

Precautions for Use of Hitachi Diode

Be sure to read this information before use.

HITACHI

Hitachi Power Semiconductor Device, Ltd.

Precautions for Safe Use and Notices

If semiconductor devices are handled in inappropriate manner, failures may result. For this reason, be sure to read "Precaution for Use" before use.



This mark indicates an item about which caution is required.



CAUTION

This mark indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury and damage to property.



CAUTION

- (1) Regardless of changes in external conditions during use "absolute maximum ratings" should never be exceed in designing electronic circuits that employ semiconductors. In the case of pulse use, furthermore, "safe operating area(SOA)" precautions should be observed.
- (2) Semiconductor devices may experience failures due to accident or unexpected surge voltages. Accordingly, adopt safe design features, such as redundancy or prevention of erroneous action, to avoid extensive damage in the event of a failure.
- (3) In cases where extremely high reliability is required (such as use in nuclear power control, aerospace and aviation, traffic equipment, life-support-related medical equipment, fuel control equipment and various kinds of safety equipment), safety should be ensured by using semiconductor devices that feature assured safety or by means of user's fail-safe precautions or other arrangement. Or consult Hitachi's sales department staff.

(If a semiconductor device fails, there may be cases in which the semiconductor device, wiring or wiring pattern will emit smoke or cause a fire or in which the semiconductor device will burst)

NOTICES

1. This Datasheet contains the specifications, characteristics(in figures and tables), dimensions and handling notes concerning power semiconductor products (hereinafter called "products") to aid in the selection of suitable products.
2. The specifications and dimensions, etc. stated in this Datasheet are subject to change without prior notice to improve products characteristics. Before ordering, purchasers are advised to contact Hitachi's sales department for the latest version of this Datasheet and specifications.
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Refer to the following website for the latest information. Consult Hitachi's sales department staff if you have any questions.

<http://www.hitachi-power-semiconductor-device.co.jp/en/>

Precautions in Use

Hitachi semiconductor devices should be handled and utilized with the following information in mind.

1 Instruction for Handling

1.1 Axial lead type device

1. Handling lead

(1) Bending

- a) Bend a lead by holding it with a pair of pliers at a point at least 3mm away from the sealed body, as shown in Fig.1(a). Two 90° bending or a single 180° bending is allowed.

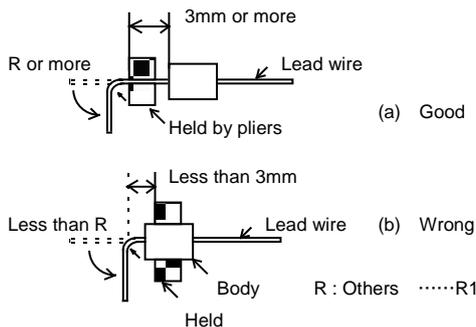


Fig. 1 Lead bending

- b) Bending a lead by holding its body with a pair of pliers or your fingers, as shown in Fig.1(b) must be avoided. Otherwise, the lead will be cut off or the body may get cracked. Additionally, it may result in degraded electrical capabilities and decreased reliability.

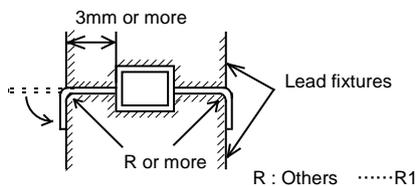


Fig.2 Lead bending fixture

- c) Any lead should be bent though a radius of at least 1mm. As shown in Fig.2, it is recommended to form the leads with a specified fixture.

(2) Tension

- a) The maximum tension applied along the axis of a lead should be 19.6N(2kg) within 1 minute for the 0.6 and 0.8 lead diameter series ; and 29.4N(3kg) within 1 minute for the 1.2 or more lead diameter series.
- b) A lead should be connected to a hole in a printed circuit board by keeping the body at least 1.5mm away from the PC board surface. This helps prevent PC board degradation due to heat, as well as direct stress on the body resulting from PC board warp. It is also necessary not to pull the lead by force from the back side of the PC board.

(3) Torsion

Only a single 90° torsion of a lead is allowed at point at least 3mm away from the body.

