

MOUNTING AND HANDLING GUIDELINES FOR TO-220 PACKAGES

Introduction

The TO-220 is a popular package for power devices because of its versatility and ability to dissipate moderate amounts of heat. This application note describes the basic guidelines for handling power MOSFETs in TO-220 packages. Please note that only mechanical and soldering guidelines are covered here. Additional precautions are required for isolating high voltage rated devices to meet safety regulations.

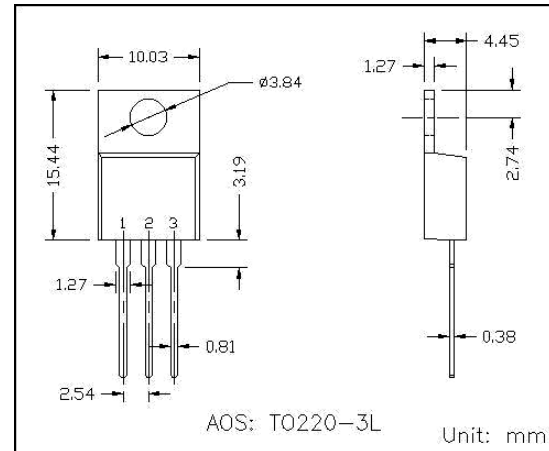


Fig 1 - TO220 General Dimensions

Securing a good thermal interface between the package and heatsink is essential to achieve better heat dissipation and improve the device reliability. Two popular methods of attaching the TO-220 device to a heatsink use either a clip or a small screw with associated hardware.

Several types of clip mountings are possible where a clip holds the TO-220 device against the heatsink and a screw tightens the clip. A single clip can be designed to hold multiple devices. It is recommended that the clip pressure be applied right on the plastic body of the package for the lowest thermal resistance

Individual screw mounting methods are shown in Fig 2). Fig 2a) shows the hardware sequence when the heatsink is thick and tapped to hold the screw and in Fig 2b) screw is held by a nut on the back of the

heatsink. The nylon washer isolates the screw from the device tab. The insulator is thermally conductive and transfers the heat away from the device to the heatsink. Even if the device is not required to be isolated from the heatsink, it is necessary to use a filler between the device tab and the heatsink to ensure good thermal contact. This may be a mica or a silicone pad or the old fashioned heatsink compound. Note that in both cases the metallic washer between the screw head and the device tab is rectangular in shape and no spring washers are used on the tab side.

If the device is soldered on PCB and attached to the heatsink, make sure that the heatsink attachment is made *prior* to soldering the leads on PCB. Otherwise the shearing stress between the soldered leads and the tab can easily damage the die during tightening.

