



# Film Capacitors

## Metallized Polypropylene Film Capacitors (MKP)

**Series/Type:** B32620, B32621

**Date:** June 2018

**High pulse (stacked)**
**Typical applications**

- Compact fluorescent lamps (CFL)
- SMPS

**Climatic**

- Max. operating temperature: 105 °C
- Climatic category (IEC 60068-1:2013): 55/100/56

**Construction**

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

**Features**

- Very high pulse strength
- Very good self-healing properties
- Smallest possible dimensions
- High contact reliability
- RoHS-compatible

**Terminals**

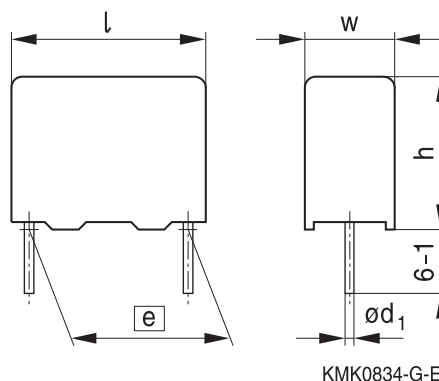
- Parallel wire leads, lead-free tinned
- Special lead lengths available on request

**Marking**

Manufacturer's logo,  
 rated capacitance (coded),  
 cap. tolerance (code letter), rated voltage,  
 date of manufacture (coded),  
 for lead spacing 7.5 mm: style (MKP),  
 for lead spacing 10 mm: lot number, series number (621)

**Delivery mode**

Bulk (untaped)  
 Taped (Ammo pack or reel)  
 For notes on taping, refer to chapter "Taping and packing".

**Dimensional drawing**


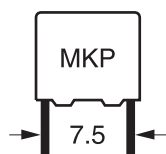
Dimensions in mm

Lead spacing	Lead diameter	Type
$e \pm 0.4$	$d_1 \pm 0.05$	
7.5	0.5	B32620
10.0	0.6 <sup>1)</sup>	B32621

 1) 0.5 mm for capacitor width  $w = 4$  mm


**Overview of available types**

Lead spacing	7.5 mm						10.0 mm				
Type	B32620						B32621				
Page	4						6				
$V_R$ (V DC)	160	250	400	630	1000	1000	160	250	400	630	1000
$V_{RMS}$ (V AC)	90	140	200	400	500	600	90	140	200	400	500
$C_R$ (nF)											
1.0											
1.5											
2.2											
3.3											
4.7											
6.8											
10											
15											
22											
33											
47											
68											
100											
150											
220											


**B32620**
**High pulse (stacked)**
**Ordering codes and packing units (lead spacing 7.5 mm)**

$V_R$	$V_{RMS}$ $f \leq 1$ kHz	$C_R$	Max. dimensions $w \times h \times l$ mm	Ordering code (composition see below)	Ammo pack pcs./MOQ	Reel pcs./MOQ	Untaped pcs./MOQ
V DC	V AC	nF					
160	90	33	4.0 × 8.5 × 10.0	B32620A5333+***	8000	7200	6000
		47	4.0 × 8.5 × 10.0	B32620A5473+***	8000	7200	6000
		68	5.0 × 10.5 × 10.0	B32620A5683+***	6400	5600	4000
		100	5.0 × 10.5 × 10.0	B32620A5104+***	6400	5600	4000
		150	6.0 × 12.0 × 10.3	B32620A5154+***	5200	4400	3000
250	140	22	4.0 × 8.5 × 10.0	B32620A3223+***	8000	7200	6000
		33	4.0 × 8.5 × 10.0	B32620A3333+***	8000	7200	6000
		47	5.0 × 10.5 × 10.0	B32620A3473+***	6400	5600	4000
		68	5.0 × 10.5 × 10.0	B32620A3683+***	6400	5600	4000
		100	6.0 × 12.0 × 10.3	B32620A3104+***	5200	4400	3000
400	200	6.8	4.0 × 8.5 × 10.0	B32620A4682+***	8000	7200	6000
		10	4.0 × 8.5 × 10.0	B32620A4103+***	8000	7200	6000
		15	5.0 × 10.5 × 10.0	B32620A4153+***	6400	5600	4000
		22	5.0 × 10.5 × 10.0	B32620A4223+***	6400	5600	4000
		33	6.0 × 12.0 × 10.3	B32620A4333+***	5200	4400	3000
630	400	1.5	4.0 × 8.5 × 10.0	B32620A6152+***	8000	7200	6000
		2.2	4.0 × 8.5 × 10.0	B32620A6222+***	8000	7200	6000
		3.3	4.0 × 8.5 × 10.0	B32620A6332+***	8000	7200	6000
		4.7	4.0 × 8.5 × 10.0	B32620A6472+***	8000	7200	6000
		6.8	5.0 × 10.5 × 10.0	B32620A6682+***	6400	5600	4000
		10	5.0 × 10.5 × 10.0	B32620A6103+***	6400	5600	4000
		15	6.0 × 12.0 × 10.3	B32620A6153+***	5200	4400	3000

MOQ = Minimum Order Quantity, consisting of 4 packing units.  
Further E series and intermediate capacitance values on request.

**Composition of ordering code**

+ = Capacitance tolerance code:

K = ±10%

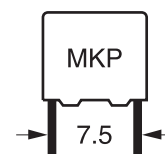
J = ±5%

\*\*\* = Packaging code:

289 = Straight terminals, Ammo pack

189 = Straight terminals, Reel

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


**Ordering codes and packing units (lead spacing 7.5 mm)**

$V_R$	$V_{RMS}$ $f \leq 1$ kHz	$C_R$	Max. dimensions $w \times h \times l$ mm	Ordering code (composition see below)	Ammo pack pcs./MOQ	Reel pcs./MOQ	Untaped pcs./MOQ
V DC	V AC	nF					
1000	500	1.5	4.0 × 8.5 × 10.0	B32620A0152+***	8000	7200	6000
		2.2	4.0 × 8.5 × 10.0	B32620A0222+***	8000	7200	6000
		3.3	5.0 × 10.5 × 10.0	B32620A0332+***	6400	5600	4000
		4.7	5.0 × 10.5 × 10.0	B32620A0472+***	6400	5600	4000
		6.8	6.0 × 12.0 × 10.3	B32620A0682+***	5200	4400	3000
1000	600	1.0	5.0 × 10.5 × 10.0	B32620J0102+***	6400	5600	4000
		1.5	5.0 × 10.5 × 10.0	B32620J0152+***	6400	5600	4000
		2.2	5.0 × 10.5 × 10.0	B32620J0222+***	6400	5600	4000
		3.3	5.0 × 10.5 × 10.0	B32620J0332+***	6400	5600	4000
		4.7	6.0 × 12.0 × 10.3	B32620J0472+***	5200	4400	3000

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

Further E series and intermediate capacitance values on request.

