Transformer Optimal Protection using Internet of Things

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Abstract: In power system transmission and distribution transformers plays crucial role. As per the consumer requirement the transformers either step up or step down voltages and deliver the power. Sometimes they are operating under overload conditions. In this paper, Microcontroller and different types of sensors can be used to protect the transformer against over load and various internal faults. Real time monitoring of the transformer is also an important part in the transformers protection. A prototype hardware module has designed to sense the temperature raise and pressure in the transformer tank using micro controller based sensors. The monitoring and protection can avoid various faults in the transformer and it can give better performance.

Keywords: Optimal protection, Transformers, Micro controllers, Sensors, Relays and Cloud data

I. INTRODUCTION

The transformers are very important devices in the power system transmission and distribution systems. They are also very costly. They are used in small distribution systems for serving large number of units. As the transformer applications are increasing it is necessary to protect transformers. Therefore protection of transformers is very important.

The electrical load on the power system networks rapidly increases due to the day-by-day population increase. With increase in the load demand the transformers get overloaded and it leads to develop various types of internal faults in the transformer. In order to avoid damage to the transformer, need to control against overload and fault current tripping to the transformer. The transformer can be protected in Differential and microprocessor based protection systems. Here, it is protected with microcontroller based protection with Internet of Things (IoT) [2] [5].

The protective relays should operate accurately and reliable. From the several years, static relay are used for the power systems. Later, new types of relays are introduced which can be controlled with microcontroller. As the digital technology advances, the digital hardware becomes low cost, reliable Operation and simple in construction. Hence, in electric power system the transformer can be protected with the use of digital relays [3] [6].

II. PROBLEM FORMULATION

The modern power system must operate under desired conditions. They can be achieved by using reliable and accurate protective devices. In this paper, microcontroller based sensors has been used to protect the transformers from overload and fault conditions. The figure 1 shows the various blocks of protective system.

![Fig.1: Block diagram of Protective System](image)

III. COMPONENTS

A. Microcontroller(ESP 32)

![Fig.2: ESP 32](image)
ESP32 microcontroller is a low-power System On Chip integrated with high speed dual core processors along with Wi-Fi, Bluetooth classic and BLE, low-noise receive amplifier, RF balun, power amplifier, power management modules, filters and antenna switches. The added peripheral features of ESP32 improve the application with reduced printed circuit board requirements. It can operate reliably in range of temperature from −40°C to +125°C. The figure 2 shows the image of ESP32.

B. Transformer

The transformer is the static device that operates according to the principle of electromagnetic induction. It is used to transfer the electric current from one circuit to another without any variation of their frequency. With electromagnetic induction, the transfer of energy from one circuit to another is done by mutual induction. i.e., the flux generated in the primary winding is coupled to the secondary winding. The figure 3 shows the image of transformer.

C. Relay

Relay is a two-way switch which operates electrically and works on the principle of an electromagnetic attraction. One electrical control circuit relays to open and close your contacts through other circuit. Relay divided into two parts: the primary and secondary. The primary section of the relay generates supply by hand. This is said to supply operating voltage of relay and secondary section of contactors to connect or disconnect mechanics. Here as shown in figure 4, two channel relay module is used as a circuit breaker to isolate the transformer when faults occur.

D. Temperature sensor

The DS18B20 is a waterproof temperature sensor with built in 12 bit ADC and communicates over a one-wire bus which uses only one wire of digital pin for communication. It is pre-wired and ideal for distance reading or in wet conditions. It measures temperature in the range of −55 to 125°C. Here as shown in figure 5, temperature sensor (DS18B20) is used to measure the temperature in transformer oil tank to detect the faults.

E. Flow Sensor

The flow sensor is used to measure the flow of water / liquid. It is also called a Hall effect water flow sensor. This sensor is aligned with the water line and contains a wind turbine sensor to measure the amount of liquid that has passed through it. There is an integrated Hall effect magnetic sensor that delivers an electrical impulse every turn. The Hall sensor is sealed against the water supply and ensures that the sensor stays safe and dry. As shown in figure 6, on the sensor, water flow indicator will be present and it indicates the direction of flow of water. Here it is used to measure transformer oil overflow from the tank when faults occur.

F. Fan

These are used in project for cooling the transformer oil.

IV. IMPLEMENTATION & RESULTS

The transformer is a major part in the power system, it can be monitored and operate under reliable and economic manner a prototype system is designed is shown in figure 7.
In this protection microcontroller (ESP-32) connected with flow sensor, temperature sensor, fans, buzzer and relay. The flow sensor is placed between transformer tank and conservator tank and temperature sensor is placed in the transformer tank.

When the temperature of transformer oil is greater than a certain temperature due to over load and weather condition, it is sensed by the temperature sensor and this information is given to the microcontroller [7] and based on the temperature one or two fans are switched ON. If the temperature is not controlled and it is greater than pre-specified value the relay disconnect the loads.

Similarly when the fault occurs in transformer, the oil will flow from main tank to conservator tank. This oil flow can be sensed by flow sensor and it will be send to microcontroller. Then the fault section will be isolated by the relay operation. If the relay will not be operated during the fault conditions, buzzer will give an indication [8]. All this information we can observe in the cloud with the Internet of Things (IoT)[9]. The operation of the designed circuit is shown figure 9.

V. CONCLUSION

In the power system transformer is major equipment. For the reliable and economic operation proper protection is required. The microcontroller based relay can be implemented for the optimal protection of transformer. This type of protection can be useful for the oil filled and air insulated transformer. The real
time data can send to the cloud and the protection can be monitor by analyzing the data through online.

**REFERENCES**


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