

Multilayer Varistors, Chip Type for Automotive

Series: **EZJZ, EZJP**

Handling Precautions

⚠ Safety Precautions

Multilayer Varistors for Automotive (hereafter referred to as “Varistors”) should be used for general purpose applications as countermeasures against ESD and noise found in vehicle electronics (Engine ECU and various body ECU, accessory equipment, etc.) equipment. When subjected to severe electrical, environmental, and/or mechanical stress beyond the specifications, as noted in the Ratings and Specified Conditions section, the Varistors’ performance may be degraded, or become failure mode, such as short circuit mode and open-circuit mode.

If you use under the condition of short-circuit, heat generation of Varistors will occur by running large current due to application of voltage. There are possibilities of smoke emission, substrate burn-out, and, in the worst case, fire.

For products which require high safety levels, please carefully consider how a single malfunction can affect your product. In order to ensure the safety in the case of a single malfunction, please design products with fail-safe, such as setting up protecting circuits, etc.

- For the following applications and conditions, please contact us for additional specifications, which is not found in this document.
 - When your application may have difficulty complying with the safety or handling precautions specified below.
 - High-quality and high-reliability required devices that have possibility of causing hazardous conditions, such as death or injury (regardless of directly or indirectly), due to failure or malfunction of the product.
 - ① Aircraft and Aerospace Equipment (artificial satellite, rocket, etc.)
 - ② Submarine Equipment (submarine repeating equipment, etc.)
 - ③ Transportation Equipment (airplanes, trains, ship, traffic signal controllers, etc.)
 - ④ Power Generation Control Equipment (atomic power, hydroelectric power, thermal power plant control system, etc.)
 - ⑤ Medical Equipment (life-support equipment, pacemakers, dialysis controllers, etc.)
 - ⑥ Information Processing Equipment (large scale computer systems, etc.)
 - ⑦ Electric Heating Appliances, Combustion devices (gas fan heaters, oil fan heaters, etc.)
 - ⑧ Rotary Motion Equipment
 - ⑨ Security Systems
 - ⑩ And any similar types of equipment

⚠ Strict Observance

1. Confirmation of Rated Performance

The Varistors shall be operated within the specified rating/performance.

Applications exceeding the specifications may cause deteriorated performance and/or breakdown, resulting in degradation and/or smoking or ignition of products. The following are strictly observed.

- (1) The Varistors shall not be operated beyond the specified operating temperature range.
- (2) The Varistors shall not be operated in excess of the specified maximum allowable voltage.
- (3) The Varistors shall not be operated in the circuits to which surge current and ESD that exceeds the specified maximum peak current and maximum ESD.
- (4) Never use for AC power supply circuits.

2. The Varistors shall not be mounted near flammables.

Operating Conditions and Circuit Design

1. Circuit Design

1.1 Operating Temperature and Storage Temperature

When operating a components-mounted circuit, please be sure to observe the “Operating Temperature Range”, written in delivery specifications. Storage temperature of PCB after mounting Varistors, which is not operated, should be within the specified “Storage Temperature Range” in the delivery specifications. Please remember not to use the product under the condition that exceeds the specified maximum temperature.

1.2 Operating Voltage

The Varistors shall not be operated in excess of the “Maximum allowable voltage”. If the Varistors are operated beyond the specified Maximum allowable voltage, it may cause short and/or damage due to thermal run away.

The circuit that continuously applies high frequency and/or steep pulse voltage please examines the reliability of the Varistor even if it is used within a “Maximum allowable voltage”. Also, it would be safer to check also the safety and reliability of your circuit.

1.3 Self-heating

The surface temperature of the Varistors shall be under the specified Maximum Operating Temperature in the Specifications including the temperature rise caused by self-heating. Check the temperature rise of the Varistor in your circuit.

1.4 Environmental Restrictions

The Varistors shall not be operated and/or stored under the following conditions.

- (1) Environmental conditions
 - (a) Under direct exposure to water or salt water
 - (b) Under conditions where water can condense and/or dew can form
 - (c) Under conditions containing corrosive gases such as hydrogen sulfide, sulfurous acid, chlorine and ammonia
- (2) Mechanical conditions

The place where vibration or impact that exceeds specified conditions written in delivery specification is loaded.

