Three Phase Transformer Fault Detection and Protection using PLC
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Abstract— Main aim of studying this project is to design and implementation of PLC (programmable logic controllers) automation to monitor as well as to diagnose condition such as load, currents, transformer temperatures and voltages of the transformers which is one of the most important Equipment in the power system network. The Data acquisition, condition monitoring, automatic controlling are important issues as there are large no of transformers and various components over a wide area in power system. In proposed system with PLC, relays and sensors are used to detect the faults of transformer such as overloading, overvoltage, under-voltage, phase to phase fault and over temperature faults. Probability of faults on Transformers is undoubtedly more and hence protection of transformer is highly essential. Automation control is used for various systems for operation of equipment. Some processes are completely automated. Benefit of automation is it saves labour and saves energy and material; improve quality, accuracy and precision, reduces dependency on human presence and decision making for any process.

Key words: PLC, Automation, Distribution Transformer, Relays, Sensors, Monitoring

I. INTRODUCTION
The purpose of transformer protection is to detect faults or abnormal operating conditions and to initiate corrective action. Relays must be able to evaluate a wide variety of parameters to establish that corrective action is required. Obviously, a relay cannot prevent the fault. Its primary purpose is to detect the fault and take the necessary action to minimize the damage to the equipment or to the system. The most common parameters which reflect the presence of a fault are the voltages and currents at the terminals of the protected apparatus or at the appropriate zone boundaries. The Protective relays require reasonably accurate reproduction of the abnormal and normal conditions in the power system for correct sensing and operation.

This information input from the power systems are usually through Current Transformer (CT) and Voltage Transformer (VT). Furthermore, for the past several years fuse, circuit breakers and electromechanical relays were used for the protection of power systems. The traditional protective fuses and electromechanical relays present several drawbacks. Alternatively, some researches were conducted on relay which can be interfaced to PLC in order to eradicate the drawbacks of the traditional protective techniques which led to many improvements in transformer protection in terms of lower installation and maintenance costs, better reliability, improved protection and control and faster restoration of outages.

Therefore a proposed solution is chosen to develop a PLC based transformer overload protection prototype because the PLC based relays provides greater flexibility, more adjustable characteristics, increased range of setting, high accuracy, reduced size, and lower costs, along with many ancillary functions, such as control logic, event recording, fault location data, remote setting, self-monitoring and checking, etc.

II. OBJECTIVES
The aim of this paper is to design and implement a PLC based transformer protection system.
1) To design the current and voltage sensing circuits that will be interfaced to the PLC for detecting faults.
2) To develop an algorithm and ladder diagram for PLC which will work for over current, over voltage, under voltage, thermal overloading and phase fault condition etc
3) To analyze and validate the performance of the system.
4) To protect transformer from faults like short circuit, and measure the parameters like oil level, fire detect temperature.

III. HARDWARE
A. Three phase Power Supply:

Normally power system has a three phase supply which is used for transmission of electrical power from one station to another station. A three-phase system is usually more convenient and economical than the single phase system. In three phase system used transformer are three phase and bigger in size than that of the single phase transformer and the protection of this equipment very essential to maintain the continuity in the power system.

B. PLC System:

Recently Programmable Logic Controller is used for industrial automation and computer control system that regularly observes the state of input devices and makes resolution based upon a custom program to control the state of output devices. Automated machine or a process is called as a process control system. The main function of this process control system is regularly monitored by input devices (sensors) and gives signals to a PLC controller. This PLC is easy to program and operation of operating person who is on the monitor desk, this PLC built in HMI and it shows the current status of system.

C. Vorlage Regulator IC (7824 & 7805):
The LM78XX series of three terminal positive regulators are available in the TO-220 package and with several fixed output voltages, making them useful in a wide range of applications. Each type employs internal current limiting, thermal shut down and safe operating area protection, making it essentially indestructible. If adequate heat sinking is provided, they can deliver over 1A output current. Although designed primarily as fixed voltage regulators, these devices can be used with external components to obtain adjustable voltages and currents.
D. MCB:
An MCB or Miniature Circuit Breaker is an electromagnetic device that embodies complete enclosure in a molded insulating material. The main function of an MCB is to switch the circuit, i.e., to open the circuit (which has been connected to it) automatically when the current passing through it (MCB) exceeds the value for which it is set. It can be manually switched ON and OFF as similar to normal switch if necessary.

E. Temperature Sensor (LM 35):
The LM35 temperature sensor is used to detect precise centigrade temperature. The output of this sensor changes describes the linearity. The o/p voltage of this IC sensor is linearly comparative to the Celsius temperature. The operating voltage range of this LM35 ranges from -55˚ to +150˚C and it has low-self heating. This is operated under 4 to 30 volts. The most extensively used electronic devices are operational amplifiers, which are certain kind of differential amplifiers. Temperature sensor circuit has terminals such as two inputs like non-inverting (+) and inverting (-) and only one output pin. Operational amplifier IC741 is used as a non-inverting amplifier. The variation between the i/p terminals amplifies the circuit.

F. Contractor:
The E-line contactors LC1E1810M5 1NO 18A 400V AC3 220V/50Hz offer proven performance for resistive loads or large motor starting applications such as fans, crushers, pumps, compressors and overhead cranes. They offer high reliability with long mechanical and electrical life and the most complete line of accessories in the industry.

IV. SOFTWARE
A. LOGO! Soft Comfort:
LOGO! Soft Comfort – stands for sensationally easy and quick configuration.

This allows the creation of user programs by selecting the respective functions and their connection via drag-and-drop. In single mode and in network mode. Automatic configuration of communication and display in network view. Up to 16 nodes can be dis-played in the network view. Up to three programs can be displayed next to each other. In network mode, you can easily drag signals from one program to another with drag-and-drop.

It has been proven useful to program the switching program step-by-step and to simulate and test it on the PC offline. This approach prevents time-consuming troubleshooting in the entire program. Short configuration times are accomplished by creating your own macro blocks in which frequently recurring program parts are stored in a macro library.

V. BLOCK DIAGRAM & WORKING
It consists of different blocks lines. This relays are used in two ways. First way is that it will trip the main circuit when any fault occurs. And second way is that PLC will check continuously to main current. If phase to phase fault will occur then relay trips the circuit automatically. It is believed that the failure zone was related to one individual phase, which was subjected to faults and experienced the initial asymmetrical component of the fault in transient.

The main component of this proposed system is PLC and, the sensors (current, temperature etc.) senses corresponding parameters such as current, voltage and temperature and send its electrical equivalent to PLC module.

If there is a rise in temperature on transformer, PLC first informs the operator by alarm if there is no response for a set period of time such extreme cases lead to circuit isolate on (tripping).

Fig. 1: Block Diagram

VI. RESULT
A. Welcome Screen:

B. Message under Normal Condition:
C. Message under Tripped Condition:

D. Message under Overvoltage & Undervoltage Condition:

E. Message under Over Current Condition:

F. Message under Overt Emperature Condition:

VII. CONCLUSION

The proposed PLC system which has been designed to monitor the transformer's essential parameters, it continuously monitors the parameters throughout its operation. When the PLC recognizes any increase or decrease in the level of voltage, current or temperature values the unit has been made shutdown in order to prevent it from further damages with the help of relays in three phase system. The system not only controls the transformer by shutting it down. This claims that the proposed design of the PLC system makes the transformer more robust against some key power quality issues which make the voltage, current or temperature to peak. Hence the system is made more secure, reliable and highly efficient by means of the proposed system.

REFERENCES


