PLC BASED TRANSFORMER FAULT DETECTION AND PROTECTION

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ABSTRACT

Power and distribution transformers of substation are one of the most bloated and inexpensiveequipment in power system network. The protection of this equipment is the major issue and this issue overcomes by the give proposed system. In a power system has an enormous number of transformers and different components over an extended area in power systems network. Monitoring, data acquisition system and automatic controlling are the important problems in a power system this problems over come by using programmable logic controllers. This paper presents design and implementation of automatic control circuits which is used in PLC (programmable logic controllers) automation to observe as well asrectify fault of transformers like temperatures of the transformer, load currents, and voltages. The proposed on-line monitoring system combinesa solid state device named PLC and a various sensor packages. The suggested PLC monitoring system will help to detectinside fault as well as outside fault of transformer and also rectify these faults with the help of desired range of parameters which is set by programmer operating person who is on the desk of control panel.

KEYWORDS: Monitoring, Transformers, Relays, Sensors, Ladder Logic, Transducer and PLC Automation.

I. INTRODUCTION

Now days, PLC automation has been played major role in power reliability and economy. A power transformer is a very valuable and needy device in a power transmission system. A monitoring is necessary to estimate transformer enforcement and safe operating conditions. High reliability of the transformer is necessary to avoid disturbances in transmission of power, because of the various adverse conditions in the power system. For this adverse condition PLCautomation is used; the various types of fault in power transformer can be detected and rectified by using PLC system. A high quality power transformer properly designed and supplied with suitable protective relays and monitors. When a fault occurs in a transformer or on the transmission line, the damage is normally severe due to high rating of power. The eventual goal is that to overcome the response time after occurring fault. In this system microcontroller is used for logging the current, voltage and temperature of a power and distribution transformer in a substation and to shield the system from any hazards conditions. The power distribution systemwithout a transformer is like heartless human, if the transformer is out of service is always very arduous to transfer the power from one station to another station. The collision of a transformer fault is more serious than a transmission line outage. There are different types of fault which occurs in power transformer,distribution transformer and on transmission line. These faults are mainly inside and outside faults of power transformer and power system. The main objective of this proposed system is to salvation

of the transformer verses internalas well as external faults and it gives the ensuring security of the transformer. Overloading of power transformers beyond the transformer rating, due to this increases the temperature of both oil and windings of the transformer. Overloading means inrush over current flow in the winding of the transformer this fault mainly occurs on secondary side of transformer. If the winding temperature increases beyond the transformer limits, the insulation will damage and may fail prematurely. External faults of Power system beyond transformer zone can cause change the voltage level will be high or low of transformer. It leads to over voltage fault and under voltage fault. Anextensive transformer protection scheme needs to include protection verses over voltage fault,transformer overload and low voltage fault as well as protection for internal faults. The fault impedance of power line being low, the fault currents are relatively high. During the occurrence of faults, the power flow is diverted towards the fault and the supply to the neighboring zone is affected and voltages become unbalanced.

II. TRANSFORMER FAULT DETECTION

A. UNDER VOLTAGE FAULT

Under voltage fault means the operating voltage goes below the predetermined limit, of voltage rating of the transformer or power system, then the under voltage fault will occur. This fault can detect by voltage sensor. Like potential transformer and potentiometer.

B. OVER VOLTAGE FAULT

Over voltage fault means the operating voltage goes above the predetermined limit, of voltage rating of the transformer or power system, then the over voltage fault will occur. This fault can detect by voltage sensor. Like potential transformer and potentiometer. An increase in terminal transformer voltage, There may be always a chance of system over voltage due to sudden disconnection of large load. The magnitude of this voltage is higher than its rating of the transformer but frequency is same as it was in normal operating condition. Over voltage in the power system causes an increase in stress on the insulation of transformer. Like potential transformer, Voltage transducer and potentiometer.

C. OVER CURRENT FAULT/OVERLOAD FAULT

Over current fault means overloading on the secondary side of transformer and excessive amount of the current flows in transformer. Over current conditions for very short time because of the protection relays which is used for the disconnect the circuit under hazards condition this relay operate before to any damage in transformer and isolate the faults from the power system line. Overload Current increases the temperature and thereby decreases the insulation life span and transformer winding. When the operating current increases beyond value of current rating, the over current fault will occur. This fault can detect by current sensor and Current transducer.