2. Design of Printed Circuit Board

2.1 Selection of Printed Circuit Boards

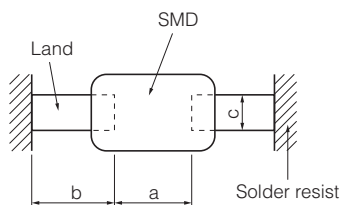
There is a possibility of performance deterioration by heat shock (temperature cycles), which causes cracks, from alumina substrate.

Please confirm that the substrate you use does not deteriorate the Varistors' quality.

2.2 Design of Land Pattern

- (1) Recommended land dimensions are shown below. Use the proper amount of solder in order to prevent cracking. Using too much solder places excessive stress on the Varistors.

Recommended Land Dimensions

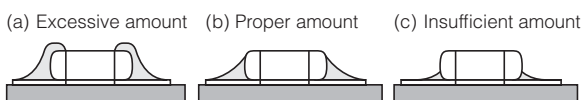


Unit (mm)

Size Code	Component dimensions			a	b	c
	L	W	T			
0(0402)	1.0	0.5	0.5	0.4 to 0.5	0.4 to 0.5	0.4 to 0.5
1(0603)	1.6	0.8	0.8	0.8 to 1.0	0.6 to 0.8	0.6 to 0.8

- (2) The land size shall be designed to have equal space, on both right and left side. If the amount of solder on the right land is different from that of the left land, the component may be cracked by stress since the side with a larger amount of solder solidifies later during cooling.

Recommended Amount of Solder



2.3 Utilization of Solder Resist

- (1) Solder resist shall be utilized to equalize the amounts of solder on both sides.
- (2) Solder resist shall be used to divide the pattern for the following cases;
 - Components are arranged closely.
 - The Varistor is mounted near a component with lead wires.
 - The Varistor is placed near a chassis.
 See the table below.

Prohibited Applications and Recommended Applications

Item	Prohibited applications	Improved applications by pattern division
Mixed mounting with a component with lead wires	The lead wire of a Component With lead wires	Solder resist
Arrangement near chassis	Chassis Solder (ground solder) Electrode pattern	Solder resist
Retro-fitting of component with lead wires	Soldering iron A lead wire of Retrofitted component	Solder resist
Lateral arrangement	Portion to be Excessively soldered Land	Solder resist

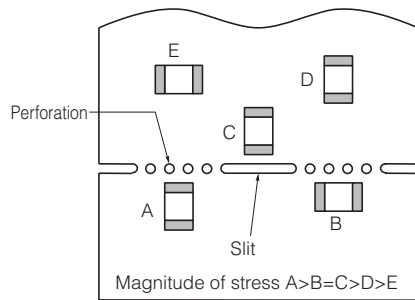
2.4 Component Layout

To prevent the crack of Varistors, place it on the position that could not easily be affected by the bending stress of substrate while going through procedures after mounting or handling.

- (1) To minimize mechanical stress caused by the warp or bending of a PC board, please follow the recommended Varistors' layout below.

Prohibited layout	Recommended layout
	 Layout the Varistors sideways against the stressing direction.

- (2) The following layout is for your reference since mechanical stress near the dividing/breaking position of a PC board varies depending on the mounting position of the Varistors.



- (3) The magnitude of mechanical stress applied to the Varistors when dividing the circuit board in descending order is as follows: push back < slit < V-groove < perforation. Also take into account the layout of the Varistors and the dividing/breaking method.

2.5 Mounting Density and Spaces

Intervals between components should not be too narrow to prevent the influence from solder bridges and solder balls. The space between components should be carefully determined.

Precautions for Assembly

1. Storage

- (1) The Varistors shall be stored between 5 to 40 °C and 20 to 70 % RH, not under severe conditions of high temperature and humidity.
- (2) If stored in a place where humidity, dust, or corrosive gasses (hydrogen sulfide, sulfurous acid, hydrogen chloride and ammonia, etc.) are contained, the solderability of terminals electrodes will be deteriorated.

In addition, storage in a place where the heat or direct sunlight exposure occurs will causes mounting problems due to deformation of tapes and reels and components and taping/reels sticking together.

- (3) Do not store components longer than 6 months. Check the solderability of products that have been stored for more than 6 months before use.

2. Adhesives for Mounting

- (1) The amount and viscosity of an adhesive for mounting shall be such that the adhesive will not flow off on the land during its curing.
- (2) If the amount of adhesive is insufficient for mounting, the Varistors may fall off after or during soldering.
- (3) Low-viscosity of the adhesive causes displacement of Varistors.

- (4) The heat-curing methods for adhesive are ultraviolet radiation, far-infrared radiation, and so on. In order to prevent the terminal electrodes of the Varistors from oxidizing, the curing shall be under the following conditions:
160 °C max., for 2 minutes max.

