

## Applications

### Smoothing or filtering

Smoothing capacitors are used to reduce the AC component of pulsating DC voltage.

Fields of application:

- measuring and control engineering and telecommunications,
- cascaded circuits and high-voltage test instruments.

### Supporting, DC link circuits

These capacitors support a DC network by briefly supplying high currents when there is a periodic peak current requirement. They are periodically and abruptly charged and discharged. The peak value of the current that occurs here is substantially greater than the rms figure.

Such capacitors must be designed for a high thermal rating in order to handle the relatively high reactive power and power dissipation.

Capacitors for use in applications with IGBT semiconductors must also be designed to have especially low inductances.

Fields of application:

- DC link circuits of inverters (GTO, IGBT or thyristor controllers for DC and three-phase drives).

### GTO clamping

Especially powerful GTO inverters for high-speed railways as well as industrial inverters call for special circuit designs to minimize switching losses. Besides snubber capacitors for protecting semiconductor devices, clamping capacitors are used, which reduce switching losses to a minimum.

### Series resonant circuits

Series resonant circuit capacitors are DC capacitors which may have very high superimposed AC voltages of purely sinusoidal form. They are configured in series with inductors and filter the harmonic components that are still present after rectification at twice the line frequency.

Series resonant circuit capacitors must be designed for very high reactive power, not produce partial discharges and be scaled for high thermal stress.

Fields of application:

High-power industrial and traction inverters fed from single-phase AC supply networks at frequencies of 10 to 100 Hz.

### Discharge

Discharge capacitors are DC capacitors that absorb or supply strong current surges. They are charged sporadically and briefly discharged in relation to the charge time or vice versa.

Discharge capacitors are subjected to high loads:

- high field strength corresponding to the required high energy density,
- large peak currents because of the fast discharge, generating considerable mechanical forces in large capacitors,
- high AC voltages on inductive loads as a result of overshoot.

Fields of application:

- in various fields of research and engineering for generating strong magnetic fields, high-energy light flashes, high temperatures and extremely high pulses of electrical energy.

## Applications

### General AC applications

AC capacitors are suitable for general-purpose applications. They are also used with non-sinusoidal voltages and currents.

Fields of application:

- in resonant circuits,
- for filtering in magnetic voltage stabilizers at line frequency,
- commutating capacitors in power inverters with interphase commutation below 100 Hz.

### Coupling

Coupling capacitors transfer information between equipment parts on different potential (e.g. connection between control and power electronics).

The load on the capacitors is primarily due to the voltage difference between the two equipment parts. The signal voltages to be transferred are much less load for the capacitor. The coupling capacitor must also prevent current flow between the equipment parts under all unspecified operating conditions.

### Commutation

Commutating AC capacitors quench the conducting state in a semiconductor component. They are periodically and abruptly charged and discharged, the peak value of the current that occurs being substantially greater than the rms figure.

Commutating capacitors are mainly subjected to high reactive power and peak current. A decisive factor is the ring-around time. At high ring-around frequencies (10 ... 100 kHz) the capacitor must still exhibit a purely capacitive reactance, i.e. it must be low-inductance in design.

### Damping

Damping AC capacitors are connected in parallel with semiconductor components to suppress or damp undesirable voltage spikes.

Damping capacitors are abruptly charged and/or discharged, the peak value of the current that occurs being substantially greater than the rms figure.

In addition to sinusoidal halfwave voltage, damping capacitors carry

- periodic voltage peaks from the hole storage effect, and
- harmonic components from phase controls.

Special requirements are made of these capacitors for high dielectric strength and peak-current capability. They are also expected to be highly reliable because, if RC circuitry fails, a power semiconductor will be destroyed in most cases.

## Applications

### GTO snubbing

Low-inductance snubber capacitors are connected in parallel with GTO thyristors to limit the rate of rise of their repetitive reverse voltage. The voltage values are derived from the repetitive peak off-state voltage  $U_{\text{DRM}}$  of the GTO thyristor.

These capacitors are periodically and abruptly charged and discharged, whereby the peak value of the current reaches extremely high values. The rms current is also significantly higher than the loads of conventional snubber capacitors, because this capacitor must briefly carry the entire load current. The wiring only allows very small circuit inductances. So especially low-inductance capacitor design is important.

### Power factor correction and filtering

These are parallel AC capacitors for improving the power factor ( $\cos \varphi$ ) in electrical power installations with rated frequencies from 15 to 60 Hz.

They keep reactive current components – produced by inductive loads – away from power-generating and power-transmission installations. The voltage load is virtually sinusoidal. High harmonic components can be produced in the capacitor current as a result of loads that draw a non-sinusoidal current, because these non-sinusoidal components are shorted with the capacitor.

Capacitors for reactive-current compensation must also sustain surge voltages from the line that are produced when inductive loads are turned off.

These AC capacitors are very best suited also for usage in harmonics filter circuits in applications, such as UPS systems, wind farms, and any kind of big inverters and drives. The capacitor in series with a filter circuit reactor forms a series resonance circuit which protects the equipment from resonance conditions and improves power quality by absorbing a certain amount of harmonic currents.