Case Study on Failure of Transformer Contactor- Discussion on Protection of Transformer Contactor Using IoT

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ABSTRACT

In several transformer failure condition there occurs a loss in human life. This work focusses on the protection of linemen, who are highly prone to dangerous electrical shocks. Linemen put their lives on the electric line each day to power the nation. They should climb the towers, dangle from heights and work on energized lines to restore power quickly to customers following severe storms. In this work several cases of transformer contactor failures and loss of human life due to it has been taken in consideration. The contactor acts as the most important part in the transformer, which is the medium of conductor. If contactor is not properly disconnected, the flow of power supply will not be interrupted. Due to physical or mechanical errors several times the failure in contactor are not noticed. To overcome the human loss due to any kind of failure the reasons has been studied and a real-time model has been designed to work as an alarm system with Internet of Things (IOT). Since the transformer contactors are made in mechanical setup, it becomes highly difficult to find the faults in contactors. In this work we have implemented a metal sensor to find out if there is any contact of the contactors even after disconnecting the contactor manually. The buzzer alarm is used to ensure the contactor state. Wi-Fi module with Internet of Things (IOT) is used to transmit the condition of the contactors to the Substation, Superior In charge of the Substation and lineman.

Keywords*:* Contactors, Sensors, Internet of Things (IOT*).*

1. INTRODUCTION

In India the lethargic attitude towards safety has cost many human lives in past and present. Specifically when it comes to Electric shocks 63% of deaths are caused due to human errors and 37% due to mechanical errors. Linemen are the most affected due to the negligence. To overcome this situation some of the references for the safety has been studied. Based on the mathematical calculations, the settings of the digital relay have been done. Thereafter, the performance of the setup was evaluated on various operating conditions of the transformer such as no-load/full load condition, internal faults, external faults and magnetizing inrush. In addition, the paper proposes new Probabilistic Neural Network (PNN) based adaptive scheme to rectify unintended operation of the conventional digital power transformer protection relays. PNN is able to provide effective discrimination between internal fault and external disturbances with an accuracy of 99.42% [1].

In [2] IEC Technical Committee (TC) 108 is developing an entirely new safety standard, applicable to consumer electronics, information technology equipment and telecommunications equipment. The standard will be performance based and technology independent. The standard is being developed using sound engineering principles and will clearly identify the hazards addressed. This is a "hazard-based safety engineering" concept (HBSE-Concept). (IEC = International Electro technical Commission) This new standard is radically different from previous standards. It is a "hazard based standard "(HBS) addressing all hazards, which could be present in equipment falling under the scope of the new IEC 62368.

In this presentation an overview of the new standard is given. On the example of the protection against electric shock details of the hazard-based concept are discussed. The Behavior of HV power transformer winding insulation to fast front time surge voltages such as lightning overvoltage's for initial stress distribution is dependent upon the square root of the ratio of total ground capacitance to total series capacitance of the winding which is termed alpha (/spl alpha/). Suitably designed metal oxide surge absorber blocks can maintain voltage across its terminals at certain level of voltage magnitudes (approximately) while passing large values of surge currents. In the present theoretical investigations, analysis has been made to identify how the initial electric stress distribution across highly stressed portion of transformer winding can be reduced by providing metal oxide surge absorber shocks across these sections of windings. High voltage windings with /spl alpha/ values 10 and 20 was analyzed [3]. A method is proposed for the analysis of risks of fatal electric shocks associated with (sub) urban distribution MV/LV transformer stations due to earth faults. Models for calculating the probability and frequency of potentially dangerous faults and possible exposures of persons are suggested, the latter based upon data acquired by observation. Expressions for assessing the overall risk for a distribution network are suggested. A practical example is included which discusses some typical cases [4].

