



## Film capacitors – Power Factor Correction

### MKV capacitors

<b>Series/Type:</b>	<b>MKV400-D-20-02</b>
<b>Ordering code:</b>	<b>B25836B3397A305</b>
Date:	September 2008
Version:	2

## Construction

- Dielectric: Polypropylene film with paper as electrode carrier
- Oil impregnated
- Extruded round aluminium can with stud
- Discharge resistors included
- Double safety system

## Features

- Three phase, delta connected
- Self-healing technology
- Naturally air cooled (or forced air cooling)
- Indoor mounting

## Typical applications

- For Power Factor Correction

## Terminals

- SIGUT terminals

## Mounting

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



## Technical data and specifications

Characteristics	MKV400-D-20-02	
Rated capacitance $C_R$	$3 \times 133 \mu\text{F}$	
Tolerance	-5/+10%	
Connection	D (Delta)	
Rated voltage $V_R$	400 V AC	
Rated frequency $f_R$	50 Hz	60 Hz
Output	20 kvar	24 kvar
Rated current $I_R$	29 A	35 A
$\tan \delta$ (dielectric)	0.2 W/kvar	

**Maximum ratings**

$V_{\max}$ (up to 8 h daily)	440 V AC
$V_{\max}$ (up to 1 min)	520 V AC
$I_{\max}$	$3 \times 55 \text{ A}$ ( $T_A = 60 \text{ }^{\circ}\text{C}$ , $V_R$ )
$I_S$	15 kA

**Test data**

$V_{TT}$	860 V AC/50 Hz during 10 s
$V_{TC}$	3000 V AC/50 Hz during 10 s
$\tan \delta$ (50 Hz)*	$\leq 0.35 \text{ W/kvar}$ (total)

\*without discharge resistors

**Climatic category**

$T_{\min}$	$-40 \text{ }^{\circ}\text{C}$
$T_{\max}$	$+70 \text{ }^{\circ}\text{C}$
Humidity $H_{\text{rel}}$	max. 95%
Maximum altitude	4000 m

**Mean life expectancy**

$t_{LD}$	Up to 300 000 hours at temperature class $-40/D$
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Max. 20 000 switchings per year according to IEC 60831-1+/2

max. 50 000 switchings per year according to IEC 60831-1+/2 in case standard PFC reactors are applied

**Design data**

Dimensions ( $\varnothing \times l$ )	$116.2 \times 325 \text{ mm}$
Weight approx	4.5 kg
Impregnation	Oil
Fixing	Threaded bolt M12
Max. torque (Al can stud)	10 Nm
Mounting position	Upright/horizontal

**Terminals**

Degree of protection	Isolated terminals, IP20
Max. torque	1.2 Nm
Terminal cross section	$16 \text{ mm}^2$ (5 AWG)
Maximum terminal current	55 A
Creepage distance	12.7 mm
Clearance	9.6 mm