**Composition of ordering code**

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K = ±10%

J = ±5%

\*\*\* = Packaging code:

289 = Straight terminals, Ammo pack

189 = Straight terminals, Reel

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


**B32621**
**High pulse (stacked)**
**Ordering codes and packing units (lead spacing 10 mm)**

$V_R$	$V_{RMS}$ $f \leq 1$ kHz	$C_R$	Max. dimensions $w \times h \times l$ mm	Ordering code (composition see below)	Ammo pack pcs./MOQ	Reel pcs./MOQ	Untaped pcs./MOQ
V DC	V AC	nF					
160	90	47	4.0 × 7.0 × 13.0	B32621A5473+***	4000	6800	4000
		68	4.0 × 9.0 × 13.0	B32621A5683+***	4000	6800	4000
		100	5.0 × 11.0 × 13.0	B32621A5104+***	3320	5200	4000
		150	5.0 × 11.0 × 13.0	B32621A5154+***	3320	5200	4000
		220	6.0 × 12.0 × 13.0	B32621A5224+***	2720	4400	4000
250	140	2.2	4.0 × 7.0 × 13.0	B32621A3222+***	4000	6800	4000
		3.3	4.0 × 9.0 × 13.0	B32621A3332+***	4000	6800	4000
		4.7	4.0 × 9.0 × 13.0	B32621A3472+***	4000	6800	4000
		6.8	4.0 × 9.0 × 13.0	B32621A3682+***	4000	6800	4000
		10	4.0 × 9.0 × 13.0	B32621A3103+***	4000	6800	4000
		15	4.0 × 9.0 × 13.0	B32621A3153+***	4000	6800	4000
		22	4.0 × 9.0 × 13.0	B32621A3223+***	4000	6800	4000
		33	4.0 × 9.0 × 13.0	B32621A3333+***	4000	6800	4000
		47	4.0 × 9.0 × 13.0	B32621A3473+***	4000	6800	4000
		68	5.0 × 11.0 × 13.0	B32621A3683+***	3320	5200	4000
100	6.0 × 12.0 × 13.0	B32621A3104+***	2720	4400	4000		
400	200	10	4.0 × 9.0 × 13.0	B32621A4103+***	4000	6800	4000
		15	4.0 × 9.0 × 13.0	B32621A4153+***	4000	6800	4000
		22	5.0 × 11.0 × 13.0	B32621A4223+***	3320	5200	4000
		33	5.0 × 11.0 × 13.0	B32621A4333+***	3320	5200	4000
		47	6.0 × 12.0 × 13.0	B32621A4473+***	2720	4400	4000

MOQ = Minimum Order Quantity, consisting of 4 packing units.  
Intermediate capacitances values on request.

**Composition of ordering code**

+ = Capacitance tolerance code:

K = ±10%

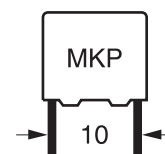
J = ±5%

\*\*\* = Packaging code:

289 = Straight terminals, Ammo pack

189 = Straight terminals, Reel

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


**Ordering codes and packing units (lead spacing 10 mm)**

$V_R$	$V_{RMS}$ $f \leq 1$ kHz	$C_R$	Max. dimensions $w \times h \times l$ mm	Ordering code (composition see below)	Ammo pack pcs./MOQ	Reel pcs./MOQ	Untaped pcs./MOQ
V DC	V AC	nF					
630	400	2.2	4.0 × 7.0 × 13.0	B32621A6222+***	4000	6800	4000
		3.3	4.0 × 9.0 × 13.0	B32621A6332+***	4000	6800	4000
		4.7	4.0 × 9.0 × 13.0	B32621A6472+***	4000	6800	4000
		6.8	4.0 × 9.0 × 13.0	B32621A6682+***	4000	6800	4000
		10	4.0 × 9.0 × 13.0	B32621A6103+***	4000	6800	4000
		15	5.0 × 11.0 × 13.0	B32621A6153+***	3320	5200	4000
		22	6.0 × 12.0 × 13.0	B32621A6223+***	2720	4400	4000
		33	6.0 × 12.0 × 13.0	B32621A6333+***	2720	4400	4000
1000	500	2.2	4.0 × 7.0 × 13.0	B32621A0222+***	4000	6800	4000
		3.3	4.0 × 9.0 × 13.0	B32621A0332+***	4000	6800	4000
		4.7	4.0 × 9.0 × 13.0	B32621A0472+***	4000	6800	4000
		6.8	5.0 × 11.0 × 13.0	B32621A0682+***	3320	5200	4000
		10	6.0 × 12.0 × 13.0	B32621A0103+***	2720	4400	4000

MOQ = Minimum Order Quantity, consisting of 4 packing units.  
Intermediate capacitances values on request.

**Composition of ordering code**

+ = Capacitance tolerance code:

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J = ±5%

\*\*\* = Packaging code:

289 = Straight terminals, Ammo pack

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**B32620, B32621**

**High pulse (stacked)**

**Technical data**

Operating temperature range	Max. operating temperature $T_{op,max}$	+105 °C	
	Upper category temperature $T_{max}$	+100 °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	$C_R \leq 0.1 \mu F$	$0.1 \mu F < C_R \leq 0.22 \mu F$
	1 kHz	—	1.0
	10 kHz	—	1.5
	100 kHz	4.0	—
Insulation resistance $R_{ins}$ at 20 °C, rel. humidity $\leq 65\%$ (minimum as-delivered values)	100 G $\Omega$		
DC test voltage	$1.6 \cdot V_R, 2 s$		
Category voltage $V_C$ (continuous operation with $V_{DC}$ or $V_{AC}$ at $f \leq 1 kHz$ )	$T_{op}$ (°C)	DC voltage derating	AC voltage derating
	$T_{op} \leq 85$	$V_C = V_R$	$V_{C,RMS} = V_{RMS}$
	$85 < T_{op} \leq 100$	$V_C = V_R \cdot (165 - T_{op})/80$	$V_{C,RMS} = V_{RMS} \cdot (165 - T_{op})/80$
Operating voltage $V_{op}$ for short operating periods ( $V_{DC}$ or $V_{AC}$ at $f \leq 1 kHz$ )	$T_{op}$ (°C)	DC voltage (max. hrs.)	AC voltage (max. hrs.)
	$T_{op} \leq 85$	$V_{op} = 1.25 \cdot V_C$ (2000 h)	$V_{op} = 1.0 \cdot V_{C,RMS}$ (2000 h)
	$85 < T_{op} \leq 100$	$V_{op} = 1.25 \cdot V_C$ (1000 h)	$V_{op} = 1.0 \cdot V_{C,RMS}$ (1000 h)
Damp heat test	56 days/40 °C/93% relative humidity		
Limit values after damp heat test	Capacitance change $ \Delta C/C $	$\leq 3\%$	
	Dissipation factor change $\Delta \tan \delta$	$\leq 0.5 \cdot 10^{-3}$ (at 1 kHz)	
		$\leq 1.0 \cdot 10^{-3}$ (at 10 kHz)	
	Insulation resistance $R_{ins}$	$\geq 50\%$ of minimum as-delivered values	
Reliability:			
Failure rate $\lambda$	1 fit ( $\leq 1 \cdot 10^{-9}/h$ ) at $0.5 \cdot V_R, 40 °C$		
Service life $t_{SL}$	200 000 h at $1.0 \cdot V_R, 85 °C$		
	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 $	$> \pm 10\%$	
	Dissipation factor $\tan \delta$	$> 4 \cdot$ upper limit value	
	Insulation resistance $R_{ins}$	$< 1500 M\Omega$	





### Pulse handling capability

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

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

*Note:*

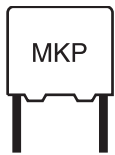
*The values of dV/dt and k<sub>0</sub> provided below must not be exceeded in order to avoid damaging the capacitor.*

### dV/dt values

Lead spacing		7.5 mm	10 mm
V <sub>R</sub> V DC	V <sub>RMS</sub> V AC	dV/dt in V/ $\mu$ s	
160	90	750	600
250	140	1 200	900
400	200	1 500	1 050
630	400	2 700	1 800
1 000	500	3 200	2 400
1 000	600	4 000	—

