JJMICROELECTRONICS

Assembly Instructions for Power Discretes in Through-hole Packages

APPLICATION NOTE

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1. Introduction

This application note provides assembly instructions for JJM power discrete devices in through-hole packages such as TO220, TO3P, TO247, and so on.

2. Precautions for device lead forming

I. Stress on leads

If excessive stress is applied to the leads of a through-hole device, the device can be damaged. The force applied in all directions, indicated by arrows shown in Fig. 1, must be less than or equal to 9.8 N.

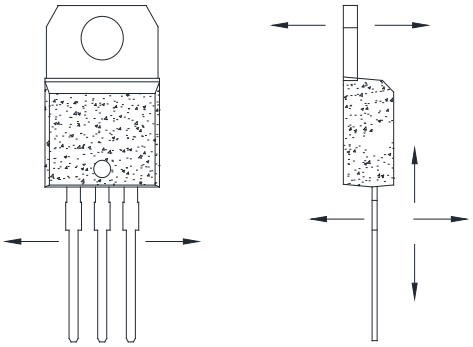

Fig. 1 TO-220 package and the force applied

II. Lead forming

- Special forming fixture and equipment with stress less than 9.8N shall be used. Alternatively, use two slender flat-nose pliers to do the lead forming. Use one pair of pliers to clamp the lead between the bend on the lead and the device body, and then use another pair of pliers to clamp the remaining part of the lead for bending, as shown in Figure 2.

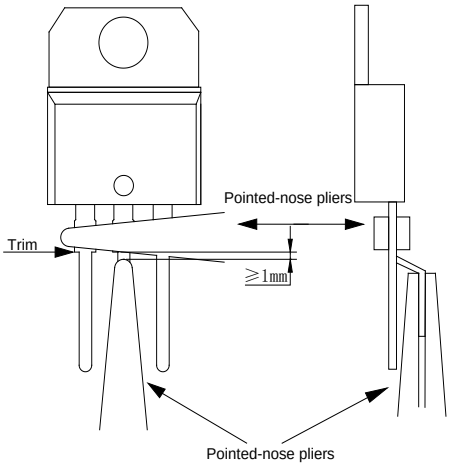

Fig. 2 Lead forming with pliers

- When bending the leads laterally, as shown in Figure 3, leads can be bent as near to the trim as

required but allow an adequate length of minimum 1mm from the trim to the start of a bend radius for bending. The angle must be ≤ 30 °.

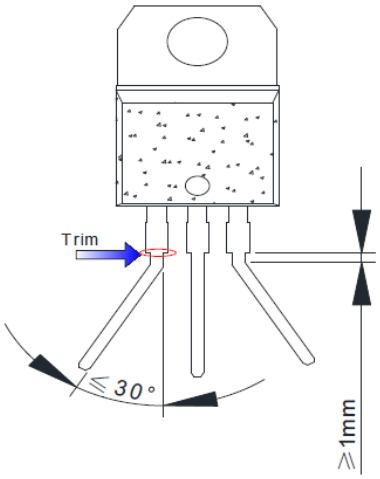

Fig. 3 Lead bending laterally

- When bending the leads vertically (perpendicular to the silk screen surface of the device), as shown in Figure 4, bend at a certain distance L (refer to table 1) from the body. See Table 1 below for details.

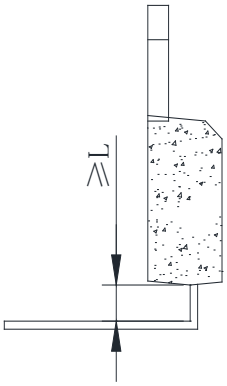

Fig. 4 Lead bending vertically

Table 1. Recommended L values for different packages

Package	L（mm）	Package	L（mm）	Package	L（mm）
TO-202-3	⩾2.5	TO-220B	⩾5	TO-3P	⩾4
TO-126, SOT-82	⩾3.5	TO-220C	⩾4.5	TO-247J	⩾5.5
TO-251	⩾3	TO-220F	⩾5	TO-247S	⩾5
TO-220A	⩾5	TO-262	⩾4.5	ITO-247	⩾5

3. Precautions for heatsink selection & mounting

I. Heatsink requirements

When mounting through-hole power discrete products on heatsinks, use heatsink with completely smooth surface and free of burrs or metal shavings. For the requirements on the roughness and flatness please refer to Table 2.

