



Film Capacitors – Power Factor Correction

DeltaCap MKD capacitors

Series/Type: B32303A/B32304A
Ordering code: B32303A****A***/B32304A****A***
Date: July. 2010
Version: 3

Construction

- Dielectric: Polypropylene film/Resin filling: Non-PCB, biodegradable soft resin
- Stacked winding
- Extruded round aluminium can with stud
- B32304 provided with integrated discharge resistors

Features

- Three-phase
- Provided with discharge resistors
- Double safety system: overpressure disconnecter, self healing technology
- Naturally air cooled (or forced air cooling)
- Indoor mounting

Typical applications

- For Power Factor Correction

Terminals

- Screw terminals

Mounting

- Threaded stud at bottom of can (max. torque for M12 = 10 Nm)



Technical data and specifications

Characteristics	
Rated capacitance C_R	According to specification table
Tolerance	-5 / +10%
Connection	D (Delta)
Rated voltage V_R	According to specification table
Rated frequency f_R	50 and 60 Hz
Output	According to specification table
Rated current I_R	According to specification table

Maximum ratings	
V_{max}	$V_R + 10\%$ (up to 8 h daily) / $V_R + 15\%$ (up to 30 min daily) / $V_R + 20\%$ (up to 5 min daily) / $V_R + 30\%$ (up to 1 min daily)
I_{max}	Up to $1.3 \cdot I_R$ (A) (including combined effects of harmonics, overvoltages and capacitance tolerance)
I_S	Up to $200 \cdot I_R$ (A)
Power dissipation (without discharge resistors)	≤ 0.2 W/kvar (dielectric) and ≤ 0.45 W / kvar (total)

Test data	
V_{TT}	$2.15 \times V_R$ during 10 s
V_{TC}	3000 V AC / 50 Hz during 2 s
* $\tan \delta$ (50 Hz)	$\leq 1.0 \times 10^{-3}$

* Without discharge resistor

Climatic category –40/D	
T_{min}	-40 °C
T_{max}	+55 °C
Humidity	Av. rel. < 95%
Maximum altitude	4000 m

Mean life expectancy	
t_{LD}	Up to 100 000 hours at temperature class -40/D Up to 135 000 hours at temperature class -40/C
Max. 5000 switchings per year acc. to IEC 60831	



Design data	
Dimensions (d x h)	According to specification table
Weight approx	According to specification table
Impregnation	Non PCB, resin filling: soft polyurethane resin
Fixing	Threaded bolt M12
Max. torque (Al can stud)	10 Nm
Mounting position	Any mounting position possible. See "Maintenance and Installation Manual" for further details.

Terminals	
Protection degree	IP00 for B32303; IP20 for B32304
Max. torque	1.2 Nm
Terminal cross section B32304	16 mm ² (5 AWG)
Maximum terminal current	50 A (screw terminals) 15 A (fast on terminals)
Creepage distance (min)	12.7 mm
Clearance (min)	9.6 mm

Safety	
Mechanical safety	Overpressure disconnecter
Max. short circuit current	(AFC: 10 kA according UL 810 standard)
Discharge resistor time	≤ 60 s to 75 V or less

