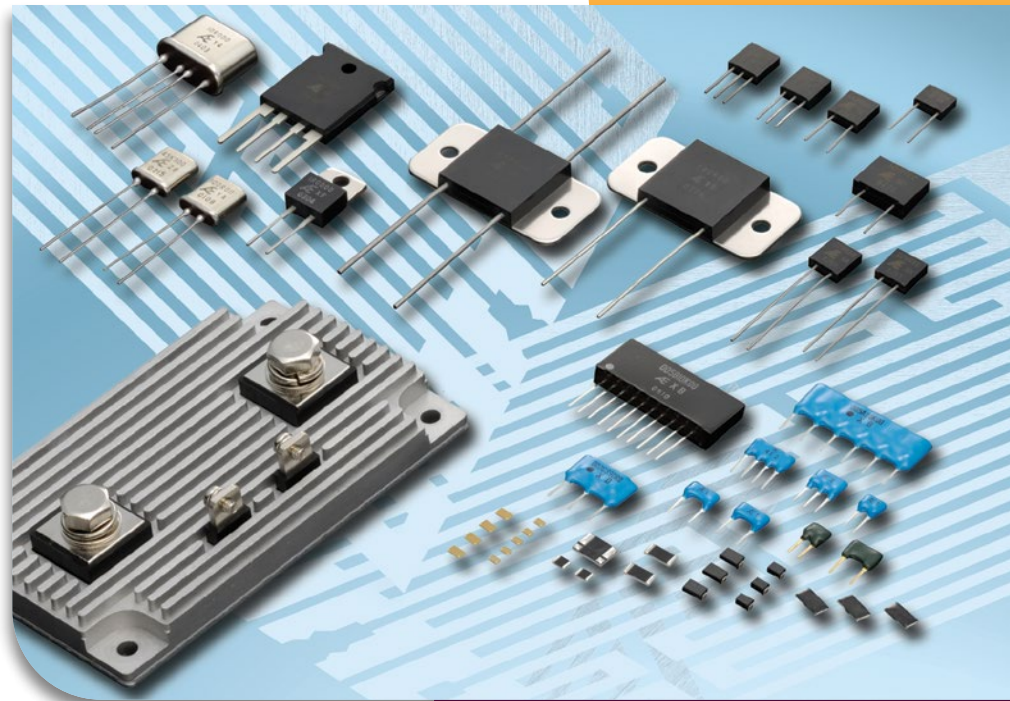


Ultra Precision Resistors

AE Alpha Electronics



Bulk Metal[®] Foil
Thin Film
Thermosensitive

Data Book

The Americas

United States

Vishay Precision Group

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Ultra Precision Resistors

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Manufacturing Process, Adjustment of Resistance Value Construction, and Temperature Characteristics of Resistance

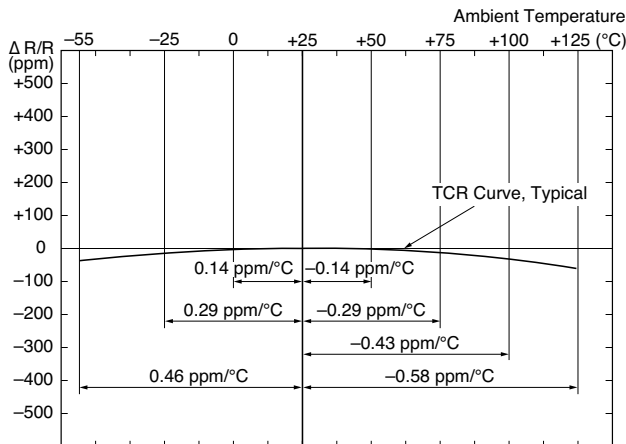
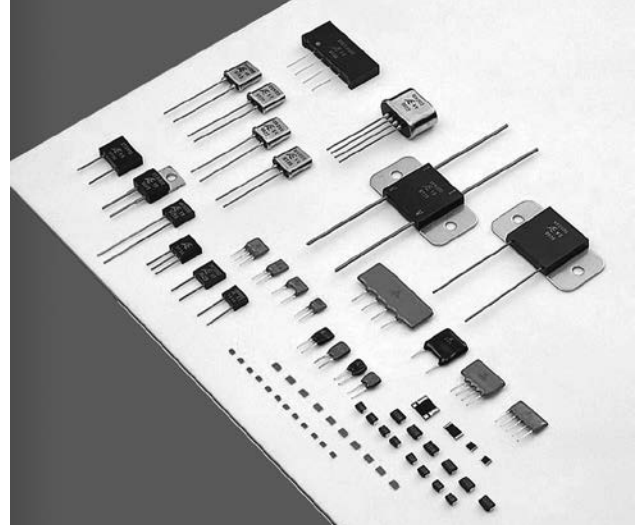
A Bulk Metal® foil high precision resistor, unlike a precision-class metal film resistor or wire-wound resistor, is an ultra precision resistor in which the primary resistance element is a special alloy foil several μm thick.

Use of this Bulk Metal® Foil as the resistance element gives superior performance not found in other resistors, satisfying military specification MIL-PRF-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.

MAIN APPLICATIONS

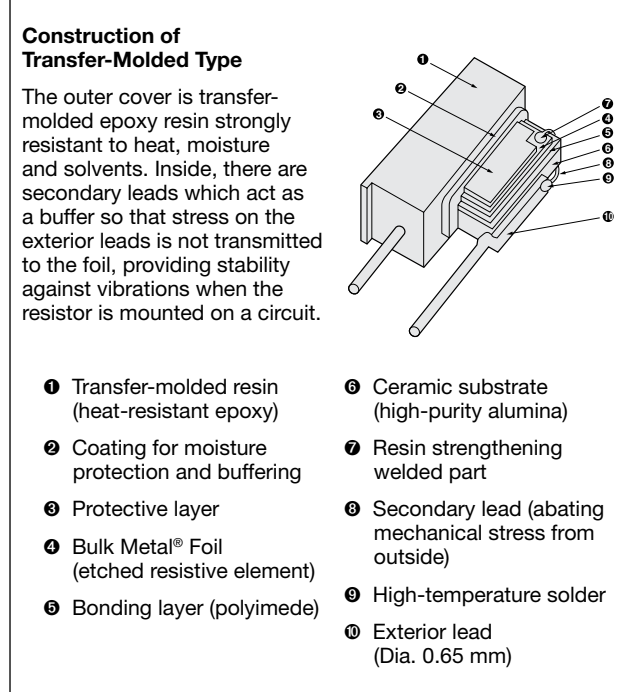
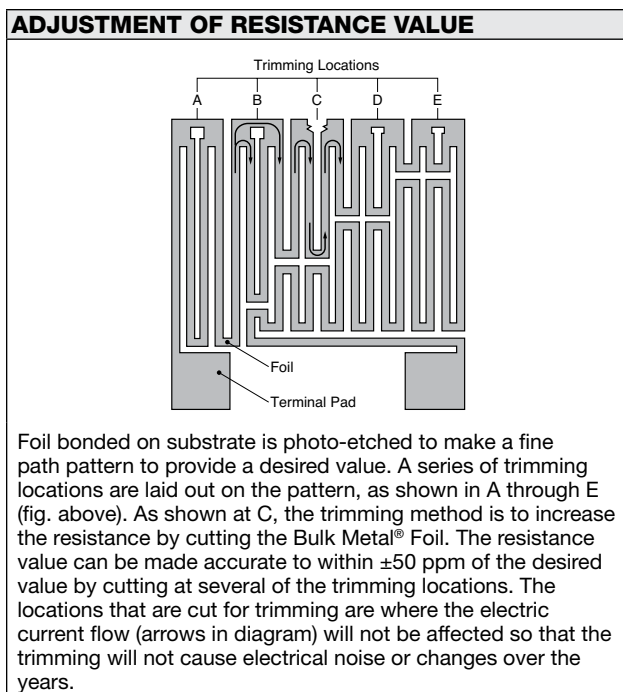
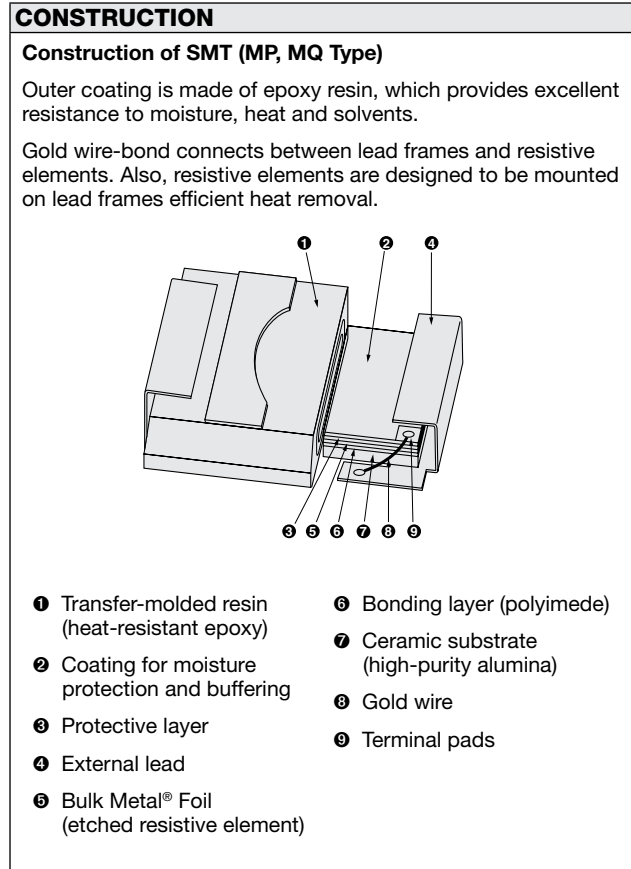
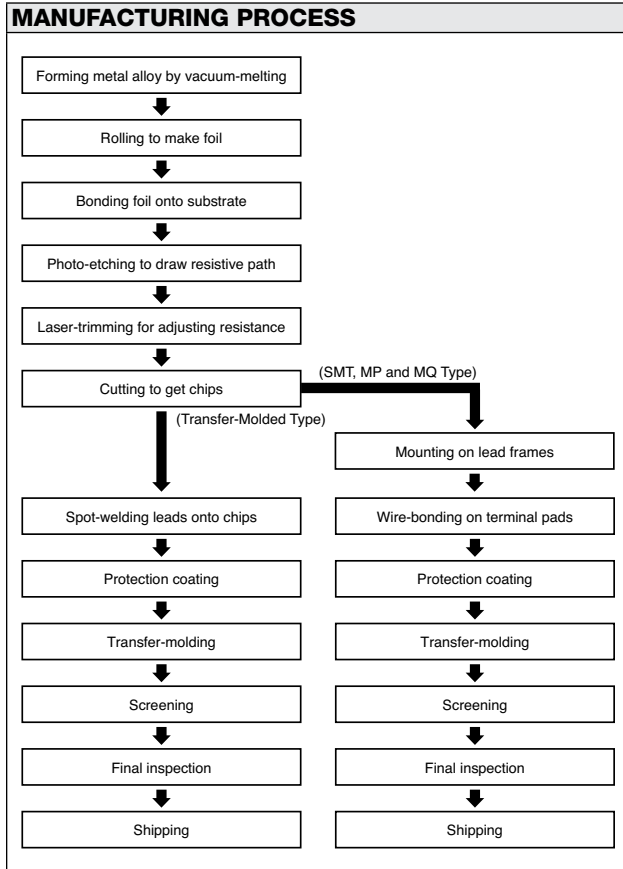
Precise amplifier circuitry and referential power supply in items such, as sophisticated electronic equipment, instrumentation and medical electronic apparatus.



CHARACTERISTICS

- ① Temperature Coefficient of Resistance:
0.14 ppm/°C (Typical, 0°C to +50°C)
- ② Resistance Tolerance: $\pm 0.005\%$
- ③ Shelf Life:
25 ppm/year; 50 ppm/3 years
(Hermetically sealed: 5 ppm/year
10 ppm/3 years)
- ④ Load Life: 0.01%/2,000 hours at Rated Power
- ⑤ Thermal EMF: 0.1 $\mu\text{V}/^\circ\text{C}$ (between leads)
- ⑥ Noise: -42 dB
- ⑦ Voltage Coefficient: 0.3 ppm/V
- ⑧ Frequency Characteristics:
Inductance: 0.08 μH
Capacitance: 0.5 pF

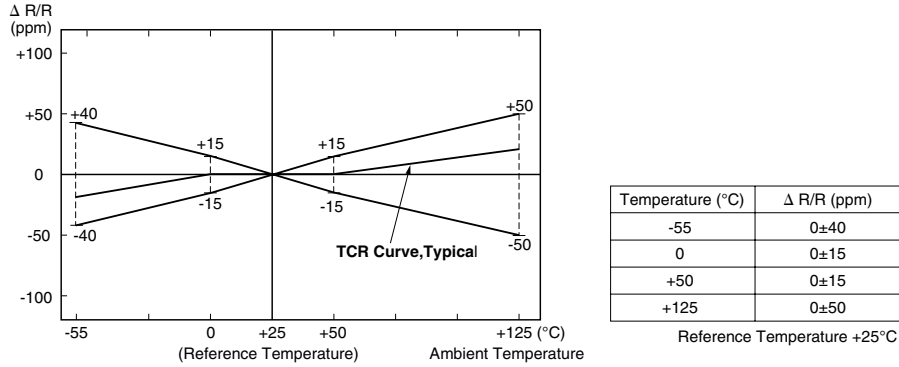
Manufacturing Process, Adjustment of Resistance Value Construction, and Temperature Characteristics of Resistance



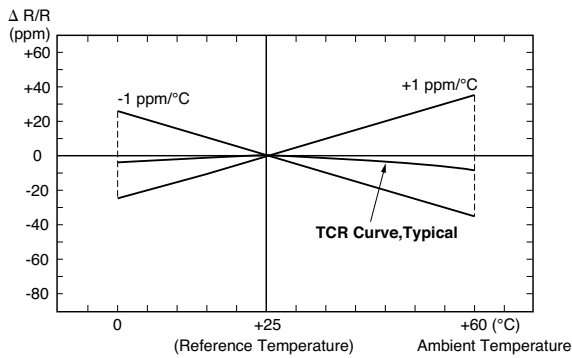
Manufacturing Process, Adjustment of Resistance Value Construction,
and Temperature Characteristics of Resistance

TEMPERATURE CHARACTERISTICS OF RESISTANCE

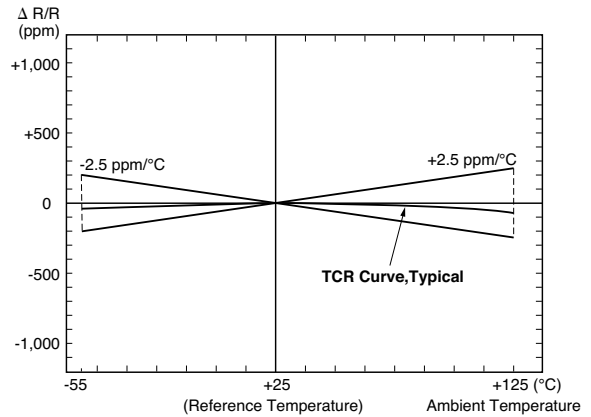
Char.S



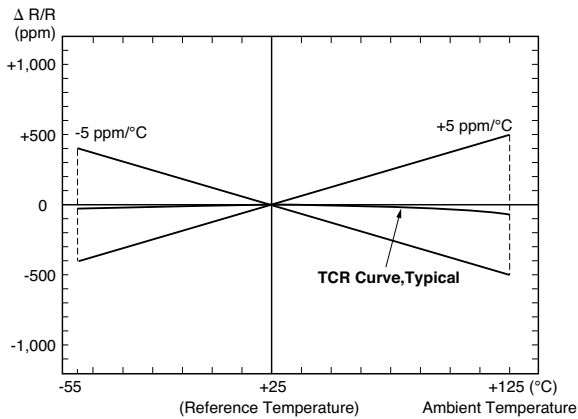
Char.Z (0 ± 1 ppm/°C)



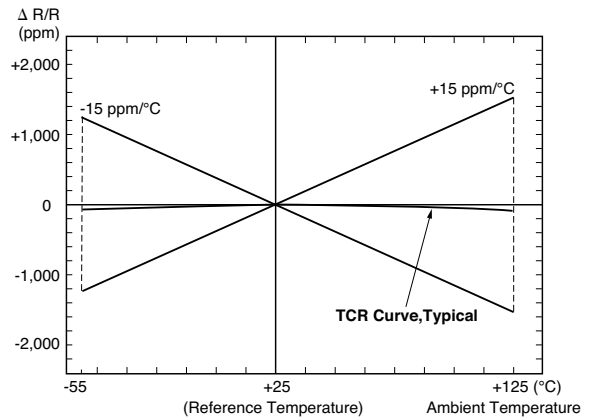
Char.Y (0 ± 2.5 ppm/°C)



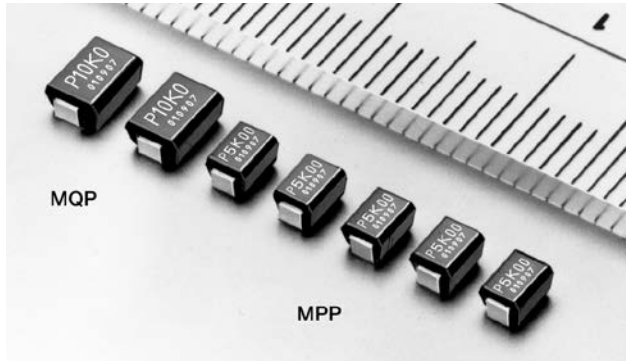
Char.X (0 ± 5 ppm/°C)



Char.W (0 ± 15 ppm/°C)



Z-Foil Ultra High-Precision SMT Resistor (Molded, J-Lead Terminal)



FEATURES

- Temperature coefficient of resistance (TCR): 0.05 ppm/°C typical (0°C to +60°C) by New Generation Z-Foil Technology
- 0.2 ppm/°C typical (-55°C to +125°C, +25°C ref.)
- Resistance tolerance: to ±0.01%
- Power coefficient “ΔR due to self heating”: 5 ppm at rated power
- Power rating: to 200 mW (MPP) and 250 mW (MQP) at +70°C
- Load life stability: to ±0.005% at 70°C, 2000h at rated power
- Not restricted to standard values, we can supply specific “as required” values at no extra cost or delivery (e.g., 1K2345 vs. 1K)

COMPOSITION OF TYPE NUMBER

Example:

MPP 10K005* T L

Tape & Reel Package Required
Resistance Tolerance
Resistance Value
Type

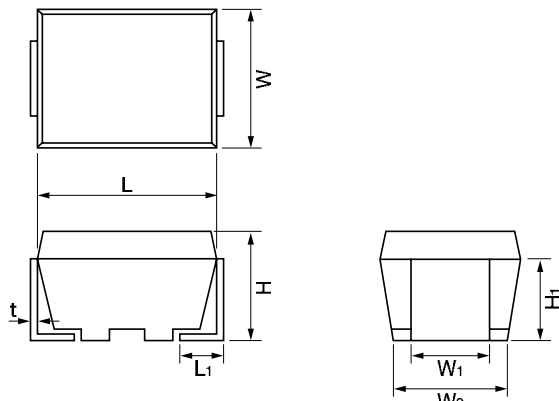
Resistance value, in ohm, is expressed by a series of six characters, five of which represent significant digits. R or K is a dual-purpose letter that designates both the value range (R for ohmic; K for kilo-ohm) and the location of the decimal point.

* Imprinting indicates up to 4 significant digits but ordered resistance value is traceable by date code

TCR, RESISTANCE RANGE, TOLERANCE, RATED POWER

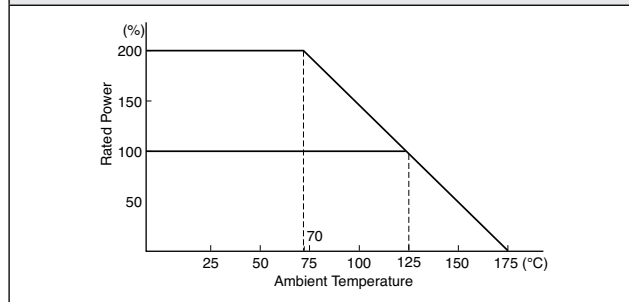
Type	TCR (ppm/°C) -55°C to +125°C	Resistance Range (Ω)	Resistance Tolerance (%)	Rated Power (W) at 125°C
MPP	±0.2±3.8	30 to <50	±0.1(B)	0.1
	±0.2±2.8	50 to <100	±0.1(B)	
	±0.2±1.8	100 to <1k	±0.1(B) ±0.05(A) ±0.02(Q)	
		1k to <20k	±0.1(B) ±0.05(A) ±0.02(Q) ±0.01(T)	
MQP	±0.2±3.8	30 to <50	±0.1(B)	0.125
	±0.2±2.8	50 to <100	±0.1(B)	
	±0.2±1.8	100 to <1k	±0.1(B) ±0.05(A) ±0.02(Q)	
		1k to <40k	±0.1(B) ±0.05(A) ±0.02(Q) ±0.01(T)	

CONFIGURATION (DIMENSIONS IN mm)

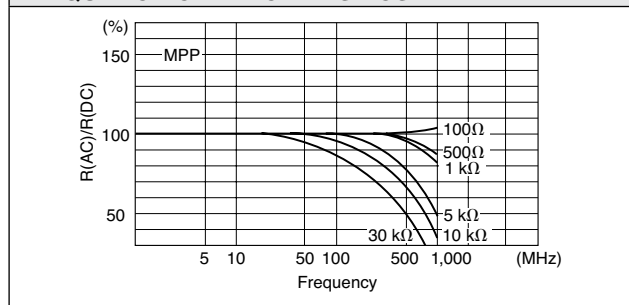


Type	MPP	MQP
L	3.2±0.2	4.5±0.2
W	2.5±0.2	3.2±0.2
H	2.0±0.2	
L1	0.6±0.2	0.8±0.2
W1	1.4±0.3	
W2	2.3±0.2	3.0±0.2
H1	1.5±0.3	
t	0.15±0.05	

POWER DERATING CURVE



FREQUENCY CHARACTERISTICS



Z-Foil Ultra High-Precision SMT Resistor (Molded, J-Lead Terminal)

PERFORMANCE				
Parameters	Test Condition	Specification		Typical MPP/MQP
		MP/MQ*	MPP/MQP	
Maximum Rated Operating Temperature Working Temperature Range Maximum Working Voltage Maximum Working Current		125°C -65°C to +175°C MP = 50V, MQ = 100V 350 mA		
Thermal Shock Overload	-65°C/30 min. ↔ +150°C/30 min., 5 cycles Rated Voltage x 2.5, 5 sec.	±0.05%	±0.01%	±0.005%
Low Temperature Storage and Life Outstanding PC Board Bending	-65°C, No Load, 24 hrs. → Rated Voltage, 45 min. 3 mm Bend, 60 sec.	±0.05%	±0.01%	±0.005%
Dielectric Withstanding Voltage Insulation Resistance Resistance to Soldering Heat Moisture Resistance	AC 200V, 1 min. DC 100V, 1 min. 260°C, 10 sec. +65°C to -10°C, 90% RH to 98% RH, Rated Voltage, 10 cycles (240 hrs.)	±0.01%	±0.01%	±0.005%
Shock Vibration, High Frequency	100G, 6 ms, Sawtooth Wave, X, Y, Z, each 10 shocks 20G, 10 Hz to 2,000 Hz to 10 Hz, 20 min., X, Y, Z, each 2.5 hrs.	±0.02%	±0.02%	±0.01%
Storage Life	15°C to 35°C, 15% RH to 75% RH, No Load, 10,000 hrs.	±0.005%	±0.005%	±0.0025%
High Temperature Exposure	175°C, No Load, 2,000 hrs.	±0.05%	±0.05%	±0.03%
Life	70°C, Rated Power, 1.5 hr. – on, 0.5 hr. – off, 2,000 hrs. 70°C, Rated Power x 2, 1.5 hr. – on, 0.5 hr. – off, 2,000 hrs.	—	±0.01%	±0.005%
		—	±0.03%	±0.01%

*Conventional MP/MQ Series

TAPE AND REEL PACKAGE (BASED ON EIA-481-1) (DIMENSIONS IN mm)

Tape Dimensions										Reel Dimensions							
Type	A	B	C	D	E	F	G	H	J	A	N	B	C	D	W1	W2	r
MPP	2.8 ±0.2	3.9 ±0.2	12.0 ±0.3	5.5 ±0.05	1.75 ±0.1	4.0 ±0.1	2.0 ±0.05	4.0 ±0.1	Dia. 1.5 ±0.1-0	Dia. 178 ±2	Dia. 60 min.	Dia. 13 ±0.5	Dia. 21 ±0.8	2 ±0.5	12.4 +2.0-0	18.4 max.	1.0 ±0.5
MQP	3.6 ±0.2	5.2 ±0.2	12.0 ±0.3	5.5 ±0.05	1.75 ±0.1	8.0 ±0.1	2.0 ±0.05	4.0 ±0.1	Dia. 1.5 ±0.1-0	Reel Capacity		MPP: 1,200 pieces/reel MQP: 800 pieces/reel					

PRECAUTION IN USING FACE-BONDED CHIP RESISTORS

1. Storage

Storage conditions or environment may adversely affect solderability of the exterior terminals. Do not store in high temperature and humidity. The recommended storage environment is lower than 40°C, has less than 70% RH humidity and is free from harmful gases such as sulphur and chlorine.

