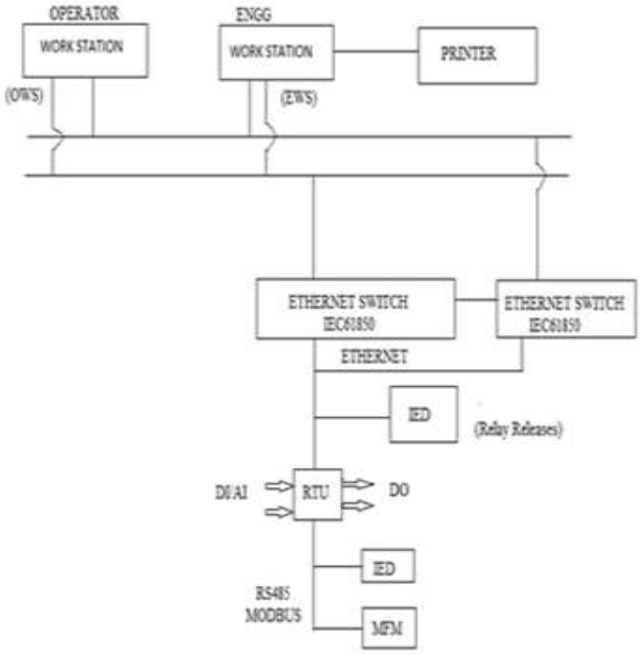

Fig.2 Architecture of Generalized SCADA System

III. Numerical Relay

Numerical relay is used to provide protection. Numerical relay are the advanced version of digital relay which is developed by the advancement in technology. These relays act as RTUs and IEDs. These are low cost and compact in size and consisting of current/voltage and power based protections for both reconstructions and new installations with event and fault recording capabilities. [1]

The main features of the installed relays are:

In-coming feeder protection, consisting of Over Current Protection, Fault Protection, Temperature Overload, Breaker Fail Protection. Out-going feeder protection, consisting of Over Current Protection, Earth Fault protection, Temperature Overload, Breaker Fail Protection. Capacitor bank protection, consisting of Over Current Protection, Earth Fault protection, Over Voltage protection, Under Voltage Protection, Breaker Fail Protection (BF). These relays are designed using a low cost, high performance, using an 8-bit microprocessor with built-in digital and analog I/O and Real Time Clock (RTC).

IV. Components of SCADA system

The three components of a SCADA system are:

1. Remote Terminal Units (RTU)

An RTU is a data acquisition and control unit,generally microprocessor based,which monitors and controls equipment at some remote location from the central station.Its primary task is to control and acquire data from process equipment at the remote location and to transfer this data back to a central station.It has the facility for having its configuration and control programs dynamically downloaded from some central station.There is also a facility to be configured locally by some RTU programming unit.

2. Communication channel infrastructure.

Communication in a substation is the process of sending the data from the numerical relay to the SCADA and vice versa. But if the devices at both ends are supplied by different vendors, a standard protocol is required. In the absence of any standard protocol, it is not possible for these devices to communicate with each other. In view of different protocols, MODBUS communication protocol was implemented between PC (master) and RTU (slave). This provides access to field devices compatible with MODBUS protocol satisfying the needs of supervisory control and data acquisition applications even under adverse condition. [1]

In today's world MODBUS is the very popular protocol used for communication in SCADA. Supporting traditional serial protocols of RS232/485/422 and Ethernet protocols allow industrial devices, such as, programmable Logic Controls (PLCs), HMIs and meters, to use MODBUS as their communication mode. Not only the standard MODBUS is very easy to implement intelligent device but also many intelligent sensors are equipped with a MODBUS interface can communicate over MODBUS, but also many intelligent sensors are equipped with a MODBUS interface to send their data to main systems. While MODBUS is mainly used on wired serial communication lines, there are also extensions to the standard for wireless communications and Transmission Control Protocol/ Internet Protocol (TCP/IP) networks.[3]

3. Master Station and HMI

Only the master station addresses the individual slaves in MODBUS protocol. The protection relays work in the RTU mode, collecting the data from the field and a PC (working as SCADA) provides Operators Work Station (OWS) or Engineer Work Station (EWS) interface. The data collector together with PC acts as the MODBUS-Master. The system consists of master station, collecting data from RTUs, acting as MODBUS slave. MODBUS communication in RTU mode was implemented in a substation on RS 485 serial bus as shown in fig.(2) Master communicates with a PC on an RS- 232 serial bus. The SCADA system usually provides the information to the operating personnel graphically or in the form of a mimic diagram. The response from the slaves (RTUs) is received by master and passed on to the PC to be either stored or displayed on the screen. Here, data (information and commands) are sent can basically be divided into two locations, centrally on the Substation level, remotely to and from the control center. [1]

V. Conclusion

Microprocessor based multi-functional numerical relays provide reliable solution to complex protection functions over the electromechanical relay. These relays plays significant role in automation, protection and control of transmission equipment in substation. Numerical relays have limited control applications. Since these relay can operate remotely by using MODBUS communication.

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