Reference standards	
IEC 60831–1/2, UL 810-5th edition	

Label design

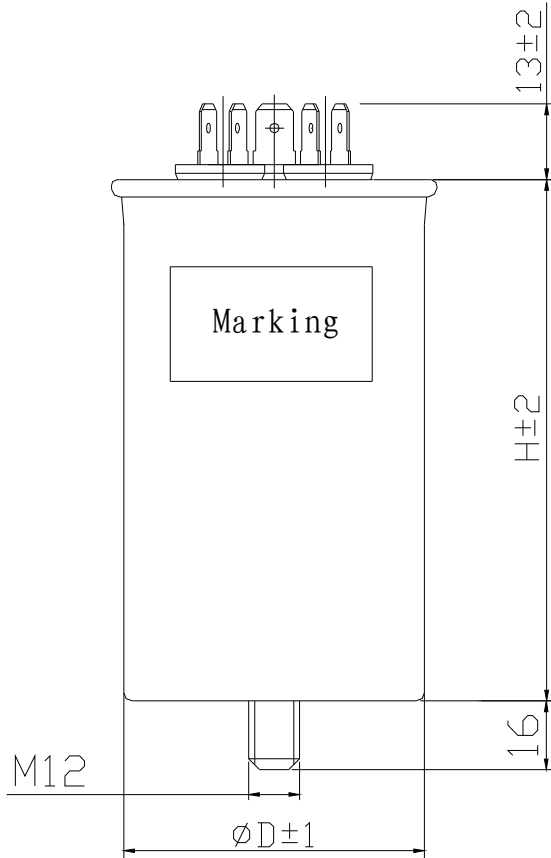
Power Quality Solutions
DeltaCap™ MKD440-D-28.0
B32304-A4282-A040
3 x 153.5 μF Δ -5 +10% SH

U _N	Q _N / 50 Hz	Q _N / 60 Hz
440V~	28.00 kvar	33.60 kvar
415V~	24.90 kvar	29.89 kvar
400V~	23.13 kvar	27.76 kvar

Ui = 3/-Kv -40 / D IEC 60831
CE Overpressure disconnecter
Protected 10K AFC Non PCB
Discharge before handling
Made by EPCOS 16 A10

