WEB BASED MONITORING OF SUBSTATIONS

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***Abstract*--- The earlier monitoring system for remote substation does not have the capability to monitor the system as quickly as possible so the integration monitoring system has to be adopted which eliminates the failures of GSM based technologies which is being used in day to day monitoring system. This project creates a new integrated monitoring system for high voltage electric power substation system. The substation has important function to maintain reliability and to keep the quality of electric power transmission system. On the other hand the exposure to high voltage environment may also be able to cause risk to human health. Therefore an integrated monitoring system is crucial to be implemented for easy monitoring and controlling the substation while minimizing the interaction of human to the substation devices [5]. The main objective of this project is to create a three phase faults and collect the information where the fault occur in substation and also parameters like voltage, current, humidity within the load of remote substation by using microcontroller which is further connects to PC through which the collected data will be further send to the server, from which the data can be collected from anywhere i.e. at any part of the world.**

Keywords— Internet,Communication, Transformer, On-line monitoring, Sensors.

I. INTRODUCTION

The assembly of apparatus used to change some characteristics of electric supply system is called a substation. An electrical substation is a subsidiary of an electricity generation, transmission and distribution system where Voltage is transformed from high to low or reverse using transformers. Electric power may flow through several substations between generating plants and consumers and may be changed in voltage in several steps. A substation may include transformers to

change voltage levels between high transmission voltages and low transmission voltages, or at the interconnection of two different transmission voltages. The words substation comes from the days before the distribution system became a grid. As central generation stations became larger, smaller generating plants were converted to distribution stations, receiving their energy supply from a larger plant instead of using their own generators. The first substation were connected to only one power station, where the generator were housed, and were subsidiaries of that power station.

II. BACKGROUND STUDY

In recent years, increased emphasis has been placed on power equipment reliability. In particular, facing deregulation and increasing competition, many utilities are looking for ways to generate and transmit power in more economical and reliable ways. The health of equipment constituting the substation is critical to assuring the supply of power [5].

Historically the maintenance of electrical power equipment has been time-based. Maintenance Crews would inspect the equipment at set intervals based on its age and performance history. As can be expected, this leaves room for many catastrophic failures of improperly or untimely diagnosed equipment. The cost in disruption of business could far outweigh the savings in maintenance costs. On the other hand, too-frequent maintenance can be very costly and unnecessary. Because of the cost of scheduled and unscheduled maintenance, especially at remote sites, new approaches using on-line monitoring and analysis systems of the substation equipment may be more reliable and cost-effective [5].

In recent years a range of monitoring and diagnosis devices have become available that provide continuous, real-time condition monitoring and analysis of substation equipment. The effective use of on-line monitoring and diagnosis has potential to provide significant benefits for substation owners, technical personnel, and even utility consumers [5].

The key benefits of on-line monitoring and diagnosis can be summarized as follows:

- Early detection and possible prevention of equipment failure, especially catastrophic failure.
- Long-term data acquisition and understanding about equipment performance.
- Automatically assessing electrical equipment condition.
- Resulting in reducing maintenance time and labor, and reducing maintenance costs associated with any failure [5].

III. STUDY OF MONITORING AND DIAGNOSIS SYSTEM

1. SUBSTATION

The assembly of apparatus used to change some characteristics of electric supply system is called a substation. An electrical substation is a subsidiary of an electricity

generation, transmission and distribution system where voltage is transformed from high to low or reverse using transformers. Electric power may flow through several substations between generating plants and consumers and may be changed in voltage in several steps.

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2. TYPES OF SUBSTATIONS

- *Transmission Substation*

A transmission substation connects two or more transmission lines. The simplest case is where all transmission lines have the same voltage

- *Distribution Substation*

A distribution substation transfer power from the transmission system to the distribution system of an area. It is a uneconomical to directly connect electricity consumers to the main transmission network, unless they used large amount of power, so the distribution station reduces voltage to a level suitable for local distribution.

