Guidelines for Handling and Mounting of 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

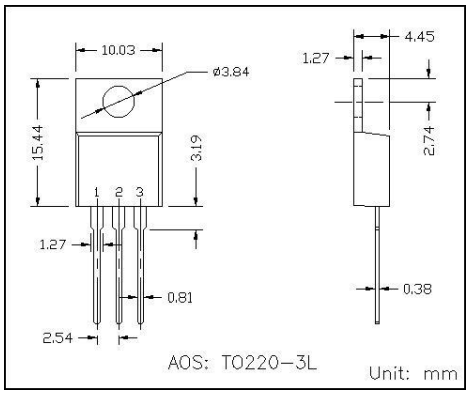

Fig 1

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Mounting on Heatsink

A good thermal interface is essential between the package and heatsink 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

Another popular method is the individual screw mounting as 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 heat. 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.

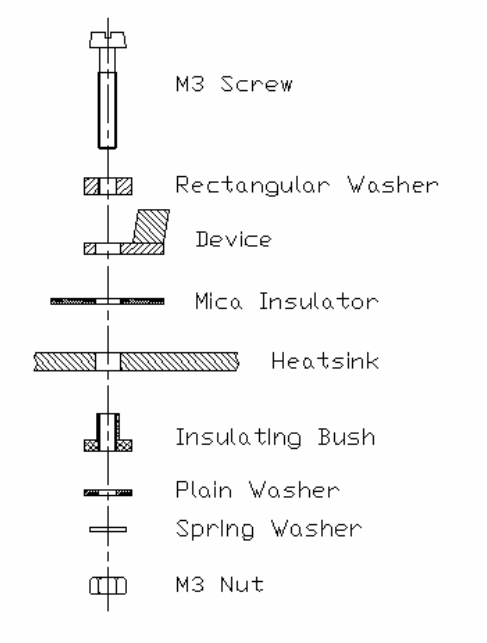
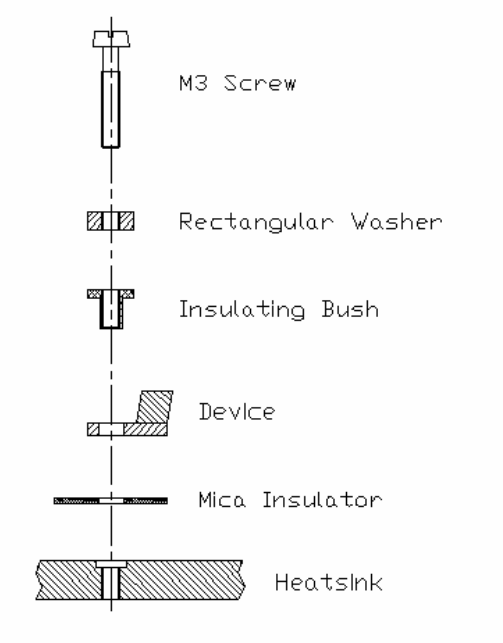


Fig 2a)



2b)

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. 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 wafer inside to shearing stress as shown and cause it to delaminate. This may show up as higher Rds in case of power MOSFETs, causing greater heat dissipation and eventual failure.

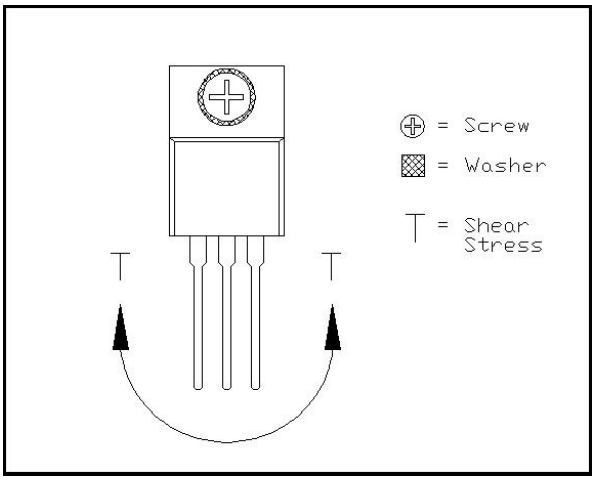


Fig 3

Studies have shown that beyond a certain limit, higher torque on the screw does not improve the thermal resistance any further. The following table gives recommended torque ranges with metric and imperial units. A torque controlled screw driver is strongly recommended for optimum performance.

	Screw Size	Recommended Torque
Metric System	M3.5	0.6 ~ 0.9 N-m, 1.2 maximum
Imperial (American) System	UNF 6-32	7 ~ 11 in-lb, 15 maximum

At excessive torques over 20 in-lb, the screw itself will be stressed, eventually cracking up above 24 in-lb.

Lead Bending

Though not recommended, bending of leads is acceptable for special application. Leads may be bent in the same plane or perpendicular to their length as shown in Fig 4a). 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) . The lead should be firmly held by the fixture or plier while bending the narrow section of the lead. To avoid lead and case damage, follow the correct bending method as shown in Figure 4a).

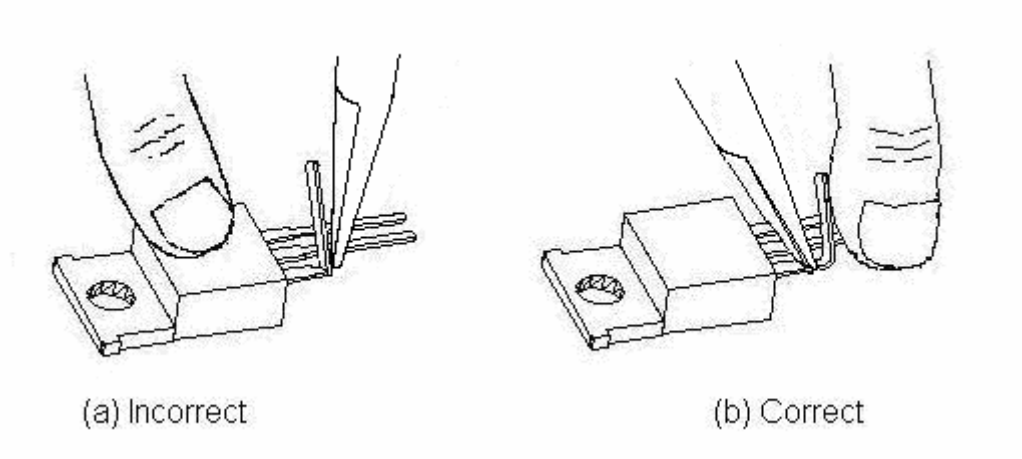


Figure 4a)

When the leads are bent within the same plane, only narrow section of the leads can be bent. Figure 4b) shows an example of plenary bending.

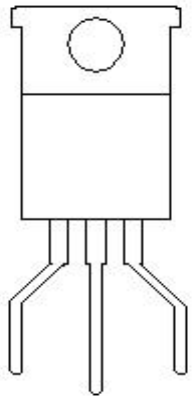


Figure 4b)

Soldering Recommendations

The most reliable method of soldering PCBs with a variety of large through hole components is by wave soldering. Manufacturers of the equipement 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 temperature cycles. Typical solder wave temperatures are in the 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 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.