D. OVER TEMPERATURE FAULT

There is not only over load current may cause damage to the transformer but also the high temperature of the windings and transformer oil remains within specified limits. Over limit values of the temperature overcome the transformer life span. The transformer rated on a 24-hour average ambient temperature of 30°C (86°F). Increase in over voltage and over current the temperature of transformer oil fail the insulation of transformer winding. When the temperature of transformer increases beyond upper limit of temperature rating, the over temperature fault will occur. This fault can detect bytemperature transducer.

E. PHASE TO PHASE FAULT

Phase to phase fault means, faultoccurs between a phases of transformer are affiliateduncommon; when fault occurs it will lead rise to an actual current compare with the earth fault currents. Phase to phase fault (L-L, L-l-L fault) in the transformer are very uncommon. When this fault occurs, it will result rise in actual current to operate the instantaneous over current relay on the primary side as well as the differential relay both and disconnect input from the transformer to safe them . Relay provided to each phase of the transformer. This relays is operated in two ways, First way is that it break the main circuit when any fault occurs and second way is that PLC check regularly to main current. When phase to phase fault occur then relay break the circuit automatically.

III. DESIGN OF PLC BASED TRANSFORMER FAULT DETECTION

The block diagram of transformer fault detection and protection by using plc is as shown in fig.1 consists of different blocks.

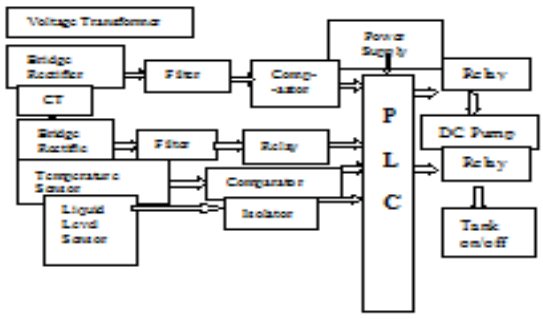

Fig.1 Transformer fault detection and protection using plc

IV. HARDWARE REQUIRED FOR PROTOTYPE MODEL

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 economicalthan 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. RELAYS

Relay is a static device which is the electrically operated switch. In this proposed system electromagneticoperated relay is used also other operating principle used. Relays are used where it is essential to control a circuit by a low power signal or where number of circuits is controlled by one signal. It is shown in below fig.- 3.

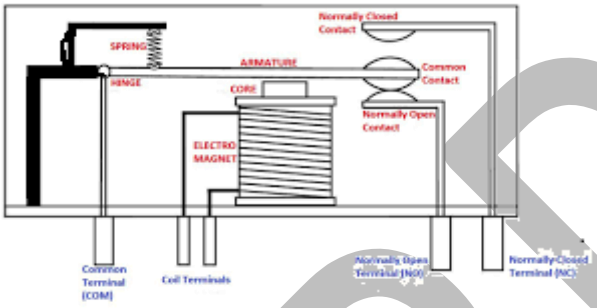

Fig. 3 - Electromagnetic relay

C. 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 givessignals to a PLC controller. In this proposed system slec Company PLC is used(MM3030). This PLC is easy to program and operation of operating person who is on themonitor desk, this PLC inbuilt HMI and it shows the current status of system.

D. COMPARATOR:

In this project we have LM324 is a 14pin comparator IC consisting of four separateoperational amplifiers compensated in a single package. In this project non-inverting operational amplifiers are used which has high gain electronic voltage amplifier with differential input and a single-ended output. The output voltage is many times higher than the input voltage,through this op-amps reference value is set and this reference value compared with the actual value if there is any difference between input and reference value gives output proportionally with the difference between them. For this operation LM324are used and operated by a single power supply and there is no need of a dual supply. The conventional op-amp applications can be more easily implemented with LM324.

E. TRANSDUCERS:

In this proposed system there are three types of transducers used like as Current transducer, Voltage transducer and temperature transducer.