2. Caution in Soldering

① Hand Soldering—Hand soldering is applicable as shown at right.

Recommended

- Temp. of iron tip: 240°C to 270°C
- Power of iron: 20W or less
- Diameter of tip: dia. 3 mm max.

② Solder Reflow in Furnace

Recommended

- Peak temperature: 250+0/-5°C
- Holding time: 10 sec. max.
- To cool gradually at room temperature

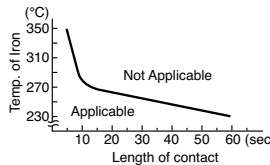
③ Dipping in Solder (Wave or Still)

Recommended

- Temp. of solder: 260°C max
- Length of dipping: 10 seconds
- To cool gradually at room temperature

④ Other

Corrosion-free flux, such as rosin, is recommended. Do not apply pressure to the molded housing immediately after soldering.

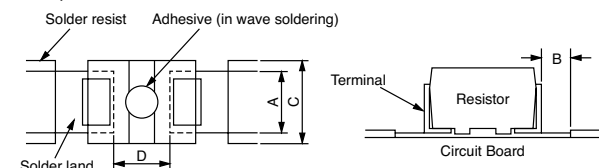


3. Cleaning

Use volatile cleaner such as methylalcohol or propyl alcohol.

4. Circuit Board Design

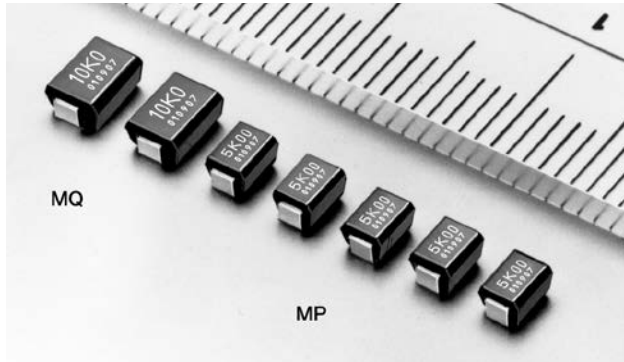
The dimensions of solder land must be determined in conformity with the size of resistors and with the soldering method. They are also subject to the mounting machine and the material of the substrate. See example below.



Type	A	B	C	D
MPP	1.6 to 2.0	0.5 to 1.5	2.2 to 2.6	1.8
MQP				2.5

When parts are mounted on a board in high density, solder can possibly attach to the resistors in an excessive amount to affect performance or reliability of the resistors. To prevent this effect, the use of solder resist is recommended to isolate solder lands.

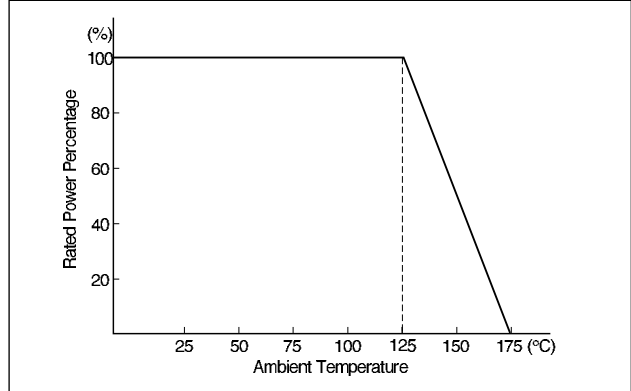
Ultra Precision SMT Resistor (Molded, J-Lead Terminal)



TCR, RESISTANCE RANGE, TOLERANCE, RATED POWER

Type	TCR (ppm/°C) -55°C to +125°C	Resistance Range (Ω)	Resistance Tolerance (%)	Rated Power (W) at 125°C
MP	0±10	30 to 100	±0.1	0.1
	0±5	100 to 30k	±0.05	
MQ	0±10	30 to 100	±0.1	0.125
	0±5	100 to 60k	±0.05	

POWER DERATING CURVE



COMPOSITION OF TYPE NUMBER

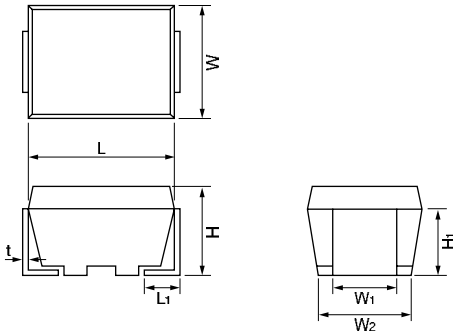
Example:

MQ 10K00 L

— Tape & Reel Package Required
 — Resistance Value
 — Type

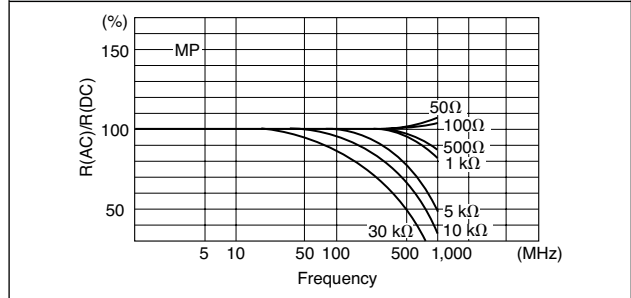
Resistance value, in ohm, is expressed by a series of five characters, four of which represent significant digits. R or K is a dual-purpose letter that designates both the value range (R for ohmic; K for kilo-ohm) and the location of the decimal point.

CONFIGURATION (DIMENSIONS IN mm)

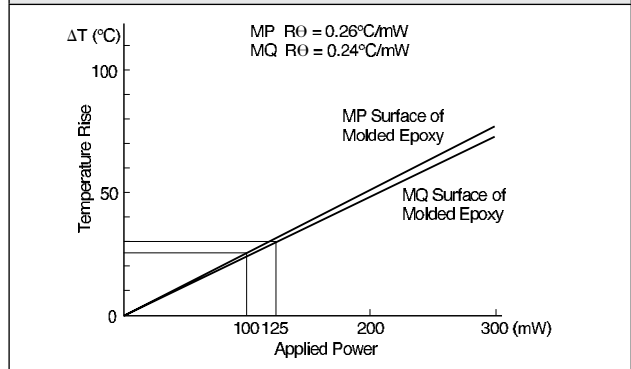


Type	MP	MQ
L	3.2±0.2	4.5±0.2
W	2.5±0.2	3.2±0.2
H	2.0±0.2	
L1	0.6±0.2	0.8±0.2
W1	1.4±0.3	
W2	2.3±0.2	3.0±0.2
H1	1.5±0.3	
t	0.15±0.05	

FREQUENCY CHARACTERISTICS



TEMPERATURE OF RESISTOR SURFACE



Ultra Precision SMT Resistor (Molded, J-Lead Terminal)

PERFORMANCE			
Parameters	Test Condition	ALPHA Specification	ALPHA Typical Test Data
Maximum Rated Operating Temperature Working Temperature Range Maximum Working Voltage Maximum Working Current			125°C -65°C to +175°C MP=50V, MQ=100V 350 mA
Thermal Shock Overload	-65°C/30 min. ↔ +175°C/30 min., 5 cycles Rated Voltage x 2.5, 5 sec.	±0.05% ±0.05%	±0.01% ±0.01%
Low Temperature Storage and Operation Substrate Bending Test	-65°C, No Load, 24 hrs. → Rated Voltage, 45 min. Substrate Bent 3 mm, 60 sec.	±0.05% ±0.05%	±0.01% ±0.01%
Dielectric Withstanding Voltage Insulation Resistance Resistance to Soldering Heat Moisture Resistance	Atmospheric: AC 200V, 1 min. DC 100V, 1 min. 260°C, 10 sec. +65°C to -10°C, 90% RH to 98% RH, Rated Voltage, 10 cycles (240 hrs.)	±0.01% over 10,000 MΩ ±0.05% ±0.05%	±0.005% over 10,000 MΩ ±0.01% ±0.03%
Shock Vibration, High Frequency	100G, 6 ms, Sawtooth Wave, X, Y, Z, each 10 shocks 20G, 10 Hz to 2,000 Hz to 10 Hz, 20 min., X, Y, Z, each 2.5 hrs.	±0.02% ±0.02%	±0.01% ±0.01%
Life	125°C, Rated Power, 1.5 hr. – ON, 0.5 hr. – OFF, 2,000 hrs.	±0.05%	±0.03%
Storage Life	15°C to 35°C, 15% RH to 75% RH, No Load, 10,000 hrs.	±0.005%	±0.0025%
High Temperature Exposure	175°C, No Load, 2,000 hrs.	±0.05%	±0.03%

TAPE AND REEL PACKAGE (BASED ON EIA-481-1) (DIMENSIONS IN mm)																	
Tape Dimensions										Reel Dimensions							
Type	A	B	C	D	E	F	G	H	J	A	N	B	C	D	W1	W2	r
MP	2.8 ±0.2	3.9 ±0.2	12.0 ±0.3	5.5 ±0.05	1.75 ±0.1	4.0 ±0.1	2.0 ±0.05	4.0 ±0.1	Dia. 1.5 ±0.1-0	Dia. 178 ±2	Dia. 60 min.	Dia. 13 ±0.5	Dia. 21 ±0.8	2 ±0.5	12.4 +2.0-0	18.4 max.	1.0 ±0.5
MQ	3.6 ±0.2	5.2 ±0.2	12.0 ±0.3	5.5 ±0.05	1.75 ±0.1	8.0 ±0.1	2.0 ±0.05	4.0 ±0.1	Dia. 1.5 ±0.1-0	Reel Capacity MP: 1,200 pieces/reel MQ: 800 pieces/reel							

PRECAUTION IN USING FACE-BONDED CHIP RESISTORS

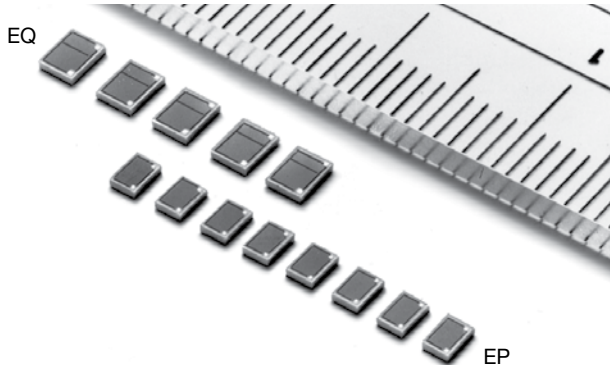
- Storage**
Storage conditions or environment may adversely affect solderability of the exterior terminals. Do not store in high temperature and humidity. The recommended storage environment is lower than 40°C, has less than 70% RH humidity and is free from harmful gases such as sulphur and chlorine.
- Caution in Soldering**
 - Hand Soldering**
Hand soldering is applicable as shown at right.
Recommended
 - Temp. of iron tip: 240°C to 270°C
 - Power of iron: 20W or less
 - Diameter of tip: dia. 3 mm max.
 - Solder Reflow in Furnace**
Recommended
 - Peak temperature: 250+0/-5°C
 - Holding time: 10 sec. max.
 - To cool gradually at room temperature
 - Dipping in Solder (Wave or Still)**
Recommended
 - Temp. of solder: 260°C max
 - Length of dipping: 10 seconds
 - To cool gradually at room temperature
 - Other**
Corrosion-free flux, such as rosin, is recommended. Do not apply pressure to the molded housing immediately after soldering.
- Cleaning**
Use volatile cleaner such as methylalcohol or propyl alcohol.
- Circuit Board Design**
The dimensions of solder land must be determined in conformity with the size of resistors and with the soldering method. They are also subject to the mounting machine and the material of the substrate. See example below.

Type	A	B	C	D
MP	1.6 to 2.0	0.5 to 1.5	2.2 to 2.6	1.8
MQ				2.5

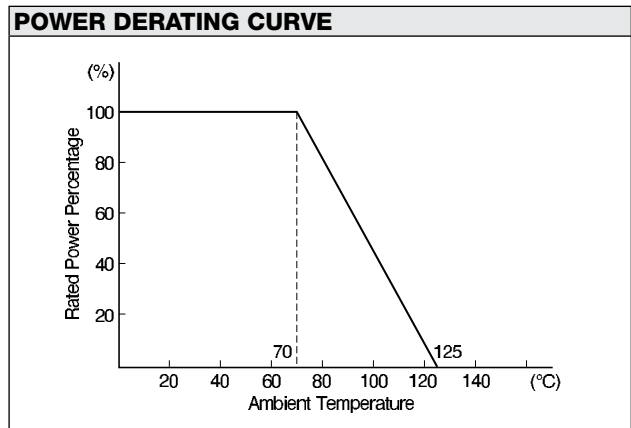
Dimensions in mm

When parts are mounted on a board in high density, solder can possibly attach to the resistors in an excessive amount to affect performance or reliability of the resistors. To prevent this effect, the use of solder resist is recommended to isolate solder lands.

Ultra Precision SMT Resistor (Wire-Bondable)



TCR, RESISTANCE RANGE, TOLERANCE, RATED POWER				
Type	TCR (ppm/°C) -55°C to +125°C	Resistance Range (Ω)	Resistance Tolerance (%)	Rated Power (W) at 70°C
EP	0±5 See Fig.1	30 to 100	±0.1	0.1
		100 to 30k	±0.05	
EQ		30 to 100	±0.1	0.125
		100 to 60k	±0.05	



COMPOSITION OF TYPE NUMBER

Example:

EQ 10K00

Resistance Value Type

Resistance value, in ohm, is expressed by a series of five characters, four of which represent significant digits. R or K is a dual-purpose letter that designates both the value range (R for ohmic; K for kilo-ohm) and the location of the decimal point.

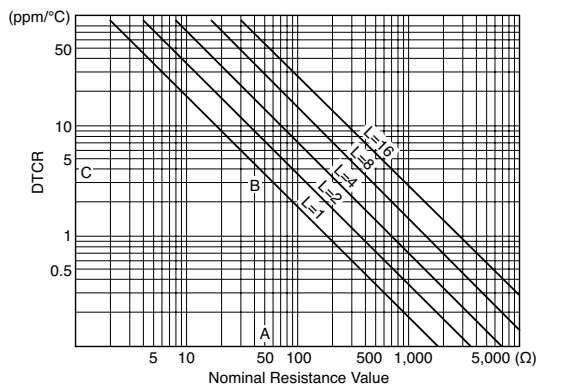
CONFIGURATION (DIMENSIONS IN mm)

Type	EP	EQ
L	2.2±0.1	3.2±0.1
W	1.6±0.1	2.2±0.1
T	0.4±0.1	
L1	0.25±0.01	
W1	0.25±0.01	

Ultra Precision SMT Resistor (Wire-Bondable)

PERFORMANCE			
Parameters	Test Condition	MIL-R-55342 Specification	ALPHA Typical Test Data
Maximum Rated Operating Temperature Working Temperature Range Maximum Working Voltage Maximum Working Current		70°C -65°C to +125°C 40V 350 mA	
Thermal Shock	-65°C/30 min. ↔ +125°C/30 min., 5 cycles	±0.05%	±0.01%
Resistance to Bonding Exposure Low Temperature Operation Overload	Room Temperature, 4 hrs. to 12 hrs. -65°C, No Load, 1 hr. → Rated Voltage, 45 min. Rated Voltage x 2.5, 5 sec.	±0.05% ±0.05% ±0.05%	±0.01% ±0.01% ±0.01%
Life	70°C, Rated Power, 1.5 hr. – ON, 0.5 hr. – OFF, 1,000 hrs.	±0.05%	±0.03%
Moisture Resistance	+65°C to -10°C, 90% RH to 98% RH, No Load, 10 cycles (240 hrs.)	±0.05%	±0.03%
High Temperature Exposure	125°C, No Load, 100 hrs.	±0.05%	±0.03%

FIG. 1 EFFECT OF TERMINATION GOLD WIRE ON TCR

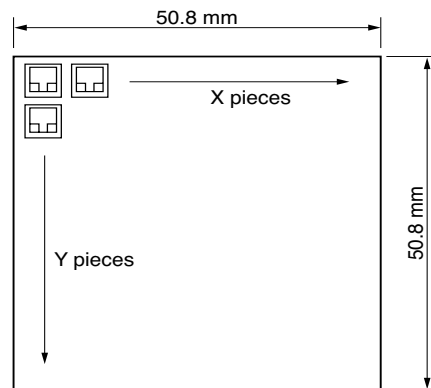


- TCR of Gold Wire: 3,900 ppm/°C
- Total Length of Two Gold Wires: L mm
- Gold Wire Diameter: 25 μm
- Resistance of Gold Wire: 46.86 mΩ/mm

Example: A nominal resistance of 50Ω (point A on the X axis) and gold wire length of 1 mm (point B on the L=1 line) results in an increase in the overall TCR of 3.5 ppm/°C (point C on the Y axis).

CHIP TRAY

Tray Size



Type	X	Y	Total Pieces
EP	13	17	221
EQ	10	14	140

PRECAUTION IN USING WIRE-BONDED CHIP RESISTORS

1. Storage

Storage condition or environment may adversely affect bondability of the terminal pad with wire. Do not store in high temperature and humidity. The recommended storage environment is lower than 40°C, has less than 70% RH humidity and is free from harmful gases such as sulphur and chlorine.

2. Caution in Mounting

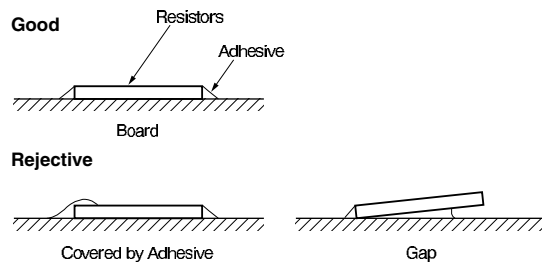
- ① Mounting Method: Die-bonding
- ② Adhesive for Placement: Thixotropic epoxy (temperature of cure ≤180°C)
- ③ State of Mounting: shown right

3. Recommended Wire Bonding Method

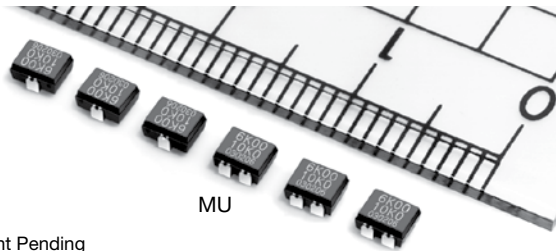
- ① Bonding Method: Thermosonic ball bonding
- ② Preheating Temperature: 80°C to 125°C (temperature of the resistors)
- ③ Connecting Wire: dia. 25 μm gold wire

4. Protective Coat

Avoid direct coating of the resistor with n-methylpyrrolidone



Ultra Precision SMT Resistor 1-2-3 Network (Molded, J-Lead Terminal)



Patent Pending

COMPOSITION OF TYPE NUMBER

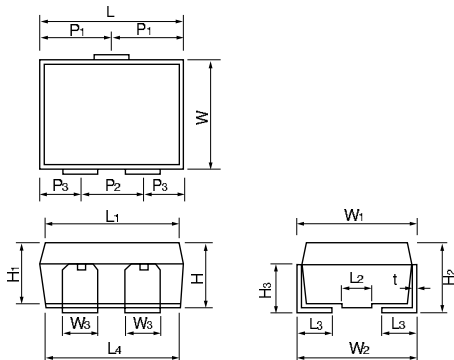
Example:

MU 1K000/ 10K00 B Q L

① ② ③ ④ ⑤ ⑥

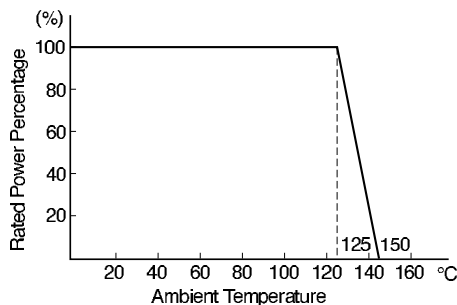
- ① Type
- ② Nominal Resistance Values (R1)
- ③ Nominal Resistance Values (R2)
- ④ Tolerance (Absolute)
- ⑤ Tolerance (Matching)
- ⑥ Tape & Reel Package Being Required

CONFIGURATION (DIMENSIONS IN mm)



L	W	H	H₁	H₂	H₃	P₁	P₂	P₃
3.2 ±0.2	2.5 ±0.2	1.5 ±0.2	1.4 ±0.2	1.6 ±0.2	1.1 ±0.2	1.6 ±0.1	1.4 ±0.1	0.9 ±0.1
W₁	W₂	W₃	L₁	L₂	L₃	L₄	t	
2.7 ±0.2	2.7 ±0.2	0.8 ±0.1	3.0 ±0.2	0.7 ±0.2	0.8 ±0.1	3.0 ±0.2	0.1 ±0.05	

POWER DERATING CURVE



RESISTANCE RANGE, TOLERANCE, RATED POWER

Type	Resistance Range Element**	Resistance Tolerance*		Rated Power/Element (W) at 125°C
		Absolute*	Matching*	
MU	10Ω ≤ R < 100Ω	±0.1% (B) ±0.5% (D)	±0.05% (A) ±0.1% (B) ±0.5% (D)	0.05
	100Ω ≤ R < 1kΩ	±0.05% (A) ±0.1% (B) ±0.5% (D)	±0.02% (Q) ±0.05% (A) ±0.1% (B) ±0.5% (D)	
	1kΩ ≤ R ≤ 20kΩ	±0.02% (Q) ±0.05% (A) ±0.1% (B) ±0.5% (D)	±0.01% (T) ±0.02% (Q) ±0.05% (A) ±0.1% (B) ±0.5% (D)	

* Symbols in parentheses are for type number composition.
** Please contact us for the availability.

