AN1908

Solder Mounting Method for the MRF19090S and Similar Packages

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INTRODUCTION

The following document describes a solder mounting method for a 90–Watt power device. This mounting methodology is recommended for any ceramic/metal flange device with similar materials and construction (copper tungsten flange with ceramic insulator and Alloy–42 leads) and up to 90 Watts of RF output power. This mounting method involves soldering the CuW flange to a heatsink with the leads soldered to a printed circuit board (PCB). Critical elements that must be carefully addressed are mechanical stress of the assembly and thermal management. The mounting method described has adequately taken these issues into account. A power life test evaluation was done as verification.

Figure 1 shows the MRF19090S power transistor. This device operates at 1.9 GHz with 90 Watts of output power. Similar devices operate between 1.8 to 2.1 GHz with 90 Watts of output power.

Figure 1. MRF19090S Power Transistor

MOUNTING METHOD

Assemblies of the new design were built in an automated solder mount assembly line with device leads solder attached to a PCB and the flange soldered to a copper pallet. The pallets were bolted to fan–cooled, finned aluminum heatsinks with thermal compound on the interface. Power life testing was done at a specific duty cycle and heatsink temperature. Assembly construction of a pallet with this device is shown in Figure 2. Configuration of the pallets onto the aluminum chassis is shown in Figure 3.