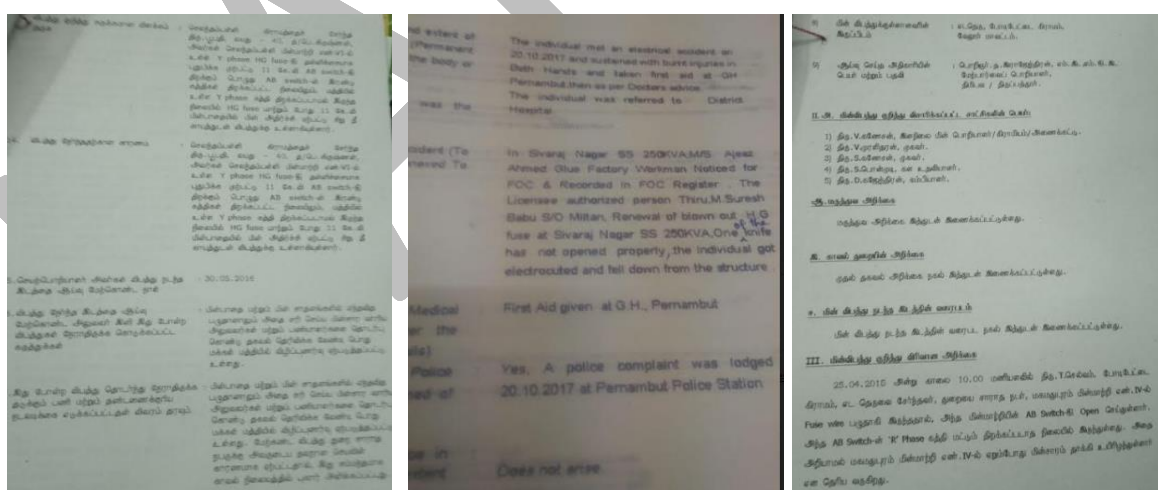
A long-standing expert on electric-shock hazards summarizes the studies that determined the effective body impedance under varying conditions. He describes perception currents, reaction currents, let-go currents, and fibrillating currents. Turning to means for reducing low-voltage (120-240-volt) hazards, double insulation, shock limitation, isolation transformers, and the use of either high frequency or direct current are discussed for various environments. Macro shock is always a hazard in the home, in industry, and in the hospital. But the extreme vulnerability to micro shock of patients with cardiac catheters, for example, requires special precautions in intensive-care and coronary-care units. Equipment such as the ground-fault interrupter (GFI) and a special isolation transformer are cited [5].

This paper is presented for the purpose of describing a new method of compensation, by the use of which the ratio and phase-angle errors of current transformers are materially reduced. There are several similar methods now in use, but these methods possess some undesirable features which are not present in the one described in this paper. By the use of this new method, in which a portion of the secondary turns and an auxiliary short-circuited turn enclose a section of the magnetic circuit, the change in ratio and phase angle between light and full load is considerably reduced, resulting in more nearly approaching a constant ratio, and phase-angle characteristics for all values of load. In view of the demand for meter and transformer combinations which must operate satisfactorily over large ranges of current, this is a desirable feature [6]. This circuit consists of capacitor in series with the interfacing inductor of the shunt active filter. The series capacitor enables reduction in DC link voltage requirement of the shunt active filter and simultaneously compensating the reactive power required by the load, SOAS to maintain unity power factor [7].

The vibration method is an effective method used for on-line monitoring the power transformer delitescent fault, it can monitor not only the winding, but also the condition of core. It is a recommended method that should be studied deeply. In this paper, a method extracting cores vibration signal with operating transformer at on-load condition was introduced. The transformer vibration accelerated signals at different on-load current and no-load condition were measured. From the fitted curve of on-load current versus fundamental frequency component of vibration accelerated signal, the value of fundamental frequency component was gained as the on-load current was zero, and it was almost equivalent to the fundamental frequency component of vibration accelerated signal measured at no-load condition, thus using on-load current method the fundamental frequency component of cores vibration can be acquired [8].

2. CASE STUDIES

From the North Arcot location of Tamilnadu, India, few case studies have been conducted in which linemen's lost their lives due to the physical negligence or mechanical errors present in the contactors.


