



## **Film Capacitors**

### **Metallized Polypropylene Film Capacitors (MFP)**

**Series/Type:** B32686A

**Date:** December 2012

**Very high pulse (wound)**
**Typical applications**

- Smoothing
- Snubbing
- High-frequency AC loads

**Climatic**

- Max. operating temperature: 110 °C
- Climatic category (IEC 60068-1): 55/100/56

**Construction**

- Dielectric: polypropylene (PP)
- Film metallized on one side and metal foils internally connected in series
- Plastic case (UL 94 V-0)
- Epoxy resin sealing (UL 94 V-0)

**Features**

- Very high pulse strength
- Highest possible contact reliability
- Self-healing properties
- RoHS-compatible

**Terminals**

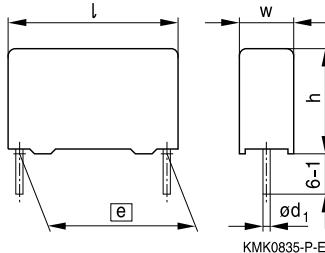
- Parallel wire leads, lead-free tinned
- Special lead lengths available on request

**Marking**

Manufacturer's logo,  
series number,  
style (MFP),  
rated capacitance,  
capacitance tolerance (code letter),  
rated DC voltage,  
date of manufacture (coded)

**Delivery mode**

Bulk (untaped)

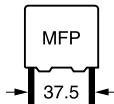
**Dimensional drawing**


Dimensions in mm

Lead spacing $e \pm 0.4$	Lead diameter $d_1$	Type
37.5	1.0	B32686A


**Overview of available types**

Lead spacing	37.5 mm			
Type	B32686A			
$V_R$ (V DC)	1000	1250	1600	2000
$V_{RMS}$ (V AC)	400	450	450	500
$C_R$ (nF)				
22				
33				
47				
68				
100				
150				
220				
330				
470				


**B32686A**
**Very high pulse (wound)**
**Ordering codes and packing units (lead spacing 37.5 mm)**

$V_R$ V DC	$V_{RMS}$ $f \leq 1$ kHz V AC	$C_R$ nF	Max. dimensions $w \times h \times l$ mm	Ordering code (composition see below)	Untaped pcs./MOQ
1000	400	68	12.0 × 22.5 × 42.0	B32686A0683+000	288
		100	12.0 × 22.5 × 42.0	B32686A0104+000	288
		150	14.0 × 25.0 × 42.0	B32686A0154+000	224
		220	16.0 × 28.5 × 42.0	B32686A0224+000	192
		330	20.0 × 39.5 × 42.0	B32686A0334+000	128
		470	20.0 × 39.5 × 42.0	B32686A0474+000	128
1250	450	68	12.0 × 22.5 × 42.0	B32686A7683+000	288
		100	14.0 × 25.0 × 42.0	B32686A7104+000	224
		150	16.0 × 28.5 × 42.0	B32686A7154+000	192
		220	18.0 × 32.5 × 42.0	B32686A7224+000	192
		330	20.0 × 39.5 × 42.0	B32686A7334+000	128
1600	450	47	12.0 × 22.5 × 42.0	B32686A1473+000	288
		68	14.0 × 25.0 × 42.0	B32686A1683+000	224
		100	18.0 × 32.5 × 42.0	B32686A1104+000	192
		150	20.0 × 39.5 × 42.0	B32686A1154+000	128
2000	500	22	12.0 × 22.5 × 42.0	B32686A2223+000	288
		33	14.0 × 25.0 × 42.0	B32686A2333+000	224
		47	16.0 × 28.5 × 42.0	B32686A2473+000	192
		68	18.0 × 32.5 × 42.0	B32686A2683+000	192
		100	20.0 × 39.5 × 42.0	B32686A2104+000	128

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

Further E series and intermediate capacitance values on request.

**Composition of ordering code**

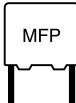
+ = Capacitance tolerance code:

