

# Notes

**●Safety precautions**

- (1) The products are designed and produced for application in ordinary electronic equipment (AV equipment, OA equipment, telecommunication equipment, home appliances, amusement equipment, etc.).  
If the products are to be used in devices requiring extremely high reliability (medical equipment, transport equipment, aircraft/spacecraft, nuclear power controllers, fuel controllers, car equipment including car accessories, safety devices, etc.) and whose malfunction or operational error may endanger human life and sufficient fail-safe measures, please consult with the company's sales staff in advance.  
If product malfunctions may result in serious damage, including that to human life, sufficient fail-safe measures must be taken, including the following.
  - 1) Installation of protection circuits or other protective devices to improve system safety
  - 2) Installation of redundant circuits in the case of single-circuit failure
- (2) The products are designed for use in a standard environment and not in any special environments.  
Application of the products in a special environment can deteriorate product performance.  
Accordingly, verification and confirmation of product performance, prior to use, is recommended if used under the following conditions:
  - 1) Use in various types of liquid, including water, oils, chemicals, and organic solvents
  - 2) Use outdoors where the products are exposed to direct sunlight, or in dusty places
  - 3) Use in places where the products are exposed to sea winds or corrosive gases, including  $\text{Cl}_2$ ,  $\text{H}_2\text{S}$ ,  $\text{NH}_3$ ,  $\text{SO}_2$ , and  $\text{NO}_2$
  - 4) Use in places where the products are exposed to static electricity or electromagnetic waves
  - 5) Use in proximity to heat-producing components, plastic cords, or other flammable items
  - 6) Use involving sealing or coating the products with resin or other coating materials
  - 7) Use involving unclean solder or use of water or water-soluble cleaning agents for cleaning after soldering
  - 8) Use of the products in places subject to dew condensation
- (3) The products are radiation resistant.
- (4) The company is not responsible for any problems resulting from use of the products under conditions not recommended herein.
- (5) The company should be notified of any product safety issues. Moreover, product safety issues should be periodically monitored by the customer.

**●Precautions regarding foreign exchange and foreign trade control law**

- (1) The company has not determined whether or not the products are considered "a controlled product or technology" as specified in the Foreign Exchange and Foreign Trade Control Law.  
Accordingly, if exportation of the products, either separately or integrated in another company's products, is intended, or giving the products to persons who are not residents is planned, additional steps are required, based upon the appropriate regulations.

## Resistors

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### ●Prohibitions regarding industrial property

- (1) These specifications contain information related to the company's industrial property. Any use of them other than pertaining to the usage of appropriate products is not permitted. Duplication of these specifications and its disclosure to a third party without the company's permission is prohibited.
- (2) Information and data on products, including application examples, contained in these specifications are simply for reference; the company does not guarantee any industrial property rights, intellectual property rights, or any other rights of a third party regarding this information or data. Accordingly, the company does not bear any responsibility for:
  - 1) infringement of the intellectual property of a third party
  - 2) any problems incurred by the use of the products listed herein.
- (3) The company prohibits the purchaser of its products to exercise or use the intellectual property rights, industrial property rights, or any other rights that either belong to or are controlled by the company, other than the right to use, sell, or dispose of the products.

### ●Precautions on use of products

- (1) Verification and confirmation of performance characteristics of products, after on-board mounting, is advised.
- (2) In particular, if a transient load (a large amount of load applied in a short period of time, such as pulse) is applied, confirmation of performance characteristics after on-board mounting is strongly recommended.

Avoid applying power exceeding normal rated power, exceeding the power rating under steady-state loading condition may negatively affect product performance and reliability.
- (3) When a highly active halogenous (chlorine, bromine, etc.) flux is used, the remainder of flux may negatively affect product performance and reliability.
- (4) In principle, the reflow soldering method must be used; if flow soldering method is preferred, please consult with the company in advance
- (5) Pay attention to the soldering condition in order to avoid problems due to silver absorption into solder.
- (6) Be careful when pick up the products with tweezers.

