GLOSSARY (CERMET TRIMMERS)
TRIMMER POTENTIOMETERS

● Overlap

Overlap refers to the end portion of the cermet device. Electrodes are printed on a ceramic base and then baked. The cermet resistor is printed over this potion and baked.

● Rotational life test

This is a test to check the life of the cermet trimmer when the product is rotated near the life expectancy.
Test conditions:
The shaft is turned back and forth 200 cycles (or 100 cycles), with no load at 90 % of the electrical effective angle or electrical adjustment number of turns, and change in resistance and mechanical damage are checked.
Specifications:
The change in total resistance value varies by model (See main text). No mechanical damage is permitted.
※In accordance with MIL-R-22097 4.6.18

● Stop strength

For single turn trimmer potentiometers with mecanical stops, this is the maximum applicable rotational torque which will not break the stops. It is specified as "XXX mN·m, minimum".

● Operating torque

This is the torque necessary to turn the rotor or shaft.

● Mechanical angle

This is the rotation angle that the rotor can be turned from the stopper on one end to the stopper on the other end. For multiturn trimmer potentiometers this is the maximum number of turns possible by the adjustment screw.

● Clutch action

Multiturn trimmer potentiometers turn a rotor gear by turning the adjustment shaft, and a screw is used to transmit this rotation. A clutch mechanism is generally used in place of a stopper at the end ot the rotational travel.
COPAL ELECTRONICS products use a blade spring or a plastic spring, with the construction differing for different models.
Generally, a clutch spring noise is heard at the end of the rotation, but there is no specification on the noise degree.

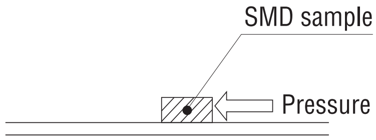
● Nominal resistance value

Resistance value between terminal 1 and terminal 3.

● Shear (Adhesion)

This test is to evaluate if any damages like electrode stripping, breaks, or cracks occur on a SMD component soldered to the printed circuit board due to stress from the flank.

Pressure: 5 N
Holding time: 10 s



● Maximum input voltage

This is the maximum voltage that can be applied at all resistance levels between terminal 1 and terminal 3.
The maximum input voltage varies depending on the resistance value.

● Maximum wiper current

This is the maximum current that can be allowed to flow through the wiper. The maximum wiper current varies depending on the resistance value.

● Cermet

Cermet resistors are called thick-film cermets, and are made by baking ceramics, glass, and precious metal particles at high temperatures. The word cermet was derived by abbreviating ceramic metal. Copal's cermets have superior temperature characteristics, heat resistance, and wide resistance ranges and are of the glass RuO_2 variety.

● End resistance

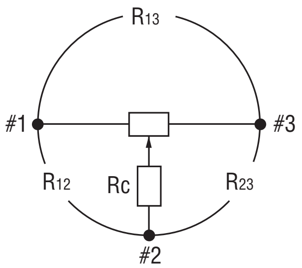
The resistance measured between the wiper and the corresponding terminals when the wiper is at the end of its mechanical travel.

● Contact resistance (Rc)

This is the resistance between the wiper and the resistor after setting and is calculated by the following formula.

$$Rc\ (\%) = \frac{(R_{12} + R_{23}) - R_{13}}{2R_{13}} \times 100$$

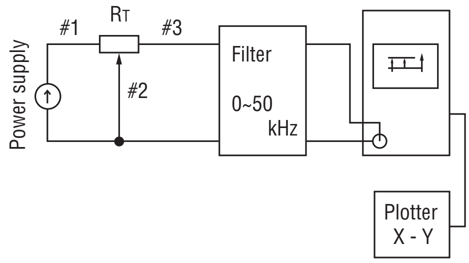
Contact resistance occurs due to the oxidation of wiper's metallic surface and resistance from the glass on the surface of the cermet or from the micro distribution of the cermet device.



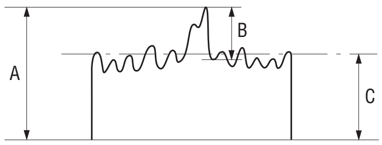
● Contact resistance variation (CRV)

Contact resistance variation is the maximum momentary change in contact resistance that occurs when the wiper is moved from one location to another location. The larger this change, the more difficult it is to set the trimmer potentiometer and the more unstable the long term setting will be.

a. Measuring circuit



b. Measuring point



CRV measured waveform
CRV waveform
DC peak value (%)
AC component peak (part guaranteed by COPAL)
Peak value (%)
DC component average value ≒ Contact resistance

Measurement of the C.R.V. is defined over 90 % of the electrical effective angle or electrical adjustment revolutions and does not include the electrically unstable area near the ends (the portion where the electrodes and resistor overlaps).