Dimensional drawings

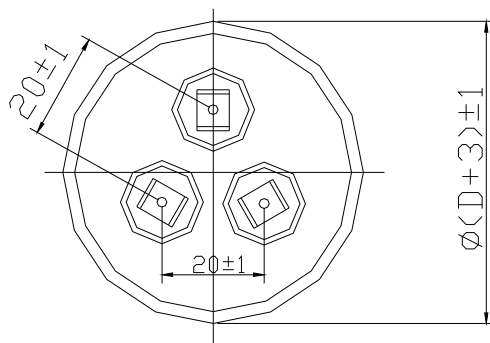
Series B32303



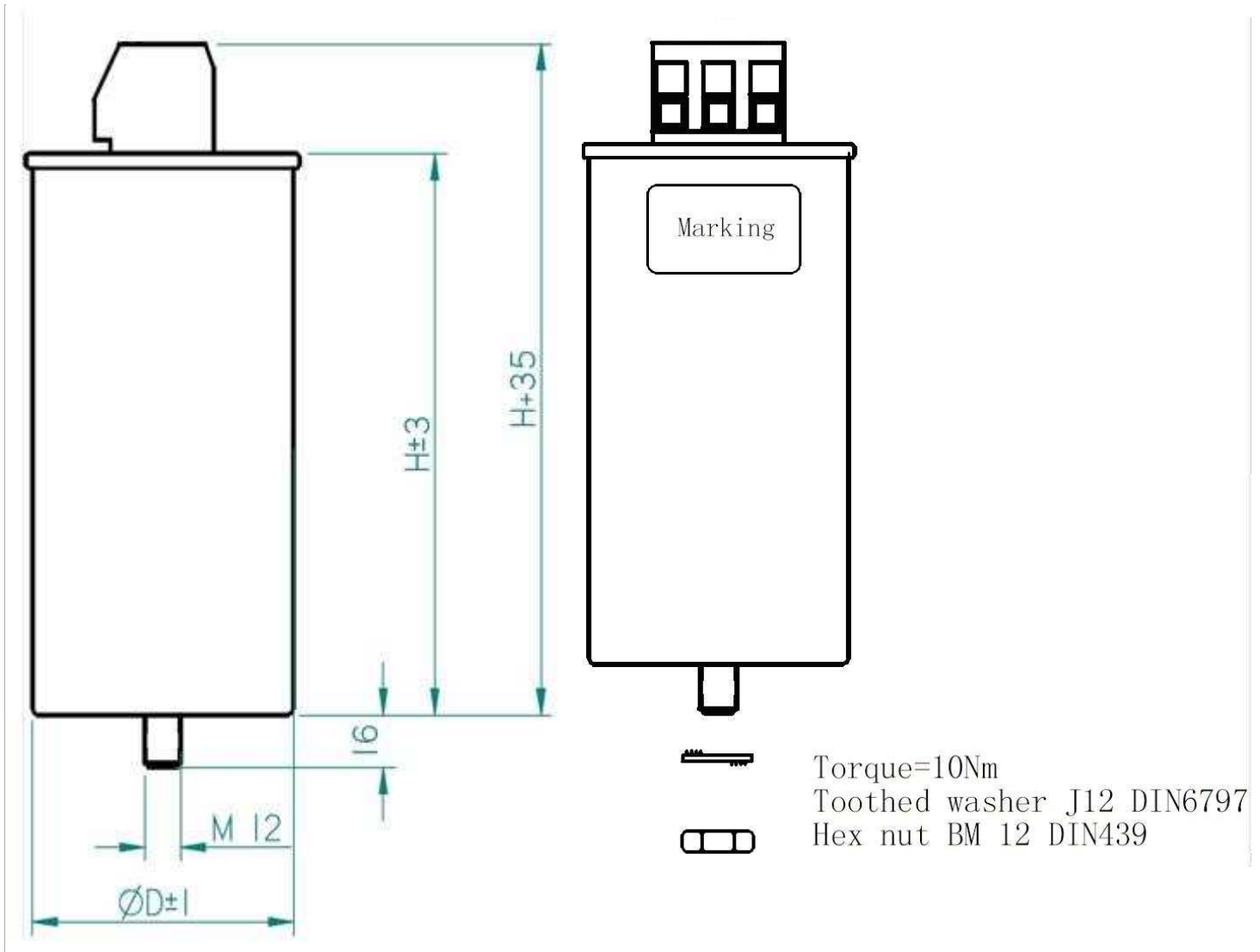
Torque=10Nm

Toothed washer J12 DIN6797

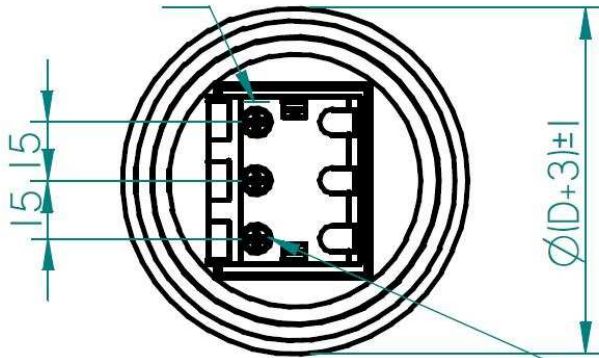
Hex nut BM 12 DIN439



Series B32304

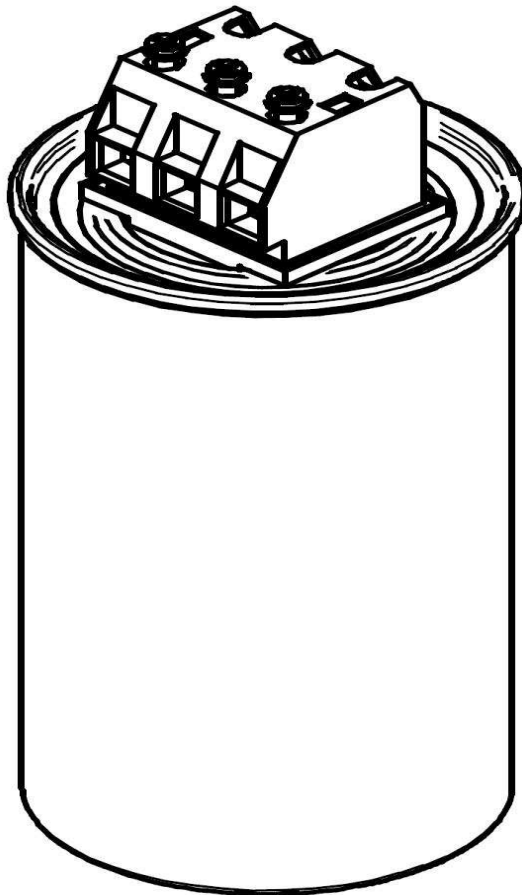


Max. cable cross section=25mm



Creepage distance > 12.7mm
Distance in air > 10mm

Max. Torque = 1.2Nm



Specification table

Type	50 Hz		60 Hz		C _R μF	d × h mm	Weight kg	Ordering code	Packing unit pcs
	Output kvar	I _R A	Output kvar	I _R A					
Rated voltage 230 V AC, 50/60 Hz, delta connection									
MKD230-D-0.5	0.5	1.3	0.6	1.6	3 • 10	50 x 148	0.4	B32303A2002A530	12
MKD230-D-0.7	0.7	1.8	0.8	2.2	3 • 14	50 x 148	0.4	B32303A2002A730	12
MKD230-D-1.0	1.0	2.5	1.2	3.0	3 • 20	50 x 148	0.4	B32303A2012A030	12
MKD230-D-1.5	1.5	3.8	1.8	4.6	3 • 30	63.5 x 148	0.6	B32303A2012A530	12
MKD230-D-2.0	2.0	5.0	2.4	6.0	3 • 40	63.5 x 148	0.6	B32303A2022A030	12
MKD230-D-2.5	2.5	6.3	3.0	7.6	3 • 50	63.5 x 148	0.8	B32303A2022A530	12
MKD230-D-5.0	5.0	12.6	6.0	15.1	3 • 100	75 x 200	1.1	B32304A2052A030	6
MKD230-D-7.5	7.5	18.8	9.0	22.6	3 • 151	75 x 275	1.4	B32304A2072A530	6
MKD230-D-10.0	10.0	25.1	12.0	30.1	3 • 201	85 x 275	1.7	B32304A2102A030	4