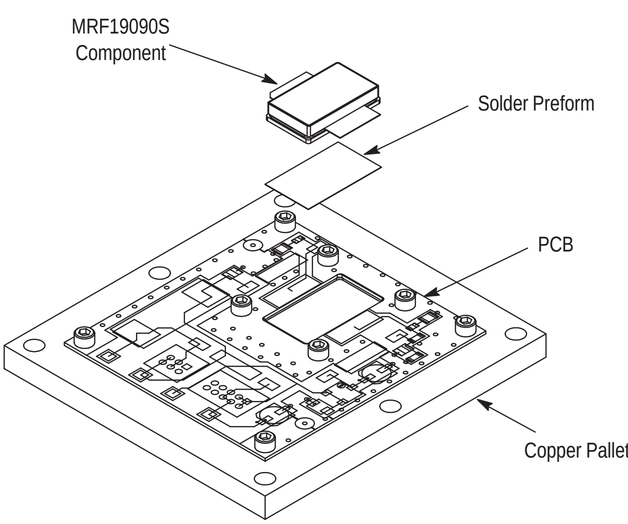

Figure 2. MRF19090S 90–Watt Power Device Board Construction

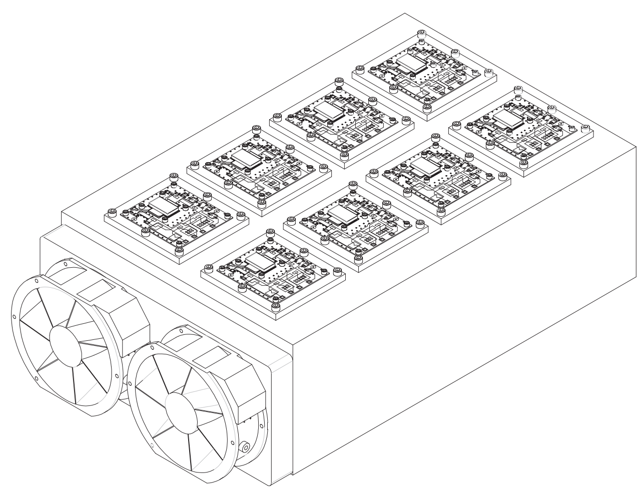

Figure 3. Full Assembly of Power Life Test

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ASSEMBLY

A challenging aspect of high volume manufacturing of any component in a board assembly involves the stack–up tolerance of the completed system. Achievable device tolerances for the seating plane height of the component are ± 0.005″. Achievable tolerances of the PCB are ± 0.007″. The tolerances of the copper can be kept to ± 0.003″ in the recessed area where the component will sit. In the assemblies built for the power life test, the recess in the copper pallet was machined so that the device leads would be assembled with a maximum lead tip deflection of 0.015″. The direction of the lead deflection is important in controlling stresses on the component and the solder joint. Figure 4 illustrates how the lead deflection should always be toward the backside of the component. A fixture was used to deflect the leads at the tip so they were in contact with the solder. This solder reflow fixture also held the component in place during reflow. The fixture used for this assembly is depicted in Figure 5. To solder multiple components at one time, a simple fixture can be designed to secure all of the components during the reflow operation. Although the solder fixture used in the reflow of the power cycling boards was screw mounted, this can be done with several techniques—for example, using an array of pins. All soldering is accomplished in one pass using 62/36/2 Sn/Pb/Ag and/or 63/37 Sn/Pb solder.

The soldering process and fixturing must be designed to provide a structurally and electrically adequate solder fillet at the drain and gate leads, as well as a void–free solder joint at the source contact for good thermal and electrical performance.