Table 2. Heatsink roughness & flatness requirements

Roughness of the mounting area	RZ≤10μm
Flatness of the mounting area	≤10μm (Heatsink size 15mm)

II. Heatsink mounting methods

Depending on different packages, there are three main methods for fixing devices to heatsink, screw mounting, spring clip mounting and rivet mounting. The first two mounting methods are generally recommended. As the force of rivet mounting method is not easy to control, it is generally not recommended.

a. Screw Mounting

Direct mounting method

- Through heatsink with nut, as shown in Figure 5. Corresponding heatsink requirements are shown in Figure 6.

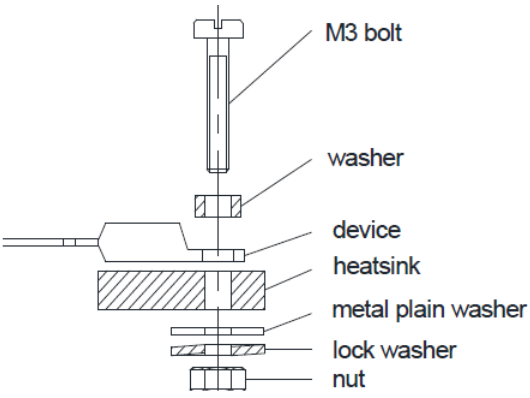

Fig. 5 Screw mounting assembly

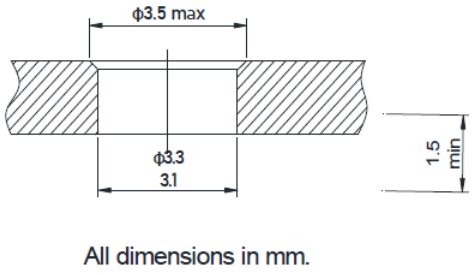

Fig. 6 Heatsink requirements

- Into tapped heatsink as shown in Figure 7. Corresponding heatsink requirements are shown in Figure 8.

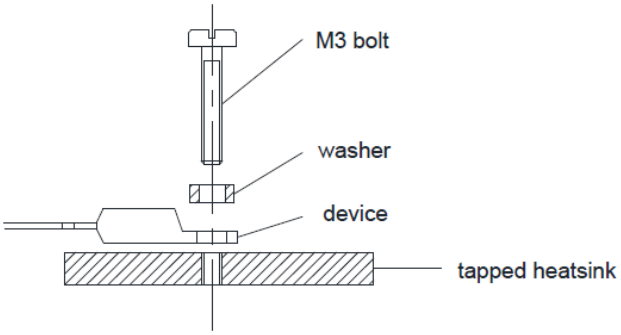

Fig. 7 Screw mounting assembly

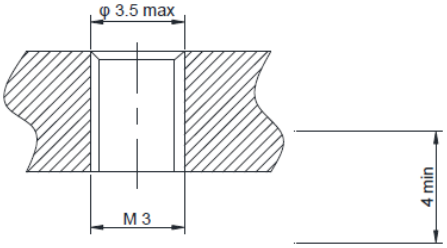

Fig. 8 Heatsink requirements

The above two screw mounting methods are more suitable for insulated package, such as TO-220A, TO-220F, TO-3P, and ITO-247.

For non-insulated packages, such as TO-220B, TO-220C, and TO-247J, although the direct mounting method provides good heat dissipation performance, it has one disadvantage - heatsink is electrified. In order to solve this problem, an insulating washer can be added between the heatsink and the device.

