NPL
National Physical Laboratory

Inductive Voltage Dividers

An Inductive Voltage Divider is an auto-transformer which divides an AC voltage in a proportion determined by the *turns ratio* between input and output circuits. If a divider is made from 10 identical windings connected in series, a total of 11 taps are produced. If an AC voltage is applied across all ten windings any ratio of this voltage between 0 and 1 in steps of $^1/_{10}$ may be selected by appropriate choice of tap.

Commercial IVDs are constructed from a number of such windings or *stages* wound on high-permeability cores and connected in cascade Rotary switches are commonly used to make the connections between stages and thereby select a ratio of the divider. The stages are normally divided equally in to 10 sections or *decades* Most IVDs have 6 , 7 or 8 decades. The dividers are not perfect but , in general, the errors are very small, do not change rapidly with either temperature or time and can be determined to a high accuracy by calibration against a reference IVD.

A set of reference IVDs are maintained at NPL which are calibrated by measuring the difference voltage between adjacent taps. The measurements are made using a floating voltage source connected in opposition to the voltage between the taps and the small voltage remaining can be measured accurately. Using the sum of all the measurements , the value of the floating voltage source can be expressed in terms of the voltage across the divider. By this means the ratio of the voltage at any tap to that across the divider can be calculated. This method of calibration is sometime called a build-up or bootstrap technique.

A Test IVD is compared with a reference IVD by energising both from a common AC voltage and measuring the voltage difference between their outputs. The ratio errors of the test IVD are then calculated from the measured differences and the known errors of the reference IVD.

The measured ratio will normally be a complex quantity;

- the In-Phase Voltage Ration portion which ideally would be equal to the nominal ratio i.e. the setting of the divider.
- The Quadrature Error refers to the imaginary part of the ration and ideally would be zero.

Measurements are normally made of separate settings of the two most significant decades on IVDS with 7 decades or less, or the three most significant decades for IVDs with 8 or more decade. In addition, on multi-decade IVDS, measurements can be made of settings that are multiples of $^1/_{11}$ of the input. The ten results produced by this test incorporate every switch position in the divider, providing a check on its operation.

Summary of AC Voltage Ratio Capability

- Measurements in the range 40 Hz - 120 kHz at specified input voltage and frequency
- 2 or 3 most significant decades tested including (10) or (X) settings if appropriate.
- Tests of multiples of $^1/_{11}$ also available
- Each measured ratio resolved into orthogonal quantities.