METHOD FOR MONITORING OF DISTRIBUTION TRANSFORMER

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Abstract— Distribution transformers are one of the most important equipment in power network. Because of, the large number of transformers distributed over a wide area in power electric systems, the data acquisition and condition monitoring is a important issue. This project presents design and implementation of a mobile embedded system to monitor and diagnose condition of transformers, by record key operation indictors of a distribution transformer like load currents, transformer oil, ambient temperatures and voltages. The proposed on-line monitoring system integrates a Global Service Mobile (GSM) Modem, with a solid state device named PLC (programmable logic controllers)and sensor packages. Data of operation condition of transformer receives in form of SMS(Short Message Service) Using the suggested online monitoring system will help utility operators to keep transformers in service for longer of time.

Keywords*— Monitoring , Distribution Transformers , Modular Software , GSM Networks* **.**

I. INTRODUCTION

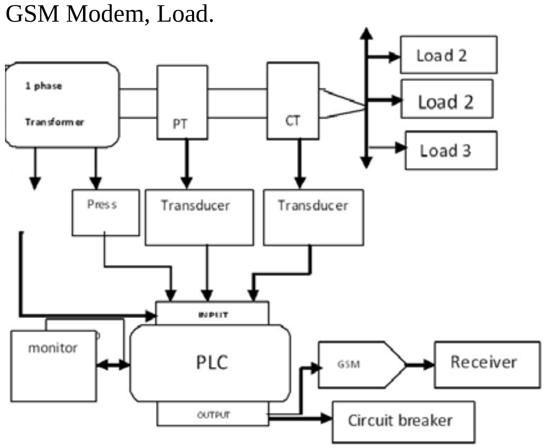
Communication network and GSM devices such as GSM modems have a large attraction in wide area network applications. To conquer the transferring and collecting problem of these large amount of data about transformer's condition, These devices would be so useful to transfer and acquire the large amount of data about the transformer's condition. So with development of infrastructure of wireless communication, offer new and cost effective possibilities to monitor distribution transformers.

II. HARDWARE REQUIRED

Controller: Programmable logical controller, Pc as a monitor device.

Sensors: Current transformer , Potential transformer, Temperature sensor , Pressure sensor.

Accessories Transducer circuit, alarming circuit, GSM Modem, Load.



III. DTMAS SOFTWARE

The DTMAS software is consist of 3 major layers, condition monitoring, analysis layer and alarm layer. Detail of layer is reviewed consequently.

A. Condition Monitoring Layer

This layer or module is utilized to display received data including three-phase voltage or current and the oil or air temperature. As we can see in (a), these parameters are shown in display window. User can choose each one of these parameters by selecting buttons, which has been located under this display window

B. Analysis Layer

In this layer of DTMAS, data has been analyzed. This layer is directly connected to the data acquisition layer. Once the data enter the server system, has been analyzed and if they exceed values, the alarm layer will be informed. In (b) the analysis part of the software has been indicated.

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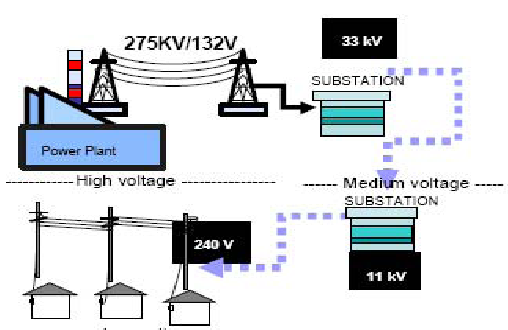
1 .Novel Software Architecture for Power Distribution Automation

In this paper, a unified, modular structure for the key software elements of distribution automation system – the master DA software and the engineering analysis software, is proposed. These software elements are responsible for achieving various DA functions. The proposed structure suggests the software development as a combination of different applications, which are functionally independent hut interfaced appropriately. An application, in turn, is conceptualized as an outcome of interaction between a set of processes andor databases. This hierarchical structure, which is composed of application process and database, facilitates modular development, maintenance, upgrade *I* modification while extending the flexibility in interfacing (including laying down the interface characteristics and specifications). Consequently, these features also lead to reducing vendor monopoly and dependence in the implementation *I* expansion of the DA system in phased manner. The proposed software structure has been successfully implemented in field..