Insulated mounting with screw and spacing washer

- Through heatsink with nut, as shown in Figure 9. Corresponding heatsink requirements for 500V insulation are shown in Figure 10; Corresponding heatsink requirements for 800V insulation are shown in Figure 11.

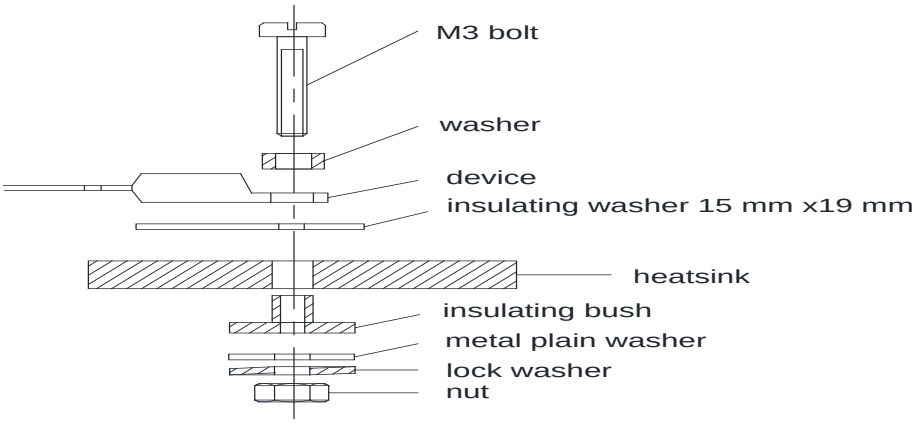

Fig. 9 Insulated screw mounting with washer

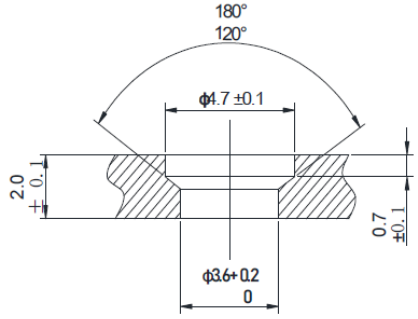

Fig. 10 Heatsink requirements for 500V insulation

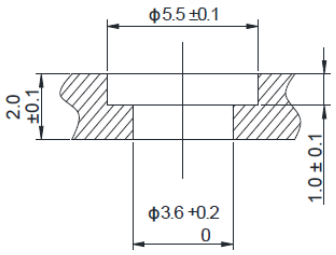

Fig. 11 Heatsink requirements for 800V insulation

- Into tapped heatsink, as shown in Figure 12. Corresponding heatsink requirements for 500V insulation are shown in Figure 13; Corresponding heatsink requirements for 800V insulation are shown in Figure 14.