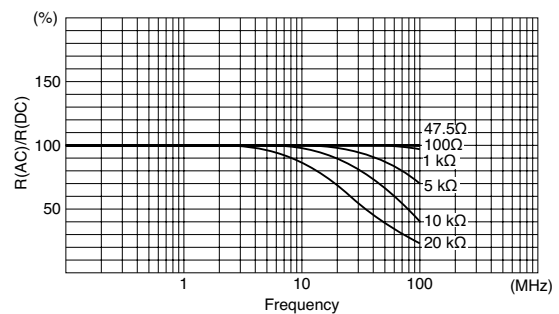
ABSOLUTE TCR

Resistance Range (Ω)	Absolute TCR (ppm/°C) -55°C to +125°C
10Ω ≤ R < 30Ω	±15
30Ω ≤ R < 100Ω	±10
100Ω ≤ R ≤ 20kΩ	±5

TCR TRACKING

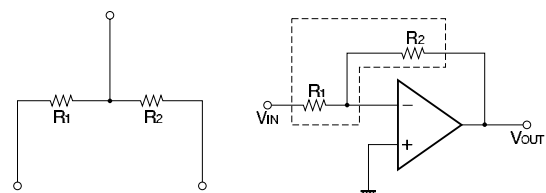
Resistance Ratio	TCR Tracking (ppm/°C) -55°C to +125°C
Ratio = 1	±1
1 < Ratio ≤ 10	±2
10 < Ratio ≤ 100	±3
100 < Ratio	±5

FREQUENCY CHARACTERISTICS



EXAMPLE OF APPLICATIONS

An Application of Type MU (input/feedback resistors for amplifiers)
Because the input and the feedback resistors are incorporated into one single element, amplification is not affected by temperature change.



Ultra Precision SMT Resistor 1-2-3 Network (Molded, J-Lead Terminal)

PERFORMANCE					
Parameters	Test Condition	ALPHA Specification		ALPHA Typical Test Data	
		ΔR	Δ Ratio	ΔR	Δ Ratio
Maximum Rated Operating Temperature Working Temperature Range		125°C -65°C to +150°C			
Thermal Shock Overload	-65°C/30 min. \leftrightarrow +150°C/30 min., 5 cycles Rated Voltage x 2.5, 5 sec.	$\pm 0.05\%$ $\pm 0.05\%$	$\pm 0.02\%$ $\pm 0.02\%$	$\pm 0.01\%$ $\pm 0.01\%$	$\pm 0.005\%$ $\pm 0.005\%$
Low Temperature Storage and Operation Substrate Bending Test	-65°C, No Load, 24 hrs. \rightarrow Rated Voltage, 45 min. 3 mm Bend 60 sec.	$\pm 0.05\%$ $\pm 0.05\%$	$\pm 0.02\%$ $\pm 0.02\%$	$\pm 0.01\%$ $\pm 0.01\%$	$\pm 0.005\%$ $\pm 0.005\%$
Dielectric Withstanding Voltage Insulation Resistance Resistance to Soldering Heat Moisture Resistance	Atom. Pres.: AC 200V, 1 min. DC 100V, 1 min. 260°C, 10 sec. +65°C to -10°C, 90% to 98% RH, Rated Power, 10 cycles (240 hrs.)	$\pm 0.01\%$ $\pm 0.05\%$	$\pm 0.01\%$ $\pm 0.02\%$	$\pm 0.005\%$ $\pm 0.03\%$	$\pm 0.0025\%$ $\pm 0.01\%$
Shock Vibration, High Frequency	100G, 6 ms, Sawtooth Wave, X, Y, Z, each 10 shocks 20G, 10 Hz to 2,000 Hz to 10 Hz, 20 min., X, Y, Z, each 2.5 hrs.	$\pm 0.02\%$ $\pm 0.02\%$	$\pm 0.01\%$ $\pm 0.01\%$	$\pm 0.01\%$ $\pm 0.01\%$	$\pm 0.005\%$ $\pm 0.005\%$
Life	125°C, Rated Power, 1.5 hrs. - ON, 0.5 hrs. - OFF, 2,000 hrs.	$\pm 0.05\%$	$\pm 0.02\%$	$\pm 0.03\%$	$\pm 0.015\%$
Storage Life	15°C to 35°C, 15% RH to 75% RH, No Load, 10,000 hrs.	$\pm 0.005\%$	$\pm 0.0025\%$	$\pm 0.0025\%$	$\pm 0.0015\%$
High Temperature Exposure	150°C, No Load, 2,000 hrs.	$\pm 0.05\%$	$\pm 0.02\%$	$\pm 0.02\%$	$\pm 0.01\%$

TAPE AND REEL PACKAGE (BASED ON EIA-481-1) (DIMENSIONS IN mm)

Tape Dimensions										Reel Dimensions (Reel capacity: 800 pieces/reel)							
Type	A	B	C	D	E	F	G	H	J	A	N	B	C	D	W ₁	W ₂	r
MU	3.6 ± 0.2	3.1 ± 0.2	12.0 ± 0.3	5.5 ± 0.05	1.75 ± 0.1	8.0 ± 0.1	2.0 ± 0.05	4.0 ± 0.1	Dia. 1.5 $\pm 0.1-0$	Dia. 178 ± 2	Dia. 60 min.	Dia. 13 ± 0.5	Dia. 21 ± 0.8	2 ± 0.5	12.4 $\pm 2.0-0$	18.4 max.	1.0 ± 0.5

PRECAUTION IN USING FACE-BONDED CHIP RESISTOR (DIMENSIONS IN mm)

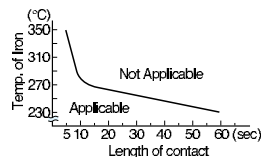
1. Storage

Storage condition or environment may adversely affect solderability of the exterior terminals. Do not store in high temperature and humidity. The recommended storage environment is lower than 40°C, has less than 70% RH humidity and is free from harmful gases such as sulphur and chlorine.

2. Caution in Soldering

1 Hand Soldering

- Hand soldering is applicable as shown at right.
- Recommended
 - Temp. of Iron Tip: 240°C to 270°C
 - Power of Iron: 20W or less
 - Diameter of Tip: Dia. 3 mm max.



2 Solder Reflow in Furnace

- Recommended
 - Peak Temperature: 250°C +0°C/-5°C
 - Holding time: 10 sec. max.
 - To cool gradually at room temperature

3 Dipping in Solder (Wave or Still)

- Recommended
 - Temp. of Solder: 240°C to 250°C
 - Length of Dipping: 3 to 4 seconds
 - To cool gradually at room temperature

4 Other

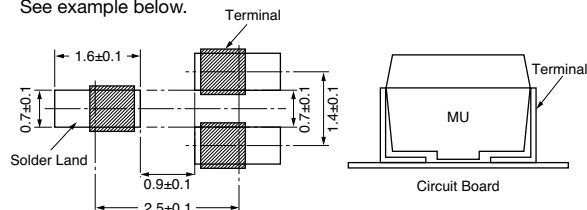
Corrosion-free flux, such as rosin, is recommended. Do not apply pressure to the molded housing immediately after soldering.

3. Cleaning

Use volatile cleaner such as methylalcohol or propylalcohol.

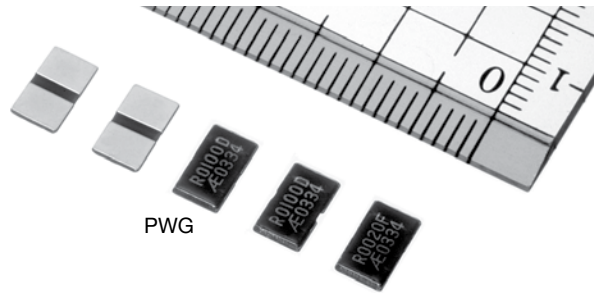
4. Circuit Board Design

The dimensions of solder land must be determined in conformity with the size of resistors and with the soldering method. They are also subject to the mounting machine and the material of the substrate. See example below.



When parts are mounted on a board in high density, solder can possibly attach to the resistors in an excessive amount to affect performance or reliability of the resistors. To prevent this effect, the use of solder resist is recommended to isolate solder lands.

Ultra Precision SMT Current Sense Resistor (Wrap-Around Terminals)



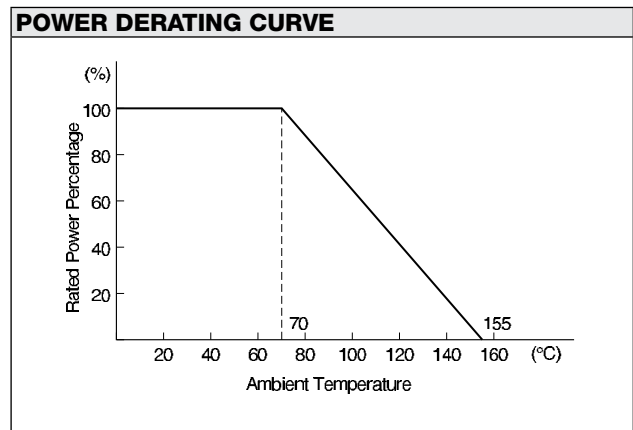
TCR, RESISTANCE RANGE, TOLERANCE, RATED POWER				
Type	TCR (ppm/°C) -25°C to +125°C*	Resistance Range (Ω)**	Resistance Tolerance (%)**	Rated Power (W) at 70°C
PWG	0±100 (K)***	0.002 to 0.003	±2 (G) ±5 (J)	2
	0±50 (H)***	0.003 to 0.01		
	0±25 (J)	0.01 to 0.02 0.02 to 0.1	±1 (F) ±2 (G) ±0.5 (D) ±1 (F)	

* Symbols parenthesized are for type number composition.
 ** Please contact us for available resistance values.
 ***Temperature Range is +25°C to +125°C

COMPOSITION OF TYPE NUMBER

Example:
PWG J R0100 F L

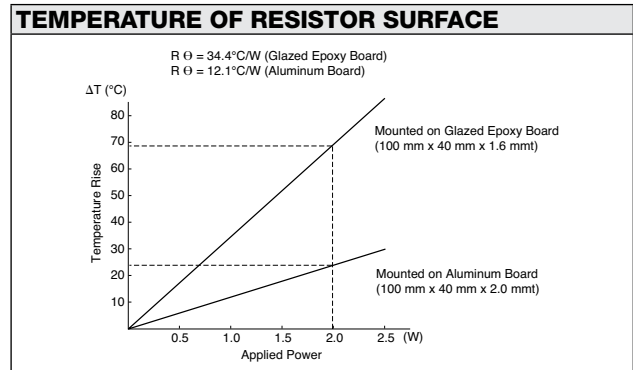
Resistance value in ohm is expressed by a series of four significant digits and an R designates the decimal point.



CONFIGURATION (DIMENSIONS IN mm)

Type	PWG
L	7.0±0.2
W	4.0±0.2
L1	0.3±0.2
L2	6.4±0.2
c	3.0±0.1
T	0.9±0.2

Dimensions in mm



Please use board made of metal for continuous use with 2W at 70°C. Please keep the temperature of board less than 90°C when using the glazed epoxy board.

CONSTRUCTION

- ① Copper Terminals
- ② Insulation Resin (Polyimide)
- ③ Metal Foil
- ④ Laser Beamed
- ⑤ External Terminal (Sn-Cu)
- ⑥ Solder Resist
- ⑦ Insulation Resin (Epoxy)

Ultra Precision SMT Current Sense Resistor (Wrap-Around Terminals)

PERFORMANCE			
Parameters	Test Condition	ALPHA Specification	ALPHA Typical Test Data
Maximum Rated Operating Temperature Working Temperature Range Maximum Working Current			70°C -65°C to +155°C 50A
Thermal Shock Overload	-65°C/30 min., +155°C/30 min., 5 cycles Rated Voltage x 2.5, 5 sec.	±0.1% ±0.1%	±0.05% ±0.05%
Low Temperature Storage and Operation Substrate Bending Test	-65°C, No Load, 24 hrs. → Rated Power, 45 min. Substrate Bent 3mm, 60 sec.	±0.1% ±0.1%	±0.05% ±0.05%
Dielectric Withstanding Voltage Insulation Resistance Resistance to Soldering Heat Moisture Resistance	Atmo. Pres.: AC 200V, 1 min. DC 100 C, 1 min. 260°C, 10 sec. -65°C to -10°C, 90% RH to 98% RH, Rated Voltage, 10 cycles (240 hrs.)	±0.05% over 10,000 MΩ ±0.1% ±0.1%	±0.01% over 10,000 MΩ ±0.05% ±0.05%
Shock High Frequency Shock	100G, 6 ms., Sawtooth Wave, X, Y, Z, 10 shocks each 20G, 10 Hz to 2,000 Hz to 10 Hz, 20 min., X, Y, Z, 2.5 hrs. each	±0.05% ±0.05%	±0.01% ±0.01%
Life	70°C, Rated Power, 1.5 hr. – ON, 0.5 hr. – OFF, 2,000 hrs.	±0.2%	±0.1%
Storage Life	15°C to 35°C, 15% RH to 75% RH, No Load, 10,000 hrs.	±0.05%	±0.01%
High Temperature Exposure	155°C, No Load, 2,000 hrs.	±0.5%	±0.1%
Internal Thermal Resistance	Between Resistive Elements and Terminals		15°C/W
Thermal Electromotive Force			1 µV/°C

TAPE AND REEL PACKAGE (BASED ON EIA-481-1) (DIMENSIONS IN mm)

Tape Dimensions									Reel Dimensions (Reel capacity: 1,000 pieces/reel)							
A₀	B₀	W	F	E	P₁	P₂	P₀	D₀	A	N	B	C	D	W₁	W₂	r
4.3 ±0.1	7.3 ±0.1	16.0 ±0.3	7.5 ±0.1	1.75 ±0.1	8.0 ±0.1	2.0 ±0.1	4.0 ±0.1	1.5 +0.1-0	Dia. 178 ±0.2	Dia. 60 min.	Dia. 13 ±0.5	Dia. 21 ±0.8	2.0 ±0.5	17.0 ±0.3	19.4 ±0.1	1.0 ±0.5

PRECAUTION IN USING SMT CURRENT SENSE RESISTORS

1. Storage

Storage conditions or environment may adversely affect solderability of exterior terminals. Do not store in high temperature and humidity. The recommended storage environment is lower than 40°C, has less than 70% RH humidity and is free from harmful gases such as sulphur and chlorine.

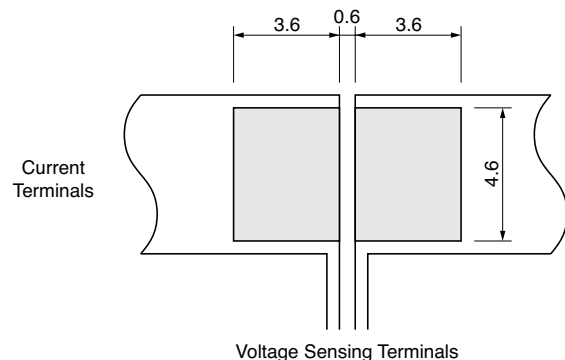
2. Caution in Soldering

- ① Solder Reflow in Furnace
Recommended
 - Peak Temperature: 230±5°C
 - Holding time: 5 to 10 seconds
 - To cool gradually at room temperature
- ② Dipping in Solder (Wave or Still)
Recommended
 - Solder Temperature: 240°C to 250°C
 - Length of Dipping: 3 to 4 seconds
- ③ Other
Corrosion-free flux such as rosin is recommended.

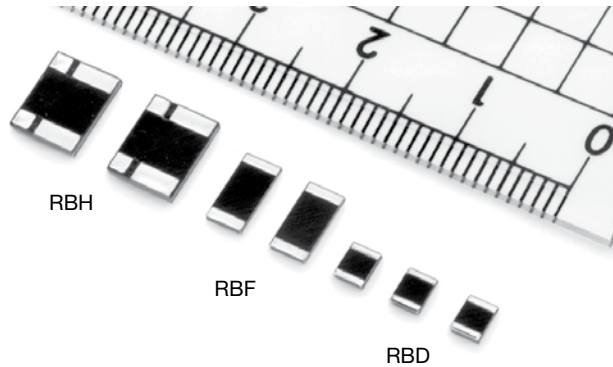
3. Cleaning

Use volatile cleaner such as methylalcohol or propylalcohol.

RECOMMENDED LAND LAYOUT

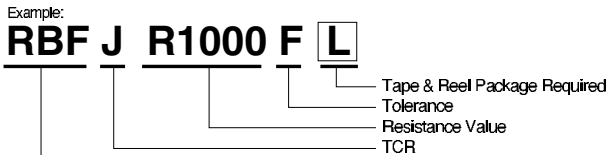


Ultra Precision SMT Current Sense Resistor (Flip-Chip)



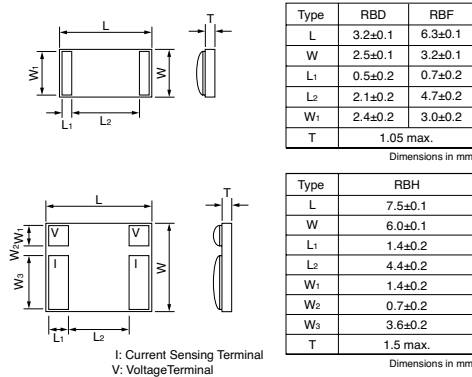
TCR, RESISTANCE RANGE, TOLERANCE, RATED POWER				
Type	TCR (ppm/°C) -25°C to 125°C*	Resistance Range (Ω)	Resistance Tolerance (%)*	Rated Power (W) at 70°C
RBD	0±50 (H)	0.005 to 0.01	±5 (J)	0.5
	0±25 (J)	0.01 to 0.1	±1 (F) ±2 (G) ±5 (J)	
RBF	0±10 (C) 0±25 (J)	0.1 to 1	±0.5 (D) ±1 (F) ±2 (G) ±5 (J)	1
	0±50 (H)	0.005 to 0.01	±5 (J)	
RBH	0±10 (C) 0±25 (J)	0.01 to 0.1	±0.5 (D) ±1 (F) ±2 (G) ±5 (J)	1.5
	0±50 (H)	0.001 to 0.01	±1 (F) ±2 (G) ±5 (J)	

COMPOSITION OF TYPE NUMBER

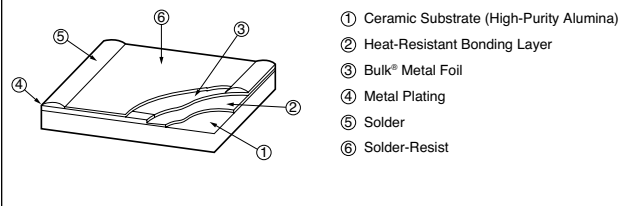


Resistance value in ohm is expressed by a series of four significant digits and an R designates the decimal point.

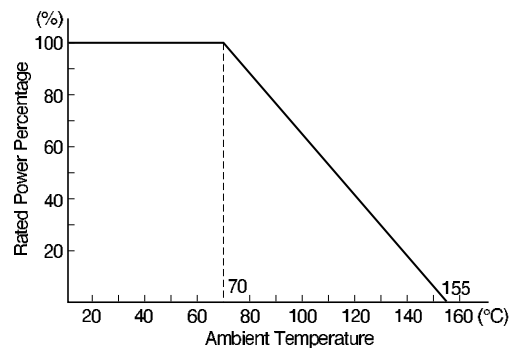
CONFIGURATION (DIMENSIONS IN mm)



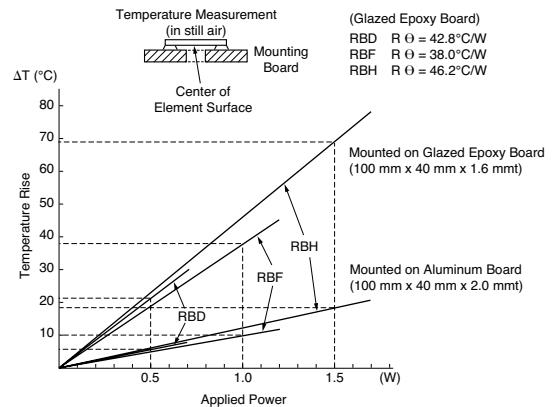
CONSTRUCTION



POWER DERATING CURVE



TEMPERATURE OF RESISTOR SURFACE



Please use board made of metal for continuous use with 2W at 70°C. Please keep the temperature of board less than 90°C when using the glazed epoxy board.

