DIGITAL PROCESSING OF PARTIAL DISCHARGE SIGNALS

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A dissertation submitted to the Faculty of Engineering, University of the Witwatersrand, Johannesburg, in fulfilment of the requirements for the degree of Master of Science in Engineering

Johannesburg, 1986

I declare that this dissertation is my own, unaided work. It is being submitted for the degree of Master of Science in Engineering in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at any other University.

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Sixteenth day of July 1986

ABSTRACT

The research carried out for this dissertation involved the design, construction and testing of an instrument which could both detect and store partial discharge signals. This device uses a novel approach to the analysis of the signal in that it stores only the polarity, peak value and time of occurrance of the signal. This is done because all information required to fully reconstruct the signal can be gathered from this information. The partial discharge could be detected in a range 1pC to 10000pC with a time resolution of 25 micro seconds, which compares favourably with the specifications of present analogue devices on the market. The instrument was tested on certain specimens of known discharge characteristics and found to give good correlation with the expected results.

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ACKNOWLEDGEMENTS

I would like to acknowledge the assistance of both the CSIR and the University of the Witwatersrand in my personal financial assistance. Further I would like to thank the University of the Witwatersrand for its financial assistance in funding the project.

I would like to give my personal thanks to my supervisors Professor J.P. Reynders and Professor M.G. Rodd for their unfailing help.

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1 Introduction

The insulation that surrounds the conductors in high voltage devices can contain small imperfections in the form of tiny air pockets. When a voltage is applied to these devices the voltage gradient created across the air pocket is greater than that in the solid material. When this is high enough a discharge in the pocket termed a partial discharge results.

This discharge causes degradation of the insulation which can cause insulation failure, and ultimately total failure of the device.(5)

The partial discharge is seen at the terminals of the device as a very fast current spike superimposed on the power frequency signal which is either driving or being produced by the machine.

This discharge is of a very short duration, with a rise time of 1-5ns and a slightly longer fall time, which means that these discharges are extremely difficult to measure directly.

It has been shown that if a partial discharge is used to excite a parallel RLC resonant circuit the peak value of the output is directly proportional to the charge contained in the discharge.(2)

Hence if a partial discharge excites a resonant circuit all the information about its charge can be obtained by capturing the peak value of the output of the resonant circuit. Further, if the time of occurrence of the discharge with respect to the AC waveform can be ascertained, a total picture of the activity can be reconstructed.

The research programme discussed in this paper was undertaken to produce an instrument which would be able to detect the peak value of a partial discharge, ascertain its polarity and time of occurrence, and to pass this information to a microcomputer for long term storage and/or manipulation. The manipulation involves calculating the actual value of the discharge and coupling this to its time of occurrence. It will then be possible to use such a device with non standard waveforms such as a very low frequency signal or ramp signal to investigate the inception of partial discharges.

Work in the field of digital processing of partial discharge signals was pioneered by Austin and James (6) who developed a data logging system which interfaced a minicomputer with an existing analogue discharge detection system and I.A Black (1) who developed a system which would discriminate noise from the discharge information. When the noise elimination system is developed from this project, the noise will be eliminated by the use of software techniques, which differs from Black's work because he used hardware to achieve this.

2 Description of present analogue techniques

There are two methods used to detect signals using analogue techniques:

a. Narrow band testing.

b. Wide band testing.

Narrow band testing, (also known as radio interference testing,) is used to pick up the radio frequency disturbance caused when a partial discharge occurs. This method uses a high sensitivity selective voltmeter, designed as a narrow band receiver. The receiver output is then amplified on either a cathode ray tube or a peak detecting meter.(3)

For wide band testing (See Figure 2.1) the partial