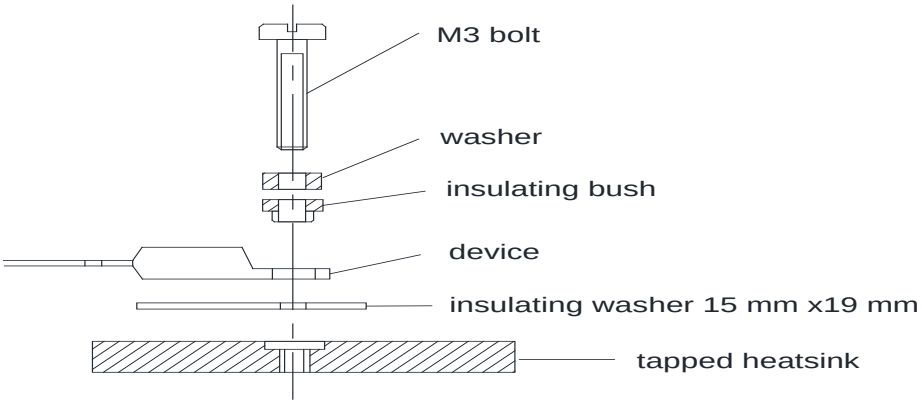

Fig. 12 Insulated screw mounting with washer into tapped heatsink

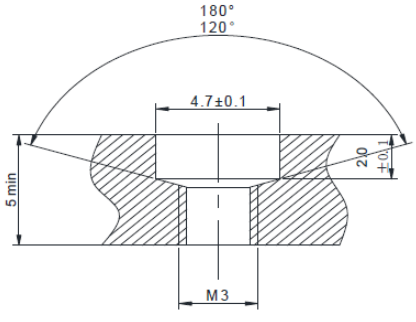

Fig. 13 Heatsink requirements for 500V insulation

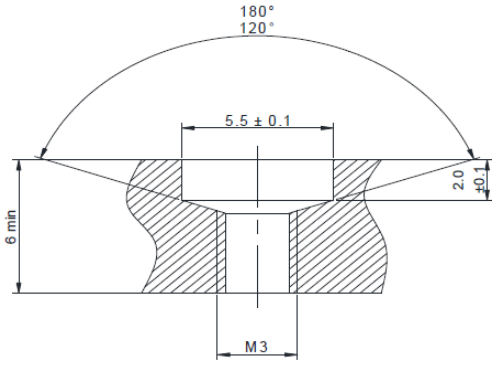

Fig. 14 Heatsink requirements for 800V insulation

Tightening torque requirements

Please use torque wrench, torque screwdriver and socket wrench for device installation. For different packages, control the mounting torque according to table 3.

Table 3. Torque reference table

Package	Bolt Φ	Maximum torque	
		N·M	Kgf·cm
TO-220B, TO-220C, TO-220F	M3	0.6	6.12
TO-220A	M3	0.8	8.16
TO-247J	M3	1.0	10.20
TO-3P, ITO-247	M3	1.4	14.28

b. Direct mounting with spring clip

TO-247S has no locating hole. Users can use direct mounting with spring clip when installing heatsink. This method is applicable to all other through-hole packages.

- Punch a suitable hole on the heatsink, and mount the device on the heatsink with 15N~50N spring clip, as shown in Figure 15.

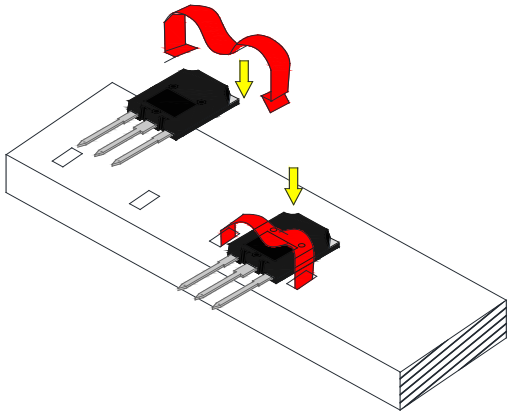

Fig. 15 Direct mounting with spring clip – A

- Mount the device on the heatsink using 15N ~ 50N spring clip, as shown in Figure 16.

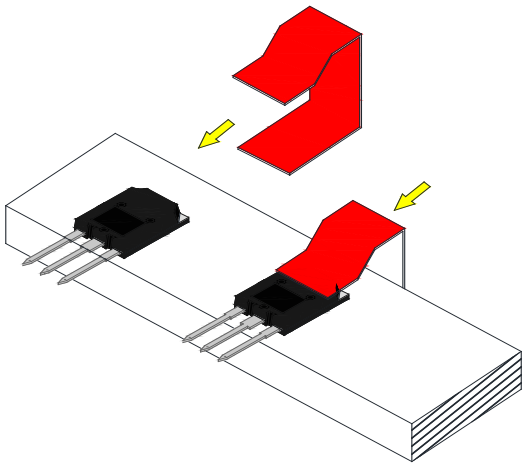

Fig. 16 Direct mounting with spring clip - B

- For heatsink with trench structure, use a 25N ~ 50N spring clip to mount the device on the heatsink, as shown in Figure 17.

