

# Film Capacitors

## Metallized Polypropylene Film Capacitors (MKP)

**Series/Type:** B32671P ... B32673P

**Date:** June 2018

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**Power Factor Correction**
**Typical applications**

- PFC (Power Factor Correction)

**Climatic**

- Max. operating temperature: 125 °C
- Climatic category (IEC 60068-1:2013): 55/110/56

**Construction**

- Dielectric: polypropylene (PP)
- Wound capacitor technology
- Plastic case (UL 94 V-0)
- Epoxy resin sealing

**Features**

- Very compact design
- Very small dimensions
- Very high ripple and peak current
- High frequency AC operation capability
- High voltage capability
- Excellent self-healing property
- RoHS-compatible
- Halogen-free capacitors available on request
- AEC-Q200D compliant

**Terminals**

- Parallel wire leads, lead free, tinned
- Special lead lengths available on request

**Marking**

- Manufacturer's logo
- Lot number, series number
- Rated capacitance (coded)
- Capacitance tolerance (code letter)
- Rated DC voltage
- Date of manufacture (coded)

**Delivery mode**

- Bulk (untaped)
- Taped (Ammo pack or reel)

For notes on taping, refer to chapter "Taping and packing".

**Dimensional drawing**


Dimensions in mm

Lead spacing	Lead diameter	Type
$e \pm 0.4$	$d_1 \pm 0.05$	
10	0.6	B32671P
15	0.8	B32672P
22.5	0.8	B32673P



### Overview of available types

Lead spacing	10 mm			15 mm			22.5 mm		
Type	B32671P			B32672P			B32673P		
Page	4			5			6		
$V_{RMS}$ (V AC)	160	200	200	160	200	200	160	200	200
$V_R$ (V DC)	450	520	630	450	520	630	450	520	630
$C_R$ ( $\mu$ F)									
0.068									
0.082									
0.10									
0.15									
0.18									
0.22									
0.27									
0.33									
0.39									
0.47									
0.56									
0.68									
1.0									
1.5									
2.0									
2.2									


**B32671P**
**Power Factor Correction**
**Ordering codes and packing units (lead spacing 10 mm)**

$V_R$	$V_{RMS}$ $f \leq 1$ kHz	$C_R$	Ordering code (composition see below)	Max. dimensions $w \times h \times l$ mm	Ammo pack pcs./MOQ	Reel pcs./MOQ	Untaped pcs./MOQ
V DC	V AC	$\mu F$					
450	160	0.10	B32671P4104+***	4.0 × 9.0 × 13.0	4000	6800	4000
		0.15	B32671P4154+***	4.0 × 9.0 × 13.0	4000	6800	4000
		0.18	B32671P4184+***	5.0 × 11.0 × 13.0	3320	5200	4000
		0.22	B32671P4224+***	5.0 × 11.0 × 13.0	3320	5200	4000
		0.27	B32671P4274+***	5.0 × 11.0 × 13.0	3320	5200	4000
		0.33	B32671P4334+***	6.0 × 12.0 × 13.0	2720	4400	4000
		0.39	B32671P4394+***	6.0 × 12.0 × 13.0	2720	4400	4000
		0.47	B32671P4474+***	6.0 × 14.0 × 13.0	2720	4400	4000
		0.68	B32671P4684+***	7.0 × 16.0 × 13.0	—	—	4000
		1.0	B32671P4105+***	8.0 × 17.5 × 13.0	—	—	2000
520	200	0.082	B32671P5823+***	4.0 × 9.0 × 13.0	4000	6800	4000
		0.10	B32671P5104+***	5.0 × 11.0 × 13.0	3320	5200	4000
		0.15	B32671P5154+***	5.0 × 11.0 × 13.0	3320	5200	4000
		0.22	B32671P5224+***	6.0 × 12.0 × 13.0	2720	4400	4000
		0.33	B32671P5334+***	7.0 × 16.0 × 13.0	—	—	4000
		0.47	B32671P5474+***	8.0 × 17.5 × 13.0	—	—	2000
630	200	0.068	B32671P6683+***	4.0 × 9.0 × 13.0	4000	6800	4000
		0.082	B32671P6823+***	5.0 × 11.0 × 13.0	3320	5200	4000
		0.10	B32671P6104+***	5.0 × 11.0 × 13.0	3320	5200	4000
		0.15	B32671P6154+***	6.0 × 12.0 × 13.0	2720	4400	4000
		0.18	B32671P6184+***	6.0 × 12.0 × 13.0	2720	4400	4000
		0.22	B32671P6224+***	6.0 × 14.0 × 13.0	2720	4400	4000
		0.33	B32671P6334+***	8.0 × 17.5 × 13.0	—	—	2000
		0.39	B32671P6394+***	8.0 × 17.5 × 13.0	—	—	2000

MOQ = Minimum Order Quantity, consisting of 4 packing units.

Further E series, intermediate capacitance values and closer tolerance on request.

**Composition of ordering code**

+ = Capacitance tolerance code:

J =  $\pm 5\%$

K =  $\pm 10\%$

M =  $\pm 20\%$

\*\*\* = Packaging code:

289 = Straight terminals, Ammo pack

189 = Straight terminals, Reel

003 = Straight terminals, untaped (lead length  
3.2 ± 0.3 mm)

000 = Straight terminals, untaped (lead length  
6–1 mm)


**Ordering codes and packing units (lead spacing 15 mm)**

$V_R$	$V_{RMS}$ $f \leq 1$ kHz	$C_R$	Ordering code (composition see below)	Max. dimensions $w \times h \times l$ mm	Ammo pack pcs./MOQ	Reel pcs./MOQ	Untaped pcs./MOQ
V DC	V AC	$\mu F$					
450	160	0.10	B32672P4104+***	5.0 × 10.5 × 18.0	4680	5200	4000
		0.22	B32672P4224+***	5.0 × 10.5 × 18.0	4680	5200	4000
		0.33	B32672P4334+***	5.0 × 10.5 × 18.0	4680	5200	4000
		0.47	B32672P4474+***	5.0 × 10.5 × 18.0	4680	5200	4000
		0.56	B32672P4564+***	6.0 × 11.0 × 18.0	3840	4400	4000
		0.68	B32672P4684+***	6.0 × 12.0 × 18.0	3840	4400	4000
		1.0	B32672P4105+***	7.0 × 12.5 × 18.0	3320	3600	4000
		1.5	B32672P4155+***	9.0 × 17.5 × 18.0	2560	2800	2000
		2.0	B32672P4205+***	9.0 × 17.5 × 18.0	2560	2800	2000
		2.2	B32672P4225+***	11.0 × 18.5 × 18.0	—	2200	1200
520	200	0.15	B32672P5154+***	5.0 × 10.5 × 18.0	4680	5200	4000
		0.22	B32672P5224+***	5.0 × 10.5 × 18.0	4680	5200	4000
		0.33	B32672P5334+***	6.0 × 11.0 × 18.0	3840	4400	4000
		0.47	B32672P5474+***	7.0 × 12.5 × 18.0	3320	3600	4000
		0.68	B32672P5684+***	8.5 × 14.5 × 18.0	2720	2800	2000
		1.0	B32672P5105+***	9.0 × 17.5 × 18.0	2560	2800	2000
		1.5	B32672P5155+***	11.0 × 18.5 × 18.0	—	2200	1200
630	200	0.15	B32672P6154+***	5.0 × 10.5 × 18.0	4680	5200	4000
		0.22	B32672P6224+***	6.0 × 11.0 × 18.0	3840	4400	4000
		0.33	B32672P6334+***	7.0 × 12.5 × 18.0	3320	3600	4000
		0.47	B32672P6474+***	8.0 × 14.0 × 18.0	2920	3000	2000
		0.68	B32672P6684+***	9.0 × 17.5 × 18.0	2560	2800	2000
		1.0	B32672P6105+***	11.0 × 18.5 × 18.0	—	2200	1200

MOQ = Minimum Order Quantity, consisting of 4 packing units.