There may be a care that the overcoat and / or the body can be chipped.
- (7) Soldering tip shall not touch the product when install product manually.
- (8) Product may be damaged when the impact, such as downfall is given.

### ●Precautions regarding product storage

- (1) Product performance and soldered connections may deteriorate if the products are stored in the following places:
  - 1) Where the products are exposed to sea winds or corrosive gases, including Cl<sub>2</sub>, H<sub>2</sub>S, NH<sub>3</sub>, SO<sub>2</sub>, and NO<sub>2</sub>  
(Recommendable condition: 5~40°C, 30~80%R.H.)
  - 2) Where the temperature or humidity exceeds those recommended by the company
- (2) The guaranteed period of solder connections and product performance is within one year from shipment by the company, provided that the above-mentioned storage conditions have been satisfied.

### ●Other matters

- (1) The design and specifications are subject to change without prior notice. Before ordering or using, please check the latest technical specifications.

## Resistors

## ●Overload failure mechanism

(1) The failure mechanism of the component when an overload voltage is applied is explained below.

(Internal structure of chip resistor)

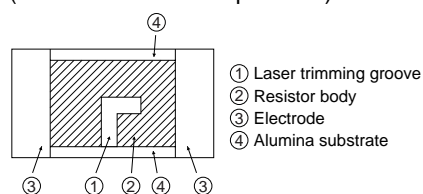
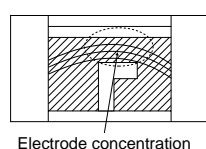


Fig.1

(Current flow concentration region)



Electrode concentration

Fig.2

Current flow concentrated in the region left after laser trimming (the region marked with the circle).

(Cutoff due to melting)

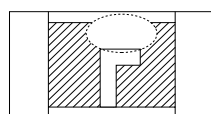


Fig.3

When an overload voltage is applied, Joule heating caused by this current concentration causes the local temperature to rise. The heat generated is dissipated via the ceramic substrate. If the amount of heat generated is greater than the amount that be dissipated, the temperature that the resistor body and glass coating can withstand will be exceeded and partial melting will occur. Higher overload voltages can cause complete melting of the resistive material left after laser trimming.

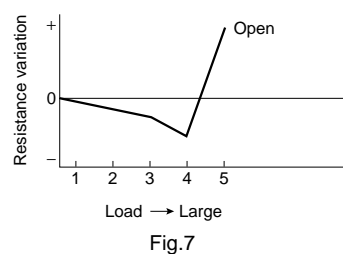
(2) Failure mode analysis

Thermal dissipation: Heat generated is transmitted from the electrodes to the solder to the PCB, and from the alumina substrate to the PCB. Therefore, the failure mode is determined by the amount of heat generated, and the thermal dissipation balance.

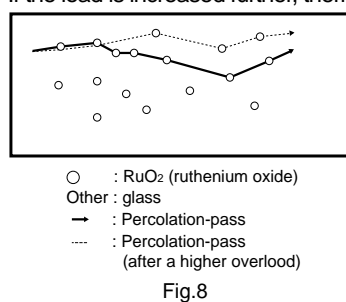
## Resistors

### ●Failure mechanism due to over voltage

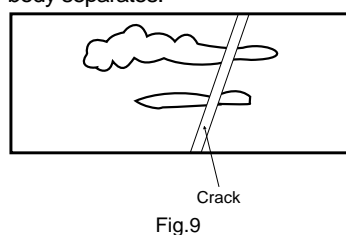
When an overload voltage is applied, the resistance value drops at first, then increases as the overload voltage is increased, until ultimately the component goes open circuit. This is illustrated in Fig.7.



- (1) The dielectric component in the resistor (glass) is destroyed, and the resistance drops (short circuit).
- (2) If a higher load is applied, chemical reduction of the metal oxide in the resistor occurs, a pure metal component with higher conductivity is formed. In other words, the resistance drops further.
- (3) If the load is increased further, thermal decomposition of the dielectric occurs which further increases the shorting.



