POWER ELECTRONICS CAPACITORS

Ideal for filter applications

- UL Certified • IEC 61071 compliant

SAFER, STRONGER CAPACITORS FOR POWER ELECTRONICS

Achieve reliability and long life expectancy for filter applications

TYPICAL APPLICATIONS

FRAKO Type LKT-F capacitors are power electronic capacitors which are designed specifically for use with non-sinusoidal voltage and current including Pulse Width Modulated (PWM) voltage. Type LKT-F capacitors may be used in various types of filters for use at the input or output side of inverters and drives. They may be applied in either DC (V_N ratings) or AC (V_{rms} ratings) filter circuits.

FRAKO EXPERTISE

FRAKO has over 90 years of experience designing and producing capacitors, plus decades of leadership in the European capacitor systems market. Based upon our experience in capacitor systems, **FRAKO** knows what real world operating conditions capacitors can be exposed to and they set high design and performance standards to assure their capacitors will meet these requirements. **FRAKO** developed the LKT-F Power Electronic Capacitor range with a combination of valuable safety features and strong ratings to assure satisfactory operation and life expectancy in power electronic (PWM) filter applications.

APPLICATIONS

- Grid-tied inverters / filters
- Renewable energy systems
- Drives with Active Front Ends
- PWM sine wave filters
- L-C-L Filters for active front ends
- Power converters
- Power electronic filters
- Input harmonic filters
- Output filters at power converters
- VFD sine wave filters

c UL us **IEC 61071**

SAFETY

Exclusive Four-Fold Safety Features

FRAKO goes to extensive lengths to ensure safety in each of our capacitors by combining four techniques that improve safety while minimizing the possibility of catastrophic failures. While all polypropylene power capacitors utilize self-healing metallized film, only **FRAKO** incorporates three additional levels of safety. **FRAKO** safety features include: Self-healing film, segmented film, all-phase disconnection for internal over-pressure plus our patented solder and heat free coil contact ring.

1. Self-healing Metallized Film

The self-healing process occurs naturally in situations where adverse conditions cause an internal short circuit between two adjacent films. Self-healing is due to the heavy short circuit current that flows between films, causing the immediate vaporization of the metallized coatings, thus ending the short circuit. This feature has the important property that if localized over-loading occurs and punctures the substrate film, the fault automatically isolates itself. A portion of the metallization is vaporized to isolate the damaged area of the film and essentially stop the short circuit. This quickly stops the flow of short circuit current and enables the capacitor to continue in use.

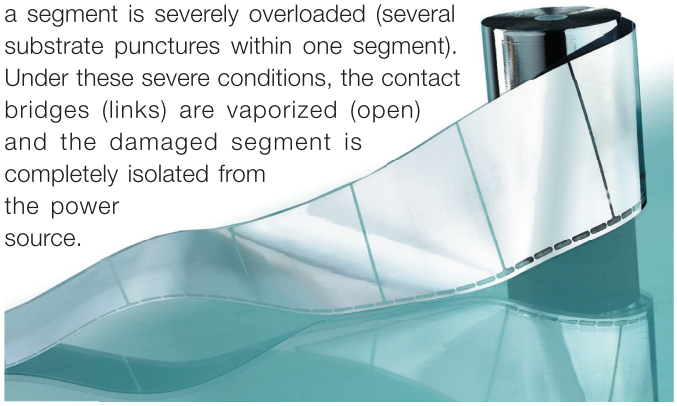
Self-healing event in typical metallized film

How it works:

An internal fault between two films causes short circuit current to flow between these two films. This causes vaporization of the metallized coatings in the faulted area. Vaporization continues until sufficient metallization is removed to isolate the fault, thus ending the short circuit.

2. Segmented Film

If several punctures occur in a localized area, the amount of energy involved may be too great for the self-healing process alone. This can lead to complete failure of the capacitor and traditional capacitors may actually explode in these cases. **FRAKO**'s segmented film protects against severe internal short circuits. The polypropylene film used in **FRAKO** capacitors contains a metallization pattern of separate individual segments. Each segment is connected to the power supply by thin contact bridges which are precisely dimensioned to act like fuse links when a segment is severely overloaded (several substrate punctures within one segment). Under these severe conditions, the contact bridges (links) are vaporized (open) and the damaged segment is completely isolated from the power source.



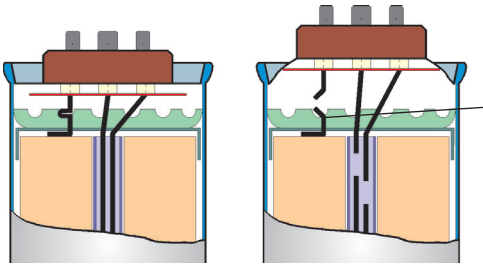
FRAKO Segmented, self-healing metallized film

How it works:

Under severe fault conditions, the contact bridges (links) are vaporized (opened) and the damaged segment is completely isolated from the power source. Major internal short circuits are isolated before they have a chance to become substantial multi-layer faults. Only an insignifcant amount of capacitance is lost if one of the thousands of individual segments is isolated and the capacitor can continue in use.

3. All-phase Over-Pressure Disconnection

If an excessive internal pressure develops due to overloading or at the end of a capacitor's life, an over-pressure disconnection device activates to disconnect the capacitor. Over-pressure disconnection is required by international safety standards, to disconnect the capacitor from its power source when internal pressure, due to repeated self-healing or at the end of capacitor life, is too high. Most capacitors have the ability to disconnect power from only two of the three internal coils. While current flow does cease, there is still voltage applied to one of the windings. **FRAKO**'s patented over-pressure disconnection method fully disconnects all three phases of the capacitor.



Overpressure disconnection system

How it works:

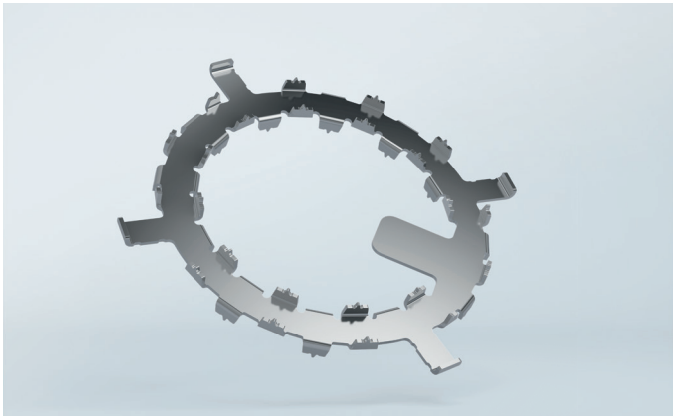
Should puncturing of the dielectric film occur on a major scale, the substrate may melt. This will generate gases which increase the internal case pressure causing the capacitor diaphragm (lid) to buldge upwards. This motion increases the tension on the internal coil leads until they break at their defined locations. Bulging of the lid also increases internal volume, thereby reducing pressure inside the capacitor. This over-pressure disconnection method is a one time device. Once the device activates, the capacitor coils are permanetly disconnected. A bulged lid on a capacitor is a visual indicator the capacitor has failed.