Further E series, intermediate capacitance values and closer tolerance on request.

**Composition of ordering code**

+ = Capacitance tolerance code:

J =  $\pm 5\%$

K =  $\pm 10\%$

M =  $\pm 20\%$

\*\*\* = Packaging code:

289 = Straight terminals, Ammo pack

189 = Straight terminals, Reel

003 = Straight terminals, untaped (lead length  
3.2 ± 0.3 mm)

000 = Straight terminals, untaped (lead length  
6–1 mm)


**B32673P**
**Power Factor Correction**
**Ordering codes and packing units (lead spacing 22.5 mm)**

$V_R$	$V_{RMS}$ $f \leq 1$ kHz	$C_R$	Ordering code (composition see below)	Max. dimensions $w \times h \times l$ mm	Ammo pack pcs./MOQ	Reel pcs./MOQ	Untaped pcs./MOQ
V DC	V AC	$\mu F$					
450	160	1.0	B32673P4105+***	6.0 × 15.0 × 26.5	2720	2800	2880
		1.5	B32673P4155+***	7.0 × 16.0 × 26.5	2320	2400	2520
		2.2	B32673P4225+***	8.5 × 16.5 × 26.5	1920	2000	2040
520	200	0.47	B32673P5474+***	6.0 × 15.0 × 26.5	2720	2800	2880
		0.56	B32673P5564+***	6.0 × 15.0 × 26.5	2720	2800	2880
		0.68	B32673P5684+***	6.0 × 15.0 × 26.5	2720	2800	2880
		1.0	B32673P5105+***	7.0 × 16.0 × 26.5	2320	2400	2520
		1.5	B32673P5155+***	10.5 × 16.5 × 26.5	1560	1600	2160
		2.2	B32673P5225+***	10.5 × 20.5 × 26.5	—	—	2160
630	200	0.33	B32673P6334+***	6.0 × 15.0 × 26.5	2720	2800	2880
		0.47	B32673P6474+***	6.0 × 15.0 × 26.5	2720	2800	2880
		0.56	B32673P6564+***	6.0 × 15.0 × 26.5	2720	2800	2880
		0.68	B32673P6684+***	7.0 × 16.0 × 26.5	2320	2400	2520
		1.0	B32673P6105+***	8.5 × 16.5 × 26.5	1920	2000	2040
		1.5	B32673P6155+***	10.5 × 18.5 × 26.5	1560	1600	2160
		2.2	B32673P6225+***	12.0 × 22.0 × 26.5	—	—	1800

MOQ = Minimum Order Quantity, consisting of 4 packing units.

Further E series, intermediate capacitance values and closer tolerance on request.

**Composition of ordering code**

+ = Capacitance tolerance code:

J = ±5%

K = ±10%

M = ±20%

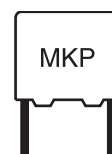
\*\*\* = Packaging code:

289 = Straight terminals, Ammo pack

189 = Straight terminals, Reel

003 = Untaped (lead length  $3.2 \pm 0.3$  mm)

000 = Untaped (lead length 6–1 mm)



### Technical data

Reference standard: IEC 60384-16:2005 and AEC-Q200D. All data given at  $T = 20\text{ °C}$ , unless otherwise specified.

Rated temperature $T_R$	+85 °C		
Operating temperature range	Max. operating temperature $T_{op, max}$	+125 °C	
	Upper category temperature $T_{max}$	+110 °C	
	Lower category temperature $T_{min}$	-55 °C	
	Rated temperature $T_R$	+85 °C	
Dissipation factor $\tan \delta$ (in $10^{-3}$ ) at 20 °C (upper limit values)	at 1 kHz:	1.0	
	at 10 kHz:	2.5	
	at 100 kHz:	25.0	
Insulation resistance $R_{ins}$ at 100 V or time constant $\tau = C_R \cdot R_{ins}$ at 20 °C, rel. humidity $\leq 65\%$ (minimum as-delivered values)	30 G $\Omega$ ( $C_R \leq 0.33\ \mu\text{F}$ ) 10000 s ( $C_R > 0.33\ \mu\text{F}$ )		
DC test voltage	$1.4 \cdot V_R$ , 2 s		
Category voltage $V_C$ (continuous operation with $V_{DC}$ or $V_{AC}$ at $f \leq 1\text{ kHz}$ )	$T_{op}$ (°C)	DC voltage derating	AC voltage derating
	$T_{op} \leq 85$ $85 < T_{op} \leq 110$	$V_C = V_R$ $V_C = V_R \cdot (165 - T_{op})/80$	$V_{C,RMS} = V_{RMS}$ $V_{C,RMS} = V_{RMS} \cdot (165 - T_{op})/80$
Operating voltage $V_{op}$ for short operating periods ( $V_{DC}$ or $V_{AC}$ at $f \leq 1\text{ kHz}$ )	$T_{op}$ (°C)	DC voltage (max. hours)	AC voltage (max. hours)
	$T_{op} \leq 100$ $100 < T_{op} \leq 125$	$V_{op} = 1.1 \cdot V_C$ (1000 h) $V_{op} = 1.0 \cdot V_C$ (1000 h)	$V_{op} = 1.0 \cdot V_{C,RMS}$ (1000 h) $V_{op} = 1.0 \cdot V_{C,RMS}$ (1000 h)
Biased humidity	1000 h / 40 °C / 93% relative humidity with $V_{R,DC}$		
Limit values after humidity test	Capacitance change $ \Delta C/C $	$\leq 5\%$	
	Dissipation factor change $\Delta \tan \delta$	$\leq 0.002$ (at 1 kHz)	
	Insulation resistance $R_{ins}$	$\geq 200\text{ M}\Omega$	
Reliability: Failure rate $\lambda$ Service life $t_{SL}$	24 fit ( $\leq 1 \cdot 10^{-7}/\text{h}$ ) at $0.5 \cdot V_R$ , 40 °C 200000 h at $0.5 \cdot V_R$ , 85 °C For conversion to other operating conditions and temperatures, refer to chapter "Quality, 2 Reliability".		
Failure criteria: Total failure	Short circuit or open circuit		
Failure due to variation of parameters	Capacitance change $ \Delta C/C $	$> 10\%$	
	Dissipation factor $\tan \delta$	$> 4 \cdot$ upper limit values	
	Insulation resistance $R_{ins}$	$< 150\text{ M}\Omega$ ( $C_R \leq 0.33\ \mu\text{F}$ )	
	Or time constant $\tau$	$< 50\text{ s}$ ( $C_R \geq 0.33\ \mu\text{F}$ )	



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Power Factor Correction

### Pulse handling capability

"dV/dt" represents the maximum permissible voltage change per unit of time for non-sinusoidal voltages, expressed in V/μs.