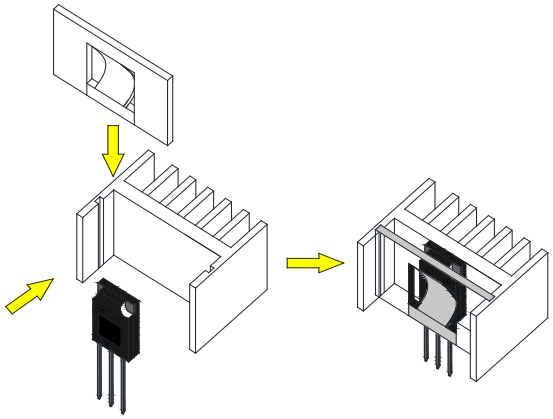

Fig. 17 Direct mounting with spring clip - C

- When multiple devices are used, metal strip with bolts at both ends can be used to fix the devices on the heatsink (as shown in Figure 18). The bolt torque should be less than 0.49N·M.

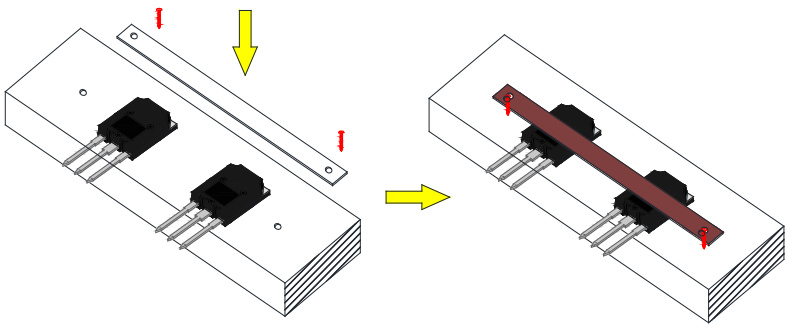

Fig. 18 Direct mounting with metal strip and bolts

- If both insulation and fixation are required, there are two options:

1. Add an insulating washer between the heatsink and the device for insulation, and select a suitable heatsink mounting methods from A to D.
2. Use solderable materials (such as Cu) for the heatsink substrate and 0.5 ~ 1.0mm thick tinned alumina (AL_2O_3) for the insulating ceramic sheet. Solder the heatsink substrate, the insulating ceramic sheet and devices together, as shown in Figure 19. See Figure 20 for soldering requirement.

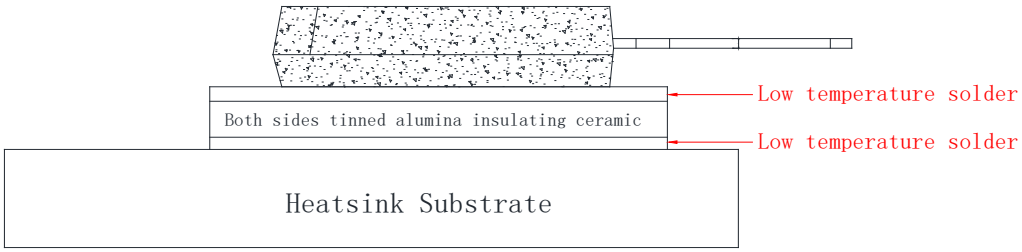

Fig. 19 Soldering the heatsink substrate, the insulating ceramic sheet and device

Note: Alumina ceramic sheet is a brittle material. The flatness of the heatsink must be ensured to prevent break during installation.

c. Rivet mounting

Unless special attention is paid, general rivet is not recommended for mounting heatsink. This mounting method may produce great stress which cannot be quantified and controlled and may lead to deformation of metal base plate, chip fragmentation and device failure. If rivets must be used for mounting, in order to reduce the failure rate, it is recommended to follow the following rules:

1. Heatsink roughness and flatness requirements as shown in table 2;
2. Heat sink mounting hole should be smaller than the mounting hole of the device;
3. The rivet shall have a gap with the metal tab of the device while have no gap with the heatsink mounting hole;
4. The metal tab side of the device shall be the rivet head, not the rivet mandrel;
5. The rivet and the mounting hole shall be perpendicular (the rivet head shall be in full contact with the metal tab of the device on the whole circumference);
6. After riveting, the rivet head shall not contact the plastic part of the device.

