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Real-Time Monitoring and Smart Transformer Protection by Using IoT

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Abstract **-** Transformers is the basic design of the electrical device which provides power transmission by transforming induced current from one circuit to another. The induced current can be converted step up or step down of current or voltage. This application mainly concentrates on the distribution as well as power transformers which are used in between the electrical Power system. Real-time monitoring and protection are done for basic features like oil level, temperature, over-voltage, over-current, under-voltage, maintenance, etc. These features are essential for effective power transmission and the long life of transformers. The monitoring and protection of the transformer are done by using an ATmega16L microcontroller, IoT, and sensors which check the level of oil, over-voltage, smoke detect and maintain temperature by continuous real-time monitoring. There are various transformer maintenance techniques, but this kit gives real-time monitoring and control of transformers by using the ATmega16L microcontroller. The design is to sense the parameters of the transformer and send the parametric information regularly to the control room. So, this design makes it possible to attain real-time protection and monitoring by using IoT. This project gives us an efficient system as well as we are connected all the power system transformers online for regular monitoring and get uninterrupted power supply to the consumer.

Keywords- Transformer, Faults, Protection, Inrush Current, Relay, IOT module, Monitoring & protection, microcontroller.

I. INTRODUCTION

As we know, the transformer is the heart of the whole electrical power system. It is very essential to protect them from various faults that happen in the system due to some natural or unnatural faults. Protection against fault in an electrical power system is very essential and vital for reliable performance. A power system is said to be faulty when an undesirable condition occurs in that power system, where the undesirable condition might be short circuits, over-current, overvoltage, etc. This system with a unique concept to date is being designed specifically to have complete extremely secure protection for transformers ranging from VAs to MVAs. Its main objectives are as follows: -

• To detect & prevent faults that are costly to repair and result in a loss of service.
• The system will be designed for monitoring voltage, current, phase angle, temperature& oil parameters of the transformer at a substation or the field.
• It will be equipped with the IoT module for a machine to machine wireless communication
• The system parameters will be displayed on the PC or any internet-operated device.
• The system will have a TFT display that will display online status in graphical and tabular data.
• The system will have all required main protection assembly to protect the transformer, with a backup power supply.

Later enormous enthusiastic technology for Machine-to-Machine communication is known as the Internet of Things (IoT). by using this technology, we can improve monitoring and get an efficient working system. this is an advanced technique that connects the system to all operators for reliable operation. Sensors are utilized to detect the fundamental parameters of the transformer, for example, over-voltage, under-voltage, over-current, high temperature, oil level this detected information is sent to the microcontroller. This controller checks break down information given by sensors and offer directions to assurance gadgets according to the prerequisite and this information is further sent to the IoT module this information ensure the correct data is close by for the administrator and the administrator can settle on valuable choices before any disastrous disappointment based on that information of parameters. With the goal that we need a continuous observing framework to identify every working parameter activity and send it to the observing focus in time. It prompts Online checking of key operational parameters of transformers can give valuable data about the soundness of transformers which will push the utilities to ideally utilize their transformers and keep the advantage inactivity for a more extended period.

II. EXPERIMENTAL

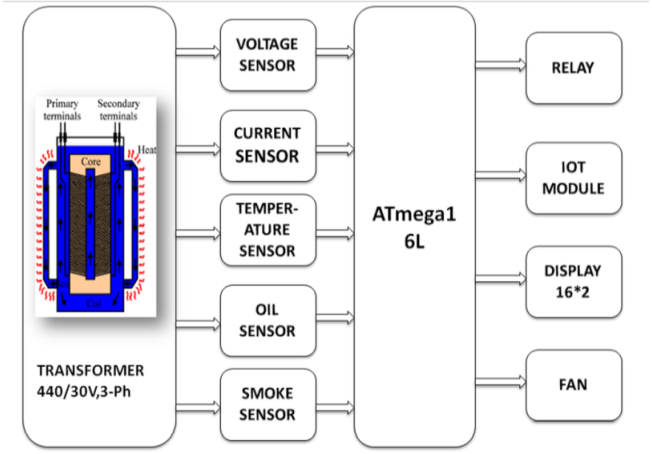

Figure 1: -Block diagram of the protection unit

We are utilizing the most recent innovation to develop this venture, it's a model for this task or this framework can be utilized in a high evaluating transformer which is exorbitant to us, and because of whole wellbeing conditions, we are indicating the entire intimation structure of a model. In this structure, we are acquainting different sensors with sense different parameters of the transformer in different climate conditions. This information can use for the insurance of the framework and use to decrease debacle that happens because of a flawed condition. We are additionally associating this information to the "IoT module " for continuous observing and if any flaw happens in the framework, at that point the administrator can without much of a stretch recognize the shortcoming area and issue type so it can decrease recuperation time and increment proficiency.

