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TITLE : SWEEP FREQUENCY RESPONSE ANALYSIS (SFRA) USING TIME FREQUENCY DISTRIBUTION (TFD)

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SWEEP FREQUENCY RESPONSE ANALYSIS (SFRA) USING TIME FREQUENCY DISTRIBUTION (TFD)

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A report submitted in partial fulfillment of the requirements for the degree of Bachelor of Electrical Engineering (Control, Instrumentation and Automation)

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“I hereby declare that I have read through this report entitle “SWEEP FREQUENCY RESPONSE ANALYSIS (SFRA) USING TIME FREQUENCY DISTRIBUTION (TFD)” and found that it has comply the partial fulfillment for awarding the degree of Bachelor of Electrical Engineering (Control, Instrumentation and Automation)”

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Signature : …….

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To my beloved mother and father

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ABSTRACT

Sweep Frequency Response Analysis (SFRA) is a powerful method can be applied in order to detect or trace the mechanical faults occurs in the transformer. SFRA by using Time Frequency Distribution (TFD) is the method or technique has been selected to be used because TFD able to reduce the noise and also produce the reliable result. This project starts with constructing the tested transformer which are healthy and unhealthy transformer with Omicron Bode 100 devices. Healthy transformer will be the reference for analysis between the healthy and unhealthy transformer such as radial fault transformer, axial fault transformer and also shorten turn transformer. The result from Omicron Bode 100 is in the form of magnitude varies with frequency. The process occurs inside the Omicron Bode 100 is only injected the signal with sweeping frequency in the range of 10 Hz to 2 MHz into the terminal transformer and the result will display at the software Omicron Lab- Bode Analyzer Suite. Next, by using software MATLAB, the result will be convert into TFD). Based on literatures, it proves that TFD capable to trace or detect the presence of mechanical faults within the transformer. Moreover, TFD is a simple method and able to implement in order to obtain the reliable result. In this project, TFD is executed in the form of spectrogram where the time and frequency plot together in one graph. Basically, spectrogram is the common tools for time-frequency analysis. Finally, the analysis will be compared between the healthy transformer and unhealthy transformer to detect the type of mechanical faults that are occurring in the transformer.

ABSTRAK

Sweep Frequency Response Analysis (SFRA) merupakan suatu kaedah yang dapat digunakan untuk mengesan atau mengenal pasti kerosakkan mekanikal yang berlaku dalam pengubah (transformer Kaedah SFRA dari Time Frequency Distribution (TFD) merupakan kaedah yang telah dipilih untuk digunakan kerana TFD dapat mengurangkan gangguan (noise) dan dapat menghasilkan keputusan yang benar. Projek ini dimulakan dengan menjalankan pengujian atau percubaan keatas pengubah (transformer) sama ada rosak mahupun tidak dengan menggunakan peralatan Omicron Bode 100. Pengubah (transformer) yang tidak rosak akan dijadikan sumber rujukan dalam menganalisis diantara pengubah rosak dan yang tidak rosak. Hasil dari Omicron Bode 100 adalah dalam bentuk magnitud berkadar pada kekerapan. Proses yang berlaku di dalam Omicron Bode 100 adalah isyarat dimasukkan dalam bentuk kekerapan menyapu (sweep frequency) di dalam lingkungan 10 Hz sehingga 2 MHz ke dalam terminal pengubah dan hasilnya akan ditunjukkan di perisian Omicron Lab- Bode Analyzer Suite. Seterusnya, dengan menggunakan perisian MATLAB, hasil dari perisian Omicron Lab- Bode Analyzer Suite akan ditukar dalam bentuk TFD). Berdasarkan literatur, membuktikan bahawa TFD mampu untuk mengesan kehadiran kerosakkan mekanikal di dalam pengubah. Malahan, TFD merupakan teknik yang mudah dan mampu dilaksanakan untuk menghasilkan keputusan yang boleh dipercayai. Di dalam projek ini, TFD dilaksanakan di dalam bentuk spectrogram di mana masa dan kekerapan berada di dalam satu graf. Akhir sekali, analisis ini akan dibandingkan diantara pengubah yang rosak dan pengubah yang tidak rosak untuk mengesan jenis kerosakkan mekanikal yang berlaku di dalam pengubah.

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UTeM	Universiti Teknikal Malaysia Melaka
SFRA	Sweep Frequency Response Analysis
TFD	Time Frequency Distribution
RVM	Recovery Voltage Measurement
DGA	Dissolved Gas in oil Analysis
FT	Fourier Transform
IFRA	Impulse Frequency Response Analysis
AC	Alternating Current
FRA	Frequency Response Analysis
STFT	Short Time Frequency Transform

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CHAPTER 1

INTRODUCTION

1.1 Project Background

Transformer is an electrical device that converts or change an alternating current (ac) of a certain value of voltage to an alternating current of different value voltage without changing the frequency [1],[2]. A transformer is a very large contribution mainly in power transmission. If any of the transformer experiencing failure or fault in power transmission system, electricity cannot be distributed in the factory and household. There are four types of fault which are electrical, thermal, environmental and mechanical faults. The most difficult fault to observe is mechanical faults [3],[4]. This is because mechanical fault occurs at the winding and the core inside of the transformer itself. Figure 1.0 shows the transformer experienced mechanical faults. The types mechanical faults that are occur in the Figure 1.0 are the windings of the transformer collapsed and also windings of the transformer loosened.