"k<sub>0</sub>" represents the maximum permissible pulse characteristic of the waveform applied to the capacitor, expressed in V<sup>2</sup>/μs.

Note:

The values of dV/dt and k<sub>0</sub> provided below must not be exceeded in order to avoid damaging the capacitor. These parameters are given for isolated pulses in such a way that the heat generated by one pulse will be completely dissipated before applying the next pulse. For a train of pulses, please refer to the curves of permissible AC voltage-current versus frequency.

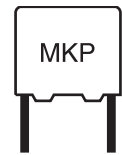
### dV/dt values

Lead spacing		10 mm	15 mm	22.5 mm
V <sub>R</sub> V DC	V <sub>RMS</sub> V AC	dV/dt in V/μs		
450	160	140	120	100
520	200	200	160	110
630	200	250	180	130

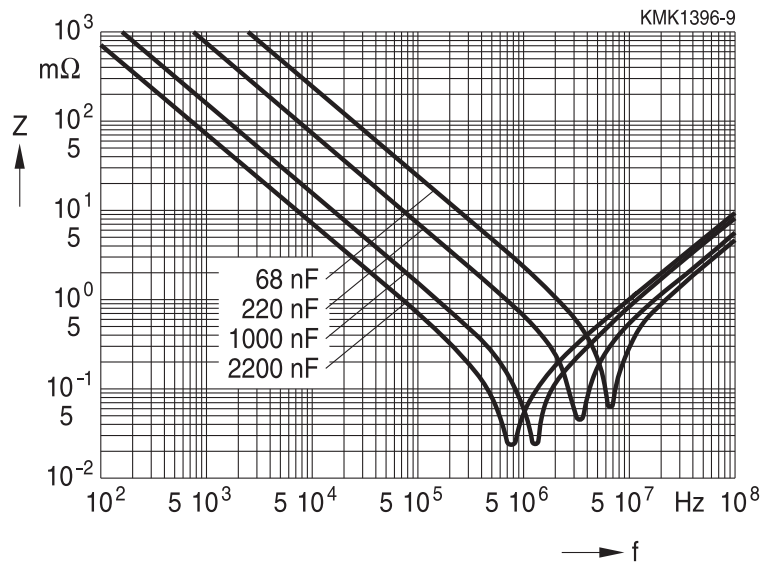
### k<sub>0</sub> values

Lead spacing		10 mm	15 mm	22.5 mm
V <sub>R</sub> V DC	V <sub>RMS</sub> V AC	k <sub>0</sub> in V <sup>2</sup> /μs		
450	160	126000	108000	90000
520	200	208000	166000	114000
630	200	315000	226000	163000





**Impedance Z versus frequency f**  
(typical values)





**B32671P**

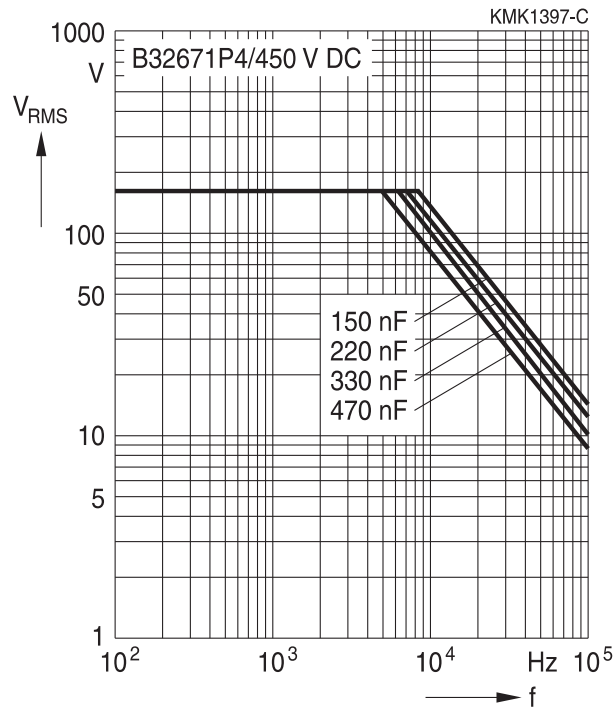
**Power Factor Correction**

**Permissible AC voltage  $V_{RMS}$  versus frequency  $f$  (for sinusoidal waveforms  $T_A \leq 100\text{ }^\circ\text{C}$ )**

For  $T_A > 100\text{ }^\circ\text{C}$ , please use derating factor  $F_T$ .

**Lead spacing 10 mm**

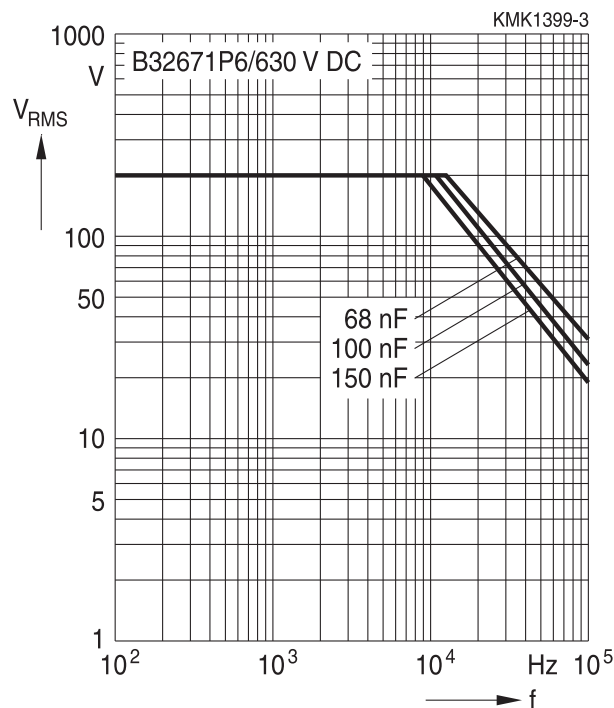
450 V DC/160 V AC



520 V DC/200 V AC



630 V DC/200 V AC



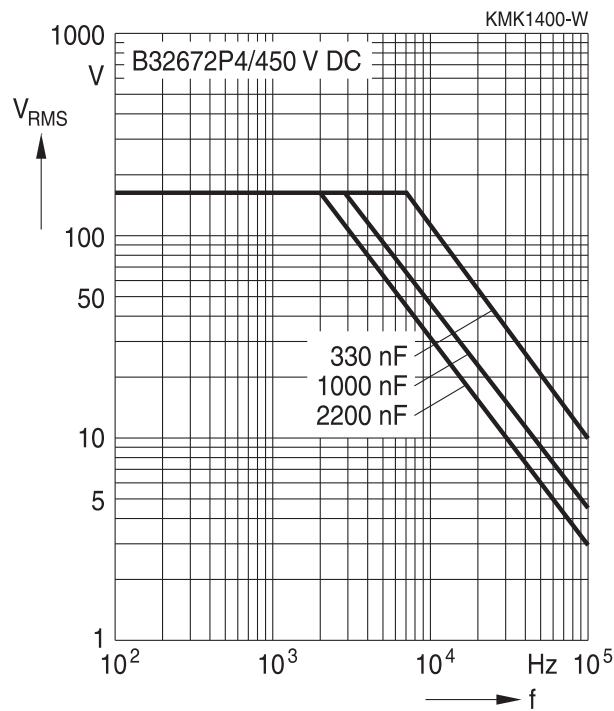


**Permissible AC voltage  $V_{RMS}$  versus frequency  $f$  (for sinusoidal waveforms  $T_A \leq 100\text{ }^\circ\text{C}$ )**

For  $T_A > 100\text{ }^\circ\text{C}$ , please use derating factor  $F_T$ .

