

A Literature Review of Transformer Protection by Using Different Protection Schemes

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Abstract – Transformers play out a crucial part in a power system in ensuring dependable power delivery to power consumers. This paper contributes the idea of approximately exceptional varieties of transformer protection to be extra useful for investigating the protection system of the transformer. In this review paper, an exertion to assemble improvements in the protection of the transformer. Endeavors had been developed to cover every one of the methods and philosophies used to that end. This consists of transformer protection using a PLC system, Fuzzy set, GSM module, relay, Arduino, etc. This paper additionally consists of observing & controlling the transformer with the assist of a PLC system and single-board pc. It additionally shows the impact of inrush current on transformer protection. There are numerous significant parts introduced in the transformer which are exorbitant so these must be protected in an abnormal condition. The transformer plays a top-notch task within the power system to alternate voltage and current levels so proper protection for the transformer is essential to keep up dependability in the system. Normally, a properly planed transformer protection system presents an extremely good life with no uninterrupted power supply. To grow life, efficiency, ordinary performance then reduces strain on the transformer is the simplest way so this protection system assist here to study those matters properly.

Key Words: Transformers, Protection, Fault, PLC, GSM, Relay, Arduino.

1. INTRODUCTION

A transformer is an important unit in the power system network. Due to, the enormous number of transformers in the different segments over a wide region in power systems, data acquisition, condition monitoring, automatic controlling, and protection are significant issues. The transformer is a static device that transfers power from one circuit to someone without any exchange within the frequency appropriate protection is required for prudent and safe activity of the electrical power system. Transformer dealing with the issue of inrush current, thermal overload, etc. So, in this paper, all technologies and protection schemes of the transformer are mentioned.

The transformer is an extravagant and imperative unit that needs appropriate protection from abnormal conditions. Due to its moderately simple construction, it is

exceptionally dependable equipment. This reliability, but, requires appropriate design methodologies, annual overhauling, and different protection schemes for different possible problems. The main objective of transformer protection is to sense faults in the protective zone with affectability, yet additionally with a serious level of resistance. The method of protection for the transformers changes relying upon the application and the significance of the transformer. Transformers are protected mainly towards fault and overload circumstances. Good protection schemes can give stability, reliability, and security to the power system. [1]

The primary purpose of this paper is to present various methodologies of transformer protection.

2. Different Protection Schemes of Transformer

2.1 Thermal Overload Protection

The overheating in a transformer is fundamental because of the overloads and short circuits. In a thermal overload protection system, if the temperature of the transformer is ascended past the safe value, the transformer is isolated from the system. It is completed by the inclusion of the manipulate circuit inside the secondary winding. This embedded circuit detects the temperature of the transformer and disengaged the system from the secondary winding. This control circuit again faculties the temperature of the transformer and on the off chance that the temperature is normal then these circuits will associate the transformer to the system. In this kind of overload protection, the working of the control circuit is programmed. The action that takes place in the control circuit depends on the temperature of the transformer. [2]

As demonstrated in the figure. 1 the protection system is associated with the secondary winding of the transformer. The primary winding of the transformer is delta connected and the auxiliary winding is star connected. The protection system is associated with the neutral point of the auxiliary winding. The auxiliary winding is associated with the three-phase contactor and this contactor is associated with the bimetallic switch. In these kinds of a switch, the bimetallic strip is to change over a temperature change into mechanical dislodging. The temperature is observed by this bimetallic switch. At the point when the temperature of the transformer is raised the bimetallic switch observes the temperature and changes its position. The switch is associated with the contractor. At this point, the switch

opens the contactor's contact. Whilst the contacts are open the auxiliary winding of the transformer is open and the system is isolated from the transformer [2]

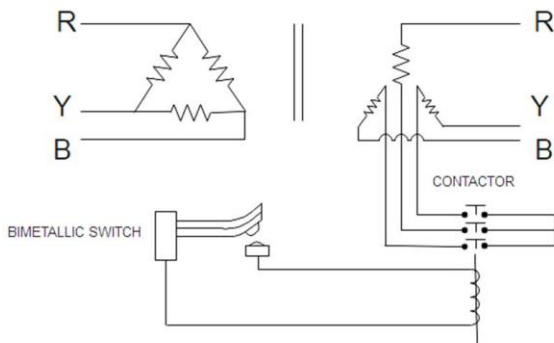


Fig-1: When transformer is overloaded.

Under normal working conditions, the contactor is connected and the transformer is associate with the system. This is an automatic kind of protection for an overload condition.