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

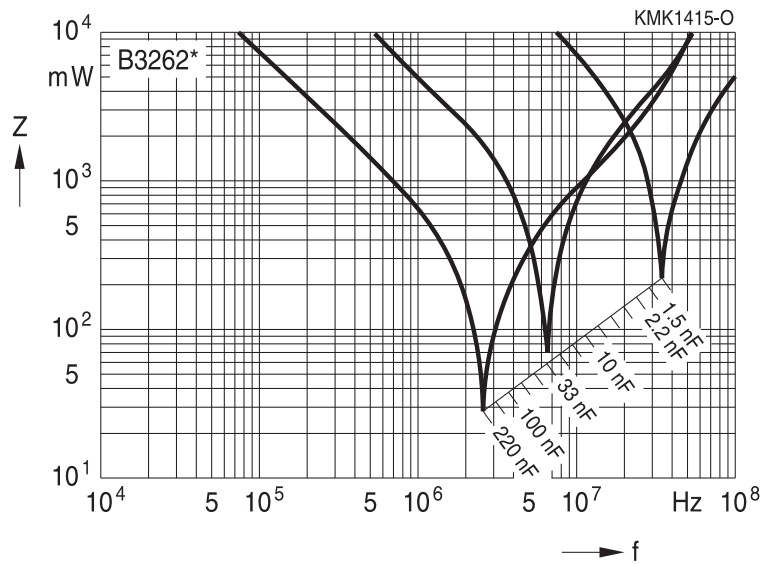
Lead spacing		7.5 mm	10 mm
V <sub>R</sub> V DC	V <sub>RMS</sub> V AC	k <sub>0</sub> in V <sup>2</sup> / $\mu$ s	
160	90	240 000	190 000
250	140	600 000	450 000
400	200	1 200 000	840 000
630	400	3 400 000	2 250 000
1 000	500	6 400 000	4 800 000
1 000	600	8 000 000	—



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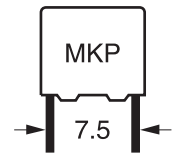
High pulse (stacked)

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



B32620

High pulse (stacked)

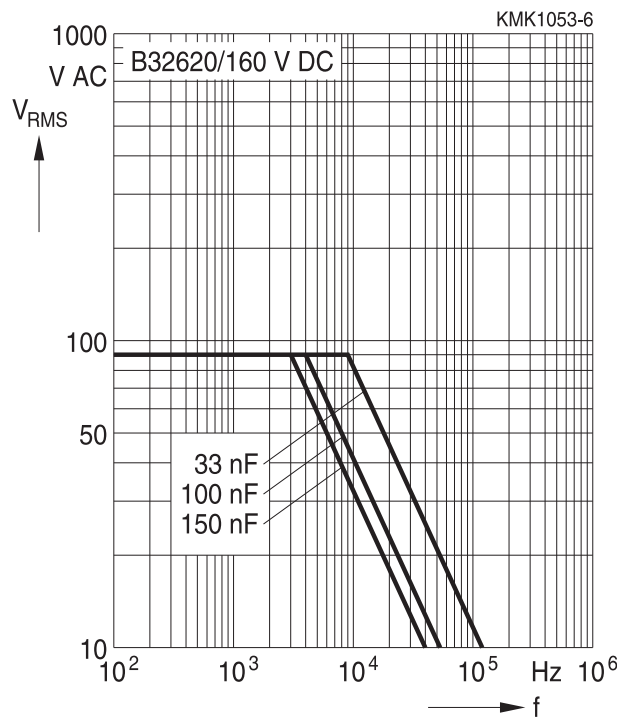


**Permissible AC voltage  $V_{RMS}$  versus frequency  $f$  (for sinusoidal waveforms,  $T_A \leq 90^\circ C$ )**

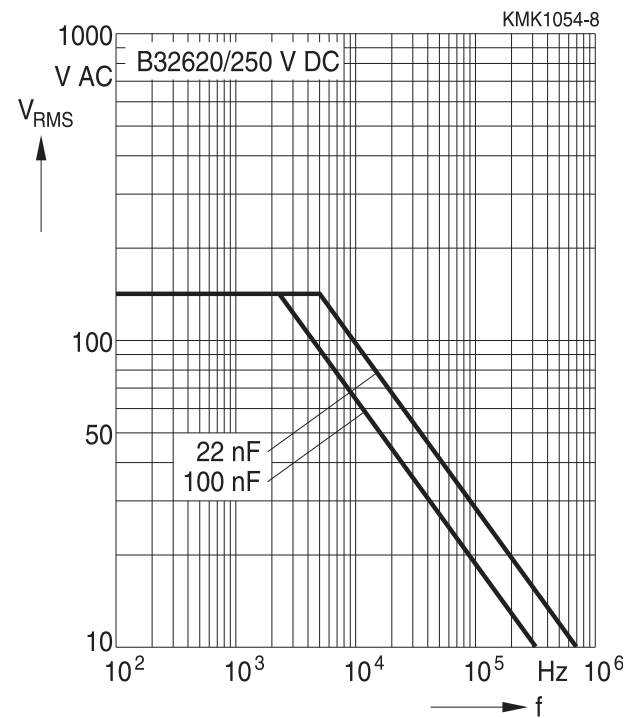
For  $T_A > 90^\circ C$ , please refer to "General technical information", section 3.2.3.

