CalRamic Technologies LLC

5462 LOUIE LANE
Reno, NV 89511
www.calramic.com
PH: 775-851-3580   FAX: 775-851-3582

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Application Note

SOLDERING HIGH VOLTAGE MULTILAYER CERAMIC CAPACITORS

OVERVIEW

Multilayer Ceramic Capacitors (MLCC's) are complex composite mechanical structures composed of alternate layers of dense ceramic and metal electrodes. Alternate electrodes are connected on opposite ends with termination metals, which typically contain glass frits. As such, the MLCC is inherently sensitive to thermal and mechanical shock. The larger size of High Voltage MLCC's increases this sensitivity, in turn requiring greater care with conventional soldering techniques.

Thermal shock encountered with any soldering method can stress the device and lead to fractures ranging from invisible micro-cracks to visible cracks. The extent of cracking which may occur depends upon

- MLCC characteristics such as internal design [metal layers, and number and thickness of ceramic layers] and nature of metal/ceramic interfaces
- Parameters of the soldering process [e.g. time, temperature exposure and imposed temperature gradients, mechanical stress]

Accordingly, electrical failures can range from decreased insulation resistance to catastrophic failure [shorts], as well as poor partial discharge performance for High Voltage MLCC's.

In general, with High Voltage MLCC's, care must be taken, with preheat and controlled cooling, to prevent thermal shocking of the part. Large parts should not see more than 50°C difference between preheat and solder temperature versus more nearly 100°C for parts with footprints smaller than .250” X 200”.

Three common soldering processes, Infrared and vapor phase reflow soldering and hand soldering [soldering iron] are discussed briefly below.

INFRARED (IR) AND CONVECTION REFLOW SOLDERING

IR and convection reflow soldering present little risk to High Voltage MLCC's. The parts are not normally subjected to thermal shock because the heat transfer rate is low, and the body and termination of the part heat at the same rate. However, it is important to note that the large MLCC acts as a heat sink, and can cause uneven temperature distribution across assemblies during soldering. Some components could receive excessive heat before solder reflows on the large MLCC solder joint.

Specific time-temperature profiles are required depending upon solder type, board size, and specific capacitors selected. Cooling should be done carefully, avoiding force cooling of components or board.

VAPOR PHASE REFLOW SOLDERING

Vapor phase soldering is a practical method for large MLCC's. Peak temperatures are limited to that of the condensing vapor, and the heat sinking effect of the capacitor is less than with IR reflow. However, because condensing vapor can cause rapid temperature changes, parts must again be adequately preheated before soldering. As with IR reflow, it is recommended that specific time-temperature profiles be developed, considering preheat guidelines presented above.

HAND (IRON) SOLDERING

Because of the concern for thermal stress damage, hand soldering is used only when mass reflow systems are not available or practical. Guidelines for hand soldering include the following:

The entire assembly, with capacitors placed in position to be soldered, should be preheated in the oven with air circulation.

- Oven temperatures should be approximately 160°C for SN60, SN62 6r SN63 solders
- For higher temperature solders, preheat temperature should be increased accordingly
- Time of preheat should ensure that the capacitor reaches the desired preheat temperature

When set preheat temperature is reached, the assembly should be moved to a hot plate which is at the same temperature

- Transfer should be accomplished quickly to minimize cooling of the MLCC

Apply solder directly to the tip of a small iron, with sufficient power to flow the solder within 2-3 seconds, and allow the solder to flow into the joint area.

- Avoid direct contact of the iron with the capacitor to reduce the possibility of cracking
- Although cool down time varies with thermal mass of the assembly, it is generally considered good practice to place the assembly back into the preheat oven after soldering 3 to 5 MLCC's
- Repeat this procedure until all MLCC's are soldered

Finally, the assembly should be placed back into the preheat oven a final time, and then removed to be allowed to slowly cool down. The assembly should in no case be force cooled.