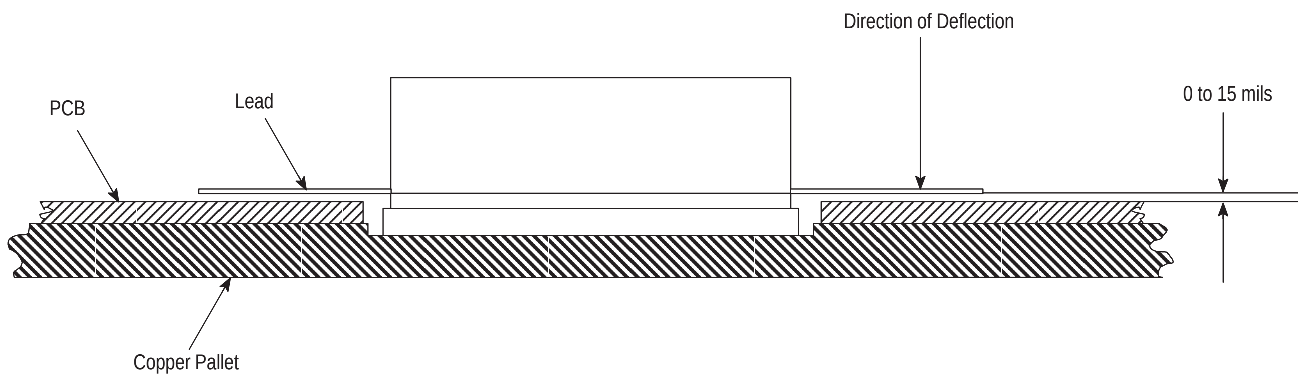

Figure 4. Direction of the Lead Deflection

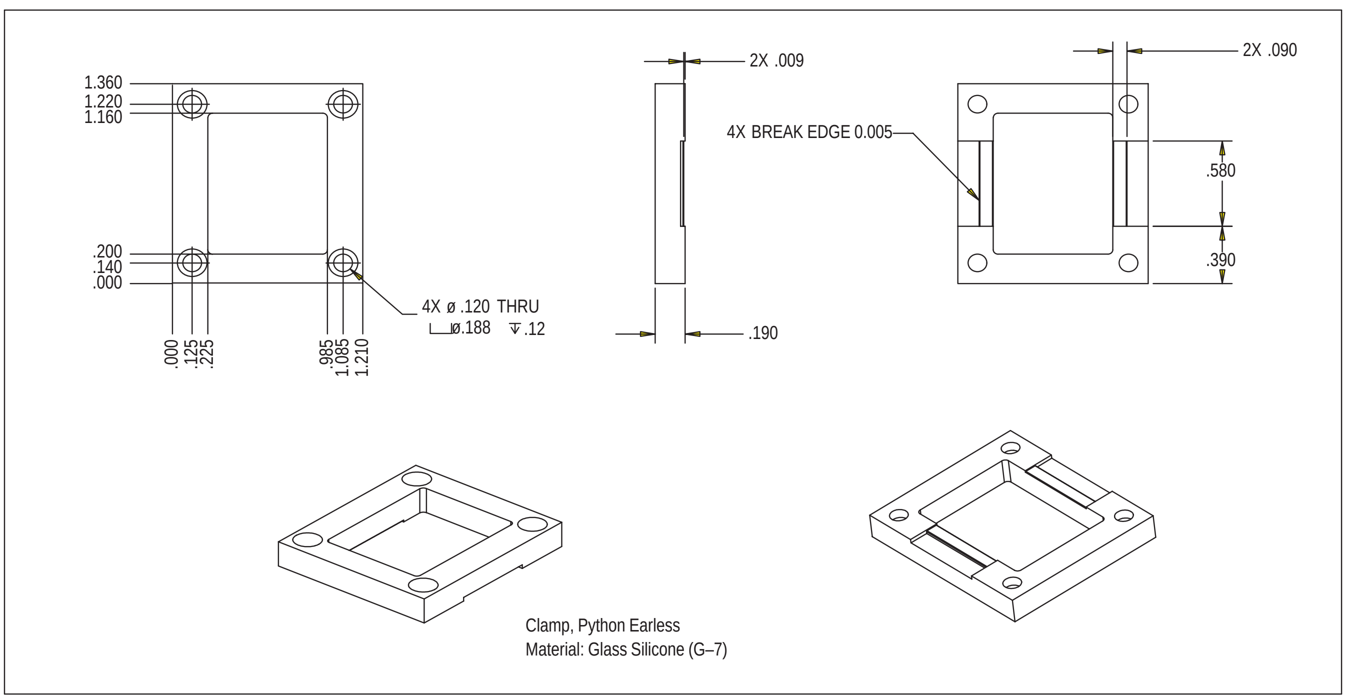

Figure 5. Component Fixture Used for Reflow

Prior to proceeding with assembly of the PCB, it is necessary to ensure that the level of gold within the solder joint does not exceed 4% by volume. One way to accomplish this is to solder dip the leads into a solder pot of molten Sn/Pb solder. An alternate way is to provide enough thickness of solder paste so that the amount of Au in the solder joint is within the desired limit set by the customer. After accomplishing this for the power life test assemblies, the PCB was screen–printed with Sn/Pb/Ag solder paste using a stainless steel stencil, 0.006″ thick. The copper pallets were plated with approximately 1,000 to 1,500 micro–inches of electroless nickel. The pallets contained a recessed cavity that was plated with 0.0003″ of tin lead (60–40). Prior to placing the component in the recessed cavity, two 0.002″ thick solder preforms and two drops of no clean flux were set into the recess. After placing the component, the PCB was placed on a reflow boat. The solder reflow fixture shown in Figure 5 was then fixed in place over the part using four #4–40 screws with 5 in.–lbs. of torque (M3 screws with 0.8 N–m of torque). Finally, the entire assembly was placed in a BTU convection reflow furnace. The recommended pad size is shown in Figure 6.

In the reflow step, the board was preheated to 150°C and held constant for a minimum of one minute to stabilize the board temperature. A “spike” above the 183°C liquidus temperature achieves best reflow characteristics. To achieve the appropriate temperature profile, the peak temperature and belt speed of the reflow furnace are determined, based on the total mass of the assembly going through soldering. Maximum time above the liquidus temperature is 90 seconds with 30 to 60 seconds typical. Maximum time above 150°C is 5.5 minutes. Figure 7 shows a typical reflow profile. After the reflow operation, the fixture was disconnected by removing the four screws. The fixture could then be reused. The PCB and component were secured to a copper pallet using six #4–40 socket head cap screws with 5 in.–lbs. of torque (M3 screws with 0.8 N–m of torque). The PCB assembly step for the process flow is shown in Figure 8. For small PCBs, it is possible to solder the backside of the entire PCB to the copper pallet instead of bolting it to the pallet.

The completed, reflowed board/pallet assemblies were screw mounted to the aluminum heatsink after evenly spreading the backside of the copper pallet with 0.0005″ to 0.001″ of thermal compound. An actual board assembly used for the power life test is shown in Figure 9.

