Inductive Voltage Transformers Calibration by the Parameters

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Abstract: - The accuracy class of an IVT – Inductive Voltage Transformer – is typically assessed in laboratory installations either by comparing with another IVT presenting greater accuracy and traceable to a national laboratory or by using a capacitive divider. Calibration in the field using internal parameters is considered herein, using results obtained from typical open and short circuit tests and winding resistances, performed with common meters. A Möllinger & Gewecke graphic diagram is employed together with the results of an accuracy test previously carried out to determine the exact value of the winding turn relation and of the primary winding dispersion reactance. These values are used to calculate the phase and ratio errors, which must lie between definite limits, defined by the accuracy class of the instrument. Four commercial IVTs were tested to determine the validity of the procedure. The errors are compared with those obtained with the Schering-Alberti method (AC Bridge and comparison with standard IVT).

Keywords: - Instrument Transformers, Inductive Voltage Transformer, Voltage Transducers, Measurement Errors, Error Estimation, Certification, Calibration

1. Introduction

In an ideal instrument transformer, the voltage quantity at the terminals of the secondary is identical to that of the primary winding in a reduced scale, presenting no phase difference. However, a real IVT - Inductive Voltage Transformer - presents divergences not only in the magnitude but also in the phases of voltages, errors that change with the burden of the instrument transformer. The current formulae for the errors require the values of the primary dispersion reactance calculated separately as well as the exact winding turn relation. The difficulty in obtaining these values probably explains the infrequent use of the analytical method in verifying IVTs accuracy class, which must be within ranges of 0.1 to 0.3%, for purposes of electrical energy billing. To accomplish this, comparative methods are normally employed in laboratories, using standard AC bridges.

The objective of this paper is to demonstrate a practical method for verifying the accuracy of commercial IVTs with typical open and short circuit tests, performed with common instruments in the field. Consequently, inconvenient and troublesome transportation to a laboratory facility for verification is avoided. A graph method employing the Möllinger & Gewecke diagram allows for determining the separate primary winding reactance, as well as the compensation value. With these values, it is possible to calculate the errors and verify the accuracy class of the transformer. The IVTs considered here are for distribution networks, with rated primary voltages up to 34.5 kV (phase to phase) and 34.5/√3 (phase to neutral). The common classes are of 15 kV, 25 kV and 36 kV, installed in substations supplying industrial and commercial loads, connected to measurement devices. In the case of higher voltages, in the range of hundreds of kVs used in transmission and sub transmission networks, CVTs – capacitive voltage transformers are more commonly employed. However, their construction is based on a capacitive divider connected to an inductive voltage transformer, therefore this process also applies to CVTs.

2. Accuracy Classes of IVT's

According to the standards [1,2], the accuracy classes of IVT's define limits of the errors of ratio and phase, and a ratio correction factor. The classes 0.3, 0.6 and 1.2, correspond to maximum errors of 0.3%, 0.6% and 1.2% of the rated secondary voltage. The IVT is considered to be in good condition if the point determined by the ratio error (ε_P) or the ratio correction factor (RCF) and by the phase angle (γ) lies within an accuracy parallelogram, Fig. 1.