**Lead spacing 7.5 mm**

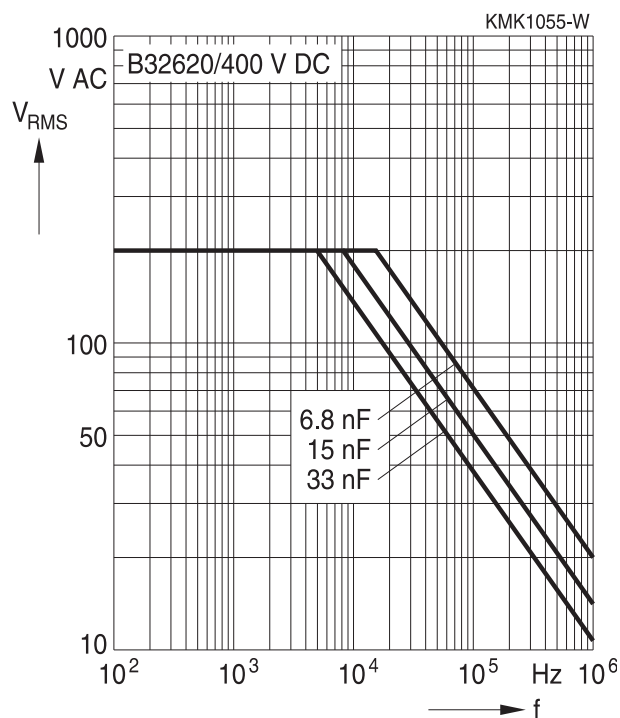
160 V DC/90 V AC



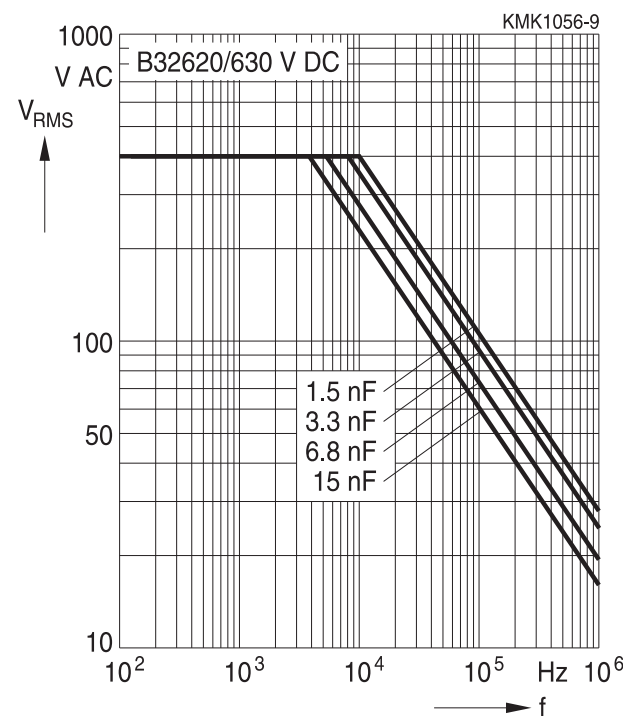
250 V DC/140 V AC

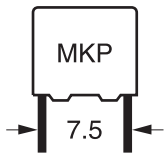


400 V DC/200 V AC



630 V DC/400 V AC





**B32620**

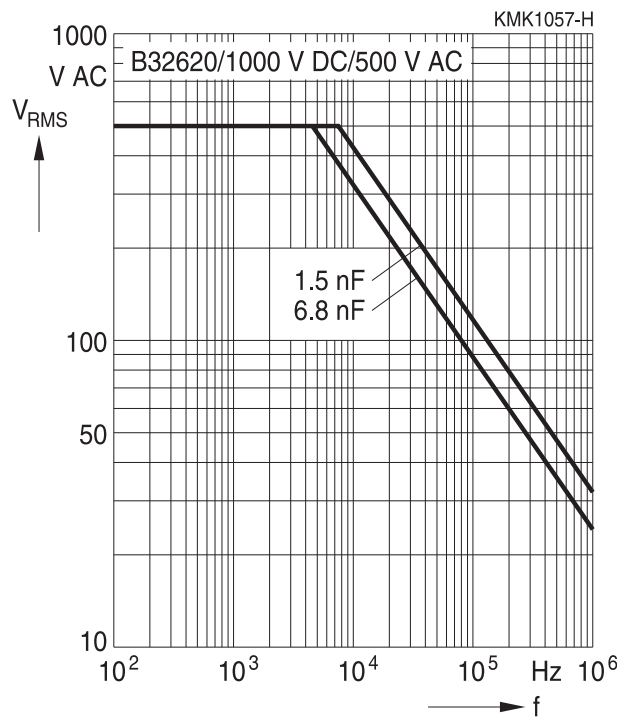
**High pulse (stacked)**

**Permissible AC voltage  $V_{RMS}$  versus frequency  $f$  (for sinusoidal waveforms,  $T_A \leq 90^\circ C$ )**

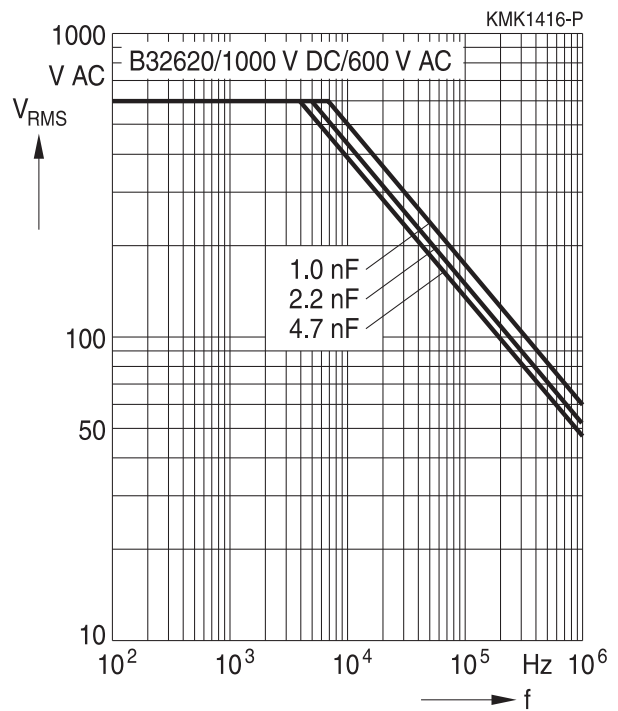
For  $T_A > 90^\circ C$ , please refer to "General technical information", section 3.2.3.

**Lead spacing 7.5 mm**

1000 V DC/500 V AC

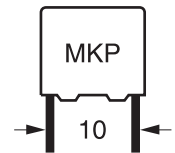


1000 V DC/600 V AC



**B32621**

**High pulse (stacked)**

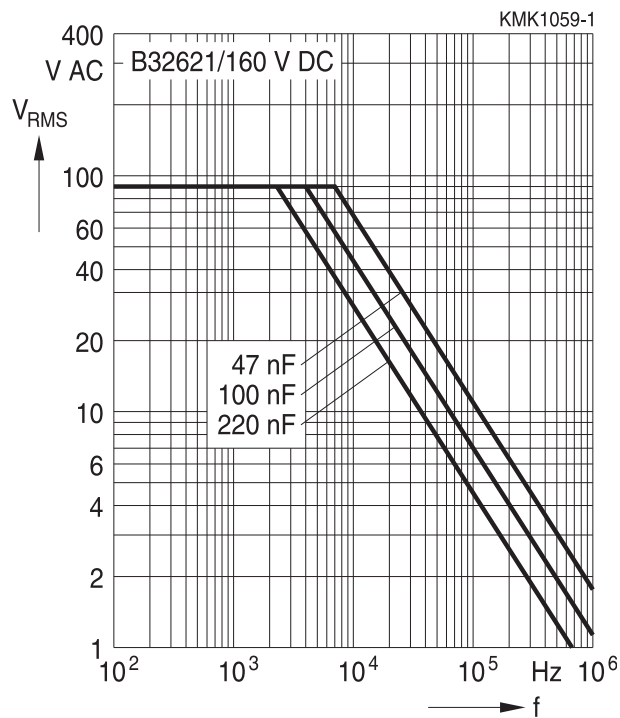


**Permissible AC voltage  $V_{RMS}$  versus frequency  $f$  (for sinusoidal waveforms,  $T_A \leq 90^\circ C$ )**

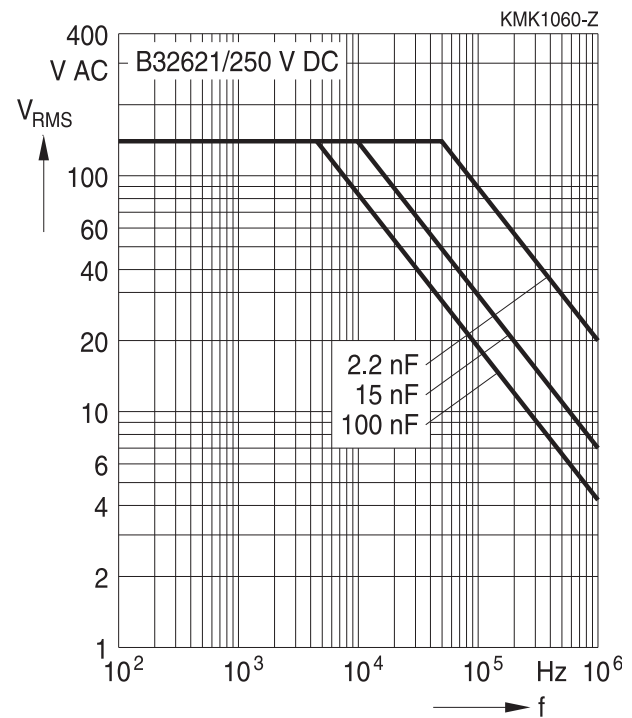
For  $T_A > 90^\circ C$ , please refer to "General technical information", section 3.2.3.