MKD230-D-12.5	12.5	31.4	15.0	37.7	3 • 251	85 x 350	2.2	B32304A2122A530	4
MKD230-D-15.0	15.0	37.7	18.0	45.2	3 • 301	85 x 350	2.2	B32304A2152A030	4
Rated voltage 400 V AC, 50/60 Hz, delta connection									
MKD400-D-1.0	1.0	1.4	1.2	1.7	3 • 6.6	50 x 148	0.4	B32303A4012A000	12
MKD400-D-1.5	1.5	2.2	1.8	2.6	3 • 10	50 x 148	0.4	B32303A4012A500	12
MKD400-D-2.0	2.0	2.9	2.4	3.5	3 • 13	50 x 148	0.4	B32303A4022A000	12
MKD400-D-2.5	2.5	3.6	3.0	4.3	3 • 17	50 x 148	0.4	B32303A4022A500	12
MKD400-D-5.0	5.0	7.2	6.0	8.6	3 • 33	63.5 x 148	0.6	B32303A4052A000	12
MKD400-D-6.3	6.3	9.1	7.6	10.9	3 • 42	75 x 163	0.8	B32304A4071A500	6
MKD400-D-7.5	7.5	10.8	9.0	13.0	3 • 50	75 x 163	0.9	B32304A4072A500	6
MKD400-D-8.3	8.3	12.0	10.0	14.4	3 • 55	75 x 200	1.1	B32304A4101A000	6
MKD400-D-10.0	10.0	14.4	12.0	17.3	3 • 66	75 x 200	1.1	B32304A4102A000	6
MKD400-D-12.5	12.5	18.0	15.0	21.6	3 • 83	75 x 275	1.4	B32304A4122A500	6
MKD400-D-15.0	15.0	21.7	18.0	26.0	3 • 100	75 x 275	1.4	B32304A4152A000	6
MKD400-D-16.7	16.7	24.1	20.0	28.9	3 • 111	85 x 275	1.8	B32304A4201A000	4
MKD400-D-20.0	20.0	28.9	24.0	34.7	3 • 133	85 x 275	1.8	B32304A4202A000	4
MKD400-D-25.0	25.0	36.1	30.0	43.3	3 • 166	85 x 350	2.2	B32304A4252A000	4
MKD400-D-30.0	30.0	43.3	--	--	3 • 199	85 x 350	2.2	B32304A4302A000	4