 K =  $\pm 10\%$ 

 J =  $\pm 5\%$

**Technical data**

Operating temperature range	Max. operating temperature $T_{op,max}$	+110 °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 $C_R \leq 0.1 \mu\text{F}$	$C_R > 0.1 \mu\text{F}$
	1 kHz	—
	10 kHz	0.4
	100 kHz	1.0
Insulation resistance $R_{ins}$ or time constant $\tau = C_R \cdot R_{ins}$ at 20 °C, rel. humidity ≤ 65% (minimum as-delivered values)	$C_R \leq 0.33 \mu\text{F}$	$C_R > 0.33 \mu\text{F}$
	100 GΩ	30 000 s
DC test voltage	2.0 · $V_R$ , 2 s	
Category voltage $V_C$ (continuous operation with $V_{DC}$ or $V_{AC}$ at $f \leq 1 \text{ kHz}$ )	$T_A$ (°C)	DC voltage derating
	$T_A \leq 85$	$V_C = V_R$
Operating voltage $V_{op}$ for short operating periods $V_{DC}$ or $V_{AC}$ at $f \leq 1 \text{ kHz}$ )	$T_A \leq 100$	$V_C = V_R \cdot (165 - T_A)/80$
	$T_A \leq 85$	$V_{op} = 1.25 \cdot V_C$ (2000 h)
	$85 < T_A \leq 100$	$V_{op} = 1.25 \cdot V_C$ (1000 h)
		$V_{op} = 1.0 \cdot V_{C,RMS}$ (2000 h)
Damp heat test Limit values after damp heat test	56 days/40 °C/93% relative humidity	
	Capacitance change $ \Delta C/C $	
	Dissipation factor change $\Delta \tan \delta$	
	Insulation resistance $R_{ins}$ or time constant $\tau = C_R \cdot R_{ins}$	
Reliability: Failure rate $\lambda$ Service life $t_{SL}$	≤ 2%	
	≤ 1.0 · $10^{-3}$ (at 10 kHz)	
	≥ 50% of minimum as-delivered values	
Failure criteria: Total failure Failure due to variation of parameters	1 fit ( $\leq 1 \cdot 10^{-9}/\text{h}$ ) at $0.5 \cdot V_R$ , 40 °C	
	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".	
	Short circuit or open circuit	
	Capacitance change $ \Delta C/C $	> 10%
	Dissipation factor $\tan \delta$	4 · upper limit value
	Insulation resistance $R_{ins}$	< 1500 MΩ ( $C_R \leq 0.33 \mu\text{F}$ )
	or time constant $\tau = C_R \cdot R_{ins}$	< 500 s ( $C_R > 0.33 \mu\text{F}$ )


**B32686A**
**Very high pulse (wound)**

### Pulse handling capability

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

" $k_0$ " represents the maximum permissible pulse characteristic of the waveform applied to the capacitor, expressed in  $V^2/\mu s$ .

*Note:*

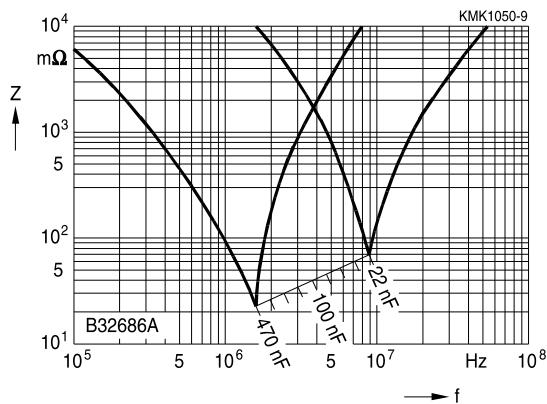
*The values of  $dV/dt$  and  $k_0$  provided below must not be exceeded in order to avoid damaging the capacitor.*

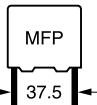
### $dV/dt$ and $k_0$ values

Lead spacing		37.5 mm	
$V_R$ (V DC)	$V_{RMS}$ (V AC)	$dV/dt$ in $V/\mu s$	$k_0$ in $V^2/\mu s$
1000	400	2 000	4 000 000
1250	450	2 800	7 000 000
1600	450	3 500	11 000 000
2000	500	4 500	18 000 000

### Impedance $Z$ versus frequency $f$

(typical values)

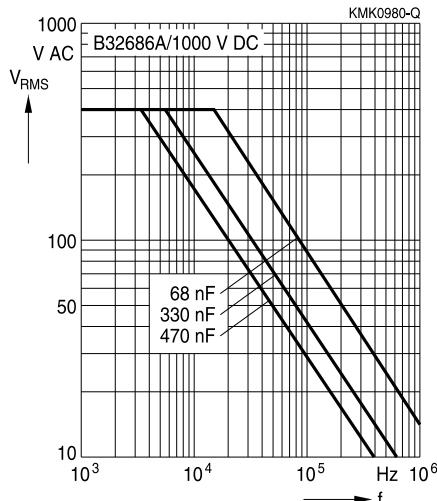



**Permissible AC voltage  $V_{\text{RMS}}$  versus frequency  $f$  (for sinusoidal waveforms,  $T_A \leq 90^\circ \text{C}$ )**

