# Surface Mounting of Larger Devices

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## Introduction

*The increasing trend to board mounted power devices has brought a demand for Surface Mount Devices (SMD) larger than the commonly available D-Pak and D²Pak packages. A series of devices have been introduced to enable this higher power levels to be achieved in SMD. This application note details some of the solutions presently available from International Rectifier, ranging from D²pak and solderable versions of the Super-220™ and TO-247 packages that can accommodate larger die (table 1).*

The Super-220 and SMD-247™ are each with available either with long straight leads suitable for mounting to a daughter board or short gull wing leads suitable for traditional surface mounting. Larger devices need somewhat more care at the surface mount assembly due to the greater thermal masses and higher thermal mismatches which are potentially present and not all the techniques described in AN-994 'Maximising the Effectiveness of Your SMD Assemblies' are applicable.

| Package | Max Die Size (mils) |
|---|---|
| | |
| Super220™ (TO-273AA) | 257 x 257 |
| SMD – 247™ | 257 x 360 |

**Table 1**

## Board Materials

At the higher power levels associated with these larger devices significant amounts of heat can be generated. Simple FR4 boards may be unable to deal with this and alternative materials such as multilayer FR4 with vias, IMS or DBC on Alumina will be required. The assembly methods and especially the times must take account of the substantial thermal mass that they represent.

## Thermal Resistance

The exact value of board mounted thermal resistance is dependant on the surrounding environment, board layout, orientation, airflow etc. Table 2 provides a guideline for comparison between some of the commonly used materials. The reference device is an IRFP450-S SMD-247™.

| | Rth j-a for IRFP450-S mounted: | |
|---|---|---|
| Board Material | In free air | Mounted to large Aluminium block |
| Single FR4 – 1.6mm, 2oz Cu | 25 | 10 |
| Al. IMS – 3mm, 3oz Cu | 6 | 1 |
| DBC – 0.38mm, 0.3mm Cu | 24 | 1 |

**Table 2**

The thermal performance of PCB structures can be improved by choice of material (e.g. weight of copper) and layout. Some examples of typical improvements that can be achieved are:

- Extended copper areas on board reduces thermal resistance by ~ 20%
- Multilayer board with groundplane reduces thermal resistance by ~ 50%
- Multilayer board with vias to groundplane reduces thermal resistance by ~ 66%

## Board Mounting

The SMD packages described are supplied with exposed rear face and leads specially treated to give good solderability during reflow. A suitable mounting pad must be defined on the substrate to accommodate the package. The package outlines and minimum footprints for the 3 large are shown in appendices 1&2. The correct amount of solder paste is dispensed onto the substrate via a stencil. Recommended thickness is 8 – 10 mils.

## Board Attach Materials

Reflow soldering paste consists of particles of solder and flux together with binder, solvents and additives. An ideal solder paste would have good printing properties, be slump-free, have good 'tack' to hold the components and remove oxides without leaving obstinate residues.
Recommended solder paste alloys for reflow are shown in table 3.

| Solder Alloy | Solidus | Liquidus | Peak Reflow |
|---|---|---|---|
| 63Pb/37Sn | 183°C | 183°C | 225°C |
| 60Pb/40Sn | 183°C | 190°C | 230°C |
| 62Pb/36Sn/2Ag | 180°C | 189°C | 230°C |

**Table 3**

## Board Attachment Methods

Convection Oven: Devices and substrates pass through a convection heating tunnel on a conveyer belt. The 4-5 zones for preheating, reflowing and cooling are independently temperature controlled. This is a preferred method, especially with substrates of significant thermal inertia.

Infra Red Reflow: Infra red radiating lamps provide the heat source. There is a danger that the relatively large 'black bodies' of the power semiconductors are overheated before the board temperature is raised sufficiently to reflow the solder. Can be successfully combined with the previous method.

Conduction Reflow: Heat is applied from hotplates to the bottom of the boards. 'Walking beams' or 'brown belts' transport the boards. Effective when used with materials like IMS.

Vapour Phase Reflow: The populated boards are lowered into the vapour cloud above a boiling fluorocarbon liquid. Provides precise temperature control but is inefficient when used with high thermal mass assemblies, resulting in slow throughput and loss of the expensive fluid.