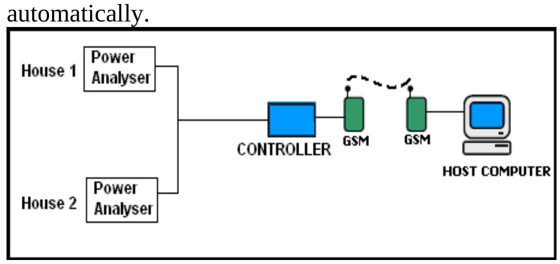
2. DEVELOPMENT OF NOVEL DISTRIBUTION AUTOMATION SYSTEM (DAS) ON CUSTOMER SIDE DISTRIBUTION SYSTEM

This research work has been done in designing and developing a Novel Distribution Automation System (DAS) in an open loop customer side distribution system. The research has utilized an automation techniques in both hardware and software environment using a communication network and embedded controllers along with power meters which has utilized the possible best solution for the fault operation and control tasks remotely. All hardware and software components have been developed and integrated together. Data exchange mechanism has been developed between the host computer and the embedded controllers that function in two way data exchanges between the two. The remote hardware controllers such as remoter terminal units (RTUs) are enabled to the communication modules to operate the substation remotely. The metering equipment is used as real time data restoration tool and gathers the customer's consumption energy information. Thus a multipurpose power meter is used as hand of the electrical utility at the customer side. IsaGraf provides communication – GSM (Global system for Mobile Communications) function blocks such as SMS (Short Message Service) "operating functions "SMS_send", "SMS_test", "SMS_gets" and developed "SMS usage functions. These are functions are created for GSM based messaging system to communicate with the person in charge to operate the system at anytime and anywhere remotely. Fabrication testing has been done on real distribution system and



2.1 SYSTEM ARCHITECTURE

First step is to check the power input whether it is turned on or turned off. The power input is referred to relay output of MK2200 (multifunction relay).If no fault condition is detected by MK2200, the power input is turned on (Normally Close (NC)). When MK2200 detects the fault condition, power input is turned off (Normally Open (NO)). In this case, the MK2200 is re-set by using a delay timer and power input is turned on automatically.



System Architecture

The contribution of this research includes developing a complete fault isolation algorithm based on an open loop distribution system. In an open loop distribution system, two feeders are used to provide electricity supply to the loads. During fault conditions, any section of the feeder can be isolated without interruption. The algorithm is developed to check the fault point starting from the one of the section feeders or OLUC algorithm and repeated with another section feeders or OLDC algorithm. At the beginning, this algorithm needs to clarify with which point is the fault point by supplying the power to each load after the fault is detected by the MK2200 (combined earth leakage relay and over current relay). When the fault point is being activated, the MK2200 detects the fault and trip mechanism is operated. The algorithm will find the false point and reset the MK2200 to restore the power supply to the loads. this time, only the un-faulted point will be restored.

3. WIRELESS DISTRIBUTED MONITORING AND CENTRALIZEDCONTROLLING SYSTEM FOR PREFABRICATED SUBSTATIONS IN CHINA

Online monitoring of the distribution transforners is very difficult to realize because of the large number and dispersed distribution of the prefabricated substations. To solve this problem, this paper has proposed a novel monitoring and controlling system integrating the GSM communication technology and the latest PIC microprocessor technology. The paper introduces the whole architecture and working principle of the GSM based remote monitoring system for prefabricated substations in China. Then it explicates the hardware architecture and software flow of the RTU. The application of the proposed system will also promote power automation to a higher level by using the microprocessor-based RTU with smart architecture.A trial was given on the implemented system for testing, and the results came out as expected. Improvements are needed for software programming to implement the controlling functions of the control station. The object oriented programming language Visual C++ was used to develop the controlling program with a utility man-PC interface. The software architecture consists of three functional modules[5].

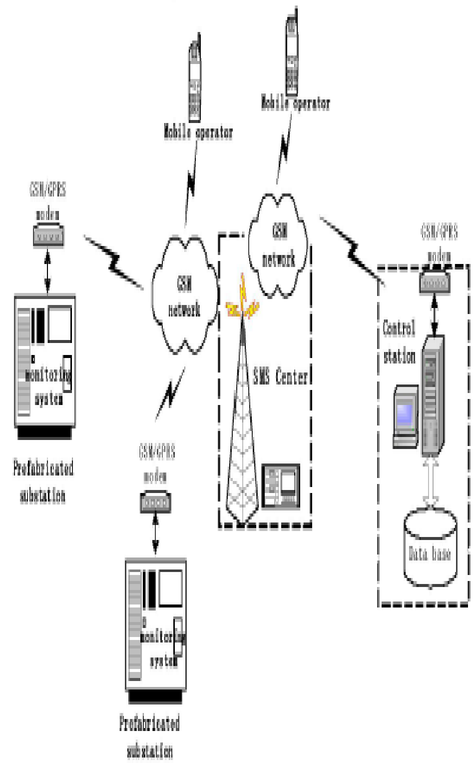


Fig. 2. System architecture

1) Alarm charge are listed on the computer's screen. If one of substations sends alarm signal, its mark will be blinking on the screen with alarm sound. ersonnel at the control station can know about the abnornality of any substation in time.