Type	50 Hz		60 Hz		C _R μF	d x h mm	Weight kg	Ordering code	Packing unit pcs
	Output kvar	I _R A	Output kvar	I _R A					
Rated voltage 415 V AC, 50/60 Hz, delta connection									
MKD415-D-1.0	1.0	1.4	1.2	1.7	3 • 6.2	50 x 148	0.4	B32303A4012A010	12
MKD415-D-1.5	1.5	2.1	1.8	2.5	3 • 9.2	50 x 148	0.4	B32303A4012A510	12
MKD415-D-2.0	2.0	2.8	2.4	3.4	3 • 12	50 x 148	0.4	B32303A4022A010	12
MKD415-D-2.5	2.5	3.5	3.0	4.2	3 • 15	63.5 x 148	0.6	B32303A4022A510	12
MKD415-D-5.0	5.0	7.0	6.0	8.4	3 • 31	63.5 x 148	0.8	B32303A4052A010	12
MKD415-D-6.3	6.3	8.8	7.6	10.6	3 • 39	75 x 200	1.0	B32304A4071A510	6
MKD415-D-7.5	7.5	10.4	9.0	12.5	3 • 46	75 x 200	1.1	B32304A4072A510	6
MKD415-D-10.0	10.0	13.9	12.0	16.7	3 • 62	75 x 275	1.4	B32304A4102A010	6
MKD415-D-12.5	12.5	17.4	15.0	20.9	3 • 77	75 x 275	1.4	B32304A4122A510	6
MKD415-D-15.0	15.0	20.9	18.0	25.1	3 • 93	85 x 275	1.7	B32304A4152A010	4
MKD415-D-20.0	20.0	27.8	24.0	33.4	3 • 123	85 x 350	2.2	B32304A4202A010	4
MKD415-D-25.0	25.0	34.8	30.0	41.8	3 • 154	85 x 350	2.2	B32304A4252A010	4
MKD415-D-27.0	27.0	37.0	32.3	45.0	3 • 166	96 x 350	2.7	B32304A4272A010	4
MKD415-D-30.0	30.0	42.0	--	--	3 • 185	96 x 350	2.7	B32304A4302A010	4
Rated voltage 440 V AC, 50/60 Hz, delta connection									
MKD440-D-0.9	0.9	1.2	1.1	1.4	3 • 5.2	50 x 148	0.4	B32303A4011A040	12
MKD440-D-1.0	1.0	1.3	1.2	1.6	3 • 5.5	50 x 148	0.4	B32303A4012A040	12
MKD440-D-1.2	1.2	1.6	1.4	1.9	3 • 6.6	50 x 148	0.4	B32303A4011A540	12
MKD440-D-1.5	1.5	2.0	1.8	2.4	3 • 8.8	50 x 148	0.4	B32303A4012A540	12
MKD440-D-2.0	2.0	2.6	2.4	3.1	3 • 11	50 x 148	0.4	B32303A4020A540	12
MKD440-D-2.1	2.1	2.8	2.5	3.4	3 • 12	50 x 148	0.4	B32303A4021A540	12
MKD440-D-2.5	2.5	3.3	3.0	4.0	3 • 14	63.5 x 148	0.6	B32303A4022A540	12
MKD440-D-4.2	4.2	5.5	5.0	6.6	3 • 23	63.5 x 148	0.6	B32303A4051A040	12
MKD440-D-5.0	5.0	6.6	6.0	7.9	3 • 27	63.5 x 148	0.8	B32303A4052A040	12
MKD440-D-6.3	6.3	8.3	7.6	10.0	3 • 35	75 x 163	0.8	B32304A4071A540	6
MKD440-D-7.5	7.5	9.8	9.0	11.8	3 • 41	75 x 200	1.1	B32304A4072A540	6
MKD440-D-8.3	8.3	10.9	10.0	13.1	3 • 46	75 x 200	1.1	B32304A4101A040	6
MKD440-D-10.0	10.0	13.1	12.0	15.7	3 • 55	75 x 275	1.4	B32304A4102A040	6
MKD440-D-10.4	10.4	13.6	12.5	16.3	3 • 57	75 x 275	1.4	B32304A4121A540	6
MKD440-D-12.5	12.5	16.4	15.0	19.7	3 • 69	75 x 275	1.4	B32304A4151A040	6
MKD440-D-15.0	15.0	19.7	18.0	23.6	3 • 82	85 x 275	1.7	B32304A4152A040	4
MKD440-D-16.7	16.7	21.9	20.0	26.3	3 • 92	85 x 275	1.7	B32304A4201A040	4
MKD440-D-20.8	20.8	27.3	25.0	32.8	3 • 114	85 x 350	2.2	B32304A4251A040	4
MKD440-D-25.0	25.0	32.8	30.0	39.4	3 • 137	85 x 350	2.2	B32304A4252A040	4
MKD440-D-28.0	28.0	36.7	33.6	44.0	3 • 154	85 x 350	2.2	B32304A4282A040	4
MKD440-D-30.0	30.0	39.0	--	--	3 • 164	96 x 350	2.7	B32304A4302A040	4
MKD440-D-33.0	33.0	44.0	--	--	3 • 185	96 x 350	2.7	B32304A4332A040	4