- (5) Insufficient curing may cause the Varistors to fall off after or during soldering. In addition, insulation resistance between terminal electrodes may deteriorate due to moisture absorption. In order to prevent these problems, please observe proper curing conditions.

3. Chip Mounting Consideration

- (1) When mounting the Varistors components on a PC board, the Varistor bodies shall be free from excessive impact loads such as mechanical impact or stress due to the positioning, pushing force and displacement of vacuum nozzles during mounting.
- (2) Maintenance and inspection of the Chip Mounter must be performed regularly.
- (3) If the bottom dead center of the vacuum nozzle is too low, the Varistor will crack from excessive force during mounting.

Please refer to the following precautions and recommendations.

- (a) Set and adjust the bottom dead center of the vacuum nozzles to the upper surface of the PC board after correcting the warp of the PC board.
- (b) Set the pushing force of the vacuum nozzle during mounting to 1 to 3 N in static load.
- (c) For double surface mounting, apply a supporting pin on the rear surface of the PC board to suppress the bending of the PC board in order to minimize the impact of the vacuum nozzles. Typical examples are shown in the table below.
- (d) Adjust the vacuum nozzles so that their bottom dead center during mounting is not too low.

Item	Prohibited mounting	Recommended mounting
Single surface mounting		
Double surface mounting		

- (4) The closing dimensions of the positioning chucks shall be controlled. Maintenance and replacement of positioning chucks shall be performed regularly to prevent chipping or cracking of the Varistors caused by mechanical impact during positioning due to worn positioning chucks.
- (5) Maximum stroke of the nozzle shall be adjusted so that the maximum bending of PC board does not exceed 0.5 mm at 90 mm span. The PC board shall be supported by an adequate number of supporting pins.

4. Selection of Soldering Flux

Soldering flux may seriously affect the performance of the Varistors. Please confirm enough whether the soldering flux have an influence on performance of the Varistors or not, before using.

5. Soldering

5.1 Flow Soldering

When conducting flow soldering, stress from abrupt temperature change is applied to the Varistors, so the temperature, especially temperature of solder should be controlled very carefully. Varistors should not be subjected to abrupt temperature change because it causes occurrence of thermal cracks as a result of excessive thermal stress inside of the Varistors from flow soldering. You should be careful to temperature difference. Therefore it is essential that soldering process follow these recommended conditions.

(1) Application of Soldering flux :

The soldering flux shall be applied to the mounted Varistors thinly and uniformly by foaming method.

(2) Preheating :

Conduct sufficient pre-heating, and make sure that the temperature difference between solder and Varistors' surface is 150 °C or less.

(3) Immersion into Soldering bath :

The Varistors shall be immersed into a soldering bath of 240 to 260 °C for 3 to 5 seconds.

(4) Gradual Cooling :

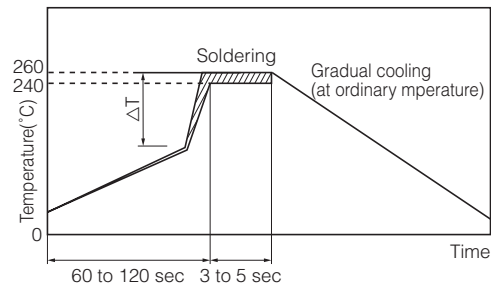
After soldering, avoid rapid cooling (forced cooling) and conduct gradual cooling, so that thermal cracks do not occur.

(5) Flux Cleaning :

When the Varistors are immersed into a cleaning solvent, be sure that the surface temperatures of devices do not exceed 100 °C.

(6) Performing flow soldering once under the conditions shown in the figure below [Recommended profile of Flow soldering (Ex)] will not cause any problems. However, pay attention to the possible warp and bending of the PC board.

Recommended profile for Flow Soldering [Ex.]



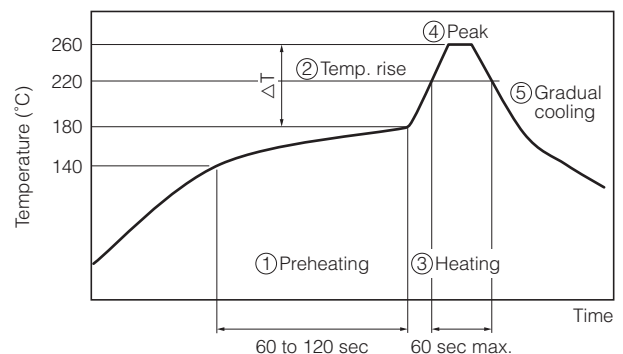
For products specified in individual specifications, avoid flow soldering.

