

Components

Power Capacitors and accessories



LKT - DL

Premium Power Capacitors for special applications

FRAKO Power Capacitors are installed in power factor correction systems and in passive filters.

FRAKO Power Capacitors have been developed and manufactured for decades solely at the company's Teningen production site in Germany. This has resulted in a consistently high product quality being maintained, the basis for assured operational reliability and a long service life.

Application Recommendations

FRAKO offers Power Capacitors for a variety of applications. They are divided into four separate categories with different specifications:

- Basic Capacitors
- Standard Capacitors
- Premium Capacitors
- Heavy Duty Capacitors

FRAKO Power Capacitors are available as single-phase and 3-phase versions.

Voltage and power ranges:

- Nominal voltage: 240–800 V, 50 / 60 Hz
- Nominal power: 1.0–40.0 kvar

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Design & quality

FRAKO Power Capacitors are manufactured in a unique dry design. Each comprises up to three interconnected capacitor coils wound in a low-loss, metallized polypropylene film and enclosed in a cylindrical aluminium casing provided with an M12 mounting stud. In addition to a PCB-free, flame-resistant mineral filler material, the casings also contain an adhesive stabilizer. Discharge resistors, permanently connected in the factory, guarantee that the residual voltage falls to <50 V within one minute after the capacitor has been disconnected. Cables are connected by means of the tried-and-tested spring clamps of the AKD range, which are 'finger-safe' and maintenance-free.

The use of rigorously inspected materials and their careful processing guarantee excellent quality and a long product service life. FRAKO manufactures its Power Capacitors to its own in-house specifications, which are far more exacting than the requirements of the applicable standards.

Quality control inspections after each individual manufacturing step ensure that the final product is of a high quality. These demanding quality standards, together with specially developed manufacturing technology, enable FRAKO Power Capacitors to achieve a longer-than-average service life. At the end of the manufacturing process, each capacitor is inspected individually. The in-house requirements for this special inspection are considerably more stringent than those of the routine tests specified by the relevant standards.

Standards

All FRAKO Power Capacitors comply with the international standards IEC 60831-1 and -2, and of course with EN 60831 1 and -2. In addition to the CE marking, our capacitors meet the standards and specifications for UL 810, UKCA, EAC as well as the ISI marking. A special series developed for the North American market also fulfils the CSA 22.2 No. 190 standard.

Four safety features ensure uninterrupted operation

The reliability of Power Capacitors is crucially important for the problem-free operation of power factor correction systems and passive filters. FRAKO's measures to ensure this are now fourfold: Power Capacitors nowadays usually use polypropylene as the dielectric material, its surfaces being metallized. This design has the important property that if local overloading occurs and punctures the substrate film, the fault automatically isolates itself, a phenomenon known as **self-healing**.

Self-healing is due to the heavy short-circuit current that flows between the films immediately vaporizing the very thin metal coating at the damaged location, thus ending the flow of current.



If several punctures occur in a small area of metallized film, the amount of energy involved might be too much for the **self-healing** action alone to cope with. This could lead to complete failure of the capacitor. However, in this case the second fail-safe function of the fourfold safety design comes into play: the **segmented metallization**.

In the manufacturing process, the polypropylene film for FRAKO Power Capacitors is metallized by vapour deposition to form a pattern of separate individual segments. Each segment is connected to the power supply by slender contact bridges, these being so dimensioned that when severely overloaded (several substrate punctures within one segment), they act as fuses by simply vaporizing, thereby securely isolating the damaged segment from the power supply.



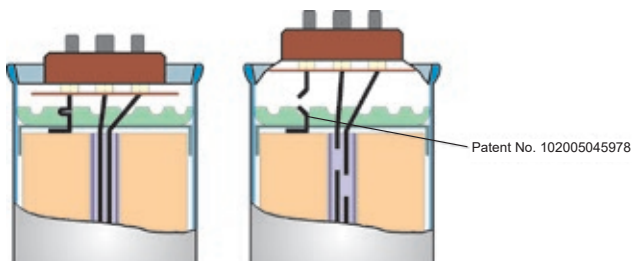
The **segmented metallization** technique increases the reliability of the capacitors and prolongs their service life.

