Technical Brief: Cracking Issues with Ceramic Capacitors

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Improvements in ceramic capacitors over the last ten years have often allowed engineers to use them in place of capacitors with electrolytic, tantalum, and more exotic dielectrics. For example, one of the best overall ceramic dielectrics, COG, is available in a 100nF size at 50V in a 1206 package for less the $0.22 in thousands (TDK CGA5L2C0G1H104J160AAL)—whereas twenty years ago, one might have had to use a large, expensive, axial polypropylene capacitor to achieve similar performance (in terms of memory effects, temperature stability, and ESR). One can get a 10µF X7R, 50V capacitor in a 1206 package for less than $0.15 (Samsung CL31B226KPHNNNE). The X7R dielectric is an excellent choice for larger capacitance values with good temperature stability.

A significant issue with ceramic capacitors is their propensity to crack under mechanical stress. At Redgarden, we typically limit the size of surface mount ceramic capacitors to 1210 (~0.12 x 0.10 inches). If larger capacitance values are required, we often use multiple capacitors in parallel. (The good news about putting multiple ceramic capacitors in parallel is that the overall series inductance is reduced.) If higher voltages are required, we sometimes put capacitors in series—again to avoid putting capacitors with larger surface areas directly on printed circuit boards (PCBs). If these solutions are impractical, then leaded capacitors are sometimes a good choice since the leads should provide all of the necessary strain relief. However, leaded capacitors have much greater height than their surface mount counterparts and generally cost a lot more to assemble. Alternatively, one can use thicker circuit boards (e.g., 92 versus 63 mils depending on the overall geometry), additional PCB mounting points, and/or stiffeners.

Recently, we had several X7R ceramic capacitor failures (1206 and 1210 size) on some densely-packed boards with poorly-scored edges. After some investigation, we learned that these had probably cracked when the boards were removed from their panels after automated assembly. The cracked capacitors slowly developed short circuits during use. This type of failure (and others) is discussed in Syfer's AN0005 (http://www.knowlescapacitors.com/syfer/en/gn/technical-info/application-notes). AN0005 recommends: (1) avoiding placement of ceramic capacitors in corners; (2) using smaller pads; (3) placing ceramic capacitors parallel (not perpendicular) to a circuit board edge; and (4) using routed slots along circuit board edges near ceramic capacitors instead of perforated scores in a PCB panel.

Another type of solution for applications with high vibration or other mechanical stresses is to use ceramic capacitors with external resin electrodes. The resin terminal can flex relatively easily to avoid cracking the ceramic. For example, check out Murata's GCJ series on page 25 of their automotive ceramic capacitor catalog: http://www.murata.com/products/catalog/pdf/c03e.pdf. One of the GCJ parts is the GCJ32ER71E106KA12L (10µF, X7R, 25V, 1206). However at $0.56 in thousands (versus the $0.15 sited above for a conventional 50V part), this can be a bit pricey—and therefore should be used judiciously.