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IEEE Guide for the Parameter Measurement of AC Transmission Lines

IEEE Power and Energy Society

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Transmission and Distribution Committee

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IEEE Guide for the Parameter Measurement of AC Transmission Lines

Developed by the

Transmission and Distribution Committee
of the
IEEE Power and Energy Society

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Abstract: In this guide, the field testing methodology and techniques are presented for measuring electrical parameters of ac transmission lines. The topics discussed are safety precautions; requirements for measuring instruments; measurement of induced voltage and current; phase verification and insulation resistance measurement; dc resistance measurement; off-line parameter measurement of symmetrical transmission line; off-line parameter measurement of asymmetrical transmission lines; eliminating power frequency interference during off-line measurement; zero-sequence parameter measurement with adjacent lines in operation; and online parameter measurement of transmission lines.

Keywords: admittance measurement, asymmetrical lines, distributed parameter, electrical parameter, IEEE 1870™, impedance measurement, off-line measurement, on-line measurement, open-circuit impedance, short-circuit impedance, transmission line

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Introduction

This introduction is not part of IEEE Std 1870-2019, IEEE Guide for the Parameter Measurement of AC Transmission Lines.

The purpose of electrical parameter measurement of ac transmission lines is to provide true parameters for power flow calculation, short-circuit current computation, power system stability analysis, protective relay setting, line fault location, and so on compared to solely calculated parameters. Therefore, a working group was formed to develop a guide that would provide guidance for parameter measurement of ac transmission lines.

This guide was prepared by working group P1870 of the IEEE-SA Board of Governors/Corporate Advisory Group (BOG/CAG).

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1. Overview

1.1 Scope

This guide will provide testing methods for impedance measurement of ac transmission lines and calculating methods for the resistance, inductance, and capacitance (RLC) distribution parameters of the tested line. It will also provide testing and calculating methods to obtain mutual inductance and coupling capacitance between double circuit lines on the same tower. This guide will outline the measuring instruments and the safety of the measurement. In addition, it will include test procedures to obtain the open-circuit and short-circuit impedances of the tested line as well as the formulas to get the distributed parameters from impedance measurements.

1.2 Purpose

The accurate parameter of the power transmission line is the basis of precise power flow calculations, stability analysis, protective settings, and line fault location. Therefore, it is necessary to develop a uniform guide to provide technical guidance for the accurate parameter measurement of ac transmission lines.

1.3 Background

To understand the importance of measuring electrical parameters, in particular, the short-circuit, positive-sequence impedance Z_1 and zero-sequence impedance Z_0, the following case study compares measured and calculated values for the positive-sequence impedance Z_1 and zero-sequence impedance Z_0 of 40 power lines with different configurations (power cables, overhead lines and mixed lines consisting of both, power cables, and overhead lines).

In Figure 1, the deviation between calculated and measured values for R and especially X of Z_1 are small relative to the ones of Z_0. This is because Z_1 can be accurately calculated by means of the geometry and the material of the conductors. However, for the calculation of Z_0, the properties of the soil return path shall be known, such as soil resistivity in different soil layers and other parallel buried conductors such as pipes and other grounded elements in residential or industrial areas. All of these properties are unknown and therefore make the calculation inaccurate in contrast to the measurement, which reflects all present properties of the soil return path and therefore provides true values for Z_0.