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Earth Leakage Protection of Various Equipment using Arduino

Akanksha Kumar[1], Harshal Vanjari[2], Akash Salunkhe[3], Prashant Mahajan[4]
[1, 2, 3]Student, AISSM's Institute of Information Technology, Pune.
[4]Assistant professor, AISSM's Institute of Information Technology, Pune

Abstract: An earth fault protection of various equipment using Arduino is proposed in this paper, Construction of this circuit is done on the basis of ground fault circuit interrupter. The circuit trip on the tiniest difference in the current of the supply and return path. The leakage is detected by this difference which may damage a device and human operator. Both hardware and software are introduced in this circuit.
Index Terms - 3 winding transformer, Arduino, relay, leakage current, fault protection.

I. INTRODUCTION

Nowadays, the leakage protection is very important technology in the various low-power rating field, this leakage current may damage the equipment also get hazardous for human being from electrical shock so, in protection of various electrical equipment we are going to construct circuit on the basis of ground fault circuit interrupter. Whenever any fault occurred in the equipment ground fault circuit interrupter (GFCI) is going to disconnect the circuit. whenever it detects the leakage current, that Causes electric current Unbalance between the energized conductor and the return neutral conductor. This unbalance indicates current leakage through the unwanted path of the circuit, which is grounded and accidentally touching the energized part of the circuit may get hazardous shock. So, to protect specific equipment's it is necessary to switch off the supply. In view of above situation this paper provides information about the protection from earth leakage current by designing protection circuit based on Arduino programming kit which helps us to give specific threshold value for the specific equipment's so that when any fault occurs and this cross the threshold value then Arduino going to trip that equipment only and other equipment's are safe for operation.

II. OBJECTIVES

A device is design to detect the leakage current in the circuit, the leakage current is given to op-amp to get the voltage waveform and by adjusting the gain we can adjust the value. and then further we give output of op-amp to rectifier which are used to get dc for Arduino programming. By designing the protection device with the help of the Arduino we can achieve so many benefits as well as the flexible operation for various power ratting equipment. Where we are designing this device so that we can achieve following objective. To protect the various equipment.

III. METHODOLOGY

Methodology is the process to find the suitable project, make the researching and study all of the project information, choose the suitable method for design this project, planning the time and selecting the equipment such as material is needed and computer software program. After selection of the topic it is very essential to separate the whole work in different phases so to make work suitable and more efficient, we divide the work in four different phases.
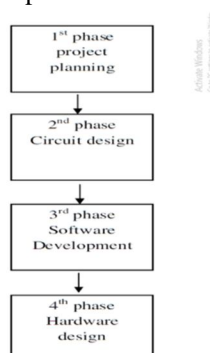

Figure 3.2: Phase planning

IV. PROJECT PLANNING

To Develop any project the main thing requires which is to collect information. In the 1st phase the all the information regarding the hardware and software is collected by reading various papers and doing literature survey, in which the selection of proper method for earth leakage current sensing device is decided then to perform the various experiment to collect the required ranges and set a proper sensing method for that equipment and the material require for designing, there ranges to sustain that leakage current also in software which type of software is going to use, there ranges all these information is collected in the project planning.

V. HARDWARE DESIGN

The main part in this project is to build the hardware, to detect the earth leakage current. The detection of earth leakage current   is main problem. With the help of the literature survey and performing various experiment for the earth leakage protection device the final conclusion is to go for 3 winding transformers to detect the earth leakage current.

A. Construction

In 3 winding transformers, 3 windings are placed on transformer core where the primary and secondary windings are having same number of turns also have same current rating but they placed are opposite to each other such that their flux cancel each other. Here the tertiary winding (tripping winding) having a large number of turns than primary and secondary where their turns ratio is 1:1:10. The test button is used to test the equipment is working or not.
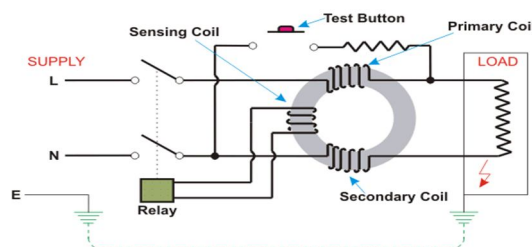

Fig. 3 Basic circuit diagram

B. Working

As show in Fig. 3 winding are placed on transformer core. In normal condition the same current pass through primary winding, and return back through secondary winding. Both primary and secondary winding are placed in such a way that the magnetic flux produced is in opposite direction so in healthy condition the same current pass through both winding so this will cancel each other's magnetic flux. In faulty condition the leakage pass to anywhere in circuit so the current returning through secondary winding is reduced. So, the magnetic flux present inside the transformer core is not equal anymore. So, the periodically changing magnetic flux inside the transformer core cut the tertiary winding conductors, this action will induce the electromotive force(emf) across the tertiary winding. Where it is an alternating in nature. The induced voltage across the tertiary winding produces a current in the (trip circuit). This current is sensed by the relay (Arduino) and it will give the command to the C.B. to operate.

