AUTOMATIC RECLOSING SYSTEM
(SMART PROTECTIVE CIRCUIT BREAKER)

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NOVEMBER 2005

"I hereby declared that I have read through this report and found that it has comply the partial fulfillment for awarding the degree of Bachelor of Electrical Engineering (Industrial Power)."

Signature : .....

Supervisor's Name : Prof. Madya Md. Noah b. Jamal

Date : 18 November 2005

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"I hereby declare this thesis is result of my own research except as cited in the references."

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ABSTRACT

Many electrical faults such as short circuit or overcurrent and earth fault that occur are momentary in nature. Because of that the breaker has to be reset manually or by remote control. The circuit breaker has no means of knowing whether the faults still exist. The automatic reclosing system is a system that can able to detect either the fault (overcurrent or short circuit and earth fault) in the system are may still exist or not. Once the fault is cleared, it will automatically switch on back the breaker/switch. It is different from other recloser that been used because this system is applied to single phase system which are one of common system in used. In this project, an attempt will be made to incorporate smart circuit into the circuit breaker system. This circuit needs to test the system for any fault that may still exist. This circuit can be performed by application of an electronic control circuit (using digital technology). This circuit consists of the electronic circuit breaker, the application circuit which function to retest the system, the conditioning circuit and also the sensor of fault. The advantages of this system are reducing in consumer equipment down time and maintenance time.

ABSTRAK

Kebanyakkan kerosakan elektrik yang berlaku seperti kerosakan ke tanah, atau kerosakan lebihan arus adalah merupakan kerosakan yang berlaku hanya sementara. Disebabkan ini, pemutus litar harus dihidupkan semula secara manual atau secara kawalan jauh. Pemutus litar tidak mengetahui samada kerosakan yang dialami dalam sistem masih ada atau tidak. Dengan itu, projek ini mampu mengesan samada kerosakan yang berlaku masih ada atau tidak di dalam sistem. Sekiranya kerosakan sudah tiada, pemutus litar akan menjadi litar tutup secara automatik. Ini berbeza dengan sistem yang sedia ada kerana sistem ini digunakan di kawasan satu fasa iaitu sistem yang biasa digunakan oleh kebanyakan pengguna. Dengan itu dalam projek ini, untuk mengatasi masalah yang timbul, adalah dengan pegabungan antara litar automatik dengan sistem pemutus litar. Litar ini boleh dipraktikkan dengan mengaplikasikan litar kawalan elektronik. Pada dasarnya, litar ini terdiri daripada pemutus litar elektronik, litar 'bijak' yang berfungsi untuk mengesan sebarang kerosakan di dalam sistem, litar penyambung dan juga pengesan kerosakan. Kelebihan projek ini ialah, ia mampu mengurangkan masa selenggaraan dan juga juga tenaga kerja operator.

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CHAPTER 1

INTRODUCTION

Many electrical faults such as short circuit or overcurrent and earth fault that occur are momentary in nature. As an example, earth fault mainly happen because of lightning. In networks with directly earthed neutral an earth fault is equivalent to a phase-to-earth short circuit. The current magnitude will in this case be almost equal to the fault current of a phase-to-phase short circuit.

Normally when the fault happened, the breaker will automatically open. Because of that the breaker has to be reset manually or by remote control. Beside that the circuit breaker has no means of knowing whether the faults still exist or not.

Therefore, this project is to design an electronics circuit that test repeatedly the system for any fault that may exist and switches on the breaker automatically once the fault is no longer exist. This project, will concentrate on low voltage usage; single phase 240V which are the common system in used.

Basically a circuit-protective and switching device has two purposes, there are:-

- It is used to isolate or break the circuit when necessary
- To protect the circuit from electrical fault before it damages the electrical device.

In this project, an attempt will be made to incorporate "smart" circuit into the circuit breaker system. This smart circuit needs to test the system for any fault that may still exist. It can be perform by application the electronic control circuit (using digital technology).

1.1 Literature Review

1.1.1 Role of protection

Power system equipment such as generator, transformers, circuit breakers, transmission lines and control apparatus are very costly. To protect the equipment, it is essential to isolate them during faults from unhealthy sections. Therefore, the protective relaying is used to disconnect the sources of faults currents during faults. Besides it the protective relaying also helps to operate the power system safely and reliably.

In this project, the fault that has been focused is earth fault. A study by Dr. Nasrullah Khan (1997, pg 1) says that the primary function of any type of protective relaying such as electromechanical, solid state or digital is eventually to isolate the defective element, through minimum tripping of circuit breakers, from the rest of healthy power

system as soon as possible but not later than preset time on the relay. The relay is supposed to operate for nearby or other types of faults in neighborhood as there are other relays that are watching to such of distinct faults.

