Application Note

Product Name: **Chip Resistor**

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CONTENT

1 Safety consideration

1.1 The products are designed and produced for application in ordinary electronic equipment (AV equipment, telecommunication equipment, home appliances amusement, etc.).If the products are to be used in devices requiring extremely high reliability (medical equipment, transport equipment, aircraft/spacecraft, nuclear power controllers, car equipment including car accessories, safety devices, etc.) and whose failure or operational error may endanger human life, please consult with the company，s Sale's Dept. to advance.

1.2 If product failures may result in serious damage, including that to human life, sufficient fail measures must be taken, including the following:

1.2.1 Installation of protection circuits or other protective to improve system safety.

1.2.2 Installation of redundant circuits in the case of single-circuit failure.

1.3 The products are designed only for use in a standard environment. If you use it in special environment, it will worsen product characteristic .Therefore, it is recommended the customer to verifying the product characteristic before using, it can't be used under the following condition:

1.3.1 Use outdoors where the products are exposed to direct sunlight, or in dusty places.

1.3.2 Use in places where the products are exposed to sea winds or corrosive gases, including Cl2, H2S, NH3, SO2, and NO2.

1.3.3 Use of the products in places subject to dew condensation.

1.3.4 Use in places where the products are exposed to static electricity or electromagnetic waves.

1.3.5 Use in proximity to heat-producing components, plastic cords, or other flammable items.

1.3.6 Use involving sealing or coating the products with resin or other coating materials.

1.3.7 Use involving unclean solder or use of water or water-soluble cleaning agents for cleaning agents for cleaning after soldering.

1.3.8 Use in various types of liquid, including water, oils, chemicals, and organic solvents.

1.4 The products are radiation resistant.

1.5 The company is not responsible for any problems resulting from use of the products under conditions not recommended herein.

1.6 The company should be notified of any product safety issues. Moreover, product safety issues should be periodically monitored by the customer.

2 Usage considerations

2.1 It is recommended the customer to verify the characteristics of products after on-board mounting.

2.2 It is strongly recommended the customer to verifying the characteristics after on board mounting if applying of a instant load (a large amount of load applied in a short period of time, such as pulse).If it exceeds the power rating under steady-state loading condition may negatively affect product characteristics and reliability.

2.3 It is recommended to be careful when pick up the products with tweezers, avoiding the overcoating and/ or the body breaking.

2.4 It is recommended to prevent the product from fall off to make product damaged.

2.5 It is recommended customer don't choose TC resistors with high resistance value in the high- humidity ambient. Although we have taken some action to improve the waterproofing of protective coating continually, it is still not perfectly, especially for the high resistance value, which is above 100KΩ. For the resistance element's thickness of high value resistors is thinner, the resistance element can be corroded by entering water molecule easier.

2.6 It is recommended to control the humidity of the end use side below 75%RH, for the TC resistors with high precision ±0.1%, it can be affected by ambient.

2.7 It is recommended to control the voltage below 100V although the working voltage for some types is above 100V when customer's design circuit.

2.8 After the surface of TC series high resistance resistors is coated with flux, the resistance value may be affected (exceeding the resistance value range). After the customer's evaluation, if necessary, corresponding cleaning measures can be taken to restore the resistance. In addition, if the surface of the resistor needs to be coated with other substances, the client needs to evaluate the impact on the product to avoid any impact during use.

2.9 Excessive humidity will affect the solderability of the resistor. During the rainy season, the humidity is high, and small-sized resistance products will cause tombstones and side-backs due to moisture during the welding process. In application, temperature and humidity need to be controlled.