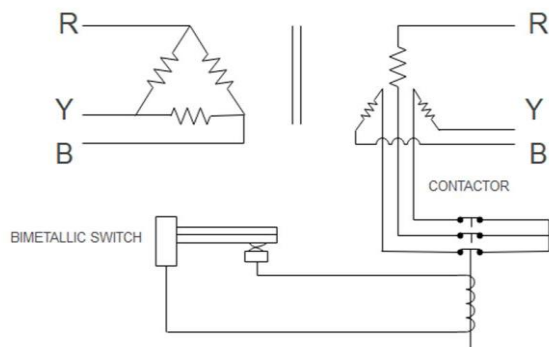


Fig-2: When transformer is normal condition.

2.2 Transformer Protection Using Differential Relay

A differential relay is a state that the relay working whiles the phase angular of two or extra identical electric values exceeds a set value. The differential relay function on the concept of differentiating with the phase angle and value of two or extra similar electrical values. Differentiate two electric values in a circuit by utilizing differential relays is easy in utility and high quality in action.

Perhaps the best technique for protection to protect transformers is the Differential protection approach with the aid of the use of differential relay circuits. This method

is primarily based on the standard that the power fed to the transformer under typical conditions is equivalent to the power out. By legitimate association of the secondary's of current transformers (CT), under typical conditions, no current will stream into the relay coil. Whenever a fault takes place the current equilibrium will not exist and relay contacts will close and fed a trip signal to Circuit Breakers (CB) to work to isolate the faulty equipment [3].

As shown in the figure. 3, the association of overcurrent relay. The dashed line shows the segment which is utilized to be protected. The current transformer is associated at both ends of the protection area. The auxiliary of the two transformers is associated in arrangement with the assistance of the pilot wire. Consequently, the current actuates in the CTs flow in the same direction. The working coil of the relay is connected at the auxiliary of the CTs.

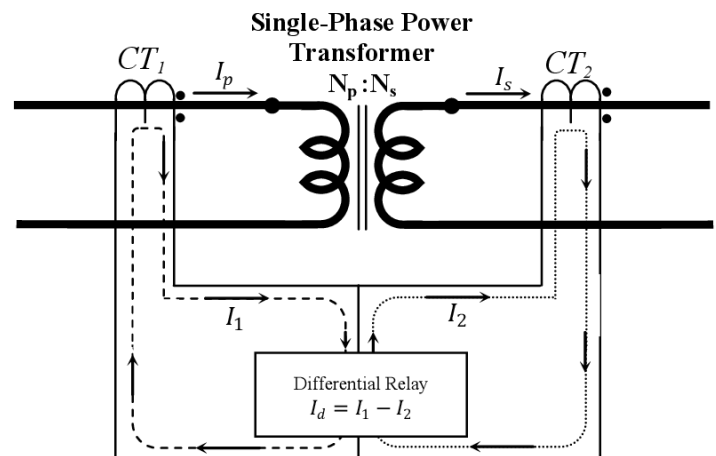


Fig-3: Differential Protection of transformer.

In the typical working condition, the magnitude of current in the auxiliary of the CTs stays the same. The zero current flows via the operating coil. On the incidence of the fault, the extent of the current on the secondary CTs becomes inconsistent due to which the relay begins working. Then, the relay fed the signal to the circuit breaker.

2.3 Monitoring & Controlling of Transformer Using GSM Module

Protection of transformer is very critical in addition to monitoring & controlling additionally significant for the transformer. Numerous transformers are damaged because of overload or fault conditions, henceforth by joining monitoring & controlling the life span of the transformer may be elevated.

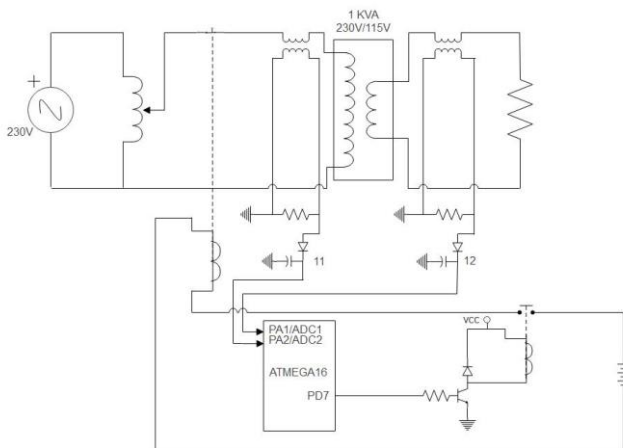


Fig -4: Monitoring & Controlling of Transformer Using GSM Module

The online monitoring system includes an embedded system, GSM modem, portable-users, and GSM networks and sensors attached at transformer site. Sensors are set up on the transformer side which peruses and measures the physical amount from the distribution transformer and afterward it changes over it into the analog signal. The embedded module is situated at the transformer site. It is used to procure measure, monitor, transmit and receive the parameters to/ from the GSM modem. The second is the GSM module. It is the connection between the embedded system and the general public GSM organization. The third is a utility module that has a PC-based -server situated at the utility control center. The server is linked with the GSM modem and collect SMS from the transformer site through the GSM

2.4 Transformer Protection Using Arduino

Arduino is an open-source electronics stage that depends on simple to utilize equipment and programming. Arduino boards are capable of examine inputs - light on a sensor, a finger on a button, or a message - and convert it into an output - initiating a motor, switch on an LED, distributing something on the web.

