Introduction

With thick film resistors, the voltage coefficient of resistance or VCR defines the change in resistance value as the applied voltage changes. VCR is linear and negative. As a result, it can be used with a great deal of accuracy to predict the resistance value of a specific resistor outside the range of voltages that can be applied using a source meter or other resistance measuring equipment. Source meters that are used to measure resistance typically have a maximum voltage output of 1000V.

Measuring VCR

The VCR can be determined by measuring the resistance value at 2 different voltages and calculating the slope of the connecting line between them. This is shown in the Figure 1 using measurement voltages of 200V and 1000V. The slope of the line is -0.5 parts per million per volt or -0.5ppm/V.

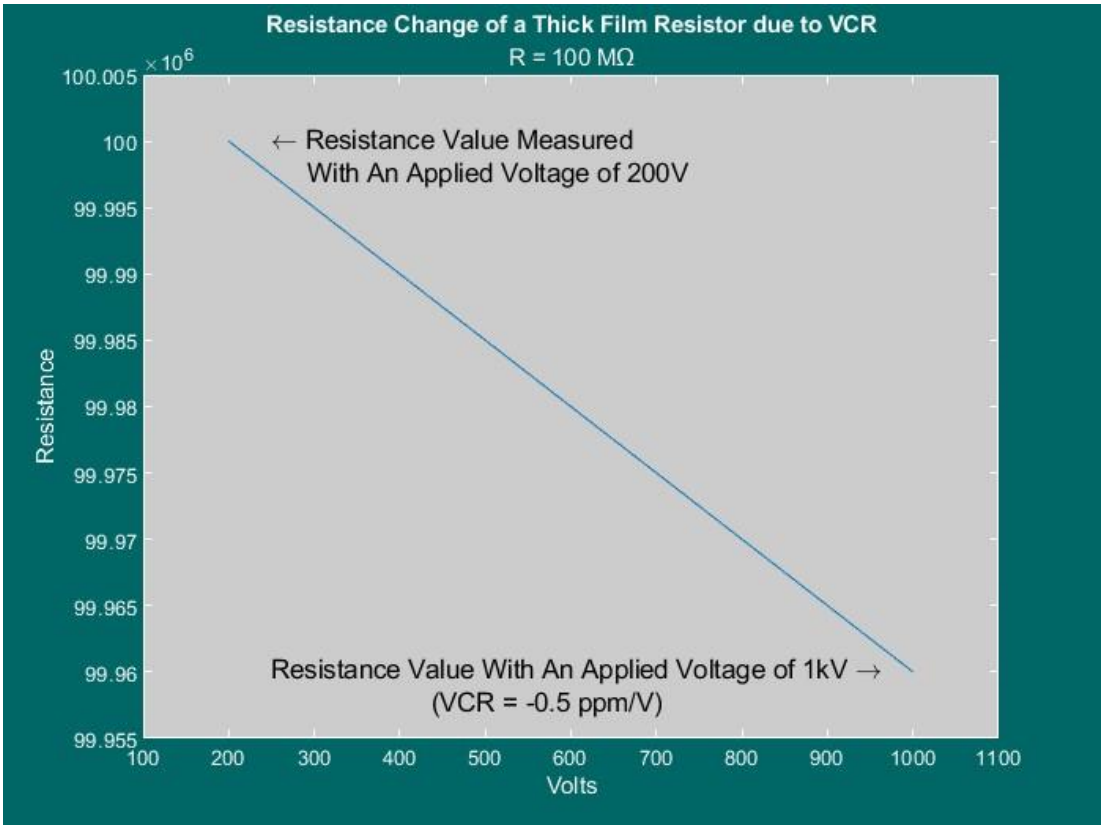

Figure 1: Measuring VCR using a Source Meter

Determining Resistance Values using VCR

Knowing the VCR allows a design engineer to extrapolate the resistance value at any other voltage either inside or outside the source meter's capability. Figure 2 shows the resistance values of 10 samples measured using a source meter with output voltages of 200V, 500V and 1000V. It also shows the calculated resistance value at 500V using VCR.

