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A comparison of transformer HF models and their application to PQ analysis

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Abstract. This research work is devoted to the comparison of some proposed high-frequency (HF) models of transformers and their application to power quality (PQ) studies. The models are classified according their structure, physical description and experimental methodology and set-up facilities needed to obtain the parameters.

1. INTRODUCTION

High-frequency modeling is essential during the design stage of power transformers in order to study the impulse voltage response, the winding integrity, power quality problems and also for insulation diagnosis. In some cases, high-fidelity models in a bandwidth up to 10 MHz are required for condition monitoring purposes.

From an experimental point of view the study of the high-frequency part of the spectra have to be done in order to obtain the stray capacitances that shunt the series inductances and dominating the response.

2. HF MODELS

A. Physics-based models

This type of model is close to the real behavior of the real transformer [1–3]. The main drawback of this approach is the neccessity of information about the physical structure of the machine, including dimensions, materials and geometry. The needed data is raraley provided by the transformer manufacturer. Fig 1 shows a finite elements model using the physical description of the machine.

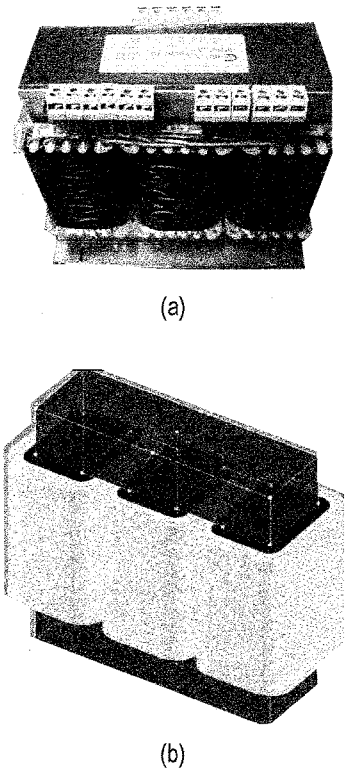

Figure 1. Finite elements description of a laboratory transformer. (a) Image of the real transformer; (b) Finite Elements model.

B. Black-box models

Black-box models are suitable to obtain the HF behavior of the transformer when it is difficult to obtain information about the machine. The basic idea is to obtain the transfer function using transient information about voltage and current [4]. The admittance matrix is defined in the frequency domain in ranges that goes from 50 Hz to 1 MHz. Numerical models are introduced based on