2) Acquire and analyze the status parameters

This functional module is used to inquire about the substations status periodically or when accidents happens. By analyzing the data package received, control station can help the mobile operator find the fault location quickly and decrease the repair and restoration time. The analysing result will be displayed on the PC screen.

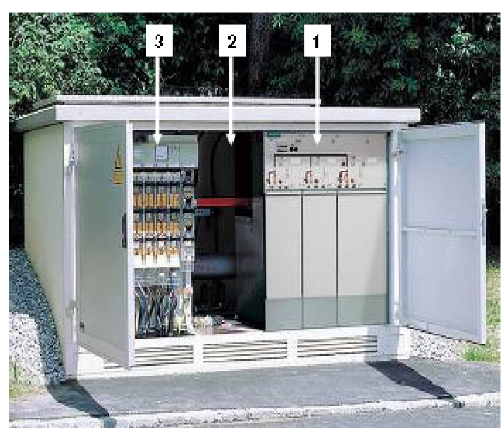
3) Administer the mobile phones

This function module is used to administer the mobile phones within the control area of the station. It includes the function of adding new mobile phones and canceling existed mobile phones by sending AT commands to rewrite appointed phone numbers.

Fig. 6. One of the experimental SMS message received by a cellphone

4. INTELLIGENT TRANSFORMER SUBSTATIONS IN MODERN MEDIUM VOLTAGE NETWORKS AS PART OF "SMART GRID"

Increasing demand for reliable electricity and achieving the climate protection targets lead to promote the renewable energies with points of infeed in the medium-voltage and low-voltage systems. Maintaining the necessary power quality and network stability requires an active distribution system with intelligent transformer substations. Possible measures reach from pure monitoring via remote control up to targeted load flow control, and are different in the companies or countries. There is everything from "zero level" up to complete remote control of the transformer substations. Incentive systems to minimize outage times, and necessary measures to secure the voltage quality are the drivers. Presently, the fault detection with monitoring and remote control with shifting of the open isolating point with the sectionalizer are still in the foreground.



Utilization of inverters from the wind power and photovoltaic systems to ensure and improve the power quality will increase in the future. Moreover, distribution transformers with tap changers will be used at critical points in the secondary distribution system.

In addition to this there are possibilities for minimization of losses in the grid and monitored utilization of the operational equipment even in the overload range. The advantages resulting from remote control and active load management are:

- Faster fault localization
- Shorter interruption times
- Measuring/signaling of operational data
- Reduced network losses
- Possibility of compensation of reactive power / harmonics
- Monitored transformer operation during overload
- Higher transmission power; thus: postponement of network extensions
- Remote object supervision

For the upcoming tasks, Siemens has a consistent concept and the suitable equipment:

- Medium-voltage switchgear 8DJH with the necessary sensors and actors [5]
- RTU telecontrol system with SICAM TM 1703 [6]
- Communication via IEC 60870-5-101/104 or IEC 61850 protocols; conventionally via wire, radio or in future via WiMAX or BBDL
- Telecontrol node / substation automation systems SICAM PAS [7] or SINAUT Power CC
- Application/consulting competence through our "network planning" department [8]

The answer to the question "Intelligent transformer substation: a need or luxury?" is: Intelligent substations and an intelligent distribution network are a must in order to meet the requirements of the future. The objective of Siemens is to continue developing intelligent solutions for the management of secondary distribution systems, thus contributing to reliable and efficient power supply.