2. Soldering lead

(1) Soldering by iron (See Table 1)

- a) Soldering should be carried out to the point on the lead at least 5mm away from the body, otherwise, device damage can result.
- b) Semiconductor devices should be naturally cooled in air after soldering. Flux, which can cause corrosion problems, should be clearly removed with a liquid like methanol.

(2) Soldering by dip(See Table 1&2)

Table 1. Soldering standard for glass-molded diode

Soldering Technique	Lead length from body	Soldering iron	Solder temperature	Contact/dip time
Soldering Iron	5 mm	30 W	—	5s max.
	5 mm	60 W	—	3s max.
	10 mm	60 W	—	5s max.
Soldering Dip	3.2 mm	—	300°	5s max.
	5 mm	—	260°	10s max.

Table 2. Soldering standard for resin-molded diode

Type	Lead length from body	Solder temperature	Dip time
Others	3.2 mm	280°	5s max.

(3) Solder and flux

Soldering of semiconductor devices calls for solder and flux that are excellent in workability and do not cause corrosion. We recommend the following solder and flux :

- a) Solder : Pb . Sn (4:6), eutectic solder or equivalent (melting point 180°C)
- b) Flux : Solderite (Glass-sealed diode)
Rosin-Isopropyl alcohol (Resin molded diode)

3. Storage and service environments

(1) Storage environment

- a) It is recommended to store semiconductor devices in an atmosphere at approximately 25°C and low humidity (lower than 60%RH) and use them within six months.
- b) Do not store semiconductor devices in a location exposed to corrosive gases such as sulfur dioxide and chlorine gas.
- c) Improper storage may sometimes result in solderability degradation.

(2) Service environment

Use of a device in the environments listed below may cause or corrosion on the lead wire, and therefore affect solderability cautions must be taken.

a) Undesirable service environments.

- 1) Environment exposed to high temperature/humidity or open air.

- 2) Environment exposed to sulfur dioxide, chlorine gas, or other corrosive gases.
 - 3) Environment containing salt or corrosive chemical in the atmosphere.
- b) For planned use under such an undesirable condition, consult Hitachi in advance. It should be noted that semiconductor devices, if treated with varnish coating as shown in Fig.3, will increase their resistance to humidity by a factor of 3 to 4 times.
- 1) Use varnish resistant to heat in consideration of diode working temperature.
 - 2) Varnish coating should be carried out after lead forming has been completed. This helps prevent varnish from getting cracked.

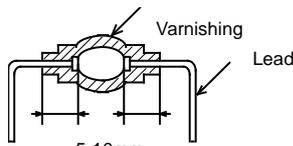


Fig.3 Varnish coating

4. Directions for epoxy molding

When electronic parts mounted on a PC board are finally epoxy-molded for their unit, note that embedding will affect heat radiation. Epoxy resins should be selected with the following characteristics in mind :

- a) Low mechanical stress and epoxy material which has a coefficient of thermal expansion less than $3.0 \times 10^{-5}/^{\circ}\text{C}$.
- b) Low in shrinkage (less than 4%)
- c) Free from lead-corroding elements.
- d) Resistant to hygroscopicity.
- e) Resistant to heat.
- f) Flame-retardant and resistant to arc and tracking.
- g) Excellent in insulating characteristics.

5. Effects of light and light source for glasssealed diode

There is a phenomenon inherent in semiconductors : that is, light has a significant effect on leakage current. Leakage current may change depending on the environment's light source condition (such as exposure to direct sunlight, photographic lamps, or fluorescent lamps), as well as the intensity of illumination. In an application where a characteristic of leakage current is utilized, consider the influences of light source and intensity of illumination in its circuit design.

6. Migration phenomenon

Make sure that moisture does not build up on the surfaces of PC boards, otherwise, shorts may occur between solder pads on the PC boards.

1.2 High voltage fast recovery diode

1. General instructions

For high voltage fast recovery diode, silicon pellets are coated by passivation material and molded by resin. Diodes must be carefully handled as follows.