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The third design feature for increases product safety is the three-phase **overpressure disconnecter**, a mechanical fuse included in every FRAKO capacitor.

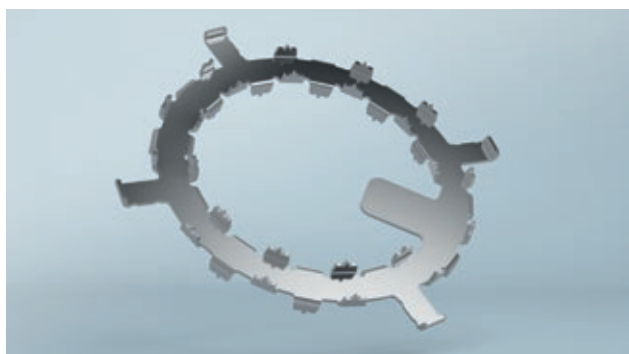
If an excessive internal pressure develops due to overloading, or at the end of the capacitor's service life, the mechanical fuse isolates the capacitor safely from the power supply by disconnecting all poles. Should puncturing of the dielectric occur on a major scale, this results in the substrate film melting and generating gases inside the casing, thus building up pressure in the capacitor. This causes the diaphragm lid to bulge outwards, thereby tensioning the internal leads to the coils until they act as mechanical fuses, breaking cleanly at defined locations. The bulging of the lid also increases the internal volume, therefore reducing the pressure inside the capacitor.



Principle of the overpressure disconnection system

In 2015, FRAKO added the patented **contact ring** to the other safety and reliability features, thus making them fourfold.

These patented rings are stamped from a special alloy and are formed with a number of pointed teeth that press into the zinc end-face contact layers on the windings to make electrical contact. The internal connecting leads are spot-welded to the **contact rings** before final assembly of the capacitor.



The great advantage of this solder-free design: it has completely excluded the risk of damaging the capacitor windings at the manufacturing stage due to overheating during soldering of the connecting leads. The quality of the winding connection is significantly increased, and the reliability of the mechanical fuse that protects against excessive internal pressure is improved by its being securely spot-welded in place.

The **contact ring** also enables FRAKO to produce completely lead-free capacitors and make yet another improvement to their operating reliability.

Special technical features

In our ongoing development work on FRAKO Power Capacitors, we always focus on those attributes that are called for in present-day applications. The three following factors are especially important:

- Overvoltage tolerance
- Current-carrying capacity
- Thermal endurance

Overvoltage tolerance

As required by the standards IEC 60831-1 & -2, as with EN 60831-1 & -2, all FRAKO Power Capacitors are designed to withstand the following overvoltages:

8 hours daily:	$1.10 \times$ capacitor nominal voltage
30 minutes daily:	$1.15 \times$ capacitor nominal voltage
5 minutes:	$1.20 \times$ capacitor nominal voltage
1 minute:	$1.30 \times$ capacitor nominal voltage

The following table shows a selection of nominal voltage ratings and maximum overvoltages:

Capacitor nominal voltage	240	400	440	480	525	600	690	760	800
8 hours daily	264	440	484	528	578	660	759	836	880
30 min daily	276	460	506	552	604	690	794	874	920
5 minutes	288	480	528	576	630	720	828	912	960
1 minute	312	520	572	624	683	780	897	988	1040

All voltages in volts [V]

Current-carrying capacity

All over the modern world, harmonics are polluting the electricity supply networks. The increasing use of devices such as frequency converters has a growing impact on capacitors. If these are operated in a power supply network contaminated by harmonics, dangerous resonances can result, which can again significantly increase the currents that the capacitors must withstand.

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The applicable standards call for a continuous current-carrying capacity of at least 1.3 times the nominal current to be designed for in Power Capacitors. In reality, however, even this value can be exceeded under conditions with extreme levels of harmonics.