4. Solder-Free Contact Ring

FRAKO added this key safety feature in 2015. These contact rings enable **FRAKO** to make the connections from the capacitor terminals to the coils without solder and without heat. This process eliminates the traditional risk of damage to capacitor windings caused by the heat associated with soldering. Soldering heat tends to burn away some of the polypropylene film and could cause weakening of capacitors. **FRAKO**'s contact rings provide reliability and solder-free (RoHS compliant) capacitors. They also eliminate the possibility of a loose "flying" lead in the event of capacitor overheating that can occur with soldered leads.

How it works:

First, coil lead wires are spot-welded to the contact rings. Single phase capacitors use two rings, while three phase capacitors use six rings. Then contact rings, stamped from a special metal alloy and having many protrusions are pressed into the zinc end faces of the coils. These low impedance contact ring to coil connections are made securely, reliably and without the use of heat.



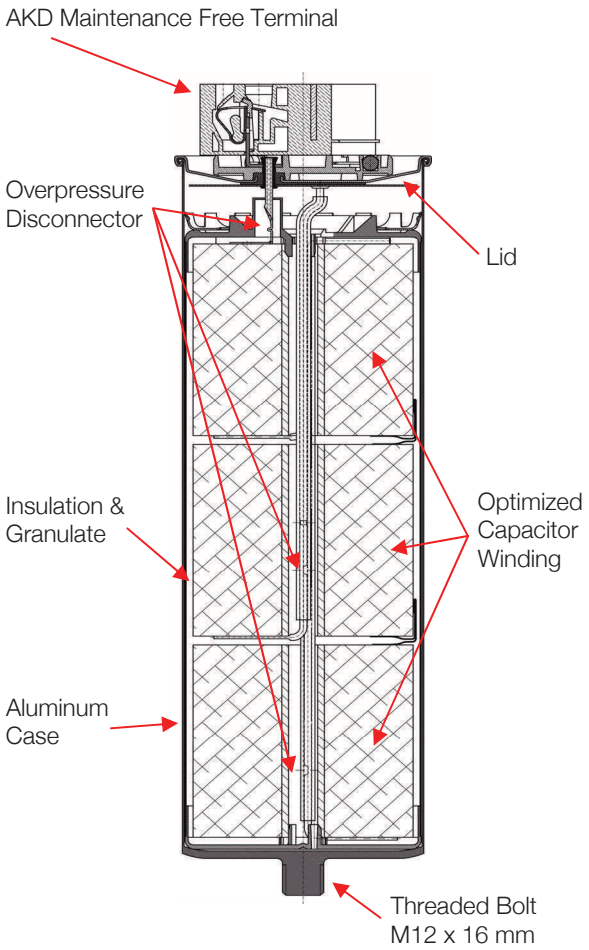
Contact ring (Patent no. US10,256,042 B2 / Date of Patent: Apr. 9, 2019)
RoHS compliant - solder-free

LKT 3-PHASE DRY-TYPE CAPACITORS

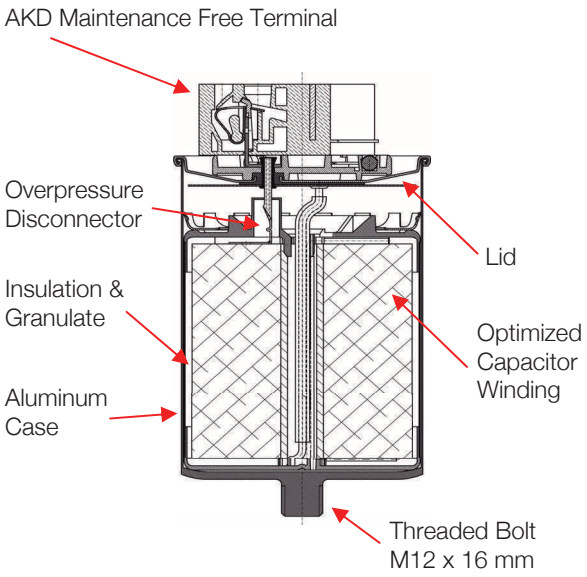
Construction Details

FRAKO produces AC Power Capacitors using their unique Dry-Type construction to provide high reliability in rigorous applications of power factor PWM harmonic filters and other power electronic filter systems. For best capacitor performance and longest life expectancy, **FRAKO** combines optimized winding construction for low internal heating with unique heat removal techniques.

3-phase capacitor



1-phase capacitor



Optimized Winding Geometry

FRAKO produces capacitor windings using relatively short coils with moderate diameters because this coil geometry is known to generate much less internal heat than other winding construction methods.

Absorbent Granulate

FRAKO capacitors are filled with dry absorbent granulate to assure the absence of liquid (oil), for heat dissipation and for improved safety by enabling overpressure disconnection to occur at lower internal pressure.

Standard Features that exceed Industry Standards

- No Leak, Dry-Type Construction
- Factory Installed Discharge Resistors
- Finger-Safe Maintenance Free Terminals
- Compact Design
- High Current Capability
- Handles Harmonic Current
- High Temperature Rating
- Fourfold Safety Features
- Handles High Altitude
- Horizontal or vertical mounting

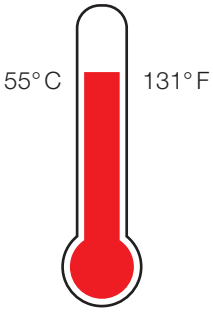
SAFER, STRONGER CAPACITORS FOR POWER ELECTRONICS

Reliability and long life for expectancy for filter applications

FRAKO produces Power Electronic Capacitors using their unique Dry-Type construction to provide high reliability in rigorous applications including a variety of PWM inverter filters. Use FRAKO's LKT-F Type capacitors in applications where a DC bus voltage is repetively switched using pulse width modulation (PWM).