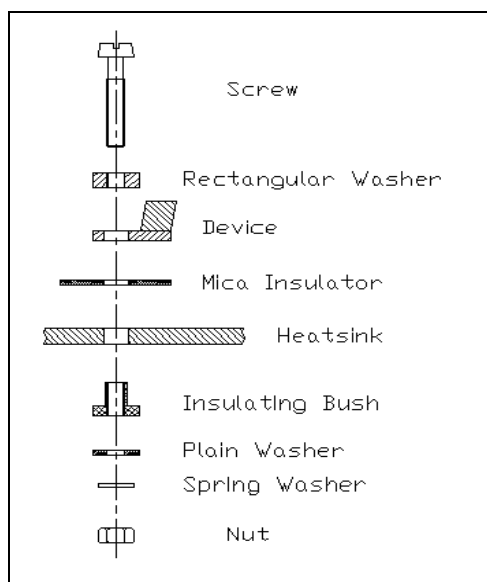


Fig 2a) Mounting through a heatsink

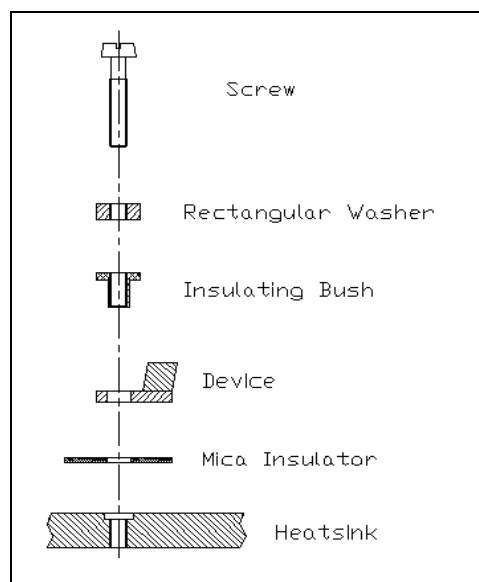


Fig 2b) Mounting on a tapped heatsink

Mounting on Heatsink

During tightening, the device has a tendency to rotate in the direction of the screw. In order to prevent the rotation, the device is usually restrained sideways, which can subject the die inside to shearing stress as shown in Fig 3) and cause it to delaminate. This may show up as higher Rds in case of power MOSFETs, causing greater heat dissipation and eventual failure. The rectangular washer above the tab is recommended to minimise this stress.

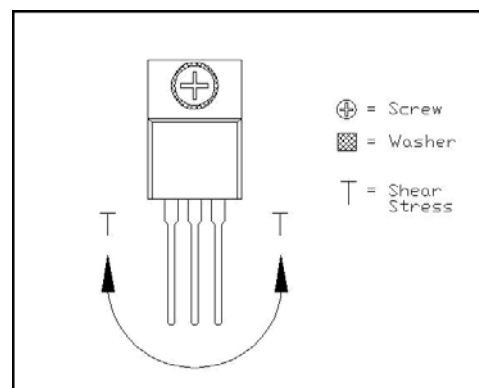


Fig 3) Shearing stress on TO220

Typical screw sizes are ISO M3.0, ISO M3.5 or 6-32 UNF. Care should be taken not to overtighten the screw, especially when the operation is done manually. Studies have shown that beyond a certain limit, higher torque on the screw does not improve the thermal resistance any further. Applying higher torques only increases shear stress without any thermal benefits. At excessive torques over 20 in-lb, the screw itself will be stressed, eventually cracking up above 24 in-lb. The following table gives recommended torque ranges with metric and imperial units. A torque controlled screwdriver is strongly recommended for achieving optimum performance.

	Screw Size	Recommended Torque
Metric System	M3 / M3.5	0.8 ~ 1.1 N-m
Imperial (American) System	UNF 6-32	7 ~ 10 in-lb