**Lead spacing 15 mm**

450 V DC/160 V AC



520 V DC/200 V AC



630 V DC/200 V AC





**B32673P**

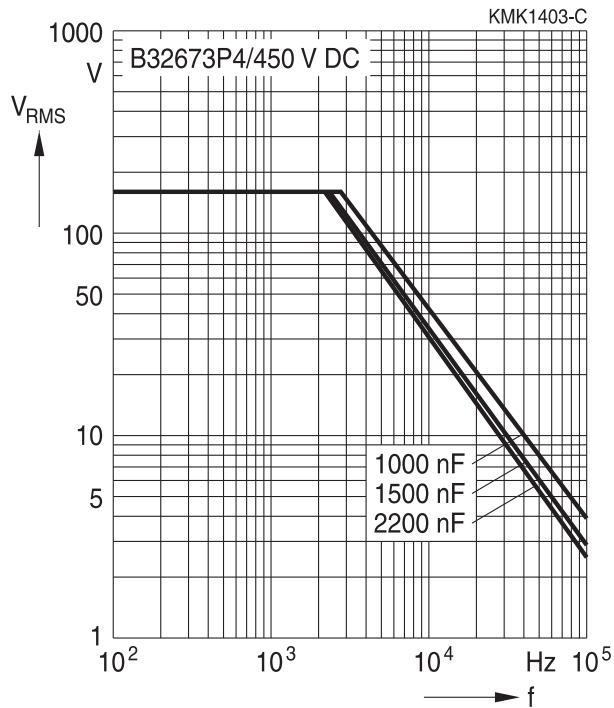
**Power Factor Correction**

**Permissible AC voltage  $V_{RMS}$  versus frequency  $f$  (for sinusoidal waveforms  $T_A \leq 100\text{ }^\circ\text{C}$ )**

For  $T_A > 100\text{ }^\circ\text{C}$ , please use derating factor  $F_T$ .

**Lead spacing 22.5 mm**

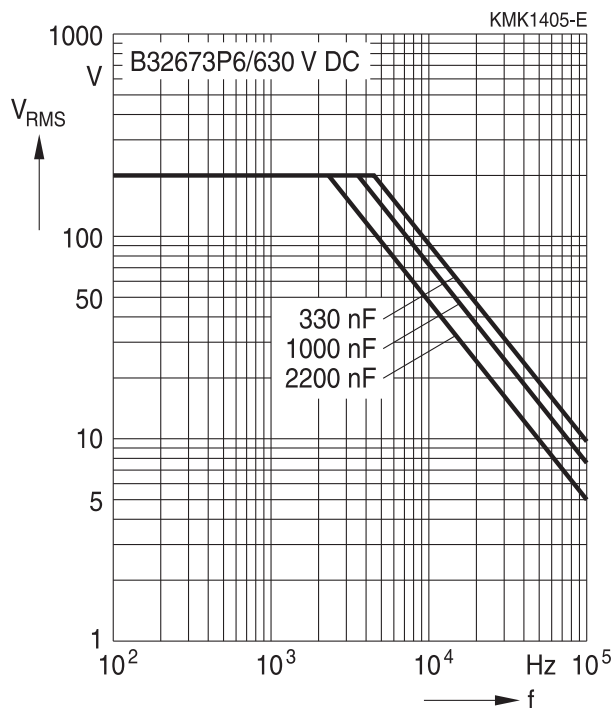
450 V DC/160 V AC

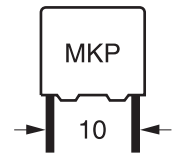


520 V DC/200 V AC



630 V DC/200 V AC

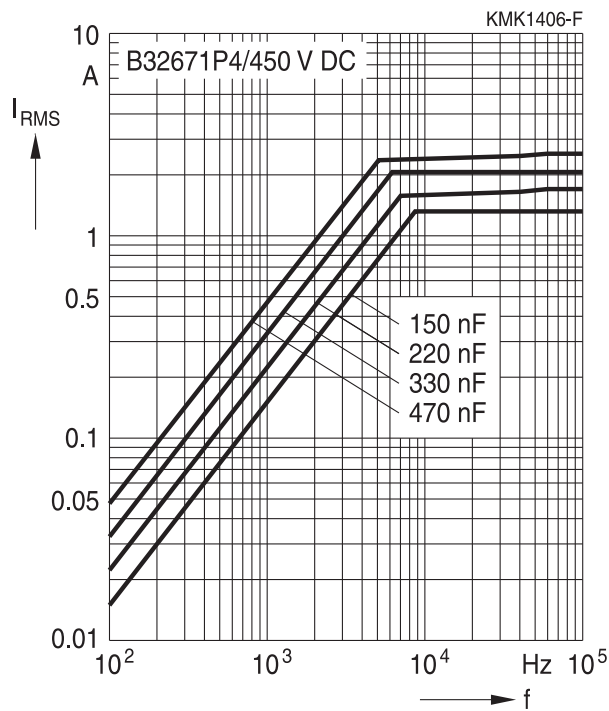



**Permissible AC current  $I_{RMS}$  versus frequency  $f$  (for sinusoidal waveforms  $T_A \leq 100\text{ }^\circ\text{C}$ )**

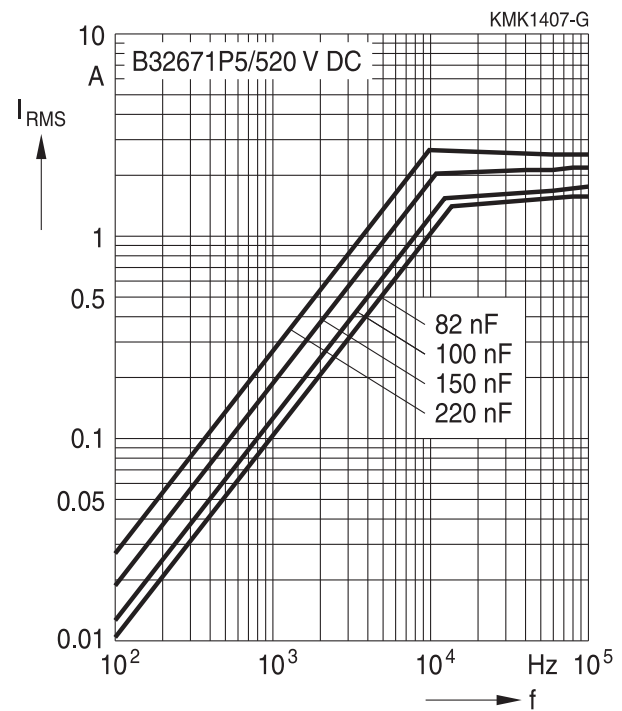
 For  $T_A > 100\text{ }^\circ\text{C}$ , please use derating factor  $F_T$ .