- *Collector Substation*

In distributed generation project such as a wind farm, a collector substation may be require it resembles a distribution substation although power flow is in opposite direction from many wind turbines up into transmission grid.

- *Converter Substation*

Substations may be associated with HVDV converter plants, traction currents or interconnected no synchronous networks .These stations contain power electronic devices to change the frequency of currents, or else convert from alternating to direct currents or the reverse.

- *Switching Substation*

A switching substation may also be known as switchyard and these are commonly located directly adjacent to or nearby a power station

3. DISTRIBUTION SUBSTATION

A distribution transformer is stationed at a distribution station. A distribution substation transfer power from the transmission system to the distribution system of an area. It is uneconomical to directly connect electricity consumers to the main transmission network, unless they use large amounts of power, so the distribution station reduces voltage to a level suitable for local distribution. The input for a distribution substation is typically at least two transmission or sub transmission lines. Input voltage may be, for example, 115 kV, or whatever is common in the area. The output is a number of feeders. Distribution voltages are typically medium voltage, between 2.4 kV and 33 kV depending on the size of the area served and the practices of the local utility. The feeders run along streets overhead (or underground) and power the distribution transformers at or near the customer premises.

In addition to transforming voltage, distribution substations also isolate faults in either the transmission or distribution systems. Distribution substations are typically the points of voltage regulation, although on long distribution circuits (of several miles/kilometers), voltage regulation equipment may also be installed along the line. The downtown areas of large cities feature complicated distribution substations, with high-voltage switching, and switching and backup systems on the low-voltage side. More typical distribution substations have a switch, one transformer, and minimal facilities on the low-voltage side.

4. *TYPES OF FAULT IN SUBSTATION*

Electrical power system is growing in size and complexity in all sectors such as generator, transmission, distribution and load system. Types of faults like short circuit condition in power system network result severe economic losses and reduces the reliability of the electrical system.

Electrical Faults is the deviation of voltage and current from nominal values or states. Under normal operation condition, power system equipment or lines carry normal voltages and current which results in a safer operation of the system.

But when fault occur, it causes excessively high current to flow which causes the damage to equipment and devices. Fault detection and analysis is necessary to select or design suitable switchgear equipment, electromechanical relay, circuit breaker and other protection devices.

The three phase faults create in substation are as follows:

a) UNSYMMETRICAL FAULTS

- *Line to ground fault (L-G)*

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.

- *Double line to ground fault (L-L-G)*

In this type of fault 15-20 percent of fault occurs and causes the two conductors to make contact with ground.

- *Line to line fault (L-L)*

Line to line fault occur when two conductors make contact with each other mainly while swinging of line due to winds and 5-10 percent of the faults are of this type.

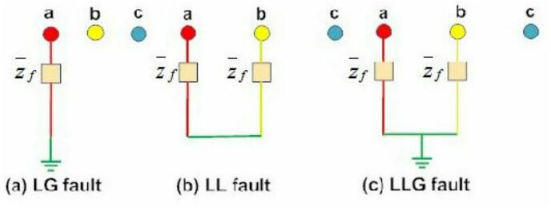

Figure 1: Unsymmetrical faults

b) SYMMETRICAL FAULTS

Line to line to line fault (L-L-L) and Line to line to ground (L-L-G)

Only 2-5 percent of system faults are symmetrical faults. If these faults occur, system remains balanced but results in severe damage to the electrical power system equipment.

Below figure shows two types of three phase symmetrical faults. Analysis of these faults 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.

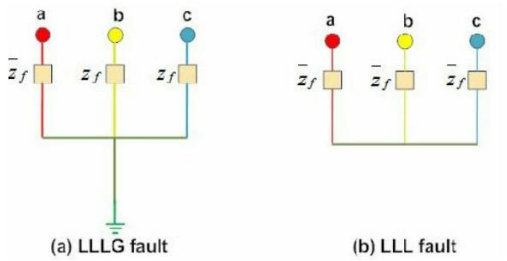

Figure 2: Symmetrical faults

c) Overvoltage

When the voltage in a circuit or part of it is raised above its upper design limit, this is known as overvoltage. The condition may be hazardous. Depending on its duration, the overvoltage event can be transient—a voltage spike—or permanent, leading to a power surge. Electronic and electrical devices are designed to operate at a certain maximum supply voltage, and considerable damage can be caused by voltage that is higher than that for which the devices are rated.

d) Under voltage

It is one of the most savior problems in induction motor. When motor has given very less voltage during starting then the motor drawn very heavy high current through supply. Under voltage may cause cogging of induction motor.