Stronger because...

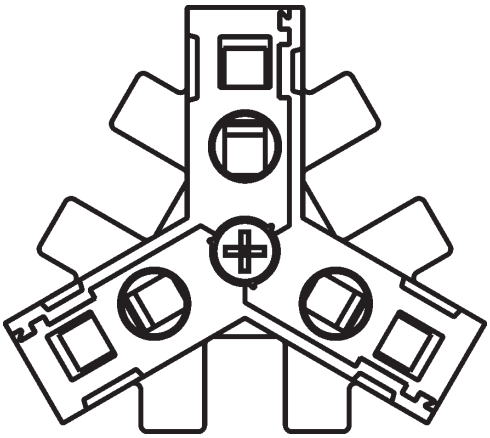
- Voltage ratings based upon DC bus voltage
- High continuous current ratings
- 55° C surrounding air temperature capability
- Lifetime, maintenance-free terminals
- Optional bolt-on terminals
- 4000 meter altitude capability



55° C refers to surrounding air temperature (inside of enclosure and next to capacitor).

85 mm diameter capacitors

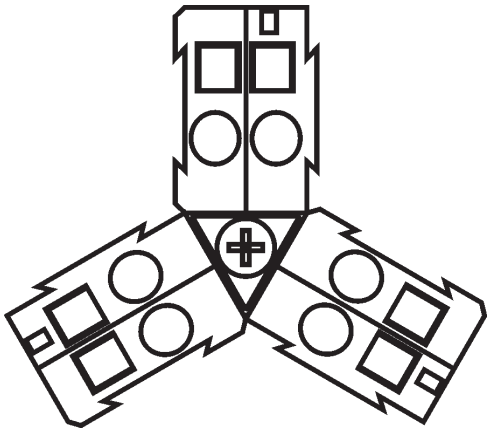
- 1 wire per phase
- 14 AWG to 6 AWG
- Wire stripping length is 16 mm



Suitable for 14 to 6 AWG solid, stranded or fine stranded (CU) copper wires

60 mm and 70 mm diameter capacitors

- 1 or 2 wires per phase
- 16 AWG to 10 AWG
- Wire stripping length is 13 mm



Suitable for 16 to 10 AWG solid, stranded or fine stranded (CU) copper wires

GENERAL TECHNICAL DATA

Design

Construction	Dry type
Dielectric	Segmented Self-Healing Metallized Polypropylene film
Impregnation	Dry type with slight film of oil on windings and dry absorbent granulate filler
Contact	Solder-free connections with contact rings
Over-Pressure (OP) Disconnection	All 3-phases disconnect under over-pressure condition
Case	Aluminum cylindrical case with 12 mm mounting stud
Terminals	Fast-wiring screwless terminal or bolt-on terminals
Discharge resistors	Factory installed (only for capacitors with fast-wiring screwless terminals)

Agency Approvals

UL symbol and number: UL 810, IEC/EN 60831-1 and -2

Electrical data

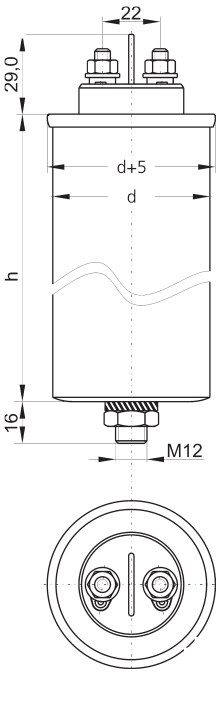
$V_{B/B}$	1.5*U_N +10 % for 2 sec.
$V_{B/G}$	V_{rms} < 690 V = 3.9 kV, V_{rms} > 690 V = 4.3 kV
V_i	1.3 kV or 1.5 kV
Endurance test / thermal stability	Acc. to IEC 61071
Capacitance tolerance	±5 %, closer tolerances on request
Loss factor tan δ_0	2×10^{-4}
Self inductance	< 300 nH

Ambient conditions

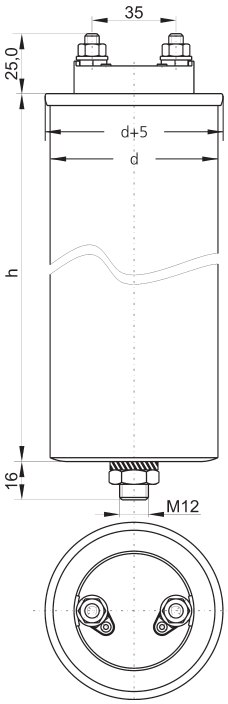
Min. temperature	- 40° C
Max. ambient temperature	55° C
Max. case temperature	75° C
Max. humidity	95 %
Max. site altitude	4 000 m
Min. max. storage temperature	- 40° C – 85° C
Service life	>100 000 h (typical)
Failure rate	< 300 FIT

Dimensions

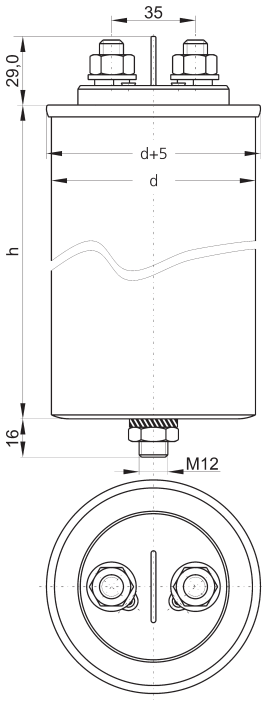
1 Phase capacitor with d = 60 mm (bolt-on terminal)



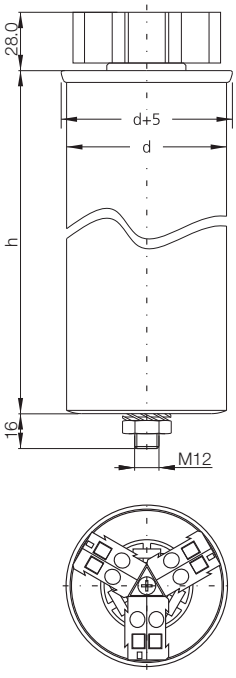
1 Phase capacitor with d = 70 mm (bolt-on terminal)



