DEKI
Film Capacitor Solutions

FILM CAPACITOR BASICS

General information

Plastic film capacitors are generally subdivided into film/foil capacitors and metallised film capacitors. The following description gives brief information about their technical features.

Film/foil capacitors

Film/foil capacitors generally consist of two aluminium foil electrodes with plastic film material used as dielectric.

In order to guarantee the necessary safety and reliability of a capacitor it is essential to use a sufficient film thickness.

Typical advantages that relatively large film/foil capacitors have over smaller metallised capacitors is their higher insulation resistance, their better capacitance stability and their good current carrying capability. High voltage and good pulse handling capability are additional features of these capacitors. Lead connections are made by means of welding.

Metallised film capacitors

In contrast to film/foil capacitors, where aluminium foils are used as electrodes, the electrodes of metallised film capacitors consist of a thin metal layer (0.03 micron thickness, approx.) which is vacuum deposited on the dielectric film. The connection of metallised capacitors is accomplished by means of a metal spraying process and by welding the leads on to the sprayed ends.

The main advantages of metallised capacitors are,

1) relatively small dimensions, a result of vacuum deposited electrodes, and,
2) self healing property.

Owing to the self healing property, relatively thinner films can be used for metallised capacitors than film/foil capacitors.

DC Capacitor

A capacitor designed essentially for application with direct voltage.

AC Capacitor

A capacitor designed essentially for application with alternating voltage.

Climatic category

Indicates the conditions applicable to climatic testing of capacitors as per the relevant standards. It is indicated as a combination of test temperatures for cold proof, heat proof and test days for damp proof (steady state) which the capacitor will withstand.

The category = XX / YYY / ZZ
XX = Test temperature for cold proof
YYY = Test temperature for heat proof
ZZ = Test days applicable

Category temperature range

Denotes the range of ambient temperature for which the capacitor has been designed to operate continuously. This is defined by the temperature limits of the appropriate category.

Rated temperature

The maximum ambient temperature at which the rated voltage may be continuously applied.

Lower category temperature

The minimum ambient temperature for which a capacitor has been designed to operate continuously.

Upper category temperature

The maximum ambient temperature for which a capacitor has been designed to operate continuously.

Self healing

The process by which the electrical properties of the capacitor, after a local breakdown of the dielectric, are rapidly restored to those before the breakdown.

Rated voltage

The maximum direct voltage or the maximum r.m.s. alternating voltage or peak value of pulse voltage which may be applied continuously to a capacitor at any temperature between the lower category temperature and the rated temperature.

FILM CAPACITOR BASICS

Rated capacitance

The capacitance value for which the capacitor has been designed and which is usually indicated upon it.

The capacitance shall be measured at one of the following frequencies unless otherwise prescribed by the relevant specification:

C_R < 1 nf : 10 kHz

1 nf < CR ≤10 µf : 1 kHz

C_R > 10 µf : 50 Hz

The tolerance on all frequencies for measuring purposes shall not exceed ±20%.

The measuring voltage shall not exceed 3% of rated voltage or 5 V_{RMS} (whichever is lower) unless otherwise prescribed in the relevant specification.

Insulation resistance

The insulation resistance is the quotient of an applied DC voltage to the current flowing after a specified time.

$$R\text{ (insulation)} = \frac{V\text{ (applied voltage)}}{I\text{ (leakage current)}}$$

The time constant (S) = M Ω × Mf

= Insulation Resistance × Rated Capacitance

Before this measurement is made, the capacitors shall be fully discharged. The insulation resistance shall be measured, at the following measuring voltage, between the points specified.

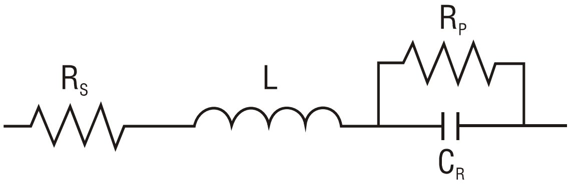
Voltage rating of capacitor	Measuring voltage
UR < 10 V	UR ± 10%
10V ≤UR < 100V	10 ± 1V
100V ≤UR < 500V	100 ± 15V
500V ≤UR	500 ± 50V

The insulation resistance shall be measured after the voltage has been applied for 1 min ± 5 sec.

Tangent of loss angle (tan δ)

The dissipation factor or tangent of loss angle is the power loss of the capacitor divided by the reactive power of the capacitor at a sinusoidal voltage of specified frequency.

Equivalent circuit of capacitor



tan δ = ϖCR = 2 × π × f × C × R where R is the Equivalent Series Resistance.

The tangent at loss angle shall be measured under the same conditions as those given for the measurement of capacitance at one or more frequencies as prescribed in the detailed specifications.

The measuring method shall be such that the error does not exceed 10% of the specified value or 0.0001, whichever is higher.

Quality factor

The reciprocal of tangent of loss angle

$$Q = \frac{1}{\varpi CR}$$

Equivalent series resistance (ESR)

The ESR is the resistive part of the equivalent series circuit and is temperature and frequency dependent. The ESR can be calculated from the dissipation factor (tan δ) as follows:

ESR = tan δ / ϖC

Power dissipation

The power dissipated by a capacitor is a function of the voltage across or the current (I) through the equivalent series resistance ESR.

$P = v \times C \times \tan\delta \times U^2$

$P = 2 \times \pi \times f \times C \times \tan\delta \times U^2$

where f = frequency, tan δ = maximum value specified, U = rated voltage