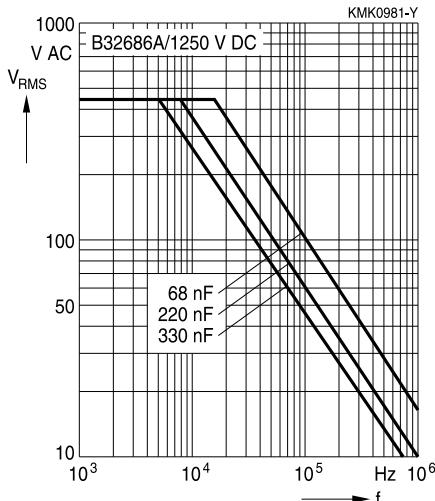
 For  $T_A > 90^\circ \text{C}$ , please refer to "General technical information", section 3.2.3.

**Lead spacing 37.5 mm**

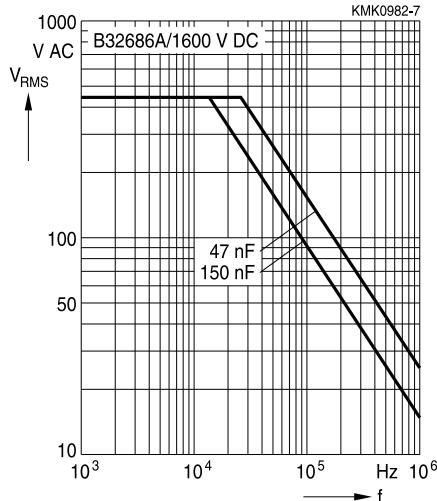
1000 V DC/400 V AC



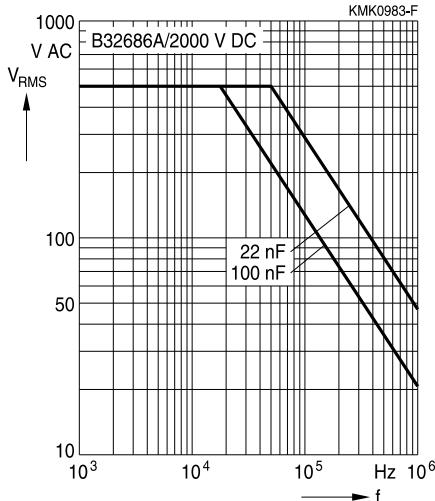
1250 V DC/450 V AC

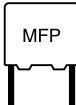


1600 V DC/450 V AC



2000 V DC/500 V AC




**B32686A**
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## 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.

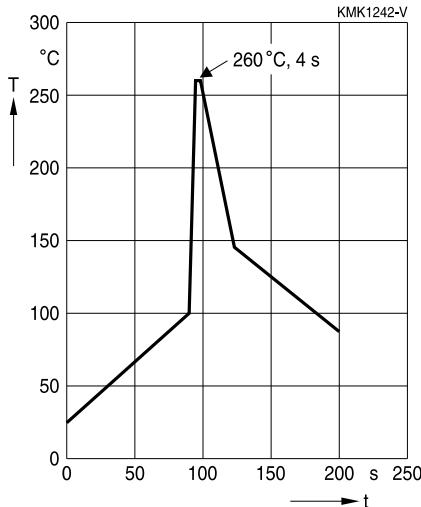
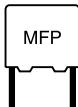
Solder bath temperature	235 $\pm 5$ °C
Soldering time	2.0 $\pm 0.5$ s
Immersion depth	2.0 $+0/-0.5$ mm from capacitor body or seating plane
Evaluation criteria:	
Visual inspection	Wetting of wire surface by new solder $\geq 90\%$ , free-flowing solder

#### 1.2 Resistance to soldering heat

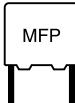
Resistance to soldering heat is tested to IEC 60068-2-20, test Tb, method 1A.

Conditions:

Series	Solder bath temperature	Soldering time
MKT boxed (except 2.5 × 6.5 × 7.2 mm) coated uncoated (lead spacing > 10 mm)	260 $\pm 5$ °C	10 $\pm 1$ s
MFP		
MKP (lead spacing > 7.5 mm)		5 $\pm 1$ s
MKT boxed (case 2.5 × 6.5 × 7.2 mm)		< 4 s
MKP (lead spacing $\leq$ 7.5 mm)		recommended soldering profile for MKT uncoated (lead spacing $\leq$ 10 mm) and insulated (B32559)
MKT uncoated (lead spacing $\leq$ 10 mm) 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
$\tan \delta$	5% for EMI suppression capacitors
	As specified in sectional specification

**B32686A****Very high pulse (wound)**

### 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 recommends the following conditions:

- Pre-heating with a maximum temperature of 110 °C
- Temperature inside the capacitor should not exceed the following limits:
  - MKP/MFP 110 °C
  - MKT 160 °C
- When SMD components are used together with leaded ones, the leaded 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.