Ultra Precision SMT Current Sense Resistor (Flip-Chip)

PERFORMANCE			
Parameters	Test Condition	ALPHA Specification	ALPHA Typical Test Data
Maximum Rated Operating Temperature			70°C
Working Temperature Range			-65°C to +155°C
Thermal Shock	-65°C/30 min. ↔ +155°C/30 min., 5 cycles	±0.1%	±0.03%
Overload	Rated Voltage x 2.5, 5 sec.	±0.1%	±0.03%
Low Temperature Storage and Operation	-65°C, No Load, 24 hrs. → Rated Voltage, 45 min.	±0.1%	±0.05%
Substrate Bending Test	Substrate Bent 3 mm, 60 sec.	±0.1%	±0.05%
Dielectric Withstanding Voltage	Atmo. Pres.: AC 200V, 1 min.	±0.05%	±0.01%
Insulation Resistance	DC 100V, 1 min.	over 10,000 MΩ	over 10,000 MΩ
Resistance to Soldering Heat	260°C, 10 sec.	±0.1%	±0.03%
Moisture Resistance	+65°C to -10°C, 90% RH to 98% RH, Rated Voltage, 10 cycles (240 hrs.)	±0.1%	±0.03%
Shock	100G, 6 ms, Sawtooth Wave, X, Y, Z, each 10 shocks	±0.05%	±0.01%
Vibration, High Frequency	20G, 10 Hz to 2,000 Hz to 10 Hz, 20 min., X, Y, Z, each 2.5 hrs.	±0.05%	±0.01%
Life	70°C, Rated Power, 1.5 hr. – ON, 0.5 hr. – OFF, 2,000 hrs	±0.1%	±0.05%
Storage Life	15°C to 35°C, 15% RH to 75% RH, No Load, 10,000 hrs.	±0.05%	±0.01%
High Temperature Exposure	155°C, No Load, 2,000 hrs.	±0.1%	±0.05%

TAPE AND REEL PACKAGE (BASED ON EIA-481-1) (DIMENSIONS IN mm)

Tape Dimensions										Reel Dimensions								
										Reel Capacity RBH: 1,000 pieces/reel RBD, RBF: 4,000 pieces/reel 								
Type	A ₀	B ₀	W	F	E	P ₁	P ₂	P ₀	D ₀	Type	A	N	B	C	D	W ₁	W ₂	r
RBD	2.85 ±0.1	3.7 ±0.1	8.0 ±0.2	3.5 ±0.05	1.75 ±0.1	4.0 ±0.1	2.0 ±0.05	4.0 ±0.1	Dia. 1.5 ±0.1-0	RBD	Dia. 178 ±2	Dia. 60 min.	Dia. 13 ±0.5	Dia. 21 ±0.8	2.0 ±0.5	8.4 ±2.0-0	14.4 max.	1.0 ±0.5
RBF	3.4 ±0.1	6.7 ±0.1	12.0 ±0.2	5.5 ±0.05	1.75 ±0.1	4.0 ±0.1	2.0 ±0.05	4.0 ±0.1	Dia. 1.5 ±0.1-0	RBF	Dia. 178 ±2	Dia. 60 min.	Dia. 13 ±0.5	Dia. 21 ±0.8	2.0 ±0.5	12.4 ±2.0-0	18.4 max.	1.0 ±0.5
RBH	6.3 ±0.1	7.8 ±0.1	16.0 ±0.2	7.5 ±0.1	1.75 ±0.1	8.0 ±0.1	2.0 ±0.1	4.0 ±0.1	Dia. 1.5 ±0.1-0	RBH	Dia. 178 ±2	Dia. 60 min.	Dia. 13 ±0.5	Dia. 21 ±0.8	2.0 ±0.5	17.0 ±0.3	19.4 ±0.1	1.0 ±0.5

PRECAUTION IN USING SMD CURRENT SENSE RESISTORS

1. Storage
Storage condition or environment may adversely affect solderability of the exterior terminals. Do not store in high temperature and humidity. The recommended storage environment is lower than 40°C, has less than 70% RH humidity and is free from harmful gases such as sulphur and chlorine.

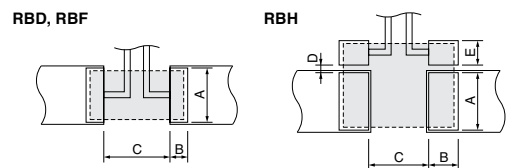
2. Caution in Soldering

- Solder Reflow in Furnace Recommended**
 - Peak Temperature: 250+0/-5°C
 - Holding time: 10 sec. max.
 - To cool gradually at room temperature.
- Dipping in Solder (Wave or Still) Recommended**
 - Temp. of Solder: 260°C max.
 - Length of Dipping: 10 sec.
- Other**
Soldering iron is never recommended. Corrosion-free flux such as rosin is recommended.

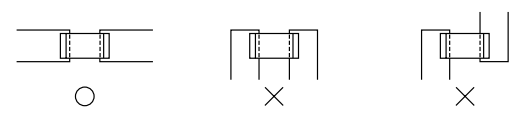
3. Cleaning
Use volatile cleaner such as methylalcohol or propylalcohol.

4. Circuit Board Design

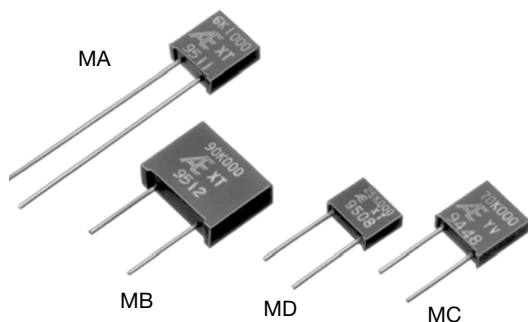
- Solder Land Dimensions**
The dimensions of solder land must be determined in conformity with the size of resistors and with the soldering method. They are also subject to the mounting machine and the material of the substrate. See example at right.
- Circuit Design**
It is recommended that the circuit be drawn so that current may approach, cross and go away from the mounted resistor in one direction as illustrated below. Thicker copper foil should be used if possible.



Type	Dimensions in mm				
	A	B	C	D	E
RBD	2.6 to 2.8	0.8	2.0	/	/
RBF	3.4 to 3.6	1.2	4.5		
RBH	3.8 to 4.0	2.0	4.0		



Ultra Precision Resistor (Transfer Molded)



COMPOSITION OF TYPE NUMBER

Example:

MA Y 10K000 A

MA: Type
 Y: TCR
 10K000: Resistance Value
 A: Tolerance

Resistance value, in ohm, is expressed by a series of six characters, five of which represent significant digits. R or K is a dual-purpose letter that designates both the value range (R for ohmic; K for kilo-ohm) and the location of decimal point.

TCR, RESISTANCE RANGE, TOLERANCE, RATED POWER				
Type	TCR (ppm/°C) -55°C to +125°C*	Resistance Range (Ω)	Resistance Tolerance (%)†‡	Rated Power (W) at 125°C
MA MC	0±15 (W)	1 to 5	±0.5 (D) ±1 (F)	0.3 (0.2 at 150 kΩ or above)
	0±5 (X)	5 to 30	±0.1 (B) ±0.5 (D) ±1 (F)	
	0±5 (X) 0±2.5 (Y) 0±1 (Z)**	30 to 200k	±0.005 (V) ±0.01 (T) ±0.02 (Q) ±0.05 (A) ±0.1 (B) ±0.5 (D) ±1 (F)	
MB	0±5 (X)	5 to 30	±0.1 (B) ±0.5 (D) ±1 (F)	0.5 (0.3 at 200 kΩ or above)
	0±5 (X) 0±2.5 (Y) 0±1 (Z)**	30 to 400k	±0.005 (V) ±0.01 (T) ±0.02 (Q) ±0.05 (A) ±0.1 (B) ±0.5 (D) ±1 (F)	
MD	0±5 (X)	5 to 30	±0.1 (B) ±0.5 (D) ±1 (F)	0.125
	0±5 (X) 0±2.5 (Y)	30 to 100	±0.05 (A) ±0.1 (B) ±0.5 (D) ±1 (F)	
	0±5 (X) 0±2.5 (Y) 0±1 (Z)**	100 to 80k	±0.01 (T) ±0.02 (Q) ±0.05 (A) ±0.1 (B) ±0.5 (D) ±1 (F)	

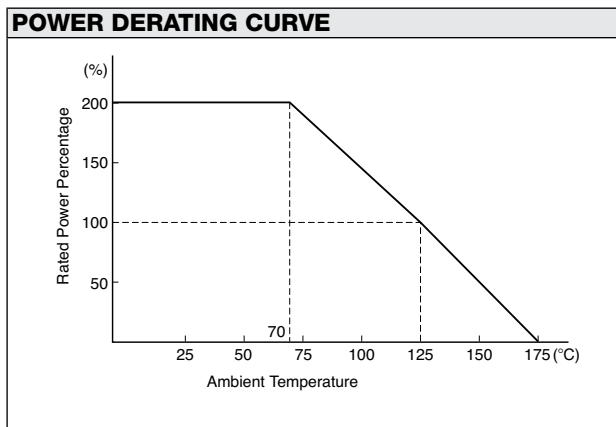
* Symbols in parentheses are for type number composition.

† Resistance figures are the values obtained by measuring the leads at point 12.7±3.2 mm away from the base for Type MA and at point 5.0±1.0 mm for Types MC, MB and MD, but, in case of resistance below 10 ohm, the value at 1.6±0.6 mm away from the base for all types.

**Temperature characteristic Z is applicable for temperature range between 0°C and 60°C.

CONFIGURATION (DIMENSIONS IN mm)

Type	MA	MC	MB	MD
L	7.9±0.2		13.0±0.3	7.4±0.2
L1	1.0 max.		1.5 max.	0.8 max.
W	8.3±0.2		10.0±0.3	6.0±0.2
W1	8.0±0.2		9.5±0.3	5.7±0.2
W2	0.3 max.		0.5 max.	0.4 max.
T	2.8±0.2	2.3±0.2	4.0±0.3	2.3±0.2
F	3.81±0.25	5.08±0.25	7.5±0.5	5.08±0.25
l	25±10		10±3	
d	Dia. 0.65±0.05			



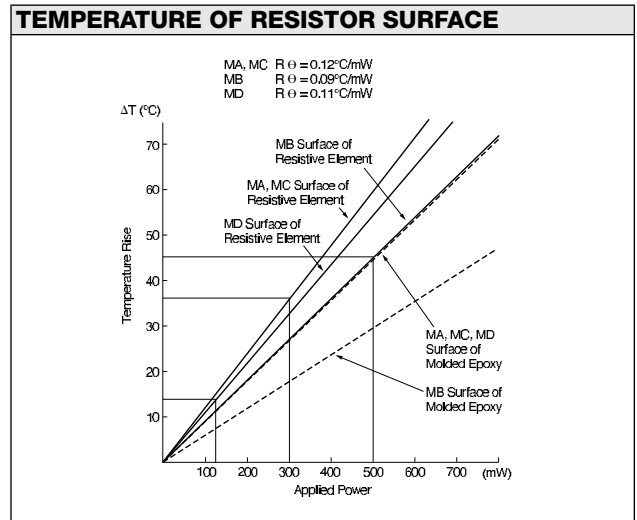
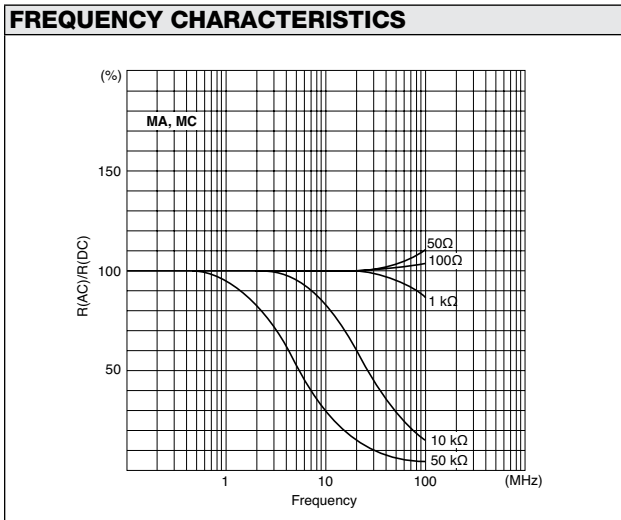
DSCC SPECIFICATIONS

97009
97010
97011

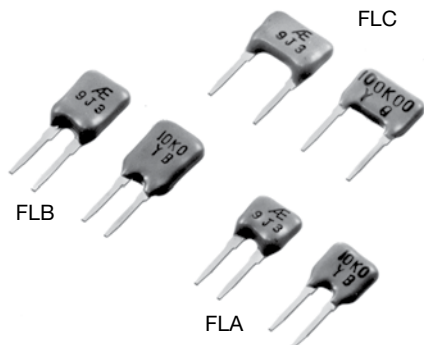
Ultra Precision Resistor (Transfer Molded)

PERFORMANCE			
Parameters	Test Condition	MIL-PRF-55182/9 Specification	ALPHA Typical Test Data
Maximum Rated Operating Temperature Working Temperature Range Maximum Working Voltage			125°C -65°C to +175°C MA=MC=300V, MB=350V, MD=250V
Power Conditioning Thermal Shock Overload	125°C, Rated Power, 100 hrs. -65°C/30 min. ↔ +150°C/30 min., 5 cycles Rated Power x 6.25, 5 sec.	±(0.20%+0.01Ω) ±0.05% ±0.05%	±0.005% ±0.005% ±0.005%
Solderability Resistance to Solvents	Steam Aging 8 hrs., 245°C, 5 sec. ☉ Isopropyl Alcohol + Mineral Spirits ☉ Water + Butyl Cellosolve + Monoethanolamine	over 95% coverage no damage	over 95% coverage no damage
Low Temperature Storage Low Temperature Operation Terminal Strength	-65°C, 24 hrs. -65°C, Rated Voltage, 45 min. 0.908 kg (2 pounds), 10 sec	±0.05% ±0.05% ±0.02%	±0.0025% ±0.0025% ±0.0025%
Dielectric Withstanding Voltage Insulation Resistance Resistance to Soldering Heat Moisture Resistance	Atmo.Pres.: 300V rms. Baro. Pres. 8 mHg: 200V rms. DC 100V, 2 min. +260°C, 10 sec. +65°C to -10°C, 90% RH to 98% RH, Rated Voltage, 10 cycles (240 hrs.)	±0.02% over 10,000 MΩ ±0.02% ±0.05%	±0.0025% over 10,000 MΩ ±0.0025% ±0.01%
Shock (Specified Pulse) Vibration, High Frequency	100G, 6 ms, Sawtooth Wave, X, Y, each 10 shocks 20G, 10 Hz to 2,000 Hz to 10 Hz, 20min., X, Y, each 4 hrs.	±0.01% ±0.02%	±0.0025% ±0.0025%
Life	125°C, Rated Voltage, 1.5 hr. – ON, 0.5 hr. – OFF, 2,000 hrs.	±0.05%	±0.015%
Life 70°C Power Rating	70°C, Rated Voltage x 2, 1.5 hr. – ON, 0.5 hr. – OFF, 2,000 hrs.	±0.05%	±0.015%
Storage Life	15°C to 35°C, 15% RH to 75% RH, No Load, 10,000 hrs.	±0.005%	±0.0025%
High Temperature Exposure	175°C, No Load, 2,000 hrs.	±0.5%	±0.015%
Current Noise Voltage Coefficient Thermal EMF		-32 dB 0,0005%/V 1.0 μV/°C	-42 dB 0,00003%/V 1.0 μV/°C

Type MA meets requirements of MIL-PRF-55182/9.



Precision Resistor (Conformally Coated)



TCR, RESISTANCE RANGE, TOLERANCE, RATED POWER				
Type	TCR (ppm/°C) -25°C to +125°C*	Resistance Range (Ω)	Resistance Tolerance (%)†	Rated Power (W) at 70°C
FLA	0±5 (X) 0±2.5 (Y)	10 to 30	±0.5 (D) ±1.0 (F)	0.125
		30 to 100	±0.1 (B) ±0.5 (D)	
		100 to 100k	±0.05 (A) ±0.1 (B)	
FLB	0±5 (X) 0±2.5 (Y)	10 to 30	±0.5 (D) ±1.0 (F)	0.25
		30 to 100	±0.1 (B) ±0.5 (D)	
		100 to 150k	±0.05 (A) ±0.1 (B)	
FLC	0±5 (X) 0±2.5 (Y)	10 to 30	±0.5 (D) ±1.0 (F)	0.25
		30 to 100	±0.1 (B) ±0.5 (D)	
		100 to 200k	±0.05 (A) ±0.1 (B)	

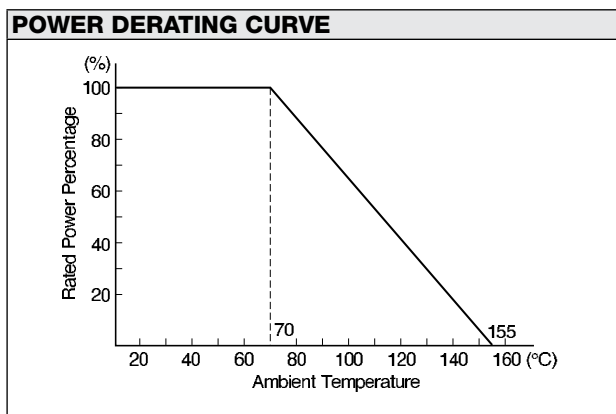
* Symbols parenthesized are for type number composition.
 † Resistance figures are the values obtained by measuring at the point 2.5±1.0 mm below the shoulder of leads.

COMPOSITION OF TYPE NUMBER

Example:
FLA X 500R00 B

└─ Type
└─ TCR
└─ Resistance Value
└─ Tolerance

Resistance value, in ohm, is expressed by a series of six characters, five of which represent significant digits. R or K is a dual-purpose letter that designates both the value range (R for ohmic; K for kilo-ohm) and the location of decimal point.

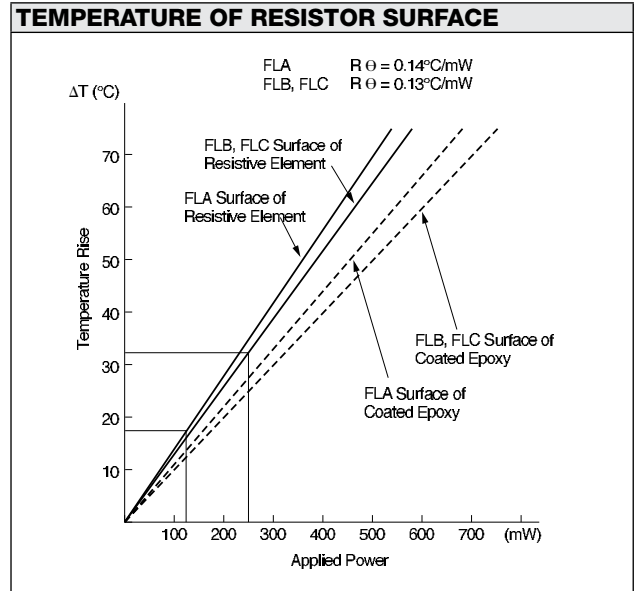
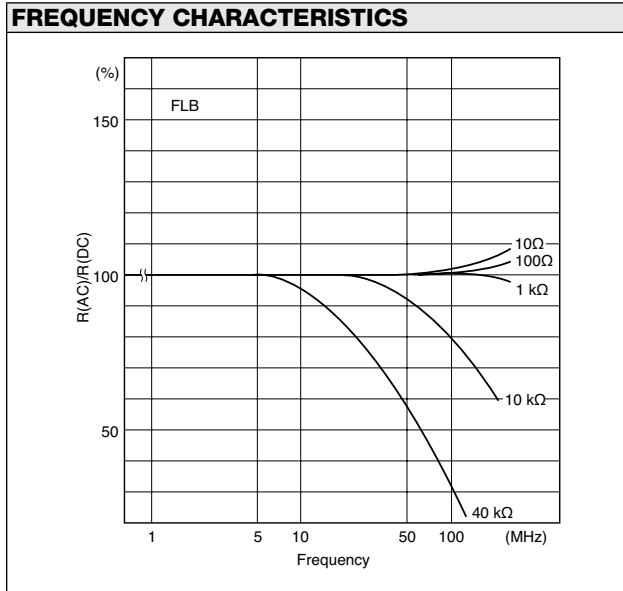


CONFIGURATION (DIMENSIONS IN mm)

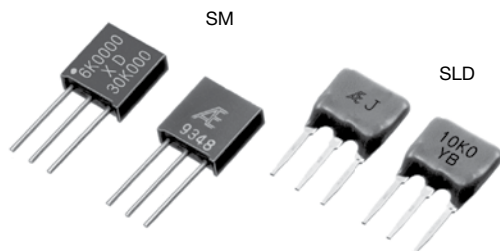
Type	FLA	FLB	FLC
L	5.6±0.5		7.5±0.5
W	6.2±0.5	8.2±0.5	6.2±0.5
T	2.2±0.5		
F	2.54±0.25		5.08±0.25
l	5±1		
t	0.3±0.05		
a	1.0±0.05		
b	0.65±0.05		
c	0.4±0.05		

Precision Resistor (Conformally Coated)

PERFORMANCE			
Parameters	Test Condition	ALPHA Specification	ALPHA Typical Test Data
Maximum Rated Operating Temperature Working Temperature Range Maximum Working Voltage			70°C -25°C to +155°C FLA=250V, FLB, FLC=300V
Temperature Cycling Overload	-25°C/30 min., Room Temperature/5 min., +155°C/30 min., 5 cycles Rated Voltage x 2.5, 5 sec.	±0.05% ±0.05%	±0.01% ±0.0025%
Solderability Resistance to Solvents	235°C, 2 sec. ① Isopropyl Alcohol ② Trichloroethylene	over 75% coverage no damage	over 75% coverage no damage
Low Temperature Storage Terminal Strength	-25°C, No Load, 2 hrs. 0.908 kg (2 pounds), 10 sec.	±0.05% ±0.05%	±0.0025% ±0.0025%
Dielectric Withstanding Voltage Insulation Resistance Resistance to Soldering Heat Moisture Resistance	Atmo. Pres.: AC 300V, 1 min. DC 100V, 1 min. 350°C, 3 sec. +65°C to -10°C, 90% RH to 98% RH, Rated Voltage, 10 cycles (240 hrs.)	±0.03% over 10,000 MΩ ±0.03% ±0.1%	±0.0025% over 10,000 MΩ ±0.0025% ±0.015%
Shock Vibration	50G, 11 ms, Half-Sine Wave, X, Y, Z, each 3 shocks 20G, 10 Hz to 55 Hz to 10 Hz, 1 min., X, Y, Z, each 2 hrs.	±0.03% ±0.03%	±0.005% ±0.005%
Life (Rated Load)	70°C, Rated Power, 1.5 hr. – ON, 0.5 hr. – OFF, 1,000 hrs.	±0.1%	±0.01%
Life (Moisture Load)	40°C, 90% RH to 95% RH, Rated Power, 1.5 hr. – ON, 0.5 hr. – OFF, 1,000 hrs.	±0.05%	±0.01%
Storage Life	15°C to 35°C, 15% RH to 75% RH, No Load, 10,000 hrs.	±0.02%	±0.005%
High Temperature Exposure	155°C, No Load, 1,000 hrs.	±0.05%	±0.01%
Current Noise Pressure Cooker Test	121°C, 100% RH, 2 atmospheric, No Load, 100 hrs.	-25 dB ±0.5%	-42 dB ±0.1%



Ultra Precision Resistor 1-2-3 Network



DSCC Specification 87026

TCR, RESISTANCE RANGE, TOLERANCE, RATED POWER

Type	TCR (ppm/°C) -55°C to +125°C		Resistance Range/ Element (Ω)**	Resistance Tolerance (%)		Rated Power/ Package (W) at 125°C
	Absolute*	Tracking		Absolute*	Matching*	
SM	0±5 (X) 0±2.5 (Y)	See Table 1	50 to 30k	±0.02 (Q) ±0.05 (A) ±0.1 (B)	±0.01 (T) ±0.02 (Q) ±0.05 (A) ±0.1 (B)	0.3
SLD	0±5 (X) 0±2.5 (Y)	See Table 1	50 to 100	±0.1 (B) ±0.5 (D)	±0.05 (A) ±0.1 (B)	0.25 at 70°C
			100 to 30k	±0.05 (A) ±0.1 (B)	±0.02 (Q) ±0.05 (A) ±0.1 (B)	

* Symbols parenthesized are for type number composition.