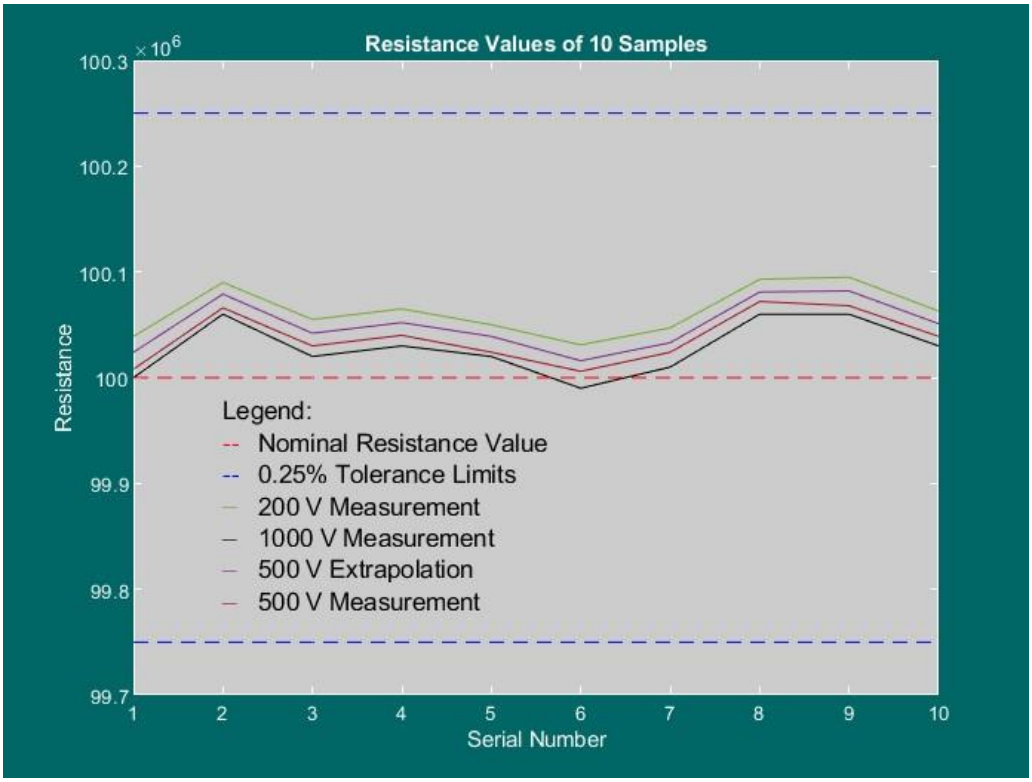

Figure 2: Comparing Measured vs. Calculated Resistance Values within a Source Meter's Measurable Range

If we compare the difference between the 500V resistance value that was measured vs the 500V resistance value that was calculated, we can show that the percent difference between the two measurements is between 0.01 and 0.02 percent as shown in Figure 3.

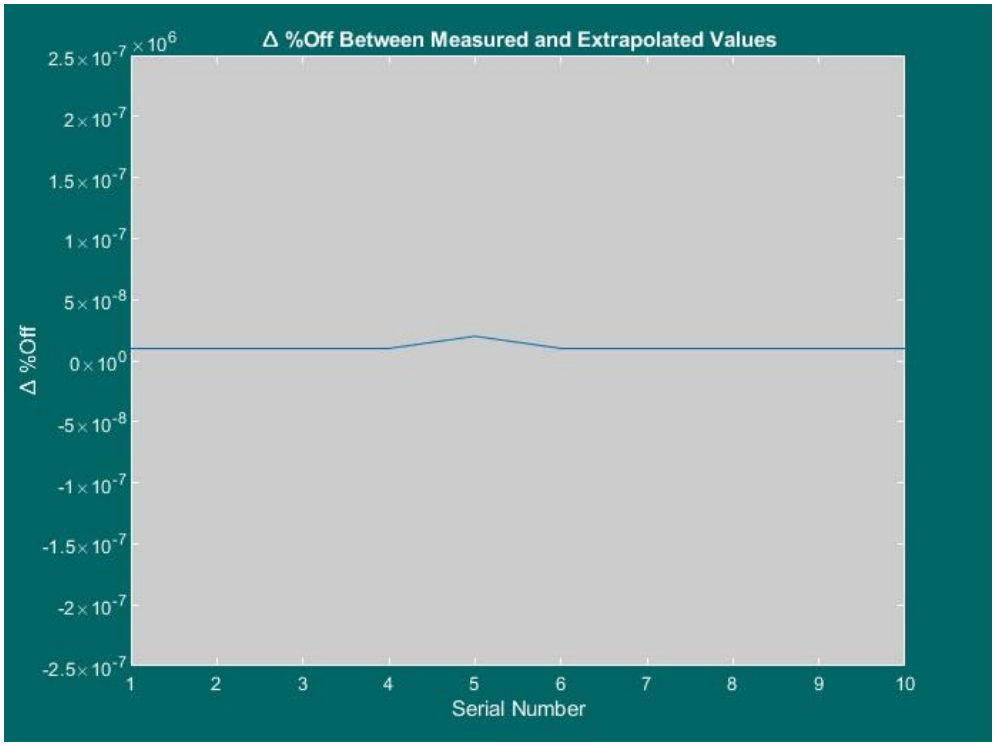

Figure 3: Percent Difference between Measured and Calculated Resistance Values in Figure 2