Type	50 Hz		60 Hz		C _R μF	d x h mm	Weight kg	Ordering code	Packing unit pcs
	Output kvar	I _R A	Output kvar	I _R A					
Rated voltage 480 V AC, 50/60 Hz, delta connection									
MKD480-D-1.5	1.5	1.8	1.8	2.2	3 • 6.9	50 x 148	0.4	B32303A4012A580	12
MKD480-D-2.0	2.0	2.4	2.4	2.9	3 • 9.2	50 x 148	0.4	B32303A4022A080	12
MKD480-D-2.5	2.5	3.0	3.0	3.6	3 • 12	63.5 x 148	0.6	B32303A4022A580	12
MKD480-D-5.0	5.0	6.0	6.0	7.2	3 • 23	75 x 163	0.8	B32304A4052A080	6
MKD480-D-6.3	6.3	7.6	7.6	9.1	3 • 29	75 x 163	0.8	B32304A4071A580	6
MKD480-D-7.5	7.5	9.0	9.0	10.8	3 • 35	75 x 200	1.1	B32304A4072A580	6
MKD480-D-8.3	8.3	10.0	10.0	12.0	3 • 38	75 x 200	1.1	B32304A4101A 80	6
MKD480-D-10.4	10.4	12.5	12.5	15.0	3 • 48	75 x 275	1.4	B32304A4121A580	6
MKD480-D-12.5	12.5	15.0	15.0	18.0	3 • 58	75 x 275	1.4	B32304A4151A 80	6
MKD480-D-15.0	15.0	18.0	18.0	21.6	3 • 69	85 x 275	1.7	B32304A4152A080	6
MKD480-D-16.7	16.7	20.1	20.0	24.1	3 • 77	85 x 275	1.8	B32304A4162A780	6
MKD480-D-20.8	20.8	25.0	25.0	30.0	3 • 96	85 x 350	2.2	B32304A4202A080	4
MKD480-D-25.0	25.0	30.1	30.0	36.1	3 • 115	85 x 350	2.2	B32304A4252A080	4
MKD480-D-30.0	30.0	36.0	36.0	43.0	3 • 138	96 x 350	2.7	B32304A4302A080	4
Rated voltage 525 V AC, 50/60 Hz, delta connection									
MKD525-D-1.0	1.0	1.1	1.2	1.3	3 • 3.9	50 x 148	0.4	B32303A5012A020	12
MKD525-D-1.5	1.5	1.6	1.8	1.9	3 • 5.8	50 x 148	0.4	B32303A5012A520	12
MKD525-D-2.0	2.0	2.2	2.4	2.6	3 • 7.7	63.5 x 148	0.6	B32303A5022A020	12
MKD525-D-2.5	2.5	2.7	3.0	3.2	3 • 9.6	63.5 x 148	0.6	B32303A5022A520	12
MKD525-D-5.0	5.0	5.5	6.0	6.6	3 • 19	75 x 163	0.8	B32304A5061A020	6
MKD525-D-6.3	6.3	6.9	7.6	8.3	3 • 24	75 x 200	1.0	B32304A5071A520	6
MKD525-D-8.3	8.3	9.1	10.0	10.9	3 • 32	75 x 275	1.4	B32304A5101A020	6
MKD525-D-10.4	10.4	11.4	12.5	13.7	3 • 40	75 x 275	1.4	B32304A5121A520	6
MKD525-D-12.5	12.5	13.7	15.0	16.4	3 • 48	75 x 275	1.4	B32304A5151A020	6
MKD525-D-16.7	16.7	18.4	20.0	22.1	3 • 64	85 x 275	1.8	B32304A5201A020	4
MKD525-D-20.8	20.8	22.9	25.0	27.5	3 • 80	85 x 350	2.2	B32304A5202A020	4
MKD525-D-25.0	25.0	27.5	30.0	33.0	3 • 96	85 x 350	2.2	B32304A5252A020	4
MKD525-D-30.0	30.0	33.0	36.0	39.0	3 • 115	96 x 350	2.7	B32304A5302A020	4