5.2 Reflow Soldering

The reflow soldering temperature conditions are composed of temperature curves of Preheating, Temp. rise, Heating, Peak and Gradual cooling. Large temperature difference inside the Varistors caused by rapid heat application to the Varistors may lead to excessive thermal stresses, contributing to the thermal cracks. The Preheating temperature requires controlling with great care so that tombstone phenomenon may be prevented.

Item	Temperature	Period or Speed
① Preheating	140 to 180 °C	60 to 120 sec
② Temp. rise	Preheating temp to Peak temp.	2 to 5 °C /sec
③ Heating	220 °C min.	60 sec max.
④ Peak	260 °C max.	10 sec max.
⑤ Gradual cooling	Peak temp. to 140 °C	1 to 4 °C /sec

Recommended profile of Reflow soldering (EX)



ΔT : Allowable temperature difference $\Delta T \leq 150$ °C

The rapid cooling (forced cooling) during Gradual cooling part should be avoided, because this may cause defects such as the thermal cracks, etc. When the Varistors are immersed into a cleaning solvent, make sure that the surface temperatures of the devices do not exceed 100 °C. Performing reflow soldering twice under the conditions shown in the figure above "Recommended profile of Reflow soldering (EX)" will not cause any problems. However, pay attention to the possible warp and bending of the PC board.

5.3 Hand Soldering

Hand soldering typically causes significant temperature change, which may induce excessive thermal stresses inside the Varistors, resulting in the thermal cracks, etc.

In order to prevent any defects, the following should be observed.

- Control the temperature of the soldering tips with special care.
- Avoid the direct contact of soldering tips with the Varistors and/or terminal electrodes.
- Do not reuse dismantled Varistors.

(1) Condition 1 (with preheating)

(a) Soldering :

Use thread solder ($\phi 1$ mm or below) which contains flux with low chlorine, developed for precision electronic equipment.

(b) Preheating :

Conduct sufficient pre-heating, and make sure that the temperature difference between solder and Varistors' surface is 150 °C or less.

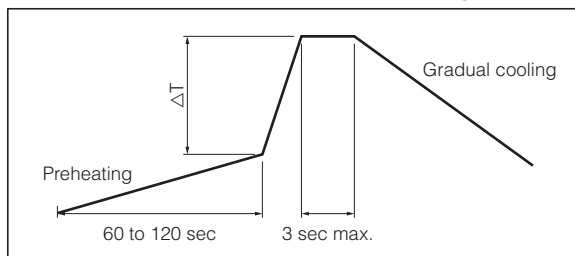
(c) Temperature of Iron tip: 350 °C max.

(The required amount of solder shall be melted in advance on the soldering tip.)

(d) Gradual cooling :

After soldering, the Varistors shall be cooled gradually at room temperature.

Recommended profile of Hand soldering [EX]



ΔT : Allowable temperature difference $\Delta T \leq 150$ °C

(2) Condition 2 (without preheating)

Hand soldering can be performed without preheating, by following the conditions below:

- (a) Soldering iron tip shall never directly touch the ceramic and terminal electrodes of the Varistors.
- (b) The lands are sufficiently preheated with a soldering iron tip before sliding the soldering iron tip to the terminal electrodes of the Varistors for soldering.

Conditions of Hand soldering without preheating

	Condition
Temperature of Iron tip	350 °C max.
Wattage	20 W max.
Shape of Iron tip	$\phi 3$ mm max.
Soldering time with a soldering iron	3 sec max.

6. Post Soldering Cleaning

6.1 Cleaning solvent

Soldering flux residue may remain on the PC board if cleaned with an inappropriate solvent. This may deteriorate the performance of Varistors, especially insulation resistance.

6.2 Cleaning conditions

Inappropriate cleaning conditions such as insufficient cleaning or excessive cleaning may impair the electrical characteristics and reliability of the Varistors.

(1) Insufficient cleaning can lead to :

- (a) The halogen substance found in the residue of the soldering flux may cause the metal of terminal electrodes to corrode.
- (b) The halogen substance found in the residue of the soldering flux on the surface of the Varistors may change resistance values.
- (c) Water-soluble soldering flux may have more remarkable tendencies of (a) and (b) above compared to those of rosin soldering flux.