**Lead spacing 10 mm**

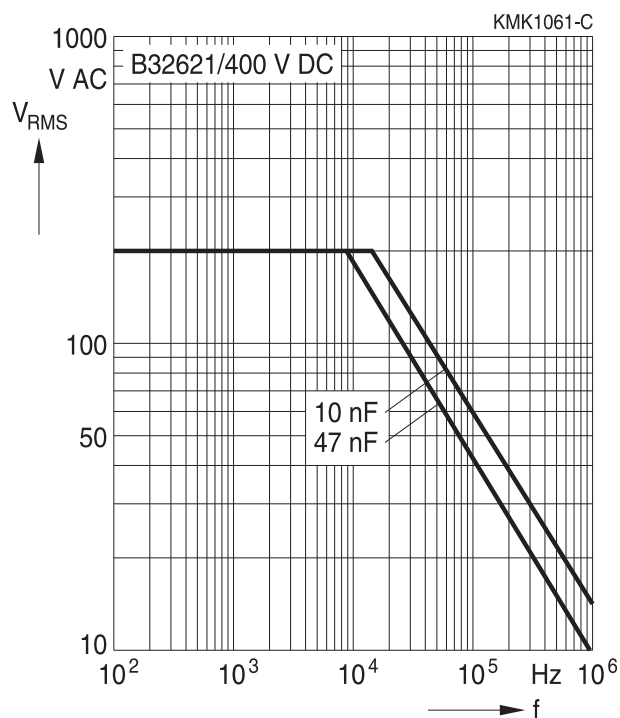
160 V DC/90 V AC



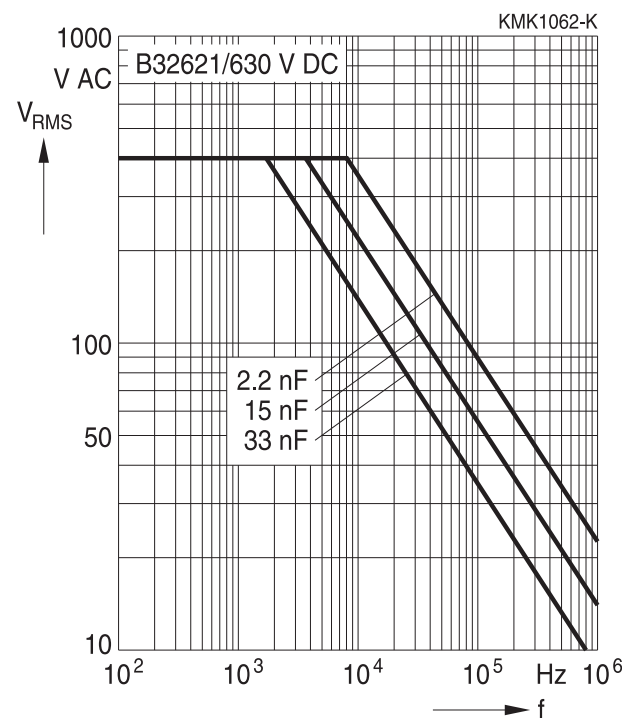
250 V DC/140 V AC



400 V DC/200 V AC



630 V DC/400 V AC





**B32621**

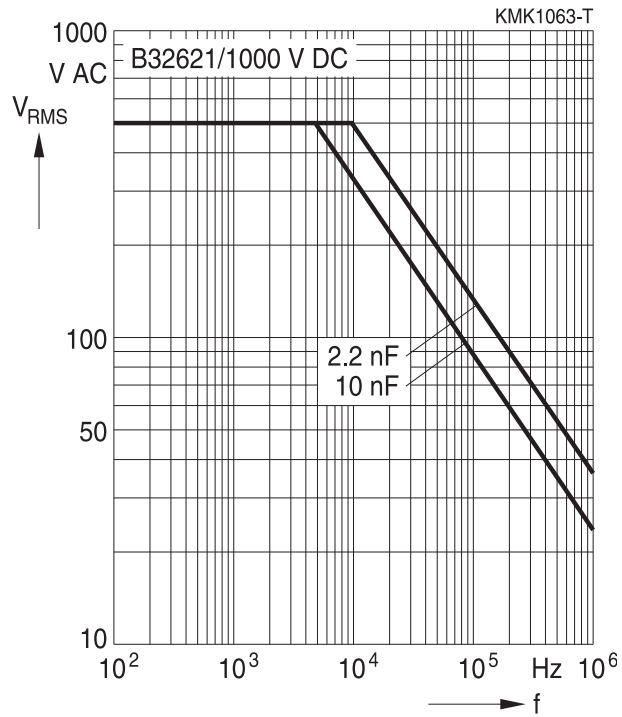
**High pulse (stacked)**

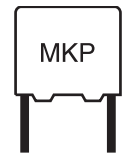
**Permissible AC voltage  $V_{RMS}$  versus frequency  $f$  (for sinusoidal waveforms,  $T_A \leq 90^\circ\text{C}$ )**

For  $T_A > 90^\circ\text{C}$ , please refer to "General technical information", section 3.2.3.