**Lead spacing 10 mm**

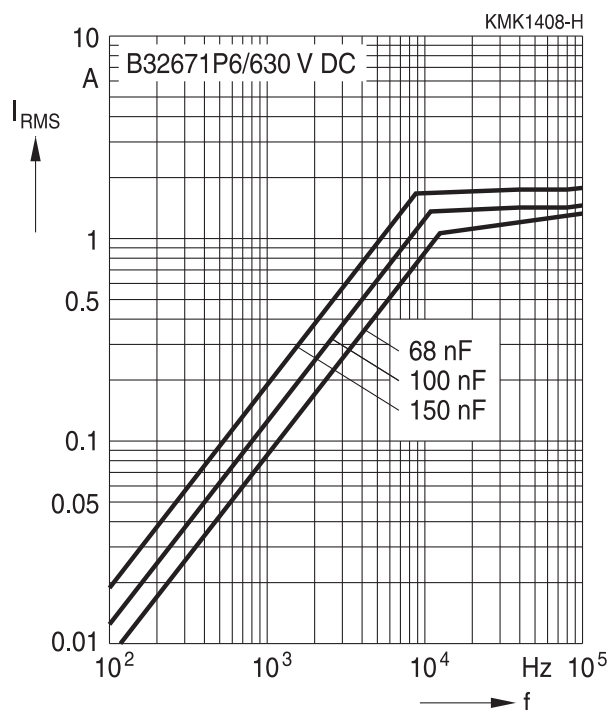
450 V DC/160 V AC



520 V DC/200 V AC



630 V DC/200 V AC





**B32672P**

**Power Factor Correction**

**Permissible AC current  $I_{RMS}$  versus frequency  $f$  (for sinusoidal waveforms  $T_A \leq 100\text{ }^\circ\text{C}$ )**

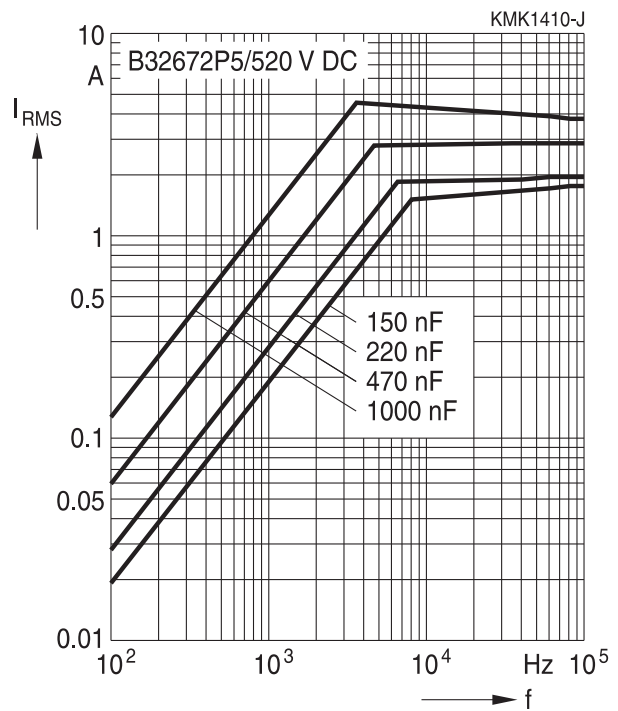
For  $T_A > 100\text{ }^\circ\text{C}$ , please use derating factor  $F_T$ .

**Lead spacing 15 mm**

450 V DC/160 V AC



520 V DC/200 V AC

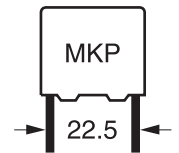


630 V DC/200 V AC



**B32673P**

**Power Factor Correction**

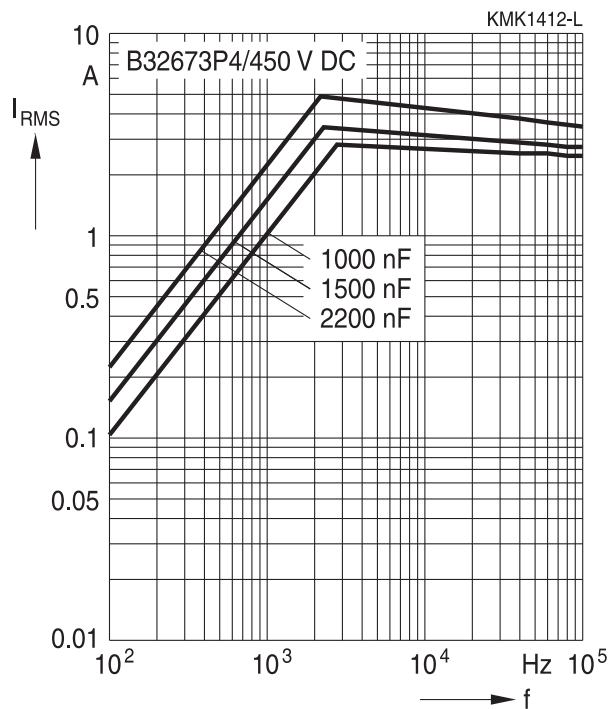


**Permissible AC current  $I_{RMS}$  versus frequency  $f$  (for sinusoidal waveforms  $T_A \leq 100\text{ }^\circ\text{C}$ )**

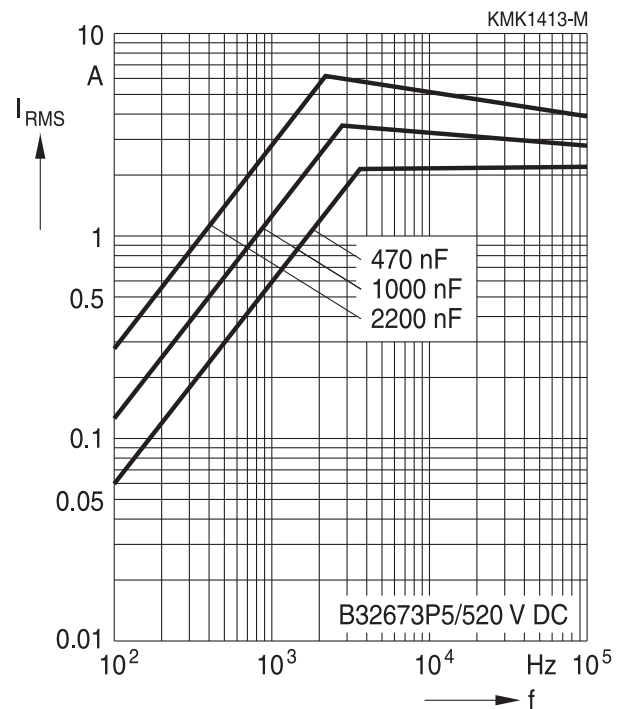
For  $T_A > 100\text{ }^\circ\text{C}$ , please use derating factor  $F_T$ .