The ultimate function of protective relaying is to instantly detect fault condition on power system and cause prompt removal from service of any element on the system when it suffers a short circuit or when it starts to operate in an abnormal manner that might cause damage or interfere with the effective operation of the rest of power system (Dr. Nasrullah Khan, 1997, pg 2).

1.1.2 Protective Relaying System

The relaying system consists of the primary protection and back up protection. As mentioned by P.M Anderson (1999, pg 17), the primary protection is the relays in front and backup layer of protection are similar but with different time settings. Primary layer may consist of normal overcurrent, distance and differential relays.

a) Overcurrent Protection

An overcurrent relay operates when its current exceeds a predetermined value. Such relays can be instantaneous or time delayed. Overcurrent relay operating characteristics involve an inverse relationship between the fault current and the time to operate.

b) Ground fault Protection

Protection against phase to ground faults can be a difficult problem since ground fault currents vary within a large range, becoming almost negligible in some situations. The ground fault current magnitude depends on the power system grounding which can vary from solidly grounded to ungrounded.

1.1.3 Fault Level Calculation

The frequency of single-line-ground, SLG, faults is far more than phase-phase or three phase faults. It can simply express this probability by the following inequality:

SLG faults >> phase-phase faults >> three phase faults

A study by J.Lewis Blackburn (1998, pg 28) says that, earth fault relay setting calculations require information of precise fault current due SLG faults whereas most of other relays require information of three phase fault level. Besides it above information is also useful for specifications of switching ratings, insulation coordination and choice of current transformer (CT).

1.2 Objective of the Project

The main objective of this project is to design electronic circuit that test the circuit for earth fault that still exist then the switch will on automatically (breaker closed) once the fault is cleared. Beside that the objective of this project also including:

1) To understand the concept of automatic circuit.
2) To design the sensor for fault current detection before feeding into the automatic circuit.

1.3 Hardware Development

Basically the "Automatically Recloser System" is the electronic circuits which are consist of the breaker, the "automatic" circuit and the conditioning circuit with the fault sensor.

1.3.1 Breaker

The breaker that been used is the electronic breaker. This is because; the electronic breaker can be controlled in automatically. For this project, Triac has been used to play a role as a breaker. This is because of it characteristic which is an almost ideal component for controlling AC power loads with a high duty cycle. Using a Triac

eliminates completely the contact sticking, bounce and wear associated with conventional electromechanical breakers.

The Triac is a three-terminal device similar in construction and operation to the SCR. The TRIAC controls and conducts current flow during both alternations of an AC cycle, instead of only one.

There are several benefits of using Triac as a breaker:-

- No mechanical moving parts
- No arching in contacts
- High switching speed
- Long operating life
- No acoustical noise

However, there is still having a disadvantage of using triac as a breaker. The main disadvantage is, it will cause the big power losses.

1.3.2 The "automatic" circuit

The "automatic" circuits basically function to give a signal to the breaker to operate. If there is any fault that occur, this circuit will sent signal to make sure that the breaker will open. But when the fault is cleared, the circuit will order the breaker to close and the system bring back to normal.

This circuit actually consists of the circuits that function to trigger the triac. As mentioned before, the triac will operate when there has a

pulse signal from the gate. Therefore this circuit will transmit a pulse signal when the fault has been occurred.

There are several types of triggering devices such as a pulse transformer and also the optocoupler. Pulse transformer is one of the easiest ways to triggering the triac, which are by applying some simple rules it can be used to design an efficient triac triggering circuit without reduction of the commutation capability of the triac. While the optocoupler, it's capable of transferring an electrical signal between two circuits while electrically isolating the circuits from each other.

For this project, the device that been used to play a role as the automatic circuit is optocoupler. The device that been used also known as DIP zero-cross optoisolators triac driver output and has their own characteristic. This optoisolators also consists of zero crossing detector (ZCD) which is function to convert turn on and off at zero voltage crossing.

1.3.3 The conditioning circuit

The conditioning circuit is the circuit that functions to condition the signal from fault sensor to the automatic circuit. Basically this circuit is used to amplify or increasing the output of fault sensor and synchronized it to the automatic circuit. For this project, operational Amplifier or op-amp is one of the devices that functional to amplify the signal current or voltage.

1.3.4 Sensor of fault

To sense the fault, a sensor like the current transformer or CT is used. The of fault that occur ix earth fault. The current transformer are used both for measurement of load current by ammeter or energy consumed by energy meter as well as protection of power equipment through various types of relays.

"There are three possible types of current transformers known there are; conventional electromagnetic, half effect and magneto-optic CT [6]". The electromagnetic types CTs are fully developed and are being used in all utilities. The Half effect CTs (HECT) are being used at small scales current measuring applications but still not used in protective relaying. The magneto-optic CTs (MOCT) are being developed along with optical inut relays and expected to retrofit electromagnetic CTs in near future.

