ohmcraft **APPLICATION NOTE**

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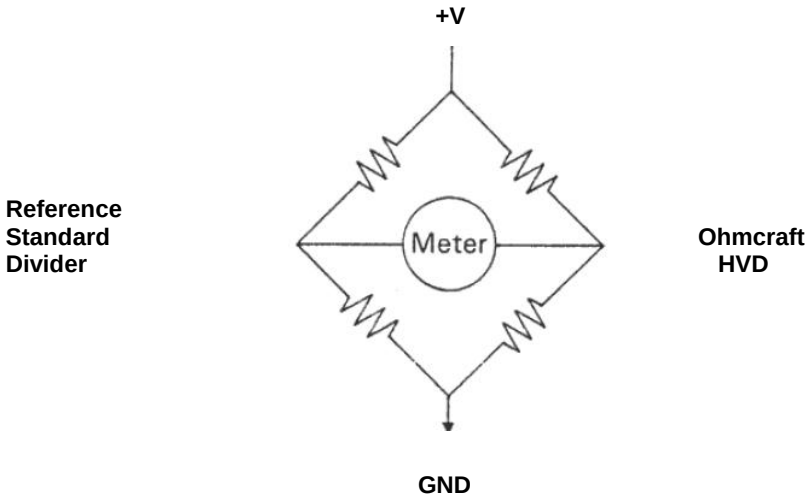
Voltage Ratio Tracking and Voltage Coefficient of Resistance

Most precision resistor divider or network applications depend upon achieving and maintaining close relative resistance values over the operating voltage range, temperature range, frequency range, etc. This application note discusses some of the considerations associated with voltage coefficient characteristics of resistors.

Voltage Ratio Tracking

Relative resistance changes within a network of resistors are called tracking. Voltage ratio tracking defines the relative change between the desired ratio, say 400:1, and the actual ratio *as the applied voltage is varied* across a network. The follow example should make this point clear.

A high voltage power supply and instrument manufacturer tested an Ohmcraft HVD voltage divider against a reference standard high voltage divider in a bridge configuration as shown below:

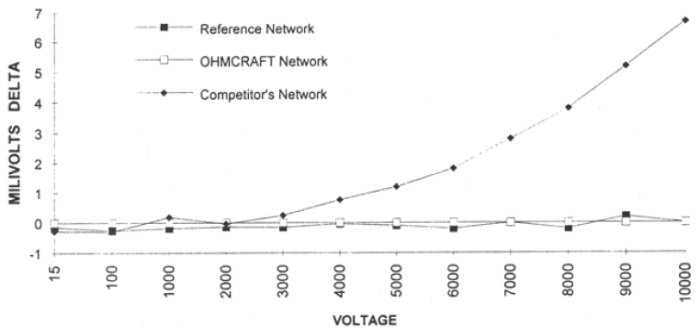


The reference standard divider network is a NBS traceable network specifically calibrated to have "perfect" voltage tracking performance. The Ohmcraft HVD voltage divider is a standard off the shelf network. specified as:

HVD Specifications

- 400MΩ, 1% absolute tolerance
- 400:1 ratio, 0.25% tolerance
- 25ppm/°C absolute TCR
- 10ppm/°C TCR ratio tracking
- 0.01ppm/volt voltage ratio tracking

Voltage Ratio Tracking



The specification we are highlighting here is **voltage ratio racking**. A perfect resistor will not vary in resistance over its operating voltage range. For high voltage or variable voltage applications this specification is central to precision divider performance.

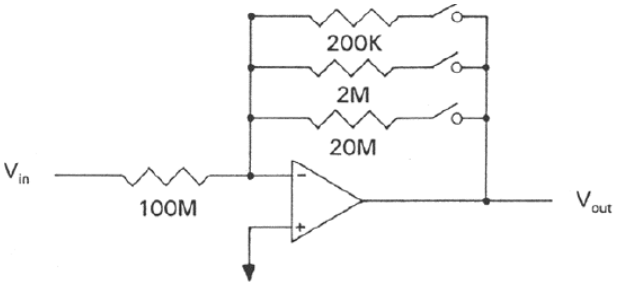
The results of testing a competitor's network and an Ohmcraft HVD voltage divider against the reference network are shown. As the voltage applied across the bridge was varied from 15 volts to 10,000 volts, the voltage ratio tracking of the Ohmcraft voltage divider was found to be nearly perfect. That is, the difference across the bridge is essentially zero when the reference network is compared to the Ohmcraft network. The comparable tracking of a competitor's voltage divider is shown for comparison. It is significantly less accurate. This customer now uses Ohmcraft HVD voltage dividers which offer superior performance in identical format at no increase in cost!

Voltage Coefficient of Resistance

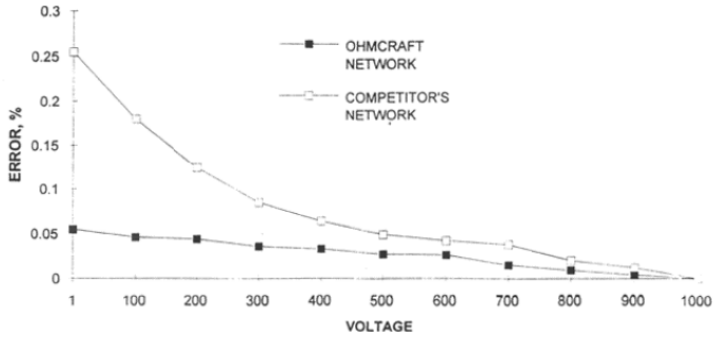
Voltage Coefficient for a resistor is defined as the change in absolute resistance with applied voltage. The following outlines why this is an important consideration in some applications.

An instrument manufacturer produces an electrometer that measures high resistance to high accuracy. Additionally this instrument is capable of measuring resistance at applied voltages ranging from 1 to 1000 volts. Using such an instrument, one can determine the Voltage Coefficient of Resistance, or VCR of resistors. Here, low VCR manifests as excellent voltage linearity. The design goals for this resistor network application include: elimination of any VCR effects, minimization of electrical noise and maximizing measurement stability.

Schematic of meter's front end



Voltage Linearity



The voltage linearity and electrical noise figure of the resistor network shown above is critical to the instrument's performance. The instrument maker found that when an Ohmcraft network was substituted for the network they were using, the accuracy and performance of the instrument improved by a factor of 5. With the competitor's network, the 0.25% accuracy goal was elusive. By using the Ohmcraft resistor network, this customer was able to produce a meter with better than 0.1% precision. Additionally, the measurement noise level decreased 5 fold due to the decrease of the inherent noise level of the Ohmcraft resistor network. Please refer to other application notes for discussions on the low noise performance of Ohmcraft's resistors.