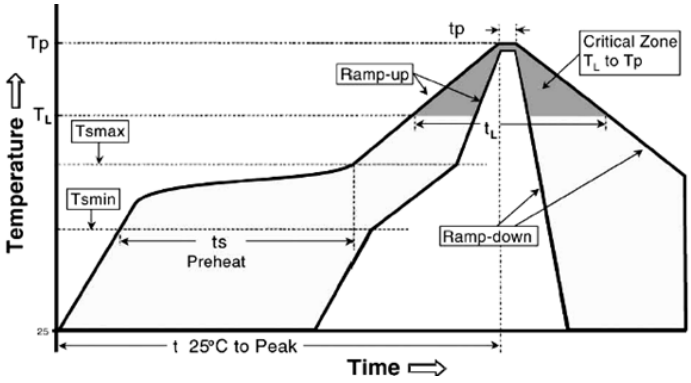
3 Mounting consideration

3.1 It is recommended to use reflow soldering for chip resistors, if flow soldering method is preferred, please consult with the company at advance. It is recommended to pay attention to the soldering condition to avoid silver leaching.

3.2 It is recommended the customer can't use highly active halogen (chlorine, bromine, etc.) flux, because the remainder of flux may negatively affect product characteristic and reliability.

3.3 After the surface of TC series high resistance resistors is coated with flux, the resistance value may be affected (exceeding the resistance value range). After the customer's evaluation, if necessary, corresponding cleaning measures can be taken to restore the resistance. In addition, if the surface of the resistor needs to be coated with other substances, the client needs to evaluate the impact on the product to avoid any impact during use.

Reflow Soldering Profile (solder: Sn 96.5 / Ag 3 / Cu 0.5):

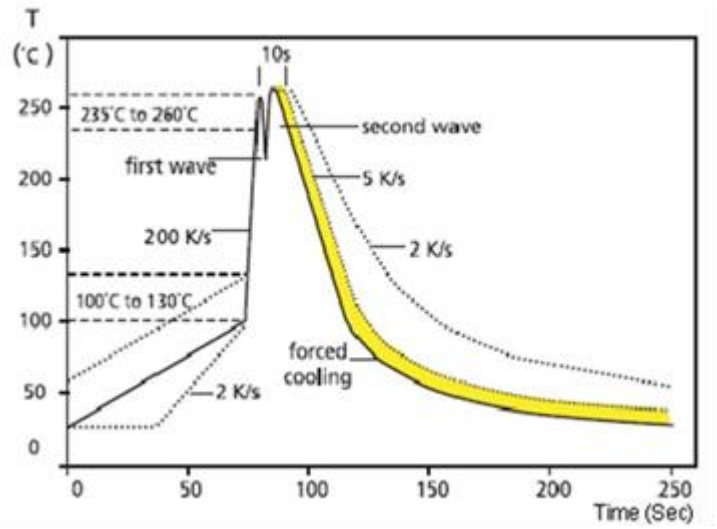


Profile Feature	Lead (Pb)-Free solder
Preheat： Temperature Min (Tsmin) Temperature Max (Tsmax) Time (Tsmin to Tsmax) (ts)	150℃ 200℃ 60 -120 seconds
Average ramp-up rate：(Ts max to Tp)	3℃ / second max.
Time maintained above :Temperature (TL) Time (tL)	217℃ 60-150 seconds
Peak Temperature (Tp)	260℃
Time within $^{+0}_{-5}$ ℃ of actual peak Temperature (tp)2	10 seconds
Ramp-own Rate	6℃/second max.
Time 25℃ to Peak Temperature	8 minutes max.

Allowed Re-flow times : 2 times

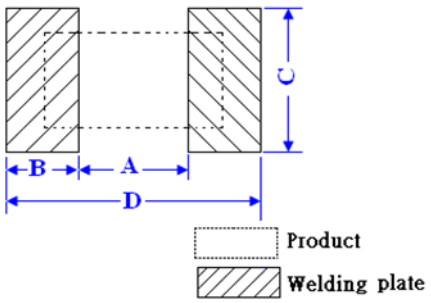
To avoid discoloration phenomena of chip on terminal electrodes, please use N2 Re-flow furnace.