Arduino comprises of both an actual programmable circuit board (often referred to as a microcontroller) and a bit of programming, or IDE (Integrated Development Environment) that runs to your pc, utilized to compose and transfer pc code to the actual board.

By programming, in Arduino, we can defend the transformer from fault. Writing computer programs is very productive than differential relay mechanisms, so it is smarter to utilized Arduino rather than a differential relay. The operating of the transformer is proven with the aid of Arduino each time. It monitors the state of the transformer every second. Assuming it observed any fault then it sends instructions to the circuit breakers to isolate the primary potential transformer. So it is the proficient and best

technique to ensure the transformers under faulty conditions. [1]

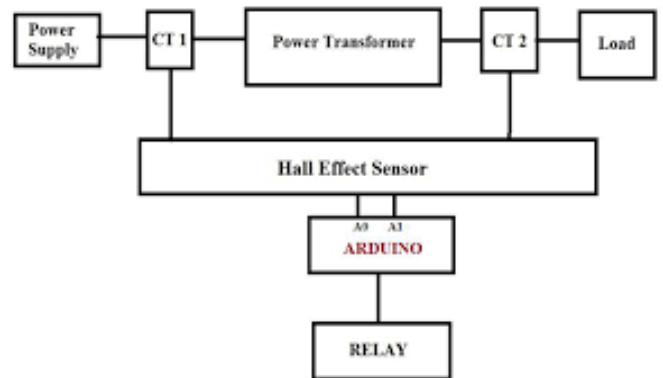


Fig -5: Differential Protection of transformer.

The above figure shows the differential protection of the transformer utilizing Arduino associate with a voice signal. Arduino is the fundamental part of this circuit. Arduino differentiates the currents in both primary and secondary winding. Two rectifiers are utilizing in this circuit to change over the AC voltage into DC voltage for the Arduino. Both current transformers are likewise given on both the main and auxiliary sides to tap the currents on both sides and to give adjusted voltage to the rectifier circuits. One relay circuit is associate with the Arduino. A relay circuit is utilized to provide the command to the voice circuit, and afterward, this voice circuit produces a voice signal.

Under typical working conditions, currents on each primary and secondary side are the same. Thus, the reasonable voltages produced by the current transformers on the primary and auxiliary sides are equal. These two voltages will provide to the Arduino. The decent voltages produced by current transformers are rectified via the rectifiers in the circuit. Under typical working conditions, these voltages will be equal in magnitude and the difference is null. Thus, the Arduino offers no command to the relay. [1]

When a fault takes place within the transformer the currents visible employing the CT on the primary and auxiliary side differs via equal amount. Accordingly, the voltage detected by the Arduino from the essential and auxiliary sides contrasts. As there is a distinction in the voltage detected by the Arduino i.e., contrast isn't zero. Arduino fed a signal to the relay. When the relay is activated via the Arduino the relay will turn on the voice circuit. The voice circuit will deliver yield predefined voice as an alarm to the administrator. After three consecutive voice alarms Arduino will provide an isolated sign to the relay board and which is associate in arrangement with the delivery will open its contacts as a consequence the supply to the hardware arrangement will be disengaged.

2.5 Transformer Protection Using Fuzzy Set Approach

The Fuzzy Set principle idea is first off based by Zadeh scientist in 1965 for managing questionable and vague properties of occasions. Also, for power system protection fuzzy set idea was first and foremost utilized in 1979. In like manner, the fuzzy set principle can be considered speculation of the standard set principles. In the fuzzy set principle, the relationship of the component can be constantly modified. Since fuzzy logic utilized heuristic knowledge, expert information, and experience, it's miles a totally useful mathematical medium to tackle decision-making hassle. So it's far a completely effective weapon to communicate quantitatively unsure values and the connection between them. [5]

The transformer is a crucial factor in the electrical power system. To amplify the fault identification affectability of conventional percentage differential current relay calculation, fuzzy logic techniques are utilized. The fuzzy derivation is a strategy that settles a choice in parallel. [5-12] Due to these assets, there's no statistics destruction at some point of the method and so resultant fault identification will be far unique than that of conventional relaying strategies. Fuzzy logic utilized phonetic factors as opposed to mathematical factors. The way toward changing over a mathematical variable into a semantic variable (fuzzy number) is called Fuzzification. Fuzzification plays out a remarkable part in managing dubious data, which may be unbiased or emotional.