**Lead spacing 10 mm**

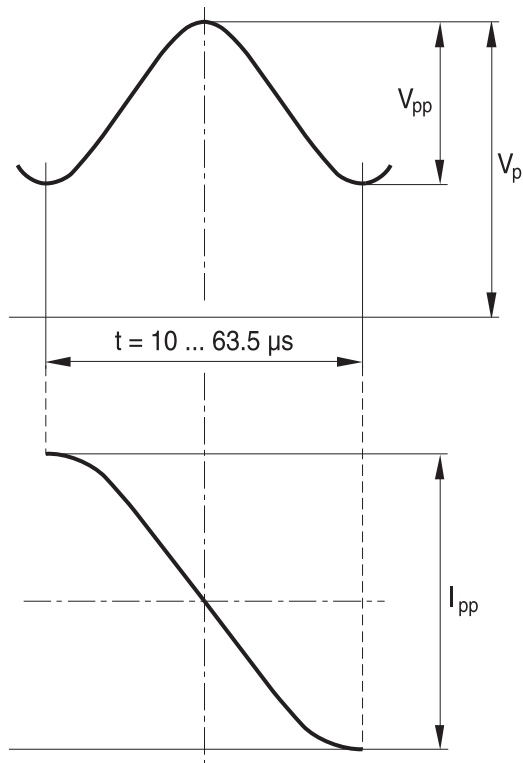
1000 V DC/500 V AC



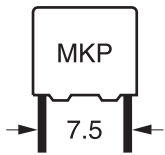


**Sinus-wave application, lighting**

**Permissible voltage and current / waveform**



KMK0721-D



**B32620**

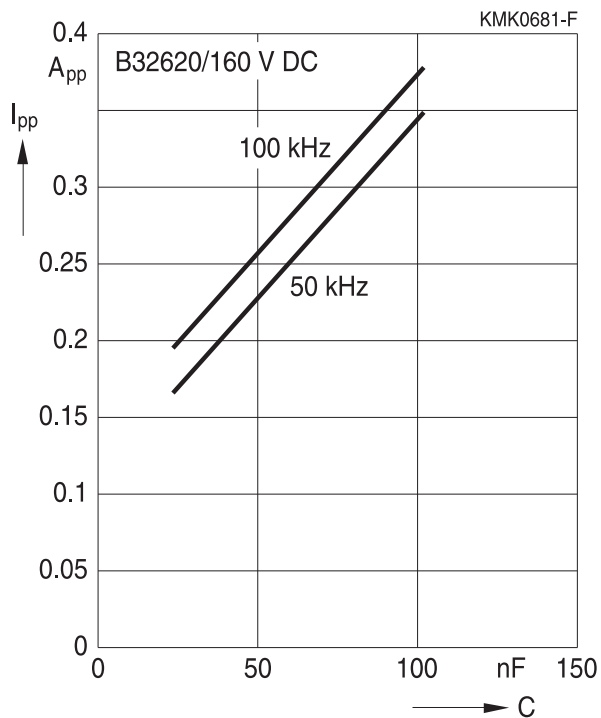
**High pulse (stacked)**

**Sinus-wave application, lighting**

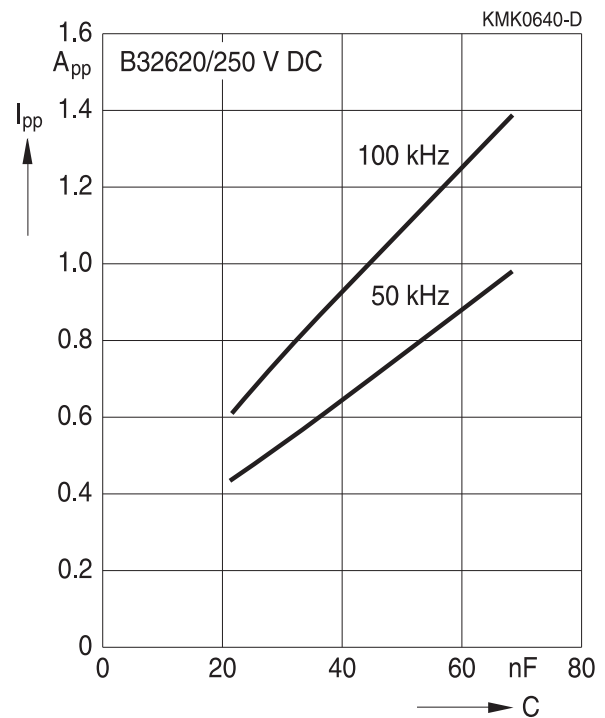
**Permissible current  $I_{pp}$  versus rated capacitance  $C_R$**

**Lead spacing 7.5 mm**

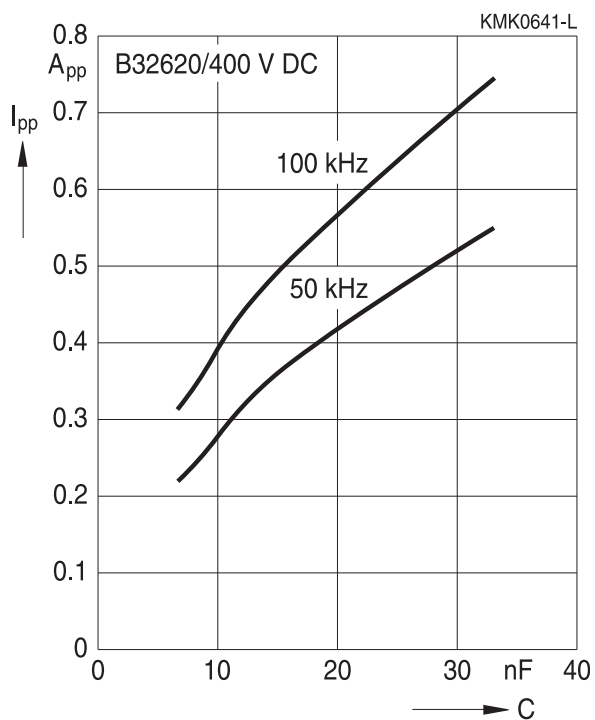
**160 V DC/90 V AC**



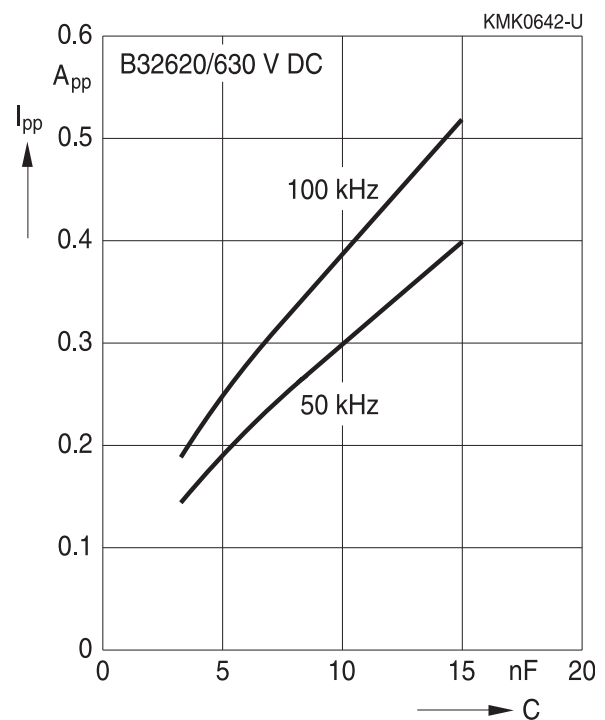
**250 V DC/140 V AC**



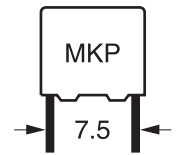
**400 V DC/200 V AC**



**630 V DC/400 V AC**





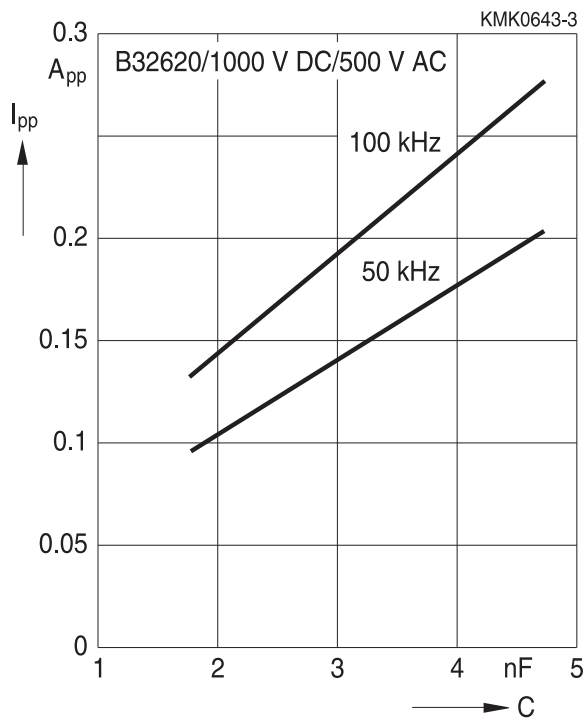


**Sinus-wave application, lighting**

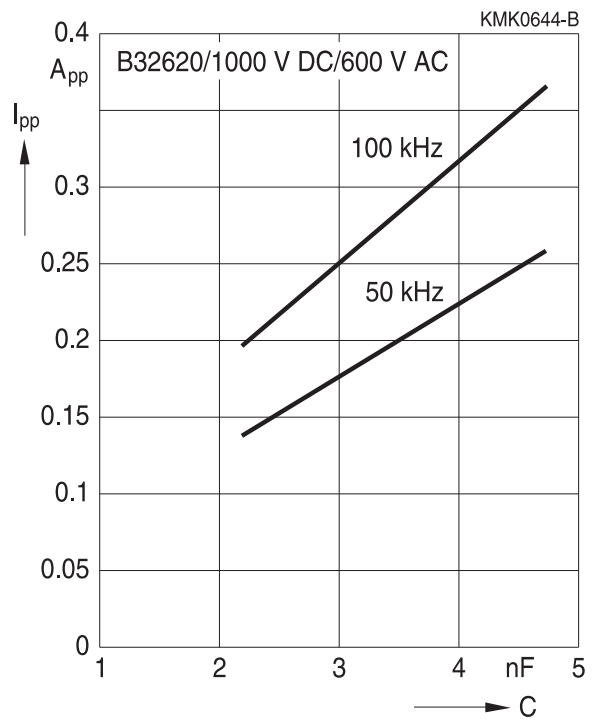
**Permissible current  $I_{pp}$  versus rated capacitance  $C_R$**