3.4 Wave Soldering Profile (Apply to 0603 and above size)：



3.5 Soldering pad size recommended

Type	Dimension(mm)			
	A	B	C	D
01005	0.14±0.03	0.2±0.03	0.2±0.03	0.54±0.03
0201	0.25±0.05	0.35±0.05	0.4±0.05	1.0±0.05
0402	0.50±0.05	0.45±0.05	0.5±0.05	1.4±0.05
0603	0.9±0.05	0.65±0.05	0.8±0.05	2.1±0.05
0805	1.0±0.1	1.0±0.1	1.3±0.1	3.0±0.1
1206	2.0±0.1	1.1±0.1	1.6±0.1	4.2±0.1
1210	2.0±0.1	1.1±0.1	2.6±0.1	4.2±0.1
1812	3.2±0.1	1.4±0.1	3.3±0.1	5.8±0.1
2010	3.6±0.1	1.3±0.1	2.6±0.1	6.2±0.1
2512	5.0±0.1	1.6±0.1	3.3±0.1	8.2±0.1



3.6 Hand-soldering chip resistors

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

(1) Soldering iron tip temperature: 380℃

(2) Solder correction time: 3~4 secs.

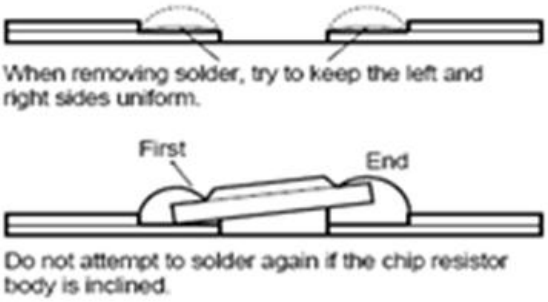
(3) Preheating: as far as is possible

(4) Adhesive: use if at all possible

(5) Position: should not be inclined, do not apply a moment force to the chip.

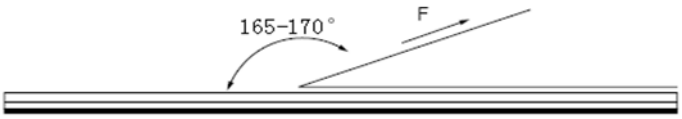
(6) Soldering time: solder with the solder on both sides of the chip resistor in the wet state (if only one side is wet, strain will remain)

(7) 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.



3.7 Peeling angle

The peeling angle must be within 165° to 170° which relatives to the bottom taping.



4 Storage consideration

4.1 The recommended storage condition for chip resistors is 20±10℃, below 70％R.H., and 6℃~35℃, 35~88%RH for dipping resistors, if the actual storage condition exceed the recommended condition, the characteristic of product and exposed connections may deteriorate.

4.2 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.

5 Exportation consideration

5.1 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.

6 Industrial property prohibitions

6.1 There 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.

6.2 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.

6.3 Infringement of the intellectual property of a third party.

6.4 Any problems incurred by the use of the products listed herein.

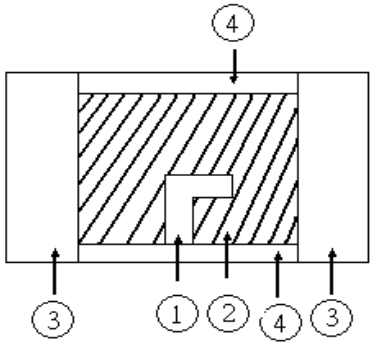
6.5 The company prohibits the purchaser of its products to exercise or use the intellectual property fights, industrial property rights, or any other rights that either belong to or are controlled by the company, other than the right to use, sell, or dispose of the products.

7 Technical Guidance

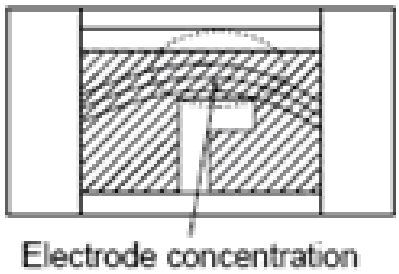
The design and specifications are subject to change without prior notice. Before ordering or using, please check the Latest technical specifications.

