

Designing with Ceramic Capacitors

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Ceramic capacitors are used in a wide variety of electronic systems, but in general they are the best choice in applications where relatively high voltage levels need to be combined with low capacitance. Depending on the context, low or high voltage can mean a number of different things but in the case of ceramic capacitors, low voltage refers to a dc range of 50 V to 500 V, and high voltage means 1 kV and up.

Perhaps more than for any other passive component type, ceramic capacitors encompass a wide range of sizes and form factors. Lower voltage disc capacitors may have a diameter and height profile as small as several millimeters whereas devices with voltage ratings in the >10 kV range may take the form of barrel- or plate-type devices with diameters and heights of several inches or more.



Vishay's focus in the ceramic capacitor market is on higher-end, higher-voltage applications that require a high level of reliability, including medical, automotive, and industrial systems. Within these markets the applications for ceramic capacitors include medical and dental X-rays, Xenon car headlights, switchmode power supplies (SMPS), LCD backlight inverters, and systems using lasers.

What these applications have in common is the need for high-voltage capacitors with very low capacitance values – down to the level of picofarads. This distinguishes ceramic technology from film capacitors, for which the lowest available capacitance levels are in the nanofarad range. Even within the same general application area, this difference can make one type of device more, or less, appropriate. For example, X-ray equipment for medical diagnostics requires the ceramic combination of high (100 kV) voltage and low capacitance for ignition of the X-ray tube whereas airport X-rays typically use film capacitors with high capacitance values.

Sometimes both ceramic and film capacitors are combined within the same circuit. In Xenon car headlight assemblies, for example, a film capacitor is used for ignition of the lamp while a ceramic capacitor is used for circuit protection at the base of the lamp, where it provides the benefits of small size and the ability to withstand very high temperatures. These same characteristics make ceramic capacitors a desirable solution for backlight inverters for large liquid crystal display (LCD) monitors and TV receivers, where the backlight may require a voltage in the range of 3 kV to 8 kV while low capacitance values and small size are also needed.

Laser excitation is an emerging application for ceramic capacitors where the requirement again is for high voltage and high power ratings and where ceramic capacitors work with significantly lower losses than film. Particularly desirable for this application are capacitors built using the N4700 ceramic dielectric material, which combines low losses, a low dissipation factor, and a high dielectric constant.

RFI suppression on ac lines is another very common application for ceramic capacitors. Safety certified capacitors are designed to withstand high impulse voltages in applications where human beings might be exposed to voltage surges. These capacitors will shunt the energy from the impulse to ground, protecting the circuit from the surge.

Safety capacitors are identified by their place in the circuit as either X capacitors or Y capacitors. X capacitors are used in situations where failure would not lead to danger of electric shock. This is also known as a line-to-line application. Conversely, Y capacitors are used in situations where failure could lead to danger of electric shock. This is also known as a line-to-ground application. A typical arrangement showing both types of capacitors is shown in Fig. 1, where C1 is the “X” capacitor and C2 and C3 are the “Y” capacitors. Vishay’s BCComponents, Cera-Mite, and Draloric brands offer a wide range of safety capacitors certified to IEC60384-14, EN132400, UL1414 and UL1283, and CSA 22.2.

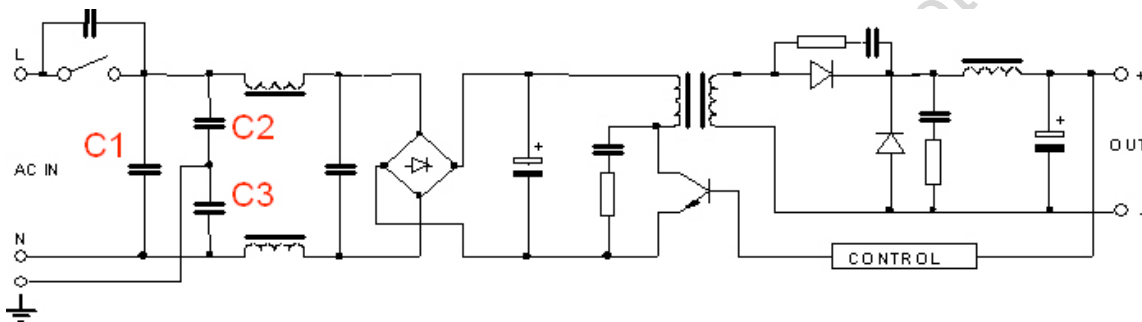


Fig. 1: Examples of X and Y Capacitor Use

One of the choices in selecting ceramic capacitors is between devices with Class 1 and Class 2 dielectrics respectively. Class 1 capacitors are characterized by a high level of stability with respect to temperature and frequency and a low dissipation factor. Class 2 capacitors offer more efficient performance for a given device size, but are less accurate and stable than Class 1 devices and are thus used mainly in non-critical coupling, filtering, transient voltage suppression, and timing applications.

Vishay continually innovates within its ceramic capacitor portfolio to increase the options available to designers and extend the benefits of ceramic technology to new applications. For instance, Vishay can offer a new down-sized version (K10) of its dipped radial-lead Mono-Kap series by using a smaller chip insert. The multilayer ceramic capacitors (Mono-Kap and Mono-Axial series) address industrial applications and are AEC-Q200 approved for automotive applications. Vishay’s MLC series offers a wide range of different dielectrics (C0G, X7R, X8R, and Y5V), voltages (50 V, 100 V, 200 V, and 500 V), and capacitance values from 10 pF to 0.1 μ F.

New Vishay Ceramite 715CxxKT screw-mounting HV disc capacitors feature a low dissipation factor of 0.2% at 1 kHz and a N4700 (T3M) Class 1, strontium-based ceramic dielectric. The devices offer designers a wide capacitance range up to 8000 pF at 10 kVdc and 2000 pF at 40 kVdc, and diameters ranging from 21mm to 60mm. The new devices are optimized for high-frequency coupling and decoupling, laser excitation, and fast-repetition pulse circuitry in high-

voltage power supplies, CO2 lasers, X-Ray equipment, and welding equipment where low losses and high permittivity are required. Vishay has also recently enhanced its anti-arc-over HV Arc Guard MLCCs with optional polymer terminations especially constructed to withstand higher levels of mechanical stress. The technology allows for higher capacitances than standard high-voltage MLCCs, and facilitates the use of smaller case sizes in high-voltage products, allowing for device miniaturization and reducing component cost.



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