

## Detection of Thermal Shock due to Soldering

The best, non destructive way, to determine if harmful cracks or "micro cracks" were induced into a ceramic capacitor is by applying full voltage. This is especially true for higher voltage capacitors, since even the rated voltage is significantly pushing the energy stored and stress on the part far in excess of that seen in a low voltage part. It is a well known fact that the DWV testing is the most stressful test on a capacitor, and hence, the highest, catastrophic losses on initial electrical screening of virgin chips is the DWV test and its yield is a good initial indicator of the lot quality.

The other problem is that high voltage capacitors, due to their large mass, are extremely susceptible to thermal shock or mechanical handling damage. That is why in the soldering operation, proper preheat becomes extremely critical on any part approaching .300" in any dimension. Extreme temperature change or shock during soldering, will and does cause cracking. Anywhere from a completely "shattered" chip in pieces in the extreme case, (Direct immersion in hot solder), right down to "micro cracks, which are the most common. Invisible visually, they are hard to detect, especially if any post testing is done at low voltage levels. The microcracks can result in slow growth which will happen in anywhere from minutes to 10's to 100's of hours, depending on the severity and electrical load. They are frustrating, since they come out generally in 100's of hours into a lower voltage testing routine and then fail, taking an expensive, and usually high value added assembly and other components with it. A high voltage (rated or higher) "flash test" can bring these defects out instantly.

We have spent many hours, working with customers (preferably prior to purchasing) on proper soldering to avoid thermal shock. The quickest and best evaluator for proper soldering process control is to apply DWV voltage to the part after the solder operation. If thermal cracks were induced, they will blow immediately. That is why, in the capacitor industry, this test has been used in the capacitor manufacturing operations forever as a "first article" evaluator off the solder line. Although it may not be possible to apply the total 120% rated voltage on a finished assembly, anything near rated voltage should weed out any thermal shock cracks if they exist.

For reference, once the MIL-SPEC's started imposing hot solder dip (dipping perfectly good, fully tested and screened capacitors in a hot solder pot as the last operation just prior to shipping to the customer) Recognizing that (Hotdipping) had to be done and that DWV is the best test to determine that no damage was done, they added the requirement of the Group A post electrical test: C, DF, IR, and the "killer" which is DWV. See statement from MIL-PRF-39014F, page 4 Para 3.5.2. See particularly 3.5.2.1.b.(1) and 3.5.2.2.a.

Also the proper preheating in the initial attachment of the part is critical to the initial and long term reliability of an inherent "perfect" component.