**Lead spacing 22.5 mm**

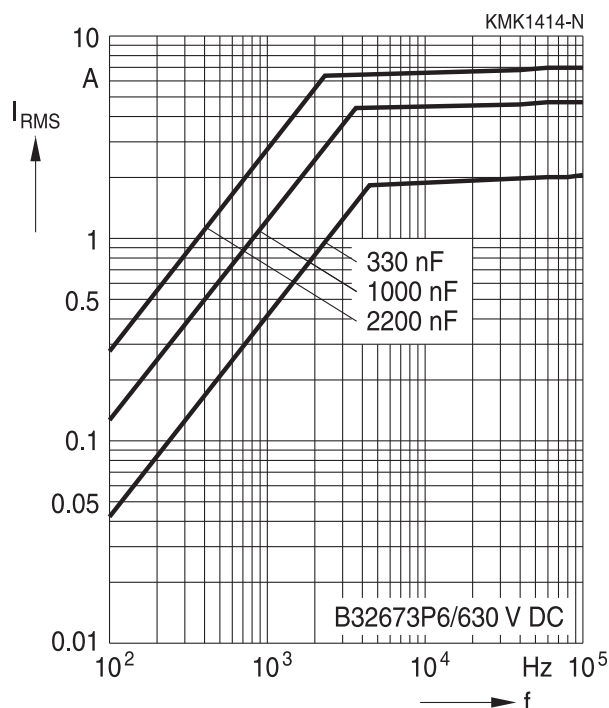
450 V DC/160 V AC

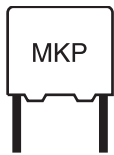


520 V DC/200 V AC



630 V DC/200 V AC





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**Power Factor Correction**

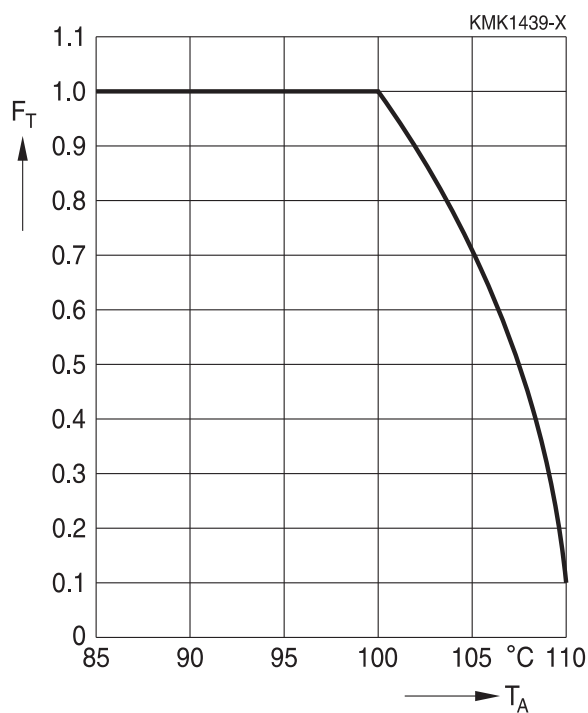
**Maximum AC voltage ( $V_{RMS}$ ), current ( $I_{RMS}$ ) versus frequency and temperature for  $T_A > 100\text{ }^\circ\text{C}$**

The graphs described in the previous section for the permissible AC voltage ( $V_{RMS}$ ) or current ( $I_{RMS}$ ) versus frequency are given for a maximum ambient temperature  $T_A \leq 100\text{ }^\circ\text{C}$ . In case of higher ambient temperatures ( $T_A$ ), the self-heating ( $\Delta T$ ) of the component must be reduced to avoid that temperature of the component ( $T_{op} = T_A + \Delta T$ ) reaches values above maximum operating temperature. The factor  $F_T$  shall be applied in the following way:

$$I_{RMS}(T_A) = I_{RMS, T_A \leq 100\text{ }^\circ\text{C}} \cdot F_T(T_A)$$

$$V_{RMS}(T_A) = V_{RMS, T_A \leq 100\text{ }^\circ\text{C}} \cdot F_T(T_A)$$

And  $F_T$  is given by the following curve:







## Testing and Standards

Test	Reference	Conditions of test	Performance requirements
Electrical parameters	IEC 60384-16:2005	Voltage proof, $1.4 V_R$ , 1 minute Insulation resistance, $R_{ins}$ Capacitance, C Dissipation factor, $\tan \delta$	Within specified limits
Robustness of terminations	IEC 60068-2-21:2006	Tensile strength (test Ua1)	Capacitance and $\tan \delta$ within specified limits
		Wire diameter   Tensile force $0.5 < d_1 \leq 0.8$ mm   10 N	
Resistance to soldering heat	IEC 60068-2-20:2008, test Tb, method 1A	Solder bath temperature at $260 \pm 5$ °C, immersion for 10 seconds	$\Delta C/C_0 \leq 2\%$ $ \Delta \tan \delta  \leq 0.001$
Rapid change of temperature	IEC 60384-16:2005	$T_A$ = lower category temperature $T_B$ = upper category temperature Five cycles, duration $t = 30$ min.	$ \Delta C/C_0  \leq 2\%$ $ \Delta \tan \delta  \leq 0.002$ $R_{ins} \geq 50\%$ of initial limit
Vibration	IEC 60384-16:2005	Test $F_C$ : vibration sinusoidal Displacement: 0.75 mm Acceleration: $98 \text{ m/s}^2$ Frequency: 10 Hz ... 500 Hz Test duration: 3 orthogonal axes, 2 hours each axe	No visible damage
Bump	IEC 60384-16:2005	Test $E_b$ : Total 4000 bumps with $390 \text{ m/s}^2$ mounted on PCB Duration: 6 ms	No visible damage $ \Delta C/C_0  \leq 2\%$ $ \Delta \tan \delta  \leq 0.001$ $R_{ins} \geq 50\%$ of initial limit
Climatic sequence	IEC 60384-16:2005	Dry heat $T_b$ / 16 h Damp heat cyclic, 1 <sup>st</sup> cycle $+55$ °C / 24 h / 95% ... 100% RH Cold $T_a$ / 2 h Damp heat cyclic, 5 cycles $+55$ °C / 24 h / 95% ... 100% RH	No visible damage $ \Delta C/C_0  \leq 2\%$ $ \Delta \tan \delta  \leq 0.001$ $R_{ins} \geq 50\%$ of initial limit
Damp heat, steady state	IEC 60384-16:2005	Test $C_a$ $40$ °C / 93% RH / 56 days	No visible damage $ \Delta C/C_0  \leq 3\%$ $ \Delta \tan \delta  \leq 0.003$ $R_{ins} \geq 50\%$ of initial limit
Advanced biased humidity		$60$ °C / 95% RH / 1000 hours with $V_{R,DC}$	No visible damage $ \Delta C/C_0  \leq 10\%$ $ \Delta \tan \delta  \leq 0.004$ $R_{ins} \geq 50\%$ of initial limit