Application based three phase fault analysis.

We can analyze three phase fault by using simple circuit as shown below. In this temporary and permanent fault are created by fault switches. If we press button once as a temporary fault, timer's arrangement trips the load and also restores the power supply back to the load. If we press ON this button for a particular time as a permanent fault, this system completely shutdowns the load by relay arrangement.

Effects of electrical faults

- over current flow
- danger to operating personnel
- loss of equipment
- disturbs interconnected active circuits
- electrical fires

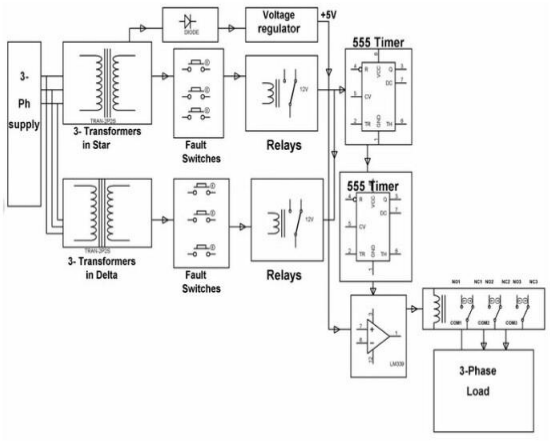

Figure3: Three phase fault analysis

IV. INTEGRATION WITH INTERNET

In order to accomplish the goal of sharing information related to the integrity of the electric power system with other utilities and organisations that are responsible for the smooth operation of the substation, communication by Internet was 'employed in our system. Using the Internet will be very helpful when the plant is in an emergency situation because all parties concerned are eager to look at the plant data simultaneously [1]. This feature was impossible in the old system using modems, the time for trouble shooting can be shortened and thus the time for system restoration to normal can be shortened as well. Before the details of the implementation are described, the state-of-art of Internet technology is introduced. The Internet is becoming an integral part of life and a comprehensive review can be found in various documents. The authors developed an Internet based building automation system and explored the idea of a global campusless university through an Internet based degree

course. With all of these advantages, it is useful for us to put the distributed on-line monitoring system onto the Internet [2].

TCPIP COMMUNICATION

TCP (Transmission Control Protocol) is a set of rules (protocol) used along with the Internet Protocol (IP) to send data in the form of message units between computers over the Internet. While IP takes care of handling the actual delivery of the data, TCP takes care of keeping track of the individual units of data (called packets) that a message is divided into for efficient routing through the Internet.

For example, when an HTML file is sent to you from a Web server, the Transmission Control Protocol (TCP) program layer in that server divides the file into one or more packets, numbers the packets, and then forwards them individually to the IP program layer. Although each packet has the same destination IP address, it may get routed differently through the network. At the other end (the client program in your computer), TCP reassembles the individual packets and waits until they have arrived to forward them to you as a single file.

TCP is known as a connection-oriented protocol, which means that a connection is established and maintained until such time as the message or messages to be exchanged by the application programs at each end have been exchanged. TCP is responsible for ensuring that a message is divided into the packets that IP manages and for reassembling the packets back into the complete message at the other end. In the Open Systems Interconnection (OSI) communication model, TCP is in layer 4, the Transport Layer [5].

IP ADDRESS (Internet Protocol address)

An **Internet Protocol address** (**IP address**) is a numerical label assigned to each device (e.g., computer, printer) participating in a computer network that uses the Internet Protocol for communication. An IP address serves two principal functions: host or network interface identification and location addressing. Its role has been characterized as follows: "A name indicates what we seek. An address indicates where it is. A route indicates how to get there."