Segments utilized in the structure are as per the following:

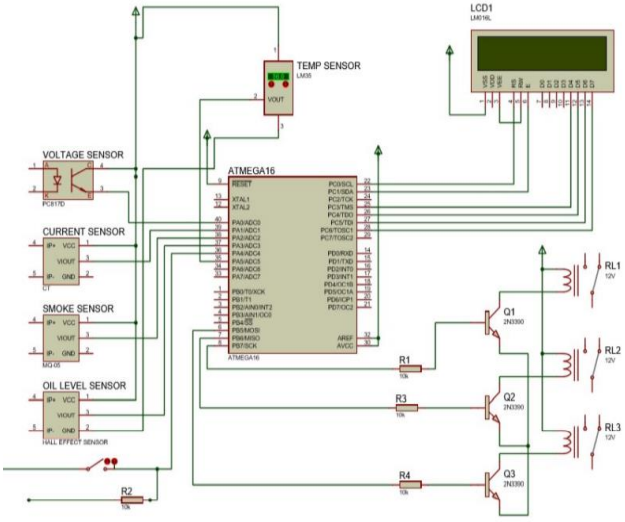

Figure 2: -Circuit diagram of the protection unit

1. VOLTAGE SENSOR

Optocoupler is used as a sensing unit to sense variation in the output voltage. The variation is to be sensed and necessary duty correction needs to be done probably by a microcontroller, Opto-couplers, are made up of a light-emitting device, and a light-sensitive device, all wrapped up in one package, but with no electrical connection between the two, just a beam of light. The light emitter has been nearly always an LED. The light-sensitive device may be a photodiode, phototransistor, or more esoteric devices such as Thyristors, TRIACs, etc. The Optocoupler is an input of a microcontroller. This project, will measure secondary side voltage and transfer the input value to the transformer.

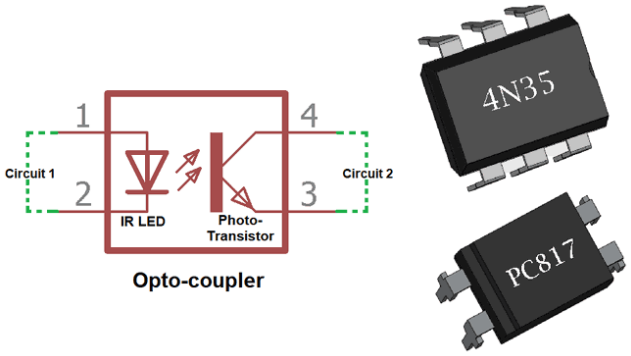

Figure 3: -Optocoupler

2. Current Sensor

A current sensor, i.e. CT (Current Transformer) is a sensor used to calculate and monitor the over-current in the transformer. If sudden changes occur in current, the sensor senses the fluctuation in current and relay trips automatically and hence transformers are protected from over-current conditions. One of the major benefits of using current transformers in our application is the isolation it provides between the circuit and the transformer. CT can be placed at any location on a board without affecting the connectivity of the circuit. The current sensor senses secondary current and sends it to the microcontroller as the current value of the transformer.

Figure 4: - Current transformer sensor

3. Temperature Sensor

The LM35 series is a precision integrated-circuit temperature sensor with an output voltage linearly proportional to the Centigrade temperature. The LM35 device has an advantage over linear temperature sensors calibrated in Kelvin, as the user is not required to subtract a

large constant voltage from the output to obtain the convenient Centigrade scaling. The LM35 device does not require any external calibration or trimming to provide typical accuracies of ±¼°C at room temperature and ±¾°C over a full −55°C to 150°C temperature range. The temperature sensor senses the transformer temperature and gives it to the microcontroller to monitor the temperature level of the transformer.

4. Smoke Sensor

A typical 117/15.2-kV, 37/50/62.5-MVA Power Transformer can contain approximately 10000 gals (37855 l) of oil. Larger transformers can contain much more oil. Transformers are filled with oil for several reasons, the most important of which is insulation. Additionally, the oil is used as a coolant and as a dielectric fluid, preventing arcing, the electrical breakdown of gases accompanied by the discharge and resulting ionization known as the corona. For comparison, a "semi" truck gasoline tanker truck holds 9000 gallons, give or take. Since oil is a combustible liquid, when a transformer fault or failure occurs, the transformer itself can provide both the ignition source and fuel for a fire. At the time of fuel fire, the smoke sensor MQ-5 sensor senses the smoke and suddenly relay trips automatically so that the transformer shuts down and hence the transformer protects from fire. The smoke sensor senses fire smoke and immediately informs the microcontroller.

Figure 5: -MQ-05 Smoke sensor

5. Oil Level Sensor

A float switch is a type of level sensor, a device used to detect the level of oil within a transformer tank. The switch is used as an indicator, an alarm, or to control the oil level of the transformer. where the switch detects the rising level of oil in the transformer tank and energizes an electrical pump which then pumps liquid out until the level of the liquid has been substantially reduced, at which point the pump is switched off again. Float switches are often adjustable and can include substantial hysteresis. That is, the switch's "turn on" point may be much higher than the "shut off" point. Oil level sensor dipped in transformer oil and sense oil level of the transformer. if the oil level is below permissible level then the sensor immediately informs the microcontroller.