Because of the accuracy of the calculated resistance value when compared with the measured resistance value, we can use the VCR to calculate the resistance at higher voltages that are outside the capability of the source measurement unit. This is shown in Figure 4.

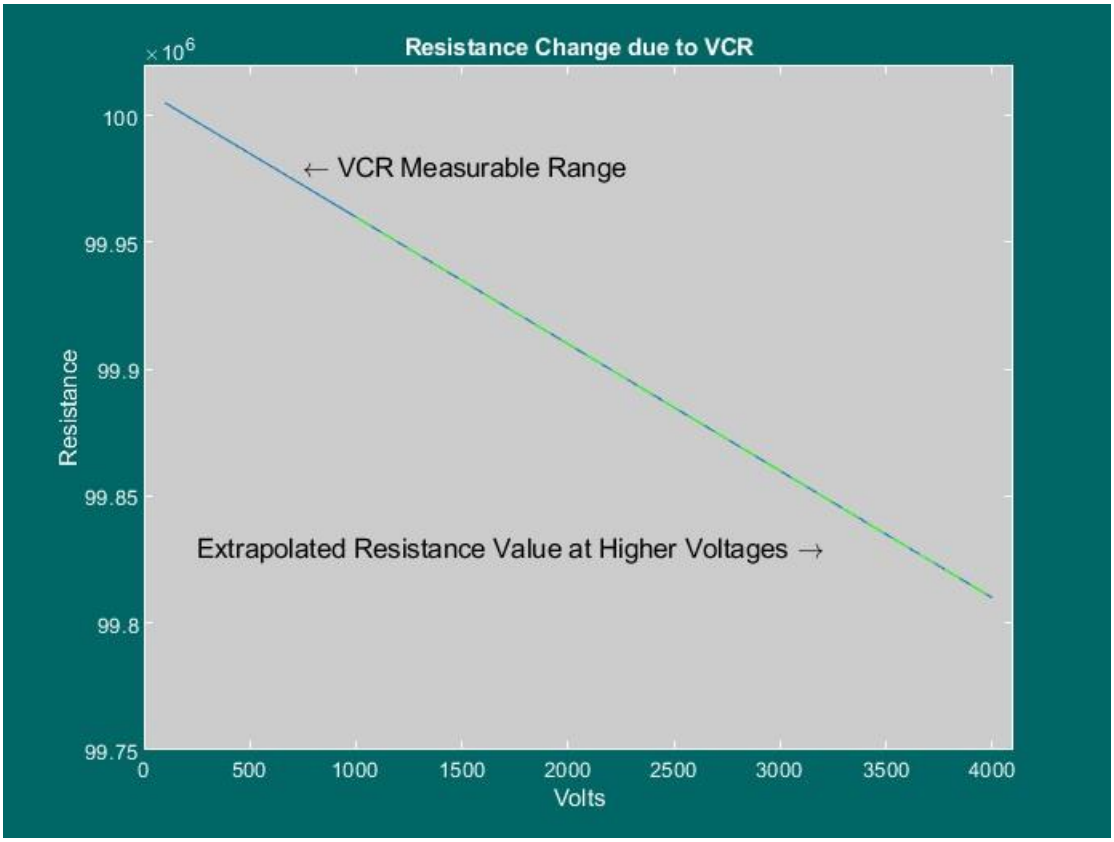

Figure 4: Using VCR to Determine Resistance Values at Voltages Outside the Measurable Range of a Source Meter

Conclusion

Applications that require high voltages to be applied to resistors that are measured for resistance value and tolerance at lower voltages need an effective method for determining how a resistor's value changes as applied voltage increases. Because the relationship between the change in resistance value with the change in applied voltage in a thick film resistor is linear with a negative slope, resistance values can be determined at voltages which exceed the capabilities of resistance measuring equipment. This relationship known as the Voltage Coefficient of Resistance or VCR is an essential tool for the high voltage design engineer when analyzing the effects of how a resistor performs in a circuit when applied voltage changes over a wide range.