Power Electronic Capacitors

**BASIC INFORMATION**

Power electronic capacitors (PEC) are specially designed for DC voltage and for non-sinusoidal AC waveforms of voltages and currents.

**DC APPLICATION**

DC capacitors are periodically charged and discharged. This capacitor type is used to reduce the AC component of a DC voltage. Supporting or DC-filter capacitors are used for energy storage.

**AC APPLICATION**

AC capacitors are periodically recharged during operation. AC capacitors serve as damping or snubber capacitors for suppression of undesirable voltage spikes. Communication capacitors quench the conductive state of thyristors.

**Definitions:**
- **Rated voltage** $U_N$
  - Maximum operating peak voltage of either polarity of a reversing or non reversing voltage.
- **Ripple voltage** $U_R$
  - Peak to peak alternating component of the unidirectional voltage

**STANDARDS**

The capacitors listed in this catalog are subject to the international standards for “capacitors for power electronics”:
- IEC 61071-1 and 2; EN 61081-1 and 2
- IEC 61881; EN 61881
- IEC 6068 basic environmental testing procedures
General Technical Information
Power Electronic Capacitors
Vishay ESTA

TECHNICAL DATA

Operating mode
• Continuous operation

Impregnation
• Vegetable oil or resin (1)

Operating temperature range
• Min./max. casing temperature: -25 °C/+ 70 °C
• Min./max. storage temperature: -40 °C/+ 75 °C
• Hot spot temperature: ≤ + 85 °C

Self-discharge time constant
• > 10 000 s

Life expectancy with 3 % failure rate
• 100 000 h; hot spot maximum + 70 °C

Mounting position
• Vertical/horizontal
• Upside down position: upon request only

Protection
• Overpressure switch (1)

Loss factor
• $\tan \delta < 10 \times 10^{-4}$

Capacitance tolerance
• ± 10 % or ± 5 % (1)

Test voltages
• Terminal/terminal
  AC test voltage RMS 1.5 $U_N$/10 s
  DC test voltage 1.5 $U_{NDC}$/10 s
• Terminal/casing
  2 x $U_I$ + 1000 V or 2000 V, whichever is the highest value

Note
(1) If values differ from this data this is mentioned separately

Overpressure tear-off fuse
• On over-running or on reaching the limits of the expected capacitor lifetime, punctures can occur, causing localized bridging and the formation of gas. An over-pressure tear-off fuse disconnects the capacitors element from the line side thereby preventing bursting.

Overpressure sensor
• For capacitors in rectangular cans, pressure sensors are available which can activate a line-side switch via a signal contact.
TECHNOLOGY AND DESIGN

MKP-Dielectric
The favourite dielectric material for PEC is Polypropylene. It is a special high temperature Polypropylene film with a thin metallization on one side of the film. The metallization has an optimized structure in mixture of Aluminium/Zinc and in the ohmic profile which depends on the application and capacitor demands.

Selfhealing effect
As a result of the selfhealing effect, the capacitor is full operativ after an electrical breakdown. A breakdown generates a small electric arc which evaporates the metallization around the area of breakdown in only a view microseconds and at very low energy. The localized increase in gas pressure caused by the high temperature of the arc, blows off the gaseous metallization away from the breakdown point. By means of this process, a metall free, non-conductive isolation crescent is formed which enables continous full operation of the capacitor.

Winding element
All selfhealing capacitors comprising of one ore more individual cylindric winding elements. For contacting the elements in parallel or in series a solderable lead-free metall base layer is sprayed onto the front sides of the winding elements. The process of metall spraying is called “schooping”. The connection of the windings in parallel or in series is accomplished by means of highly flexible copper material. In this way the capacitors are able to fulfill the most highest demands of current load, low inductive characteristics, low ohmic drop and shock and vibration fail proof.

Filling material
After mounting the stack of winding elements into the cases, the capacitors are dried under vacuum and gas impregnated with N2 (Nitrogen) before filling.

- Dry casting
Most of the selfhealing capacitors in rectangular cases and a number of capacitors in cylindrical cans are filled with a soft resin mainly based on vegetable castor oil. The casting compound R25 developed by Vishay remains elastic throughout the entire life of the capacitor. This elastic casting compound offers outstanding shock and vibration protection for the internal structure and long-lasting protection against the penetration of moisture into the electrical components of the capacitor. A very good thermal conductivity of the casting compound enables maximum capacitor loads under high temperature stress conditions. The casting compound can be treated as ordinary waste.

- Vegetable oil
For capacitors with tear-off protection, preference is given to impregnation using a specially produced and stabilized vegetable oil.

DEFINITIONS

Rated capacitance (C_R) of a capacitor is the capacitance by which it is designated. The term is related to 20 °C capacitor temperature, 50 Hz and rated voltage.

Tolerance on capacitance is the capacitance range within which the actual capacitance may differ from rated capacitance (C_R).

Rated voltage (U_N) is the maximum of mixed voltages or the peak of AC voltages for which the dielectric of capacitors is designed, adhering to the characteristics and other rated values specified. Rated voltage is not the rms value but the maximum or peak capacitor voltage.

Rated voltage (U_N) DC-capacitors is the maximum operating peak voltage of either polarity but of a non-reversing type waveform, for which the capacitors have been designed, for continuous operation.

Periodic peak voltage (U_S) is the periodically permissible peak voltage. The characteristic and permissible duration of exposure are given.

Peak voltage (U_Smax.) is the maximum voltage which may be allowed to occur across the capacitor sporadically and for a brief period, e.g. in the event of a fault. The characteristic and permissible load duration are given in most cases.

Ratio of voltage reversal (D) is the ratio between the second voltage peak and the first voltage peak for dampened dying-out surge discharge, expressed as a percentage.

Rated insulation voltage (U_I) is the rms AC voltage for which the insulation of the capacitor is designed and designed with terminal connected to case.

Rated current (I_N) is the current by which the capacitor is designated and in particular for which its current paths are designed. Rated current is the maximum rms level of steady-state current.

Peak surge current (I_S) is the maximum level of current which may be allowed to occur across the capacitor sporadically for a short period e.g. in the event of a fault. The characteristic and permissible duration are given.

Dielectric loss factor (tan δ) is the loss factor of the dielectric which is assumed to be constant for the normal dielectrics and their operating frequency range.
Minimum temperature
The lowest temperature at the surface of the capacitor case (ready for operation) at which the capacitor may be switched on. Lower temperatures are usually permissible for transport and storage.

Maximum temperature
The highest temperature which the hottest point of the capacitor case may reach during operation, including selfheating.

Reliability
The operating reliability of the capacitor is determined by the number of failures within an adequately large batch expected to occur after a specified time (life expectancy). DIN 40040 has replaced the previous term “operating reliability” by the new term “reference reliability”.

Reference reliability
Reference reliability is expressed in terms of failure quota and respective load duration (not including storage times). Reference reliability is the reliability for defined load (reference load). The reference exposure figure quoted relates to operation under nominal conditions and the application class given in the data lists.

Failure ratio
The failure ratio is the relationship between the number of failed capacitors and the total number of capacitors used. It applies to a particular capacitor only and the load duration cited (life expectancy). The figure quoted in the data lists is an average which is generally not exceeded if examining an adequately large number of capacitors.

FIT
FIT = failures in time
The failure rate in FIT indicates the maximum failed components within $1 \times 10^9$ component operation hours.