- (4) If the load is increased further, the metal conductive component heats up, and the resistance starts to increase. Under certain conditions, the resistor body melts or cracks, and due to differences in thermal expansion rates, the resistor body separates.



## Resistors

## ●Splintering of the overcoat glass, electrodes, and resistor body, and countermeasures

## (1) Positioning chip resistors

Chip resistors are positioned from four directions simultaneously. When positioning a chip resistor, use a positioning catch below the resistor as shown in Fig.10 so that the resistor does not drop.

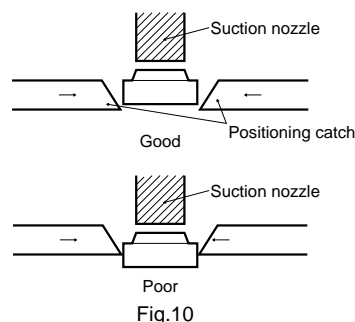


Fig.10

This is an important point for chip resistor mounting equipment that has a function for detecting the orientation of the component using the vacuum center. This is because, for the positioning shown in the diagram above, it is easy for a gap to form between the chip resistor and the nozzle. The same consideration is required for the timing of the closure of the positioning catch.

## (2) Chucking pressure

The pressure with which the chip resistor is held during positioning is called the chucking pressure. This is normally set in the range 0.98N to 2.94N (100gf to 300gf) static pressure. In practice, in the same way as with mounting, as the chip is only gripped for a short time, a shock load is applied to it.

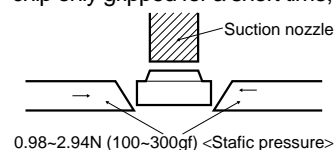


Fig.11

## (3) Adjusting the closure dimensions of the positioning catch

Adjust the closure dimensions so that the chip resistors are not destroyed due to excessive loading.

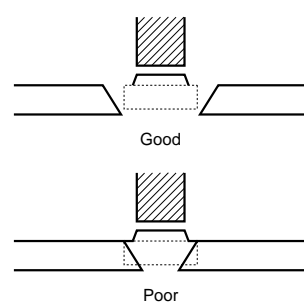
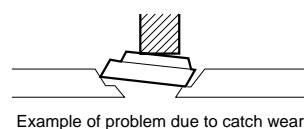


Fig.12

In addition, if the position catch is worn, the load on the chip will be concentrated and may result in cracking or splintering of the chip, or poor positioning accuracy. Careful inspection is required.



Example of problem due to catch wear

Fig.13

## Resistors

## ●Bending of the resistor body, separation of the electrodes and countermeasures

## (1) Mounting orientation of chip resistors

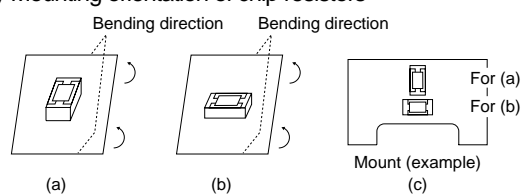


Fig.14

In terms of the strength of the stress applied to components a and b, b receives the greater stress.

## (2) Points to note regarding separated boards

Component d receives the greatest bending stress, followed by b, a and c in that order. With this pattern layout, separation of the electrodes due to bending stress is most likely to occur with components d, b and a. For this reason, the layout pattern should be revised so that d, b and a are subject to the same bending stress as c.

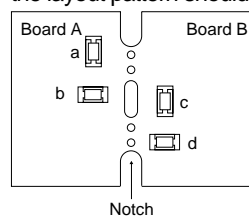


Fig.15

## Resistors

## ●Body bending and countermeasures

When applying adhesive with a dispenser to a board that already has chip resistors soldered onto the rear of the board, if the nozzle of the dispenser is too low, it will warp the board and may damage the solder connections and components on the rear of the board.

