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Development of earth leakage circuit breaker auto re-close  
with metering / Mohd Aminuddin Ibrahim.

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**DEVELOPMENT OF EARTH LEAKAGE CIRCUIT BREAKER  
AUTO RE-CLOSE WITH METERING**

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**Bachelor of Electrical Engineering**

**June 2012**

## APPROVAL

This report is submitted to the Faculty of Electrical Engineering of UTeM as a partial fulfillment of the requirements for the degree of the Bachelor of Electrical Engineering (Control, Instrumentation and Automation) with Honors. The member of the supervisory committee is as follow.

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**DEVELOPMENT OF EARTH LEAKAGE CIRCUIT BREAKER (ELCB) AUTO RE-CLOSE WITH METERING**

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**DATE: 01 JUNE 2012**

**A report submitted in partial fulfillment of the requirements for the degree of electrical engineering (Control, Instrumentation and Automation) with honors**

**Faculty of Electrical Engineering**

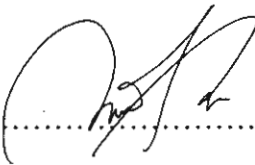
**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

**2012**

## DECLARATION

I hereby, declared this report entitle “DEVELOPMENT EARTH LEAKAGE CIRCUIT BREAKER (ELCB) AUTO RE-CLOSE WITH METERING” is the result of my own research except as cited in references.

Signature

:.....

Author's Name

:MOHD AMINUDDIN BIN IBRAHIM

Date

: 01 JUNE 2012.....

To my beloved mother and father

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## ABSTRACT

Circuit breaker is a device to protect electrical circuit from damage and to detect a fault condition and immediately disconnect electric flow. There are many type of circuit breaker which Earth Leakage Circuit Breaker (ELCB) is one of them. The ELCB will protect human or home appliances from being damage by the earth's leakage current. The earth's leakage current can occur by conditions, the trip cause by lightning or trip cause by the appliances. ELCB operate by calculate the unbalanced current between the Life, Neutral and Earth terminal in the system. For the temporary fault cause by the lightning, the Auto Re-closer ELCB will trip once, then it will go to the origin condition and after second times of trip, the Auto Re-closer ELCB will not be closed again because it is assumed that the permanent fault has occur. This project will use Microcontroller program has to control the operation of the Auto Re-closer ELCB.

## ABSTRAK

Perlindungan arus bocor ke bumi (ELCB) yang banyak digunakan pada masa kini adalah berfungsi untuk melindungi manusia atau peralatan yang digunakan daripada terdedah kepada kejutan elektrik atau menyebabkan peralatan yang digunakan rosak. Ini adalah kerana terdapatnya arus bocor ke bumi. Arus bocor ke bumi ini akan menyebabkan sistem ini terputus berpunca daripada dua keadaan iaitu kerosakan sementara yang disebabkan oleh kilat. Satu lagi keadaan adalah disebabkan kerosakan yang kekal seperti kerosakan yang berlaku pada peralatan. Alat ini (ELCB) akan berfungsi untuk mengoperasikan semula sistem dalam masa 30 saat jika terdapat sebarang kerosakan yang bersifat sementara atau pun kerosakan yang kekal. Jika kerosakan ini bersifat sementara, sistem akan beroperasi seperti keadaan biasa selepas 30 saat tersebut. Untuk kerosakan yang kekal alat ini tidak akan berkendali kembali dan perlu menetapkan semula secara manual. Kita akan menganggap kerosakan yang berlaku adalah kerosakan yang kekal disebabkan bilangan kerosakan sebanyak 2 kali. Alat ini direka adalah untuk memudahkan manusia untuk menghidupkan sistem kembali sedia kala kerana alat ini akan berfungsi secara automatik. Untuk menjadikan ia automatik kita menggunakan “microcontroller” sebagai cip yang mengawal alat ini.



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## LIST ABBREVIATIONS

ELCB	-	Earth Leakage Circuit Breaker
Micro C	-	Micro Controller
e.m.f	-	Electromotive force
GFCI	-	Ground fault circuit Interrupter
L	-	Live wire supply
N	-	Neutral wire
PIC	-	Peripheral Interface controller
IC	-	Integrated chip
PLC	-	Programmable Logic Controller
RAM	-	Random access memory
ADC	-	Digital converter
EEPROM	-	Electrically erasable programmable read only

## **CHAPTER 1**

### **INTRODUCTION**

#### **1.1 Problem statement**

The device Earth Leakage Circuit Breaker (ELCB) has in the market today needed to be turned on manually when the trip occurs. This situation will waste the manpower and needs sometime to turn on the ELCB. The normal ELCB in the market use the combination of mechanical and electrical parts to operate. There are difficult to find the right specification for the mechanical parts in the ELCB. Mechanical parts of the normal ELCB are too expensive compare to the electrical parts.