The individual met an electrical accident on 20.10.2017 and sustained with burnt injuries in Both Hands and taken first aid at GH Pernambut then as per Doctors advice The individual was referred to District Hospital

In Sivaraj Nagar SS 250KVA M/S Ajeez Ahmed Glue Factory Workman Noticed for FOC & Recorded in FOC Register . The Licensee authorized person Thiru.M.Suresh Babu S/O Mittan, Renewal of blown out H.G fuse at Sivaraj Nagar SS 250KVA,One of the knife has not opened properly, the individual got electrocuted and fell down from the structure

First Aid given at G.H., Pernambut

Yes, A police complaint was lodged 20.10.2017 at Pernambut Police Station

Does not arise

Fig 1: Government Report on Linemen Death's (a) Case location: Madavalam Village; (b) Case location: Pernambut; (c) Case location: Mohamadapuram village;

In the above Fig 1, government reports of 3 different cases have been depicted. In all the 3 cases linemen fell as prey for the physical negligence and mechanical errors. Fig 1 (a) & (b) case reports of Madhavalam village and Pernambut town explains about the mechanical error occurred in the contactor. When the linemen disconnected the contactor mechanically, a mechanical error occurred and the contactor did not come out of the conduction, the supply was on. Though physical examination with naked eye is not proper mode of safety check, linemen physically try to find the error with naked eyes. Due to the height or improper vision linemen concluded contactor was properly disconnected and went on to climb the transformer. As the power was still flowing the linemen got electrocuted.

Especially in south Asian nations this is a big threat, where linemen are habituated to work without proper safety. To avoid such fatal deaths, we have come up with a System having buzzing alarm on the transformer location and associated Internet of Things to communicate the failure to the corresponding linemen, officials and substation.

3. PROPOSED WORK

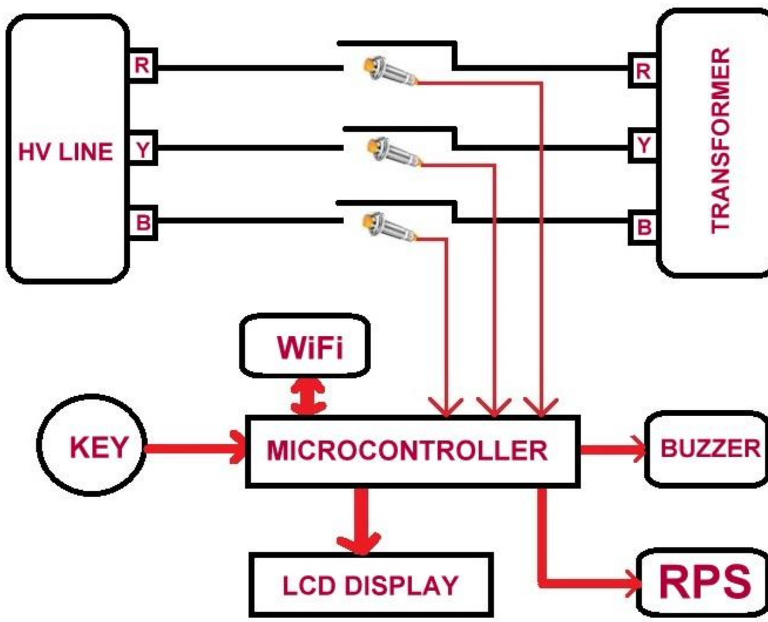


Fig 2: Block Diagram of the Proposed System

In this work a certain model has been proposed with both analog and digital security system. Fig 2 shows the block diagram of the proposed system which has to be designed and installed between the AB switch made of GI gauge - Copper and Contact Rod. The metal sensor between the contact rod and AB switch senses the fault condition and enables the alarm system. Apart from alarm system A Microcontroller has been used along with the wifi module, which acts as the medium for IOT based Buzzer system. The metal sensor based alarm system gives the safety signal on the spot of the fault location, while IOT based buzzer sends the message to the corresponding officials regarding the fault condition.

In Fig 3, circuit has been implemented using Proteus. ESP 8266 has been used as the wifi module, PIC 16F833 PIC controller, LM 317 to regulate the voltage corresponding capacitors and resistors have been proposed to build the circuit.

The fault condition i.e., if the air break switch is not properly disconnected, metal sensor senses the conduction present in the contactor and enables the Buzzer. Using SQL microcontrollers is enabled, the fault condition in the contactor is sensed and sent to the buzzer and to the connected internet gadgets using IOT.

