General Safety Data Sheet for Power Capacitors

General safety data sheet of power capacitor manufacturers who are members of the *ZVEI - German Electrical and Electronic Manufacturers' Association*

I. Area of Validity

This safety data sheet applies to the following power capacitors and standards. Its purpose is to describe the state of technology which usually must be adhered to by all relevant supplier and service contracts.

1.	Power capacitors for reactive power compensation (PFC = Power Factor Compensation) up to 1000 V	IEC / DIN-EN 60831 and 60931
2.	Power capacitors for reactive power compensation (PFC) above 1000 V	IEC / DIN-EN 60871
3.	Power capacitors for inductive heat generation (PFC)	IEC / DIN-EN 60110
4.	Capacitors for power electronics (PEC)	IEC / DIN-EN 61071
5.	Capacitors for railroad applications	IEC / DIN-EN 60881
6.	Lighting capacitors (AC)	IEC/DIN-EN 61048/49
7.	Motor capacitors (AC)	IEC / DIN-EN 60252

II. General Rules of Safety

Since power capacitors are electrical energy storage devices, they must always be handled with caution. Even after being turned off for a longer period of time, they can still contain hazardously high voltages (danger of death). The same applies to all system components and devices which have an electrically conductive connection to the capacitor. The safety rules of electrical good practice must always be complied with when handling voltage-conducting components in electrical systems.

III. General Conditions for Storage and Use

1. The installation, application and maintenance notes of the manufacturer and the relevant standards must always be complied with.
2. **Capacitors must never be stored or used outside the specified temperature ranges.**
3. Capacitors may not be stored or operated in corrosive atmospheres, particularly not when chlorides, sulfides, acids, lye, salts, organic solvents or similar substances are present.
4. In dust and dirt-prone environments, regular checks and maintenance (particularly of the connection terminals and insulators) are absolutely necessary to prevent creation of creepage distances between potential-conducting components among themselves and/or to the protective conductor/ground.
5. **The maximum temperatures (including inherent heat), voltages, currents, power, reactive power, thermal resistances, frequencies, discharge times and switching frequencies specified in the data sheet must be adhered to.**
6. **A means of sufficient dissipation of heat loss (fan, cooling) or escaping gases in case of malfunction must be provided. Required minimum distances (e.g., to sources of heat) must be adhered to.**
7. Specified torques for electrical connections and mounting elements must be adhered to.
8. Mechanically or electrically damaged, leaky or otherwise damaged capacitors may not be used or continue to be used.
9. Existing protective devices of the capacitors may not be manipulated, removed or impaired in their function.

IV. Internal Protective Devices

1. The following table gives an overview of the known internal protective devices:

Protective Device/ Protective Mechanism	Application Area PEC	PFC	AC
Without protective devices	x		
Exclusively self-healing	x	x	x
Singly or in combination:			
Improved self-healing	x		
Overpressure interrupter	x	x	x
Overpressure switch	x	x	x
Overpressure valve	x	x	
Overpressure membrane	x		
Reinforced housing	x	x	
Segmented film	x		x
Winding fuse		x	
Thermal fuse			x

2. Internal protective devices offer basic protection against certain internal faults, aging and overload.

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3. Internal protective devices alone are not sufficient to prevent all conceivable dangers in case of malfunction. The so-called self-healing capability is not the same as fail safe system stability.
4. Depending on their protective mechanism, internal protective devices are subject to technical and functional limits which when exceeded will definitely cause malfunctions. Such violations can be: **excess temperature, overvoltage, wrong application, wrong installation, faulty maintenance, mechanical damage, operation outside the technical limits of the specification.**
5. Most internal protective devices can interrupt the voltage only within the capacitor. They are not fuses in the classical sense such as cable or device fuses which interrupt the voltage in front of the faulty system component.

V. Risk Factors for the Capacitor

The most frequent risk factors which cause capacitor damage and possibly also the failure of the protective devices are:

1. Exceeding the permissible temperature on the capacitor surface (an excess temperature of 7 °K cuts life expectancy in half)
2. Voltage increases, overcurrents and high turn-on currents even if they only occur briefly or cyclically (an overvoltage of 8 % cuts life expectancy in half)
3. Network harmonics, resonances with harmonics or flicker even when they occur only briefly or cyclically
4. Aging of the lighting equipment and consequential excess temperature or high UV stress
5. Failure of other components in a common switch connection and consequential overvoltages or overcurrents
6. Interaction with other reactive power elements, also parasitic capacitances or inductivities in common switch connections
7. Even if the test based on the capacitor standard is passed, this does not ensure comprehensive protection against all possible overloading.

VI. Risks When a Fault Occurs

1. Power capacitors can be a significant risk in case of failures due to their stored energy and/or their properties during operation in networks with high short-circuits power.
2. Power capacitors can actively fail when internal or external protective devices are missing, incorrectly dimensioned or have failed. They can burst, burn or, in extreme cases, explode.
3. The gases (e.g., hydrocarbons as decomposition products of the organic insulating materials used) released in case of damage are flammable and can create explosive mixtures. The fire load of a power capacitor is approx. 40 MJ/kg.

VII. Risk Minimization

1. The capacitor manufacturer cannot predict all possible stresses which a power capacitor can be subjected to and which must be provided for in the design. This means that the user carries crucial co-responsibility here. Alone for this reason, safety and quality should be the top criteria when a capacitor is selected. **This is why we urgently recommend the use of capacitors with good internal protective devices.**
2. Before designing the application, capacitors must be checked for their suitability for this particular application. All influences (parameters) must be considered. Unexamined use in an application may have serious consequences.
3. Particularly with sensitive applications, the internal protective devices of the capacitors should be supplemented by the user with suitable external protective measures. External protective measures are even mandatory when capacitors are used without internal protective devices.
4. When power capacitors are used, you must always provide suitable measures to eliminate possible danger to humans, animals and property both during operation and when a failure occurs. This applies to capacitors without and with protective devices.
5. The power capacitor manufacturers organized in the ZVEI will be glad to give users preliminary advice already before planning of the application begins and provide concrete application recommendations.

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