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Automated System for Determining Frequency Dependent Parameter Model of Transmission Line in a Laboratory Environment

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Abstract--This work presents an automated system for determining transmission line model parameters at various frequencies. The system was developed and implemented on General Electric test reactors designed to model power transmission line behavior in a laboratory environment. The measurement system and data processing are controlled and automated via custom developed LabVIEW software. Measurements are obtained from voltage and current probes interfacing with oscilloscopes. This data is then acquired and processed in LabVIEW software. The structure of the transmission line model, desired confidence level and number of tests to conduct are specified user inputs. The system subsequently provides the transmission line impedance parameters based on these specifications. These parameters are calculated using both time domain and frequency domain techniques. While this work focuses on determining transmission line model parameters, this automated test measurement system is applicable to any device that can be parameterized via a current-voltage (I-V) characteristic or frequency response.

Keywords: Impedance measurement, Uncertainty, Digital signal processing, RMS measurement, Frequency dependence, Experimental Analysis

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1. Introduction

Power systems exhibit both fundamental and non-fundamental frequency components [1]. An emerging characteristic of modern power systems is an increased level of non-fundamental frequency components attributed to the augmented use of power electronic switches. Common power electronic devices introduce a wide range of harmonics [2]. Specifically, up to the 39^{th} harmonic should be monitored in accordance with power quality standard EN50160 [3]. In addition, up to the 15^{th} harmonic component is introduced into the network in a capacitor switching scenario. Under the increasing presence of non-fundamental frequency components, it is necessary to characterize components at various frequencies and develop appropriate models.

State of the art simulation tools utilize manufacturer specifications. However, these specifications are often made at rated conditions (e.g. 50-60Hz in power systems). It is often the case that operating conditions seen by hardware are not at rated levels and electrical parameters can vary based on current levels, voltage levels and frequency. In order to obtain accurate simulation results, and subsequently proper system control strategies, these parameters must be known for various operating conditions. The automated test measurement system developed in this work can determine parameters at different voltages, currents, and frequencies.

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