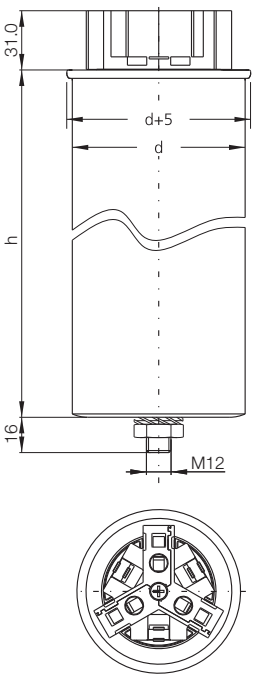
1 Phase capacitor with d = 85 mm (bolt-on terminal)



1 Phase and 3 Phase with d = 60 / 70 mm (fast-wiring screwless terminal)



3 Phase capacitor with d = 85 mm (fast-wiring screwless terminal)



LKT DRY-TYPE CAPACITORS FOR POWER ELECTRONICS

General Specification

Type		LKT-F (1-phase)	LKT-F (3-phase)
Safety Features		Self-healing polypropylene film, segmented metallized film All phases overpressure disconnector, Solder-free contact rings	
Applicable Standards		UL 810, IEC/EN 60831-1 and -2	
Agency Approvals		c UL us UL No. 810 E 337088	
Rated Voltage	$V_{DC\text{-}bus}$	680, 850, 1080, 1200 (V_{pk})	450, 680, 1080 (V_{pk})
Rated Voltage	V_{rms}	480, 600, 760, 850 V_{rms}	320, 480, 760 V_{rms}
Rated Frequency	f_N	50 Hz or 60 Hz	
Tolerance (µF)		-5 % / +5 % standard (closer tolerances upon request)	
Internal Connection		n/a	delta
Loss Factor		$< 10 \times 10^{-4}$	
Self Inductance		< 300 *n*H	
Discharge (resistors factory installed)		≤ 50 V, within 60 seconds	
Temporary Overvoltage		110 % V_{MAX}, 8 hours per day 115 % V_{MAX}, 30 minutes per day 120 % V_{MAX}, 5 minutes 130 % V_{MAX}, 1 minute	
Other Routine Tests		Case seal test, capacitance, loss factor and resistance measurement	
Ambient Temperature		-40° C to 55° C (continuous rating)	
Case Temperature		75° C maximum allowable	
Storage Temperature		Minimum -40° C to maximum 85° C	
Humidity (max.)		95 % non-condensating	
Altitude (max.)		4,000 meters above sea level	
Life Expectancy		100,000 hours	
Mounting and Fixing		Vertical or horizontal by M12 × 16 mm stud (15 Nm tightening torque)	
Terminals		Patented maintenance free, fast-wiring screwless terminals are standard Bolt-on terminals upon request	

Why do LKT-F Capacitors have both DC and AC Voltage Ratings?

FRAKO AC and DC ratings are based on a voltage relationship where Vdc is 1.414 × Vac-rms. In many filter applications, the peak AC system voltage is 1.414 times the DC bus voltage. However, some filter applications involve inverters with DC bus voltage higher than this (ie: 1.5-1.75 × Vac-rms). The capacitor voltage ratings must always satisfy both the AC and DC voltage levels.

Capacitance Measurement (+/-5%)

3-phase: Internal windings are connected in delta configuration. Capacitance from terminal to terminal will therefore read as 1.5 times the nominal capacitance value.

Ex: 3 × 20 µF will measure as 30 µF

1-phase: Terminal-to-terminal capacitance should measure as per rated capacitance.

1-PHASE CAPACITORS WITH BOLT-ON TERMINALS

Four-Fold safety Features:

1) Self-healing film
2) Segmented film
3) All-phase over-pressure disconnection
4) Solder-free contact ring

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Type List 1-phase

	V_N = 680 V	V_{rms} = 480 V	V_s = 1450 V							
	Article-No.	Type	Capacitance in µF	I_{max} in A	Î in kA	R_{th} in K/W	R_S in mΩ	Diameter in mm	Height in mm	Weight in kg
	31-13200	LKT-F-010.0-1-680-CA	1 × 10	15	0.5	≤ 6.30	3.15	60	121	0.380
	31-13201	LKT-F-015.0-1-680-CA	1 × 15	15	0.8	≤ 6.30	2.30	60	121	0.380
480 V_{rms}	31-13202	LKT-F-020.0-1-680-CA	1 × 20	15	1.0	≤ 6.30	1.85	60	121	0.380
	31-13203	LKT-F-025.0-1-680-CA	1 × 25	15	1.3	≤ 6.30	1.60	60	121	0.380
680 V_{pk}	31-13204	LKT-F-035.0-1-680-CB	1 × 35	22	1.8	≤ 4.70	3.30	60	169	0.550
	31-13205	LKT-F-045.0-1-680-CB	1 × 45	22	2.4	≤ 4.70	2.75	60	169	0.550
680 V_{dc}	31-13225	LKT-F-050.0-1-680-CH	1 × 50	40	1.5	≤ 2.00	1.45	85	160	1.230
	31-13226	LKT-F-060.0-1-680-CH	1 × 60	40	1.8	≤ 2.00	1.25	85	160	1.230
	31-13227	LKT-F-070.0-1-680-CH	1 × 70	40	2.1	≤ 2.00	1.10	85	160	1.230
	31-13228	LKT-F-095.0-1-680-CI	1 × 95	45	2.9	≤ 1.60	1.55	85	192	1.230
	31-13229	LKT-F-105.0-1-680-CI	1 × 105	45	3.2	≤ 1.60	1.45	85	192	1.230
	31-13230	LKT-F-120.0-1-680-CI	1 × 120	45	3.6	≤ 1.60	1.30	85	192	1.230

Type List 1-phase

	V_N = 850 V	V_{rms} = 600 V	V_s = 1800 V							
	Article-No.	Type	Capacitance in µF	I_{max} in A	Î in kA	R_{th} in K/W	R_S in mΩ	Diameter in mm	Height in mm	Weight in kg
	31-13206	LKT-F-010.0-1-850-CA	1 × 10	15	0.7	≤ 6.30	1.60	60	121	0.380
	31-13207	LKT-F-015.0-1-850-CA	1 × 15	15	1.0	≤ 6.30	1.25	60	121	0.380
600 V_{rms}	31-13208	LKT-F-020.0-1-850-CA	1 × 20	15	1.3	≤ 6.30	1.10	60	121	0.380
	31-13209	LKT-F-025.0-1-850-CB	1 × 25	22	1.6	≤ 4.70	2.35	60	169	0.550
850 V_{pk}	31-13210	LKT-F-035.0-1-850-CB	1 × 35	22	2.3	≤ 4.70	1.90	60	169	0.550
	31-13231	LKT-F-045.0-1-850-CH	1 × 45	40	1.7	≤ 2.00	0.85	85	160	1.230
850 V_{dc}	31-13232	LKT-F-050.0-1-850-CH	1 × 50	40	1.9	≤ 2.00	0.80	85	160	1.230
	31-13233	LKT-F-060.0-1-850-CH	1 × 60	40	2.3	≤ 2.00	0.70	85	160	1.230
	31-13234	LKT-F-068.0-1-850-CH	1 × 68	40	2.6	≤ 2.00	0.65	85	160	1.230
	31-13235	LKT-F-095.0-1-850-CI	1 × 95	45	3.6	≤ 1.60	0.80	85	192	1.230
	31-13236	LKT-F-120.0-1-850-CJ	1 × 120	50	4.5	≤ 1.60	0.70	85	244	1.580