F. SINGLE PHASE TRANSFORMER (230V/12V):

The conversion of the 230V /12V and voltage single phase step down transformer is used. Single phase 230V/12V transformer is used

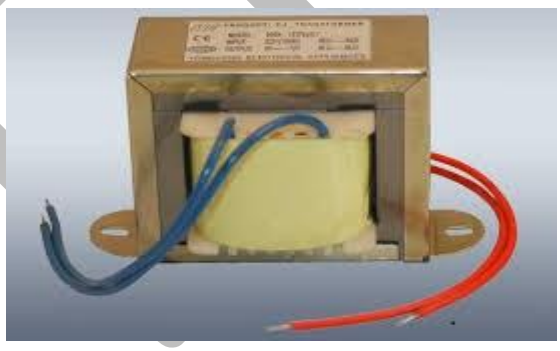

Fig.4 Single phase transformer (230/12V AC)

G. POWER SUPPLY:

In this proposed system PLC, relay and micro-controller is used for both this regulated supply is required. For the PLC 24V DC, for the relay operation 12V DC and for the micro-controller 5V DC is required. The conversion of the 230V/12V and voltage is rectified in a pure DC voltage and given to the PLC, relay board and micro-controller. Below fig,4 is the power supply circuit from the single phase supply to the required supply and for this single phase transformer also necessary.

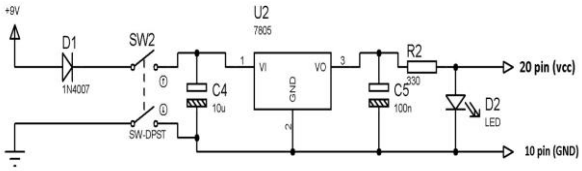

Fig.4 Circuit Diagram of Power Supply

H. LOAD:

For convenient and reliable operation of this project, we are used 2 lamps rating of each 4W. and both side of load placed sensors to sense the change in the voltage and current. If any abnormal condition occurs then this sensors

sense this values and gives signal to the plc for further operation.

V. FLOW CHART OF PROPOSED SYSTEM

A fig.6 shows that the sequential operation of protecting system. When system start it continuous monitor voltage and current value .Is the value of V&I more than the predetermined value, the command window send the signal "YES" the desired LED will be ON and the SMS send through GSM, at gives trip command to the relay circuit. If values are within a limit, it gives "ON" command and continuous monitor. At the same time it monitor oil level ,if oil level is low then it send signal to pump ON and SMS send trough the GSM. If is sufficient then it gives the NO command and continuously monitors the oil level. Similarly at same time the process monitoring temperature is goes on, if the monitored temperature is more than set value it gives the YES command and fan ON ,if NO then its continuous monitors the temperature.

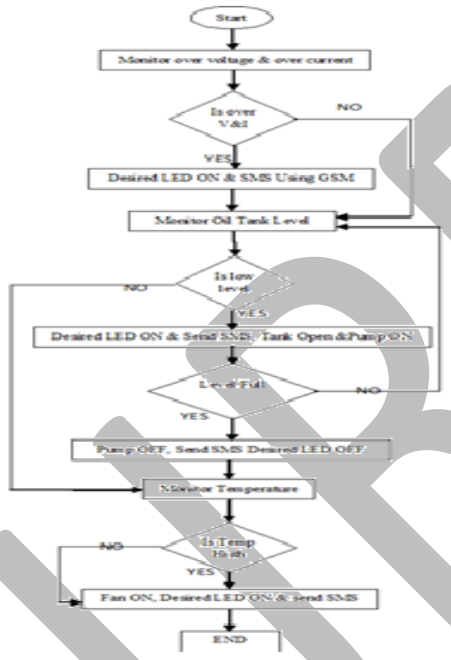

Fig. 6 flow chart of the proposed system

VI.CONCLUSION

In this proposed system we have design protection system of transformer based on PLC that is used to observe and control the current, voltage and temperature of a power and distribution transformer on both the primary and secondary sides. The proposed PLC system which has been designed to monitor the transformer's required parameter continuousmonitor this parameters throughout its operation. When the PLC identify any change in the level of voltage, current or temperature values ,the transformer has been made shut-down in order to protect from damages with the help of relays in single and three phase system. The system not only controls the transformer in the substation by shutting it down, but also displays the values throughout the process for users on HMI screen of PLC. This demand that the proposed design of the PLC system makes the transformer more robust against the adverse issues which makes the voltage, current or temperature to peak. Hence the distribution is made more secure, reliable and highly efficient by means of the proposed system. From this model we protect the distribution or power transformer from the adverse condition hence total life span of the transformer increase up to some extent.

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