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**Power Factor Correction**

Test	Reference	Conditions of test	Performance requirements
Endurance A		85 °C / 1.1 V <sub>R</sub> / 1000 hours	No visible damage  ΔC/C <sub>0</sub>   ≤ 5%  Δ tan δ  ≤ 0.004 R <sub>ins</sub> ≥ 50% of initial limit
Endurance B		110 °C / 1.1 V <sub>C</sub> / 1000 hours	No visible damage  ΔC/C <sub>0</sub>   ≤ 10%  Δ tan δ  ≤ 0.004 R <sub>ins</sub> ≥ 50% of initial limit
Endurance C		125 °C / 1.1 V <sub>C</sub> / 1000 hours	No visible damage  ΔC/C <sub>0</sub>   ≤ 10%  Δ tan δ  ≤ 0.004 R <sub>ins</sub> ≥ 50% of initial limit
Endurance D		85 °C / V <sub>R</sub> + 4 A <sub>RMS,1000 KHz</sub> / 1000 hours	No visible damage  ΔC/C <sub>0</sub>   ≤ 10%  Δ tan δ  ≤ 0.004 R <sub>ins</sub> ≥ 50% of initial limit

**Mounting guidelines**

**1 Soldering**

**1.1 Solderability of leads**

The solderability of terminal leads is tested to IEC 60068-2-20, test Ta, method 1.

Before a solderability test is carried out, terminals are subjected to accelerated ageing (to IEC 60068-2-2, test Ba: 4 h exposure to dry heat at 155 °C). Since the ageing temperature is far higher than the upper category temperature of the capacitors, the terminal wires should be cut off from the capacitor before the ageing procedure to prevent the solderability being impaired by the products of any capacitor decomposition that might occur.

Solder bath temperature	235 ±5 °C
Soldering time	2.0 ±0.5 s
Immersion depth	2.0 +0/-0.5 mm from capacitor body or seating plane
Evaluation criteria:	
Visual inspection	Wetting of wire surface by new solder ≥90%, free-flowing solder



## 1.2 Resistance to soldering heat

Resistance to soldering heat is tested to IEC 60068-2-20, test Tb, method 1.

Conditions:

Series	Solder bath temperature	Soldering time
MKT boxed (except 2.5 × 6.5 × 7.2 mm) coated uncoated (lead spacing >10 mm)	260 ±5 °C	10 ±1 s
MFP MKP (lead spacing >7.5 mm)		
MKT boxed (case 2.5 × 6.5 × 7.2 mm) MKP (lead spacing ≤7.5 mm)	260 ±5 °C	5 ±1 s
MKT uncoated (lead spacing ≤10 mm) insulated (B32559)		<4 s
		recommended soldering profile for MKT uncoated (lead spacing ≤ 10 mm) and insulated (B32559)



Immersion depth	2.0 +0/−0.5 mm from capacitor body or seating plane
Shield	Heat-absorbing board, (1.5 ±0.5) mm thick, between capacitor body and liquid solder
Evaluation criteria:	
Visual inspection	No visible damage
$\Delta C/C_0$	2% for MKT/MKP/MFP 5% for EMI suppression capacitors
$\tan \delta$	As specified in sectional specification



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**Power Factor Correction**

**1.3 General notes on soldering**

Permissible heat exposure loads on film capacitors are primarily characterized by the upper category temperature  $T_{max}$ . Long exposure to temperatures above this type-related temperature limit can lead to changes in the plastic dielectric and thus change irreversibly a capacitor's electrical characteristics. For short exposures (as in practical soldering processes) the heat load (and thus the possible effects on a capacitor) will also depend on other factors like:

- Pre-heating temperature and time
- Forced cooling immediately after soldering
- Terminal characteristics:  
diameter, length, thermal resistance, special configurations (e.g. crimping)
- Height of capacitor above solder bath
- Shadowing by neighboring components
- Additional heating due to heat dissipation by neighboring components
- Use of solder-resist coatings

The overheating associated with some of these factors can usually be reduced by suitable countermeasures. For example, if a pre-heating step cannot be avoided, an additional or reinforced cooling process may possibly have to be included.

**EPCOS recommendations**

As a reference, the recommended wave soldering profile for our film capacitors is as follows:



$T_s$ : Capacitor body maximum temperature at wave soldering

$T_p$ : Capacitor body maximum temperature at pre-heating

KMK1745-A-E



KMK1744-9-E

Body temperature should follow the description below:

- MKP capacitor
  - During pre-heating:  $T_p \leq 110 \text{ }^\circ\text{C}$
  - During soldering:  $T_s \leq 120 \text{ }^\circ\text{C}$ ,  $t_s \leq 45 \text{ s}$
- MKT capacitor
  - During pre-heating:  $T_p \leq 125 \text{ }^\circ\text{C}$
  - During soldering:  $T_s \leq 160 \text{ }^\circ\text{C}$ ,  $t_s \leq 45 \text{ s}$

When SMD components are used together with leaded ones, the film capacitors should not pass into the SMD adhesive curing oven. The leaded components should be assembled after the SMD curing step.

Leaded film capacitors are not suitable for reflow soldering.

In order to ensure proper conditions for manual or selective soldering, the body temperature of the capacitor ( $T_s$ ) must be  $\leq 120 \text{ }^\circ\text{C}$ .

One recommended condition for manual soldering is that the tip of the soldering iron should be  $< 360 \text{ }^\circ\text{C}$  and the soldering contact time should be no longer than 3 seconds.

For uncoated MKT capacitors with lead spacings  $\leq 10 \text{ mm}$  (B32560/B32561) the following measures are recommended:

- pre-heating to not more than  $110 \text{ }^\circ\text{C}$  in the preheater phase
- rapid cooling after soldering

Please refer to EPCOS Film Capacitor Data Book in case more details are needed.



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**Power Factor Correction**

**Cautions and warnings**

- Do not exceed the upper category temperature (UCT).
- Do not apply any mechanical stress to the capacitor terminals.
- Avoid any compressive, tensile or flexural stress.
- Do not move the capacitor after it has been soldered to the PC board.
- Do not pick up the PC board by the soldered capacitor.
- Do not place the capacitor on a PC board whose PTH hole spacing differs from the specified lead spacing.
- Do not exceed the specified time or temperature limits during soldering.
- Avoid external energy inputs, such as fire or electricity.
- Avoid overload of the capacitors.
- Consult us if application is with severe temperature and humidity condition.
- There are no serviceable or repairable parts inside the capacitor. Opening the capacitor or any attempts to open or repair the capacitor will void the warranty and liability of EPCOS.
- Please note that the standards referred to in this publication may have been revised in the meantime.

The table below summarizes the safety instructions that must always be observed. A detailed description can be found in the relevant sections of the chapters "General technical information" and "Mounting guidelines".