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● Setting stability
This shows the stability of the trimmer potentiometer after the wiper is set in an arbitrary position. Stability can be divided into voltage setting stability (S.S.) and resistance setting stability.

<Voltage setting stability>
When used as a potentiometer as in the Fig. 1, current does not flow through the wiper, so the change in contact resistance does not affect the setting stability. The following formula applies.

$$\text{S.S. } (\%) = \left\{ \left(\frac{V}{E}\right) \text{after test} - \left(\frac{V}{E}\right) \text{before test} \right\} \times 100$$

<Resistance setting stability>
When used as a rheostat as in the Fig. 2, the change in contact resistance of the wiper changes the set value.
Here the setting stability is calculated from the resistance between terminals:

$$\Delta \frac{R_{12}}{R_{13}} (\%) = \left\{ \left(\frac{R_{12}}{R_{13}}\right) \text{after test} - \left(\frac{R_{12}}{R_{13}}\right) \text{before test} \right\} \times 100$$

$$\Delta \frac{R_{23}}{R_{13}} (\%) = \left\{ \left(\frac{R_{23}}{R_{13}}\right) \text{after test} - \left(\frac{R_{23}}{R_{13}}\right) \text{before test} \right\} \times 100$$

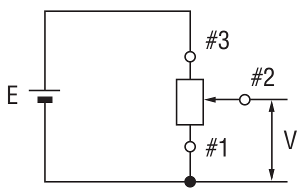


Fig.1

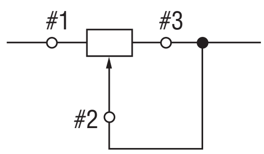
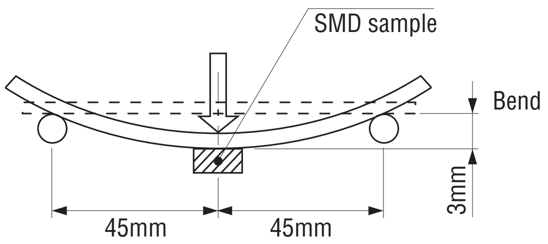


Fig.2

● Insulation resistance
This is the resistance between the housing, rotor, shaft, and other non-terminal parts and the terminal when a designated D.C. voltage is applied.

● Total resistance
This is the resistance between #1 and #3 terminals. The usual unit is ohm, with a plus or minus percent attached to show tolerance. Measurment is performed with the wiper set at the #1 or #3 terminal electrode to minimize the affect of the wiper on measurement accuracy.

● Substrate bending
This test is to evaluate durability against stress due to distortion of the print circuit board at the time or after SMD is mounted.



● Dielectric strength
This is the ability to withstand the application of voltage between the housing, rotor, shaft, and other external conducting parts and the terminal without exceeding the specified leakage current leakage.

● Power rating
The power rating is the maximum power that can be applied over all the resistance element (from terminal 1 to terminal 3) with a continuous load at the operating ambient temperature.
Mathematically, it follows the formula below (Fig.1):
Because the applied power creates heat in the resistor, the rated power is determined by the heat released and the ability of the components to withstand the heat. Thus, the rated power changes with the ambient temperature. (Fig. 2)

$$P = I^2R \text{ or } P = \frac{E^2}{R}$$

P : Power (W)
I : Current (A)
E : Voltage (V)
R : Resistance (Ω)

Fig.1

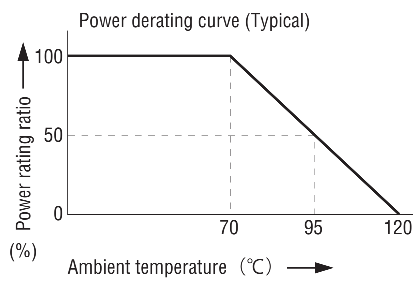


Fig.2

GLOSSARY (CERMET TRIMMERS)
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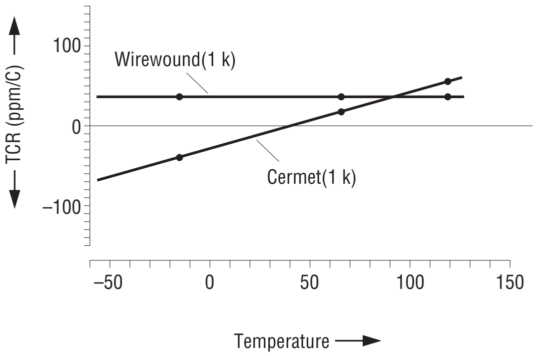
● Resistance temperature characteristic