Wave Soldering: Not recommended for large devices with high thermal mass and large interface areas to reflow. Large package devices tend to create 'shadow' areas that create difficulties for other smaller SMD parts to be soldered on the same board.

## Reflow Profile

The optimum profile for a given application will depend on the materials used for board and solder and on the degree of population. However, the following guidelines will provide a satisfactory result.

Preheat phase: The subassembly is raised to and stabilised at a temperature of 105°C - 150°C at a ramp rate of < 6°C/s (typ.2.5°C/s). Volatile components of the solder paste are driven off and the flux is activated. If the ramp is too steep it could result in thermal shock damage. The required stabilisation time will vary depending on the mass of the subassembly. Excessive dwell can over bake the solder and reduce the effectiveness of the flux.

Reflow phase: The temperature is raised above the melting point of the solder. Peak temperature is chosen to achieve good solder fluidity. Excessively high peak temperatures can cause die damage. Time above 183°C should not exceed 150 seconds. (typ. ~100 secs).

Cooling phase: The temperature is brought down again close to ambient and the assembly exits the furnace. Mechanical shock should be avoided during this phase. Rapid cooling rates promote small grain size in the solder layer, which is desirable for improved thermal fatigue performance. However extremely rapid cooling rates can result in excessive shock. Ramp rates of
< 6°C/s are recommended. (typ.2.5°C/s).

A typical reflow profile for any of the large power devices is shown in fig. 1

## Board cleaning

If an RA, RMA or water soluble flux has been used a cleaning phase should follow reflow. The solder paste vendors will advise appropriate materials and process. Although 'no clean' fluxes are available from a number of sources, in high voltage applications a cleaning stage is still recommended - especially if a conformal coating or potting process is to be used.

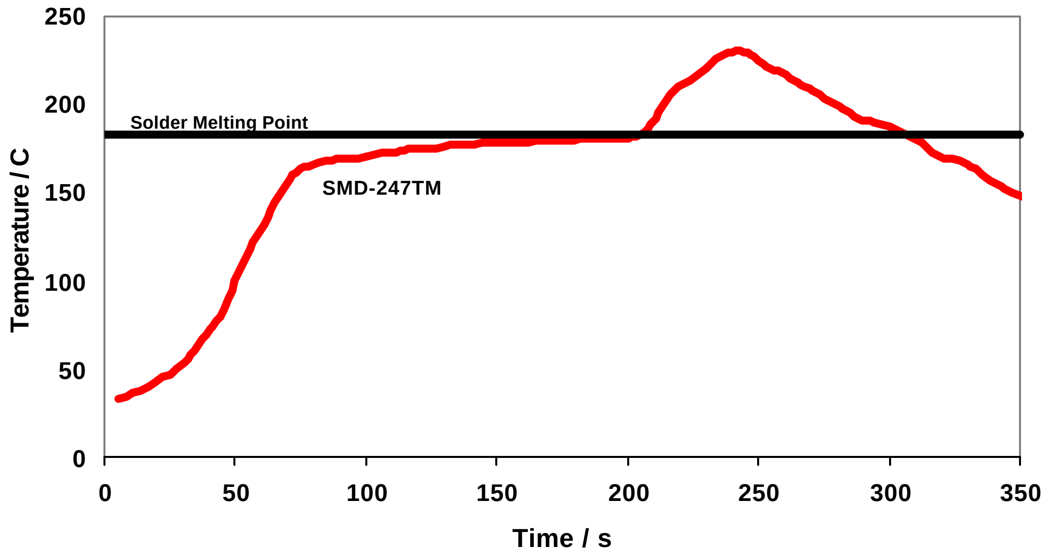
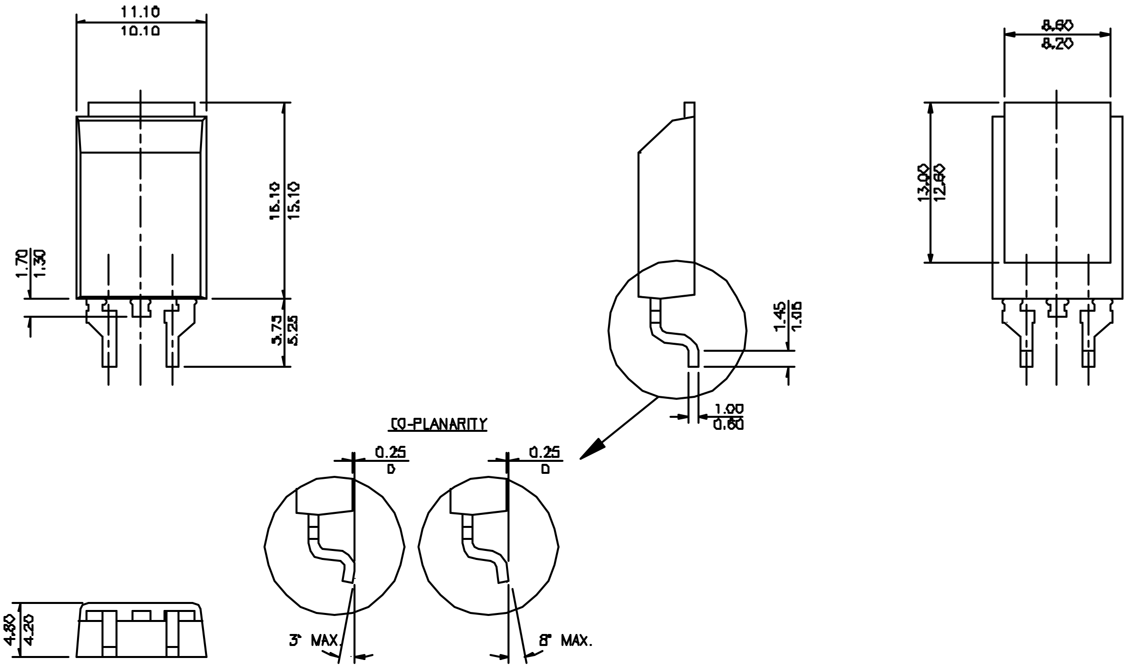