** -25°C to +125°C for SLD type.

*** Please contact us for the availability.

COMPOSITION OF TYPE NUMBER

Example: R₁=R₂

SM 1X 10K00 B A

① ② ③ ④ ⑤ ⑥

Example: R₁≠R₂

SLD 2X 1K000 / 10K00 B Q

① ② ③ ④ ⑤ ⑥

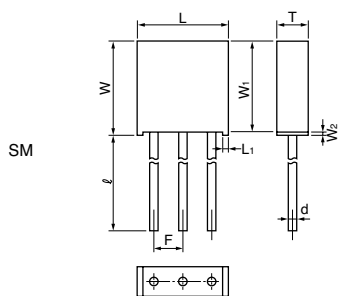
- ① Type
- ② Number of Values
- ③ TCR Absolute
- ④ Nominal Resistance Values
- ⑤ Resistance Tolerance (Absolute)
- ⑥ Resistance Tolerance (Matching)

Resistance value, in ohm, is expressed by a series of five characters, four of which represent significant digits. The fifth R or K is a dual-purpose letter that designates both the value range (R for ohmic; K for kilo-ohm) and the location of decimal point.

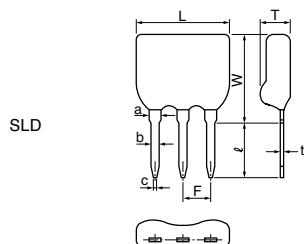
TABLE 1. TCR TRACKING IS SUBJECT TO RESISTANCE RATIO

Resistance Ratio	TCR Tracking (ppm/°C)
Resistance Ratio = 1	±0.5
1 < Resistance Ratio ≤ 10	±1
10 < Resistance Ratio ≤ 100	±2
100 < Resistance Ratio	±3

CONFIGURATION (DIMENSIONS IN mm)

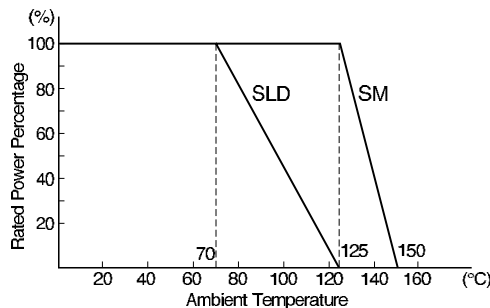


Type	SM
L	7.7±0.2
L ₁	1.0 max.
W	8.1±0.2
W ₁	7.8±0.2
W ₂	0.3 max.
T	2.6±0.2
F	2.54±0.25
l	10±3
d	φ0.65±0.05

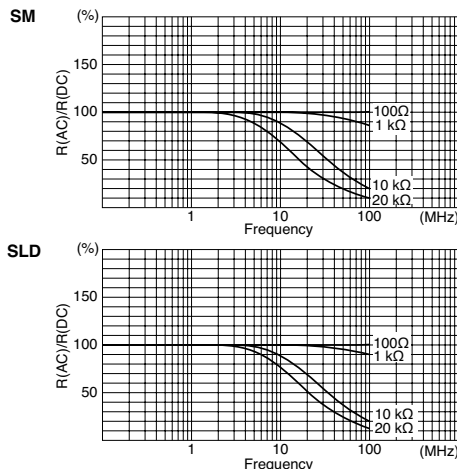


Type	SLD
L	7.5±0.5
W	7.5±0.5
T	2.2±0.5
F	2.54±0.25
l	5±1
t	0.3±0.05
a	1.0±0.05
b	0.65±0.05
c	0.4±0.05

POWER DERATING CURVE



FREQUENCY CHARACTERISTICS



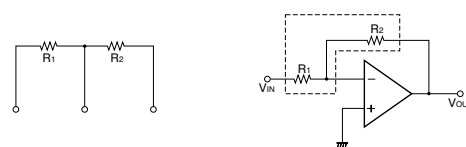
Ultra Precision Resistor 1-2-3 Network

PERFORMANCE – SM					
Parameters	Test Condition	ALPHA Specification		ALPHA Typical Test Data	
		ΔR	$\Delta Ratio$	ΔR	$\Delta Ratio$
Maximum Rated Operating Temperature Working Temperature Range		125°C -65°C to +150°C			
Thermal Shock Overload	-65°C/30 min. ↔ +150°C/30 min., 5 cycles Rated Voltage x 2.5, 5 sec.	±0.02%	±0.01%	±0.005%	±0.0025%
Solderability	245°C, 5 sec.	over 95% coverage		over 95% coverage	
Resistance to Solvents	① Isopropyl Alcohol + Mineral Spirits ② Water + Butyl Cellosolve + Monoethanolamine	no damage		no damage	
Low Temperature Storage and Operation Terminal Strength	-65°C, No Load, 24 hrs. → Rated Voltage, 45 min. 0.908 kg (2 pounds), 10 sec.	±0.05%	±0.02%	±0.0025%	±0.001%
Dielectric Withstanding Voltage Insulation Resistance Resistance to Soldering Heat Moisture Resistance	Atmo. Pres.: AC 300V, 1 min. Baro. Pres. 8 mHg; AC 200V, 1min. DC 500V, 2 min.	±0.02%	±0.01%	±0.0025%	±0.001%
	350°C, 3 sec.	over 10,000 M Ω		over 10,000 M Ω	
	+65°C to -10°C, 90% RH to 98% RH, Rated Voltage, 10 cycles (240 hrs.)	±0.05%	±0.02%	±0.02%	±0.01%
Shock Vibration, High Frequency	100G, 6 ms, Sawtooth Wave, X, Y, Z, each 10 shocks 20G, 10 Hz to 2,000 Hz to 10 Hz, 20 min., X, Y, Z, each 2.5 hrs.	±0.01%	±0.005%	±0.0025%	±0.001%
Life	125°C, Rated Power, 1.5 hr. – ON, 0.5 hr. – OFF, 2,000 hrs.	±0.05%	±0.02%	±0.015%	±0.005%
Storage Life	15°C to 35°C, 15% RH to 75% RH, No Load, 10,000 hrs.	±0.005%	±0.0025%	±0.0025%	±0.0015%
High Temperature Exposure	150°C, No Load, 2,000 hrs.	±0.05%	±0.02%	±0.015%	±0.005%
Current Noise Voltage Coefficient Thermal EMF		-32 dB 0.0005%/V 1.0 $\mu V/^{\circ}C$		-42 dB 0.00003%/V 1.0 $\mu V/^{\circ}C$	

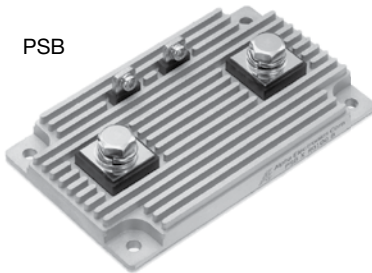
PERFORMANCE – SLD					
Parameters	Test Condition	ALPHA Specification		ALPHA Typical Test Data	
		ΔR	$\Delta Ratio$	ΔR	$\Delta Ratio$
Maximum Rated Operating Temperature Working Temperature Range		70°C -25°C to +125°C			
Thermal Cycling Overload	-25°C/30 min., Room Temperature/5 min., 125°C/30 min., 5 cycles Rated Voltage x 2.5, 5 sec.	±0.05%	±0.01%	±0.01%	±0.005%
Solderability Resistance to Solvents	235°C, 2 sec. Isopropyl Alcohol	over 75% coverage no damage		over 75% coverage no damage	
Low Temperature Operation Terminal Strength	-25°C, No Load, 2 hrs. 0.908 kg (2 pounds), 10 sec.	±0.05%	±0.01%	±0.0025%	±0.001%
Dielectric Withstanding Voltage Insulation Resistance Resistance to Soldering Heat Moisture Resistance	Atmo. Pres.: AC 300V, 1 min. DC 100V, 1 min.	±0.03%	±0.01%	±0.0025%	±0.001%
	350°C, 3 sec.	over 10,000 M Ω		over 10,000 M Ω	
	+65°C to -10°C, 90% RH to 98% RH, Rated Voltage, 10 cycles (240 hrs.)	±0.1%	±0.05%	±0.03%	±0.01%
Shock Vibration	50G, 11 ms, Half-Sine Wave, X, Y, Z, each 3 shocks 20G, 10 Hz to 55 Hz to 10 Hz, 1 min., X, Y, Z, each 2 hrs.	±0.03%	±0.01%	±0.005%	±0.001%
Life (Rated Load)	70°C, Rated Power, 1.5 hr. – ON, 0.5 hr. – OFF, 1,000 hrs.	±0.1%	±0.05%	±0.01%	±0.005%
Life (Moisture Load)	40°C 90% RH to 95% RH, Rated Power 1.5 hrs – ON, 0.5 hr. – OFF, 1,000 hrs.	±0.05%	±0.01%	±0.01%	±0.005%
Storage Life	15°C to 35°C, 15% RH to 75% RH, No Load, 10,000 hrs	±0.02%	±0.01%	±0.005%	±0.0025%
High Temperature Exposure	125°C, No Load, 1,000 hrs.	±0.05%	±0.01%	±0.01%	±0.005%

EXAMPLE OF APPLICATION

An application of type SM/SLD (input/feedback resistors for amplifiers) Because the input and the feedback resistors are incorporated into one single element, amplification is not affected by temperature range.



Ultra Precision Shunt Resistor (40 Watts)

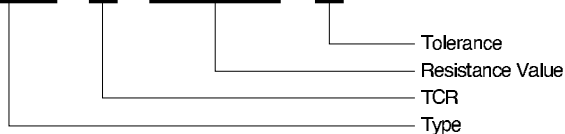


PSB

COMPOSITION OF TYPE NUMBER

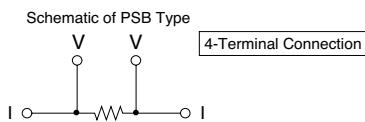
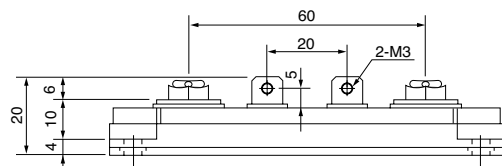
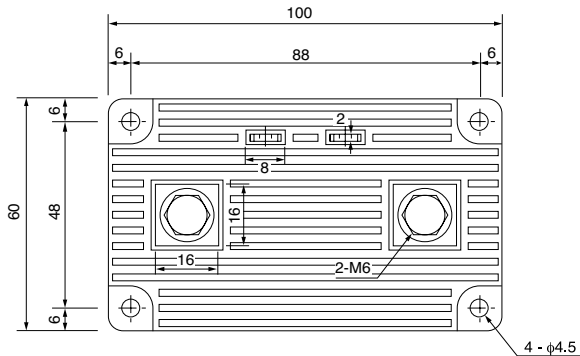
Example:

PSB X R0100 B



Resistance value in ohm is expressed by a series of four significant digits and an R designating the decimal point.

CONFIGURATION (DIMENSIONS IN mm)



Weight = 170g

FEATURES

- Excellent temperature characteristics created by Bulk Metal® foil technology
- Accurate value on four-terminal wiring, even in low extremity of resistance
- High heat dissipation due to aluminum-clad construction with fins
- Readiness to mount to heat sink or water-cooled radiator
- Availability of threaded holes to fix cables with screw

APPLICATIONS

- Current-sensing in precise power supply, motor driver, etc.

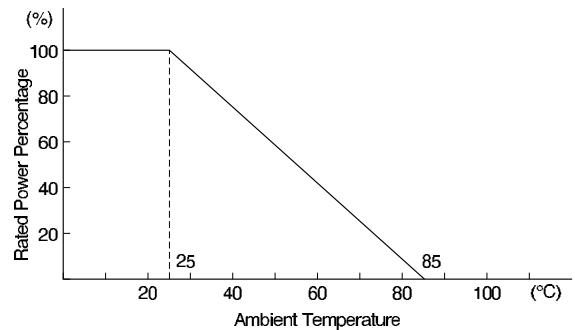
TCR, RESISTANCE RANGE, TOLERANCE, RATED POWER

TCR (ppm/°C) 0°C to +60°C	Resistance Range (Ω)	Resistance Tolerance (%)	Rated Power (W) at 25°C
0±15 (W)	0.001 to 0.005	±0.1 (B) ±0.5 (D) ±1 (F)	12 in free air and 40 On heat sink*
0±5 (X) 0±15 (W)	0.005 to 1		

*Thermal resistance of the heat sink 1°C/W.

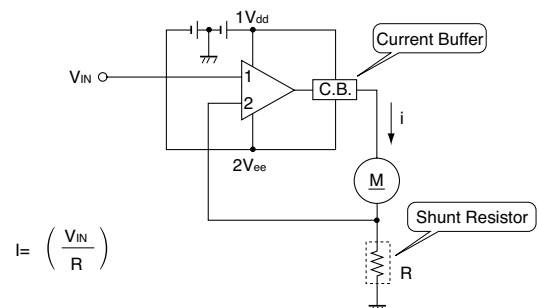
Available to use higher rated power with elevation of cooling effect. Please keep temperature of element surface less than 60°C.

POWER DERATING CURVE



EXAMPLE OF APPLICATIONS

Motor Control Circuit Using Shunt Resistor

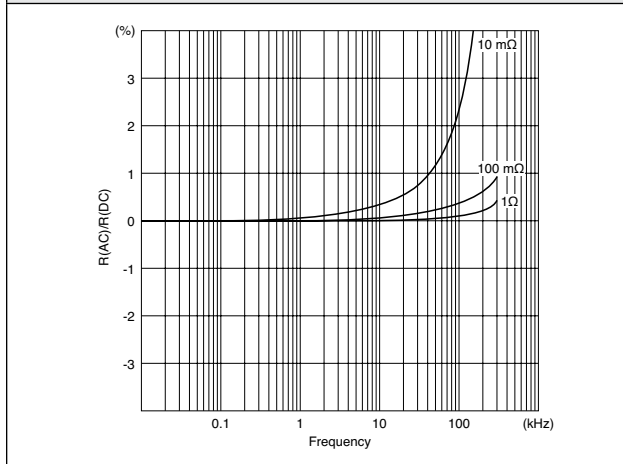


$$I = \left(\frac{V_{IN}}{R} \right)$$

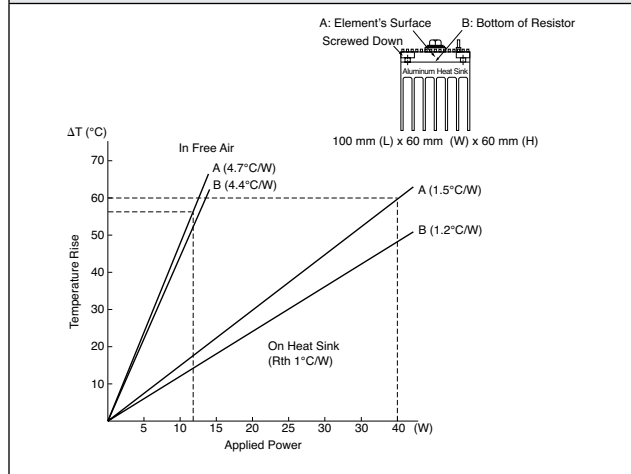
Ultra Precision Shunt Resistor (40 Watts)

PERFORMANCE			
Parameters	Test Condition	ALPHA Specification	ALPHA Typical Test Data
Maximum Rated Operating Temperature Working Temperature Range Maximum Working Current			25°C -55°C to +85°C 100A
Power Conditioning	25°C, Rated Power, 96 hrs.	±0.1%	±0.05%
Low Temperature Storage and Operation	-55°C, No Load, 24 hrs.	±0.1%	±0.05%
Dielectric Withstanding Voltage Insulation Resistance Low Temperature Operation Overload	Atmo. Pres.: AC 750V, 1 min. DC 500V, 2 min. -55°C, Rated Power Rated Power x 2.5, 5 sec.	±0.05% over 10,000 MΩ ±0.1% ±0.1%	±0.01% over 10,000 MΩ ±0.05% ±0.05%
Moisture Resistance	+65°C to -10°C, 90% RH to 98% RH, Rated Voltage, 10 cycles (240 hrs.)	±0.1%	±0.05%
Shock High Frequency Shock	30G, 11 ms., Half-Sine Wave, X, Y, Z, 10 shocks each 10 Hz to 50 Hz to 10 Hz, 1 min. X, Y, Z, 2.0 hrs. each	±0.05% ±0.05%	±0.1% ±0.1%
Life	25°C, Rated Power, 1.5 hrs. – ON, 0.5 hrs. – OFF, 2,000 hrs.	±0.2%	±0.05%
High Temperature Exposure	85°C, No Load, 2,000 hrs.	±0.2%	±0.05%
Storage Life	15°C to 35°C, 15% RH to 75% RH, No Load, 10,000 hrs.	±0.05%	±0.01%
Internal Thermal Resistance	Between resistive element and base plate		0.3°C/W
Thermal Electromotive Force			1 µV/°C

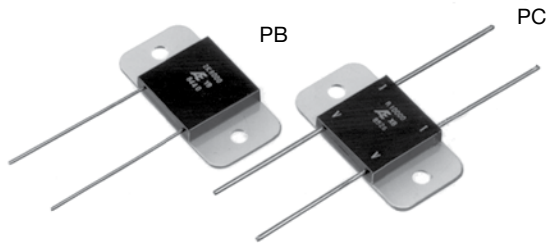
FREQUENCY CHARACTERISTICS



TEMPERATURE OF RESISTOR SURFACE



Ultra Precision Power Resistor (10 Watts)



COMPOSITION OF TYPE NUMBER

Example:
PB X 50R000 B

Tolerance
Resistance Value
TCR
Type

Resistance value, in ohm, is expressed by a series of six characters, five of which represent significant digits. R or K is a dual-purpose letter that designates both the value range (R for ohmic; K for kilo-ohm) and the location of decimal point.

TCR, RESISTANCE RANGE, TOLERANCE, RATED POWER				
Type	TCR (ppm/°C) -25°C to 125°C*	Resistance Range (Ω)	Resistance Tolerance (%)†‡	Rated Power (W) at 25°C
PB	0±15 (W)	0.4 to 1	1 to ±5 (F, G, J)	2 in free air and 10 On heat sink **
	0±15 (W) 0±5 (X) 0±2.5 (Y)	1 to 5	±0.5 to ±5 (D, F, G, J)	
		5 to 10	±0.1 to ±5 (B, D, F, G, J)	
		10 to 25	±0.05 to ±5 (A, B, D, F, G, J)	
		25 to 50	±0.02 to ±5 (Q, A, B, D, F, G, J)	
	50 to 50k	±0.01 to ±5 (T, Q, A, B, D, F, G, J)		
PC	0±15 (W)	0.002 to 0.05	±0.5 to ±5 (D, F, G, J)	
	0±15 (W) 0±5 (X)	0.05 to 0.1	±0.5 to ±5 (D, F, G, J)	
	0±15 (W) 0±5 (X) 0±2.5 (Y)	0.1 to 5	±0.1 to ±5 (B, D, F, G, J)	
		5 to 10	±0.05 to ±5 (A, B, D, F, G, J)	
		10 to 25	±0.02 to ±5 (Q, A, B, D, F, G, J)	
	25 to 100	±0.01 to ±5 (T, Q, A, B, D, F, G, J)		

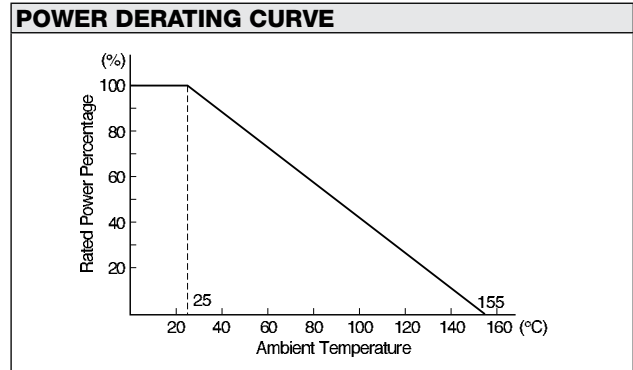
* Symbols in parentheses are for type number composition.

† Resistance figures for type PB are the values obtained by measuring the leads at point 12.7±3.2 mm away from the root, but in case of resistance below 10 ohm, the values at 5.08±0.6 mm away.

