



MLCCs for Automotive Electronics: Focusing on Interference Suppression and High Operating Temperatures

By Martin Leupold

Electronic components in vehicles must function properly, not only for the safety of passengers, but also for their comfort. However, the more cars incorporate communication and connectivity technology, the higher the risk of signal interference and its effects. To guarantee undisturbed functionality, the emission and transmission of electromagnetic interference must be reduced to a regulated value. A popular option is ceramic capacitors, which effectively filter out voltage spikes.

Due to their importance in automotive applications, Vishay makes sure that these components not only meet but exceed the highest quality standards according to AEC-Q200. During qualification tests, the capacitors are exposed to extreme temperature changes, high humidity, strong vibrations, and the highest operating temperatures - all of which reflect the harsh operating environments found in cars.

With the latest extension of ceramic capacitor lines, the HOTcap® series, we tested the devices unpowered for 2000 hours at 175 °C, which is much longer than the 1000 hours that the AEC-Q200 standard requires. We also specified the high temperature operating life test for 2000 hours at 175 °C and twice the rated voltage, which is again much higher than the AEC-Q200 standard requires (the AEC-Q200 standard is 1000 hours at 125 °C and rated voltage). Furthermore, temperature cycling is tested from -55 °C to +175 °C (the AEC-Q200 standard specifies a max. of +125 °C) and the 85 / 85 test (85 °C, 85 % relative humidity) for 1000 hours at rated voltage. The AEC-Q200 criteria are used as the basis for extended test specifications we perform in our internal approval process, ensuring our components perform above the AEC-Q200 level ⁽¹⁾.

With the HOTcap devices (K...H series), Vishay has set the benchmark in terms of quality and performance to strengthen our competitive edge. In fact, the capacitors are the world's first Class 1 and 2 ceramics to feature extremely high operating temperatures of 175 °C and 200 °C, respectively, making them unique among automotive electronic components. The series features multi-layer ceramic capacitors (MLCCs), which are manufactured with high tech ceramic and precious metal electrodes in a special wet-cast process. This procedure strengthens the bonding of individual layers to each other and contributes a tremendous share to the increased reliability, lifetime, and performance of the components. This is because under extreme conditions, a delamination of single layers is effectively suppressed. Radial lead-wires are soldered onto the terminations of the chips, which are finally covered with high temperature resistant epoxy resin.

This technology enables high capacitance along with small body sizes at a competitive price. The products are available with capacitances starting from 100 pF to 1 µF at rated voltages up to 200 V_{DC}. The devices feature a very stable C0G ceramic dielectric (± 30 ppm/K) and a new X0U ceramic dielectric with a permissible change in capacitance of +22 % / -56 % within the operating temperature range of -55 °C to +175 °C. All capacitors are lead (Pb)-free according to RoHS and REACH regulations.

Through-hole capacitors show two major benefits versus surface-mount devices: a higher temperature resistance and a higher resistance against mechanical stress. Due to the use of lead-wires, twists and / or vibrations of the PCB cause less harm to the chip capacitor, which prevents breakage and other defects. Hence, the lead-wires take over a shock-absorbing function. To save space, it is also possible to assemble the leaded MLCCs without having a PCB. For instance, they may be welded onto lead frames and overmolded with plastics. This could be beneficial for sensors used in automobiles, DC motors, or cable harnesses.

Along with the introduction of HOTcap (K...H series) devices, Vishay has defined a new quality and performance standard for interference signal suppression in automotive applications, while meeting the requirements for higher operating temperatures. This means added value for customers in terms of performance and temperature resistance, resulting in higher reliability and longer lifetimes.

Note

- ⁽¹⁾ The usage of HOTcap capacitors at 175 °C is unlimited in duration.
Furthermore, temperatures of 200 °C are permissible for a limited cumulated lifetime of 500 hours