CHAPTER 2

PROJECT METHODOLOGY

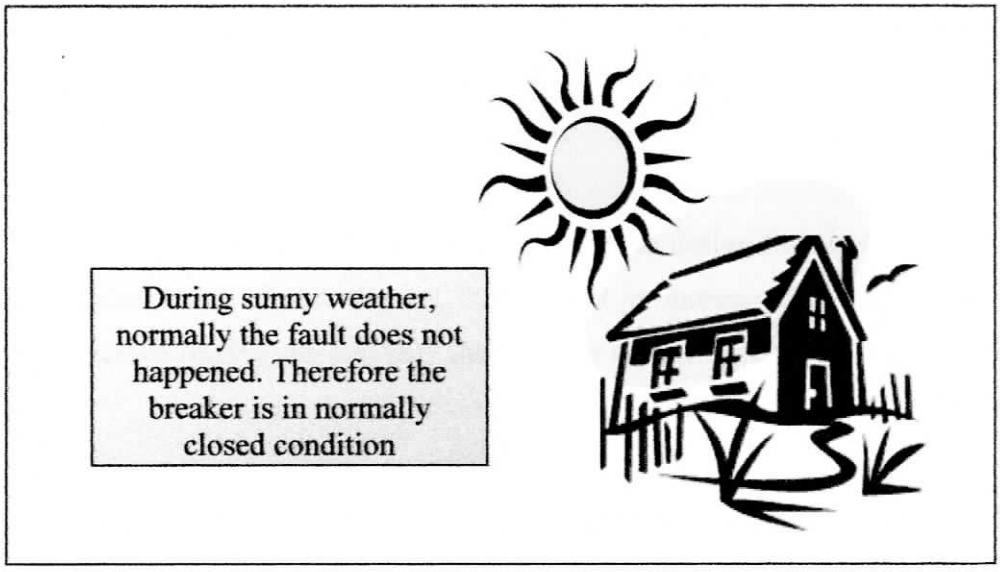
Basically in this project is needed to understand the concept of "smart application" circuit. The circuit will repeatedly test the electrical fault that may be exist in the system. After the fault may not exist, the breaker will switch on automatically.

2.1 Problem Statement

Before going any further, let us understand the problem statement of this project.

Many electrical faults such as overcurrent and earth fault that occur are momentary in nature. The circuit breaker has no means of knowing whether the faults still exist or not.

Therefore the breaker has to be reset manually or by remote control when the fault is cleared. It clearly explains by figure below.



a

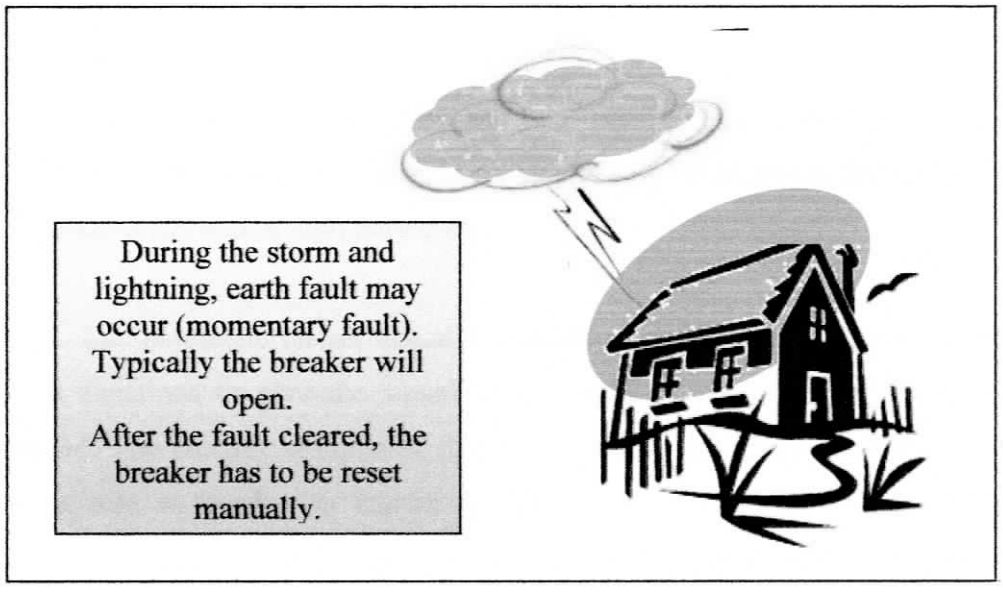


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Figure 2.1: The phenomenon of problem statement