7.1 Overload failure mechanism

7.1.1 The failure mechanism of the component when an overload voltage is applied is explained below.(internal structure of chip resistor)

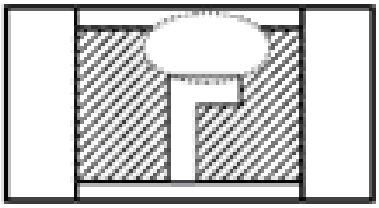


①Laser trimming groove
②Resistor body
③Electrode
④Alumina substrate
(Current concentration region)



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

(Cut off due to melting)



7.1.3 When an overload voltage is applied, joule heating caused by this current concentration caused the local temperature to rise. The heat generated is dissipated via the ceramic substrate. If the amount of heat generate 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 resistive material left trimming.

7.1.4 6.1.4 Failure mode analysis

Thermal dissipation: Heat generated is transmitted form the electrodes 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.

7.2 Over voltage failure mechanism

7.2.1 When a short-time overload voltage is applied, the resistance value will drop. When the short-time overload voltage exceeds a certain value, the resistance value will start to rise. However the short-time overload voltage increase to a certain limited value, the component goes open circuit. This is illustrated in Fig.1.

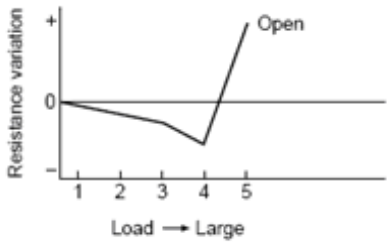
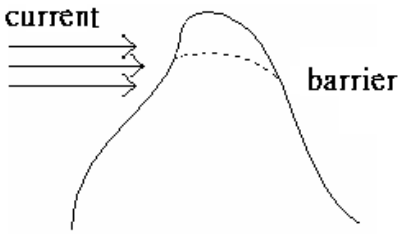


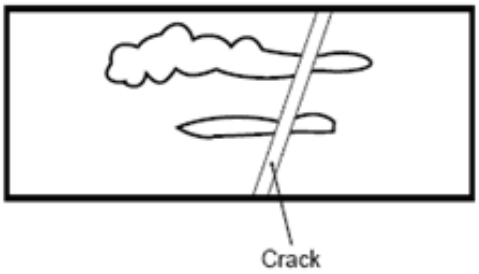
Fig.1

7.2.2 The resistance will be lower after the instant high voltage .the inside electric part is RuO2 and glass, it is the barrier conducting mode, if the barrier is higher, and the resistance will be higher. If the barrier is lower, the resistance will be lower .The barrier will reduce after suffered by the high voltage, at this time the resistance will be lower. The following is resistor element conducting structure and barrier conducting mode:



7.2.3 The barrier structure of resistor element is destroyed after suffered by the high voltage, so the barrier is reduced leading to the resistance being lower. (above picture)

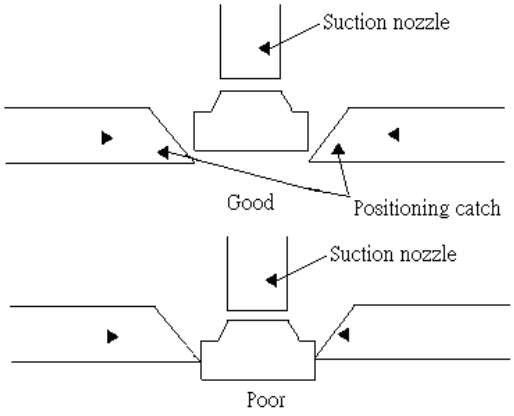
7.2.4 If the load is increased further, the metal conductive component heats up, and the resistance starts to increase. Under certain conditions, the resistors body melts or cracks, and due to differences in thermal expansion rates, the resistor body separates.



7.3 Overcoat glass, electrodes, and resistor body splintering failure mechanism

7.3.1 Chip resistors mounting

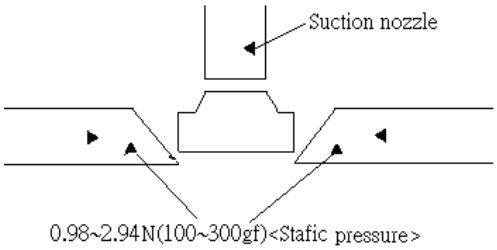
Chip resistors are mounted from four directions simultaneously. When mounting a chip resistor, use a positioning catch below the resistor as shown in Fig. 10 so that the resistor does not drop.