### Uncoated capacitors

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

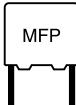
- pre-heating to not more than 110 °C in the preheater phase
- rapid cooling after soldering

## Cautions and warnings

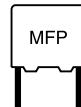
- Do not exceed the upper category temperature (UCT).
- Do not apply any mechanical stress to the capacitor terminals.
- Avoid any compressive, tensile or flexural stress.
- Do not move the capacitor after it has been soldered to the PC board.
- Do not pick up the PC board by the soldered capacitor.
- 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.

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".

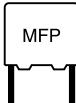
Topic	Safety information	Reference chapter "General technical information"
Storage conditions	Make sure that capacitors are stored within the specified range of time, temperature and humidity conditions.	4.5 "Storage conditions"
Flammability	Avoid external energy, such as fire or electricity (passive 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. 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"

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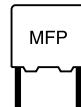
Topic	Safety information	Reference chapter "Mounting guidelines"
Soldering	Do not exceed the specified time or temperature limits during soldering.	1 "Soldering"
Cleaning	Use only suitable solvents for cleaning capacitors.	2 "Cleaning"
Embedding of capacitors in finished assemblies	When embedding finished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


**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)


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Symbol	English	German
$I_{\text{RMS}}$	(Sinusoidal) alternating current, root-mean-square value	(Sinusförmiger) Wechselstrom
$i_z$	Capacitance drift	Inkonstanz der Kapazität
$k_0$	Pulse characteristic	Impulskennwert
$L_s$	Series inductance	Serieninduktivität
$\lambda$	Failure rate	Ausfallrate
$\lambda_0$	Constant failure rate during useful service life	Konstante Ausfallrate in der Nutzungsphase
$\lambda_{\text{test}}$	Failure rate, determined by tests	Experimentell ermittelte Ausfallrate
$P_{\text{diss}}$	Dissipated power	Abgegebene Verlustleistung
$P_{\text{gen}}$	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
$R_{\text{ins}}$	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
$T_A$	Ambient temperature	Umgebungstemperatur
$T_{\text{max}}$	Upper category temperature	Obere Kategorietemperatur
$T_{\text{min}}$	Lower category temperature	Untere Kategorietemperatur
$t_{\text{OL}}$	Operating life at operating temperature and voltage	Betriebszeit bei Betriebstemperatur und -spannung
$T_{\text{op}}$	Operating temperature	Betriebstemperatur
$T_R$	Rated temperature	Nenntemperatur
$T_{\text{ref}}$	Reference temperature	Referenztemperatur
$t_{\text{SL}}$	Reference service life	Referenz-Lebensdauer
$V_{\text{AC}}$	AC voltage	Wechselspannung



Symbol	English	German
$V_c$	Category voltage	Kategoriespannung
$V_{c,RMS}$	Category AC voltage	(Sinusförmige) Kategorie-Wechselspannung
$V_{CD}$	Corona-discharge onset voltage	Teilentlad-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	Ausgangssspannung
$V_{op}$	Operating voltage	Betriebsspannung
$V_p$	Peak pulse voltage	Impuls-Spitzenspannung
$V_{pp}$	Peak-to-peak voltage	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, 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 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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<http://moschip.ru/get-element>

Вы можете разместить у нас заказ для любого Вашего проекта, будь то серийное производство или разработка единичного прибора.

В нашем ассортименте представлены ведущие мировые производители активных и пассивных электронных компонентов.

Нашей специализацией является поставка электронной компонентной базы двойного назначения, продукции таких производителей как XILINX, Intel (ex.ALTERA), Vicor, Microchip, Texas Instruments, Analog Devices, Mini-Circuits, Amphenol, Glenair.

Сотрудничество с глобальными дистрибуторами электронных компонентов, предоставляет возможность заказывать и получать с международных складов практически любой перечень компонентов в оптимальные для Вас сроки.

На всех этапах разработки и производства наши партнеры могут получить квалифицированную поддержку опытных инженеров.

Система менеджмента качества компании отвечает требованиям в соответствии с ГОСТ Р ИСО 9001, ГОСТ Р В 0015-002 и ЭС РД 009

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