For this reason, all FRAKO Power Capacitors are designed for a continuous current-carrying capacity of at least 1.5 times the nominal current. More information on ampacity is given in the specifications table on the following page.

Thermal endurance

Excessive temperatures also have a negative impact on the service life of a capacitor. Storage or operation of capacitors above their permitted temperature limits results in a drastic shortening of their service life. Power Capacitors are assigned to different temperature classes according to the permitted ambient temperature as follows:

Temperature class	Maximum ambient temperature		
	Absolute maximum temp.	Max. average temp. over 1 day	Max. average over 1 year
B	45 °C	35 °C	25 °C
C	50 °C	40 °C	30 °C
D	55 °C	45 °C	35 °C

The temperatures stated above refer to the direct environment of the capacitors. This means the internal temperature in the enclosure or control cabinet that houses them. Experience shows that the limits given in the table for the temperature classes can easily be exceeded in practice. Higher temperatures are to be expected in particular in the case of power factor correction systems fitted with filter reactors.

Power Capacitors in the Standard, Premium and Heavy Duty categories are therefore designed for continuous ambient temperatures of at least 60 °C.

This continuously rated thermal endurance is helped by the compact construction of the capacitors, which is conducive to optimum heat dissipation.

Maintenance-free capacitor connections

The connecting terminal (AKD) is based on the proven technology of the Wago Cage Clamp®. These connectors use special spring clamps that ensure a simple, vibration-resistant and maintenance-free electrical contact with the capacitor. They can be used to connect single-core, stranded or fine-filament copper cables. The AKD spring clamp complies with the IP20 rating as per EN 60529, thus qualifying as 'finger-safe'.



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Specifications of FRAKO Power Capacitors

Category	Basic	Standard	Premium		Heavy Duty
Type designation	LKT ...-DB	LKT ...-DP	LKT ...-DL		LKT ...-HD
Nominal voltage	400–525 V	280–800 V	400–525 V	440–615 V ¹⁾	480–525 V
Nominal frequency	50/60 Hz				
Power rating	5.0–36 kvar	5.0–40 kvar	1.0–24 kvar	1.2–29 kvar	16.8–21.6 kvar
Capacitance tolerance ²⁾	-5 / +5 %				
Dielectric losses	0.2 W / kvar				
Power loss ³⁾	0.5 W / kvar				
Residual voltage after 60 seconds discharge time	≤50 V				
Maximum overvoltage	1.10 x V _N – 8 hours daily 1.15 x V _N – 30 minutes daily 1.20 x V _N – 5 minutes 1.30 x V _N – 1 minute				
Maximum continuous overcurrent at nominal voltage (50 Hz)	1.5 x I _N	1.8 x I _N	2.2 x I _N	2.0 x I _N	2.7 x I _N
Maximum inrush current at nominal voltage (50 Hz)	200 x I _N	250 x I _N	300 x I _N	272 x I _N	450 x I _N
Test voltage (metal film–metal film)	2.15 x V _N , 2 seconds 1.85 x V _N , 10 seconds				
Test voltage (metal film–casing)	V _N < 600 V = 3.9 kV, 2 seconds V _N > 600 V = 4.3 kV, 2 seconds				
Insulation voltage rating dependent on V _N and diameter	3.9 / 8 kV 3.9 / 12 kV 4.3 / 8 kV 4.3 / 12 kV				
Temperature class	-25 / D	-40 / 60	-40 / 65	-40 / 60	-40 / 68
Min. / max. temperature ⁴⁾	-25 / +55 °C	-40 / +60 °C	-40 / +65 °C	-40 / +60 °C	-40 / +68 °C
Max. casing temperature	+70 °C	+75 °C	+78 °C	+75 °C	+78 °C
Min. / max. storage temperature	-25 / +85 °C	-40 / +85 °C			
Max. humidity	95 % non-condensing				
Max. site altitude	4 000 metres				
Service life	130 000 h	160 000 h	200 000 h	160 000 h	250 000 h
Max. number of switching cycles per year	20 000	40 000	60 000	40 000	100 000

¹⁾ Capacitors of the Premium category can be operated above their nominal voltage if a reduced specification is acceptable. The tables on pages 18 and 19 give the maximum permissible continuous overvoltage for each capacitor type.