**Lead spacing 7.5 mm**

1000 V DC/500 V AC



1000 V DC/600 V AC





**B32621**

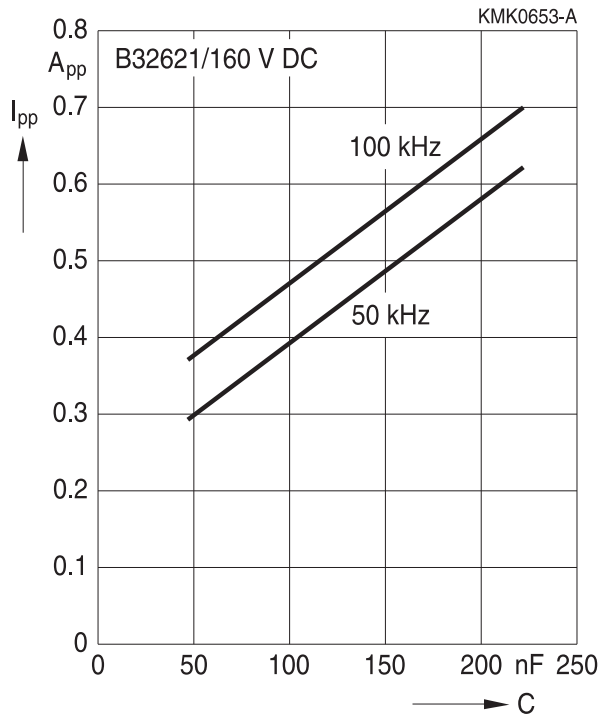
**High pulse (stacked)**

**Sinus-wave application, lighting**

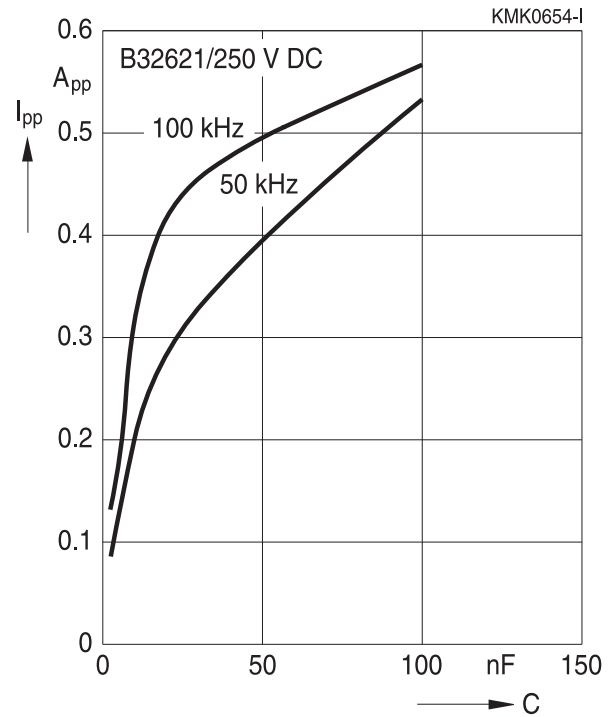
**Permissible current  $I_{pp}$  versus rated capacitance  $C_R$**

**Lead spacing 10 mm**

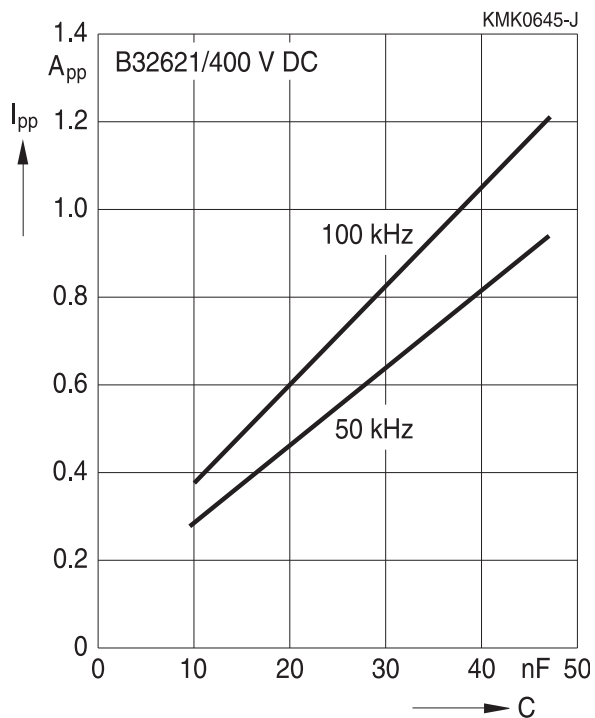
**160 V DC/90 V AC**



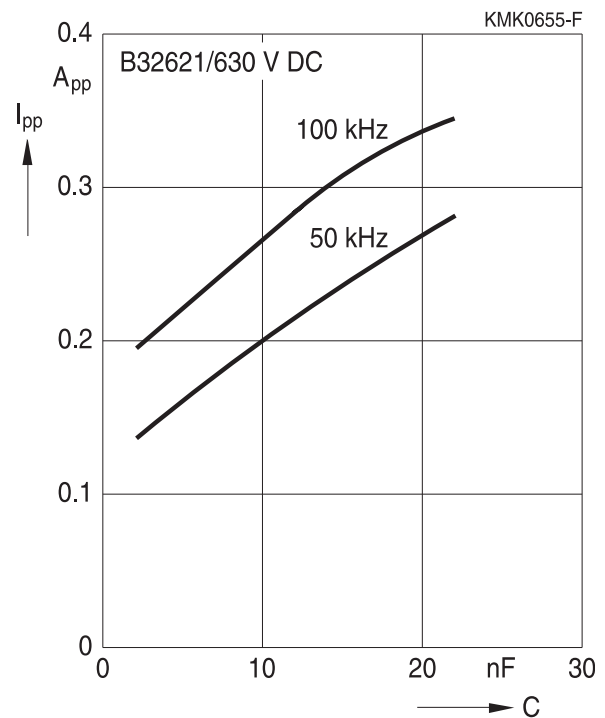
**250 V DC/140 V AC**



**400 V DC/200 V AC**



**630 V DC/400 V AC**



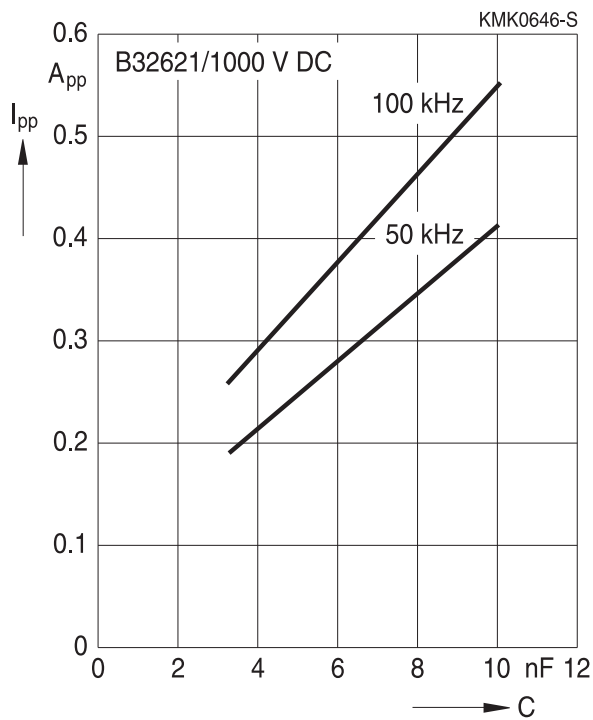


**Sinus-wave application, lighting**

**Permissible current  $I_{pp}$  versus rated capacitance  $C_R$**

**Lead spacing 10 mm**

1000 V DC/500 V AC





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**High pulse (stacked)**

## Mounting guidelines

### 1 Soldering

#### 1.1 Solderability of leads

The solderability of terminal leads is tested to IEC 60068-2-20:2008, test Ta, method 1.