2. Reverse voltage rating and creeping

Although a resin encapsulated diode is a high voltage device, its creeping distance is approximately 6 ~ 10mm. This is because the external shape is reduced as small as possible. (incorporated in the TV high volt- age multiplier box or FBT and remolded with resin or used in insulating oil) Consequently, reverse voltage and its characteristics under the specifications cannot be secured when it is used under ordinary atmospheric conditions. When testing each single device, observe the following procedure. (Unnecessary when the test is other than a reverse voltage impression test.)

(1) Method of remolding with epoxy resin.

When testing device characteristics or life test, remold with resin for approximately $8_{\text{mm}} \times 8_{\text{mm}} \times 40_{\text{mm}}$, to secure the creeping distance and the good heat radiation.

(Note): Regarding the handling method while remolding, refer to clause 4.

(2) Method of measuring in insulation oil

The following insulation oil is recommended since no cleaning is necessary.

FluorinertFC40

(product of Sumitomo 3M)

3. Storage

(1) The products should be stored at a temperature of less than 35°C and relative humidity of less than 70% away from direct sunlight and moisture. Upon storage, keep them packed until ready for use, and they should be used within 12 months.

(2) The storage room should not contain any corrosive gas (e.g. sulfurous acid gas and chlorine gas).

(3) When stored for a long time after unpacked, it must be stored and sealed in a dry box or in a moisture-proof package together with desiccant.

(*1) The box or package should be kept at less than 35°C and relative humidity of less than 70% and free from corrosive gas. Such products should be used within 30 days of unpacking.

*1 Degas and seal a vinyl bag thermally

(4) If the products are stored in an inadequate environment, the package molding may absorb moisture and solderability of the leads may be degraded.

4 . Cautions on lead handling

(1) Lead bending

Lead must securely be held by a pair of pliers, and bent at a position more than 3mm from the body portion as shown in Fig.4. The bending range shall be limited under this state to one side through 90° back-and-forth 2 times.

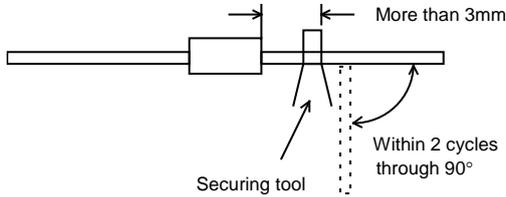


Fig.4 Lead bending

(2) Lead tensile strength

The tensile force acting upon a lead shall be limited to within 2kg and 10 seconds in the lead-out direction.

(3) Method using a soldering iron

Soldering position spaced from sealed portion	soldering iron	Work time
5mm	60W	3seconds

(4) Solder heat-resistant characteristic

The solder heat-resistant characteristic curves are shown in Fig.5.

(5) Other cautions

- 1) A diode body should not be dipped in solder bath.
- 2) A low-temperature solder (ex.: Pb . Sn eutectic solder, or equivalent, melting point(180°C)) and a corrosion resistive flux (ex.: Solderite) are recommended.

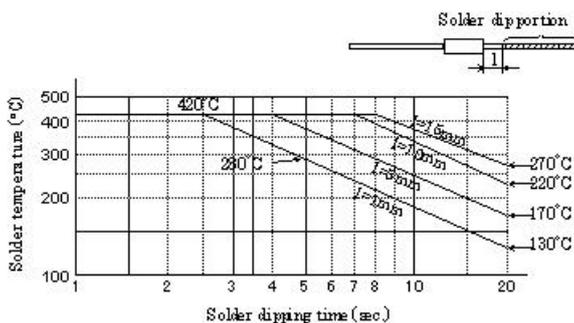


Fig.5 Solder heat-resistant characteristic

3) After soldering, leave it for natural cooling.

The flux should be completely wiped off with methanol.

5 . Handling of the body

Hitachi high voltage resin diodes are each cleaned in the final process, thus no special treatment is necessary before use.

As high voltage parts, however, they require care with regard to the points below.

(1) Do not touch the body with the bare hand or

fingers, but with nylon gloves or finger protectors, etc.

(2) Soldering flux weakens the adhesion of the glass to resin, so in the soldering process, be sure no flux adheres to the body.

(3) In the process of mounting the diode in a flyback transformer, if the body becomes contaminated, it is recommended that ultrasonic cleaning be done using HCFC (freon alternative) for about five minutes. Ultrasonic output should be 300W×29kHz or less.