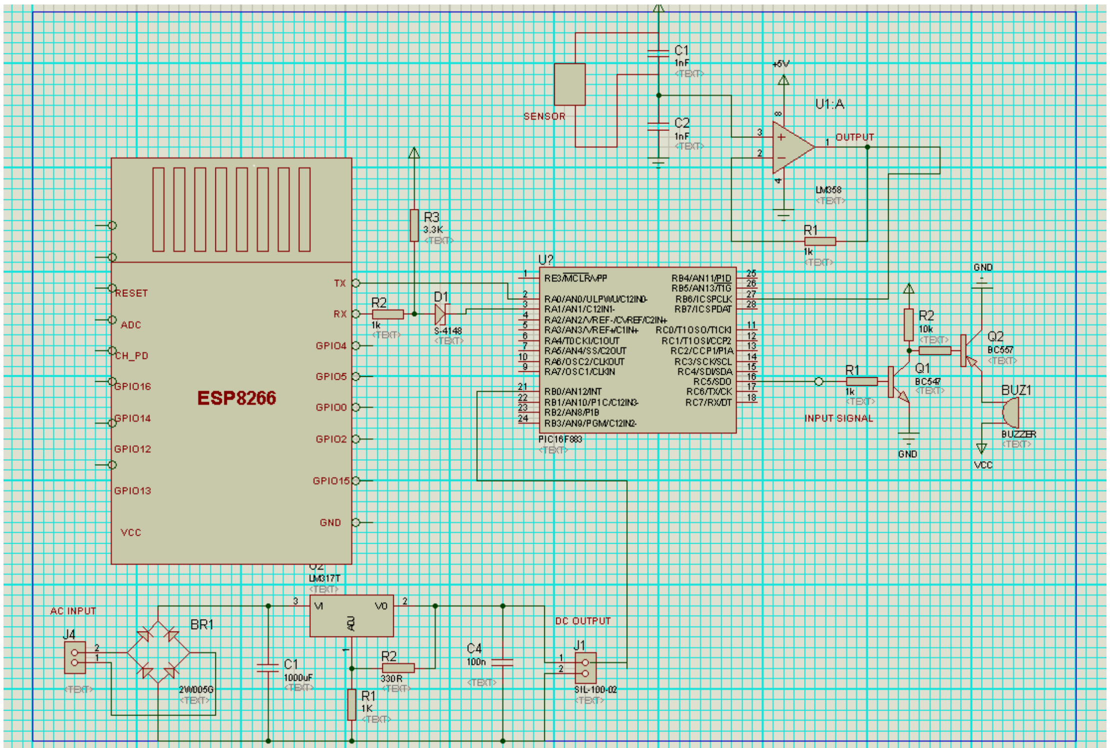


Fig 3: Circuit Diagram of the Proposed System

The proposed work could be a safety precaution to the linemen who risk their lives. Though there were repeated fatal loss of lives no proper measures has been provided to reduce the loss of human lives. Our proposed work may help the linemen to a better extent and might increase the working safety

4. DISCUSSIONS

Sl. No	R- Phase	Y- Phase	B- Phase	Output	Buzzer
1	OFF	OFF	OFF	0	OFF
2	OFF	OFF	ON	1	ON
3	OFF	ON	OFF	1	ON
4	OFF	ON	ON	1	ON
5	ON	OFF	OFF	1	ON
6	ON	OFF	ON	1	ON
7	ON	ON	OFF	1	ON
8	ON	ON	ON	0	OFF

Table 1: Operation Sequence of the Proposed Model

- When the AB switch is in closed condition, the metal sensor contact stays in contact with the GI metal of AB switch knife and the copper is closed with the fixed contact post type insulator.
- When the AB switch is in open condition, the metal sensor contact is stays in touch with the GI metal of AB switch knife and the copper is opened with the fixed contact of post type insulator.

Table 1 gives the data and working sequence of the proposed work. 3 phases R, Y and B fault sequences are discussed along with the corresponding buzzer output. Whenever there is a fault condition in any single phase the buzzer siren is enabled to ON state.

5. CONCLUSION

The suggested work could be a welfare protection to the linemen who danger their lives. Nevertheless there were recurrent fatal loss of lives still no appropriate procedures has been provided to bring down the loss of human lives. Our proposed work may help the linemen to a better extent and might increase the working safety from fatal electric shocks. The advanced technology IOT based alarming- communicative system will act as a higher precaution method by alerting all the corresponding officials, so that linemen can be alerted prior.

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