

## AN INTRODUCTION TO SELECTING FILM CAPACITORS

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Today's engineers are quite well versed about how to employ embedded processors, write code and even robotic technologies. However, when it comes to the selection and application of passive components, such as film capacitors, we often see a knowledge gap. Having a basic background in the differences between alternate capacitor technologies can serve the engineer well. Several different types of capacitors may appear to function equally well in a circuit, but which capacitor will provide the optimum combination of size, reliability, performance and cost.

Film capacitors are still among the most widely used types of capacitors in electronic and electrical devices. While film capacitors have been in use since the early to mid-20<sup>th</sup> century, today's film capacitors are far more complex and much higher in performance, as compared to the original film/foil wound elements.

While film capacitors do not have the high capacity of some electrolytic capacitors, for many applications, they have a number of significant advantages. These include:

- virtually unlimited shelf life
- they can be manufactured to close tolerances
- their characteristics remain highly stable over time.
- better capability to absorb power surges without damage
- lower in ESR
- low self-inductance.
- Film capacitors are also non-polarized, which is an advantage in many circuit configurations.

Specific types of film capacitors have other unique characteristics, as we will see shortly.

## Dielectrics

While there are a number of types of dielectric films in use, today, the 2 most commonly found dielectric materials of film capacitors are polyester and polypropylene.

Each dielectric has characteristics that are advantageous in the applications they are used in.

### Polyester

Polyester is the most common and oldest dielectric in use today. Capacitors manufactured with polyester film are:

- Smallest in size
- Inexpensive
- Have a wide operating temperature range (125°C)
- High dielectric strength

### Polypropylene

Polypropylene films are commonly used in AC and power circuits.

- High pulse current rating
- High operating frequency range
- High insulation resistance
- Very low ESR
- High AC current rating

## Metalized Film Capacitors

A film capacitor can be constructed with a metalized film construction or alternating layers of film and metallic foil (film/foil). Metallized film capacitors differ from film/foil capacitors in the sense that the aluminum foil is replaced by a layer of metal that is vapor-deposited onto the film surface. The metallization is so thin that if a single layer of metalized film is held up against a light, it would appear transparent.

Metallized film capacitors have significant advantages over film/foil capacitors

- Reduced physical size
- The ability of the device to “self-heal” when damaged.

The self-healing property is exclusive to capacitors with metallized films and is the single biggest advantage over film/foil capacitors.

In a film/foil capacitor, if the foils are exposed to each other, the foils would touch and

fused together turning the capacitor into a short circuit. This is a dangerous and potentially fatal flaw when used in power application. When a capacitor with metalized film has the foils exposed to each other and the foils contact each other the capacitor only momentarily short together. During the short the energy density is so high in the short area that the metallization vaporizes around the short area. The capacitor simply repairs itself (self-heals) allowing the capacitor to remain in operation. Self-healing is due to the combination of the metallization thickness and the high-energy density in the fault area.

## Applications

Like other types of capacitors, film capacitors are used in an almost limitless range of products and circuit types. Common applications for polyester are for blocking, bypass, coupling / decoupling (low pulse), and filtering while common applications for polypropylene are EMI/RFI filtering, general purpose AC, motor run and power film applications.

## Power Film Capacitors

Power Film Capacitors are a specialized family of film capacitors intended primarily for [high-frequency / high-current applications such as](#) DC-link and power semiconductor snubber applications. They are especially well suited for high-frequency inverters, switching power supplies, motor speed controls, power conditioning products and other high-performance power applications where harmonics, irregular signals, complex waveforms and continuously changing signal levels are present.

A great deal of care must be used when selecting power film capacitors. The actual operating conditions both electrical and environmental must be carefully taken into account. Failure to take all factors into account can lead to capacitors being selected that may work for a short period of time then fail very quickly and dramatically. Power film capacitors are not to be used at low frequencies. These capacitors may work for a while but eventually the capacitors will fail much earlier than expected in such applications.

Power film capacitors are available in several different types of terminations and packages. Terminations range from standard 2 leaded axial and radial types to multiple leads to Lugs to screw terminals. Case styles from standard axial and radial lead configurations to large aluminum round tubes.