Researchers advanced on the protection of differential power transformers after 1990 utilizing a fuzzy logic idea. The fuzzy logic method can additionally with the traditional DGA strategy for fault identify and choice-making. So this thesis additionally indicates an improved approach for fault identification of transformer parallel with the conventional approach. [10] This approach offers the self-adjusting feature and this could allow in the identification of faults within the transformer. It has been guaranteed that the strategies can recognize incipient faults. To make extra effective a blended technique of multi-criteria, fuzzy set and wavelet-based method were moderators by Jiao et al. [11] This article sums up a fuzzy-based algorithm consisting of flux-differential current spinoff curve, harmonic limitation, and percentage differential feature curve. [5]

2.6 Transformer Protection Using Programmable Logic Controller (PLC)

A programmable logic controller (PLC) is an industrial virtual computer that has been tough and adjusted for the manipulate of production approaches, for example, sequential construction systems, robotization, or automated devices, or any action that calls for more reliability manipulate and simplicity of command and process fault analysis. These controllers are in particular designed to continue to exist in harsh conditions and

protected from warmth, cold, residue, and dampness, and so forth PLC includes a microprocessor that's programmed using the pc language. The program is composed on a pc and is downloaded to the PLC through cable. These stacked commands are stored in the permanent storage of the PLC.

Because of the wide scope of PLC robotization, the different sorts of shortcomings in the power transformer can be diagnosed and analyzed by utilizing a PLC device.

As shown in the figure. 6, the fault sense and protection of the transformer utilizing a PLC system. In this framework, three sensors are utilized. One sensor is utilized for the relay circuit, another one for the transformer, and the third one is utilized for temperature detecting.

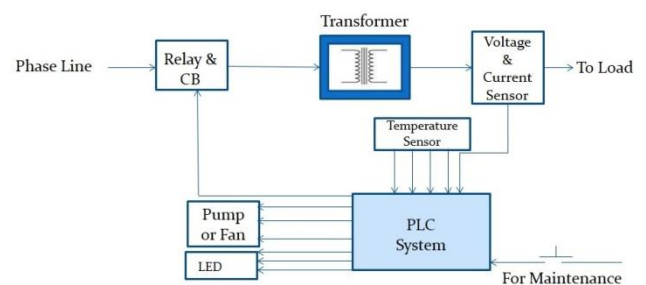


Fig -5: Transformer Protection using PLC.

All the sensors detect the fault and provide a signal to the PLC system. This PLC system fed a command to the relay.

At the point when the PLC perceives any increment or abatement in the magnitude of voltage, current, or temperature esteems the unit has been caused closure to keep away it from additional harm with the assistance of relay. [5]

3. Research Objectives

- 3.1 Provide a reliable and continuous power supply to the consumers it ensures.
- 3.2 If the transformer encounters any fault then automatically trips the circuit.
- 3.3 Continuously observed the parameters via its operation.
- 3.4 Save the fault parameters for forthcoming reference of maintenance engineers.
- 3.5 No manpower is required to monitor the transformer.

4. CONCLUSIONS

In this paper distinctive kinds of techniques for the transformer, protection is mentioned, & controlling and observing of transformer is also likewise talked about. In this paper, five techniques of transformer protection are talked about like transformer protection by utilizing thermal overload protection using a bimetallic switch, differential relay, Arduino, Fuzzy logic, and PLC systems. Initially, thermal overload protection portrays the

protection techniques of the transformer from the overheating of the transformer. The advantage of this technique is, it is miles automated protection approach no manual operation is required. The second is transformer protection by utilizing Arduino. This protection conspires works proficiently. The affectability and dependability of this technique are exceptionally high for faulty conditions. In the future, this work can likewise be expanded by utilizing PLC. The third is transformer protection using PLC. PLC is utilized to control and observed the magnitude of temperature degree, current, and voltage of the transformer.

PLC system makes the transformer stronger against different issues. This technique makes the transformer more dependable, protected, and effective. Fourth is transformer protection utilizing a differential relay. This is the best technique to protect the transformer from fault. This relay has the unique benefit of lessening the hour of activity to a minimum for faults near the source wherein the fault current is the more.

More exploration in fault evaluation and relay will bring about better execution in transformer protection. If circuit counter and GSM circuit, IoT, SCADA with PLC are associated then we will observe the transformer from a remote location.

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