** For heat sinking, an aluminum chassis in 152.4 (L) x 101.6 (W) x 50.8 (H) x 1.0 mm (T) shall be used.

CONFIGURATION (DIMENSIONS IN mm)

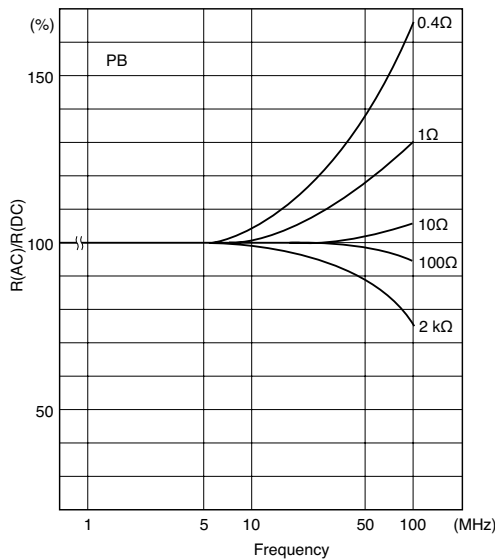
Type	PB	PC
L	40.0±0.2	
L1	20.0±0.2	
L2	30.0±0.5	
W	20.0±0.2	
T	5.0±0.2	
T1	1.0±0.1	
F	15.0±0.5	
ℓ	30±10	
D	Dia. 4.0	
d	Dia. 0.8±0.05	Dia. 1.2±0.05



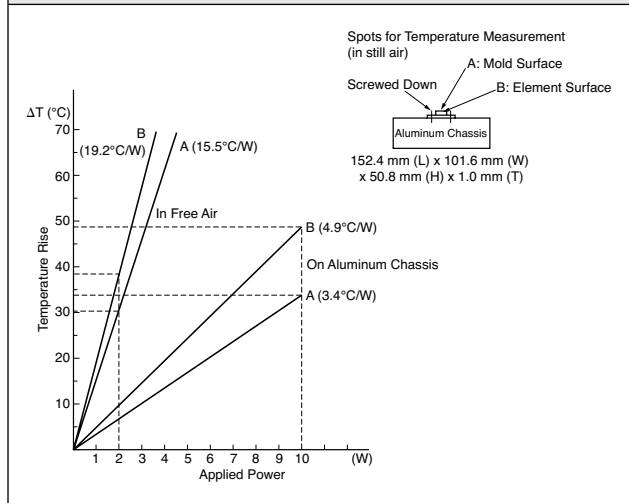
Ultra Precision Power Resistor (10 Watts)

PERFORMANCE			
Parameters	Test Condition	MIL-R-39009 Specification	ALPHA Typical Test Data
Maximum Rated Operating Temperature Working Temperature Range Maximum Working Voltage Maximum Working Current		25°C -55°C to +155°C 750V PB=5A, PC=32A	
Power Conditioning	25°C, Rated Voltage, 96 hrs.	±0.2%	±0.2%
Low Temperature Storage Dielectric Withstanding Voltage Insulation Resistance Low Temperature Operation Overload Moisture Resistance Terminal Strength	-55°C, No Load, 24 hrs. Atmo. Pres.: AC 1 KV, 1 min. Baro. Pres. 8 mHg: AC 500V, 1min. DC 500V, 2 min. -55°C, Rated Voltage Rated Voltage x 2.5, 5 sec. +65°C to -10°C, 90% RH to 98% RH, Rated Voltage, 10 cycles (240 hrs.) 2.27 kg (5 pounds), 10 sec.	±0.3% ±0.2% over 10,000 MΩ ±0.3% ±0.3% ±0.5% ±0.2%	±0.005% ±0.005% over 10,000 MΩ ±0.005% ±0.01% ±0.05% ±0.005%
Shock Vibration, High Frequency	100G, 6 ms., Sawtooth Wave, X, Y, Z, each 3 shocks 20G, 10 Hz to 2,000 Hz to 10 Hz, 20 min., X, Y, Z, each 4 hrs.	±0.2% ±0.2%	±0.005% ±0.005%
Life	25°C, Rated Power, 1.5 hr. - ON, 0.5 hr. - OFF, 2,000 hrs.	±1.0%	±0.01%
High Temperature Exposure	155°C, No Load, 2,000 hrs.	±1.0%	±0.01%
Solderability	245°C, 5 sec.	over 95% coverage	

FREQUENCY CHARACTERISTICS

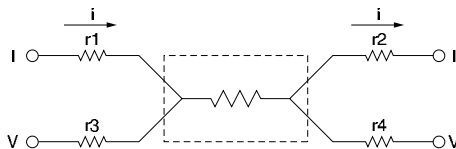


TEMPERATURE OF RESISTOR SURFACE

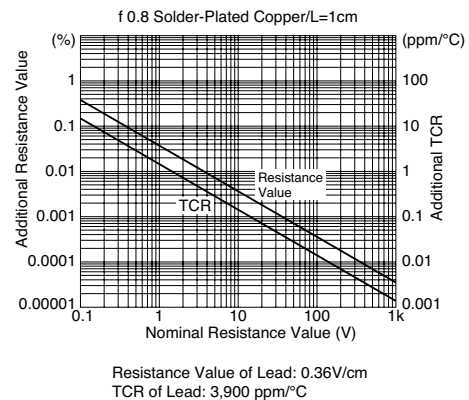


FOUR-TERMINAL RESISTOR

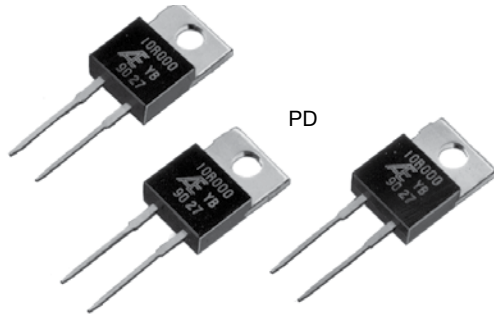
For low ohmic resistor (less than 10 ohm), the resistance value and TCR of the copper lead increases overall resistance value. Four-terminal (Kelvin) connection is recommended per the following figure. Loading current at terminals (V) causes measurement error.



AFFECT OF PB TYPE LEAD FOR RESISTANCE VALUE AND TCR



Ultra Precision Power Resistor (8 Watts, TO-220)



TCR, RESISTANCE RANGE, TOLERANCE, RATED POWER

Type	TCR (ppm/°C) -25°C to +125°C*	Resistance Range (Ω)	Resistance Tolerance (%)†	Rated Power (W) at 25°C
PD	0±15 (W)	0.1 to 1	±1 to ±5 (F, G, J)	1.5 In free air
		1 to 5	±0.5 to ±5 (D, F, G, J)	
	0±5 (X) 0±2.5 (Y)	5 to 10	±0.1 to ±5 (B, D, F, G, J)	8 On heat sink**
		10 to 25	±0.05 to ±5 (A, B, D, F, G, J)	
		25 to 10k	±0.02 to ±5 (Q, A, B, D, F, G, J)	

* Symbols in parentheses are for type number composition.

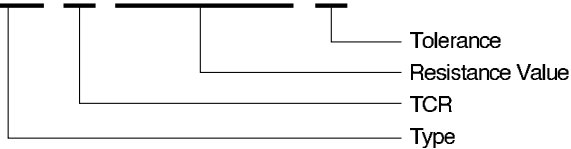
† Resistance figures are the values obtained by measuring the leads at point 5.08±0.6 mm away from the root.

** For heat sinking, an aluminum chassis in 152.4 (L) x 101.6 (W) x 50.8 (H) x 1.0 mm (T) should be used.

COMPOSITION OF TYPE NUMBER

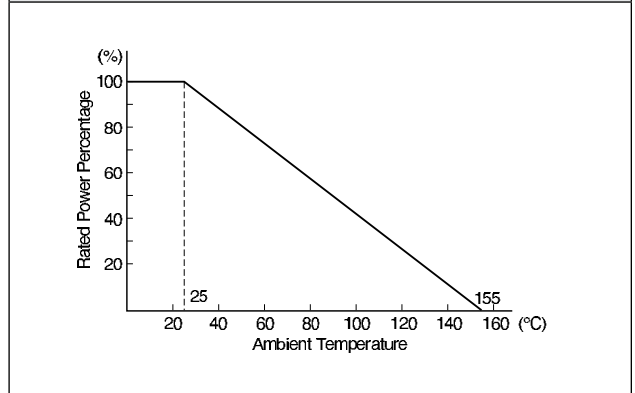
Example:

PD X 50R000 B

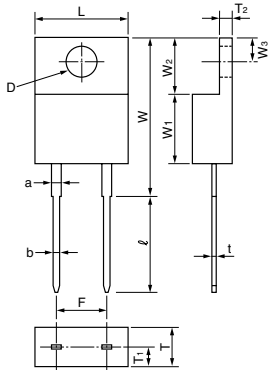


Resistance value, in ohm, is expressed by a series of six characters, five of which represent significant digits. R or K is a dual-purpose letter that designates both the value range (R for ohmic; K for kilo-ohm) and the location of decimal point.

POWER DERATING CURVE



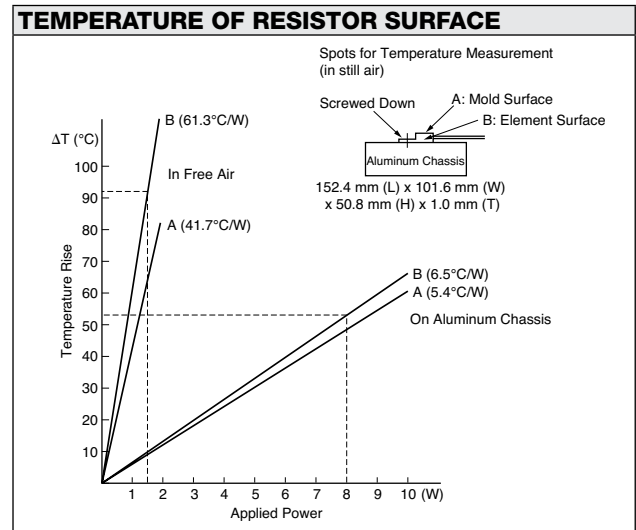
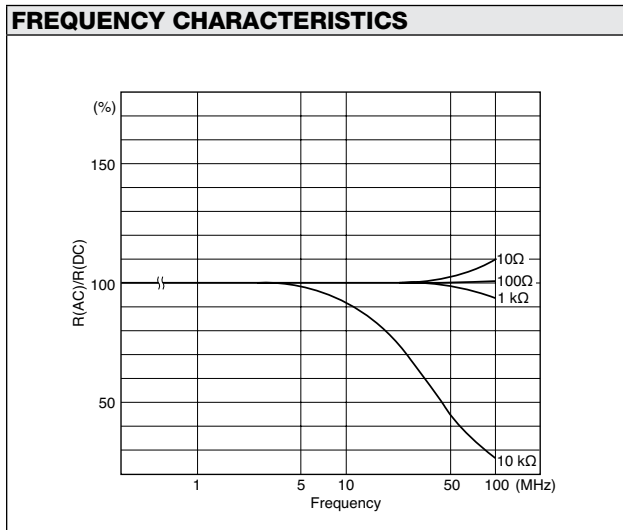
CONFIGURATION (DIMENSIONS IN mm)



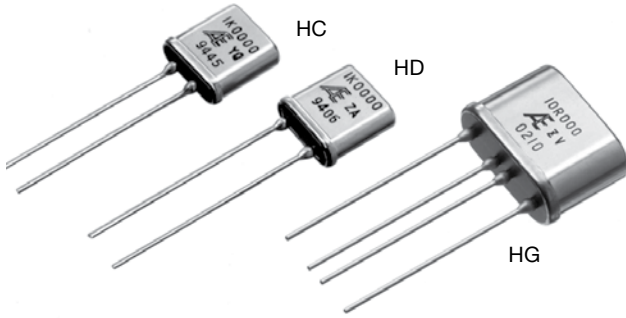
Type	PD
L	10.6 max.
W	19.0±0.5
W ₁	8.5±0.2
W ₂	6.5±0.2
W ₃	2.7±0.5
T	4.5±0.2
T ₁	2.0±0.5
T ₂	1.5±0.2
F	5.08±0.5
ℓ	11.0±2
t	0.5±0.05
a	1.2±0.1
b	0.75±0.05
D	Dia. 3.6

Ultra Precision Power Resistor (8 Watts, TO-220)

PERFORMANCE			
Parameters	Test Condition	MIL-R-39009 Specification	ALPHA Typical Test Data
Maximum Rated Operating Temperature Working Temperature Range Maximum Working Voltage Maximum Working Current			25°C -55°C to +155°C 250V 4A
Power Conditioning	25°C, Rated Voltage, 96 hrs.	±0.2%	±0.02%
Low Temperature Storage Dielectric Withstanding Voltage Insulation Resistance Low Temperature Operation Overload	-55°C, No Load, 24 hrs. Atmo. Pres.: AC 1 kV, 1 min. Baro. Pres. 8 mHg: AC 500V, 1min. DC 500V, 2 min. -55°C, Rated Voltage Rated Voltage x 2.5, 5 sec.	±0.3% ±0.2% over 10,000 MΩ ±0.3%	±0.005% ±0.005% over 10,000 MΩ ±0.005%
Moisture Resistance Terminal Strength	+65°C to -10°C, 90% RH to 98% RH, Rated Voltage, 10 cycles (240 hrs.) 0.908 kg (2 pounds), 10 sec.	±0.3% ±0.5% ±0.2%	±0.01% ±0.05% ±0.005%
Shock Vibration, High Frequency	100G, 6 ms, Sawtooth Wave, X, Y, Z, each 3 shocks 20G, 10 Hz to 2,000 Hz to 10 Hz, 20min., X, Y, Z, each 4 hrs.	±0.02% ±0.02%	±0.005% ±0.005%
Life	25°C, Rated Power, 1.5 hr. – ON, 0.5 hr. – OFF, 2,000 hrs.	±1.0%	±0.01%
High Temperature Exposure	155°C, No Load, 2,000 hrs.	±1.0%	±0.01%
Solderability	245°C, 5 sec.	over 95% coverage	



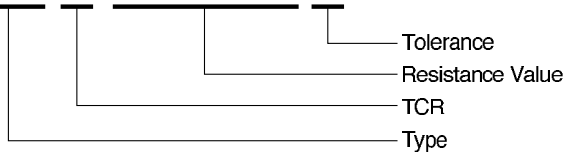
Ultra Precision Resistor (Hermetically Sealed)



COMPOSITION OF TYPE NUMBER

Example:

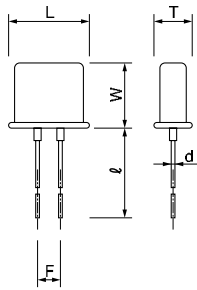
HC Y 30K000 T



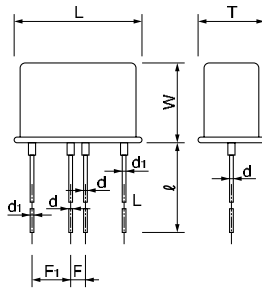
Resistance value, in ohm, is expressed by a series of six characters, five of which represent significant digits. The sixth R or K is a dual-purpose letter that designates both the value range (R for ohmic; K for kilo-ohm) and the location of decimal point.

CONFIGURATION (DIMENSIONS IN mm)

HC, HD Type



HG Type



Type	HC	HD	HG
L	10.7±0.3		19.0±0.3
W	10.7±0.3		12.8±0.3
T	4.3±0.3		8.8±0.3
F	3.81±0.25	5.08±0.25	2.54±0.25
F1			5.08±0.25
l	30±10		
d	Dia. 0.65±0.05		
d1	Dia. 0.8±0.05		

TCR, RESISTANCE RANGE, TOLERANCE, RATED POWER

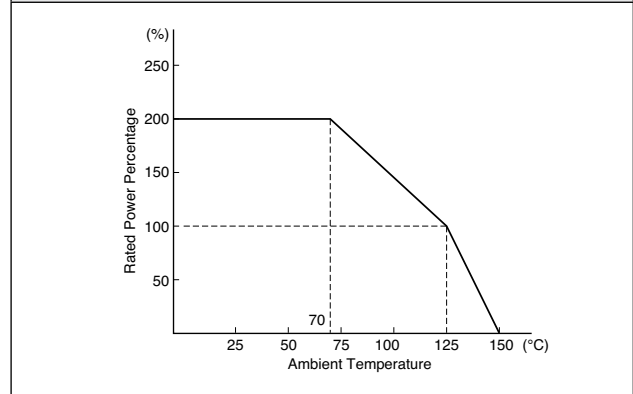
Type	TCR (ppm/°C) -55°C to +125°C*	Resistance Range (Ω)	Resistance Tolerance (%)†‡	Rated Power (W) at 125°C
HC HD	0±15 (W)	1 to 5	±0.5 (D) ±1 (F)	0.3
	0±5 (X)	5 to 30	±0.1 (B) ±0.5 (D) ±1 (F)	
	0±5 (X) 0±2.5 (Y) 0±1 (Z)**	30 to 120k	±0.005 (V) ±0.01 (T) ±0.02 (Q) ±0.05 (A) ±0.1 (B) ±0.5 (D) ±1 (F)	
HG	0±2.5 (Y) 0±1 (Z)**	1 to 10	±0.01 (T) ±0.02 (Q) ±0.05 (A) ±0.1 (B) ±0.5 (D) ±1 (F)	0.3
		10 to 10k	±0.005 (V) ±0.01 (T) ±0.02 (Q) ±0.05 (A) ±0.1 (B) ±0.5 (D) ±1 (F)	

* Symbols in parentheses are for type number composition.

† Resistance figures are obtained by measuring the leads at point 12.7±3.2 mm away from the base for type HC and HD, but, in case of resistance below 10 ohm, the value at 1.6±0.6 mm away from the base for all types.

**Temperature characteristic Z is applicable for temperature range between 0°C and 60°C.

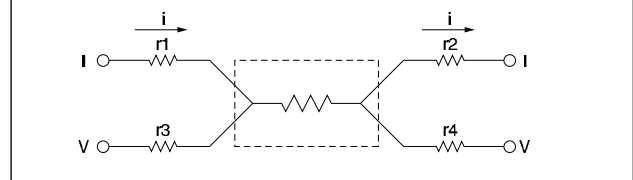
POWER DERATING CURVE



FOUR-TERMINAL (KELVIN) CONNECTION

For low ohmic resistor (less than 10 ohm), the resistance value and TCR of the copper lead increases overall resistance value. Four-terminal (Kelvin) connection is recommended per the following figure. Loading current at voltage and current terminals (V, I) causes measurement error.

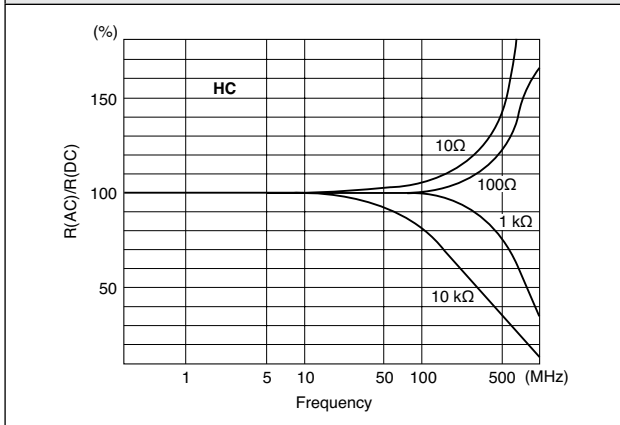
Four-Terminal Resistor



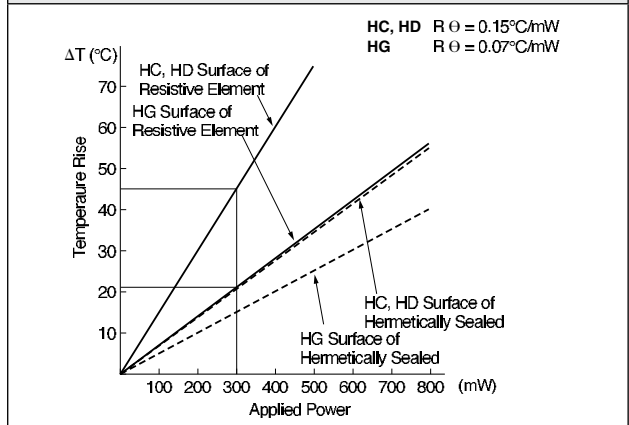
Ultra Precision Resistor (Hermetically Sealed)

PERFORMANCE			
Parameters	Test Condition	MIL-PRF-55182/9 Specification	ALPHA Typical Test Data
Maximum Rated Operating Temperature Working Temperature Range Maximum Working Voltage		125°C -65°C to +150°C 300V	
Power Conditioning Thermal Shock Overload	125°C, Rated Power, 100 hrs. -65°C/30 min. ↔ +150°C/30 min., 5 cycles Rated Voltage x 6.25, 5 sec.	±(0.20% +0.01%) ±0.05% ±0.05%	±0.0025% ±0.0025% ±0.0025%
Solderability	Steam Aging 8 hrs., 245°C, 5 sec.	over 95% coverage	
Resistance to Solvents	① Isopropyl Alcohol + Mineral Spirits ② Water + Butyl Cellosolve + Monoethanolamine	no damage	
Low Temperature Storage Low Temperature Operation Terminal Strength	-65°C, 24 hrs. -65°C Rated Voltage, 45 min. 0.908 kg (2 pounds), 10 sec.	±0.05% ±0.05% ±0.02%	±0.0025% ±0.0025% ±0.001%
Dielectric Withstanding Voltage Insulation Resistance Resistance to Soldering Heat Moisture Resistance	Atom. Pres.: 300V rms. Baro. Pres. 8 mHg: 200V rms. DC 100V, 2 min. 260°C, 10 sec. ±2 sec. +65°C to -10°C, 90% RH to 98% RH, Rated Voltage, 10 cycles (240 hrs.)	±0.02% over 10,000 MΩ ±0.02% ±0.05%	±0.0025% over 10,000 MΩ ±0.0025% ±0.0025%
Shock (Specified Pulse) Vibration, High Frequency	100G, 6 ms, Sawtooth Wave, X, Y, Z, each 10 shocks 20G, 10 Hz to 2,000 Hz to 10 Hz, 20 min., X, Y, each 4 hrs.	±0.01% ±0.02%	±0.0025% ±0.0025%
Life	125°C, Rated Power, 1.5 hr. – ON, 0.5 hr. – OFF, 2,000 hrs.	±0.05%	±0.01%
70°C Power Rating	70°C, Rated Voltage x 2, 1.5 hrs. – ON, 0.5 hr. – OFF, 2,000 hrs.	±0.05%	±0.01%
Storage Life	15°C to 35°C, 15% RH to 75% RH, No Load, 10,000 hrs.	±0.005%	±0.0005%
High Temperature Exposure	175°C, No Load, 2,000 hrs.	±0.5%	±0.01%
Current Noise		-32 dB	-42 dB
Voltage Coefficient		0.0001%/V	0.00003%/V
Thermal EMF		1.0 μV/°C	0.1 μV/°C

FREQUENCY CHARACTERISTICS



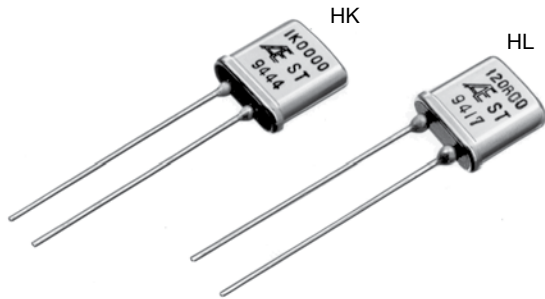
TEMPERATURE OF RESISTOR SURFACE



PRECAUTION IN USING HC, HD OR HG RESISTORS

When soldering to mount HC, HD or HG on a board, keep the resistor over 10 mm away from the board surface by using an insulating tube.