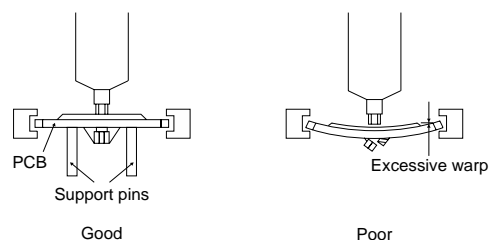


Fig.16

	Poor example	Improved example by land separation
Combined with components with leads		
Installation close to chassis		
Subsequent attachment of components with leads		
Side placement		

Fig.17

Set the nozzle to between 0 and 0.5mm above the surface of the board, and use support pins below the board to prevent warping. Be certain to check this again after changing the nozzle or adhesive syringe.

## ●Electrode separation and countermeasures

It is necessary to arrange the placement of the components so that they do not take too much of the installation solder. When chip and lead components are mounted together, or when mounting chip components near a chassis, partition the land so that excessive amounts of installation solder are not used (Fig.17). When using flow soldering, soldering problems may arise due to the placement of the components and the flow method of the board, so care is required. This is most likely to occur when small components are in the shadow of large components.

## Resistors

### ●Splintering of the overcoat glass and countermeasures

If excessive shock is applied to the component by the nozzle of the insertion machine, the overcoat glass may crack, causing resistance value to change. Pay attention to the following points.

#### (1) Reducing the nozzle weight

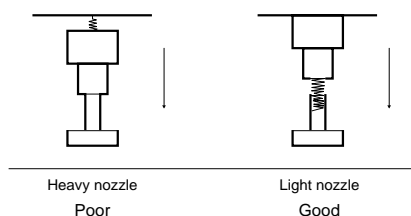


Fig.18

#### (2) Deceleration at the point of mounting

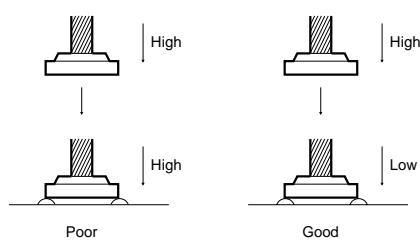


Fig.19

Decelerate the nozzle just before contact to reduce the shock load applied to the component.

### ●Splintering of the overcoat glass and countermeasures

#### (1) Nozzle control (optimization of the amount of paste and adhesive)

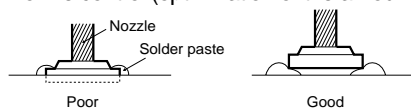


Fig.20

#### (2) Backup pin position

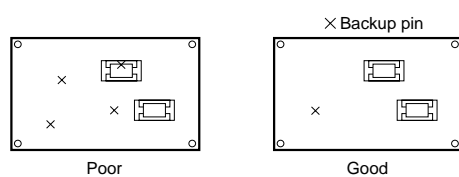


Fig.21

Ensure that there are no backup pins in the vicinity of the mounted chip, Either change the position of the chip resistor, or do away with the backup pins.

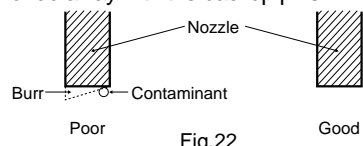


Fig.22



## Resistors

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### ●Hand-soldering chip resistors

Note the following points with regard to hand-soldering chip resistors.

- (1) Soldering iron tip temperature: 350°C
- (2) Solder correction time: 3secs. Max.
- (3) Preheating: as far as is possible
- (4) Adhesive: use if at all possible
- (5) Position: should not be inclined, do not apply a moment force to the chip
- (6) Soldering time: solder with the solder on both sides of the chip resistor in the wet state (if only one side is wet, strain will remain)

In general, there will be no problems when the soldering is performed by an experienced operator, but a combination of poor conditions may result in electrodes becoming separated.



When removing solder, try to keep the left and right sides uniform.



Do not attempt to solder again if the chip resistor body is inclined.

Fig.23

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