Terminology Glossary of High Voltage Resistors

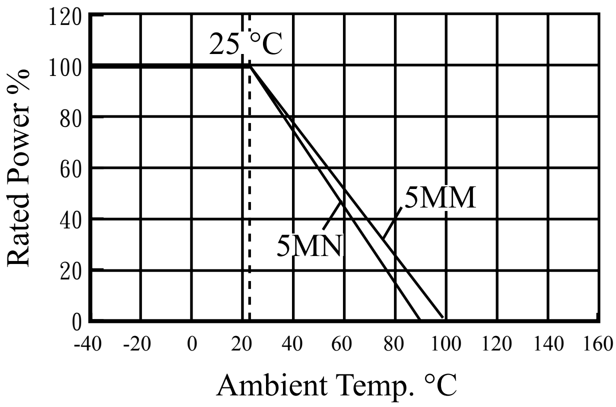
Cermet

A cermet resistive element is made from a mixture of glass and metal oxides. The metal oxide is typically RuO2 or an AgPt alloy. Applying cermet materials to a flat or cylindrical substrate, and then firing them at 850°C produce thick Film resistors. In the electronic industry cermet material is typically called Thick Film paste or ink.

Critical Resistance Value

The maximum nominal resistance value at which the rated power can be applied continuously without exceeding the maximum working voltage is the critical resistance value. The rated voltage is equal to the maximum working voltage in the critical resistance value. If the circuit designs permits, the choice of a high ohmic value resistor or divider network will eliminate this consideration.

Power Derating Curve



Derating Curve

The curve that describes the relationship between the resistors's operating temperature and the maximum value of continuous power permitted at that temperature. If the circuit designs permits, the choice of a high ohmic value resistor or divider network will minimize this consideration and improve the resistor's performance because it will operate at lower power.

Maximum Working Voltage

The maximum voltage applied continuously to a resistor or a resistor element. The maximum value of the applicable voltage is the rated voltage at the critical resistance value or lower. If the circuit designs permits, the choice of a high ohmic value resistor or divider network will improve the resistor's performance because it will operate at lower power.

Noise

Resistive noise can have a devastating effect on low-level signals, charge amplifiers, high gain amplifiers, and other applications sensitive to noise. The best approach is to use resistor types with low or minimal noise in applications that are sensitive to noise. Because of their construction and manufacturing processes.

Power Rating

Power ratings are based on physical size, allowable change in resistance over life, thermal conductivity of materials, insulating and resistive materials, and ambient operating conditions. For best results, employ the largest physical size resistors at the less than their maximum rated temperature and power. Never use them continuously at their maximum rating unless you are prepared to accept the maximum allowed life cycle changes. If the circuit designs permits, the choice of a high ohmic value resistor or divider network will minimize the power level and improve the resistor's performance as it is operating at a lower power level.

Rated Power

Rated power is the maximum value of power (watts), which can be continuously applied to a resistor at a rated ambient temperature. The basic mathematical relationship is **Equation: Power (watts) = (Current (Amps))2 × Resistance (Ohms).**

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Rated Voltage

The maximum voltage applied continuously to a resistor at the rated ambient temperature. Rated voltage is calculated from the following formula, but it must not exceed the maximum working voltage. **Equation: Rated Voltage (V) = (Rated Power (W) × Nominal Resistance Value (Ω))1/2.**

High voltage resistors often are potted or operated in oil as the arc over voltage, in air, is approximately 10,000 volts per inch. Token's resistors feature higher voltage ratings due to their high square count and associated design characteristics.

Resistor Tolerance

Resistor Tolerance is expressed as the deviation from nominal value in percent and is measured at 25°C only with no appreciable load applied. A resistors value will also change with applied voltage (VCR) and temperature (TCR). For networks, absolute resistor tolerance refers to the overall tolerance of the network. Ratio tolerance refers to the relationship of each resistor to the others. It is often practical to specify tight ratio tolerances and loose absolute tolerances.

Temperature Coefficient of Resistance (TCR)

The Temperature Coefficient of Resistance (TCR) is expressed as the change in resistance in ppm (0.0001%) with each degree of change in temperature Celsius (°C). For example, a resistor with a TCR of +100 ppm/°C will change +0.1% total over a 10-degree change and +1% total over a 100-degree change.