Capacitor catalog numbers include the peak voltage rating (LKT-F-xxx.x-x-**680**-xx). If using in a PWM application where a DC voltage is switched, capacitor peak voltage rating must be equal to or greater than DC bus voltage.

1-PHASE CAPACITORS WITH BOLT-ON TERMINALS

Four-Fold safety Features:

1) Self-healing film
2) Segmented film
3) All-phase over-pressure disconnection
4) Solder-free contact ring

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Type List 1-phase

	V_N = 1080 V	V_{rms} = 760 V	V_s = 2320 V							
	Article-No.	Type	Capacitance in µF	I_{max} in A	Î in kA	R_{th} in K/W	R_S in mΩ	Diameter in mm	Height in mm	Weight in kg
760 V_{rms}	31-13211	LKT-F-010.0-1-1080-CA	1 × 10	15	0.8	≤ 6.30	1.40	60	121	0.380
	31-13212	LKT-F-015.0-1-1080-CB	1 × 15	22	1.2	≤ 4.70	2.75	60	169	0.550
1080 V_{pk}	31-13213	LKT-F-020.0-1-1080-CB	1 × 20	22	1.7	≤ 4.70	2.25	60	169	0.550
	31-13214	LKT-F-025.0-1-1080-CN	1 × 25	28	2.1	≤ 4.70	2.00	70	163	0.670
	31-13237	LKT-F-035.0-1-1080-CH	1 × 35	40	1.7	≤ 2.00	0.80	85	160	1.230
1080 V_{dc}	31-13238	LKT-F-045.0-1-1080-CI	1 × 45	45	2.1	≤ 1.60	1.20	85	192	1.230
	31-13239	LKT-F-050.0-1-1080-CI	1 × 50	45	2.4	≤ 1.60	1.10	85	192	1.230
	31-13240	LKT-F-060.0-1-1080-CJ	1 × 60	50	2.9	≤ 1.60	1.05	85	244	1.580
	31-13241	LKT-F-070.0-1-1080-CJ	1 × 70	50	3.3	≤ 1.60	0.90	85	244	1.580

Type List 1-phase

	V_N = 1200 V	V_{rms} = 850 V	V_s = 2580 V							
	Article-No.	Type	Capacitance in µF	I_{max} in A	Î in kA	R_{th} in K/W	R_S in mΩ	Diameter in mm	Height in mm	Weight in kg
	31-13215	LKT-F-001.0-1-1200-CA	1 × 1	15	0.1	≤ 6.30	7.00	60	121	0.380
	31-13216	LKT-F-001.5-1-1200-CA	1 × 1.5	15	0.1	≤ 6.30	4.90	60	121	0.380
	31-13217	LKT-F-002.2-1-1200-CA	1 × 2.2	15	0.2	≤ 6.30	3.95	60	121	0.380
	31-13218	LKT-F-003.0-1-1200-CA	1 × 3	15	0.3	≤ 6.30	3.05	60	121	0.380
850 V_{rms}	31-13219	LKT-F-003.3-1-1200-CA	1 × 3.3	15	0.3	≤ 6.30	2.85	60	121	0.380
	31-13220	LKT-F-004.5-1-1200-CA	1 × 4.5	15	0.4	≤ 6.30	2.25	60	121	0.380
1200 V_{pk}	31-13221	LKT-F-006.8-1-1200-CA	1 × 6.8	15	0.6	≤ 6.30	1.70	60	121	0.380
	31-13222	LKT-F-007.1-1-1200-CA	1 × 7.1	15	0.7	≤ 6.30	1.65	60	121	0.380
1200 V_{dc}	31-13223	LKT-F-010.0-1-1200-CB	1 × 10	22	0.9	≤ 4.70	3.45	60	169	0.550
	31-13224	LKT-F-015.0-1-1200-CB	1 × 15	22	1.4	≤ 4.70	2.60	60	169	0.550
	31-13242	LKT-F-020.0-1-1200-CH	1 × 20	40	1.1	≤ 2.00	1.15	85	160	1.230
	31-13243	LKT-F-025.0-1-1200-CH	1 × 25	40	1.3	≤ 2.00	0.95	85	160	1.230
	31-13244	LKT-F-035.0-1-1200-CH	1 × 35	40	1.9	≤ 2.00	0.80	85	160	1.230
	31-13245	LKT-F-045.0-1-1200-CI	1 × 45	45	2.4	≤ 1.60	1.10	85	160	1.230
	31-13246	LKT-F-050.0-1-1200-CI	1 × 50	45	2.7	≤ 1.60	1.05	85	192	1.230
	31-13247	LKT-F-060.0-1-1200-CJ	1 × 60	50	3.2	≤ 1.60	0.95	85	244	1.580

Capacitor catalog numbers include the peak voltage rating (LKT-F-xxx.x-x-**680**-xx). If using in a PWM application where a DC voltage is switched, capacitor peak voltage rating must be equal to or greater than DC bus voltage.

1-PHASE CAPACITORS
WITH FAST-WIRING SCREWLESS TERMINALS

Four-Fold safety Features:

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1) Self-healing film
2) Segmented film
3) All-phase over-pressure disconnection
4) Solder-free contact ring

Fast-wiring, maintenance free and anti-vibration connections.