Cautions and warnings

- In case of dents of more than 1 mm depth or any other mechanical damage, capacitors must not be used at all.
- This applies also in cases of oil leakages.
- To ensure the full functionality of the overpressure disconnecter, elastic elements must not be hindered and a minimum space of 12 mm has to be kept above each capacitor.
- Do not handle the capacitor before it is discharged.
- Resonance cases must be avoided by appropriate application design in any case.
- Handle capacitors carefully, because they may still be charged even after disconnection due to faulty discharging devices.
- Protect the capacitor properly against over current and short circuit.
- Failure to follow cautions may result, worst case, in premature failures, bursting and fire.

Discharging

Capacitors must be discharged to a maximum of 10% of rated voltage before they are switched in again. This prevents an electric impulse discharge in the application, influences the capacitor's service life and protects against electric shock. The capacitor must be discharged to 75 V or less within 3 minutes. There must be not any switch, fuse or any other disconnecting device in the circuit between the power capacitor and the discharging device. DeltaCap capacitors are delivered with discharge resistor included; alternatively discharge reactors are available from EPCOS. Discharge and short circuit capacitor before handling!

Service life expectancy

Electrical components do not have an unlimited service life expectancy; this applies to self-healing capacitors too. The maximum service life expectancy may vary depending on the application the capacitor is used in.

Safety

Electrical or mechanical misapplication of capacitors may be hazardous. Personal injury or property damage may result from bursting of the capacitor or from expulsion of oil or melted material due to mechanical disruption of the capacitor.

- Ensure good, effective grounding for capacitor enclosures.
- Provide means of disconnecting and insulating a faulty component/bank.
- The terminals of capacitors, connected bus bars and cables as well as other devices may also be energized.
- Follow good engineering practice.

Thermal load/over-temperature

After installation of the capacitor it is necessary to verify that maximum hot-spot temperature is not exceeded at extreme service conditions.

Overpressure disconnecter

To ensure full functionality of an overpressure disconnecter, the following must be observed:

1. The elastic elements must not be hindered, i.e.
 - Connecting lines must be flexible leads (cables).
 - There must be sufficient space (min. 12 mm) for expansion above the connections. This will enable a longitudinal extension of the can to secure the overpressure disconnecter work.
 - Folding beads must not be retained by clamps.
2. The maximum allowed fault current of 10000 A in accordance with UL 810 standard must be assured by the application.
3. Stress parameters of the capacitor must be within the IEC60831 specification.

