

**UNIVERSITI TEKNOLOGI MARA**

**ULTRASONIC DETECTION OF  
PARTIAL DISCHARGE AND  
PATTERNS IDENTIFICATION USING  
FAST FOURIER TRANSFORM AND  
WAVELET ANALYSIS FOR  
INSULATION FAILURE**

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## **CANDIDATE'S DECLARATION**

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the result of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any other degree or qualification.

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## ABSTRACT

This thesis proposes about the method for locating the source of ultrasonic signals and to detect the different types of partial discharges (PD) i.e. external and internal discharges on cable insulation. PD are the electric discharges in insulating material that does not bridge a pair of electrodes completely. The magnitude of PD is small, but, it can cause deterioration and may lead to breakdown. External PD was created by removing some of the portion of the insulation midway along the length of 5 meters RF Uniradio cable exposing the braid to the air. Internal PD was created by piercing small holes (0.8, 1, 2 and 3 milimetres) on the middle layer of a three-parallel sheet of wacker silicone rubber so that it creates void at the inner part of the insulation. The external and internal PD test setup were subjected to a voltage supply of 5kV to 20kV in 2.5 kV level increment, and 1kV to 6kV in 1kV increment, respectively. The voltage is supplied to the test jigs from low voltage then increased gradually to observe the PD activity in the insulation. The voltage is stopped as the discharges becoming audible and the existence of the spark at the insulation started to occur. The emitted sounds of the external and internal PD are laudable to naked ears at 12.5kV and 5kV respectively. The ultrasonic waves emitted by the PD detector by ultrasonic detector known as the Ultraprobe 2000, where it translate the ultrasonic signal into electrical signal and with the aid of signal converter, the signal can be recorded in the PC. These signals emitted from the discharges are known as faulty signals. The ultrasonic waves of the samples prior to the creation of the holes were also recorded in similar manner. These signals are known as healthy signals. The Fast Fourier Transform (FFT) and Wavelet Analysis (WA) were employed for analysis. With FFT, the signals are represented in frequency-domain and the trend of signal the PD can be detected and be located. There are significant changes in FFT plots for faulty signals when comparing with the FFT plots for healthy signals. The peak magnitude lies on the low frequency range if the signal is healthy, meanwhile, if the signal is faulty, then the peak magnitude lies at the high frequency range. WA analyzes signal in time-domain in order to search for basic or commonly recurring pattern. Here, WA employed the dyadic downsampling technique in the analyses where the procedures taken in order to determine the suitable mother wavelet and its number of level. Each resulting signal produced from the dyadic is compared to the original signal. With different void sizes, it shows that the discharges at larger void size, the lower the peak frequency i.e 4 kV, just before the discharges become audible. It was found that these analyses are able to predict the patterns of faulty signals clearer than the original ultrasonic signals. For the case of external PD, it was found that the suitable mother wavelet is Daubechies at the number of level 7 (db7). For internal PD, the best mother wavelet is Symlet with the number of level 3 (sym3).

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# CHAPTER 1

## INTRODUCTION

### 1.0 Introduction to the Research

Partial discharges (PD) are electric discharges in insulating material that do not completely bridge the pair of electrodes in which the material is sandwiched in between. Although the magnitude of partial discharges is usually small, they cause progressive deterioration and may lead to ultimate failure. In fact, partial discharges occur before the actual breakdown [1]. Therefore, it is important to detect the partial discharges at the early stage in order to reduce the number of breakdown cases.

There are two methods of partial discharges namely the electrical and non-electrical method. The non-electrical method can be classified into four basic forms of non-electrical phenomena that includes; a) chemical transformation, b) gas pressure, c) heat d) sound (also known as acoustical) and e) light.

In this thesis, the partial discharges phenomena representations in insulating materials were carried out. Two types of PD to be detected in this thesis namely the external (combination of surface and corona discharges) and internal discharges. Non-electrical (i.e. sound) is preferable to be adopted since it is a non-destructive control test especially the ultrasonic technique. The ultrasonic technique is more valuable compared to audible technique [1] since this technique is immune to electrical interference, in