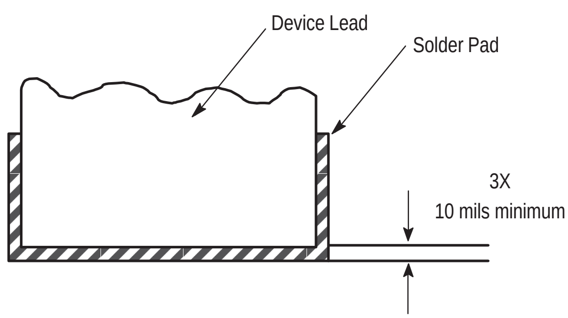

Figure 6. Pad Size in Relation to the Lead

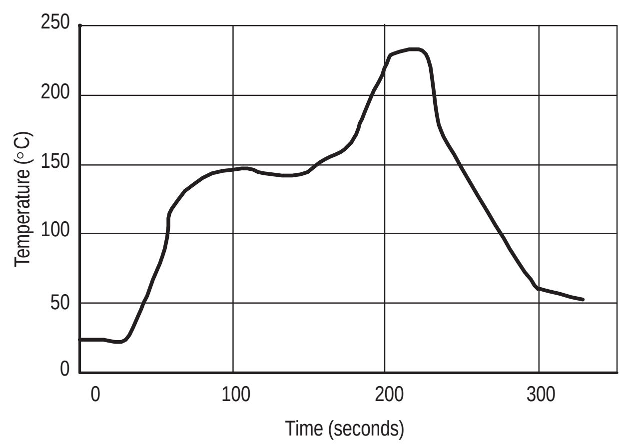

Figure 7. Typical Solder Reflow Profile for Sn/Pb/Ag Solder

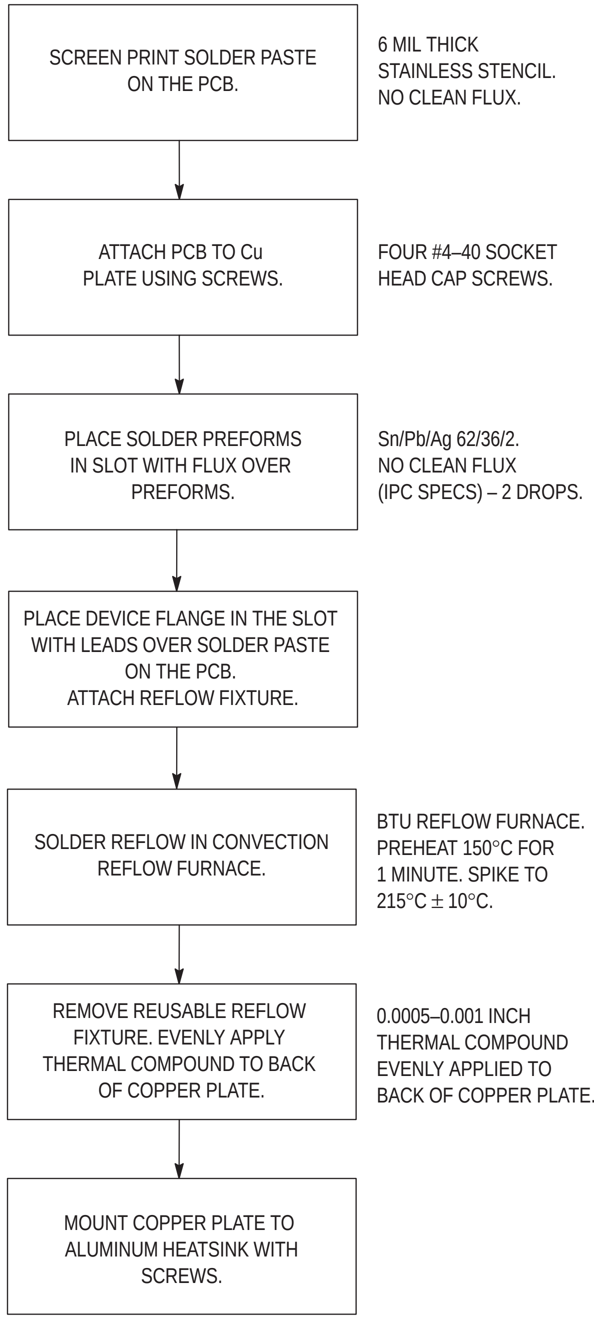

Figure 8. Process Flow for Board Assembly

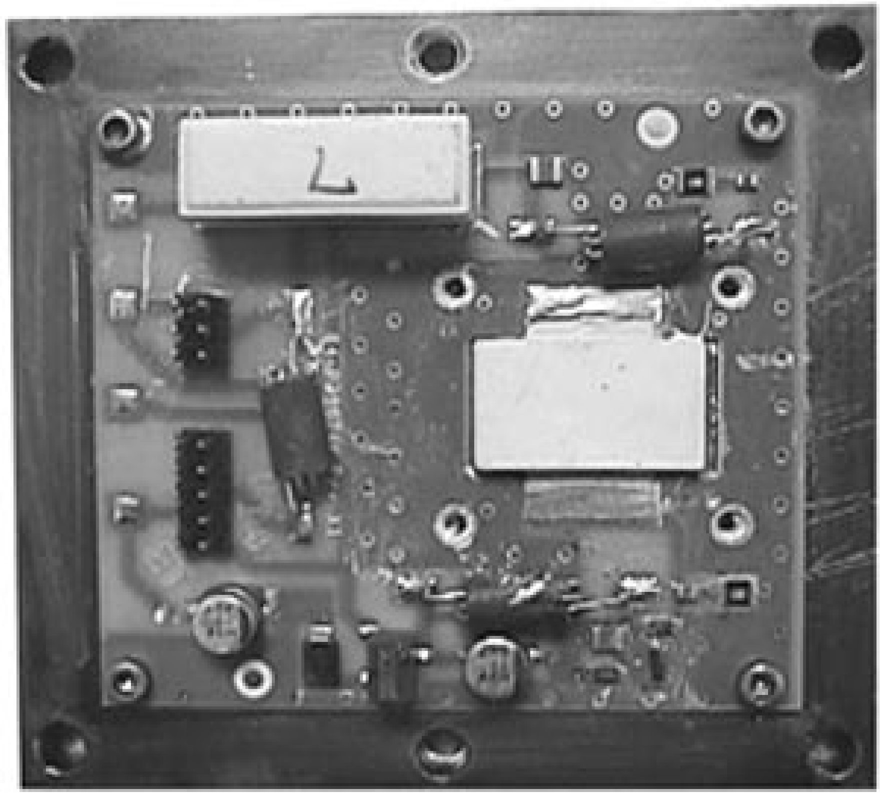

Figure 9. Power Life Test Board

RESULTS

The assemblies were cycled under DC conditions at 26 Volts and 135 Watts of dissipated power. At 90 Watts of RF output power at 40% efficiency, the dissipated power is 135 Watts (see Figure 10). A peak case temperature of more than 90°C was achieved as measured by a thermocouple directly under the heatsink of each device. The MRF19090S device has the specified junction to case resistance (θ_{JC}) of 0.65°C/W. Based on this, the junction temperature at 135 Watts power dissipation will be 180°C when the sink temperature is 90°C. The temperature rise is calculated based on the θ_{JC} plus the interface resistance. The devices were powered at a 50% duty cycle for 2000 cycles, representing 1000 hours of cycling.