Topic	Safety information	Reference chapter "General technical information"
Storage conditions	Make sure that capacitors are stored within the specified range of time, temperature and humidity conditions.	4.5 "Storage conditions"
Flammability	Avoid external energy, such as fire or electricity (passive flammability), avoid overload of the capacitors (active flammability) and consider the flammability of materials.	5.3 "Flammability"
Resistance to vibration	Do not exceed the tested ability to withstand vibration. The capacitors are tested to IEC 60068-2-6:2007. EPCOS offers film capacitors specially designed for operation under more severe vibration regimes such as those found in automotive applications. Consult our catalog "Film Capacitors for Automotive Electronics".	5.2 "Resistance to vibration"

Topic	Safety information	Reference chapter "Mounting guidelines"
Soldering	Do not exceed the specified time or temperature limits during soldering.	1 "Soldering"
Cleaning	Use only suitable solvents for cleaning capacitors.	2 "Cleaning"



Topic	Safety information	Reference chapter "Mounting guidelines"
Embedding of capacitors in finished assemblies	When embedding finished circuit assemblies in plastic resins, chemical and thermal influences must be taken into account. Caution: Consult us first, if you also wish to embed other uncoated component types!	3 "Embedding of capacitors in finished assemblies"

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**Power Factor Correction**

**Symbols and terms**

Symbol	English	German
$\alpha$	Heat transfer coefficient	Wärmeübergangszahl
$\alpha_C$	Temperature coefficient of capacitance	Temperaturkoeffizient der Kapazität
A	Capacitor surface area	Kondensatoroberfläche
$\beta_C$	Humidity coefficient of capacitance	Feuchtekoeffizient der Kapazität
C	Capacitance	Kapazität
$C_R$	Rated capacitance	Nennkapazität
$\Delta C$	Absolute capacitance change	Absolute Kapazitätsänderung
$\Delta C/C$	Relative capacitance change (relative deviation of actual value)	Relative Kapazitätsänderung (relative Abweichung vom Ist-Wert)
$\Delta C/C_R$	Capacitance tolerance (relative deviation from rated capacitance)	Kapazitätstoleranz (relative Abweichung vom Nennwert)
dt	Time differential	Differentielle Zeit
$\Delta t$	Time interval	Zeitintervall
$\Delta T$	Absolute temperature change (self-heating)	Absolute Temperaturänderung (Selbsterwärmung)
$\Delta \tan \delta$	Absolute change of dissipation factor	Absolute Änderung des Verlustfaktors
$\Delta V$	Absolute voltage change	Absolute Spannungsänderung
dV/dt	Time differential of voltage function (rate of voltage rise)	Differentielle Spannungsänderung (Spannungsflankensteilheit)
$\Delta V/\Delta t$	Voltage change per time interval	Spannungsänderung pro Zeitintervall
E	Activation energy for diffusion	Aktivierungsenergie zur Diffusion
ESL	Self-inductance	Eigeninduktivität
ESR	Equivalent series resistance	Ersatz-Serienwiderstand
f	Frequency	Frequenz
$f_1$	Frequency limit for reducing permissible AC voltage due to thermal limits	Grenzfrequenz für thermisch bedingte Reduzierung der zulässigen Wechselspannung
$f_2$	Frequency limit for reducing permissible AC voltage due to current limit	Grenzfrequenz für strombedingte Reduzierung der zulässigen Wechselspannung
$f_r$	Resonant frequency	Resonanzfrequenz
$F_D$	Thermal acceleration factor for diffusion	Therm. Beschleunigungsfaktor zur Diffusion
$F_T$	Derating factor	Deratingfaktor
i	Current (peak)	Stromspitze
$I_C$	Category current (max. continuous current)	Kategoriestrom (max. Dauerstrom)





Symbol	English	German
$I_{RMS}$	(Sinusoidal) alternating current, root-mean-square value	(Sinusförmiger) Wechselstrom
$i_z$	Capacitance drift	Inkonstanz der Kapazität
$k_0$	Pulse characteristic	Impuls Kennwert
$L_S$	Series inductance	Serieninduktivität
$\lambda$	Failure rate	Ausfallrate
$\lambda_0$	Constant failure rate during useful service life	Konstante Ausfallrate in der Nutzungsphase
$\lambda_{test}$	Failure rate, determined by tests	Experimentell ermittelte Ausfallrate
$P_{diss}$	Dissipated power	Abgegebene Verlustleistung
$P_{gen}$	Generated power	Erzeugte Verlustleistung
$Q$	Heat energy	Wärmeenergie
$\rho$	Density of water vapor in air	Dichte von Wasserdampf in Luft
$R$	Universal molar constant for gases	Allg. Molarkonstante für Gas
$R$	Ohmic resistance of discharge circuit	Ohmscher Widerstand des Entladekreises
$R_i$	Internal resistance	Innenwiderstand
$R_{ins}$	Insulation resistance	Isolationswiderstand
$R_P$	Parallel resistance	Parallelwiderstand
$R_S$	Series resistance	Serienwiderstand
$S$	severity (humidity test)	Schärfegrad (Feuchtetest)
$t$	Time	Zeit
$T$	Temperature	Temperatur
$\tau$	Time constant	Zeitkonstante
$\tan \delta$	Dissipation factor	Verlustfaktor
$\tan \delta_D$	Dielectric component of dissipation factor	Dielektrischer Anteil des Verlustfaktors
$\tan \delta_P$	Parallel component of dissipation factor	Parallelanteil des Verlustfaktors
$\tan \delta_S$	Series component of dissipation factor	Serienanteil des Verlustfaktors
$T_A$	Temperature of the air surrounding the component	Temperatur der Luft, die das Bauteil umgibt
$T_{max}$	Upper category temperature	Obere Kategorietemperatur
$T_{min}$	Lower category temperature	Untere Kategorietemperatur
$t_{OL}$	Operating life at operating temperature and voltage	Betriebszeit bei Betriebstemperatur und -spannung
$T_{op}$	Operating temperature, $T_A + \Delta T$	Betriebstemperatur, $T_A + \Delta T$
$T_R$	Rated temperature	Nenntemperatur
$T_{ref}$	Reference temperature	Referenztemperatur
$t_{SL}$	Reference service life	Referenz-Lebensdauer



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**Power Factor Correction**

Symbol	English	German
$V_{AC}$	AC voltage	Wechselspannung
$V_C$	Category voltage	Kategorie <span>spannung</span>
$V_{C,RMS}$	Category AC voltage	(Sinusförmige) Kategorie-Wechselspannung
$V_{CD}$	Corona-discharge onset voltage	Teilentlade-Einsatzspannung
$V_{ch}$	Charging voltage	Ladespannung
$V_{DC}$	DC voltage	Gleichspannung
$V_{FB}$	Fly-back capacitor voltage	Spannung (Flyback)
$V_i$	Input voltage	Eingangsspannung
$V_o$	Output voltage	Ausgangsspannung
$V_{op}$	Operating voltage	Betriebsspannung
$V_p$	Peak pulse voltage	Impuls-Spitzen <span>spannung</span>
$V_{pp}$	Peak-to-peak voltage Impedance	Spannungshub
$V_R$	Rated voltage	Nennspannung
$\hat{V}_R$	Amplitude of rated AC voltage	Amplitude der Nenn-Wechselspannung
$V_{RMS}$	(Sinusoidal) alternating voltage, root-mean-square value	(Sinusförmige) Wechselspannung
$V_{SC}$	S-correction voltage	Spannung bei Anwendung "S-correction"
$V_{sn}$	Snubber capacitor voltage	Spannung bei Anwendung "Beschaltung"
$Z$	Impedance	Scheinwiderstand
$e$	Lead spacing	Rastermaß

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