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Glossary of Precision Resistor Terminology

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► Resistor Terminology

Glossary of Resistor Terminology

Absolute Tolerance

The tolerance of a resistor or a specific resistor in a network is also called the absolute tolerance.

Absolute TCR

The Temperature Coefficient of Resistance (TCR) of a resistor or a specific resistor in a network is also called the absolute TCR.

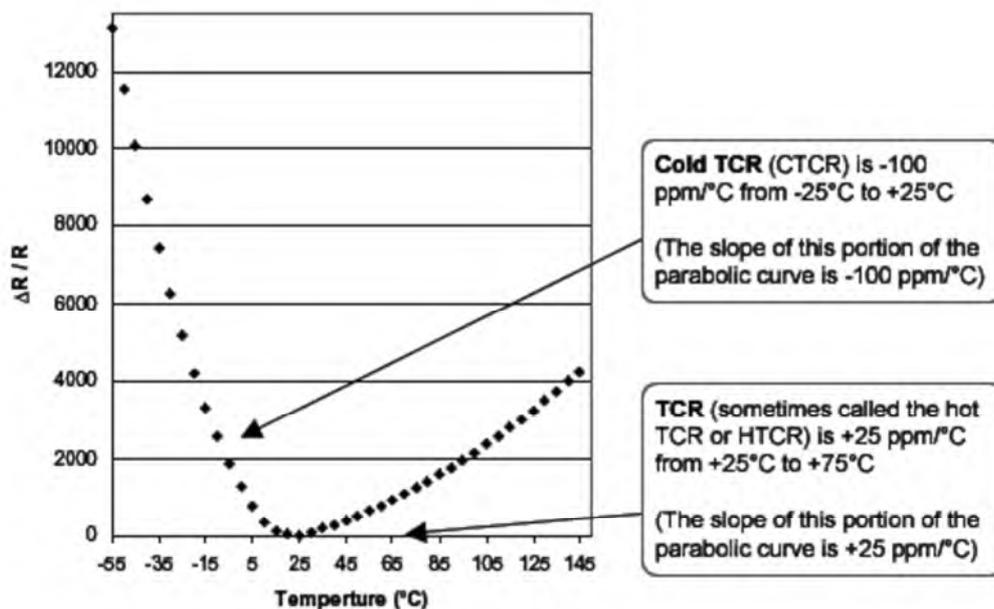
Temperature Coefficient of Resistance (TCR)

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:

- $TCR (ppm/°C) = (R - R_0) / R_0 \times 1 / (T - T_0) \times 10^6$
- R: Measured resistance (Ω) at T °C; R₀: Measured resistance (Ω) at T₀ °C
- T: Measured test temperature (°C); T₀: 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.



Typical Temperature Coefficient of Resistance (TCR)

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:

- $VCR (ppm/V) = (R_o - R) / R_o \times 1 / (V_o - V) \times 10^6$
- R: Measured resistance (Ω) at base voltage; V: Base voltage
- R_o : Measured resistance (Ω) at upper voltage; V_o : Upper voltage

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.

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. See the Derating curve entry in this glossary.

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 (Ohm).

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 because it is operating at a lower power and temperature level.

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.

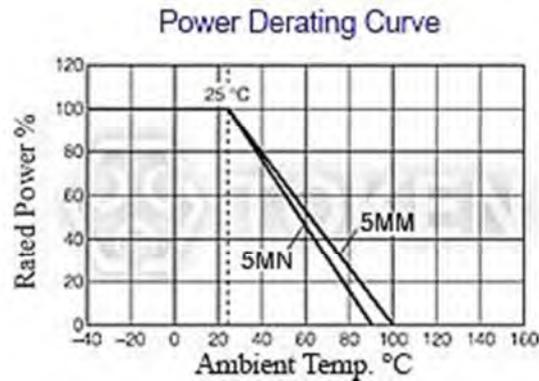
Equation: Rated Voltage (V) = (Rated Power (W) × Nominal Resistance Value (Ω))^{1/2}

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



Derating Curve

The curve that describes the relationship between the resistors' 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.



Typical Derating Curve

Nominal Resistance

The adjective nominal (ultimately from Latin means "name") generally relates to the concept of names, and often to the difference between what something is in name (ideally or theoretically) and what it is in reality. Thus it may refer to: a value that is used as the name for an actual value of resistance which is close but not exactly the same.

Dielectric Withstanding Voltage

The rated voltage that can be applied to a designated point between the resistive element and the outer coating, or the resistive element and the mounting surface, without causing dielectric breakdown.

Noise

Noise is an unwanted AC signal from within the resistor. 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.