METAL FOIL PRECISION RESISTOR

A metal foil precision resistor, unlike a precision-class metal film resistor or wire wound resistor, is an ultra-precision resistor in which the primary resistance element is a special alloy foil several μm thick.
Use of this metal foil as the resistance element gives superior perfomance not found in other resistors, satisfying military specification MIL-R-55182/9. In particular, the temperature coefficient of resistance has been reduced to an unprecedented extremely low value by strict quality control of alloy composition and newly developed foil stabilization treatment technology. In addition, from the point of view of long-term stability which is an important property of a resistor, since the foil has a thickness of several μm instead of the extremely thin film of a metal film resistor, the natural stability of metal is preserved, resulting in very little resistance change over several years. By developing our own original fine photo etching technology, we have made it possible to form the complicated resistance pattern required for highly accurate resistance values.

Characteristics

❶ Temperature Coefficient of Resistance: 0.14ppm/°C(Typical)
❷ Resistance Tolerance:±0.005%
❸ Shelf Life:25ppm/year 50ppm/3years (Hermetically Sealed 5ppm/year 10ppm/3years)
❹ Load Life:0.03%/2000hours
❺ Thermal EMF:0.1μV/°C(between leads)
❻ Noise:−42dB
❼ Voltage Coefficient:0.1ppm/V
❽ Frequency Characteristics: Inductance:0.08μH Capacitance:0.5pF

Main Applications

Precise amplifier circuitry, referential power supply etc. in sophisticated electronic equipment, instrumentation, medical electronic apparatus etc.

Manufacturing Process

Adjustment of Resistance Value

Foil bonded on substrate is photetched to make a fine path pattern to provide a desired value. A series of trimming locations are laid out on the pattern, as shown in A through E.(Fig. above) As shown at C, the trimming method is to increase the resistance by cutting the metal foil. The resistance value can be made accurate to within ±50ppm of the desired value by cutting at several of the trimming locations.
The locations which are cut for trimming are where the electric current flow (arrows in diagram) will not be affected so that the trimming will not cause electrical noise or changes over the years.

Construction

Construction of Conformally Coated Type

Outer coating is made of epoxy resin which is excellent at resistance to moisture, heat and solvents. Lead wire is flat and made of copper alloy having high electrical conductivity.
Lead wire is connected to element pad with high-temperature solder, producing solid construction of junction. As a result, the resistor is stable against thermal and mechanical stress given when being mounted.

❶ Outer coating ❷ Coating for moisture protection & buffering
❸ Protective layer ❹ Metal foil (Etched resistive element)
❺ Bonding layer ❻ Ceramic substrate (High purity alumina)
❼ High-temperature solder ❽ Flat lead

Construction of Transfer Molded Type

The outer cover is a transfer-molded epoxy resin strongly resistant to heat, moisture and solvents. Inside, there are secoundary leads which acts as buffer so that stress on the exterior leads is not transmitted to the foil, providing stability against vibrations when the resistor is mounted on a circuit.

❶ Transfer molded resin (Heat-resistant epoxy)
❷ Coating for moisture protection & buffering ❸ Protective layer
❹ Metal foil (Etched resistive element) ❺ Bonding layer
❻ Ceramic substrate (High purity alumina)
❼ Resin or solder strengthening welded part
❽ Secondary lead (Abating mechanical stress from outside)
❾ High-temperature solder ❿ Exterior lead (ϕ0.65)

Temperature Characteristics of Resistance

Char.S

Temperature(°C)	ΔR/R(ppm)
−55	0±40
0	0±15
+50	0±15
+125	0±50

Reference Temperature +25°C

Char.Z(0±1ppm/°C)

Char.Y(0±2.5ppm/°C)

Char.X(0±5ppm/°C)

Char.W(0±15ppm/°C)