TRANSFORMER PROTECTION USING MICROCONTROLLER BASED RELAY AND MONITORING USING IOT AND GSM

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Abstract: World is moving fast and is being more connected. Thus as to be ready for future upgrades we must bring in new technologies and use it for better understanding and protection. In the following paper we will discuss about protection of transformer using microcontroller based relays and the store the respective analyzed data on the closed cloud network for real time monitoring, controlling of devices and future updation. This paper deals with real time monitoring of voltage levels, oil levels, and temperature of transformer and gas sensors. Minimum and maximum values are set for each parameter mentioned. These devices will continuously compare both set values with values at that particular instant, if any of the equipment shows disturbance in the values then error message will be displayed

Keywords: Transformers protection, Relay, Internet of things, Voltage control, microcontroller arduino

I. Introduction

Faults in an active system can result in damages of various levels. It becomes necessary to protect the electrical equipment connected to the system for steady flow of energy without disturbance. While few faults can be eliminated instantly, other faults can severely damage respective equipments and can disturbed whole line. Transformer is one of the most important electrical equipment in a system. Thus protection of transformer is utterly necessary. In the following paper we will be discussing about the protection of various components of transformer and protection schemes which are being applied. To protect the transformers from various faults, relays are used. Relay are the devices which will trip if any incoming fault occurs in the transformer. This relay will protect the transformer from further damages. We are using microcontroller relays as a protection scheme. Microcontrollers are programmable devices which gives us an opportunity to control the devices according to required operation.

Programming is done on Arduino software which is C/C++ language supported software. The main objective is to protect the transmission line and transformer using safe and secure method that is where harm to human life would be low. Thus microcontroller will automatically compare the set value with incoming values and can act accordingly. The readings from the instant the fault occurred to clearing of fault can be store on cloud service which can be access by the respective team of authority. This will help to make future upgrades to grid more secure. Also, due to real time monitoring information will be access to any corner of the world. This will allow us to share data for study or research purpose.

Due to increase in demand, there’s a need to increase electric power generation. For this purpose high voltage generators are used. This generator brings new issues over the transmission line and on transformers. To protect line from these issues new types of relay are being manufactured. Ultra High Voltage (UHV) projects were first experimented in the year of 2002[1]. One of the technical issues was to increase transformer capacity for overcoming transmission restrictions. Differential relay plays an important role overcoming such technical issues.

Previously many development were seen to design relay’s to overcome limits such development were made to increase number of analog inputs, CT saturation countermeasure and high speed operation of differential relay [2]. Survey allowed us to study various problems with previous methods. CT saturation must be considered for differential protection. If the saturation of CT occurs during external fault, current does not flow during the non saturation period. Hence digitized relay were used for protection. On the distribution side of the line to solve the specific protection
and control problems, digital relays have been used. Digital relays have advantages over analog relays previously used. Now mostly digital multifunction relays are used as they provide reliability, versatility and have low cost [3]. Differential relays protection can sometimes malfunction. The reason of this malfunction is considered to be due to inrush current in transformer at the time of starting. Several methods like per-phase method, cross blocking method, Percent average blocking method and Harmonic sharing method were used. To overcome such malfunction and to protect the transformer, protection using fuzzy methods were introduced which was more sophisticated than the previous methods[4]. Internet of things is now used almost everywhere and industries are booming due to IOT.

Use of multifunction relay allows differentiating inrush current from fault current. IOT provides simplification, reliability and control of the devices. Few electrical devices are controlled using IOT [5-7]. More sophisticated methods in the field of electrical are needed to be introduced.

II. Scheme of implementation

Fig.1: Block diagram of the system

The major blocks of the implementation are mentioned below

A. Microcontroller: In our work we use Atmega 328 microcontroller. It is a single chip microcontroller with 23 I/O lines. It is a 10 bit Analog to Digital converter. It has 1kB EEPROM.

B. Potential Transformer: It is a step-down voltage transformer. It is coupled with input line to measure the voltage input to the transformer winding output to potential transformer is amplified and fed to microcontroller.

C. Current Transformer: It is a electrical device which produce an alternating current in secondary which is proportional to AC in primary. It is coupled with I/P lines to measure current input to the transformer winding O/P to current transformer is amplified and fed to microcontroller.

D. Temperature Sensor: We use LM35 temperature sensor to sense the temperature of oil we use in transformer. It is immersed in the oil of the transformer tank. The resistance of temperature sensor changes as the temperature of oil changes.

E. Oil Level Sensor: We use float sensor which is mounted inside the tank immersed in oil. As oil level changes oil sensor detects the change and send the signal to control room in case of emergency.

F. Relay: It is electrically operated switch. The rated coil voltage relay is used. The voltage is required for relay to perform the opening and closing of switch.

