Applications Guide

The following bulletin is intended to help the design engineer select the proper capacitor to fill a particular need. In order to select the proper capacitor for a job, the designer is required not only to have a description of the device but also some insight into its advantages and disadvantages for a given application. Some peculiarities of construction, mechanical or environmental limitations, reliability, and failure modes or mechanisms must be taken into consideration.

Selection

Regardless of the application, the designer must consider several factors before selecting the capacitor type required to fulfill a given need. The following list gives some of the factors that must be considered.

Electrical

Capacitance
Tolerance
Voltage rating (DC/AC)
Current (DC pulse/AC)
Insulation Resistance
Equivalent Series Resistance (ESR)
Dissipation Factor (DF)
Capacitance change with temperature

Mechanical

Size

Terminal configuration
Type of mounting

Environmental

Operating Temperature Range
Moisture Resistance (aqueous board cleaning)

Shock and Vibration
Chemical Resistance

Applications

Capacitors are used in one of three basic ways: (1) as a means of discriminating between higher and lower AC frequencies, (2) a method of storing or releasing energy, and (3) as a method of discriminating between AC and DC. Various capacitor applications are broadly classified below; however, the dividing lines between each application are not always sharply drawn.

Coupling/Decoupling (Blocking)

Coupling capacitors are used to "couple" two circuits together. The coupling is accomplished by means of the capacitive reactance common to both circuits. The decoupling capacitor is one which provides a low impedance path to ground to prevent "coupling" between the stages of a circuit.

A capacitor can be used to block DC voltage since once it is charged; it is essentially an open circuit to DC while passing AC currents. Effective coupling demands low capacitor reactance over the entire frequency range of interest. Otherwise certain frequencies may be attenuated when compared to the other frequencies.

The polypropylene or polycarbonate dielectric is the common dielectric for this application.

By-Passing

By definition, a bypass capacitor is a device employed to conduct an AC current around a component or group of components, and it must offer negligible opposition to the frequencies being bypassed. The capacitor acts like a "conduit" for the AC signal by passing it to ground. Three of the most important factors to consider when choosing a bypass capacitor are its impedance, its dissipation factor, and insulation resistance. When the device is installed the leads must be kept as short as possible to eliminate parasitic inductance.

The film polycarbonate, polyester or polypropylene capacitor should be selected for this application.

Power Factor Correction

Power-Factor, in an AC circuit, is the ratio (expressed as a percentage or decimal) of the power actually consumed to the apparent power (product of voltage and current). Power Factor Correction is the practice of raising the **power factor** of an inductive circuit by inserting capacitance. The efficiency of power generation, transmission or conversion is improved when operated at near unity power-factor. The least expensive way is to install power factor correction capacitors. Power factor correction capacitors must be able to withstand high voltage transients and power line variations without breakdown. The best selection for this application is a Polyester Kraft and Foil or a Polypropylene type power factor correction capacitor.

Timing, Sample & Hold

In this type of application, the capacitor is used as a temporary storage cell until the time constant is reached or, in a sample and hold circuit, until the next sample is taken. To change the voltage across a capacitor, it is necessary to change the stored charge which takes a finite time. This phenomenon is put to use in timing circuits, such as oscillators, signal generators, and latch timers. Capacitors selected for this application must have extreme capacitance stability, high insulation resistance, relatively low ESR, and a low dielectric absorption. The polystyrene capacitor would be the proper device to select for this critical application.

Energy Storage

In some applications, a brief but high energy pulse of current is required periodically, rather than a continuous flow of current. Examples are a photo-flash unit or an automotive capacitance discharge. This pulse might have a current level of hundreds or even thousands of amperes. A capacitor for this application should demonstrate an extremely low ESR, along with a high current carrying capability, such as the polypropylene/foil capacitor.

Filtering

Power supplies receive "power" from an AC source such as a commercial power line, a motor driven generator or an inverter. Under normal circumstances, the AC power is rectified producing a pulsating DC. The DC is "smoothed" to eliminate the voltage variations. The simple method is to utilize a single large capacitor or a combination of capacitors and inductors. The polyester capacitor is generally used in a "brute-force" power supply application because of its small size and economic considerations. For switching power supply applications, the polypropylene capacitor is the best selection, because of the low ESR and the high current carrying capability.