Voltage Coefficient of Resistance

Kory Schroeder
Director of Marketing & Product Engineering
kschroeder@seielect.com

As applications for electronics continue to grow, a wider range of application requirements is a natural evolution. For most applications, paying attention to power ratings, temperature coefficient of resistance, and the expected shift of the resistor is enough to ensure good long-term reliability. However, if the application requires high voltage handling, another lesser known parameter known as VCR may become important. But what is VCR and what are the key factors that affect VCR?

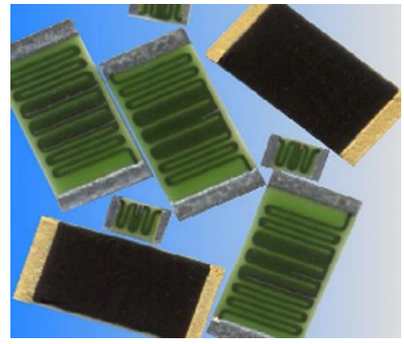

Fig. 1 High Voltage Chip Resistors

VCR

VCR (Voltage Coefficient of Resistance) is defined as the change in resistance over a specified change in voltage. In simple terms, it means how stable the resistance value will be at different voltages. Some design engineers may not realize that VCR even exists, but every resistor has some level of instability over voltage. For applications where voltage levels are stable or are regulated and predictable, VCR is a non-issue. For other applications such as power delivery systems or test equipment, changes in voltage can lead to unacceptable changes in resistance.

General purpose film resistors, especially those with high resistance values, may have VCR of 10 ppm/V or higher. This would mean as much as 1% change in resistance when measuring over a voltage range of 1KV. Resistors with a higher VCR or used in applications with larger ~~al~~ voltage swings would see even larger changes in resistance value.

VCR Factors

VCR can be minimized through proper resistor selection and understanding the factors that affect VCR. Resistors that utilize standard thick film deposition processes will have poorer VCR than those that utilize direct writing processes. This is due to the improved resistance definition and reduced edge effects. Larger size resistors will have better VCR because lower ohmic value materials may be used to realize the high resistance values.

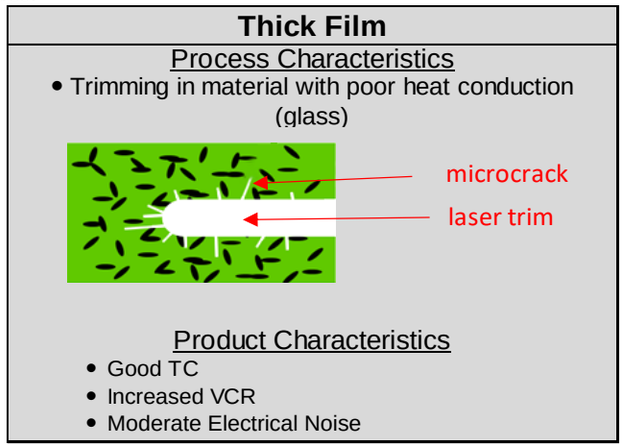

Fig. 2 Thick Film Trimming Process Characteristics

In the manufacturing process for resistors, it is common to use a laser or mechanical trimming process to adjust the resistance value within the specified tolerance. This is most common for resistance tolerances of 1% or tighter. But trimming the resistive element during the manufacturing process has an adverse effect on the VCR of the resistor. For thick film chip resistors, this calibration trimming of the resistive element will cause microcracks as the thick film materials cool after trimming. This effect is shown in Fig. 2 above. These microcracks cause parasitic impedance changes, increased electrical noise, and increased VCR.

Fig. 3 below demonstrates the positive VCR effects of larger case sizes and of untrimmed resistors.

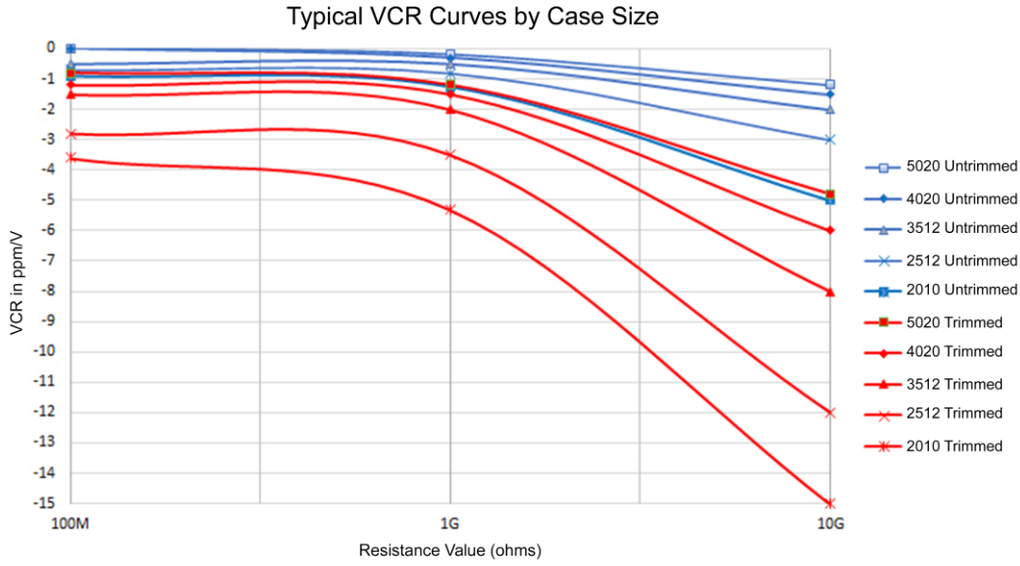

Fig. 3 VCR Curves for High Performance High Voltage Resistive Elements

Summary

Understanding VCR and the factors that affect it are important to high voltage applications and test systems. Selecting an untrimmed resistor with the proper element deposition process and in the largest body size will minimize the effects of VCR and provide the best performance over the widest voltage range.