QuadTech

Application Note

What Voltage and Current is Applied to the Unknown?

When a device is tested with a Digibridge it is not uncommon to need to know what voltage is across the device or what current is passed through it. To compute the actual voltage or current it is necessary to understand the output configuration of the instrument. The test voltage is applied to the DUT with a range resistor (R_S) in series with it. The value of R_S is known and varies as the impedance of the DUT changes. Table 1 lists the values of R_S for the QuadTech 1600 Series Digibridges.

Table 1: Range Resistor Values of 1659, 1692, 1689, 1693 Digibridges

Range #	R_S	Auto Z Range
1	102.4 kΩ	> 25 kΩ
2	6.4 kΩ	1.6 kΩ - 25 kΩ
3	400 Ω	100 Ω - 1.6 kΩ
4	25 Ω	< 100 Ω
Constant Voltage	25 Ω	any

With known values of V_{PROG}, R_S, and Z_{DUT}, we can calculate the values of V_{DUT} and I_{DUT} using Ohms Law and derivative equations as illustrated in Figure 1.

$$X_{DUT} = 2\pi fL \qquad = \frac{1}{2\pi fC}$$

$$Z_{TOT} = \sqrt{\left(X_{DUT}\right)^2 + \left(R_{DUT} + R_S\right)^2} \qquad Z_{DUT} = \sqrt{\left(X_{DUT}\right)^2 + \left(R_{DUT}\right)^2}$$

$$V_{PROG} = I_{DUT}\left(Z_{DUT}\right) \qquad I_{DUT} = \frac{V_{PROG}}{Z_{TOT}}$$

$$R_{DUT} = X_C D \qquad = \frac{X_L}{Q}$$

$$V_{DUT} = \frac{Z_{DUT}}{Z_{TOT}}\left(V_{PROG}\right)$$

Figure 1: Formulas for Calculating DUT Voltage, Current & Impedance

Prior to determining the voltage across the DUT or the current through the DUT, one must first establish the test voltage and frequency. The source resistance is then established based on the resistance range used by the test instrument. A capacitor is used as an example to illustrate the calculation of the voltage across the DUT.

Calculate the voltage across the DUT

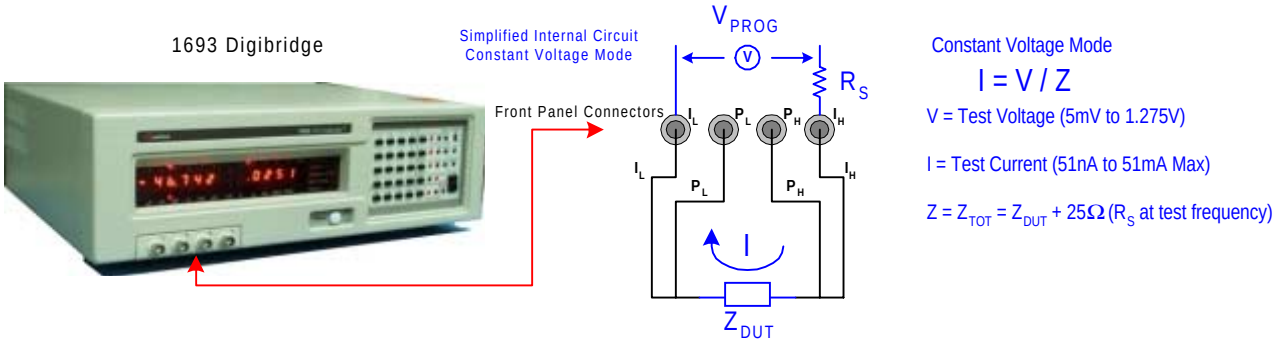
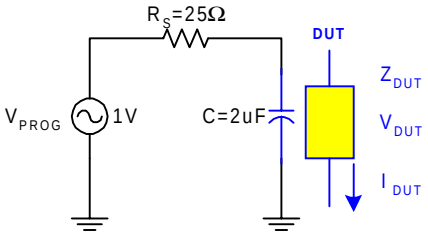


Figure 2: Constant Voltage Mode with 1600 Series Digibridge

Device Under Test:

DUT = 2uF capacitor
D = 0.1
Test Voltage = VPROG = 1V
Test Frequency = f = 1kHz
1693 Resistance Range = range 4
Source Resistance = R_S = 25Ω



Given the above values for the capacitor under test and the test parameters, we can calculate X_C, R_C, Z_{DUT} and Z_{TOT}. Once we have these values, we can calculate V_{DUT} using the equations in Figure 1.

$$X_{DUT} = \frac{1}{2\pi fC} = \frac{1}{2\pi 1kHz2uF} = 79.57\Omega$$

$$R_{DUT} = X_C D = (79.57\Omega)\ (0.1) = 7.957\Omega$$

$$Z_{DUT} = \sqrt{(X_{DUT})^2 + (R_{DUT})^2} = \sqrt{(79.57\Omega)^2 + (7.95\Omega)^2} = \sqrt{6394.58\Omega} = 79.96\Omega$$

$$Z_{TOT} = \sqrt{(X_{DUT})^2 + (R_{DUT} + R_S)^2} = \sqrt{(79.57\Omega)^2 + (7.95\Omega + 25\Omega)^2} = \sqrt{7417.80\Omega} = 86.12\Omega$$

$$V_{DUT} = \frac{Z_{DUT}}{Z_{TOT}}(V_{PROG}) = \frac{79.96\Omega}{86.12\Omega}(1V) = 0.928V$$

After calculating the voltage across the DUT (0.928V), we calculate the current running through the DUT using Ohm's Law: V=RI or I=V/Z. $I_{DUT} = V_{DUT}/Z_{DUT}$ = (0.928V)/(79.96Ω) = 0.0116A = 11.6mA.

