CONIMED SA

A TRANSFORMER BRIDGE FOR TESTING HIGH VOLTAGE STATOR INSULATION

Ricardo Garcia

Electricity Division – National Institute of Industrial Tecnology – INTI
Buenos Aires – Argentina

Guemes 4193 – (B1603BEM) Villa Martelli – Pcia. de Buenos Aires – Argentina
Tel: (54) 11 4709 –2659 Fax: (54)11 4709 4707 - E-Mail: coneduar@satlink.com

ABSTRACT

This paper describes and gives design details of a transformer bridge. It is adequate for the measurement of the capacitance, loss tangent, energy and integrated charge transfer, due to partial discharges (PD); in bars, coils and complete windings of high voltage machines fron 1 to 16 kV.

A similar bridge is known in some countries as Dielectric Loss Analizer (DLA).

1. INTRODUCTION

The power factor tip up, is the most common non destructive test of HV insulation. This is established in many standards f.e. IEEE 286 and V.D.E. 530.

Nortwithstanding, some authors, [1..4] and standards REM 500 and ASTM 3382, give other magnitudes such as energy due to PD and the capacitance increases with the applied voltage, for the evaluation of the insulation.

All the above mentionated quantities can be measured with the transformer bridge, in coils or complete windings.

2. DESCRIPTION OF THE BRIDGE

The figures 1 and 2 show two typical configurations of the bridge.

The voltage transformer VT and the inductive voltage divider IVD, are the ratio arms.

The VT's ratio is k=15000/100 V. Their ratio and phase errors are below 0.01 % and 0.01 cradians over all voltage range of the bridge.

The IVD is of two stages type with 3 decades and with and additional 5 Ω potenciometer gives a resolution of $2\ 10^{-4}$ of the input; the voltage error and phase shift are lower than 0.01% and 0.01 cradrians.

The range capacitors C_s may take four values 0.15, 1.5, 15 and 150 μF. They are commercial self healing polypropylene capacitors.

The compensation of the loss angle of C_x is obtained by means of the conductance G. To avoid the high dissipation in the higher ranges (15 and 150 μF), is additionated the capacitor C (fig.2).

The conductance G has three decades and its value is so that, the loss tangent is direct reading at 50 Hz.

For the measurement of the capacitance and loss tangent (see fig 1) the bridge is balanced with a tunned detector or an osciloscope with a slot filter.

The balance equations are:

$$C_x = \frac{D}{K-D} C_s \sim \frac{D}{K} C_s$$

$$\mathrm{tg}\,\delta_x = \frac{G}{\omega \ C_x}$$

in 1 nF and 10 nF ranges.

$$\mathrm{tg}\,\delta_x = G \frac{(G + C_s)}{\omega \ C \ C_x}$$

in 0.1 μF and 1 μF ranges.

An additional balance of strays capacitances to earth is not neccessary, because of low impedance of the IVD.

For de measurement of the integrated charge and energy due to PD, the null detector is replaced by an oscilloscope (see fig. 2).

The measured procedure is fully explained in [1] and the ASTM Standard 3382.

3. SPECIFICATIONS

The technical specifications of the bridge are the followings:

Capacitance:
- Ranges 1 nF; 10 nF; 100 nF; 1 μF
- Resolution 0.002 % of the range
- Accurancy ± 0.05%

Loss tangent:
- Range 10 %
- Resolution 0.01 %
- Accurancy ± 0.05

Integrated charge:
- Sensitivity 0.15 μC/V - 1.5 μC/V
- 15 μC/V - 150 μC/V

Voltage Range:
- 1 kV - 16 kV

4. CONCLUSIONS

The transformer bridge has the following adventages over the bridges described in the references.

1. Direct reading of the capacitance and loss tangent.

2. Wide capacitance and voltage range.

3. An additional guard circuit voltage range is not necessary.

4. A general purpose, low price oscilloscope is adequate. In other bridges a differential amplifier or transformer are necessaries because of the oscilloscope grounding requeriments.

ACKNOWLEDGEMENTES: The author wishes to acknowledge to the firm Conimed by the construction of the prototype, and his collegues E. Choleva and A. Medina by their advices.

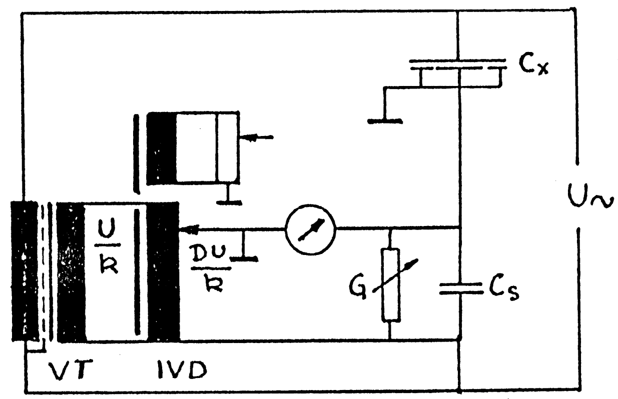

Fig. 1

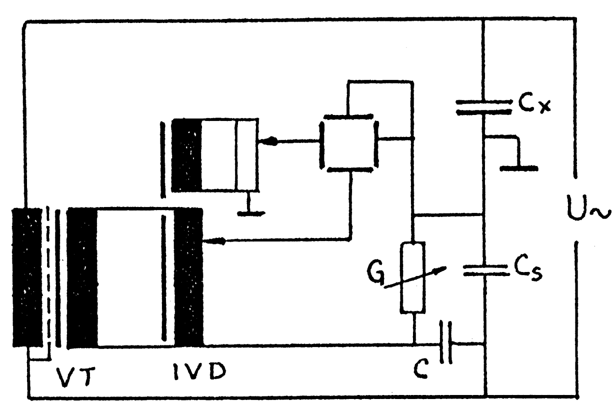

Fig. 2