Figure 1.0: The transformer experienced mechanical faults [2]

There are a few of faulty diagnostic technique that can be applied including method recovery voltage measurement (RVM), the dissolved gas in oil analysis (DGA). However, all of these methods are not relevant in order to detect the transformer winding deformation [4],[5]. The structures of the transformer are made up of a combination of capacitance, resistance, self inductance and also mutual inductance. When a fault occurs in the winding, the frequency response from the winding will change immediately. This is happening due to the parameter of transformer is changed.

The winding displacement can affect the transformer insulation withstand. Therefore, SFRA is used by using TFD method in order to analyze the signal and interpret the signal to classify the transformer whether healthy or unhealthy transformer.

1.2 Motivation

Mechanical faults occurs within the power transformer is very difficult to detect or trace because most of the power transformer built with cover. By using Sweep Frequency Response Analysis (SFRA), the power transformer able to check whether the transformer is healthy or unhealthy. To detect the present of mechanical faults by using Omicron Bode 100 is convenient, however to transfer the signal into time-frequency distribution (TFD) is very difficult. In this technology era, the skill to detect mechanical faults to the transformer is indispensable. This is because the power transformer is very costly and to replace the power transformer with the new transformer is not a good solution. Moreover, SFRA is not only able to detect the mechanical fault but also electrical faults occur in the power transformer. This project is needed to reduce the rate of damage that can cause significant losses to the industries and also manufacturing by establish the monitoring system that can help in diagnosing the faults occur within the power transformer.

1.2 Problem Statement

First of all, this project was implemented to detect the mechanical faults that are occurring in the power transformer. This is because the presences of mechanical faults are quite difficult to trace because of the transformer built with its cover. Basically, power transformers are crafted and designed to endure or detain this current from short circuit, however the strong electrodynamics forces resulting from short circuit will affect the transformer windings and also the core collapse. Mechanical faults could be trace by using Time Frequency Distribution (TFD) methods from SFRA [4],[5],[6],[7]. Therefore, TFD is proposed to be used in order to detect the presence of mechanical faults in the transformer. Basically, TFD is a new method use to determine and identify the mechanical fault occurred in the power transformer[4]. The different between TFD and Fourier Transform (FT) are FT only 1 Dimensional representation and TFD is 2 Dimensional representations. From [4],[8] it states that FT is the methods for Impulse Frequency Response Analysis (IFRA), not the same with TFD which is from Sweep Frequency Response Analysis (SFRA). For this is the reasons why TFD is selected and be used due to the factor of TFD having a 2 Dimensional representatives are both the time and frequency applied at the same time in one plot graph. From [4] and [8] it states that the results from the sweep frequency system are very much repeatable then impulse frequency system. At this point of view, SFRA is better than IFRA in order to achieve the result precisely.

1.4 Objective

1. To investigate the effectiveness of Sweep Frequency Response Analysis (SFRA) using Time Frequency Distribution (TFD) as a diagnostic technique in single phase transformer
2. To analyze the capability of Omicron Bode 100 for the detection of mechanical faults occurring in single phase transformer.
3. To examine the frequency ranges of the mechanical faults occurring using Time Frequency Distribution (TFD).

1.5 Scope of research

1. The application of Omicron Bode 100 device is used for the SFRA measurement system.
2. SFRA measurement conducted on three types of single phase transformers with two transformers already in defective condition while the other one is non-defect transformers.
3. Analyze the mechanical fault occurring in the single phase transformer
4. SFRA using TFD measurement results is taken for comparison between healthy and mechanical faults transformer

1.6 Report Outline

This report consists of 5 chapters. In chapter 1, this report focuses on the background of the project, problem statement, objectives of research and scope of the research. In chapter 2, the literature review of this project is precisely describes in detail. It contains the general theory of transformer, type of faults in the power transformer, fault diagnosis in the SFRA, the frequency ranges, time-frequency distribution and also the type of diagnosis applied.

Chapter 3 discusses the method used and the procedure that is used in the experiment. Furthermore, in this chapter it explains in more detail about the constructing of the Omicron Bode 100, testing each of simulated transformer faults and non defect transformer condition. Next, Chapter 4 discusses the preliminary result regarding to the hardware and software in this project. Last but not least, Chapter 5 will discuss the conclusion and recommendation can be made from this project.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In this chapter, it explains several of relevant information about theory characteristic of the transformer. Furthermore, it also includes the variant type of faults in the power transformer, fault diagnosis using Sweep Frequency Response Analysis (SFRA), frequency ranges used for evaluating the transformer core, type of diagnosis applied to the power transformer. Last but not least, TFD is applied to the power transformer in order to detect the faults occurs.

2.2 Type of Faults in Power Transformer

Initially, the power transformer is designed to endure or detain the short circuit current. But even so, the effect of the mechanical forces notably short circuit may affect the power transformer in terms of life expectancy. This is because when the presence of mechanical forces will achieve a limit, the impact will cause the insulation of the mechanical strength in the transformer to become poor.