Digibridge Voltage & Current Ranges

Figures 3 and 4 present graphical illustrations of the voltage across a DUT (for resistors or low loss capacitors and inductors) and the maximum current of the Digibridge instrument at 1.275V. Actual voltage and current values depend on the device being tested (DUT).

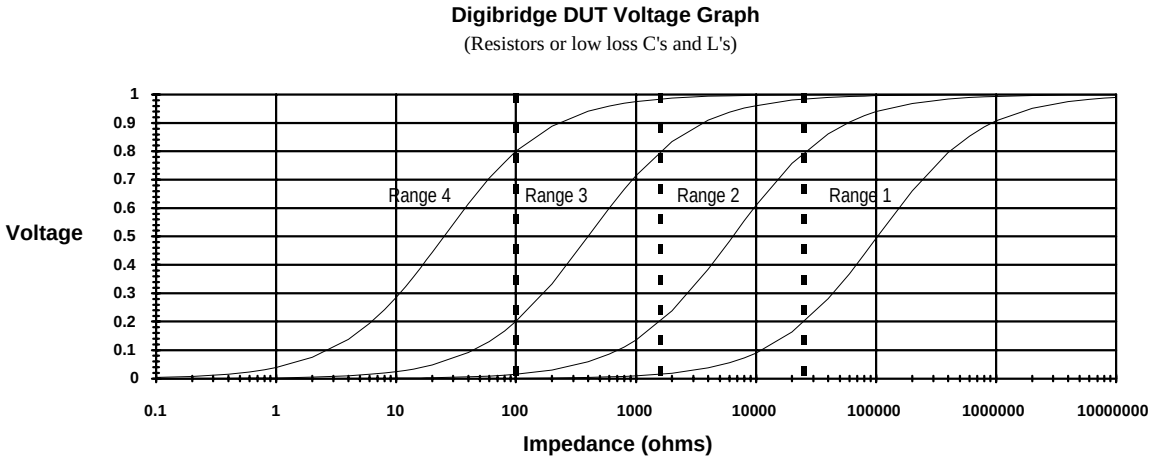


Figure 3: 1600 Series Digibridge Voltage versus Impedance

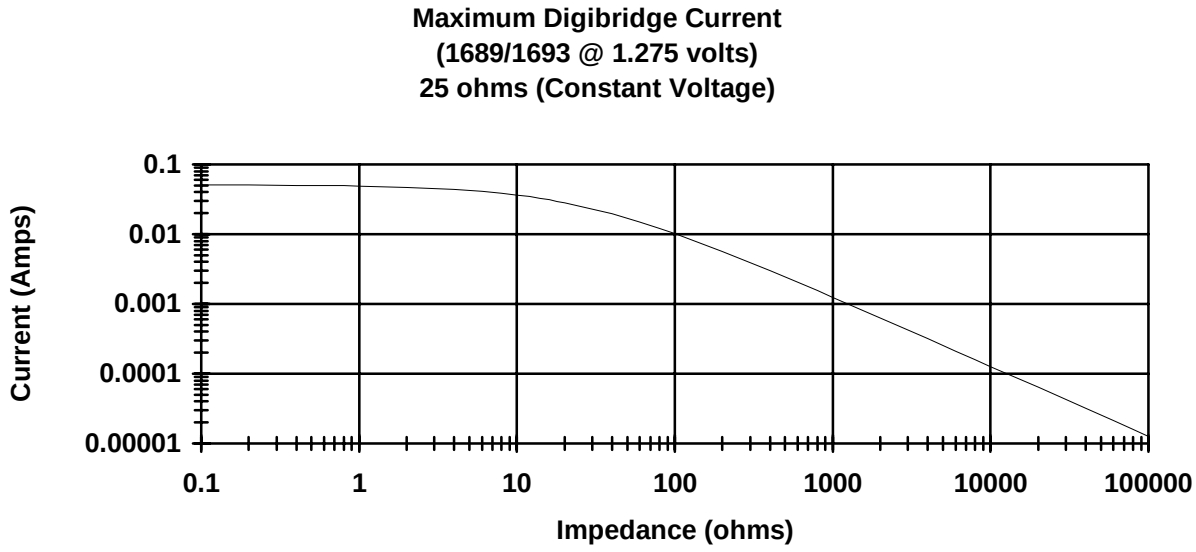


Figure 4: 1600 Series Digibridge Current versus Impedance

For complete product specifications on the classic 1600 Series Digibridge instruments or any of QuadTech's products, visit us at http://www.quadtech.com/products. Call us at 1-800-253-1230 or email your questions to info@quadtech.com.

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