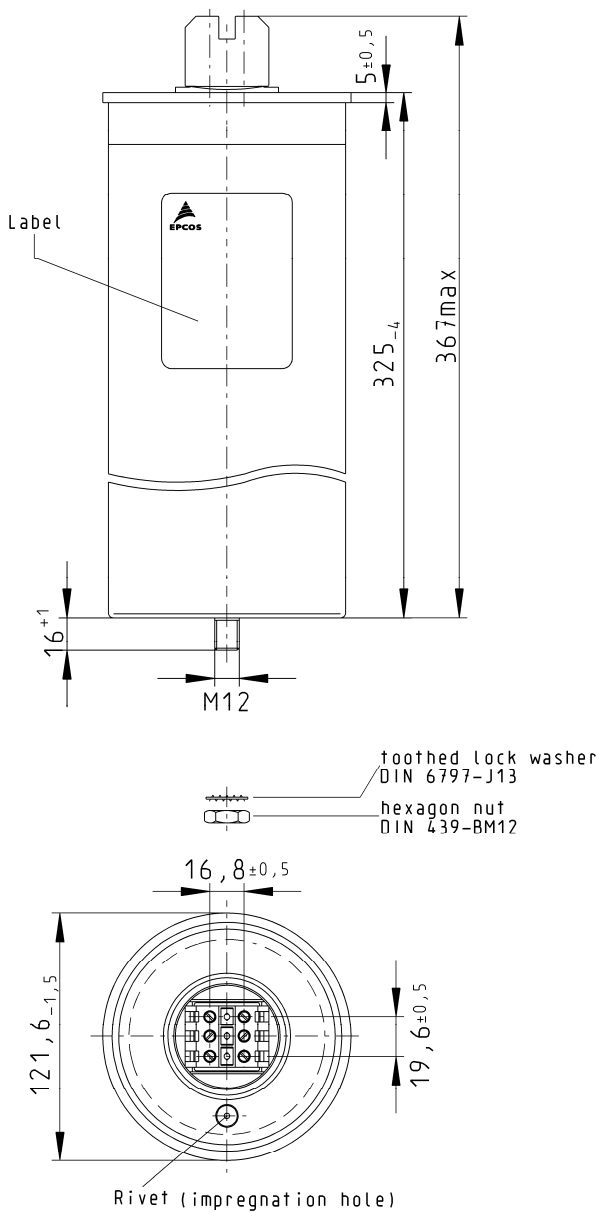
## Safety

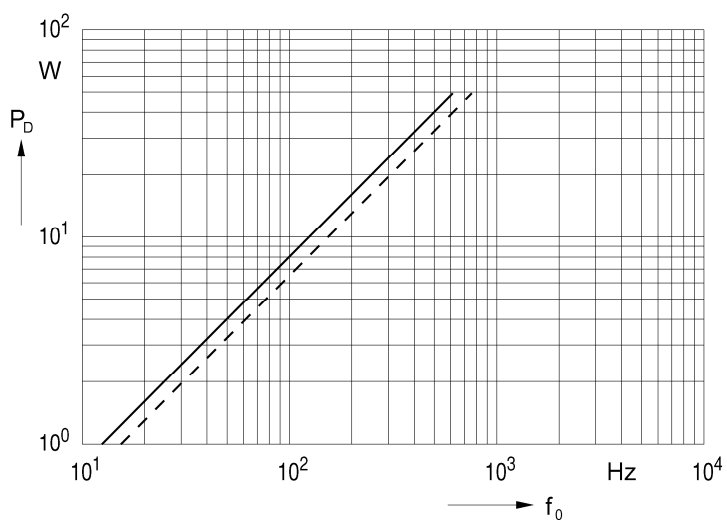
Mechanical safety

Overpressure disconnecter

## Reference standards

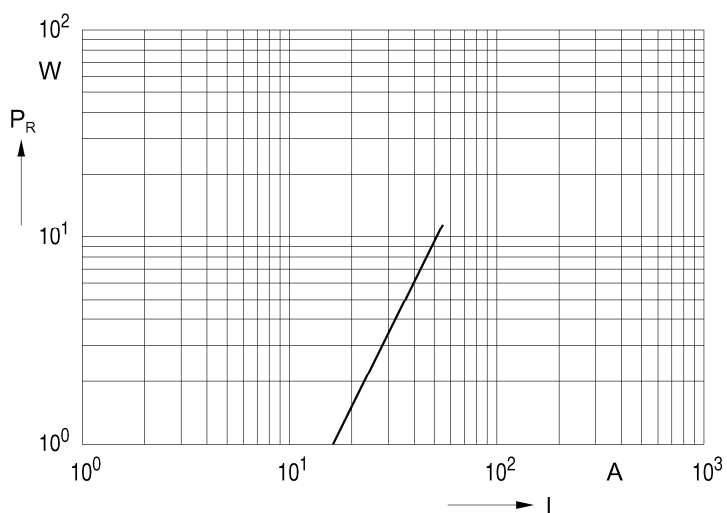
IEC 60831-1/2, EN 60831-1: 1996+A1:2003 + EN 60831-1: 1996,  
VDE 560-46+47





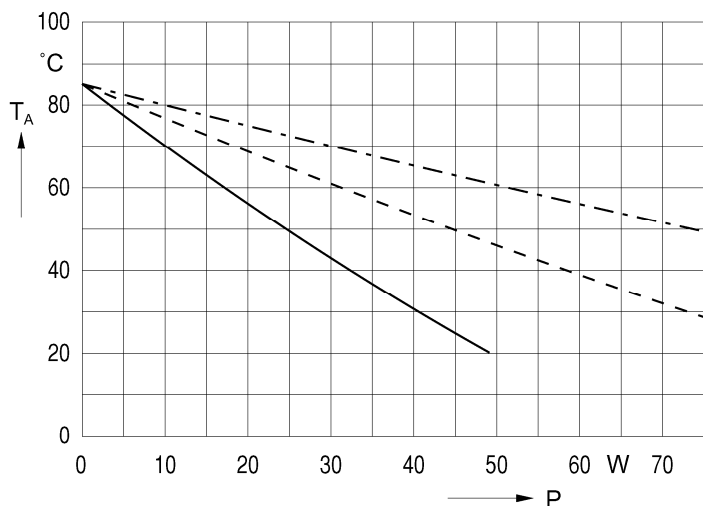
Dielectric power dissipation  $P_D$   
vs. repetition frequency  $f_0$

$V_R = 400$  V AC —————  
 $0.9 \cdot V_R = 360$  V AC - - - - -



Ohmic power dissipation  $P_R$   
vs. RMS current value  $I$

$R_S(85^\circ\text{C}) = 3.8$  m $\Omega$   
 $I_{\max} = 55$  A



Permissible ambient temperature  $T_A$   
vs. total power dissipation  $P$

Natural cooling —————  
Forced cooling 2 m/s - - - - -  
Perm. capacitor temp. - . - . - .

upright mounting position

### **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. MKV PFC-capacitors B-series have a pre-mounted ceramic discharge module; 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. 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 IEC 60831 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 aluminium 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 50 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: Please note that the „General Safety Recommendations for Power Capacitors“ by ZVEI (German Electrical and Electronic Manufacturers' Association (ZVEI) have to be observed in addition to the caution guidelines stated in the data sheet (Internet: [www.epcos.com/pfc](http://www.epcos.com/pfc)).



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