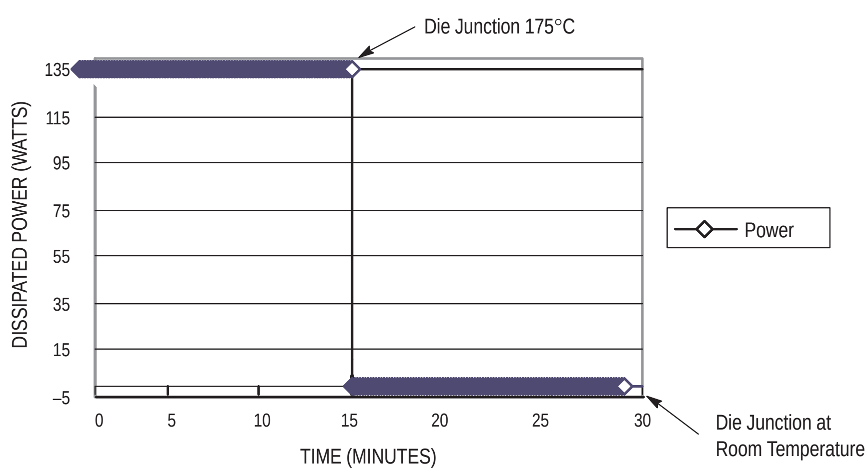

Figure 10. Power as a Function of Time for One Cycle

Lead and solder joint temperatures were measured on several PCBs using a scanning infrared microscope after the power cycling. Lead temperatures were found to be approximately 90°C at 135 Watts of power dissipation and a 90°C sink temperature. Figure 11 displays an image taken from the infrared microscope. Following the power life testing, solder joints were visually inspected and found to have no cracks after 2000 cycles. This prescribed mounting methodology will adequately account for the thermal and mechanical requirements of mounting a power transistor in a metal/ceramic up to 90 Watts of output power.

The mounting scheme design significantly influences both the thermal and electrical performance of the device. The mounting method described here uses the solder as an interface between the source contact of the MRF19090S device and the customer's heat sink. It is highly recommended that the customer carefully evaluate thermal and electrical performance for their power amplifier assembly. The selection of the interface material will depend on the customer's sink temperature, as well as the amount of power being dissipated by the transistor in the application. The total thermal resistance between the junction and the sink should be such that the temperature rise between the junction and the sink at maximum power and maximum sink temperature condition will still keep the junction temperature below the maximum value based on the expected lifetime. Similarly, the interface layer should also be evaluated to provide proper electrical contact with the source contact. The mounting method described here is a guide; it should not be substituted for a complete system–level performance analysis.

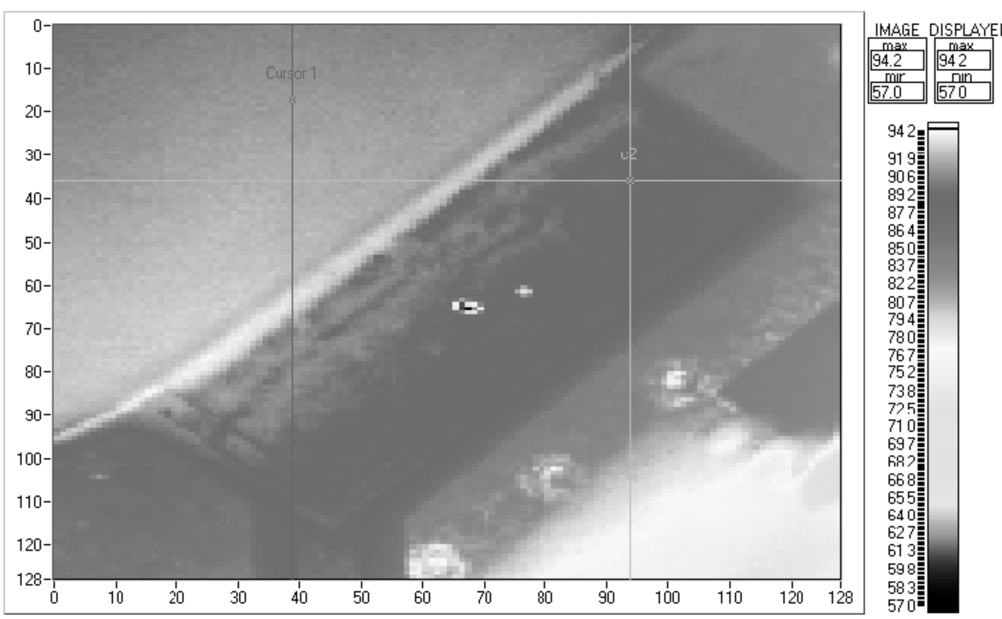

Figure 11. Typical IR Scan Image of the MRF19090S Lead and Solder Joint

NOTES

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