Type List 1-phase

	V_N = 680 V	V_{rms} = 480 V	V_s = 1450 V							
	Article-No.	Type	Capacitance in µF	I_{max} in A	Î in kA	R_{th} in K/W	R_S in mΩ	Diameter in mm	Height in mm	Weight in kg
	31-13021	LKT-F-010.0-1-680-BA	1 × 10	15	0.5	≤ 6.30	3.15	60	90	0.355
	31-13022	LKT-F-015.0-1-680-BA	1 × 15	15	0.8	≤ 6.30	2.30	60	90	0.355
480 V_{rms}	31-13023	LKT-F-020.0-1-680-BA	1 × 20	15	1.0	≤ 6.30	1.85	60	90	0.355
	31-13024	LKT-F-025.0-1-680-BA	1 × 25	15	1.3	≤ 6.30	1.60	60	90	0.355
680 V_{pk}	31-13025	LKT-F-035.0-1-680-BB	1 × 35	22	1.8	≤ 4.70	3.30	60	138	0.530
	31-13026	LKT-F-045.0-1-680-BB	1 × 45	22	2.4	≤ 4.70	2.75	60	138	0.530
680 V_{dc}	31-13046	LKT-F-050.0-1-680-BH	1 × 50	40	1.5	≤ 2.00	1.45	85	131	1.200
	31-13047	LKT-F-060.0-1-680-BH	1 × 60	40	1.8	≤ 2.00	1.25	85	131	1.200
	31-13048	LKT-F-070.0-1-680-BH	1 × 70	40	2.1	≤ 2.00	1.10	85	131	1.200
	31-13049	LKT-F-095.0-1-680-BI	1 × 95	45	2.9	≤ 1.60	1.55	85	163	1.200
	31-13050	LKT-F-105.0-1-680-BI	1 × 105	45	3.2	≤ 1.60	1.45	85	163	1.200
	31-13051	LKT-F-120.0-1-680-BI	1 × 120	45	3.6	≤ 1.60	1.30	85	163	1.200

Type List 1-phase

	V_N = 850 V	V_{rms} = 600 V	V_s = 1800 V							
	Article-No.	Type	Capacitance in µF	I_{max} in A	Î in kA	R_{th} in K/W	R_S in mΩ	Diameter in mm	Height in mm	Weight in kg
	31-13027	LKT-F-010.0-1-850-BA	1 × 10	15	0.7	≤ 6.30	1.60	60	90	0.355
	31-13028	LKT-F-015.0-1-850-BA	1 × 15	15	1.0	≤ 6.30	1.25	60	90	0.355
600 V_{rms}	31-13029	LKT-F-020.0-1-850-BA	1 × 20	15	1.3	≤ 6.30	1.10	60	90	0.355
	31-13030	LKT-F-025.0-1-850-BB	1 × 25	22	1.6	≤ 4.70	2.35	60	138	0.530
850 V_{pk}	31-13031	LKT-F-035.0-1-850-BB	1 × 35	22	2.3	≤ 4.70	1.90	60	138	0.530
	31-13052	LKT-F-045.0-1-850-BH	1 × 45	40	1.7	≤ 2.00	0.85	85	131	1.200
850 V_{dc}	31-13053	LKT-F-050.0-1-850-BH	1 × 50	40	1.9	≤ 2.00	0.80	85	131	1.200
	31-13054	LKT-F-060.0-1-850-BH	1 × 60	40	2.3	≤ 2.00	0.70	85	131	1.200
	31-13055	LKT-F-068.0-1-850-BH	1 × 68	40	2.6	≤ 2.00	0.65	85	131	1.200
	31-13056	LKT-F-095.0-1-850-BI	1 × 95	45	3.6	≤ 1.60	0.80	85	163	1.200
	31-13057	LKT-F-120.0-1-850-BJ	1 × 120	50	4.5	≤ 1.60	0.70	85	215	1.550

Capacitor catalog numbers include the peak voltage rating (LKT-F-xxx.x-x-**680**-xx). If using in a PWM application where a DC voltage is switched, capacitor peak voltage rating must be equal to or greater than DC bus voltage.

1-PHASE CAPACITORS
WITH FAST-WIRING SCREWLESS TERMINALS

Four-Fold safety Features:

c UL us IEC 61071

1) Self-healing film
2) Segmented film
3) All-phase over-pressure disconnection
4) Solder-free contact ring

Fast-wiring, maintenance free and anti-vibration connections.

Type List 1-phase

	V_N = 1080 V	V_{rms} = 760 V	V_s = 2320 V							
	Article-No.	Type	Capacitance in µF	I_{max} in A	Î in kA	R_{th} in K/W	R_S in mΩ	Diameter in mm	Height in mm	Weight in kg
760 V_{rms}	31-13032	LKT-F-010.0-1-1080-BA	1×10	15	0.8	≤6.30	1.40	60	90	0.355
	31-13033	LKT-F-015.0-1-1080-BB	1×15	22	1.2	≤4.70	2.75	60	138	0.530
1080 V_{pk}	31-13034	LKT-F-020.0-1-1080-BB	1×20	22	1.7	≤4.70	2.25	60	138	0.530
	31-13035	LKT-F-025.0-1-1080-BN	1×25	28	2.1	≤4.70	2.00	70	138	0.650
1080 V_{dc}	31-13058	LKT-F-035.0-1-1080-BH	1×35	40	1.7	≤2.00	0.80	85	131	1.200
	31-13059	LKT-F-045.0-1-1080-BI	1×45	45	2.1	≤1.60	1.20	85	163	1.200
	31-13060	LKT-F-050.0-1-1080-BI	1×50	45	2.4	≤1.60	1.10	85	163	1.200
	31-13061	LKT-F-060.0-1-1080-BJ	1×60	50	2.9	≤1.60	1.05	85	215	1.550
	31-13062	LKT-F-070.0-1-1080-BJ	1×70	50	3.3	≤1.60	0.90	85	215	1.550