III. Other tips

a. Apply a smear of aluminum oxide compound between the contact surfaces to reduce

the thermal resistance from mounting base to heatsink.

b. The device should be mounted to the heat sink first before being assembled on the PCB, and soldered. This can minimize the stress applied to the device leads.

4. Soldering

- Maximum permissible at a distance from the body of > 2mm.
- The soldering iron's maximum permissible power is 80W. Maximum permissible temperature is 260℃ and for a total contact time with the soldering iron of < 10s. Or Maximum permissible temperature is 350℃ and for a total contact time with the soldering iron of < 3s.
- Solder and flux
  a. Solder: Pb:Sn ≤ 4:6; Low melting point solder (melting point:180℃), for example Sn63
  b. Flux: Solderite
- Reflow thermal profile, as shown in Figure 20.

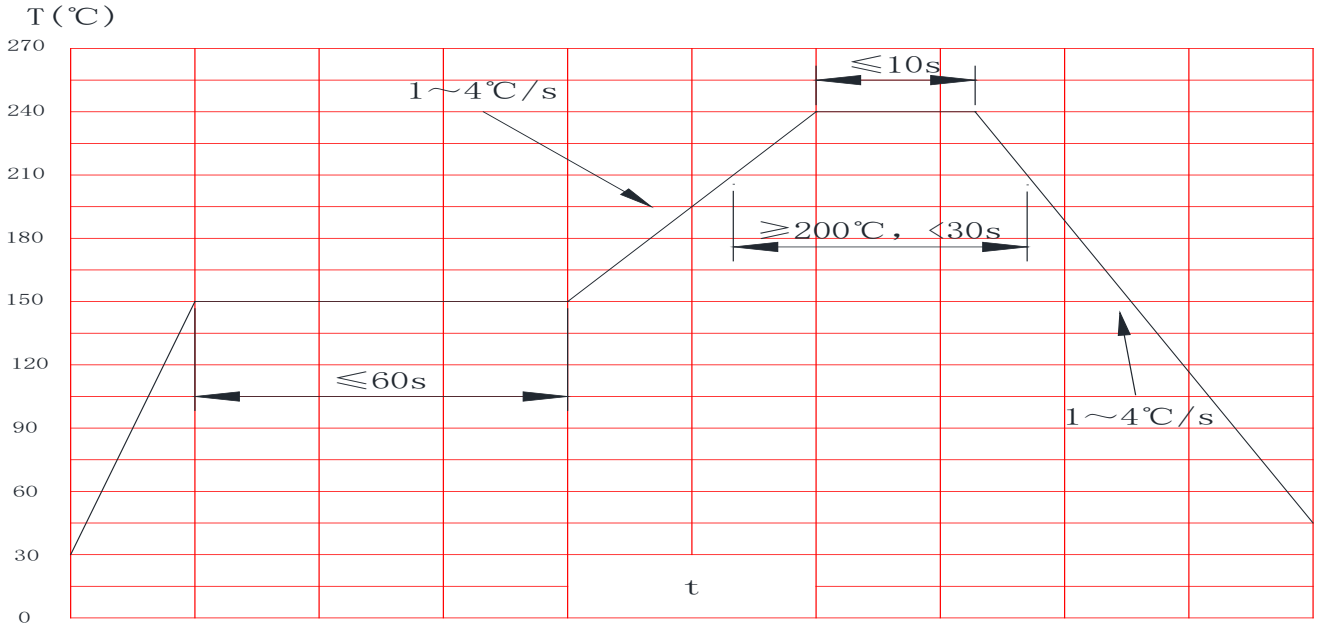

Fig. 20 Reflow thermal profile

- Dip or wave soldering thermal profile, as shown in Figure 21.