Zero-TCR Ultra Precision Resistor (Hermetically Sealed)



TCR, RESISTANCE RANGE, TOLERANCE, RATED POWER

Type	TCR	Resistance Range (Ω)	Resistance Tolerance (%) ^{*†}	Rated Power (W) at 70°C
HK HL	Char. S	100 to 100k	±0.005 (V) ±0.01 (T) ±0.02 (Q) ±0.05 (A) ±0.1 (B) ±0.5 (D) ±1 (F)	0.3

* Symbols parenthesized are for type number composition.

† Resistance figures are obtained by measuring the leads at point 12.7±3.2 mm away from the root.

COMPOSITION OF TYPE NUMBER

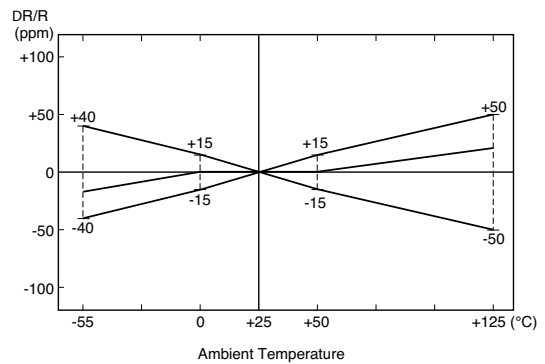
Example:

HK S 10K000 T



Resistance value, in ohm, is expressed by a series of six characters, five of which represent significant digits. R or K is a dual-purpose letter that designates both the value range (R for ohmic; K for kilo-ohm) and the location of decimal point.

TEMPERATURE CHARACTERISTICS OF RESISTANCE

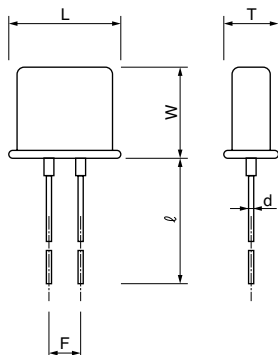


Temperature (°C)	ΔR/R (ppm)
-55	0±40
0	0±15
+50	0±15
+125	0±50

Reference Temperature +25°C

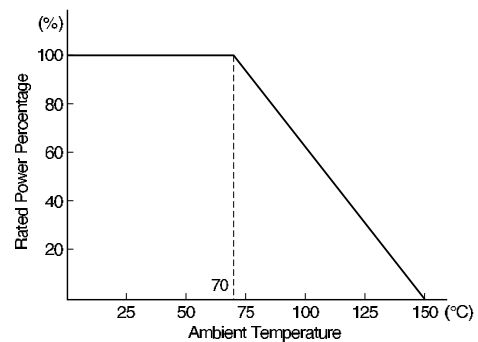
CONFIGURATION (DIMENSIONS IN mm)

HK, HL



Type	HK	HL
L	10.7±0.3	
W	10.7±0.3	
T	4.3±0.3	
F	3.81±0.25	5.08±0.25
l	30±10	
d	φ0.65±0.05	

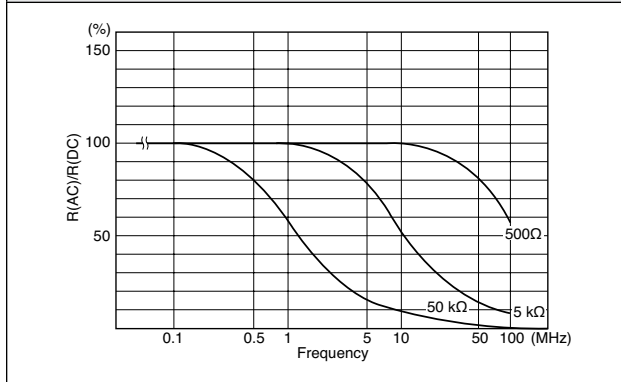
POWER DERATING CURVE



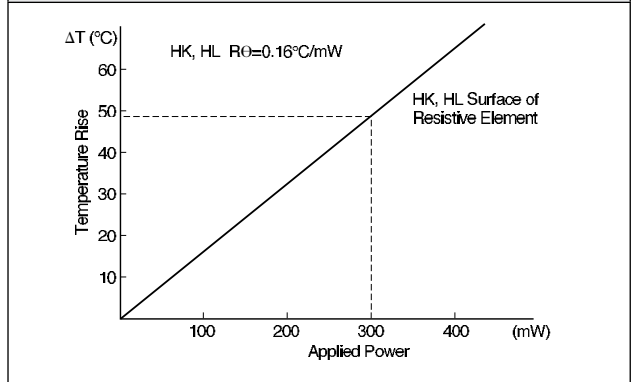
Zero-TCR Ultra Precision Resistor (Hermetically Sealed)

PERFORMANCE			
Parameters	Test Condition	ALPHA Specification	ALPHA Typical Test Data
Maximum Rated Operating Temperature Working Temperature Range Maximum Working Voltage		70°C -65°C to +150°C 300V	
Power Conditioning Thermal Shock Overload	25°C, Rated Voltage, 96 hrs. -65°C/30 min. ↔ +150°C/30 min., 5 cycles Rated Voltage x 2.5, 5 sec.	±0.05%	±0.0025%
Solderability	245°C, 5 sec.	over 95% coverage	over 95% coverage
Resistance to Solvents	① Isopropyl Alcohol + Mineral Spirits ② Water + Butyl Cellosolve + Monoethanolamine	no damage	no damage
Low Temperature Storage Terminal Strength	-65°C, No Load, 24 hrs. → Rated Voltage, 45 min. 0.908 kg (2 pounds), 10 sec.	±0.05% ±0.02%	±0.0025% ±0.001%
Dielectric Withstanding Voltage Insulation Resistance Resistance to Soldering Heat Moisture Resistance	Atmo. Pres.: AC 300V, 1 min. Baro. Pres. 8 mHg: AC200V, 1min. DC 500V, 2 min. 350°C, 3 sec. +65°C to -10°C, 90% RH to 98% RH, Rated Voltage, 10 cycles (240 hrs.)	±0.02% over 10,000 MΩ ±0.05% ±0.05%	±0.0025% over 10,000 MΩ ±0.0025% ±0.0025%
Shock Vibration, High Frequency	100G, 6 ms, Sawtooth Wave, X, Y, Z, each 10 shocks 20G, 10 Hz to 2,000 Hz to 10 Hz, 20 min., X, Y, Z, each 2.5 hrs.	±0.01% ±0.02%	±0.0025% ±0.0025%
Life	70°C, Rated Power, 1.5 hr. – ON, 0.5 hr. – OFF, 2,000 hrs.	±0.05%	±0.01%
Storage Life	15°C to 35°C, 15% RH to 75% RH, No Load, 10,000 hrs.	±0.0025%	±0.0005%
High Temperature Exposure	150°C, No Load, 2,000 hrs.	±0.05%	±0.01%
Current Noise Voltage Coefficient Thermal EMF		-32 dB 0.0005%/V 1.0 μV/°C	-42 dB 0.00003%/V 0.1 μV/°C

FREQUENCY CHARACTERISTICS



TEMPERATURE OF RESISTOR SURFACE



PRECAUTION IN USING HK OR HL RESISTORS

When soldering to mount HK or HL on a board, keep the resistor over 10 mm away from the board surface by using an insulating tube.

Resistor networks from Alpha Electronics, specialists in precision resistors, featuring Bulk Metal® Foil technology, provide excellent performance in TCR tracking, resistance ratio matching and stability.

Characteristics

- Temperature Characteristics of Resistance: 0 ± 5 ppm/°C
- TCR Tracking: ± 1 ppm/°C
- Resistance Ratio Matching: $\pm 0.01\%$
- Resistance Stability: $\pm 0.005\%$ /year

STANDARD CIRCUIT

Circuit A (Array)

Circuit Symbol

Circuit B (Independent)

Circuit Symbol

Circuit C (Divider)

Circuit Symbol

Composition of Circuit Symbol

Example:

0 02 A

Circuit Symbol
Number of Resistance Elements
Generic Number

Circuit E (A Circuit Divided into Two)

Circuit Symbol

Composition of Circuit Symbol

Example:

1 03 E

Circuit Symbol
Number of Resistance Elements
Generic Number

Circuit F (C Circuit Divided into Two)

Circuit Symbol

Composition of Circuit Symbol

Example:

1 03 F

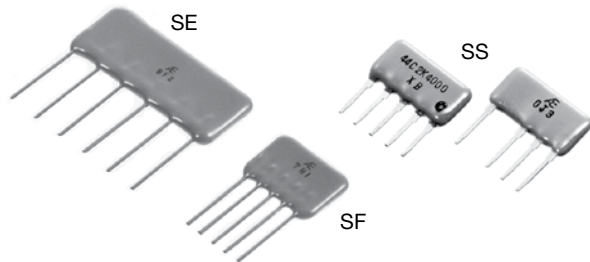
Circuit Symbol
Number of Resistance Elements
Generic Number

Circuits other than listed are available.

RESISTANCE RANGE AND NUMBER OF ELEMENTS MOUNTABLE					
Type	Case Encapsulated Type	Conformally Coated Type			
	SC	SE	SF	SS	
Max. Resistance Value/Element (Ω)	120k	120k	120k	20k	
Min. Resistance Value/Element (Ω)	30	30	30	30	
Max. Resistance Value/Package (Ω)	1,200k	600k	240k	100k	
Maximum Number of Network Elements	Circuit A	8	4	—	5
	Circuit B	5	5	2	3
	Circuit C	10	5	2	5
	Circuit E	8	—	—	4
	Circuit F	9	5	—	4

TABLE 1. TEMPERATURE CHARACTERISTICS OF RESISTANCE		
TCR (ppm/°C) -55°C to $+125^{\circ}\text{C}$		
Absolute	Tracking	
	Resistance Ratio (R max./R min.)	TCR Tracking Available
0 ± 5	$1 \leq R \text{ max./R min.} \leq 10$	± 1
	$10 < R \text{ max./R min.} \leq 100$	± 2
	$100 < R \text{ max./R min.}$	± 3

Precision Resistor Network (Conformally Coated)



COMPOSITION OF TYPE NUMBER

Example:

SE 004A 1K000 / 8K000 B A

- ① Type
- ② Circuit Symbol
- ③ Resistance Value (R1)
- ④ Resistance Value (Rn)
- ⑤ Resistance Tolerance (Absolute)
- ⑥ Resistance Tolerance (Matching)

Specify all values for R1 to Rn

CONFIGURATION (DIMENSIONS IN mm)

Type	SE	SF	SS
L	29.0±0.5	14.0±0.5	7.5±0.5 to 16.5±0.5
W	11.5±0.5	9.5±0.5	7.3±0.5
T	2.7±0.5		2.2±0.5
ℓ	5±1		
t	0.25±0.05		0.3±0.05
a	1.0±0.5		
b	0.5±0.5		0.65±0.05
c	—		0.4±0.05
F	Multiple of 2.54		

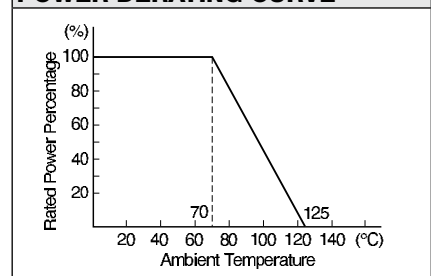
TCR, RESISTANCE RANGE, TOLERANCE, RATED POWER

Type	TCR (ppm/°C)* -25°C to +125°C	Resistance Range Element (Ω)	Maximum Resistance Value Package (Ω)	Resistance Tolerance (%)**		Rated Power/Package (W) at 70°C
				Absolute	Matching	
SE	0±5	30 to 120k	600k	±0.05 (A)	±0.01 (T) ±0.02 (Q)	1
SF		30 to 120k	240k	±0.1 (B) ±0.5 (D)	±0.05 (A) ±0.1 (B) ±0.5 (D)	0.5
SS		30 to 20k	100k	±1 (F)	±0.5 (D) ±1 (F)	0.5

*TCR tracking is dependent on resistance ratio. See table 1 on page 32.

**Symbols parenthesized are for type number composition.

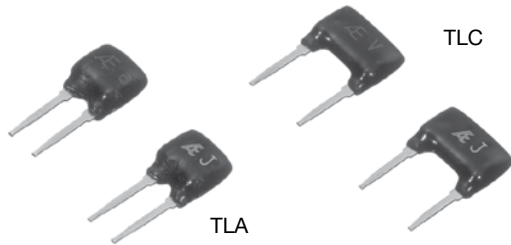
POWER DERATING CURVE



PERFORMANCE

Parameters	Test Condition	ALPHA Specification		ALPHA Typical Test Data	
		ΔR	ΔRatio	ΔR	ΔRatio
Maximum Rated Operating Temperature Working Temperature Range		70°C -25°C to +125°C			
Temperature Cycling	-25°C/30 min., Room Temperature/5 min., +125°C/30 min., 5 cycles	±0.05%	±0.01%	±0.01%	±0.005%
Low Temperature Storage Overload Terminal Strength	-25°C, No Load, 2 hrs. Rated Voltage x 2.5, 5 sec. 0.51 kg (1.123 pounds), 10 sec.	±0.05%	±0.01%	±0.005%	±0.0025%
Dielectric Withstanding Voltage Insulation Resistance Resistance to Soldering Heat Moisture Resistance	Atmo. Pres.: AC 300V, 1 min. DC 100V, 1 min. 350°C, 3 sec. +65°C to -10°C, 90% RH to 98% RH, Rated Voltage, 10 cycles (240 hrs.)	±0.03%	±0.01%	±0.005%	±0.0025%
Shock Vibration	50G, 11 ms., Half-Sine Wave, X, Y, Z, each 3 shocks 20G, 10 Hz to 55 Hz to 10 Hz, 1 min., X, Y, Z, each 2 hrs.	±0.03%	±0.01%	±0.005%	±0.0025%
Life (Rated Load)	70°C, Rated Power, 1.5 hrs. – ON, 0.5 hr. – OFF, 1,000 hrs.	±0.1%	±0.05%	±0.01%	±0.005%
Life (Moisture Load)	40°C, 90% RH to 95% RH, Rated Power, 1.5 hrs. – ON, 0.5 hr. – OFF, 1,000 hrs.	±0.1%	±0.05%	±0.01%	±0.005%
High Temperature Exposure	125°C, No Load, 1,000 hrs.	±0.1%	±0.05%	±0.01%	±0.005%
Storage Life	15°C to 35°C, 15% RH to 75% RH, No Load, 10,000 hrs.	±0.05%	±0.03%	±0.005%	±0.0025%

Precision Thin Film Resistor (Conformally Coated)



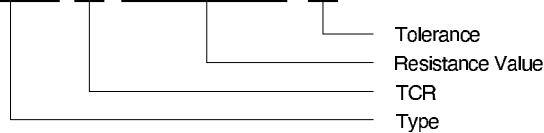
Features

- ① High Resistance Value: up to 10 M Ω
- ② Tolerance: $\pm 0.02\%$
- ③ TCR: ± 5 ppm/ $^{\circ}\text{C}$
- ④ Long-Term Stability: 200 ppm/year

COMPOSITION OF TYPE NUMBER

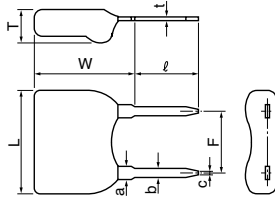
Example:

TLA X 500K00 B



Resistance value, in ohm, is expressed by a series of six characters, five of which represent significant digits. K or M is a dual-purpose letter that designates both the value range (K for kilo-ohm; M for mega-ohm) and the location of decimal point.

CONFIGURATION (DIMENSIONS IN mm)



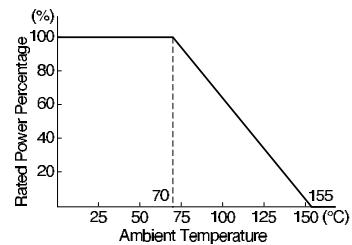
Type	TLA	TLC
L	5.6 ± 0.5	7.5 ± 0.5
W	6.2 ± 0.5	
T	2.2 ± 0.5	
F	2.54 ± 0.25	5.08 ± 0.25
l	5 ± 1	
t	0.3 ± 0.05	
a	1.0 ± 0.05	
b	0.65 ± 0.05	
c	0.4 ± 0.05	

TCR, RESISTANCE RANGE, TOLERANCE, RATED POWER

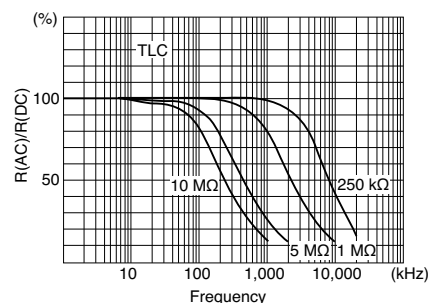
Type	TCR (ppm/ $^{\circ}\text{C}$) -25 $^{\circ}\text{C}$ to +125 $^{\circ}\text{C}$ *	Resistance Range (Ω)	Resistance Tolerance (%)*	Rated Power (W) at 70 $^{\circ}\text{C}$
TLA	0 ± 10 (C) 0 ± 5 (X)	100K to 5M	± 0.05 (A) ± 0.1 (B) ± 0.5 (D) ± 1 (F)	0.125
TLC		200K to 10M	± 0.02 (Q) ± 0.05 (A) ± 0.1 (B) ± 0.5 (D) ± 1 (F)	0.25

* Symbols in parentheses are for type number composition.

POWER DERATING CURVE



FREQUENCY CHARACTERISTICS



PERFORMANCE

Parameters	Test Condition	ALPHA Specification	ALPHA Typical Test Data
Max. Rated Operating Temperature Working Temperature Range Maximum Working Voltage		70 $^{\circ}\text{C}$ -25 $^{\circ}\text{C}$ to +155 $^{\circ}\text{C}$ TLA = 250V, TLC = 300V	
Temperature Cycling Overload	-25 $^{\circ}\text{C}$ /30 min., Room Temperature/5 min., +55 $^{\circ}\text{C}$ /30 min., 5 cycles Rated Voltage \times 2.5, 5 sec.	$\pm 0.05\%$ $\pm 0.05\%$	$\pm 0.01\%$ $\pm 0.0025\%$
Solderability Resistance to Solvents	235 $^{\circ}\text{C}$, 2 sec. Isopropyl Alcohol	over 75% coverage no damage	
Low Temperature Storage Terminal Strength	-25 $^{\circ}\text{C}$, No Load, 2 hrs. 0.908 kg (2 pounds), 10 sec.	$\pm 0.05\%$ $\pm 0.05\%$	$\pm 0.0025\%$ $\pm 0.0025\%$
Dielectric Withstanding Voltage Insulation Resistance Resistance to Soldering Heat Moisture Resistance	Atmospheric: AC 300V, 1 min. DC 100V, 1 min. 350 $^{\circ}\text{C}$, 3 sec. +65 $^{\circ}\text{C}$ to -10 $^{\circ}\text{C}$, 90% RH to 98% RH, Rated Voltage, 10 cycles (240 hrs.)	$\pm 0.03\%$ over 10,000 M Ω $\pm 0.03\%$ $\pm 0.1\%$	$\pm 0.0025\%$ over 10,000 M Ω $\pm 0.01\%$ $\pm 0.05\%$
Life (Rated Load)	70 $^{\circ}\text{C}$, Rated Power, 1.5 hrs. - ON, 0.5 hr. - OFF, 1,000 hrs.	$\pm 0.1\%$	$\pm 0.01\%$
Storage Life	15 $^{\circ}\text{C}$ to 35 $^{\circ}\text{C}$, 15% RH to 75% RH, No Load, 10,000 hrs.	$\pm 0.02\%$	$\pm 0.01\%$
High Temperature Exposure	155 $^{\circ}\text{C}$, No Load, 1,000 hrs.	$\pm 0.05\%$	$\pm 0.02\%$
Current Noise		-25 dB	-35 dB

Ultra Precision Thermosensitive Resistor

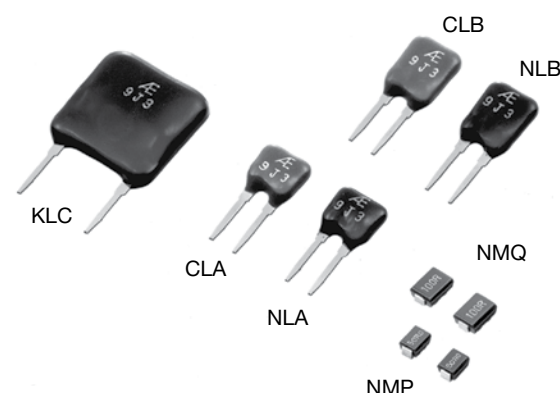
This ultra precision thermosensitive resistor is a new type of resistor produced by the application of Alpha foil resistor technology. It is made of material only a few μm thick and responds rapidly to temperature changes. The metal foil that is used has a resistivity that varies linearly with temperature change. Strict control of foil composition maintains uniform quality without fluctuation of temperature characteristics of resistance. This thermosensitive resistor is produced by the same fine photo-etching technology used in the metal foil precision resistors. The pattern is ideally designed for temperature detection, providing small size and rapid response.