The TCR value quoted on specification sheets is typically quoted as being referenced at +25°C and is the +25°C to +75°C slope of the TCR curve. TCR is typically not linear, but parabolic with temperature, as illustrated by the accompanying fig-1. Often the circuit designer treats the TCR as being linear unless very accurate measurements are needed. MIL STD 202 Method 304 is often referenced as a standard for measuring TCR. The following formula expresses the rate of change in resistance value per 1 °C in a prescribed temperature range:

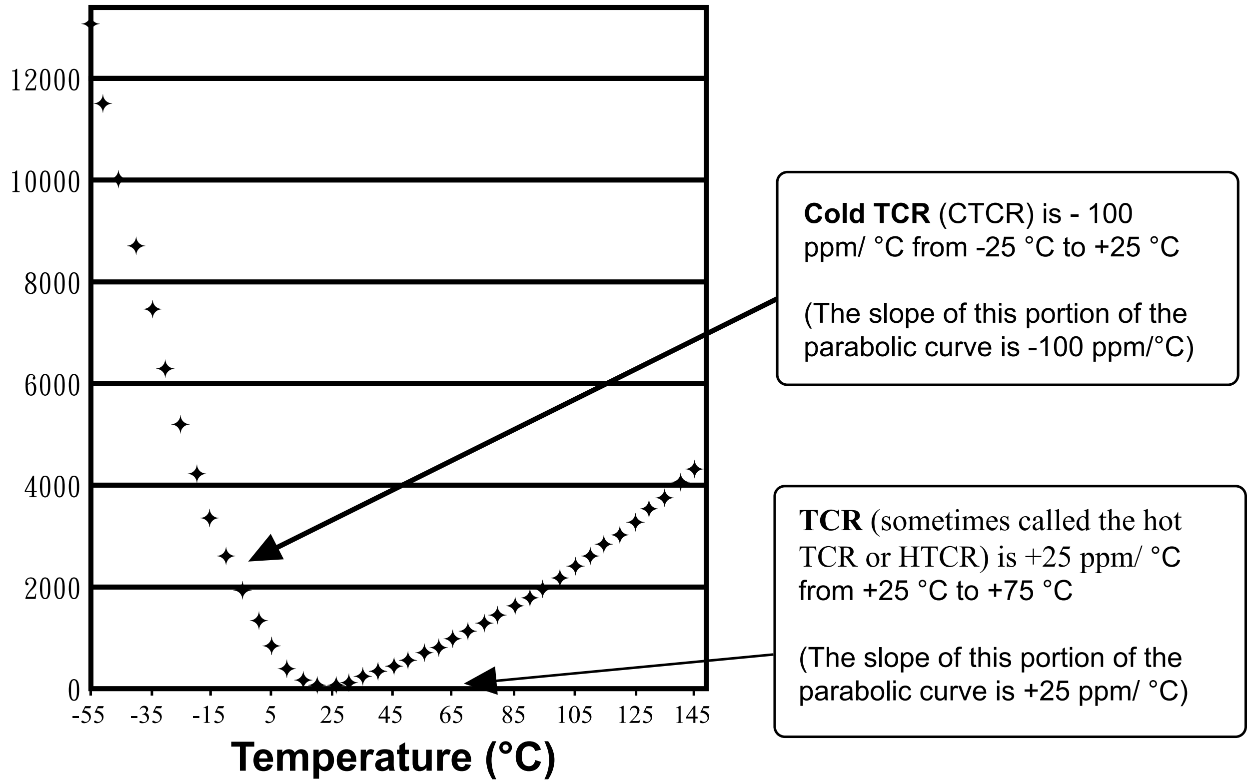
- **TCR (ppm/°C) = (R - Ro) / Ro × 1 / (T - To) × 10^6**
- **R: Measured resistance (Ω) at T °C; Ro: Measured resistance (Ω) at To °C**
- **T: Measured test temperature (°C); To: Measured test temperature (°C)**

In the context of a resistor network, this TCR value is called the absolute TCR in that it defines the TRC of a specific resistor element.

Voltage Coefficient of Resistance (VCR)

The Voltage Coefficient is the change in resistance with applied voltage. This is entirely different and in addition to the effects of self-heating when power is applied. A resistor with a VCR of 100 ppm/V will change 0.1% over a 10 Volt change and 1% over a 100 Volt change. The rate of change in resistance value per 1 Volt in the prescribed voltage range is expressed by the following formula:

- **VCR (ppm/V) = (Ro - R) / Ro × 1 / (Vo - V) × 106**
- **R: Measured resistance (Ω) at base voltage; V: Base voltage**
- **Ro: Measured resistance (Ω) at upper voltage; Vo: Upper voltage**



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