It is important for 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 from between the chip resistor and the nozzle. The same consideration is required for the timing of the closure of the positioning catch.

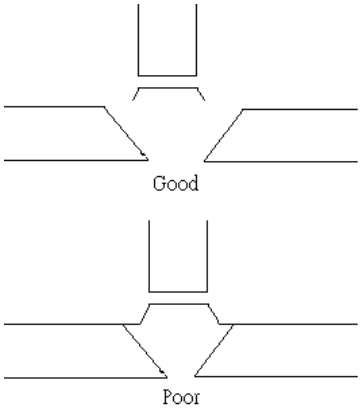
7.3.2 Chucking pressure

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

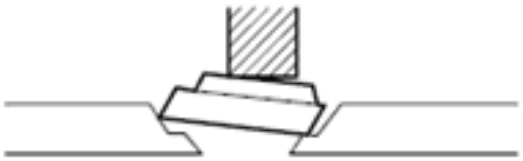


7.3.3 Adjusting the closure dimensions of the positioning catch

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



7.3.4 In addition, if the position catch is worn, the load in the chip will be concentrated and may result in cracking or splintering of the chip, or poor positing accuracy. It is necessary to inspect it carefully.

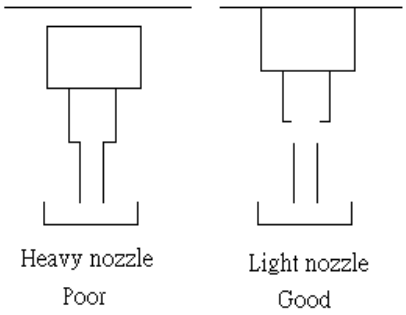


Example of problem due to catch wear

7.4 Splintering of the overcoat glass and countermeasures

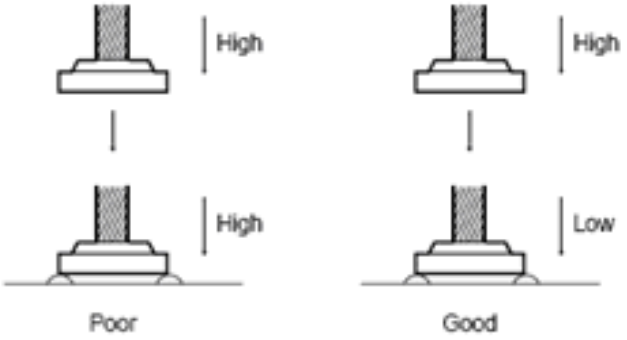
7.4.1 If excessive shock is applied to the component by the nozzle of the insertion machine, the overcoat glass may crack, causing resistance value to the following points.

(1) Reducing the nozzle weight



(2) Deceleration at the point of mounting

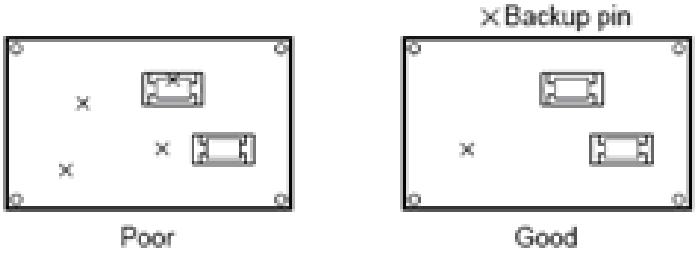
Decelerate the nozzle just before contract to reduce the shock load applied to components.