The designers of the Internet Protocol defined an IP address as a 32-bit number and this system, known as Internet Protocol Version 4 (IPv4), is still in use today. However, due to the enormous growth of the Internet and the predicted depletion of available addresses, a new version of IP (IPv6), using 128 bits for the address, was developed in 1995 IPv6 was standardized as RFC 2460 in 1998, and its deployment has been ongoing since the mid-2000s [5].

V. DISPLAY SYSTEM

The display system consists of remote parameter to a native substation in a simple manner which can be achieved by using VISUAL BASICS which allows us to develop the windows which can display the parameters in one view and further decisions can be made to achieve the particular task.

A. VISUAL BASICS .NET

Visual basics is a programming language and development environment crated by Microsoft Visual Basic provides a graphical user interface GUI that allows the developer drag and drop objects into the program as well as manually write program code. Visual Basic, also referred to as "VB," is designed to make software development easy and efficient

A visual basic .net derives from the much older BASIC programming language, and so is considered useful and easy

programming language for the beginner to learn. Visual Basic 6.0 was the final edition of Visual Basic.

Feature Of visual basic .net

1. Learning Consists of all necessary tools required to build main stream Windows Applications.
2. Professional Includes advanced features such as tools to develop ActiveX and Internet controls.
3. Enterprise In addition to all Professional features; it also includes tools such as Visual.

Feature Of visual basic

1. GUI Interface
2. Modularization
3. Object Oriented
4. Debugging
5. Macros IDE
6. Data access feature.

VI. EXPERIMENTAL SETUP AND RESULT

A. CONSTRUCTION

The microcontroller is main part of the whole circuit. The potential transformer, current transducer, humidity sensor, oil temperature and oil level of transformer. The 5V of supply is being given to the microcontroller, MAX232, and the various sensors. And the 12V is given to the driver IC2803 to operate the relay. The relay is here is used as a switch where it will only connects the contactor in case of normal condition or disconnects in case of abnormal condition [5].

The general block diagram of the system is as shown in figure above. In web base substation monitoring, the various parameter such as voltage, current, humidity, level and temperature of a substation transformer is sensed by their related sensor. For ex. Temperature is sensed by temperature sensor for e.g.(LM35),PT100,THERMOCOUPLE,etc. Humidity sensor module SY-HS-230. Light is measured with LDR(light dependent resistance), The output produced by

sensor is in the form of voltage or current. Current is sensed by current transducer (WCS 1702) and humidity sensor is used to sense the moisture level inside the transformer oil tank & voltage is directly checked across the load. This all quantities are in analog form. This can never read by microcontroller. So all these analog signal are converted into digital signal by the use of inbuilt ADC of PIC. These digital formed signals are transferred to the microcontroller LCD is interfaced with microcontroller to display all the monitored parameters. This is available at output port of microcontroller. According to change in input depending on the sensors is then processed further as explained above & displayed on 16*4 display Simultaneously all these parameters are send to PC/laptop by interfacing a MAX-232 IC. (PC side monitoring by visual basic program) Microcontroller PIC 18F2520 is heart of whole system, if the microcontroller fails to work by any mean, then the whole system will not work. The microcontroller verifies i/p parameters and compare with the settled reference values.(set by the user inside the microcontroller program) if the logged data is abnormal to the system in that case the action (such as buzzer, relay) will driven by Driver IC(ULN2803). To run all this electronic component, it is required regulated +5V, 750MA power supply. Three terminal voltage Regulator (lm7805) is used for voltage regulation. And bridge type full wave rectifier is used to rectify the AC output of secondary of 230/12V step down transformer. The circuit diagram is as shown below[5]

