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# The Factors Influence the Implementation of Electrical Automated Home Fault Isolation System: The case of Dar Es salaam.

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**Abstract**
*Currently fuse and circuit breakers are employed to safeguard the electrical equipment's. Miniature circuit breaker (MCB) is based on thermal bimetal lever trip mechanism. MCB is very slow and the trip time varies according to the Percentage of overload and surrounding temperature. This research paper is objected to point out the factors that influence the implementation of Automated home fault isolation system in Tanzania due to the cut off the power supply whenever* ***overload*** *or* ***short circuit*** *occur. Therefore, the findings are pointed out at the end of the paper.*



## 1. Background

The sudden surge of electrical current due to increased load or electric short circuit lead to the control panel damage in homes, companies or other institutions, and may also cause damage of the electric wires which carries the electric current. This has become an issue in Tanzania for the user of electrical domestic appliance. To limit this risk, Automated circuit breaker is developed using sophisticated tools to improve the tripping respond of the circuit breaker [1]

The increase of technological home appliances causes a number of problems to increased such as exposure to direct shock due to electric short circuit or over loading and thus damaged the control panel as well as electrical home appliances, therefore the more attention is needed on sophisticated electrical equipment's as well as intelligent measures should be taken to limit those risks such the smart and fast response circuit breaker.

The protection of electrical domestic appliance from short circuit or over load current trip time of circuit should be very low and this can be achieved by automated circuit breaker [2] in which they are made from semiconductor materials'. An automated online circuit breaker monitoring system [3] is proposed to monitor condition, operation and status of high and medium voltage circuit breakers

The primary goal is to ensure that the circuit breakers plays a vital role in carefully protecting electrical appliances. However, in a serious case, an extreme surge of power may penetrate the equipment and sequentially cause explosion or fire [4].

## 2. Related work.

In this part of the study presents literature review, deals with an Automated home electrical fault isolation system that concerned with protection of domestic appliance.

### *2.1 Concept and theory*

*Fuse* is one of the most popular protection devices to protect electrical circuits against the negative effects of overload and short-circuit currents. The diagram below shows the internal components of a cartridge fuse. The main component of the fuse is a metal wire. In the case of overload and short-circuit faults, this wire melts and breaks the path of current. However, the fuse is not a fast tripping protection device in the case of high currents like the short-circuit fault

The most used protective device is *Miniature* circuit breaker which take longer time to trip especially for sensitive domestic equipment such as Television, fridge, computer and microwave. For home appliances it is important to activate the tripping mechanism for short time.

In different operating conditions, electrical devices sometimes start to draw more current than their overall capacity, this fail to predict event and may leads damage the domestic electrical appliances. To avoid overvoltage, the installation of sensitive protective devices is required where will automatically shut down the extra amount of voltage flowing in the circuit [5].

Short-circuit current occurs under specific conditions when there is a short connection between phase and null wires. This means that the current finds a short way to bypass the electrical loads. The amount of short-circuit current is order of magnitude higher than the nominal current and can cause critical damages in electrical circuits. The short-circuit current can produce extreme heating that can damage the insulation of electrical devices and cause an electrical fire [6].

## 3. Factors Influence the Implementation of Automated Home Fault Isolation System

### *3.1 Time delay of miniature circuit breaker*

The time of the miniature circuit breaker to respond when the short circuit and overvoltage occurs is much longer compared with automated domestic fault isolation system. For domestic appliances, it is necessary to activate the protective device within the précised time. The current flow through the electrical appliance is better to be sensed by automated circuit breaker in which the corresponding voltage drop and the preset voltage is compared with a level comparator and the resultant signals are given to the microcontroller through a metal oxide semiconductor filed effect transistor (MOSFET) which drives the relay to trip the load.

### *3.2 Material used in making the device*

Circuit current regardless of core position thus it can be by passing the delay feature. Conventional circuit breakers like miniature circuit breaker or a fuse is good at breaking the circuit when a short circuit fault occurs. But when an overload fault occurs, the tripping time is slow and depends on the percentage of overload. However, for sensitive loads it is very important to activate the tripping mechanism at the shortest possible time.