The ELCB was designed to ease and reduce the work energy to switch the system on as the system was automatically re-operated. The cost will be reducing as the mechanical usages lessen by using the relay as a switch and also as trip mechanism. When the auto reclose concept used in the system, the user do not have to worry about any circuit trip or system down because the system will re-operated automatically if it was a temporary error. The auto reclose concept also would not damage the operated system.



## 1.2 Objective

The project objectives need to be achieved in order to make the project useful. The project is expected to help users and grant them more advantages. The objectives for this project are:

- 1) To minimize the usage of mechanical parts of the ELCB component with the electrical parts. For example, the motor usage to reclose can be change using relay.
- 2) To reduce or save the manpower and time that has been use to turn on the normal ELCB manually.
- 3) To develop a more practical electrical safety system.

## 1.3 Scope

- 1) Design an Auto Re-closer ELCB to be use by the domestic user.
- 2) Design an Auto Re-closer ELCB that will be automatically “ON” for the temporary fault and has to be turn “ON” manually for the permanent fault after the fault was solve. The temporary error occurred because of the lightning and the system will be reclosing less than three (3) times in less than a minute. If the circuit trip occurred three times per minute, it determined as permanent fault or error.
- 3) Using the software Micro C to program the Peripheral Interface controller (PIC). PIC16f877A as the controller of the Auto Re-closer ELCB.

#### 1.4 Thesis outlines

Basically, this report is divided into five chapters, which include introduction, theory, equations, previous researches references, simulation result, expected result, discussion and conclusion.

##### Chapter 1

- Includes the project objective, problem statement, scope of work and thesis outlines.

##### Chapter 2

- Presents literature review on this project such as phenomena of lightning induce voltage, principle of the earth leakage circuit breaker operation and type, introduction of PIC, earthing system, and current leakage effect to human body.

##### Chapter 3

- Presents the methodologies of constructing of the overall of project, system auto re-close and system the meter. The method will be presented in flow chart.

##### Chapter 4

- Present the expected result or preliminary results of the operation circuit in simulation. This result also the circuit because the simulation have error.

##### Chapter 5

- Conclude all the works and studies that had been presented in the previous four chapters.

## CHAPTER 2

### LITERRATURE REVIEW

#### 2.1 Introduction

The product is build for the protection from current leakage to ground. The protection is focusing on the people and the equipments. The leakage current happens when a person has direct connection to the electrical equipment, which eventually exposed the person to electric shock. The Earth Leakage Circuit Breaker (ELCB) is a power system protection device. ELCB can detect the current leakage to ground by installing the equipment.

#### 2.2 Earthing system

Have a few name of TT Earthing system and can describe by international standard IEC 60364 distinguishes three families of Earthing arrangements using the two-letter codes TN, TT and IT. The first letter indicates the connection between earth and the power-supply equipment. (generator or transformer). The codes are:

- i. T : Direct connection of a point with earth (French: terre)

- ii. I : No point is connected with earth (isolation) except perhaps via high impedance.

The second letter indicates the connection between earth and the electrical device being supplied. The code for this letter is:

- i. T : Direct connection with earth, independent of any other earth connection in the supply system.
- ii. N : Connection to earth via the supply network.

The TT Earthing system is the system direct connection with earth and it is one of the systems that use this device, which functioned as local connection provider to ground. The system is independent of any earth connection at the distributor's line generator. The Earth Leakage circuit breaker (ELCB) is an electrical device that disconnects protected circuit from electrical supply. ELCB functioned when the device detects any unbalance current in circuit between the live wire supply, (L) and the neutral wire (N). [1]

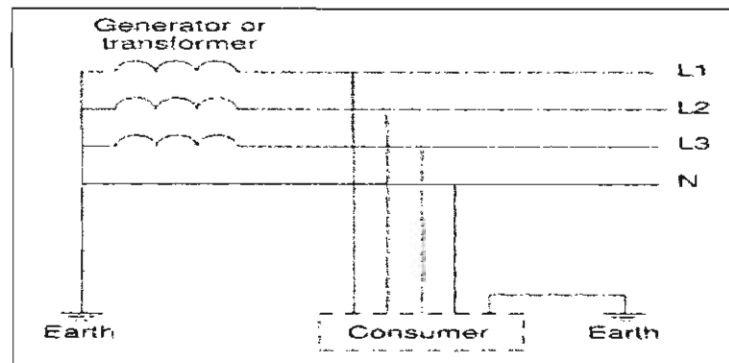


Figure 2.1: TT network. [1]

Electric shock can be interpreted in the right- ranged of 5miliampere to 30miliampere of current leakage to earth. Based on a study in United State, the national code requires GFCI (Ground fault circuit Interrupter) which were found in specific range to protect human being.