The resistance temperature characteristic shows the rate of change in the total resistance when the ambient temperature changes. The unit of measure for the resistance temperature coefficient is $10^{-6}/°C$.

$$\text{Temperature coefficient}\quad (10^{-6}/℃) = \frac{R - R_0}{R_0} \times \frac{1}{t - t_0} \times 10^6$$

R : Measured resistance at t ℃ (Ω)
R_0 : Measured resistance at t_0 ℃ (Ω)
t : Measured temperature in test room (℃)
t_0 : Measured reference temperature (℃)



The resistance temperature characteristic is highly affect-ed by the resistor material of the trimmer potentiometer and the physical structure.
For wirewound trimmer potentiometers, the rate of change is usually constant at around ±50 ppm/℃. For cermet trimmer potentiometers, the resistance temperature coefficient is temperature dependent. In other words, the rate of resistance value changes as the ambient temperature changes. Thus, the change in resistance experienced when the ambient temperature changed from 25 ℃ to 35 ℃ would be different from that experienced when the ambient temperature changed from 100 ℃ to 110 ℃.

● Resistance code

COPAL ELECTRONICS products, with the exception of the ST-32 indicate resistance values with a three digit code.

● Resistance law

These characteristics can be divided into four types based on the change in output voltage ratio between terminals 1 and 2 or 2 and 3, when a voltage is applied between terminals 1 and 3 (below the rated voltage) and the adjustment shaft is turned CW or CCW.
A characteristic: Change logarithmic as shown in Fig. 1, A
B characteristic: Change linearly as shown in Fig. 1, B
C characteristic: Change logarithmic as shown in Fig. 2, C
D characteristic: Change logarithmic as shown in Fig. 1, D

※ COPAL's cermet trimmers have B characteristic.

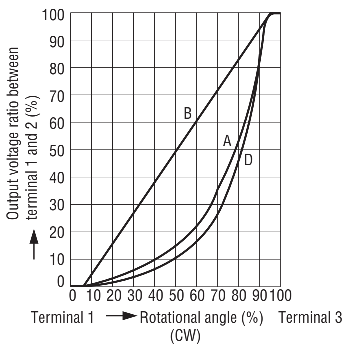


Fig.1

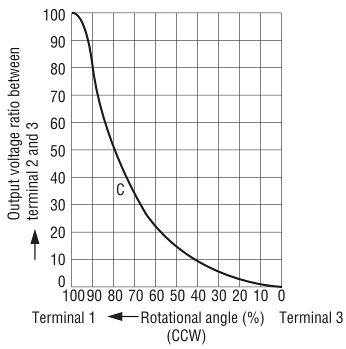


Fig.2

● Trimmer potentiometers

Also referred to as preset variable resistors, trimmer potentiometers differ from normal volume controls and are used to adjust the irregularities between parts in equipment and to allow arbitrary settings and are seldom moved after their initial setting.

● Soldering heat

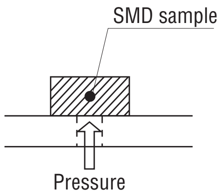
This is to evaluate heat resistance in soldering components.

GLOSSARY (CERMET TRIMMERS)
TRIMMER POTENTIOMETERS

● Solderability
This is a wetting evaluation test to find out how much new solder cover the terminals dipped in the soldering bath, and to confirm the proper fillet formation in the soldering process.

● Pull-off strength
This test is to evaluate adherence strength of a SMD component soldered to the printed circuit board against peel off strength.

Test condition
Pressure: 5 N
Holding time: 10 s



● Resolution
For cermet trimmer potentiometers this is essentially infinite.

● Effective electrical angle (Effective electrical turn)
The rotation angle (or number of turns of the shaft) within which the output voltage actually changes.

● CW, CCW
These are abbreviations for clockwise (CW) and counter clockwise (CCW).

● EIAJ STD
Standards of Electronic Industries Association of Japan

● JIS
Japanese Industrial Standards

● SMD (Surface Mount Device)
As electronics equipment becomes more miniaturized, needs for miniaturization of electronics components have increased. Further, surface mounting technology has emerged to increase the density of components mounted on circuit boards. SMD have been developed in response to this trend. This has allowed automation of soldering and mounting processes.
The characteristics required of SMD trimmer potentiometers are shown below:
- High heat resistance
- Sealed structure
- Compatible for automatic mounting