6 . Selection of material for mold

The following performance characteristics are recommended for the resin to be used when molding the high voltage diode in a flyback transformer, etc.

- i) Excellent bonding strength with body.
- ii) Small mechanical stress exerted upon the components (resin diode and others).
 - Low expansion coefficient resin
- iii) Excellent insulating characteristics.
 - High volumetric intrinsic resistance
..... $\rho > 10^{15} \Omega \cdot \text{cm}$ (at 25°C)

Note : This implies that volumetric intrinsic resistance does not drastically drop at high temperature.

- High dielectric breakdown voltage
.....Over 20kV/mm
- iv) Excellent in moisture absorbing characteristics
 - Low coefficient of water absorption
.....Below 0.05% (wt%)
- v) Excellent heat resistivity
 - High thermal deformation temperature
..... $T_g > 140^\circ\text{C}$
- vi) Excellent non-inflammability as well as resistivity to arc and tracking

1.3 Surface Mount Diodes (SMD)

Large Package type : ZSH5MA27, ZSH5MAZ27

Small Package type : DSM1MA□, DSM3MA□
DFM1MF□, DAM1MA□□
DFM3MF□, DAM3MA□□

1 . Standard packing, recommended soldering pad dimensions, and applicable soldering methods.

Table3 and Table4 show standard packing, numbers of devices per reel, recommended soldering pad dimensions, and applicable soldering methods.

2 . Storage environment and treatment of unpacked products

(1) Storage environment and expiration

The packed products should be stored in a room at a normal temperature and a normal relative humidity (60% or less).

They should be used within 12 months.

(2) Treatment of unpacked products

- The unpacked products should be stored at a normal temperature (approximately 25°C and a normal relative humidity (60% or less). They should be mounted on printed circuit boards (PCBs) within 1 month of unpacking.
- If unpacked products have to be stored for longer than one month, seal them in a dry package and keep them in the environment mentioned in (1) above.

(3) Improper storage

An improper storage environment and/or storage period may reduce solderability. Check the solderability before mounting.

3 . Soldering pad dimensions (Example of a typical design)

(1) For Large Package type

* The dimensions of soldering pads shown in Table 3 are recommended regardless of PCB materials.

* The pads, except for soldering should be protected with solder resist as shown in Fig.6. This will help prevent of movement of components, solder absorption, provide electric insulation, and prevent moisture damage.

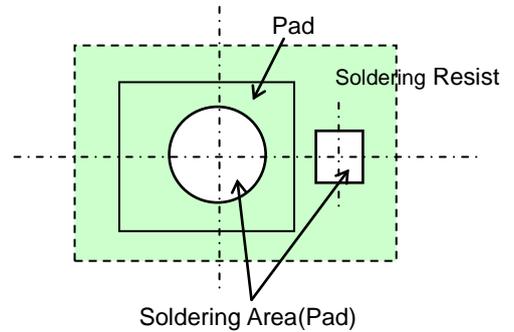


Fig.6 Soldering pad & resist pattern (for Example)

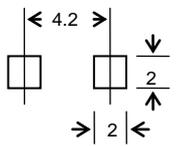
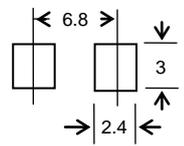
Table 3 Standard packing, recommended soldering pad, and applicable soldering methods for large package type.(Dimensions are in mm)

Type		ZSH5MA27,ZSH5MAZ27
Standard packing (Number of product per reel)	Embossed carrier taping	○ (1,200 pieces/reel)
	Magazine	—
Soldering Method (Refer to paragraph 4)	Reflow	○
	Flow	—
	Soldering iron (for correction)	○

○ : Available

— : Not available

Table 4 Standard packing, recommended soldering pad dimensions, and applicable soldering methods for small package type. (Dimensions in mm.)

Items \ Type		DSM1MA□ DFM1MF□ DAM1MA□□	DSM3MA□ DFM3MF□ DAM3MA□□
Standard packing (Number of product per reel)	Embossed carrier taping	○ (1500 pieces/reel)	○ (800 pieces/reel)
	Magazine	—	—
			
Soldering (See "4")	Reflow soldering	○	○
	Flow soldering	○	○
	Soldering iron (for correction)	○	○

○ : Available — : Not available

(2) For small package type

Products for consumer equipment which requires high mounting density tend to have extremely small soldering pads.

