Proceedings of the Technical Session of Institute of Physics, Sri Lanka 5 (1989) c4

Development of a Phase Sensitive, Frequency Selective Detector

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Accurate measurement of thermometer resistance, at given temperatures, is of prime importance especially in the field of thermometry. The Inductively Coupled Double Ratio Bridge (which is analogues to the Kelvin Double Bridge) is an instrument which is commonly used for such precise measurement of resistance.

The Double Ratio Bridge uses an alternating current technique carried to obtain out at low frequencies. The bridge arms consist of inductive dividers to obtain a ratio read-out, the accuracy of being about one part in ten million or so. The use of alternating currents and inductive dividers introduces unwanted noise and phase factors into the measurement which causes null balancing of the bridge exceedingly difficult, using only frequency selective detection, as the resolution of the ratio readout is increased. This in turn introduces errors in measurement resulting in the decrease of the high precision required.

The Detector used by the bridge for null balance is of the frequency selective type (which selectively picks out the input signal from the noise superimposed on it) having a transformer input and a positive deflection meter read-out. This arrangement is insensitive to phase, maintains a fairly high noise level at the output and also does not indicate whether the bridge is over or under balanced, all of which are disadvantage to the user. The detector was reconstructed to show and eliminate the introduced phase factors and to greatly reduce the noise level of the output.

This was achieved by incorporating a circuit, after the frequency selective detection, which synchronously detects both the in-phase and in-quadrature components of the output relative to the input signal to the bridge. These signals are later independently integrated over a period of time and the read-out is taken on a centre-zero moving coil instrument. Here in-quadrature component indicates the unwanted phases factors which could be effectively read and eliminated. Integrating the output signal before the read-out greatly reduces the noise level, since the integration of random noise over a period of time usually results in very small output. The use of a centre-zero instrument also has an added advantage of being able to indicate whether the bridge is under or over balanced. Therefore, phase Sensitive Frequency Selective Detection supplies more information about the measurement, is easier to perform and is also rid of most phase related and noise errors, thus, enabling signals as small as a few nanovolts to be detected.