Medium Power Film Capacitors

General Description

DC FILTERING
The series uses a dry-wound (non-oil-filled) segmented metallized polypropylene or polyester dielectric, which features the controlled self-healing process, specially treated to have a very high dielectric strength in operating conditions up to 85°C, and up to 105°C for the FFB series.

For more information on how segmented metallized films and controlled self-healing works see a complete presentation.

AN ALTERNATIVE TO ELECTROLYTICS
FF series capacitors are an ideal alternative to electrolytic capacitors, because they can withstand much higher levels of surge voltage, very high rms currents and offer longer lifetimes (see section on lifetime as well as determination tables and application notes).

APPLICATIONS
The FF series capacitors are specifically designed for DC filtering and low reactive power. Main applications are: power supplies, motors, drives, electric utilities, induction heating, people movers, tramways, metro systems, unit supported power supplies, etc.

STANDARDS
IEC 61071-1, IEC 61071-2: Power electronic capacitors
IEC 60068-1: Environmental testing
IEC 60077: Rules for electric traction equipment
UL 94: Fire requirements
NF F 16-101: Fire and smoke requirements
NF F 16-102: Fire and smoke requirements
IEC 60384-2: Fixed metallized polyester capacitors
IEC 61881: Railway applications, rolling stock equipment, capacitors for power electronics

LIFETIME EXPECTANCY
One unique feature of the segmented metallized technology is how the capacitor acts at the end of its lifetime. Unlike electrolytic capacitors, which are a short circuit failure mode, film capacitors only experience a parametric loss of capacitance of about 2%, with no catastrophic failure mode. The capacitor gradually loses capacitance over its lifetime (like a battery), and eventually becomes an open circuit.

Lifetime, therefore, as it is defined here, is a function of several elements:
- Decrease in capacitance limit (-2% in the example above)
- Average applied voltage (expressed as a ratio vs nominal rated voltage)
- Average hot spot temperature

By changing any of these parameters we can change the defined “lifetime” of the capacitor. The capacitor will continue to function even beyond the preestablished limit for capacitance decrease. See lifetime expectancy tables in the individual series data sheets to help in this determination.

ELECTRICAL CHARACTERISTICS FOR POLYPROPYLENE AND POLYESTER DIELECTRIC

CAPACITANCE FOR POLYPROPYLENE DIELECTRIC
Polypropylene has a constant dielectric constant, irrespective of frequency up to 1 MHz: $\varepsilon_r = 2.2$

TANGENT OF LOSS ANGLE (TAN $\delta_0$) FOR POLYPROPYLENE DIELECTRIC
Polypropylene has a constant dielectric loss factor of $2 \times 10^{-4}$ irrespective of temperature and frequency (up to 1 MHz).
CAPACITANCE FOR POLYESTER DIELECTRIC

Capacitance of polyester capacitors is a function of temperature and frequency (see the curves).

TANGENT OF LOSS ANGLE (TANδ₀) FOR POLYESTER DIELECTRIC

Dielectric loss factor of polyester is a function of temperature and frequency (see the curves).

HOT SPOT TEMPERATURE

The maximum operating (hot spot) temperature of film capacitors can be calculated in the following manner:

The loss factor of the capacitor is made up of the sum of two components. The first represents electrical losses in the dielectric and the second component represents the Joule heating effect in the external connection and foils (Rs.C.2πf).

For all applications, the temperature in the hot spot must be lower than the maximum operating temperature for the particular capacitor series.

\[ \theta_{\text{hot spot}} = \theta_{\text{ambient}} + (\tan \delta_0 Q + R_s \cdot (I_{\text{rms}})^2) \cdot R_{\text{th}} \]

With:
- \( Q \): Reactive power in Var
- \( R_s \) in Ohm
- \( I_{\text{rms}} \) in Ampere
- \( R_{\text{th}} \): Rth ambient / hot spot in °C/W
- \( \tan \delta_0 (10^{-4}) \) is the tangent of loss angle [see \( \tan \delta_0 \) page 2 (polypropylene) and graph 4 above (polyester)]