Type List 1-phase

	V_N = 1200 V	V_{rms} = 850 V	V_s = 2580 V							
	Article-No.	Type	Capacitance in µF	I_{max} in A	Î in kA	R_{th} in K/W	R_S in mΩ	Diameter in mm	Height in mm	Weight in kg
	31-13036	LKT-F-001.0-1-1200-BA	1×1	15	0.1	≤6.30	7.00	60	90	0.355
	31-13037	LKT-F-001.5-1-1200-BA	1×1.5	15	0.1	≤6.30	4.90	60	90	0.355
	31-13038	LKT-F-002.2-1-1200-BA	1×2.2	15	0.2	≤6.30	3.95	60	90	0.355
	31-13039	LKT-F-003.0-1-1200-BA	1×3	15	0.3	≤6.30	3.05	60	90	0.355
850 V_{rms}	31-13040	LKT-F-003.3-1-1200-BA	1×3.3	15	0.3	≤6.30	2.85	60	90	0.355
	31-13041	LKT-F-004.5-1-1200-BA	1×4.5	15	0.4	≤6.30	2.25	60	90	0.355
1200 V_{pk}	31-13042	LKT-F-006.8-1-1200-BA	1×6.8	15	0.6	≤6.30	1.70	60	90	0.355
	31-13043	LKT-F-007.1-1-1200-BA	1×7.1	15	0.7	≤6.30	1.65	60	90	0.355
1200 V_{dc}	31-13044	LKT-F-010.0-1-1200-BB	1×10	22	0.9	≤4.70	3.45	60	138	0.530
	31-13045	LKT-F-015.0-1-1200-BB	1×15	22	1.4	≤4.70	2.60	60	138	0.530
	31-13063	LKT-F-020.0-1-1200-BH	1×20	40	1.1	≤2.00	1.15	85	131	1.200
	31-13064	LKT-F-025.0-1-1200-BH	1×25	40	1.3	≤2.00	0.95	85	131	1.200
	31-13065	LKT-F-035.0-1-1200-BH	1×35	40	1.9	≤2.00	0.80	85	131	1.200
	31-13066	LKT-F-045.0-1-1200-BI	1×45	45	2.4	≤1.60	1.10	85	163	1.200
	31-13067	LKT-F-050.0-1-1200-BI	1×50	45	2.7	≤1.60	1.05	85	163	1.200
	31-13068	LKT-F-060.0-1-1200-BJ	1×60	50	3.2	≤1.60	0.95	85	215	1.550

Capacitor catalog numbers include the peak voltage rating (LKT-F-xxx.x-x-**680**-xx). If using in a PWM application where a DC voltage is switched, capacitor peak voltage rating must be equal to or greater than DC bus voltage.

3-PHASE CAPACITORS
WITH FAST-WIRING SCREWLESS TERMINALS

Four-Fold safety Features:

c UL us IEC 61071

1) Self-healing film
2) sSegmented film
3) All-phase over-pressure disconnection
4) Solder-free contact ring

Fast-wiring, maintenance free and anti-vibration connections.

Type List 3-phase

	V_N = 450 V	V_{rms} = 320 V	V_s = 970 V							
	Article-No.	Type	Capacitance in µF	I_{max} in A	Î in kA	R_{th} in K/W	R_S in mΩ	Diameter in mm	Height in mm	Weight in kg
320 V_{rms}	31-13000	LKT-F-020.0-3-450-BC	3 × 20	22	0.7	≤ 4.2	1.36	60	150	0.590
	31-13001	LKT-F-030.0-3-450-BC	3 × 30	22	1.0	≤ 4.2	1.10	60	150	0.590
450 V_{pk}	31-13002	LKT-F-040.0-3-450-BF	3 × 40	28	1.4	≤ 3.5	1.79	70	223	1.090
	31-13003	LKT-F-050.0-3-450-BF	3 × 50	28	1.7	≤ 3.5	1.66	70	223	1.090
450 V_{dc}	31-13004	LKT-F-075.0-3-450-BF	3 × 75	28	2.6	≤ 3.5	1.49	70	223	1.090
	31-13011	LKT-F-100.0-3-450-BJ	3 × 100	45	3.5	≤ 2.9	0.57	85	215	1.550
	31-13012	LKT-F-135.0-3-450-BK	3 × 135	50	4.7	≤ 2.6	0.80	85	278	1.900
	31-13013	LKT-F-150.0-3-450-BK	3 × 150	50	5.2	≤ 2.6	0.77	85	278	1.900

Type List 3-phase

	V_N = 680 V	V_{rms} = 480 V	V_s = 1460 V							
	Article-No.	Type	Capacitance in µF	I_{max} in A	Î in kA	R_{th} in K/W	R_S in mΩ	Diameter in mm	Height in mm	Weight in kg
748 V_{rms}	31-13005	LKT-F-010.0-3-680-BC	3 × 10	22	0.5	≤ 4.2	1.38	60	150	0.590
	31-13006	LKT-F-015.0-3-680-BC	3 × 15	22	0.8	≤ 4.2	1.18	60	150	0.590
680 V_{pk}	31-13007	LKT-F-020.0-3-680-BD	3 × 20	25	1.0	≤ 3.8	1.99	60	223	0.840
	31-13014	LKT-F-030.0-3-680-BI	3 × 30	40	1.6	≤ 3.0	0.46	85	163	1.200
680 V_{dc}	31-13015	LKT-F-050.0-3-680-BJ	3 × 50	45	2.6	≤ 2.9	0.63	85	215	1.550
	31-13016	LKT-F-090.0-3-680-BL	3 × 90	55	4.7	≤ 2.1	0.91	85	320	2.200

Type List 3-phase

	V_N = 1080 V	V_{rms} = 760 V	V_s = 2320 V							
	Article-No.	Type	Capacitance in µF	I_{max} in A	Î in kA	R_{th} in K/W	R_S in mΩ	Diameter in mm	Height in mm	Weight in kg
760 V_{rms}	31-13008	LKT-F-005.0-3-1080-BC	3 × 5	22	0.4	≤ 4.2	1.14	60	150	0.590
	31-13009	LKT-F-010.0-3-1080-BD	3 × 10	25	0.8	≤ 3.8	1.70	60	223	0.840
1080 V_{pk}	31-13010	LKT-F-015.0-3-1080-BF	3 × 15	28	1.2	≤ 3.5	1.53	70	223	1.090
	31-13017	LKT-F-020.0-3-1080-BJ	3 × 20	45	1.7	≤ 2.9	0.58	85	215	1.550
	31-13018	LKT-F-025.0-3-1080-BK	3 × 25	50	2.1	≤ 2.6	0.83	85	278	1.900
1080 V_{dc}	31-13019	LKT-F-030.0-3-1080-BK	3 × 30	50	2.5	≤ 2.6	0.77	85	278	1.900
	31-13020	LKT-F-035.0-3-1080-BL	3 × 35	55	2.9	≤ 2.1	0.88	85	320	2.200

Capacitor catalog numbers include the peak voltage rating (LKT-F-xxx.x-x-**680**-xx). If using in a PWM application where a DC voltage is switched, capacitor peak voltage rating must be equal to or greater than DC bus voltage.