7.5 Splintering of the electrodes and body and countermeasures

7.5.1 Nozzle control (optimization of the amount of paste and adhesive)

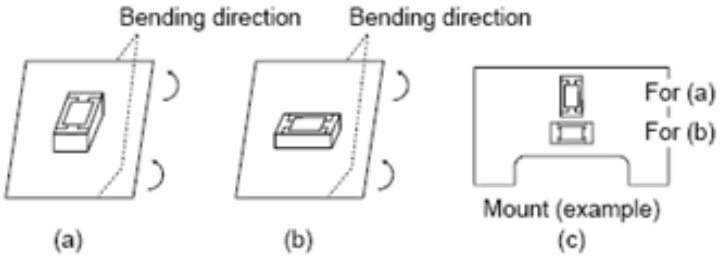
7.5.2 Backup pin position



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.

7.6 Bending of the resistor body, separation of the electrodes countermeasures

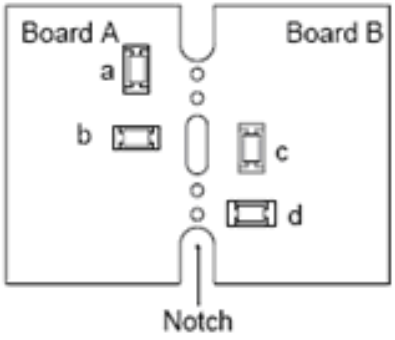
7.6.1 Chip resistors mounting



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

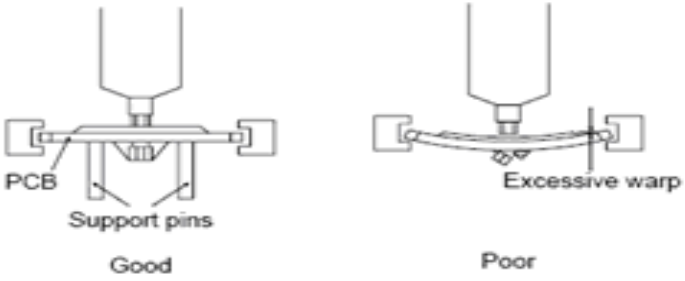
7.6.2 Points to note regarding separated boards

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.



7.7 Body bending and countermeasures

7.7.1 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 near of the board.



7.8 Electrode separation and countermeasures

7.8.1 It is necessary to arrange 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 (Figs. 2). 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 like to occur when small components are in the shadow of large components.