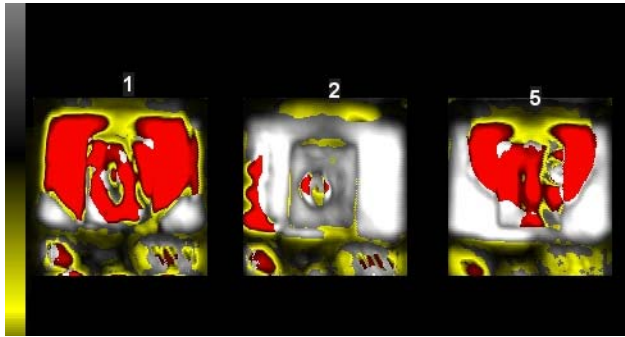


Fig 4) Accoustic scan showing die delamination

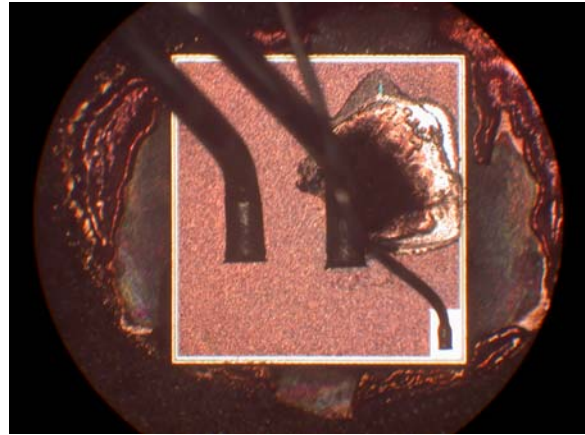


Fig 5) Decapped view of device #1

The pictures above show the damage done to TO220 die as a result of excess torque during mounting. Fig 4) depicts an acoustic scan of three damaged devices. The regions marked in red represent the air bubbles formed due to delamination of the die. Fig 5) on the right is a microscopic view of device #1 which subsequently failed in the application circuit due to excessive heat.

Lead Bending

Though not recommended, bending of leads is acceptable for special applications. Leads may be bent in the same plane or perpendicular to their length as shown in Fig 6). For perpendicular bending, maximal force along the lead axis is 4.5 lb (20N). Lead bending fixture or a long nose plier is recommended for bending. Minimum distance from bent point to wider section of the lead is 0.080 inch (2 mm).

To avoid damage to the lead and case, follow the correct bending method as shown in Figure 6b). The device should be firmly held by a fixture and the lead itself should be held by a fixture or plier while bending the narrow section of the lead. When the leads are bent within the same plane, only narrow section of the leads can be bent. Figure 7) shows an example of plenary bending.

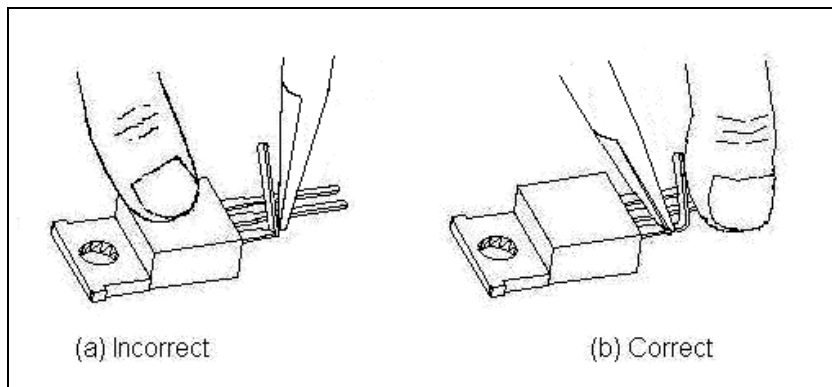


Fig 6) Lead bending at right angles

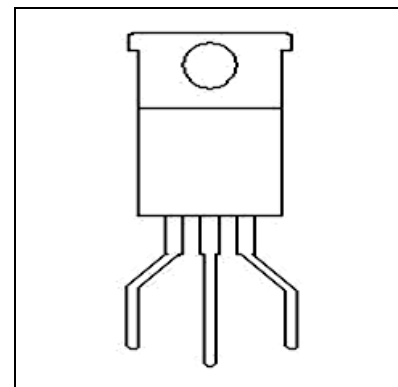


Fig 7) Plenary lead bending

Soldering Recommendations

The most reliable method of soldering PCBs with a variety of large through hole components is by wave soldering. Manufacturers of the equipment issue proper guidelines for optimum soldering profile for different types of boards. These should be adhered to, particularly with regard to pre heating and regulating the time and temperature cycles. Typical solder wave temperatures are 240 ~ 260 °C, depending on the solder material used. The recommended Pb/Sn solder pot temperature is 465 ~ 475°F (240 ~ 245 °C), and pure tin solder pot temperature is higher at 490 ~ 500 °F (255 ~ 260 °C).

Though not recommended, hand soldering is acceptable in practice. Do not use high powered irons with large tips. Small or medium powered instruments less than 50W and pencil type tips are recommended. Tip temperature should be in the 650 - 750 °F (350 - 400°C) range. Ensure that the solder junction is heated quickly and the time-temperature specification of the package is not exceeded in the soldering operation.

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