Chapter 6 Precautions for Mounting and Handling

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This chapter describes the precautions for mounting and handling.

1. Electrostatic Destruction Prevention Measures

Compared with small-signal MOSFET and IC, although IGBT has significantly higher electrostatic breakdown tolerance, they can be destroyed by static electricity.

＜How to remove static electricity from a conductor＞

As shown in Fig. 6-1, the static electricity charged on the conductor can be removed by proper use of conductive table mats, wrist straps and floor mats. The speed at which the charge is removed is determined by the resistance of the discharging path. Fig. 6-2 shows the equivalent circuit when the charged object of the conductor has a capacitance *C* and the path resistance is *R*. The voltage of the charged object is given as a function of time *t* as follows.

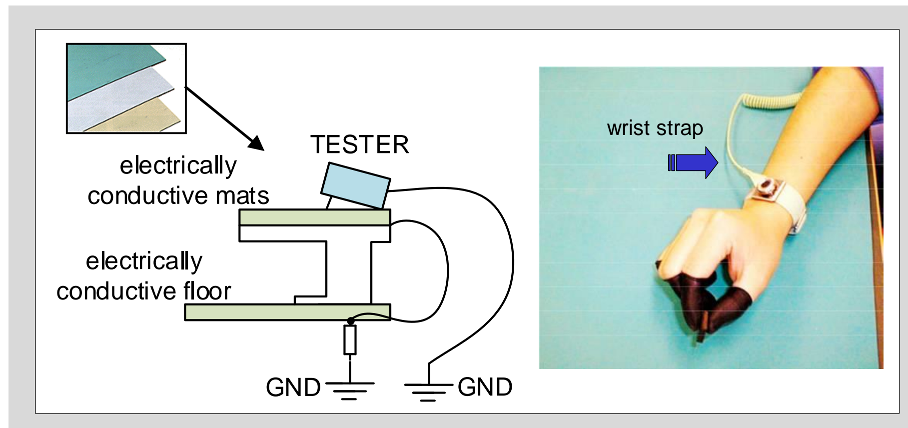

Fig.6-1 Example of measures against breakdown by static electricity

$$V = V_0 \cdot \exp\left(-\frac{t}{RC}\right)$$

V : Voltage of the charged body at time t [V]
V_0 : Initial voltage of the charged body [V]
t : Second [sec]
C : Capacitance of the charged body [F]
R : Path resistance [Ω]

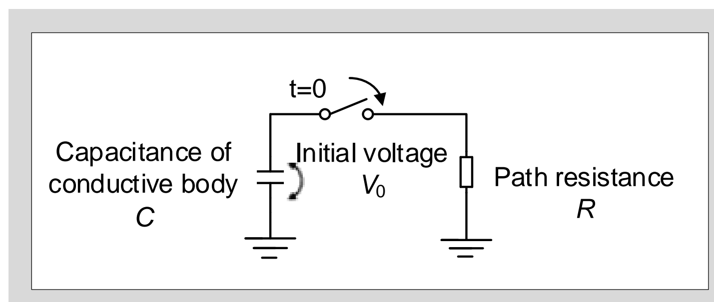

Fig.6-2 Equivalent circuit for static electricity discharge

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<Example>

This example shows how to calculate the resistance when the static electricity level of workers is decreased to 100V or lower within 1 second according to technical document TB57-1 of the Electronic Industries Association of Japan (EIAJ, currently JEITA). Substitute the following into the formula:

V = 100V (safe voltage), V_0 = 10kV (Initial voltage of the human body or charged body)
t = 1sec. (Longest permissible time for achieving the safe voltage of 100V)
C = 200pF (Average value of human body capacitance of 100pF to 400pF)
R = Max. permissible resistance to the ground [Ω]

$$100 = 1 \times 10^4 \cdot \exp\left(-\frac{1}{200 \times 10^{-12} \cdot R}\right)$$

Thus, R ≅ 1.09 × 10^9Ω = 1090 MΩ is obtained. From this calculation, it is found that if the resistance from the table mat, floor mat, or wrist strap to the ground is 1000MΩ or lower, discharge to a safe voltage of 100V can be achieved within 1 sec., and the devices can thus be protected against electrostatic breakdown. Table.6-1 lists the voltage range in which various devices may result in breakdown due to electrostatic discharge from workers.

Table.6-1 Breakdown voltage by device

Type	Voltage range [V]
IGBT, MOSFET	100～200
Junction FET	140～10000
C MOS	250～2000

2. Soldering

During soldering, usually the temperature of the terminal exceeds the max. T_{stg}. Pay attention to the following when soldering.

(a) Recommended mounting condition

Package	Method				
	Wave Soldering (Full dipping)	Wave Soldering (Only terminal)	Infrared Reflow	Air Reflow	Soldering iron (Re-work)
TO-247	×	◎	×	×	○

◎ : Possible ○ : Limited to once × : Not possible

Soldering temperature	Immersion time
260±5℃	10±1 sec
350±10℃	3.5±0.5 sec

(b) The immersion depth of the terminal should be 1 to 1.5 mm away from the package.
(c) Be careful not to immerse the product in the soldering liquid when mounting the device by the solder flow method.
(d) When using flux, it is desirable to use rosin-based flux, and not chlorine-based flux.