For power products, effective and efficient heat radiation from leads and pads is required, and wider pad area is necessary as shown in Figure 7

- The dimensions of soldering pads shown in Table 4 are recommended regardless of PCB materials.
- The dimensions of the radiating pads vary according to device types and must be calculated referring to their specification.

The radiating pads should be protected with solder resist or the like for prevention of movement of components, solder absorption, electric insulation, and moisture prevention.

4. Soldering

Table 5 shows typical methods for soldering devices on PCBs. To protect PCBs against damage by thermal shock during soldering, the soldering temperature must be controlled exactly, as described in the following paragraphs and tables.

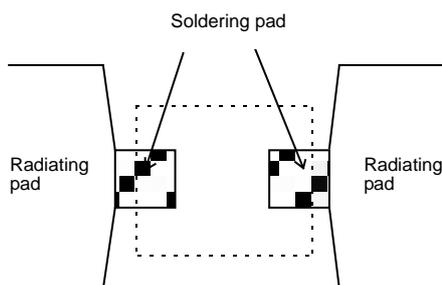


Fig.7 Soldering pad and radiating pad patterns (Example)

Table 5 Soldering methods and recommended conditions.

Soldering methods	Recommended conditions
• Reflow soldering Soldering in high temperature atmosphere	Table 6 (See Fig. 8 for temperature profiles.) Soldering should be done with once in principle, twice is allowed.
• Flow soldering (after dipping) Soldering by dipping the whole device in a solder bath.	Table 7 (See Fig. 9 for temperature profiles.)
• Soldering iron Re-soldering leads with a soldering iron.	350°C, 3 seconds or less (Temperature at the soldering tip just before heating.)

Table 6 Recommended reflow soldering conditions.(Example)

Item	Conditions	Remarks
Preheating	Temperature T1	80~150°C Surface temperature of body, Time of passing through the
	Time t1	2 to 5minutes Processing-atmosphere.
Soldering	Temperature T2	230~260°C
	Time t2	10 seconds

Y-axis: Surface temperature of body.

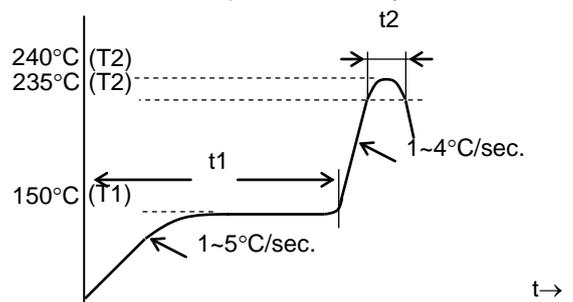


Fig.8 Temperature profile for reflow soldering (Example)

Table 7 Recommended flow soldering conditions.(Example)

Item	Conditions	Remarks
Preheating	Temperature T1	80~150°C PCB temperature (or atmospheric temperature)
	Time t1	1~3minutes
solder dipping	Temperature T2	230~260°C Solder bath temperature
	Time t2	2~4 seconds Dipping time (Time of passing through the solder bath)

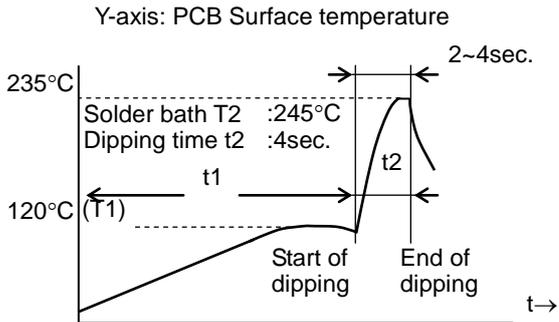


Fig.9 Temperature profile for flow soldering (Example)

5. PCB Washing

In washing PCBs with solvents after soldering to remove flux stains, attention must be paid not only to soldering efficiency but also to treatment of waste water and solvent for prevention of environmental pollution.