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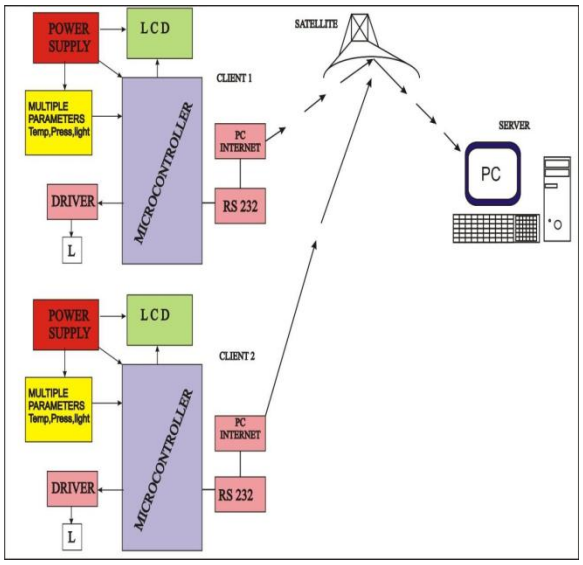

Figure 4: Block diagram

B. WORKING

The above block diagram (fig.2) represents the actual block diagram of the web based monitoring of substation transformer. It consists of various blocks such as microcontroller, measurement devices and sensor unit along with interfacing IC. The parameters to be analyse for monitoring are voltage, current, humidity, oil level and oil temperature within transformer by using microcontroller which is further

connects with a PC or laptop this collected data will further send to server which will situated at any part of world through internet communication.

In further connection in case of fault such as unbalanced voltage, under voltage, over voltage etc the fault is being analysed by microcontroller programming and the signal is being send to the driver relay to disconnect the contactor and isolate the substation.

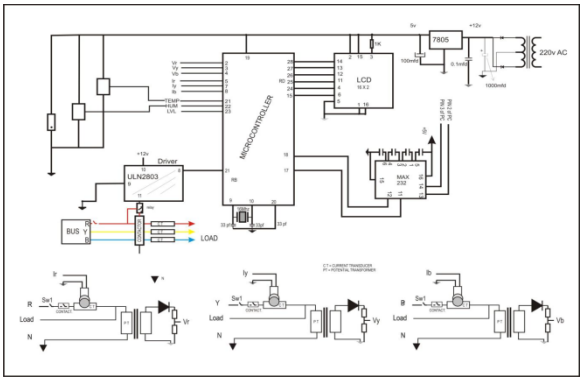

Figure5: circuit diagram

As shown in the figure the power transformer is used to step down the voltage of 230V single phase to 12V. The 12V supply is being rectified to 12V by using the full wave rectifier. This rectified supply is regulated to 5V. This 5V of supply is need for the working of microcontroller, MAX232 IC, and the various equipped sensors. The P.T. and the current transducer are energized by the line conductors. The LCD used to display the monitored parameters on the station substation itself. The driver IC is used as a current booster to amplify the current from the microcontroller, used to drive the relay.

The microcontroller is being programmed to certain limits. Whenever the fault occurs such as over voltage, over current, under voltage, phase failure etc. the direct effect will be developed on the transformer. So in case of fault condition the microcontroller will give the command to driver IC, so that the relay is to be tripped and the transformer will be isolated, i.e. the substation will be protected. The MAX232 IC

is used as an interfacing IC so as to interface the data of microcontroller with PC. The PC will send the data to the server of known IP address, and the same data will be retrieved by the known PC who has the known IP address. In this manner the data will be monitored and the data will be used for future forecasting [5].

VII. CONCLUSION

The substation has a crucial function to maintain the reliability and to keep the quality of an electric power transmission system. On the other hand, the exposure to high voltage environment may also be able to cause risk to human health. Therefore an integrated monitoring system is necessary to be implemented for easy monitoring and controlling the substation while minimizing interaction of humans to the substation devices. All the substation devices conditions are displayed uninterruptedly in remote area or a monitoring place. In short the easy parameter monitoring will allow reducing the man power requirement at the substation area. This parameter monitoring system will be done around the clock throughout the year. The overall efficiency of the substation will increase as its maintenance plan is reduced [5].

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