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3. Processing and Mounting of Through Hole Terminal

(a) Stress to the terminals

Applying unnecessary stress to the terminals will damage the internal chip and external package.
The load applied in the direction shown in Fig. 6-3 should be 1 kg or less.

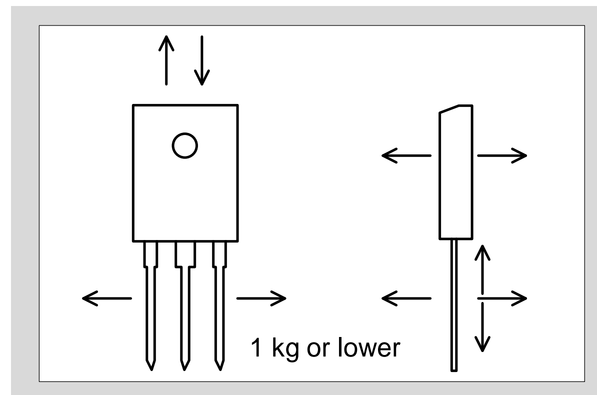

Fig.6-3 Stress to the terminals

(b) Cautions in molding terminals

If there is no other choice but to mold terminals for convenience of parts layout, pay attention to the following:

- Use special jigs that does not put stress on the internal chip and external package.
- When bending the terminal in the horizontal direction, bend it at a distance of 4.5mm or more away from the package, and keep the bending angle within 30° (Fig.6-4).
- When bending the terminal at right angle against the package, bend it at a point that is at least 4.5mm or more away from the package.
- Molding should be performed only once at a place, and do not perform re-molding or restore to the original shape.

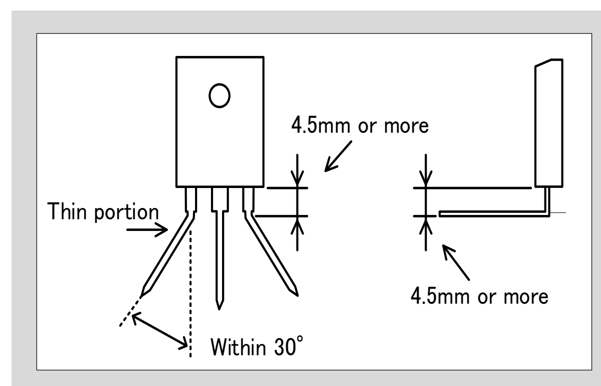

Fig.6-4 Cautions in molding terminals

(c) Insertion into printed circuit board

When inserting terminals into printed circuit board, coincide the distance between terminals and that of insertion holes to prevent excessive stress from being applied to the base of the terminals.

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4. Cleaning

When soldering is performed with using flux, cleaning with solvent is required. In this case, pay attention to the following :

(a) Solvent

- Do not use flammable, toxic, and corrosive solvent.
- Never use trichloroethylene series solvent because it contains chlorine.

(b) Cleaning method

Soaking is recommended. When conducting ultrasonic cleaning, set the frequency to avoid the resonance point (several tens of kHz), and be careful not to let the device or printed circuit board to come into contact with the oscillation source directly.

5. Mounting to Heat Sink

(a) If the tightening torque of the mounting screw is too small, the thermal resistance will increase and there are risks of thermal destruction. We recommend values within the range shown in Table 6-2.

Table.6-2 Semiconductor device tightening torque

Package	Diameter of mounting hole	Used screw	Optimum tightening torque (N • cm)
TO-247	φ3.2	M3	40-60

(b) It is recommended to apply grease thinly and uniformly to improve the thermal conductivity between the device and the heat sink to improve heat dissipation.

(c) Application of thermal grease

In order to fill the gap between the device and the insulating sheet, and between the insulating sheet and the heat sink with thermal grease, apply the grease in dots to the case and the surface of the heat sink directly under the semiconductor chip, and tighten the heat sink with screws with the recommended tightening torque.

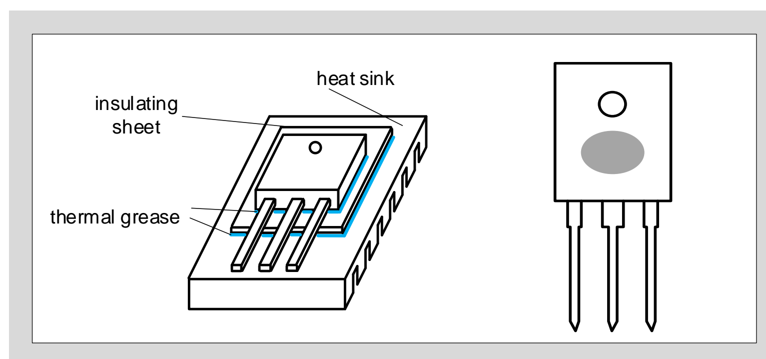

Fig.6-5 Thermal grease application

(d) Surface flatness of heat sink ≦ ±30μm

(e) Surface roughness of heat sink ±10μm

(f) Do not taper the screw holes.

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