Overcurrent and short circuit protection

- Use HRC fuses or MCCBs for short circuit protection. Short circuit protection and connecting cables should be selected so that 1.5 times the rated capacitor current can be permanently handled.
- HRC fuses do not protect a capacitor against overload – they are only for short circuit protection.
- The HRC fuse rating should be 1.6 to 1.8 times rated capacitor current.
- Do not use HRC fuses to switch capacitors (risk of arcing).
- Use thermal magnetic over current relays for overload protection.

Resonance cases

Resonance cases must be avoided by appropriate application design in any case. Maximum total RMS capacitor current (incl. fundamental harmonic current) specified in technical data must not be exceeded.

Re-switching vs. phase-opposition

In case of voltage interruption, a sufficient discharge time has to be ensured to avoid phase-opposition and resulting high inrush currents.

Vibration resistance

The resistance to vibration of capacitors corresponds to IEC 68, part 2–6.

Max. test conditions:

Test duration	6 h*
Frequency range 1	10 ... 55 Hz*
Displacement amplitude	0.75 mm*

*corresponding to max. 98.1 m/s or 10 g

These figures apply to the capacitor alone. Because the fixing and the terminals may influence the vibration properties, it is necessary to check stability when a capacitor is built in and exposed to vibration. Irrespective of this, you are advised not to locate capacitors where vibration amplitude reaches the maximum in strongly vibrating equipment.

Mechanical protection

The capacitor has to be installed in a way that mechanical damages and dents in the aluminum can be avoided.

Grounding

The threaded bottom stud of the capacitor has to be used for grounding. In case grounding is done via metal chassis that the capacitor is mounted to, the layer of varnish beneath the washer and nut should be removed. The maximum tightening torque is 10 Nm.

Maintenance

- Check tightness of the connections/terminals periodically.
- Take current reading twice a year and compare with nominal current. Use a harmonic analyser or true effective RMS-meter.
- In case of current above the nominal current check your application for modifications.
- If a significant increase in the amount of non-linear loads has been detected, then a consultant has to be called in for a harmonic study.
- In case of the presence of harmonics installation of a de-tuned capacitor bank (reactors) must be considered.
- Check the discharge resistors/reactors and in case of doubt, check their function:
 - (1) Power the capacitor up and down.
 - (2) After ≤ 60 seconds the voltage between the terminals must decline to less than 75 V.
- Check the temperature of capacitors directly after operation for a longer period, but make sure that the capacitors have been switched off. In case of excessive temperature of individual capacitors, it is recommended to replace these capacitors, as this should be an indication for loss factor increase, which is a sign for reaching end of life.

Storage and operating conditions

Do not use or store capacitors in corrosive atmosphere, especially where chloride gas, sulfide gas, acid, alkali, salt or the like are present. In dusty environments regular maintenance and cleaning especially of the terminals is required to avoid conductive path between phases and/or phases and ground.

Note

For detailed information about PFC capacitors and cautions, refer to the latest version of EPCOS PFC Product Profile.

Important notes

The following applies to all products named in this publication:

1. Some parts of this publication contain **statements about the suitability of our products for certain areas of application**. These statements are based on our knowledge of typical requirements that are often placed on our products in the areas of application concerned. We nevertheless expressly point out **that such statements cannot be regarded as binding statements about the suitability of our products for a particular customer application**. As a rule, EPCOS is either unfamiliar with individual customer applications or less familiar with them than the customers themselves. For these reasons, it is always ultimately incumbent on the customer to check and decide whether an EPCOS product with the properties described in the product specification is suitable for use in a particular customer application.
2. We also point out that **in individual cases, a malfunction of electronic components or failure before the end of their usual service life cannot be completely ruled out in the current state of the art, even if they are operated as specified**. In customer applications requiring a very high level of operational safety and especially in customer applications in which the malfunction or failure of an electronic component could endanger human life or health (e.g. in accident prevention or life-saving systems), it must therefore be ensured by means of suitable design of the customer application or other action taken by the customer (e.g. installation of protective circuitry or redundancy) that no injury or damage is sustained by third parties in the event of malfunction or failure of an electronic component.
3. **The warnings, cautions and product-specific notes must be observed.**
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