C. Winding Transformer Design

In 3 winding CT we have to convert the current into the voltage because voltage is sensed by the Arduino easily. For this conversion we have to put a resistor. This resistor causes the burden on the CT. The main reason to go for 3 winding transformers instead of current transformer (CT) is because of problems arrive due to burden on CT. During the Fault condition the unbalance current derive is very small so due to burden this value get negligible. Due to this in the tertiary winding it fails to maintain CT ratio so it is better to design 3 winding transformers rather than current transformer (CT).
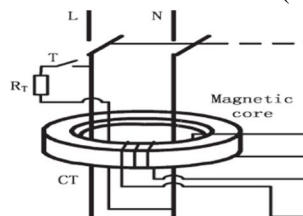

Fig. 3 Winding Transformer

To design the 3 winding Transformer, the turns ratio for primary and secondary winding are kept to be equal which is 40 turns and 2 amp. current rating is to be calculated by practical performance and tertiary winding has 400 number of turns are calculated through practical performance where 3 tapping are to be given to tertiary for identification of magnitude of fault current. This three tapping are given at 120, 280, 400 number of turns. Where current ranging for tertiary winding has 50-100 m amp. These are on the basis of 1:10 turns ratio which can be calculated as above.

VI. SOFTWARE DESIGN

After hardware designing, we step forward toward the software designing. In this we are going to use Arduino for giving command to the circuit for protection. And protection is as per the threshold value given for operation to the Arduino. whereas Arduino is an open source hardware & software device. Arduino consist of variety of microprocessor and controller. The Arduino board consist of set of digital and analog input and output (i/o). Arduino has many benefits such as easy programming, flexible operation and inexpensive. the main task of circuit is to detect the leakage current and calculate the valid value, calculating variation in leakage current, judging and processing for the protection

The software system mainly consists of main program, data processing sub program, and leakage protection program. the main program will be carried as top-down infinite loop, the interruption in system will respond according to as per priority as given by software as interruption occur it will return to the main program and continue the execution after being completed.

A. Main Programming Design

The main function of main program to conduct the program flow & connecting each sub program. the main program provide initialization, data processing, failure treatment and interrupt handling and also timer & commutation interruption.

B. Data Processing Sub Program Design

The timing detection of current and digital filter is realized by data processing. the adjustment of the threshold value by adaptive adjusting is done by calculating the average value of data as per the tripping circuit. the variation of the leakage current should be greater than that of threshold leakage value set as per circuit. And the time duration must be greater than the set relay time.

C. Earth Leakage Protection Sub Program Design

The leakage current protection is detected by the circuit accordingly to compare between the leakage current value and setting value, the delay time as per provided in the circuit and also as per given by user. The value of leakage variation is less than rated value then the action would be normally operated. if the time duration is more than action should be relatively adjusted.

VII. TESTING

Testing phase are divided into two level first level is unit step, where the system is tested part by part and error is to be measured. Second level is integration test where the complete combine system between hardware and software part is examined. As per practical performance the error occurred are eliminated through changing the Arduino programming. The timer is to be set as if small fault come then the circuit is trip for only small period of time. And after this time the circuit again come in on condition.

VIII. PROBLEM STATEMENT

When the earth fault occurs and someone barely touched it they may get hazardous shock. so, there we use elcb (earth leakage circuit breaker) but this device trip all the system so if sometimes some small fault occur and this breaker sense this fault and trip all compartment. it requires time to erase this fault and due to such small fault, we could not use our other equipment and in industries it gets huge loss. So, we are going to develop an equipment which can trip only faulty part and others equipment remains healthy.

We are going to develop this equipment by using Arduino which is used to give separately command to circuit breaker to trip only faulty equipment and secure the other part also secure from fault occurring to all other compartment.

IX. ADVANTAGES

EARTH leakage circuit breaker has one major advantage over RCDs that they are less sensitive to fault conditions, and therefore have fewer nuisance trips. There is situation in which an ELCB can nuisance trip because the voltage and current on the earth line is usually fault current from live wire. While voltage and current on the earth line is usually fault current from a live wire, this is not always the case.

As the high current lightning strike would cause a voltage gradient in the soil, presenting the earth leakage circuit breaker sense coil with enough voltage to cause it trip this is only because of an installation has two connections to earth.

Also, this device is cost efficient device which has minimum the required cost as compare to other equipment's.

This equipment can also be used in AC as well as DC. but for DC we have to modify the transformer design as per the requirement.

By using Arduino, we can use this devise for wide range for equipment in which we only have to change the programming as per the equipment.

And this devise can also be used for commercial as well as industrial purpose, only due use of Arduino we can modify programming as per our requirement.

X. DISADVANTAGES

They do not detect faults that don't pass current through the CPC to the earth rods. They do not allow a single building system to be easily split into multiple sections with independent fault protection, because earthing systems are usually use common earth Rod.

We can assume that the earth leakage fault protection device is the ***brain for the shock protection***, and the grounding as the backbone. Therefore, without a functional grounding (Proper Earthing of Electrical System) there is totally no protection against electrical shocks in your house even if You have installed ELCB and its TEST switch show proper result. Looking after the ELCB alone is not enough. The electrical Earthing system must also be in good working order for the shock protection system to work. The qualified electrician had done the routine inspection, to check the grounding system should be inspected regularly at shorter intervals by homeowner and need to pour water in Earthing Pit to minimize the earth resistance at regular basis.

This brings us or alarming us to think over second basic requirement for earth protection. The second requirement for the proper operation of a home shock protection system is electrical grounding.

XI. CONCLUSION

The main focus of the project is to develop the device in cost efficient way. the device is use for safety of industries, residential & commercial etc. one single device will give wide range of control over equipment. As device is programmable, new firmware will unleash new intelligence and advance feature in the device. Protection and control of equipment play very important role in today's era. where protection is provided to eliminate the leakage in the system. so, we are using Arduino programming for various benefits.

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