A Technique for Avoiding Connection Errors in Computerized Impedance-Measuring Systems

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Abstract—The technique described uses a series of impedance measurements with different lead combinations and a calculation to determine the impedance of an unknown in the presence of lead and loading impedances. In general, a four-terminal ac or dc measurement requires four leads, four switches, and a series of five two-terminal measurements. However, an ac bridge is shown that requires only two switches and three measurements. The impedance of the switches used to select the lead combinations has no effect on the measurement if it is constant and changes in switch resistance between closures can be avoided by choosing a measurement sequence that closes each switch only once.

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Most guarded four-terminal bridges are subject to errors caused by impedance to guard at the unknown end of the leads. A series of seven three-terminal measurements corrects for this type of error, which is particularly important for *in situ* measurements or for high-precision measurements on three-terminal standards.

The technique is particularly applicable to an automatic computerized device because two-terminal automatic bridges are substantially simpler than four-terminal bridges and because the speed of such a system and its computer can easily overcome the main disadvantages of the method—the necessity for several measurements and the calculation (which includes square roots). However, three two-terminal measurements and a simple calculation will measure a four-terminal impedance with a residual error that can be very small if the lead impedances are approximately equal. Thus the method may be practical for manual measurements as well.