Characteristics

- ① Since the resistance is provided by metal foil, the resistance is highly stable with little change over time
- ② Temperature characteristics of resistance are almost linear
- ③ Response to temperature changes is rapid
- ④ This thermosensitive resistor is small and low-priced
- ⑤ Highly accurate with tolerance of resistance values $\pm 0.5\%$
- ⑥ Temperature characteristics can be freely adjusted (KLC type)

Main Applications

- Cold-junction reference for thermocouple
- Temperature-compensation in load cell
- Temperature-compensation device in semiconductor circuit
- Temperature-sensing device



COMPOSITION OF TYPE NUMBER

Example 1:

NLA 100R0 F

① ② ③

- ① Type
- ② Resistance Value*
- ③ Tolerance

Example 2:

KLC 3000-500R0 F

① ② ③ ④

- ① Type
- ② TCR**
- ③ Resistance Value*
- ④ Tolerance

Example 3:

NMP 100R0 F L

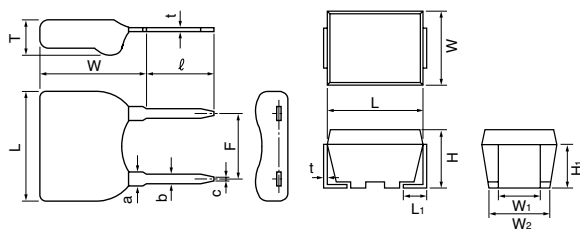
① ② ③ ④

- ① Type
- ② Resistance Value*
- ③ Tolerance
- ④ Tape & Reel Package Required

*Resistance value, in ohm, is expressed by a series of five characters, four of which represent significant digits. R or K is a dual-purpose letter that designates both the value range (R for ohmic; K for kilo-ohm) and the location of decimal point.

**Specify a desired TCR, following the type, in four-digit coding. The example "3000" means 3,000 ppm/°C while "0500" means 500 ppm/°C.

CONFIGURATION (DIMENSIONS IN mm)



Type	NLA, CLA	NLB, CLB	KLC
L	5.6±0.5		12.4±0.5
W	6.2±0.5	8.2±0.5	13.3±0.5
T	2.2±0.5		3.3±0.5
F	2.54±0.25		7.62±0.25
l	5.0±1.0		
t	0.3±0.05		
a	1.0±0.05		
b	0.65±0.05		
c	0.4±0.05		

Type	NMP	NMQ
L	3.2±0.2	4.5±0.2
W	2.5±0.2	3.2±0.2
H	2.0±0.2	
L1	0.6±0.2	0.8±0.2
W1	1.4±0.3	
W2	2.3±0.2	3.0±0.2
H1	1.5±0.3	
t	0.15±0.05	

TCR, RESISTANCE RANGE, TOLERANCE, RATED POWER

Type	TCR (ppm/°C)	Resistance Range (Ω)	Resistance Tolerance (%)* at 0°C	Rated Power (W) at 70°C
NMP	+6,040±2% (0 to 25°C)	5 to 250	±0.5 (D) ±1.0 (F) ±2.0 (G) ±5.0 (J)	0.1
NMQ	+6,220±2% (0 to 50°C)	5 to 500		0.125
NLA	+6,040±1% (0 to 25°C)	5 to 500		0.125
NLB	+6,220±1% (0 to 50°C)	5 to 1k		0.25
CLA	+6,590±2% (0 to 100°C)	5 to 100		0.125
CLB	+4,250±1% (0 to 100°C)	5 to 200		0.25
KLC	See Fig.1 on next page			0.25

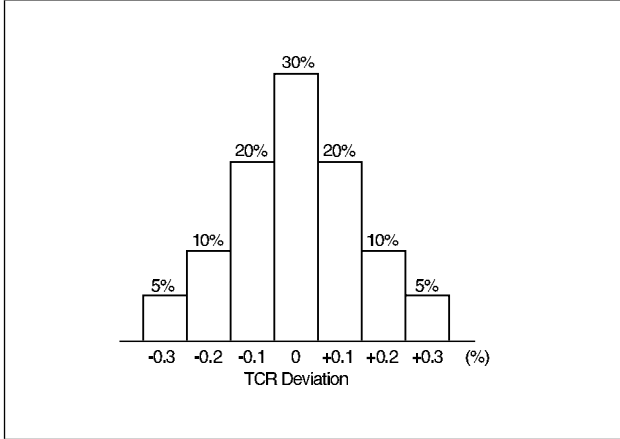
*Symbols parenthesized are for type number composition.

TAPE AND REEL PACKAGE (BASED ON EIA-481-1)

For details, refer to MP, MQ Series Ultra Precision SMT Resistor (Molded, J-Lead Terminal) datasheet at:
<http://www.vishaypg.com/doc?67000>

Ultra Precision Thermosensitive Resistor

TCR SPREAD FROM NOMINAL AND DISTRIBUTION



TEMPERATURE CHARACTERISTICS OF RESISTANCE

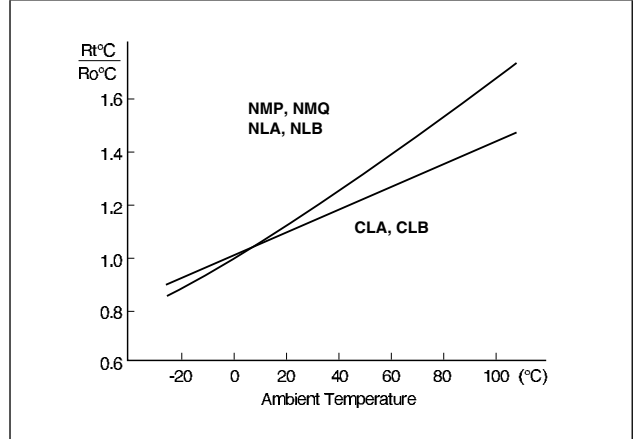
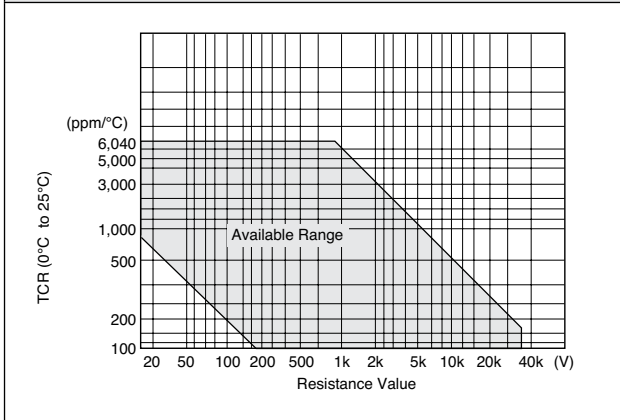
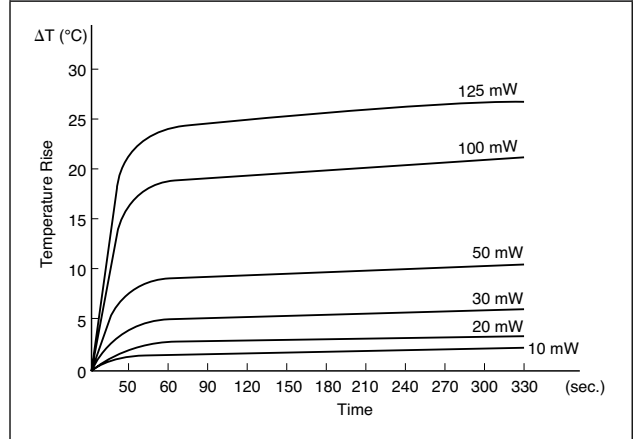


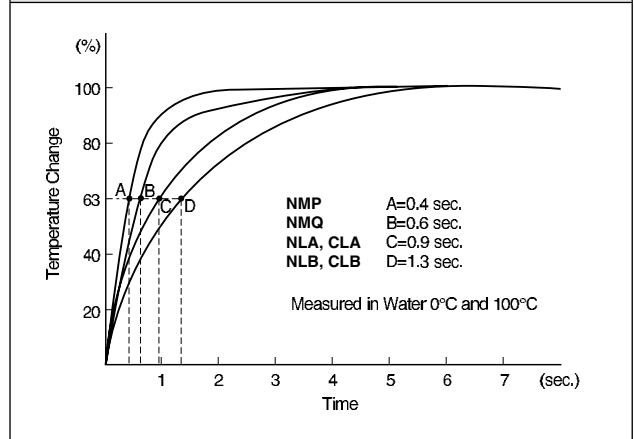
FIG. 1 TCR AND RESISTANCE AVAILABLE IN KLC TYPE



TEMPERATURE OF RESISTOR SURFACE



RESPONSE TIME TO TEMPERATURE CHANGE



Ultra Precision Thermosensitive Resistor

PERFORMANCE			
Parameters	Test Condition	ALPHA Specification	ALPHA Typical Test Data
Working Temperature Range Max. Rated Operating Temp. Maximum Working Voltage		-25°C to +125°C 70°C NMP: 50V; NMQ: 100V NLA, CLA: 250V; NLB, CLB, KLC: 300V	
Temperature Cycling Overload	-25°C/30 min., Room Temperature/5 min., +125°C/30 min., 5 cycles Rated Voltage x 2.5, 5 sec.	±0.2% ±0.2%	±0.03% ±0.03%
Solderability Resistance to Solvents	235°C, 2 sec. ● Isopropyl Alcohol ● Trichloroethylene	over 75% coverage no damage	
Low Temperature Storage Terminal Strength	-25°C, No Load, 2 hrs. 0.908 kg (2 pounds), 10 sec.	±0.2% ±0.2%	±0.03% ±0.03%
Dielectric Withstanding Voltage Insulation Resistance Resistance to Soldering Heat Moisture Resistance	Atmospheric: AC 300V, 1 min. DC 100V, 1 min. 350°C, 3 sec. +65°C to -10°C, 90% RH to 98% RH, Rated Voltage, 10 cycles (240 hrs.)	±0.2% over 10,000 MΩ ±0.2% ±0.5%	±0.03% over 10,000 MΩ ±0.01% ±0.02%
Shock Vibration	50G, 11 ms, Half-Sine Wave, X, Y, Z, each 3 shocks 20G, 10 Hz to 55 Hz to 10 Hz, 1 min., X, Y, Z, each 2 hrs.	±0.2% ±0.2%	±0.03% ±0.03%
Life (Rated Load)	70°C, Rated Power, 1.5 hr. – ON, 0.5 hr. – OFF, 1,000 hrs.	±0.5%	±0.03%
Life (Moisture Load)	40°C, 90% RH to 95% RH, Rated Power, 1.5 hr. – ON, 0.5 hr. – OFF, 1,000 hrs.	±0.5%	±0.03%
Storage Life	15°C to 35°C, 15% RH to 75% RH, No Load, 10,000 hrs.	±0.5%	±0.05%
High Temperature Exposure	125°C, No Load, 1,000 hrs.	±1.0 %	±0.1 %

APPLICATIONS OF THERMOSENSITIVE RESISTORS

Example: Cold-junction compensation for temperature measurement using thermocouple

Cold-Junction Compensation

Example: Temperature-sensing circuit

Thermosensitive Resistor

As shown in:

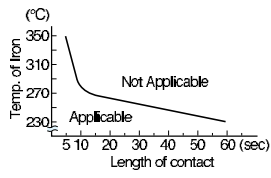
$$V_{OUT} = \left(\frac{R_2}{R_1+R_2} - \frac{R_1}{R_1+R_2} \times \frac{R_4}{R_3} \right) \times V_{dd}$$

Op-Amp output (V_{out}) becomes zero when R_1/R_2 and R_3/R_4 are balanced. So, output voltage ΔV_{out} is $\pm i_2 \times \Delta R_4$ when R_4 is changed to ΔR_4 from balanced point, $i_1=i_2$ and offset voltage is zero. The formula is as follows:

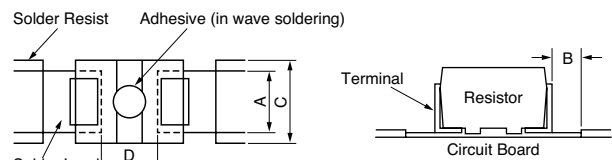
$$V_{OUT} = - \left(\frac{R_1}{R_1+R_2} \times \frac{1}{R_3} \right) \times \Delta R_4 \times V_{dd}$$

PRECAUTION IN USING NMP AND NMQ RESISTORS

- Storage**
Storage condition or environment may adversely affect solderability of the exterior terminals. Do not store in high temperature and humidity. The recommended storage environment is lower than 40°C, has less than 70% RH humidity and is free from harmful gases such as sulphur and chlorine.
- Caution in Soldering**
 - Hand Soldering**
Hand soldering is applicable as shown at right.
Recommended
 - Temperature of Iron Tip: 240°C to 270°C
 - Power of Iron: 20W or less
 - Diameter of Tip: Dia. 3 mm max.
 - Solder Reflow in Furnace**
Recommended
 - Peak Temperature: 250+0/-5°C
 - Holding time: 10 sec. max.
 - Dipping in Solder (Wave or Still)**
Recommended
 - Temp. of Solder: 260°C max.
 - Length of Dipping: 10 sec. max.
 - To cool gradually at room temperature
 - Other**
Corrosion-free flux, such as rosin, is recommended.
Do not apply pressure to the molded housing immediately after soldering.



- Cleaning**
Use volatile cleaner such as methylalcohol or propylalcohol.
- Circuit Board Design**
The dimensions of solder land must be determined in conformity with the size of resistors and with the soldering method. They are also subject to the mounting machine and the material of the substrate. See example below.

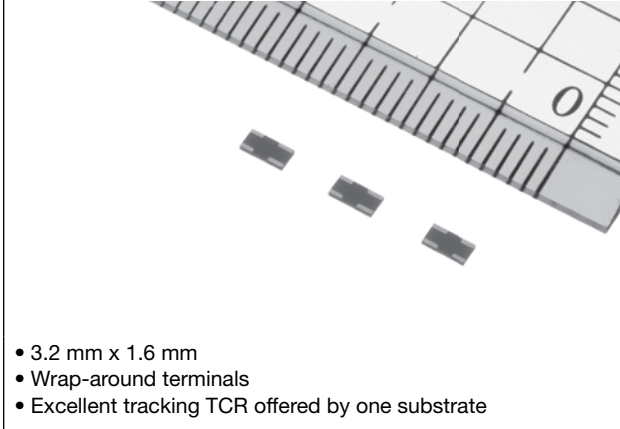


Type	A	B	C	D
NMP	1.6 to 2.0	0.5 to 1.5	2.2 to 2.6	1.8
NMQ				2.5

Dimensions in mm

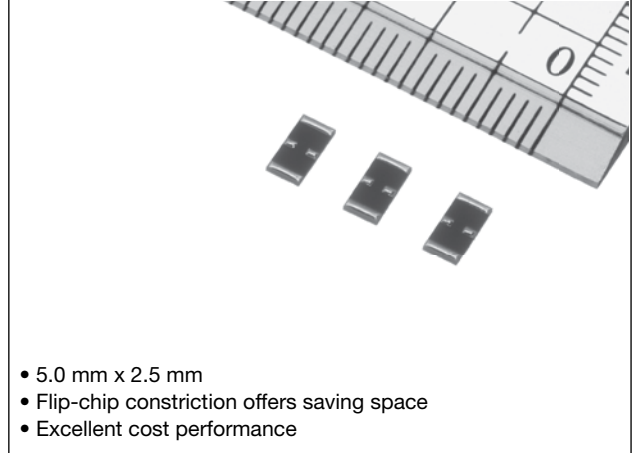
When parts are mounted on a board in high density, solder can possibly attach to the resistors in an excessive amount to affect performance or reliability of the resistors. To prevent this effect, the use of solder resist is recommended to isolate solder lands.

SMT NETWORK RESISTOR (WRAP-AROUND TERMINALS)



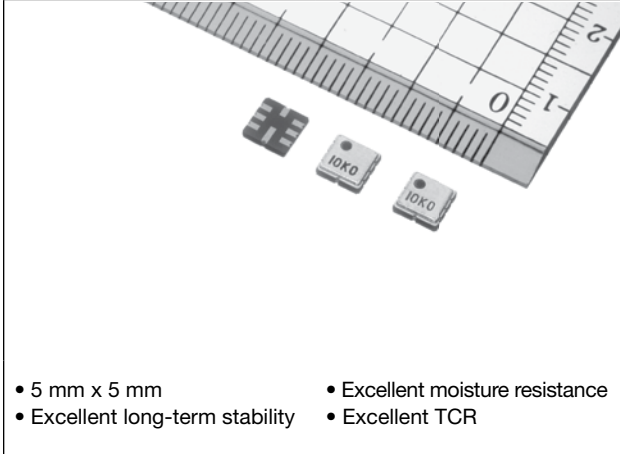
- 3.2 mm x 1.6 mm
- Wrap-around terminals
- Excellent tracking TCR offered by one substrate

SMT 1-2-3 NETWORK RESISTOR (FLIP-CHIP)



- 5.0 mm x 2.5 mm
- Flip-chip constriction offers saving space
- Excellent cost performance

SMT NETWORK RESISTOR (HERMETIC PACKAGE)



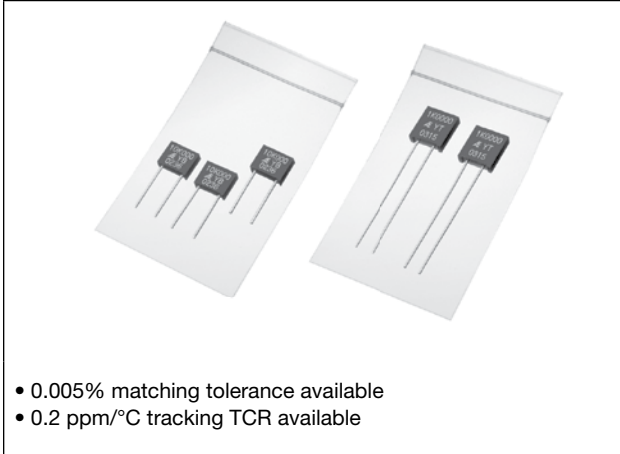
- 5 mm x 5 mm
- Excellent long-term stability
- Excellent moisture resistance
- Excellent TCR

PRECISION THIN FILM VOLTAGE DIVIDER



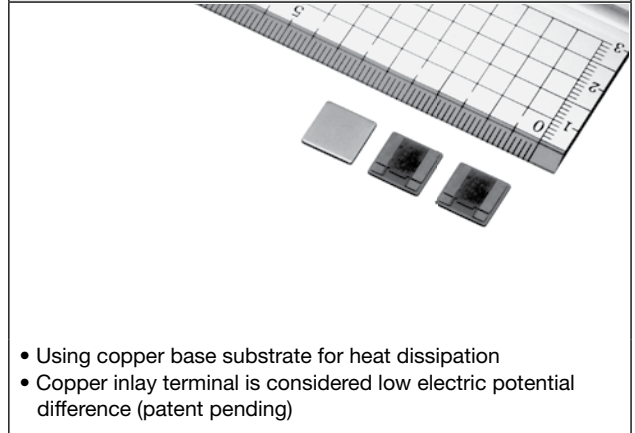
- Low TCR
- High resistance available

MATCHED RESISTOR SETS



- 0.005% matching tolerance available
- 0.2 ppm/°C tracking TCR available

PRECISION WIRE-BONDABLE CURRENT SENSE RESISTOR



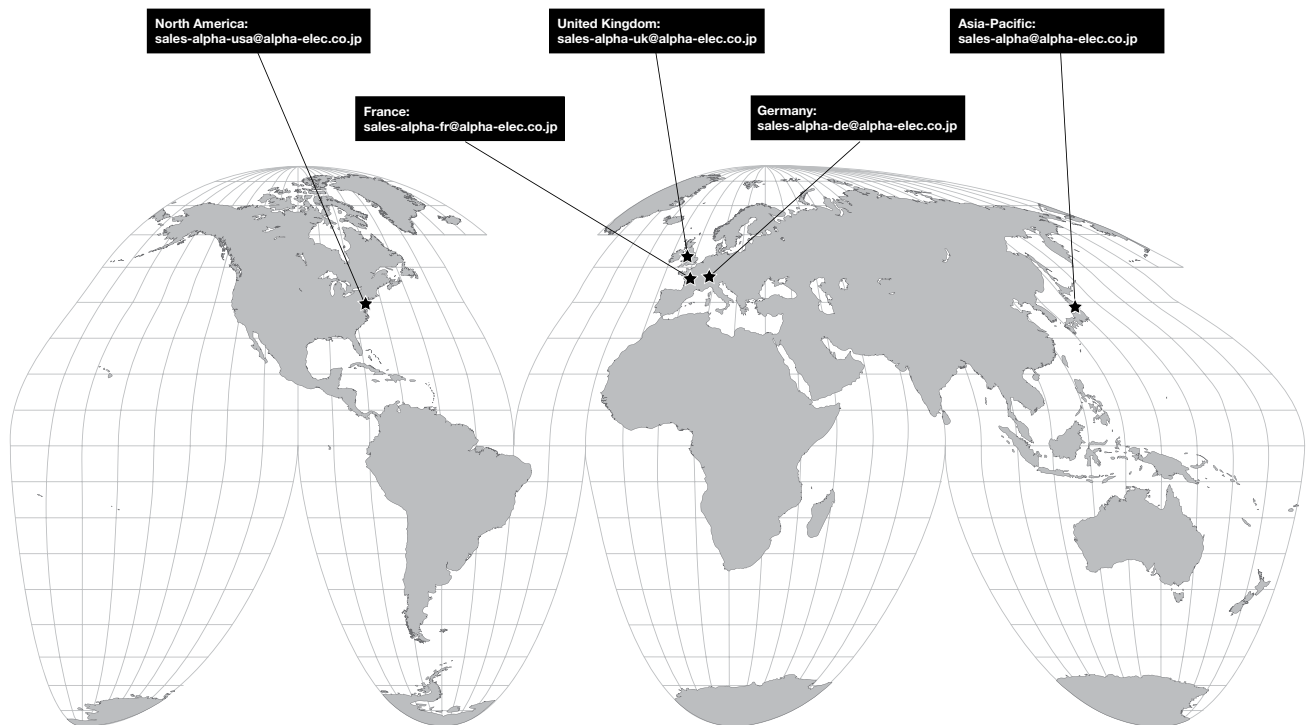
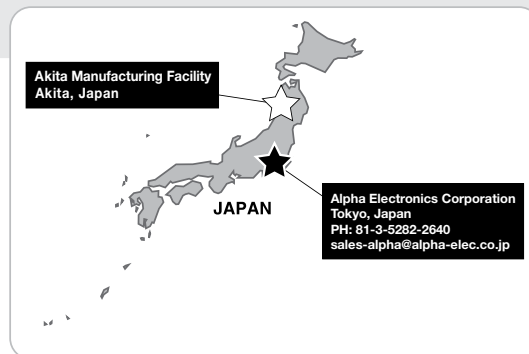
- Using copper base substrate for heat dissipation
- Copper inlay terminal is considered low electric potential difference (patent pending)

Product and Contact Information

PRODUCT LISTING

Bulk Metal® Foil Ultra Precision Resistors
Precision Thin Film Resistors
Thermosensitive Resistors
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