Before a solderability test is carried out, terminals are subjected to accelerated ageing (to IEC 60068-2-2:2007, 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 60068-2-20:2008, 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)		5 ±1 s
MKT (lead spacing ≤7.5 mm) MKT uncoated (lead spacing ≤10 mm) insulated (B32559)		<4 s recommended soldering profile for MKT uncoated (lead spacing ≤ 10 mm) and insulated (B32559)

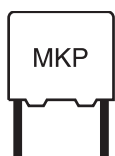


Immersion depth	2.0 +0/−0.5 mm from capacitor body or seating plane
Shield	Heat-absorbing board, (1.5 ±0.5) mm thick, between capacitor body and liquid solder
Evaluation criteria:	
Visual inspection	No visible damage
$\Delta C/C_0$	2% for MKT/MKP/MFP 5% for EMI suppression capacitors
$\tan \delta$	As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

### 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



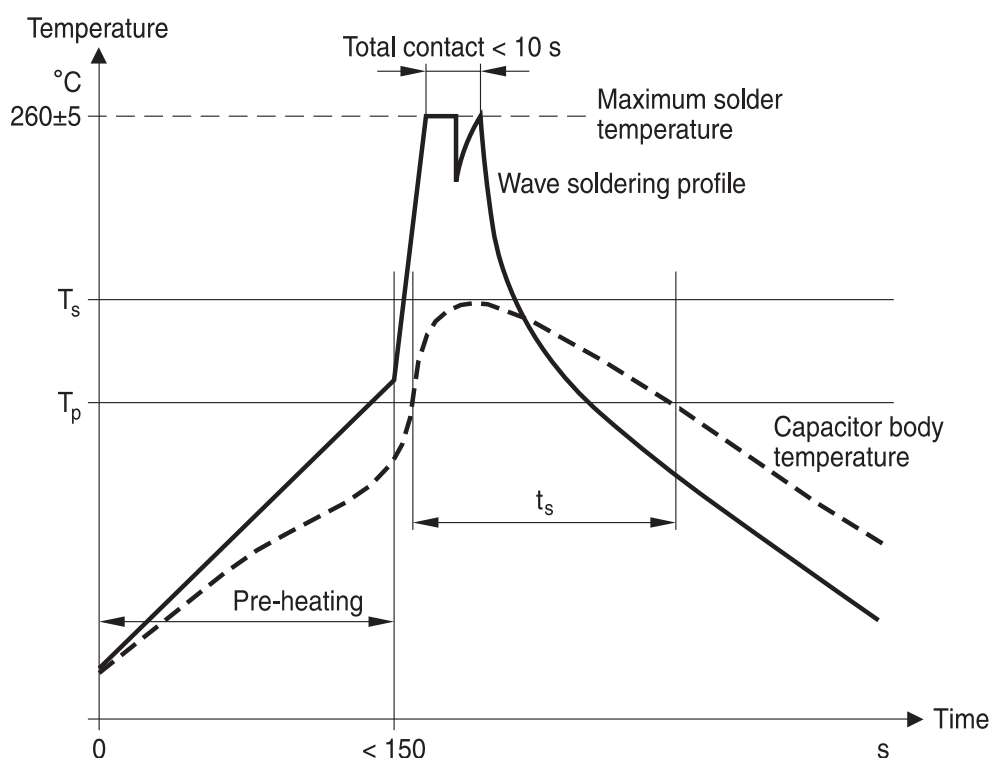
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High pulse (stacked)

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.

### Recommendations

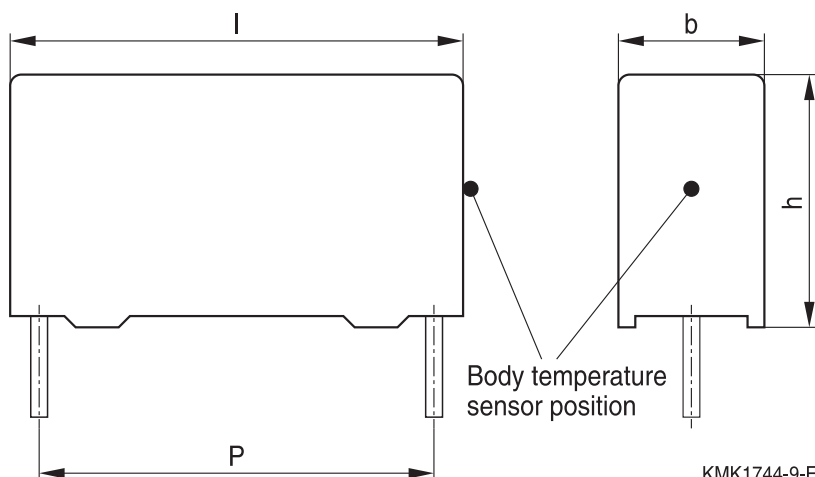
As a reference, the recommended wave soldering profile for our film capacitors is as follows:



$T_s$ : 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 our Film Capacitors Data Book in case more details are needed.



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**High pulse (stacked)**

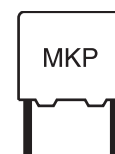
### Cautions and warnings

- 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 TDK Electronics.
- 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. TDK Electronics 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"
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"

### Display of ordering codes for TDK Electronics products

The ordering code for one and the same product can be represented differently in data sheets, data books, other publications, on the company website, or in order-related documents such as shipping notes, order confirmations and product labels. The varying representations of the ordering codes are due to different processes employed and do not affect the specifications of the respective products.

Detailed information can be found on the Internet under [www.tdk-electronics.tdk.com/orderingcodes](http://www.tdk-electronics.tdk.com/orderingcodes).

### Correlation of data sheet values and modelling tool outputs

Data sheet values and results of design tools may deviate as they have not been derived in the same context.

While data sheets show individual parameter statements without considering a possible dependency to other parameters. Tools model a complete given scenario as input and processed inside the tool.

Furthermore as we constantly strive to improve our models, the results of tools can change over time and be a non-binding indication only.



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## 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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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

## 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, we are 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 a 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 lifesaving 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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## Important notes

7. **Our manufacturing sites serving the automotive business apply the IATF 16949 standard.** The IATF certifications confirm our compliance with requirements regarding the quality management system in the automotive industry. Referring to customer requirements and customer specific requirements (“CSR”) TDK always has and will continue to have the policy of respecting individual agreements. Even if IATF 16949 may appear to support the acceptance of unilateral requirements, we hereby like to emphasize that **only requirements mutually agreed upon can and will be implemented in our Quality Management System.** For clarification purposes we like to point out that obligations from IATF 16949 shall only become legally binding if individually agreed upon.
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