²⁾ Other tolerances on request

³⁾ Total power loss incl. discharge resistor

⁴⁾ The table of temperature classes on the previous page applies to capacitors of the Basic category. Capacitors of the categories Standard, Premium and Heavy Duty are specified for continuous operation at the stated maximum temperature.

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Premium Capacitors (three-phase, V_N : 400 V...480 V)

Type LKT...-DL for 50 Hz / 60 Hz

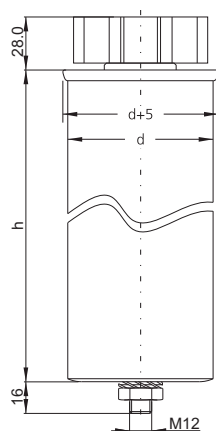
Article-No.	Type	Capacitance [μF]	Rated Reactive Power in kvar at Rated Voltage (V _N) 50 Hz / 60 Hz							Rated current at V _N 50 Hz / 60 Hz [A]	Dimensions (d x h)	Packing Unit (pcs.)
			230V	400V	415V	440V	460V	480V	525V		Weight (net) [mm] [kg]	
31-10613	LKT 3.6-480-DL	3 x 16.6	0.8 1.0	2.5 3.0	2.7 3.2	3.0 3.6	3.33 4.0	3.6 4.3	4.3 5.2	4.3 5.2	60 x 150 0.590	9
31-10388	LKT 4.5-480-DL	3 x 20.7	1.0 1.2	3.1 3.8	3.4 4.0	3.8 4.6	4.1 5.0	4.5 5.4	5.4 6.5	5.4 6.5	60 x 225 0.840	9

Areas shaded dark grey indicate power (kvar) at higher voltages according to capacitor type "DP" (see specification page).

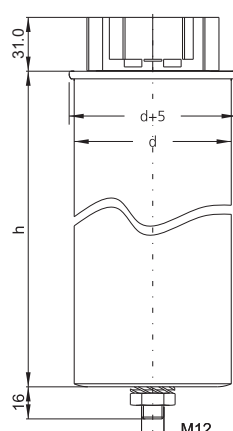
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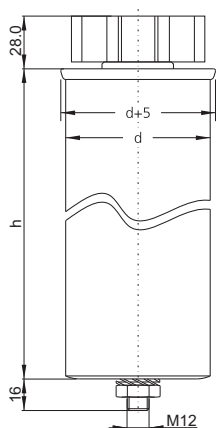
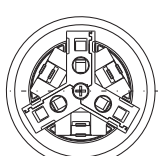
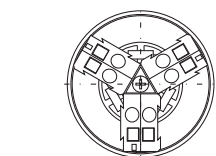
Dimensions



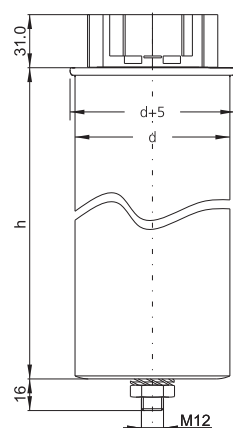
Three-phase capacitor with $d = 60/70$ mm
Spring tension terminal AKD 25/3 for $2 \times 6 \text{ mm}^2$



Three-phase capacitor with $d = 85$ mm
Spring tension terminal AKD 30/3 for 16 mm^2



Single-phase capacitor with $d = 60/70$ mm
Spring tension terminal AKD 25/2 for $2 \times 6 \text{ mm}^2$



Single-phase capacitor with $d = 85$ mm
Spring tension terminal AKD 30/2 for 16 mm^2