The device need to have the feature that automatically handle problem. The electronic circuit breaker is based on the voltage drop across a series element proportional to the load current, typically a low-value resistor. This voltage is sensed and rectified to DC, and then is compared with a preset voltage by a level comparator to generate an output that drives a relay through the MOSFET to trip the load. The relay use in place of a semiconductor switch is preferred because such solid state switches would invariably fail in case of accidental short circuits [7]. A circuit breaker is automatic operated switch designed to shut down the power supply when overloaded. The tripping depends on the current passing through the CT's which is connected in series with load. It uses the microcontroller into which program is dumped for the operation [8].

### *3.3 Ambient or surrounding air Temperature*

Presence of temperature has significant play a role in accurate working of the device. High or low temperature has adversary effect on the device. When short circuit or overcurrent occurs, current flowing through bimetallic strip increases also temperature increases, causes deformation of bimetallic strip and open the circuit. In this way it protects the circuit. When the temperature is low and there is sudden increase of voltage the bimetallic remain closed. Change in temperature reduces current capacity of circuit breaker [9] Ambient temperature affects the time delay but does not affect the current rating of a circuit breaker [10]. The use of accurate protective device is needed to handle the situation.

***3.4 Overheating***

Overheating is another problem associated with the use of conventional protection devices. The components of a conventional RCBO are enclosed in a plastic structure that may break or explode because of unexpected heating of overload or short-circuit currents. In this case, the RCBO will be out of order. Thus, we must replace the whole device. A quick power recovery is important for equipment or electrical appliances which require continuous power supply such as refrigerator, water pump for aquarium, alarm system and others [11].

***3.5 Complex and sensitive electronic components***

Modern electrical appliances use very complex and sensitive electronic components. The systems are very sensitive and could easily burn out if over- current or short circuit occurs. The modern systems demand fast tripping speed. An automated domestic fault isolation system can meet the demands of the isolation of short circuit and overvoltage on electrical appliances made by sensitive electronics components.

***3.6 Current rating***

This Miniature Circuit Breaker (MCB) is capable of handling up 10000 amps current but when current rating is exceeded by 1000 amps then MCB is not economical. Therefore, improvement by using automatic circuit breaker can adjust current rating according to load and its tripping not depends on surrounding temperature

**4. Automated home fault isolation system for short circuit and over-current**

It was proved that electronic circuit breaker is very useful circuit for sensitive loads. The main advantage of this circuit is that over all tripping time is less as compare to conventional [12].

4.1 ***Tripping respond for automated home electrical fault isolation system***

The automatic system is designed for domestic electrical system to detect if any short circuit or overvoltage occurred. The AC supply to the load is thus cut off from the load and the load is tripped. Once the circuit is tripped it must be reset for further use using either case, the microcontroller is programmed so as to show the status of the output on the LCD interfaced to it. In case of normal operation microcontroller will pin will receive 5v dc from regulator and accordingly displays the status on the LCD. In case of any abnormalities, the microcontroller pin doesn't receive the 5V input signal and the related status is accordingly displayed on the LCD [13]. According to [14] shows the tripping action of automated domestic electrical fault isolation system

Testing is done under different loading conditions. Under the variation of load, overloading is detected and the relay tends to trip. The LCD showed the overload status to the user through message and later supply has been cutoff. Supply is restored back after clearing the fault. With switching action, a short circuit condition was simulated and seems to be tripping time of around 0.022 seconds [15]. Thus, the system can be used to replaced miniature circuit breaker devices since tripping respond is faster

### *4.2 Validate the automated home electrical fault isolation system*

To validate the system, a scenario is defined to control short circuit and overvoltage. Microcontroller is the main component for control the process. According to [16], testing is done under the assumption that one lamp constitutes the rated load of the system. So when the second lamp is turned on, an overloaded condition is detected and the relay trips instantaneously. The LCD showed the overloaded status and an SMS was received stating that the system has been overloaded and that supply has been cut off. A short circuit condition is simulated with the help of a switch. When the switch is closed, a short circuit fault was created. Therefore, it is important to confirm the circuit to determine the working efficiency.

