



# Using correlation coefficients for locating partial discharge in power transformer

Mehdi Nafar<sup>a</sup>, Taher Niknam<sup>b,\*</sup>, Amirhossein Gheisari<sup>c</sup>

<sup>a</sup> Islamic Azad University, Marvdasht Branch, Iran

<sup>b</sup> Department of Electrical and Electronics Engineering, Shiraz University of Technology, Shiraz, P.O. 71555-313, Iran

<sup>c</sup> Islamic Azad University, Fars Science and Research Branch, Iran

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## ABSTRACT

Most serious failure of power transformers is due to the insulation breakdown. Partial discharge (PD) that damages insulation by gradual erosion is major source of insulation failure. The effective ability of the wavelet packets analysis as a tool for disk-to-disk partial discharge faults detection and localization in transformer windings is shown in this paper. Techniques for locating a PD source are of the major importance in both the maintenance and repair of a transformer. One of the most well-known methods of PD localization in transformers is based on winding modeling and current of neutral point analysis. Since the impedance between PD location and neutral point of winding depends on the PD location in respect to neutral point, the frequency spectrum of neutral point current varies when the PD location changes. In the other word, the current components of neutral points vary according to the place where PD occurs. So in this paper, detailed model of transformer winding is modeled and the neutral point current is studied for locating PD. The used method is validated by the simulated model of transformer windings. This model produces a very acceptable current when compared to the experimental data. In this paper for locating partial discharge (PD) in transformer windings, a simulated model is developed for the transformer winding and the PD phenomenon mechanism. The impulse current test and wavelet packets transformation are used to locate PD. It is shown that the neutral current measurement of the transformer winding has useful information about PD location.

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## 1. Introduction

Since large power transformers are the most expensive and strategically important components of any power generator and transmission system, their reliability is crucially important for the energy system operation. Most serious failures of a large power transformer are due to the insulation breakdown. The partial discharge (PD) which damages insulation because of the gradual erosion, is the major source of the insulation failure. Techniques for locating a PD source are of the major importance in both the maintenance and repair of a transformer [1–3].

In the previous projects, the discharge between the winding of the transformer and the ground has been analyzed [1–10]. It is too difficult to determine the PD propagation in a complicated multi-material insulation system of a transformer winding accurately. It has been shown in [11] that sectional winding transfer functions, computed by high frequency modeling winding, can be used for PD localization. In [12–14] detailed model and in [15–17] multi-conductor transmission line model (MTLM) have been used for PD

localization. Although lots of efforts have been made in solving the problem, the localization of PD source in transformers is still a challenge for all testing engineers [18,19]. Recently, Werle et al. [20,21] have worked on PD location investigations in the dry type and distribution transformers. These transformers are sensitive to the effects of partial discharges in this point of view that non-self-restoring insulation is used in the construction of dry type transformers [20]. Although a new method has been investigated by authors of Ref. [21], they have concluded that more experiences are needed for using this method of PD analysis. Analysis of PD in the coil to coil capacitance is so difficult that it was not considered completely in previous papers. In this paper, partial discharge of coil to coil insulation ( $C_s$ ) is investigated using EMTP simulation tools. The current of neutral point of winding was measured when PD model was located at different positions in the winding. This current was analyzed by the Db12 in wavelet packets; then coefficients at different wavelet packet nodes were saved. PD will be located by comparing the correlation between these coefficients and the neutral current measurement signal.

## 2. High frequency winding model

In the range of frequency associated to PD, the transformer winding behaves as a complex ladder network consisting of

\* Corresponding author. Address: Department of Electrical and Electronics Engineering, Shiraz University of Technology, Modars Blvd., P.O. 71555-313, Shiraz, Iran. Tel.: +98 711 7264121; fax: +98 711 7353502.

E-mail addresses: [niknam@sutech.ac.ir](mailto:niknam@sutech.ac.ir), [taher\\_nik@yahoo.com](mailto:taher_nik@yahoo.com) (T. Niknam).