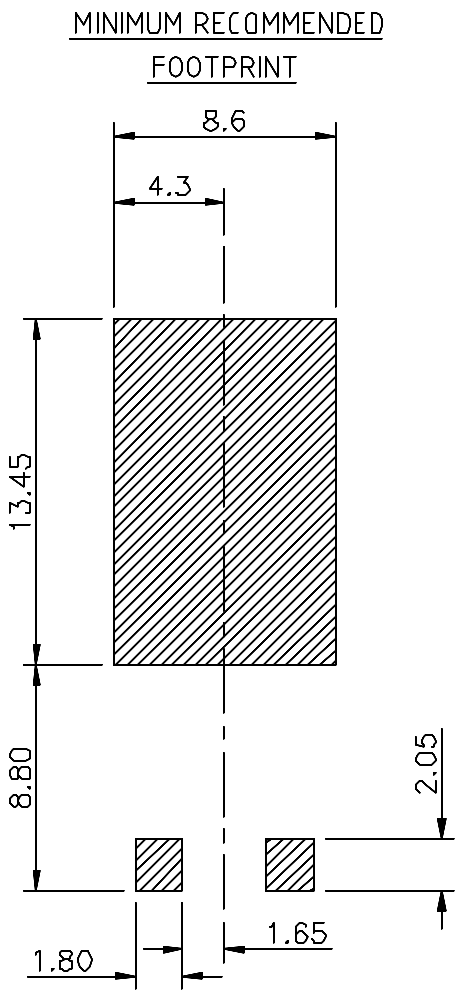

**Fig.1 Typical reflow profile for SMD-247TM**

## Conclusion

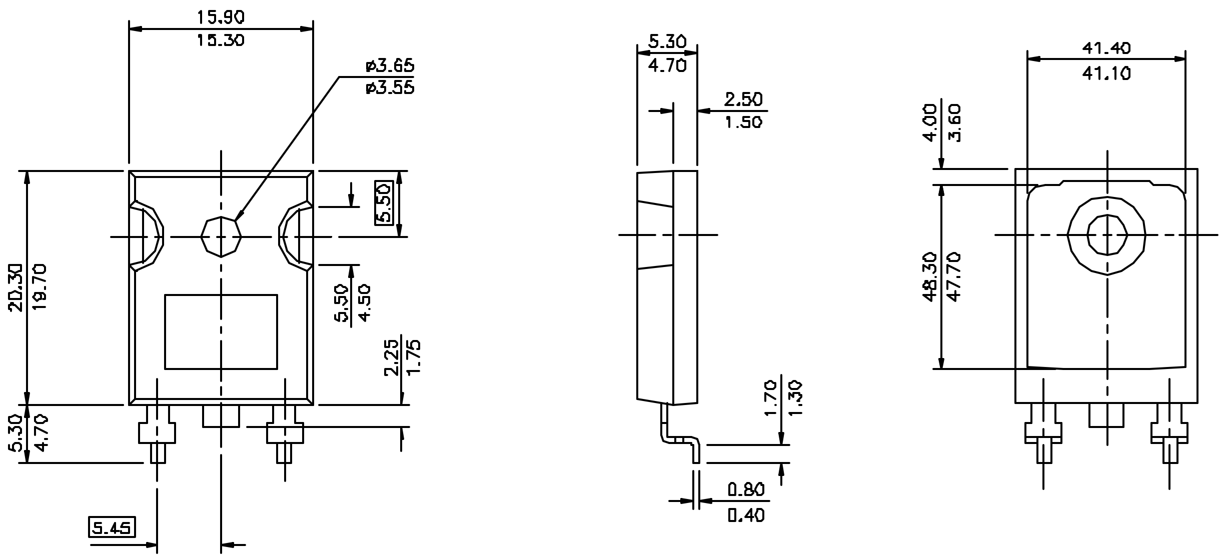
International Rectifier has developed a range of higher power surface mount packages. Following the industry standard guidelines described in this note will ensure trouble free mounting and performance.



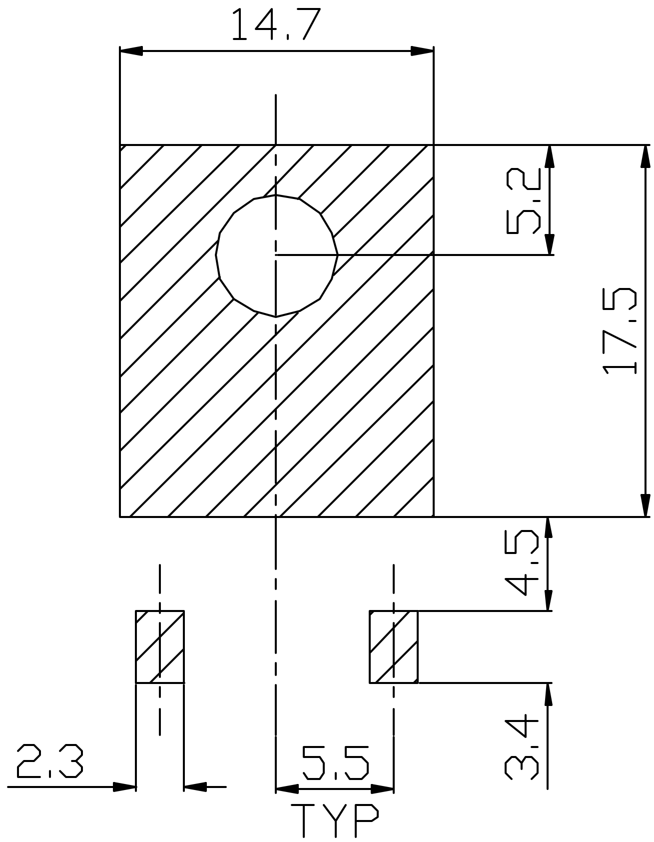

**Appendix 1a Super-220™ Outline drawing**




**Appendix 1b Super-220™ minimum footprint**




**Appendix 2a SMD-247™ Outline drawing**




**Appendix 2b SMD-247™ Minimum Footprint**