Figure 6: -Float sensor

6. Microcontroller

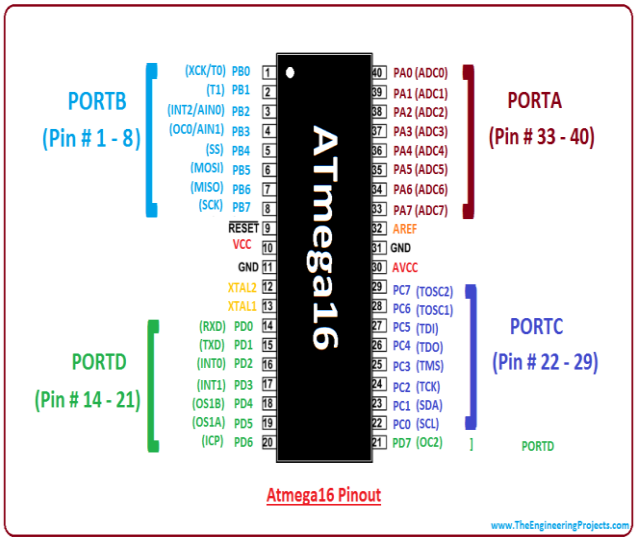

Figure 7: -ATmega 16 microcontroller

A microcontroller is embedded inside of a system to control a singular function in a device. ATMEGA 16 Microcontroller is that controls all sensors it receives data from the sensor and then sends the data to the IoT module, Relay, and cooling fan. The ATmega16L is a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. By executing powerful instructions in a single clock cycle, the ATmega16 achieves throughputs approaching 1 MIPS per MHz allowing the system designer to optimize power consumption versus processing speed. The microcontroller works as a control processing unit in this project. The microcontroller takes all input values from the sensor and processes on it as per programmed and generates out as given below: -

i. **Voltage Sensor: -**

voltage	display	The action was taken by the protection device
At 190 V	Under-voltage	Relay trip circuit
At 250 V	Over-voltage	Relay trip circuit

ii. **Current Sensor: -**

current	**display**	**The action was taken by the protection device**
Below 4A	Under-current	Relay trip circuit
At 6A	Over-current	Relay trip circuit

iii. **Temperature Sensor: -**

Temperature	**display**	**The action was taken by the protection device**
At 75^{o} C	Overheated fan ON	Fan ON
At 90^{o} C	Overheated	Relay trip circuit

iv. **Smoke Sensor: -**

Smoke	**The action was taken by the protection device**
Smoke detected	Relay trip circuit

v. **Oil Level Sensor: -**

Oil level	**The action was taken by the protection device**
Low level detected	Relay trip circuit

7. IoT Module

An IoT (Internet of Things) module is a small electronic device embedded in objects, machines, and things that connect to wireless networks and send and receive data. To provide Real-time monitoring to the transformer the data collected by IoT from the microcontroller and stored data in the cloud then sends to the operator through the internet connection. IoT module provides real-time monitoring to the transformer. IoT software addresses its key areas of networking and action through platforms, embedded systems, partner systems, and middleware. These individual and master applications are responsible for data collection, device integration, real-time analytics, and application and process extension within the IoT network. IoT device is the main advantageous part of this project, by using IoT we will monitor all transformer parameters and display them online for the operator.

8. Relay

Relay is a switch that controls (open and close) circuits electromechanically. The main operation of this device is to make or break contact with the help of a signal which is received from the microcontroller when sensors sense over current, overvoltage and over-temperature then relay trip without any human involvement and protect the transformer from any faults. A relay is an electromagnetic switch operated by a relatively small electric current that can turn on or off a much larger electric current. We are using a relay for shutdown circuit when microcontroller gives instruction to relay in un-favorable condition for the transformer to shutdown circuit it will work as circuit breaker and shutdown circuit immediately without any delay.

III. FUTURE ASPECTS

In this project, we provide protection and monitoring for distribution as well as power transformer in future, we can use this for all types of transformer with making changes in protection devices and sensor rating, we can also connect all transformers in one screen to monitor all areal power supply by transformer & for maintaining efficient power system and transformer working with consumer satisfaction.

IV. CONCLUSION

The issue of significant expense upkeep due to the disfigurement of transformer twisting because of the ruinous powers created in the transformer center and twisting get together under deficiency condition because of flaw present or some other parametric change could be redressed by the created assurance structure. The planned unit is fit for giving all the current essential insurance to the transformer which incorporates differential assurance, confined earth flaw security, over-current insurance, overvoltage assurance with temperature observing and controlling by means of cooling structure just as it additionally gives over-temperature insurance. The propelled highlight incorporates a correspondence framework for information trade by means of the IoT module. This predefined structure makes the unit fit for trading information with the ideal framework set at wherever with high productivity and unwavering quality with great similarity and availability. The locally available presentation mounted on the unit is equipped for giving the information in an appropriate graphical and unthinkable structure which is anything but difficult to peruse and see likewise gives a great deal of useful information. The progressed IoT module procedure helps in better methods for interchanges which upgrade the improvement in the constant observing procedures. This framework most developed procedures and assurance gear to give 100% proficiency.

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