### *4.3 Features of automated home electrical fault isolation system*

The system offer more features compared to mechanical ones. Features like nearly unlimited short circuit capability by current limitation, programmable rated current, programmable trip time curve, wire break indication, remote controllability and monitoring functions for current and voltage [17]. Online monitoring can be implemented with the help of the GSM module with the network connectivity. A coordination analysis is made to achieve optimum protective system by determining the settings of ampere ratings and over current settings. Protective device nearest to the fault will open when an over current occurs. Tripping characteristics of circuit breaker Operating characteristics of the breaker can be graphically represented on time-current characteristics. Tripping characteristics of the circuit breaker can be represented by a tripping curve which plots tripping time and current level. The curve represents the time required for a breaker to trip at a given excess current level. The proposed methodology protects the sensible equipment's when fault occurs by cutting the supply in fraction of seconds. It is done by means of Wi-Fi technology.

**5. Design of automated home circuit isolation system**

The main power supply is given directly to load through step down transformer of 220 AC voltage at the input and is Step down to 12 AC voltage then the output is given to bridge rectifier for convention of voltage from AC to DC voltage and then passed through 7805 regulator to get 5v supply for working of microcontroller, in the microcontroller, when there is short circuit or overvoltage the microcontroller generate the signal to trip through the current sensor. Capacitor filters are used in parallel to remove the distortion to get pure constant dc voltage that is applied to the microcontroller for operation. The current passing to load is sensed by the current transformer in which the output of CT will be in analog form and given to the ADC pin of PIC microcontroller for converting the analog output to digital data.

The current sensed by CT is compared with the inbuilt comparator of microcontroller which as pre-set reference value. If the current sensed is less than the pre-set value than MOSFET will be in OFF state and relay will not trip the supply to load. As we increase the load current drawn is more so if the current is increase than the pre-set value than MOSFET will turn ON and energizes the relay. Thus LED used as an Indicator is properly biased, and it glows. The relay coil gets energized, causing the armature to shift its position to the normal open point from the normal closed point. The AC supply to the load is thus cut off from the load and the load is tripped.

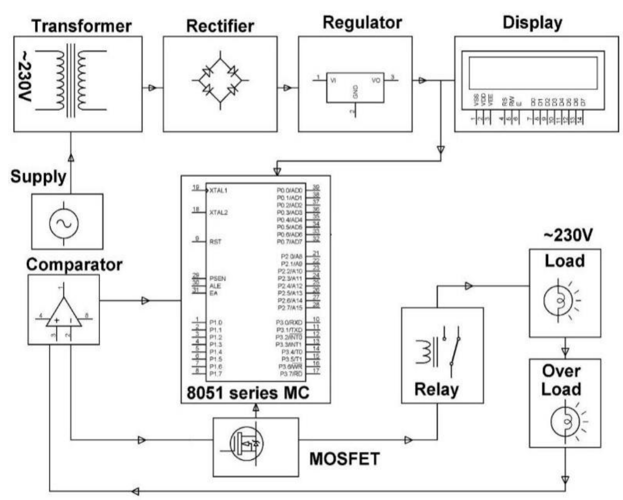


*Figure 5.1: Complete circuit diagram*

***5.1 Testing results at 220Vac & Discussion***

In order to developing a prototype, the hardware is tested with a 220Vac supply and a load resistor having a small inductance. Instead of putting a real fault at the load terminals, the load resistance is varied from 60 ohms to 6.4 ohm so that final steady state value of load current is beyond overcurrent threshold set in micro-controller.