G. GSM Modem: Global system for mobile communication is used for cellular communication. In our work we used GSM for sending messages to mobile in case of failure of component. It’s main function is to send messages,
monitoring signal strength and reading, writing, searching phone contacts.

H. LCD Display: Here we are using LCD 16*2 connected to the arduino. That means 16 characters per line by 2 lines.

I. Gas Sensor: We are using LPG gas sensor. It is simple to use liquefied petroleum gas (LPG) sensor, suitable for sensing LPG concentration in the air. The MQ-6 can detect gas concentrations from 200 to 1000ppm.

III. System Specification

The list of components used along with rating and specifications are shown in Table 1 below.

| Sr No. | COMPONENTS LIST | RATINGS | SPECIFICATION |
|--------|-----------------|---------|---------------|
| 1      | 16/2 LCD display | 5v      | Character resolution-5x8 pixel Module dimension:80x36x12 |
| 2      | GSM modem       | 5v      | Indicators- PWR, Status, LED, net LED includes RoHS, UART |
| 3      | GSM modem antenna | -      | Frequency range-824–960MHZ 1710–1990MHZ |
| 4      | IOT modem       | -       | It will connect or will share the data on cloud |
| 5      | Resistors       | -       | Resistors include resistance range, tolerance, power rating, and temperature coefficient. Resistance (R) is the main specification for resistor elements |
| 6      | Arduino Board   | -       | Microcontroller used is ATmega328. |
| 7      | Diodes          |         | 194007 |
| 8      | Capacitors      | 1000    | Type: Radial. Tolerance: 20% Size: 17mm x 9mm. Temperature: -40°C to +105°C. |
| 9      | Capacitors      | 100 uF  | Tolerance: +- 20%, voltage rated 50v, size 8x12mm |
| 10     | Variable Resistors | -  | Diameter of a variable resistor is 6mm |
| 11     | Gas sensor      | -       | It detects the gas |
| 12     | IC              | -       | LM3258 |
| 13     | Transformer     | 12-012, 1A | It used to step-up and step down the voltage |
| 14     | Voltage Regulator | 3v   | |
| 15     | Capacitors      | 0.1 uf  | Tolerance: ±10% Max voltage: 50V. Radial Lead(pin) spacing: 5.08mm (0.2in) |
| 16     | Oil level mechanism | -   | It checks the oil level and indicates whenever the oil increases above preset value |
| 17     | Transistor      | -       | BC5477 |
| 18     | Relay           | 12V     | It is a protection switch which trips on overload of voltage |
| 19     | Potential Transformer | -  | It is a voltage transformer |
| 20     | Current Transformer | -  | |
| 21     | Battery OR Supply | 9V OR 250V | It used to supply the power to model |
IV. WORKING OF SIMULATION CIRCUIT METHODOLOGY:

This scheme is based on transformer protection using microcontroller based really and monitoring using GSM technology is shown in Fig. 2.

Firstly, the MCU gets initialized. When C code is written, compiled and uploaded from the USB port in Arduino board, the microcontroller starts running. Modem initialization refers to the running of A/D convertor. All the preset values fed in the Arduino are checked in this step and compared to the preset values. For example, if over voltage occurs, this is checked and immediately the relay operates. Similarly, if over current occurs, the oil level is decreased below a certain amount or the oil temperature falls below or above (mostly above) from the temperature range of LM-35, the relay starts operating. All numeric values are displayed on the LCD screen so that the person can see the accurate amount of fault values. Now, if the recorded values remain in the range or less than the preset values, there is no alarm generated. If the load connected is greater than the preset values, the relay is again operated and the 3rd step gets repeated. Otherwise the correct and accurate values are displayed on the LCD screen and messaging is done using GSM technology.
V. RESULT AND DISCUSSION

As can be seen from the circuit shown in Fig. 3, when the voltage in the transformer increases above the preset value, the relay operates within seconds. Similarly, when the temperature gets high above a certain value, LM35 detects and immediately shows on the display. Also, when the oil level gets above the preset value, it immediately shows on display. To protect the transformer, the transformer is disconnected automatically from the supply. Voltage decreases to zero immediately. Hence, the transformer is isolated from the system, and it avoids damage due to overloading and overheating issues. Hence, the transformer is protected from faults.

VII. CONCLUSION

A design of a circuit for transformer monitoring. If the transformer is in an abnormal condition, we can know from anywhere. No human power is needed to monitor the transformer. Details about the transformer are automatically updated in the webpage and text message when the transformer is in an abnormal condition. We have described a remote monitoring system for distribution transformers utilizing the existing GSM communication network, which has low investment and operation cost.

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