(2) Excessive cleaning can lead to :

- (a) When using ultrasonic cleaner, make sure that the output is not too large, so that the substrate will not resonate. The resonance causes the cracks in Varistors and/or solders, and deteriorates the strength of the terminal electrodes.

Please follow these conditions for Ultrasonic cleaning:

- Ultrasonic wave output : 20 W/L max.
- Ultrasonic wave frequency : 40 kHz max.
- Ultrasonic wave cleaning time : 5 min. max.

6.3 Contamination of Cleaning solvent

Cleaning with contaminated cleaning solvent may cause the same results as that of insufficient cleaning due to the high density of liberated halogen.

7. Inspection Process

The pressure from measuring terminal pins might bend the PCB when implementing circuit inspection after mounting Varistors on PCB, and as a result, cracking may occur.

- (1) Mounted PC boards shall be supported by an adequate number of supporting pins on the back with bend settings of 90 mm span 0.5 mm max.
- (2) Confirm that the measuring pins have the right tip shape, are equal in height, have the right pressure and are set in the correct positions. The following figures are for your reference to avoid bending the PC board.

	Prohibited setting	Recommended setting
Bending of PC board		

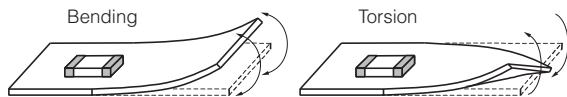
8. Protective Coating

When the surface of a PC board on which the Varistors have been mounted is coated with resin to protect against moisture and dust, it shall be confirmed that the protective coating does not affect the performance of Varistors.

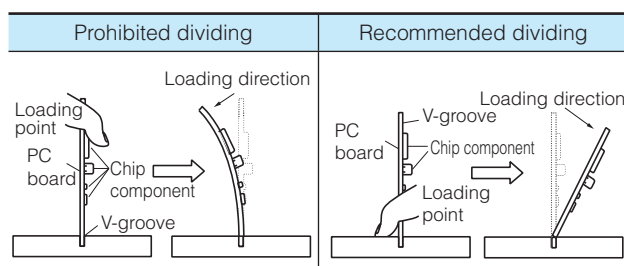
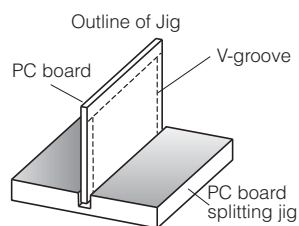
- (1) Choose the material that does not emit the decomposition and/or reaction gas. The Gas may affect the composing members of the Varistors.
- (2) Shrinkage and expansion of resin coating when curing may apply stress to the Varistors and may lead to occurrence of cracks.

9. Dividing/Breaking of PC Boards

- (1) Please be careful not to stress the substrate with bending/twisting when dividing, after mounting components including Varistors. Abnormal and excessive mechanical stress such as bending or torsion shown below can cause cracking in the Varistors.



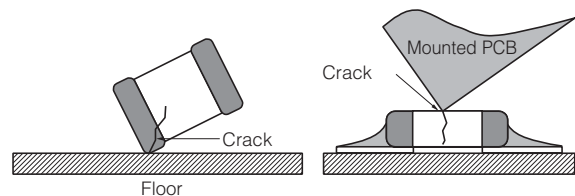
- (2) Dividing/Breaking of the PC boards shall be done carefully at moderate speed by using a jig or apparatus to prevent the Varistors on the boards from mechanical damage.
- (3) Examples of PCB dividing/breaking jigs:
The outline of PC board breaking jig is shown below. When PC board are broken or divided, loading points should be close to the jig to minimize the extent of the bending.
Also, planes with no parts mounted on should be used as plane of loading, in order to prevent tensile stress induced by the bending, which may cause cracks of the Varistors or other parts mounted on the PC boards.



10. Mechanical Impact

- (1) The Varistors shall be free from any excessive mechanical impact. The Varistor body is made of ceramics and may be damaged or cracked if dropped. Never use a Varistor which has been dropped; their quality may already be impaired, and in that case, failure rate will increase.
- (2) When handling PC boards with Varistors mounted on them, do not allow the Varistors to collide with another PC board.

When mounted PC boards are handled or stored in a stacked state, the corner of a PC board might strike Thermistors, and the impact of the strike may cause damage or cracking and can deteriorate the withstand voltage and insulation resistance of the Varistor.



Other

The various precautions described above are typical. For special mounting conditions, please contact us.