

Nondestructive testing in Electrical Devices using Loop antennas

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Abstract—This paper proposes a method for identifying and classifying electric and electronic equipment defects by using a large loop antenna. The method is based on the radiated magnetic field assessment, using Wavelet decomposition. As an application a set of four three-phase power transformers was tested for common defects and misconfigurations such as phase inversion phase disconnection and short circuits. For each type of defect, the signature or energy was characterized and classified. Some numerical simulations were carried out in order to compare with the experimental data.

Index Terms—Failure detection, van Veen & Bergervöet. Antenna, wavelets

I. INTRODUCTION

The van Veen and Bergervöet antenna provides for a simple and cost effective way to detect magnetic radiation from sources in a wide range of sizes, without the need for an anechoic chamber. Because of its small weight, it may be moved around or placed in any production line with ease [1] – [2]. Thus, the small cost and flexibility of the antenna allow for testing of small equipment in any phase of the assembly process, avoiding unnecessary transportation and dismantling costs. Also it allows for testing the equipment when already in site, assuring that there were no damages during transportation and that all connections were built correctly. In this paper we analyze a few possible scenarios for defects or misconfiguration of a small three-phase power transformer operating at 60Hz. Phase inversion, phase disconnection and low intensity short circuits are identified by the typical signature and energy level of the signal emitted, in each circumstance, by applying wavelets [3]. Although the specifications of the antenna assume a working frequency interval of 9 kHz to 30 MHz, the antenna may also be used to test low frequency equipment.

II. ANTENNA CONSTRUCTION AND CONFIGURATION

A van Veen and Bergervoet antenna was built according to CISPR 15 specifications using PVC electrical conduits as a guide for the coaxial cables, and a wooden structure. The antenna was calibrated according to the CISPR specifications in order to assure the functionality for the range of 9 kHz to 30 MHz [2]. The current on the loop antenna was measured using an amplified current probe with a precision of 1V/A, connected to a network enabled oscilloscope.

III. OBSERVED RESULTS

Based on the studied scenarios, it was possible to realize that the total energy rate of the radiated signal has assumed values from 358% to 1370% of the original energy level for phase

disconnection; from 7300% to 12500% for the short circuits, and from 359000% to 362000% for phase inversions. Many details could be taken into account like the ones regarding a small duration short circuit on the secondary side of the transformer (Fig. 1), in which a disruption can be observed in the mid frequency details of the decomposition, indicating the exact time of occurrence accompanied by a change in the energy level of those details.

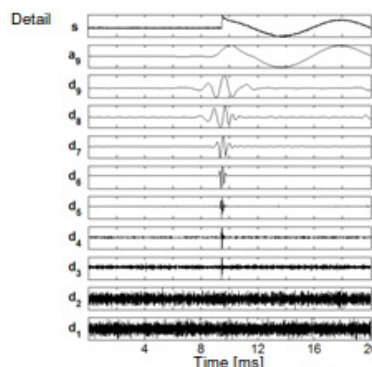


Fig. 1. Wavelet decomposition of the measured signal at the moment of occurrence of a short circuit

A continuous wavelet analysis could help identify which coil of the transformer was disconnected, like shown in Fig 2:

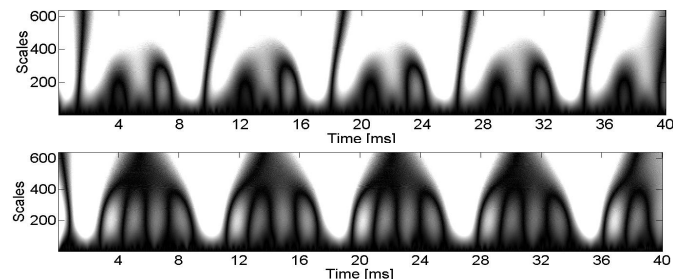


Fig. 2. Characteristic signal of disconnected coils: #1 and #3 (Scales)

All the results were verified for the four tested transformers, which were identical, custom built following the same specifications.

IV. ACKNOWLEDGEMENT

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