REGULATIONS AND SAFETY INSTRUCTIONS

General

FRAKO capacitors for power electronics are supplied ready to install, and have been submitted to thorough routine testing to assure their quality and verify their good working order before they leave our factory. Some important points must be observed to prevent injury to personnel or damage to assets when installing, commissioning and maintaining power electronics capacitors. When installing and using capacitors for power electronics, it is essential to follow and comply with the instructions given here, together with the applicable international standards, such as IEC and (in Europe) EN standards, and the relevant national codes and regulations. In Germany, for example, these are issued by the VDE (German Association for Electrical, Electronic & Information Technologies). In the USA and Canada these are issued by Underwriters Laboratories (UL), National Electrical Code (NEC) and Canadian Electrical Code (CEC). Please comply with the relevant legal requirements when recycling the packaging materials.

Safety instructions

Caution! Capacitors for power electronics operate at a dangerously high voltage that can cause loss of life. Furthermore, the capacitors are able to retain this high voltage for long periods after de-energization! All work on capacitors must therefore only be carried out by qualified electricians. Before the current-carrying parts of a capacitor are touched, they must be discharged and short-circuited by means of suitable components. The installation of power electronics capacitors and the inspection to verify their correct application may only be carried out by appropriately qualified specialists who have been instructed about the electrical hazards. Safety notices drawing attention to the potential dangers associated with power electronics capacitors must be prominently displayed. Capacitors must be installed so that any inadvertent contact with live components is completely prevented.

Before any work is done on power electronics capacitors, it must be verified that their current-carrying components are at zero potential. To achieve this, the capacitor must first be discharged and then short-circuited.

Capacitors must be permanently and securely grounded.

Low voltage, high breaking capacity (LV HBC) fuses installed in series with power electronics capacitors as short-circuit protection may only be removed or replaced when they are not carrying current. Similarly, fuse switch disconnectors installed for the same purpose may not be operated when under load, since this might produce a dangerous arc, which could cause injury and damage. This is a life-threatening danger! Do not expose the capacitors to direct sunlight and do not locate them near to heat sources. Ensure that the capacitors kept within the specified range of storage and operating temperatures at all times. Temperatures outside these ranges can permanently damage the capacitors without this being visible externally.

If power electronics capacitors appear to be visibly damaged, they must not be installed, wired up or put into service.

LKT-F type power electronics capacitors are only suitable for indoor applications. They are designed for use in clean, dry, dust-free rooms at elevations 4 000 m above sea level.

Storage and operating conditions

Power electronics capacitors can be stored in a dry, dust-free, non-corrosive environment at temperatures between - 25 (- 40) and + 85° C and elevations ≤ 4 000 m.

The capacitors are suitable for ambient temperatures of - 40° C up to 55° C. The ambient temperature is one of the main factors affecting power electronics capacitors and has a major impact on their service life. EN 61071 describes the conditions regarding the ambient temperature of power electronics capacitors in detail. The maximum permissible ambient humidity is 95 %, and the maximum operating elevation above sea level is 4 000 m. Power electronics capacitors must have been discharged to a voltage of less than 50 V before they are switched on again!!!

Installation

FRAKO power electronics capacitors are suitable for use indoors in a dry, dust-free, non-corrosive environment. The degree of protection (EN 600529) is IP 00 for screw terminals and IP 20 when fitted with the terminal base. The ambient temperature must not exceed the limits specified above. Each capacitor case must be spaced at least 20 mm from the next one and enclosure walls in order to ensure unrestricted circulation of air. Sources of heat, such as harmonic filter reactors, must not be installed directly adjacent to power electronics capacitors. If it is possible for hot air to accumulate at the location where the capacitors are installed, it is necessary to provide forced ventilation, for example with a fan / filter unit.

If dust is present at the location where the capacitors are installed, it must be removed from the ventilation air intake by means of filter mats. Regular maintenance and cleaning, particularly of the capacitor terminal bases, is an absolute necessity. If a layer of dust is allowed to accumulate, it can result in flashovers between conductors or from a conductor to earth!

The capacitors can be installed and will function correctly in any desired orientation. It must always be ensured, however, that they are adequately secured mechanically, especially if the capacitor bank may be transported! The enclosure for the capacitors must be provided with a reliable earth connection.

Commissioning, operation and maintenance

Before the supply voltage is applied to the system, a visual check should be carried out by a qualified technician to verify that no equipment or connections have worked loose during transport and no mechanical damage can be identified. Damaged capacitors must not be put into service. Capacitors should be checked once every year in a systematic inspection by a specialist. Make sure there is no wire insulation trapped in any of the capacitor terminals.

General

Please ensure that the capacitors are kept clean at all times, if necessary having them cleaned without delay by skilled personnel. During the annual inspection the capacitors must be given a visual check by an electrician to verify good working order (sound electrical contacts, no evidence of overheating, no blown fuses, etc.). Any variation in capacitance or distortion by harmonics can be inferred from the operating currents measured. There must always be good electrical contact at the capacitor connections, which must remain clean and dry.

KEY TO SYMBOLS

C_N Nominal capacitance

V_N Maximum operating peak recurrent voltage of either polarity of a reversing type waveform for which the capacitor has been designed

V_{rms} Root-mean-square value of the maximum recurrent operating voltage

V_S Peak voltage induced by switching or any other disturbance of the system which is allowed for a limited number of times and for durations shorter than the basic period

V_i Root-mean-square value of the sine wave voltage designed for the insulation between the terminals of the capacitors to the casing or earth

$V_{B/B}$ Voltage coating / coating

$V_{B/G}$ Voltage coating / housing

$V_{B/B}$ Isolation voltage

I_{max} Root-mean-square value of the maximum current in continuous operation

$\hat{I}$ Maximum repetitive peak current that can occur for a short duration in continuous operation

I_S Peak non-repetitive current induced by switching or any other disturbance of the system which is allowed for a limited number of times, for durations shorter than the basic period

L_{self} Self-inductance

R_{th} Thermal resistance

R_S Effective ohmic resistance of a capacitor's conductors and metallic coating under specified operating conditions

P_V Maximum power loss at which the capacitor may be operated at the maximum casing temperature

f_1 Frequency at which the power loss of the capacitor is maximum at the nominal voltage

f_2 Maximum frequency at which the maximum current produces the maximum power loss in the capacitor

θ_{min} Lowest temperature at which the capacitor may be energized

θ_{max} Hottest temperature of the casing at which the capacitor may be operated

NOTES

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FRAKO 95-00394/01/23 Subject to technical changes