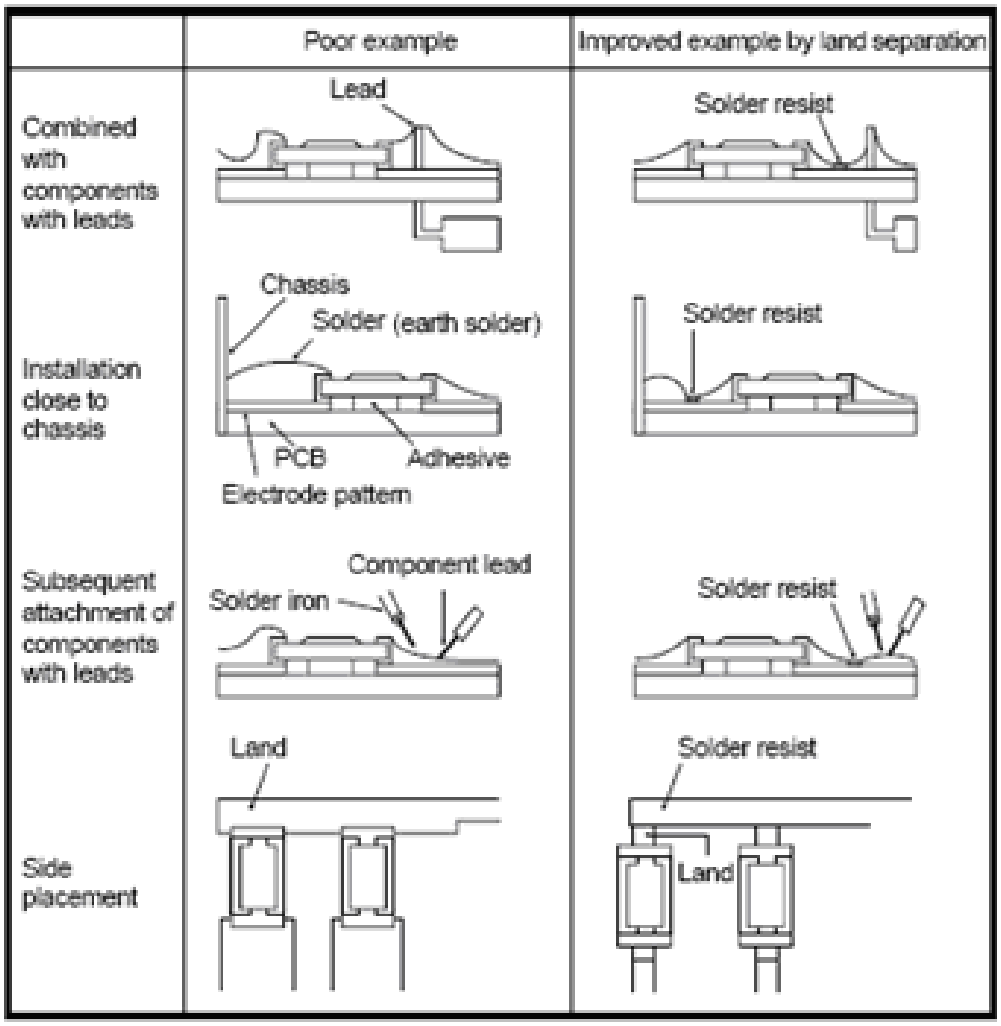
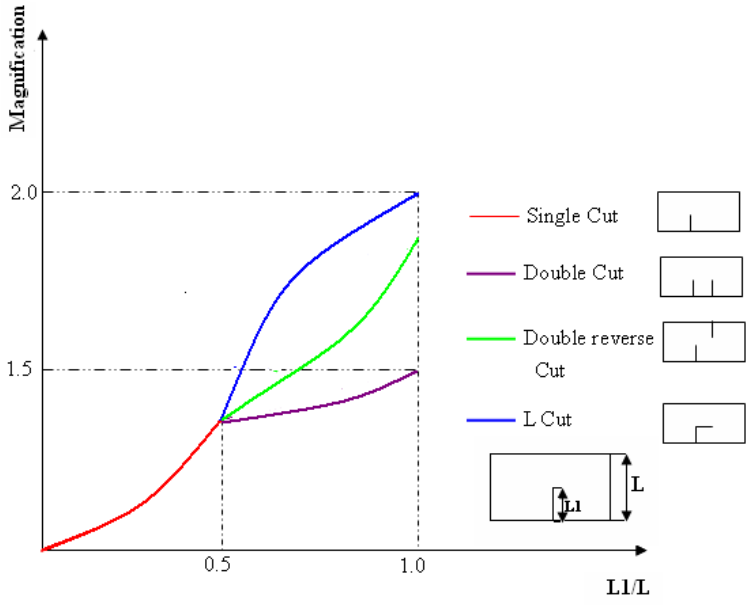


Fig.2

7.8.2 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.

8 Other matters

8.1 Resistance Increase vs. Trimming for Trimmable Resistors



L1=Total Trimmed Length

Trimming by laser increases the initial resistance Amount of resistance increase is dependent on the laser cut configuration as shown. L 1 means the total trimmed length of first and second cut, L means the available trimmed length. The first cut trimming length must not exceed 1/2 L to ensure power rating of the unit. The second cut trimmed length should equal as the first cut's.

8.2 Trimming parameter

(1) Filed lens focal of laser device is 150mm

(2) Focal plane is the surface of ceramic substrate, the resistive element should be trimmed completely.

(3) Trimming speed is 80mm/s , pulse is 130p/mm, and trimming power is 4.5W.

Notes

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- Application circuit diagrams and circuit constants contained herein are shown as examples of standard use and operation. Please pay careful attention to the peripheral conditions when designing circuits and deciding upon circuit constants in the set.

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