QuadTech

Application Note

Transformer Ratios Measured Directly on the Quadtech 1689 and 1693 Digibridge ™

The 1689 Precision RLC Digibridge can measure voltage ratio directly using the connection shown in Figure 1. This method is particularly suitable for inductance voltage dividers that could be formed by any two windings of a transformer connected as series aiding. The Digibridge resistance readout indicates the real part of the voltage ratio.

In Figure 1, the Digibridge is actually measuring the auxiliary resistor Rp, but the potential connections are across the divider so that the measured Ex is g (Ex), where g is the divider ratio. Therefore the indicated resistance is g (Rp). To make the Digibridge direct reading in g, Rp should be set to an even decade value, say 1.0000kΩ. To do this, Rp may be a precision resistance, or it may be adjustable and set to give a reading of 1.0000kΩ when g is unity (i.e., the P+ and I+ are both connected to the divider input).

The ratio mode of the Digibridge makes it possible to use a stable resistor of any value as Rp. First, measure Rp with the PH connector tied to the IH connector. Then note the resistor value. Enter this at the NOMINAL VALUE and go to the RATIO value ([2] [=] [SHIFT] [SPECIAL] [6]). Now, when PH is tied to the junction of the windings, the 1689 will read g directly. The main source of error, and it is small, is caused by lead resistance and finite inverter amplifier gain. The effective value of Rp is:

$$Rp(1+\frac{r}{Rp}+\frac{r}{1+K})$$

where r is lead resistance and K the amplifier gain at the test frequency. This error is removed if Rp is adjusted to give a reading of 1.0000 when g = 1. Perhaps the most useful application is in measuring transformer turns ratios. In this case

$$g \cong \frac{N2}{N1+N2}(1+\frac{N1(N1Z2-N2Z1)}{(N1+N2)^{Zm}})$$

where Z1 and Z2 are the leakage impedances of the two windings and Zm is the mutual impedance between them. The error term is usually very small (particularly if the same wire size is used for both windings so that the winding resistances are proportional to the number of turns). The Digibridge should be set to measure Series Resistance and the measured resistance used to calculate g.

Measurement Procedure

It is useful to note that these are several of the methods of measuring turn ratios of transformers but these all require at least two measurements and a calculation. The method described above is particularly good for production tests if the turns-ratio (N1/N2) limits are converted to limits as N2/(N1+N2) because, as setup, no future adjustments or calculations are required.

This application note describes a method to measure the turns-ratio of a transformer using a QuadTech digibridge. Briefly stated, the method measures a precision resistor and uses the transformer, connected series aiding, as a divider to determine the ratio.

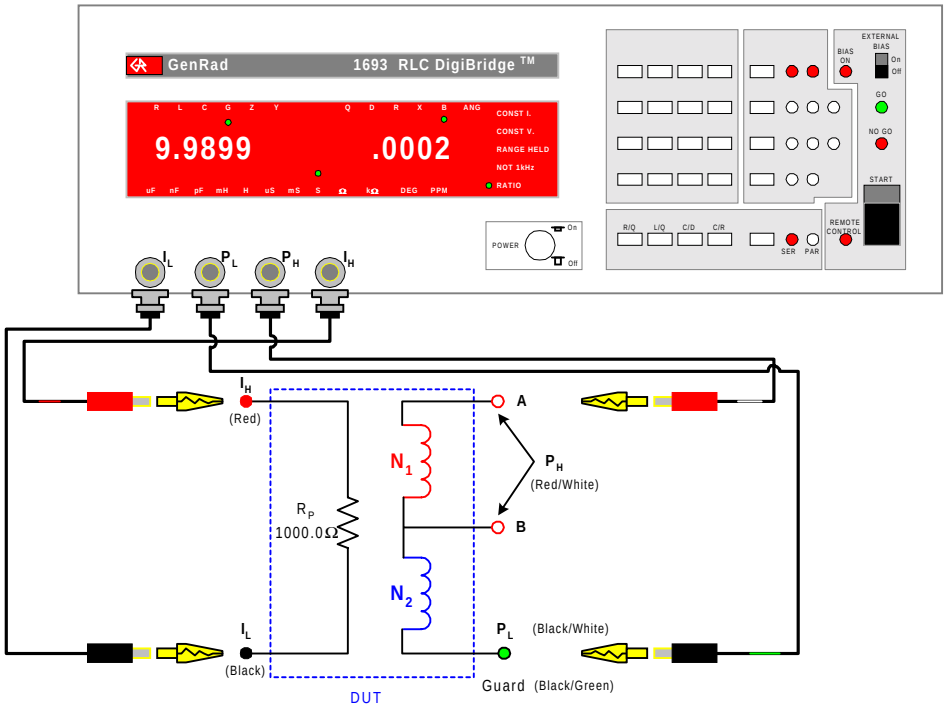

Figure 1: Test Setup

A) PROCEDURE FOR ANY DIGIBRIDGE:

1. Connect the test setup as shown with PH set to position **B**.
2. Press R/Q and measure R to be 1000.0Ω. Use a precision resistor or decade box to get this value as close as possible.
3. Connect PH to position **A**.
4. Measure the resistance and insert the value in the equation:

$$\frac{N1}{N2} = \frac{1000.0 - \text{reading}}{\text{reading}}$$

Measurement Procedure

B) ALTERNATE PROCEDURE FOR 1689: (using RATIO mode)

1. Connect the test setup as shown with PH set to position **B**.
2. Press R/Q and measure R to be 1000.0Ω. Use a precision resistor or decade box to get this value as close as possible.
3. Connect PH to position **A**.
4. Store the value measured in step 2 as the NOMINAL VALUE (1000Ω).
5. Enter the RATIO MODE: [1] [=] [SHIFT] [SPECIAL] [6]
6. Measure the value and insert in the equation:

$$\frac{N1}{N2} = \text{reading} - 1$$

C) ALTERNATE PROCEDURE FOR 1693: (using Conductance and delta RLC)

1. Connect the test setup as shown with PH set to position **B**.
2. Press R/Q and measure R to be 1000.0Ω. Use a precision resistor or decade box to get this value as close as possible.
3. Connect PH to position **A**.
4. Store the value measured in step 2 as the NOMINAL VALUE (1000Ω).
5. Set Display to G/B and Delta RLC.

$$\frac{N1}{N2} = \text{reading}$$

For complete product specifications on the 1600 Series Digibridge Line or any of QuadTech's products, visit us at http://www.quadtech.com/products. Do you have an application specific test? Call us at 1-800-253-1230 or email your questions to info@quadtech.com. Put QuadTech to the test because we're committed to solving your testing requirements.

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