Chroma Systems Solutions, Inc.

What Voltage And Current Is Applied To the Unknown?

LCR Meters 11021,11025

Keywords: Test Voltage, Test Current, DUT Voltage, Current, Impedance

Title: # What Voltage And Current Is Applied to the Unknown

Product Family: **11021, 11025**

When testing a device, the object is to determine the voltage across the device or the current passed through it. To compute the actual voltage or current we should first understand the output configuration of the testing instrument.

The programmed test voltage (V_{PROG}) is applied to the DUT in series with a source resistor (R_S). Table 1 lists the values of R_S.

Table 1: Range Resistor Values

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

The next step is to select the test frequency (f) and the dissipation factor (D). Then we can calculate V_{DUT} and I_{DUT} using Ohm's Law and the derivative equations, which are listed at the end of this application note.

What follows is an example in which the DUT is a capacitor.

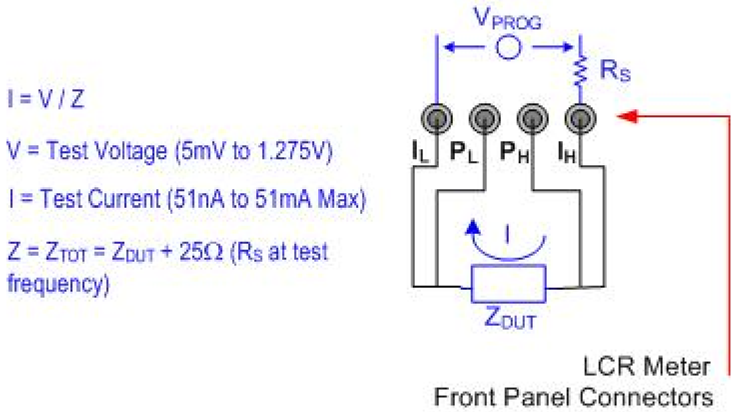

Figure 1: Block Diagram

DUT = 2µF capacitor

D = 0.1

Test Voltage = V_{PROG} = 1V

Test Frequency = f = 1kHz

Resistance Range = range 4

Source Resistance = R_S = 25W

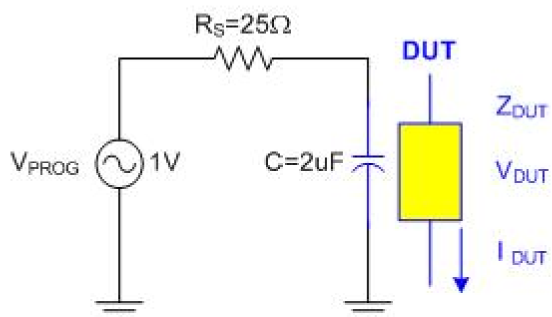

Figure 2: Schematic

Given the test parameters, we can calculate X_{DUT} (which in this example is X_C), R_{DUT} (which in this example is R_C), Z_{DUT} and Z_{TOT}. Once we have these values, we can calculate V_{DUT} and $I_{DUT.}$

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

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

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

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

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

After calculating the voltage across the DUT (0.928V), we calculate the current running through the DUT using Ohm's Law, I=V/Z.

$I_{DUT} = V_{DUT}/Z_{DUT}$ = (0.928V)/(79.96W) = 0.0116A = 11.6mA.

LCR Voltage & Current Ranges

Figures 3 and 4 illustrate the voltage across a DUT (for resistors or low-loss capacitors and inductors) and the maximum current of the LCR instrument at 1.275V. Actual voltage and current values depend on the DUT.

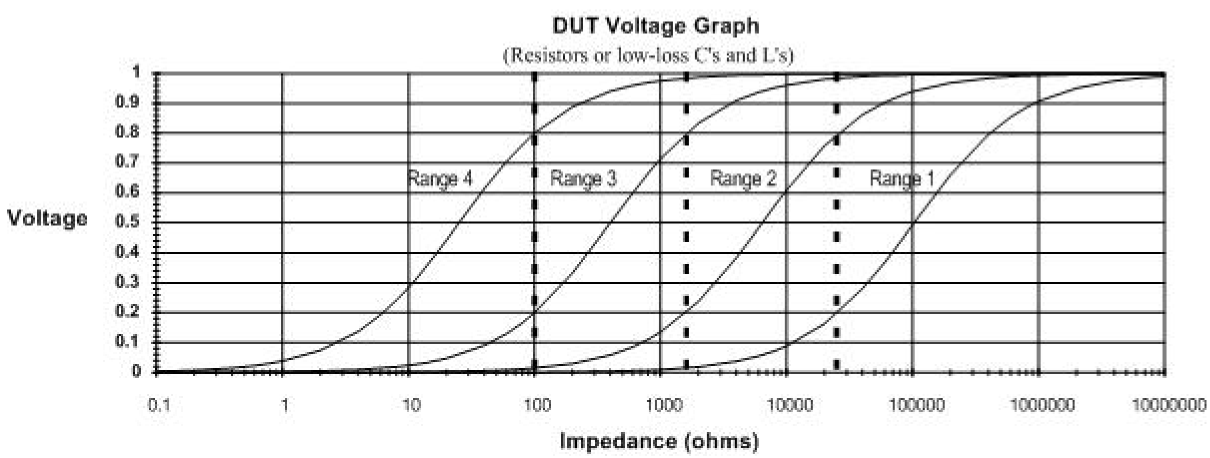

Figure 3: Voltage versus Impedance

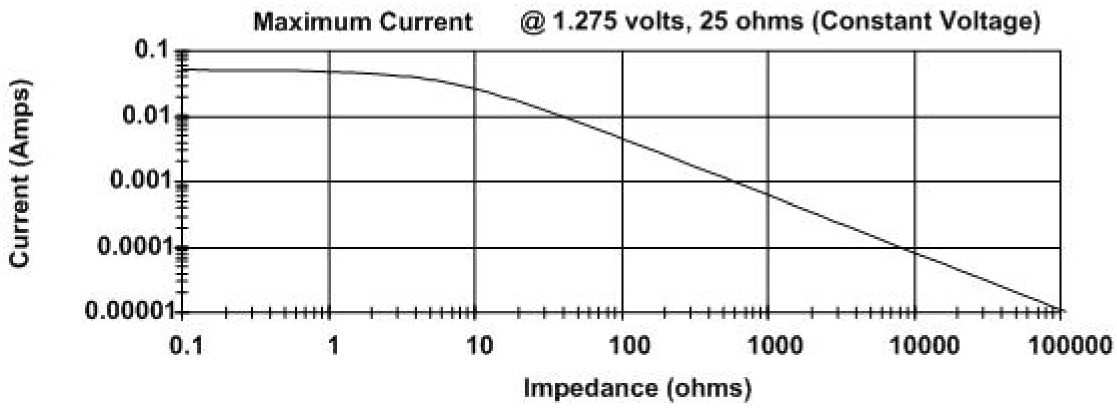

Figure 4: Current versus Impedance

Formulas for Calculating DUT Voltage, Current & Impedance

$$X_{DUT} = \frac{1}{2\pi fC} \quad \text{or} \quad 2\pi fL$$

$$R_{DUT} = X_C D \quad \text{or} \quad \frac{X_L}{Q}$$

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

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

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

$$I_{DUT} = \frac{V_{PROG}}{Z_{TOT}}$$