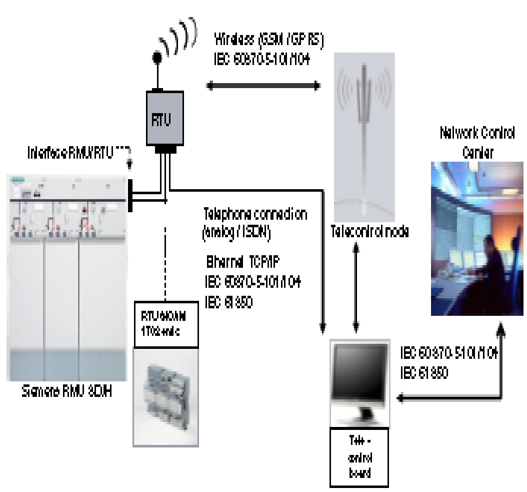


Figure 5: Substations – RTU – Communications - Control Level

5.Online Monitors Keep Transformers in Service

Applying commercially available standard hardware and software components was one of the basic thoughts in developing the new transformer monitoring system. This ensures a high availability and exchangeability. Furthermore, a later upgrade of the system can be easily carried out. The product cycles of electronic components are much faster compared with the high lifetime of power transformers in the range of 30 years and more. This requires a modular system concept. Individual components, especially hardware, can be exchanged easily, even after years of operation, and the use of standard hardware interfaces guarantees a high flexibility of the system. The monitoring system consists of three main components: sensors, analog-to-digital conversion modules, and a computer for data processing and analyzing.

Sensor

the voltage measurement is made using the bushing's measuring tap. Such sensors have been in operation on a 200 MVA transformer for 4 years and on a 350 MVA transformer for 2 years without any disruption. Recently, two large power transformers in German utilities were equipped with these voltage sensors. If there are no capacitor bushings available, voltages can be picked up by any kind of external voltage transformer. In the case of equipping a new designed transformer, current transformers mounted in the bushing domes are used for picking up currents. When retrofitting a power transformer with a monitoring system, external current transformers can be used. The top oil temperature corresponds with good approximation to the temperature at the top of the cooling unit. In contrast to the temperature measured at the cover of the transformer tank,

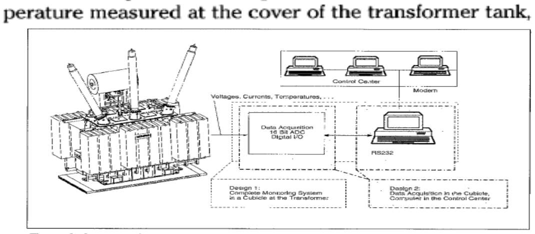


Figure 3. Concept of a modular monitoring system for power transformers with different designs

there is much less influence of climate conditions like rain on the temperature measured in the pipeline to the cooling unit. From this temperature, the hot-spot temperature and the aging rate of the transformer are calculated according to international standards. The measurement of temperature at the bottom of the cooling unit and ambient temperature provides information on the cooling process and, in a further step of development, allows the calculation of the cooling efficiency. The Hydran sensor is commonly in use for online trend analysis of the gas content in the oil. It displays a value that depends on the H_2 content and to a much lesser degree on CO_2. For measuring the moisture content in the oil, a sensor based on thin-film technology is used by the monitoring system. Both sensors should be mounted in the pipeline between the cooling unit and transformer to guarantee that the analyzed oil is pumped through the windings. The operating condition of pumps and fans is picked up. This enables determination of the operating duration and supports condition-based maintenance of this equipment. Moreover, the velocity of the oil in the pipeline to the cooling unit and the air flow through the heat exchanger is measured. The aim of future development is to calculate from these quantities, together with load and temperatures, the efficiency of the cooling system. The seeds of some trees and shrubs can pollute the cooling system and lead to a reduced cooling efficiency. This is to be indicated by the monitoring system. Additionally, some other quantities like oil level in the compensator and the tap changer tank as well as the oil pressure in the bushings are measured in order to provide more information about the transformer condition.

Hardware

The monitoring system exists in two versions, as shown in Figure 3. The first version (Design 1) means that both the computer and the data acquisition unit are located in a cubicle directly at the transformer. In the second version (Design 2), the monitoring system is split. The computer is located in a control room near the transformer, and the data acquisition hardware is mounted in a cubicle at the transformer. In this case, an optoelectronic RS232 interface can be used to avoid external disturbances. The cubicle that contains the main hardware components is equipped with a heater and fans for avoiding extreme climatic conditions inside. Both heater and fans are controlled by temperature and moisture inside the cubicle.

Software

One of the most important features of a modern power transformer monitoring system is data communication to the world outside. This is realized by remote-control software in combination with modem connection. Using this software, the screen of the host computer at the transformer is transmitted online to the screen of the remote computer in the office or a utility control room. The user has access to the complete functionality of the monitoring system and can analyze the data conveniently. The system configuration can be changed by remote control, and data from the hard disk of the host computer can be transferred to the remote computer. Figure 5 shows a screen shot of the remote computer screen. In the background, the surface of Windows 95 can be seen.

6. CONCLUSION

In this paper, we have described an advanced remote monitoring system for distribution transformers utilizing the existing GSM communication network, which has low investment and operation costs. It is also easy to install and use. For this purpose, we have introduced a novel software (DTMAS) and used it for three different types of distribution transformers in order to analyze voltage unbalance condition.

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