*When current is 2.7 A.*

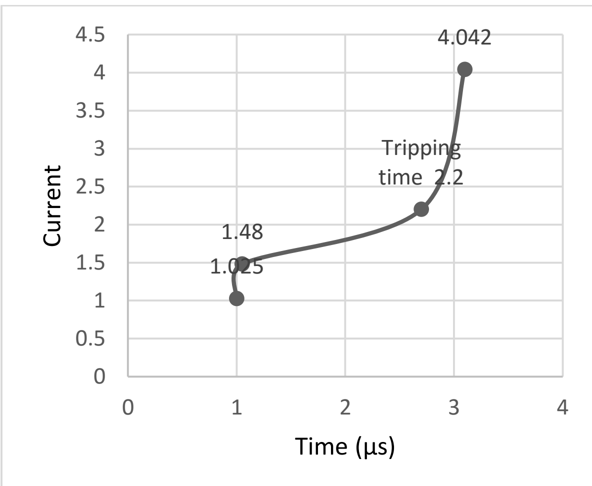


*Fig 5.2: Graph shows when current is 2.7 A*

When current threshold is set at 2.7 A, micro-controller output command to opt couple and gate driver. The system makes auto-re closure (Auto re closure is a phenomenon in which the breaker tries to reconnect the line between two points with the delay or without delay at the time of the fault) attempts and if the fault is still persistent main switch remains off until micro-controller is reset manually. The time taken by micro-controller can vary up to a maximum of 2.2µs depending on which instruction the micro-controller is executing when a fault occurs.

Before fault occurred, load current was 1 A. When fault occurs, current starts to rise and as a result, current sensor circuitry output (sensor and OPAMP buffer) begins to rise. When feedback to micro- controller increases beyond programmed threshold, the micro-controller sends OFF command to opto-coupler and gate driver circuitry. Gate driver and opto-coupler take finite amount of time to send OFF command to main switch and finally main switch takes some time to turn OFF and then load current begins to commutate to freewheeling diode decaying exponentially as stored energy in inductor dissipates

After micro-controller sends OFF command to opto-coupler and gate driver, it waits for 50S (auto-reclosure time) and sends command to turn ON main switch again.

With switching action, a short circuit condition was simulated and seems to be tripping time of around 2.2µs

***When current is 8 A.***

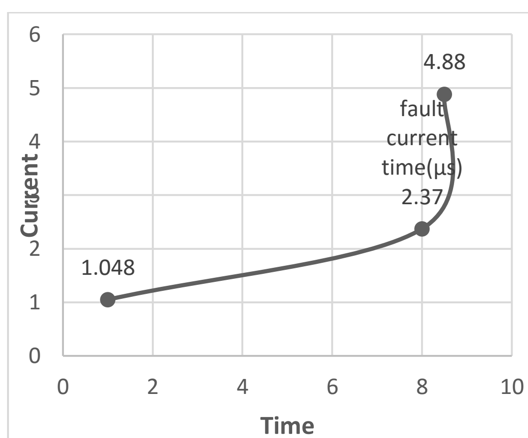

*Fig 5.3 Graph show when current is 8A*

The prototype performs an auto-reclosure attempts and if the fault is still persistent main switch remains off until micro-controller is reset manually. The time taken by micro-controller can vary up to a maximum of 2.2uS then the micro-controller is executing when a fault occurs. The figure 4.6 shows that the microcontroller trip at 2.37µs and reset again after the fault is cleared.

### *5.2 Results evaluation and discussion*

It is seen from comparison of the miniature circuit breaker and the developed Automated fault isolation systems that, the MCB tripping time respond is much longer in which the maximum is about five second in order to detect the fault, and it has observed that for a modern electronics equipment's has less effect on provision of protection and hence the risk of damaged is quite higher. Up on implementation of the automated fault isolation system has shown some improvement in which the detection of fault is around 0.002s. During the experiment the noise is negligible, less voltage is used which is around five volts.

## 6. Conclusion and future research

Conclusively, the Comprehensive factors conducted by constructing the necessary circuit yielded successful results. Automated fault isolation system is very useful circuit for sensitive loads. The main advantage of this circuit is that over all tripping time is less as compare to miniature circuit breaker. The other factors influenced to implement the circuit which was also testes by experiment is successful and energy saving. Further research on improving the load capacity and tripping time is being undertaken. This study of influencing the implementation of automated home fault isolation system shows that the tripping of load takes place in case of short circuit or overload condition is less compared to MCB. This system has very fast tripping mechanisms compared to the miniature circuit breakers. Fast clearing of electrical failure like overload or short circuit is very necessary. Automated home fault isolation system is very efficiently for fault clearing. I recommend the implementation of automated switch to the society due to its safety and economic growth increment of the country. More research is required on developing the automated home fault isolation system that can fit at all environment despite of the changes of temperature.

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