(1) Solvents for washing resin flux

The use of some solvents (freon, trichloroethylene, etc.) are prohibited by the freon regulations. Although freon alternatives (HCFC), alcohol solvents, or organic solvents are available as solvents to wash resin flux, it should be noticed that solvents which are more effective to remove resin flux also cause more damage to PCB markings and device characteristics.

(2) Dip-washing and steam-washing

These washing methods wash PCBs chemically and give the least damage to devices. The temperature of the washing solvent should be 50°C or less and the washing time should be 3 minutes or less.

(3) Ultrasonic washing

This method washes PCBs mechanically by vibrations and impacts, giving high washing effects in a short washing time. A long-time ultrasonic washing should be avoided because it has fatal results on devices such as reduction of contact between the casing resin and metallic leads. The ultrasonic washing time should be as short as possible. Hang the PCBs in the washing bath so that the PCBs and their components do not touch the ultrasonic vibrator in operation.

The ultrasonic effects on PCBs and their

components are dependent upon the size of the washing bath and the installation of components. Perform test washings to determine optimum washing conditions.

Recommended conditions:

- * Frequency: 27kHz to 29 kHz
- * Ultrasonic output: 15W/l to 20W/l
- * Washing time: 30 seconds or shorter

(4) Washing water-soluble flux

Water-soluble flux can be washed away by hot water or alkaline water. Perform test washings to determine optimum washing conditions.

6. Notices on the use of products

(1)

⚠ CAUTION
Power diodes are frequently used in AC and DC circuits directly connected to a power source. If a power failure occurs, power (energy) is short-circuited by diodes. Accordingly be sure to equip the board with a protection means such as a fuse. (The short-circuited diodes or circuit pattern may possibly be parched or burnt out.)

(2) Components mounting by an automatic handler.

Components can be mounted on PCBs automatically by automatic handlers (using vacuum-picking and part chucking methods).

Be careful not to apply any excessive static load (500 g.f or more for 10seconds or longer) or impact force (10N to 20N (1 kgf to 2kgf) or more) to components in automatic mounting.

(3) Re-soldering

(a) For large package type

Improper soldering can be corrected by a soldering iron. Table 8 shows recommended re-soldering methods. The pad component being re-solded should be preheated to 120°C before soldering.

Table 8 Recommended re-soldering methods with a soldering iron.

Item	Temperature at the soldering tip (Note 1)	Preheating120°C/ Recommended methods
Shortage of solder	350°C (about 5~6 seconds or less)	The first heating to terminal side within 3 seconds and just after heating to base side within 3 seconds.
Improper position of components	250°C (about 10 seconds or less)	The first heating to terminal side within 3 seconds and just after heating to base side within 5 seconds.

(Note 1) The temperature just before heating

For heating, apply the soldering tip to both the soldering pad and components directly, where the component makes contact with the soldering pad on the PCB.

Re-soldering should be done within once.

If a second re-soldering is required, remove components which are improperly soldered from the PCB, clean their soldering site, mount new components on the PCB correctly, then solder them with a soldering iron.

(b) For small package type, improper soldering can be corrected by a soldering iron (See "Soldering iron" in Table 5). Remove components which are improperly soldered from the PCB, clean their soldering site, mount new components on the PCB correctly, then solder them with a soldering iron.

(4) Coating the PCBs

PCBs on which components are mounted can be coated with resin for protection (e. g. against moisture). Basically, resin coatings will reduce the effect of heat radiation and some PCB resin coatings will have an increased leakage current when they absorb moisture. Further, the coating resin may give mechanical stresses to contacts

and plastic parts when they are hardened and shrunk.

Select optimum coating resins and check the reliability of performance of PCBs after coating.

(5) Migration

In general components to be mounted on the surface of a PCB have leads which are arranged very close to each other, and are operated with high DC voltages. They are mounted densely on PCBs. Therefore, any moisture on the PCB will cause a migration (metal transfer, a kind of electrochemical corrosion) among leads and pads on the circuit pattern.

(6) Protection against electro-static discharge

SMD type diodes are not as sensitive to electro-static discharge (ESD) as MOS devices. They do not need particular means (in shipping, packaging, treatment, etc.) to protect against ESD.