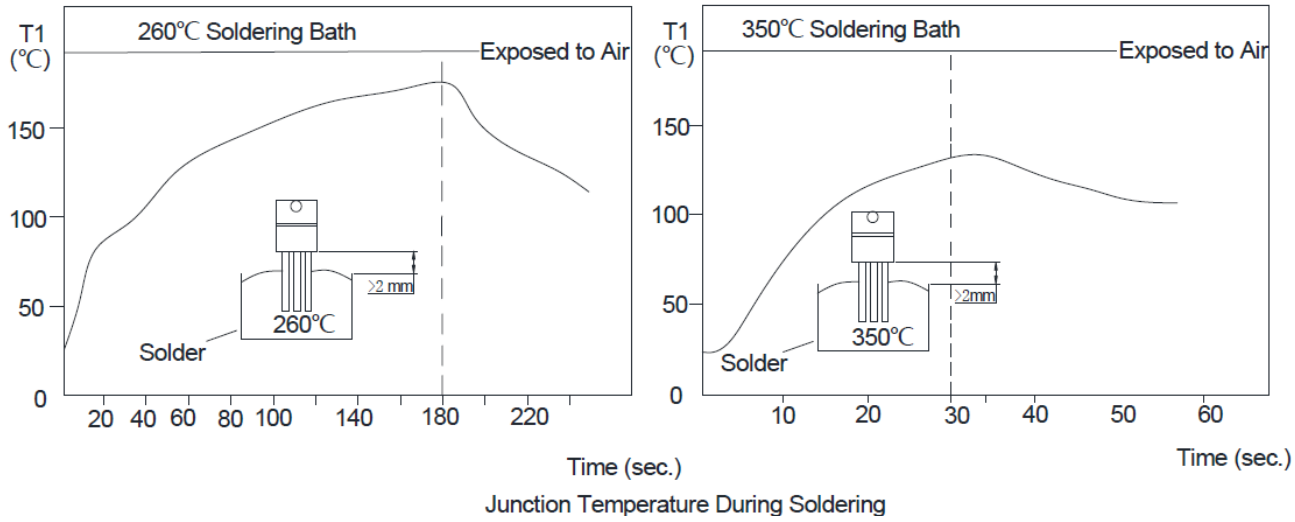

Fig. 21 Dip or wave soldering thermal profile

5. PCB cleaning

Please pay attention to the following when cleaning the PCB to remove the flux after soldering:

- Do not scrub the device marking with a brush or hand while cleaning or when the cleaning solution is still present.
- When ultrasonic cleaning is used, the following conditions are recommended:
  - Ultrasonic frequency f≤28kHz;
  - Ultrasonic output ≤20W/L;
  - Cleaning time t≤30sec;
  - The ultrasonic oscillator shall not be in direct contact with PCB or devices and should not cause resonation with the device.

6. Operating and environment conditions

- Storage temperature Tstg: -40℃~150℃ (Refer to individual datasheet);
- Maximum junction temperature Tj_max: 125℃, 150℃ or 175℃ (Please refer to individual datasheet);
- Maximum operating temperature: When working under the rated current of the thyristors or diodes, the case temperature of the device should be kept below the T_C temperature indicated in the datasheet. For MOSFET devices, the junction temperature should be kept below maximum Tj rating during operation. Proper thermal management is necessary to maintain safe operating temperature and prevent thermal-related failures.
- ESD protection
  - Thyristor:

- HBM: CLASS 3B(≥8000V)
- MM: M4(≥400V)
- CDM: C7(≥2000V)

o MOSFET:

- Refer to individual datasheet

- Storage environment and shelf life
  - o Storage place: ventilated, dry and free of corrosive gas
  - o Storage conditions and shelf life

Humidity	Temperature	Period
5%-50%	-5 ~ 50℃	12 Months