The range required is between 4milliamperere to 6milliamperere in 25 milliseconds. The device will eventually trip when current leakages exceed 500milliamperere. There will be some effect on human beings in any classified value of current. The examples of the effects to human based on the current values are described in the table below. [1]

Table 1: Effect of Electrical Current for the Human Body. [1]

<b>Value of current</b>	<b>Effects to human</b>
1Milliamperere	Faint Tingle
2Milliamperere	swelling of the hands
5Milliamperere	Slight shock felt. Not painful but disturbing. Average individual can let go. Strong involuntary reactions can lead to other injuries.
6 - 25Milliamperere	Painful shocks. Loss of muscle control.
9 - 30Milliamperere	The freezing current or “let go” range. If extensor muscles are excited by shock, the person may be thrown away from the power source. Individuals cannot let go. Strong involuntary reactions can lead to other injuries.
50-250Milliamperere	Extreme pain, respiratory arrest, severe muscle reactions. Death is possible.
1.0 -4.3 Amperes	Amperes Rhythmic pumping action of the heart ceases. Muscular contraction and nerve damage occur; death is likely.
10 Amperes	Cardiac arrest, severe burns, death is probable

## **2.3 Fault**

Fault occurs for some reason such as damage of the equipment in the circuit or to the body of the equipment that can cause contact of live wire and neutral wire.

Fault also occurs when a person uses the damage equipment and touches it. It will make the hand to become conductor between power supply and the earth wire. There are some types of fault that can be classed below:

- 2.3.1 Over load
- 2.3.2 Single line to ground
- 2.3.3 Line to line fault
- 2.3.4 Double line to ground fault

### **2.3.1 over load**

Overload occurs when the circuit has high voltage that exceeds the limit of the equipment to accommodate the voltage as normally it operates. This fault occurs because of short circuit, lightning strike, wire damage, equipment not function properly and others.

### 2.3.2 Single line to ground.

Single line to ground, line to line fault and double line to ground fault is symmetrical fault. This kind of situation normally occurs on third phase system, except the single line to ground fault which also occur in single phase. [2]

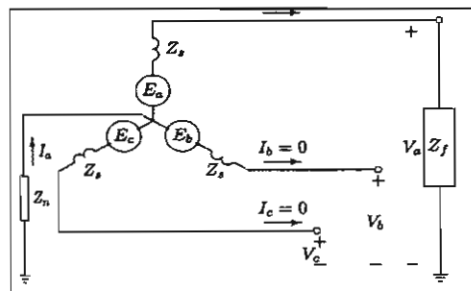


Figure 2.2: Single Line-ground fault occurs on phase through impedance  $Z_f$ . [2]

Single line to ground fault is unbalanced faults or unbalance the network, but only at the fault location. This fault occur because a coupling of the sequence networks. The fault also occurs when there is a leaking current on electric equipment with flows straight into the earth trough the earth wire. The current might also flows through human body if they touch the equipment. [2]

### 2.3.3 Line-line fault

The second symmetrical fault failure is the line-to-line fault, which occurs when two of the conductors come in contact with each other as shown in Figure 2.2. The failure occurred on the third phase system and will occasionally cause a fire sparks which can lead to fire if the power source did not shut off. [2]

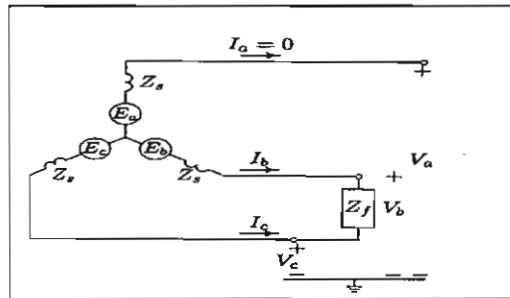


Figure 2.3: A fault occurs between phase b and c through impedance  $Z_f$  [2]

#### 2.3.4 Double line-to-ground

A double line-to-ground (DLG) fault occurs when two line conductors come in contact with each other and will connect to the ground. It is a dangerous situation if it occurs. [2]

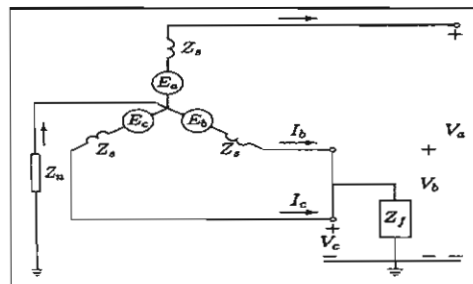


Figure 2.4: A fault occurs between phase b and c through impedance  $Z_f$  to ground.[2]

Permanent fault at transmission line can occurs because of lightning strike, falling trees on the transmission line, unexpected accident, broke off transmission cable and etc. While for