AN1041

MOUNTING PROCEDURES FOR VERY HIGH POWER RF TRANSISTORS

Prepared by: Helge O. Granberg
RF Engineering
Advanced Products Group

Freescale Semiconductor, Inc.
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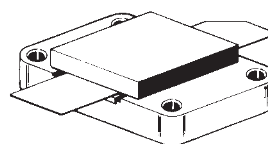
RF power semiconductors such as MRF153, MRF154, MRF155, MRF156 and MRF430 are housed in Case 368-01, whereas MRF141G, MRF151G, MRF175G and MRF176G use Case 375-01 (both shown below). All of these are high power devices (200 – 600 W), which results in an abnormally large amount of heat dissipated within a small physical area. For such high power transistors, special attention must be paid to the heat sink material as well as the finish and flatness of the mounting surface. The material should have at least a thermal conductivity equal to or better than copper and for the mounting surface flatness ± 0.0005″ can be considered sufficient. The heat sink can be made of material with lower thermal conductivity such as aluminum, but in that case a copper heat spreader should be used. The heat spreader should have a minimum thickness of 0.25″ for case 375-01 and 0.375″ for 368-01 and should extend at least 0.5″ to 1.0″ beyond the flange edges, depending on the device type and the amount of dissipation involved. For die temperature calculations of devices in case 368-01, the Δ temperature between the mounting screw areas and the bottom center of the flange is approximately 5°C and 10°C under normal operating conditions and dissipations of 150 W and 300 W respectively.

Although the data sheets contain information on the subject above as well as the mounting procedures of these devices, very few designers actually follow them. The maximum recommended torque on the #4 size mounting screws is 4 – 5 in.-lbs. along with split lock- and flat-washers, of which the latter should be in immediate contact with the flange's top surface. Experiments have shown that merely compressing the split lock washer to its full flatness produces enough torque for sufficient pressure against the heat sink. The split lock washers are available with various spring tensions. Bell type compression washers would be an even better choice if found with 5 in.-lbs. or lower torque specifications.

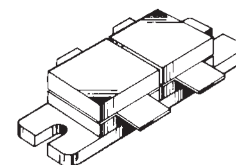
Calculations indicate that the length of the case 368-01 copper flange increases in excess of two thousands of an inch with a temperature change of 75°C. In such case, if the mounting screws are torqued too tight, the flange cannot expand in length but will bend upwards in the mid section, cracking the Beryllium Oxide insulators as well as the dice. It must also be noted that the thickness of the flange increases with temperature. For the excursion mentioned above, the amount is around 0.25 mils, which results in further tightening of the mounting screws, thus increasing the effective torque from the initial value. However the amount of increase is difficult to measure and depends on the exact type of mounting hardware used. The copper-tungsten flange of case 375-01 has a much lower expansion coefficient than copper, but if mounted on a copper or aluminum heat sink, it can be similarly bent during a cooling cycle as the heat sink material contracts.

Deformation can also occur during the initial mounting of the device if an excessive amount of thermal compound is applied along with sufficient screw torque. The thermal compound will squeeze out of the mounting hole areas, but will remain under the center of the flange, deforming it in a similar manner. Depending on the amount of thermal compound and its type, deflections of 2 – 3 mils have been measured between the flange center and corners created by such conditions. The same can happen with all flange mounted RF devices, but with thicker Beryllium Oxide insulators and lower dissipation levels the problem is less severe.

The maximum operating junction temperature and the total dissipation are usually given in the data sheets. It should be able for the device to be operated within these limits if the case temperature can be kept at 25°C or the derating factor is taken into account. The 150°C storage temperature indicated implies that the device can be operated at that case temperature, which is true but at a much derated dissipation rating. However good engineering practices would limit the case temperature to 70 – 80°C and the die temperature to not higher than twice that.



CASE 368-01



CASE 375-01

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