



## Film Capacitors

### Metallized Polypropylene Film Capacitors (MFP)

Series/Type: B32686A  
Date: December 2012

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

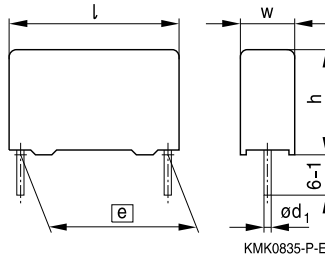
Marking

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

Delivery mode

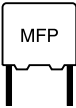
Bulk (untaped)

Dimensional drawing



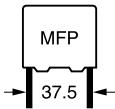
Dimensions in mm

Lead spacing	Lead diameter	Type
$e \pm 0.4$	$d_1$	
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)**

$V_R$	$V_{RMS}$ f $\leq 1$ kHz	$C_R$	Max. dimensions w ´ h ´ l mm	Ordering code (composition see below)	Untaped pcs./MOQ
V DC	V AC	nF			
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

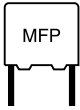
+ = Capacitance tolerance code:

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 $\tan d$ (in $10^{-3}$ ) at 20 °C (upper limit values)	at	$C_R \leq 0.1$ nF	$C_R > 0.1$ nF
	1 kHz		0.4
	10 kHz	0.4	0.5
	100 kHz	1.0	
Insulation resistance $R_{ins}$ or time constant $t = C_R R_{ins}$ at 20 °C, rel. humidity $\leq 65\%$ (minimum as-delivered values)	$C_R \leq 0.33$ nF	$C_R > 0.33$ nF	
	100 GW	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 $\leq 1$ kHz)	$T_A$ (°C)	DC voltage derating	AC voltage derating
	$T_A \leq 85$ $85 < T_A \leq 100$	$V_C = V_R$ $V_C = V_R (165 T_A)/80$	$V_{C,RMS} = V_{RMS}$ $V_{C,RMS} = V_{RMS} (165 T_A)/80$
Operating voltage $V_{op}$ for short operating periods $V_{DC}$ or $V_{AC}$ at f $\leq 1$ kHz)	$T_A$ (°C)	DC voltage (max. hours)	AC voltage (max. hours)
	$T_A \leq 85$ $85 < T_A \leq 100$	$V_{op} = 1.25 V_C (2000 \text{ h})$ $V_{op} = 1.25 V_C (1000 \text{ h})$	$V_{op} = 1.0 V_{C,RMS} (2000 \text{ h})$ $V_{op} = 1.0 V_{C,RMS} (1000 \text{ h})$
Damp heat test Limit values after damp heat test	56 days/40 °C/93% relative humidity		
	Capacitance change DC/C	£ 2%	
	Dissipation factor change $D \tan d$	£ 1.0 $10^{-3}$ (at 10 kHz)	
	Insulation resistance $R_{ins}$ or time constant $t = C_R R_{ins}$	³ 50% of minimum as-delivered values	
Reliability: Failure rate I Service life $t_{SL}$	1 fit (£ 1 $10^{-9}$ /h) at 0.5 $V_R$ , 40 °C 200 000 h at 1.0 $V_R$ , 85 °C For conversion to other operating conditions and temperatures, refer to chapter "Quality, 2 Reliability".		
Failure criteria: Total failure Failure due to variation of parameters	Short circuit or open circuit		
	Capacitance change DC/C	> 10%	
	Dissipation factor $\tan d$	4 upper limit value	
	Insulation resistance $R_{ins}$ or time constant $t = C_R R_{ins}$	< 1500 MW ( $C_R \leq 0.33$ nF) < 500 s ( $C_R > 0.33$ nF)	



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/ms.

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

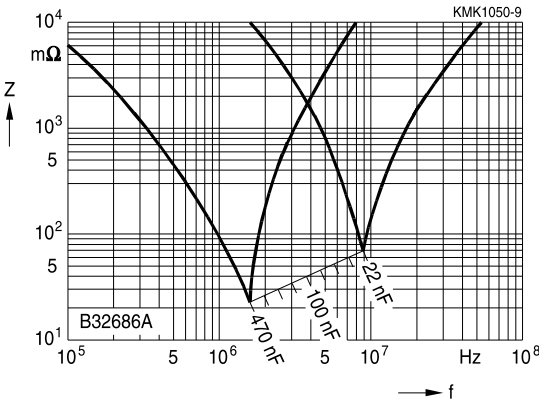
#### Note:

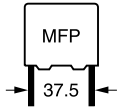
The values of dV/dt and k<sub>0</sub> provided below must not be exceeded in order to avoid damaging the capacitor.

#### dV/dt and k<sub>0</sub> values

Lead spacing		37.5 mm	
V <sub>R</sub> (V DC)	V <sub>RMS</sub> (V AC)	dV/dt in V/ms	k <sub>0</sub> in V <sup>2</sup> /ms
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)

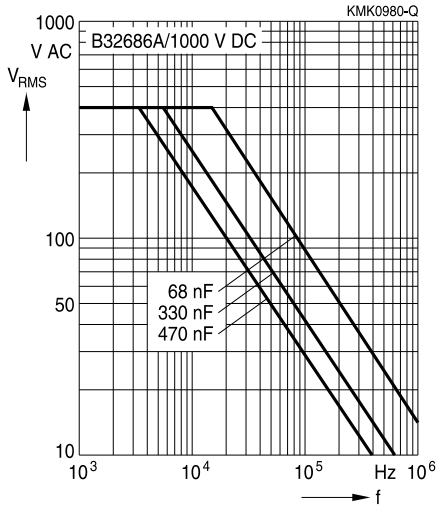




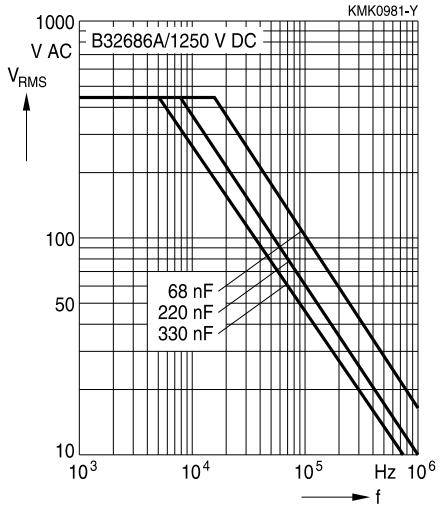
Permissible AC voltage  $V_{RMS}$  versus frequency  $f$  (for sinusoidal waveforms,  $T_A \leq 90^\circ C$ )  
 For  $T_A > 90^\circ C$ , please refer to "General technical information", section 3.2.3.

Lead spacing 37.5 mm

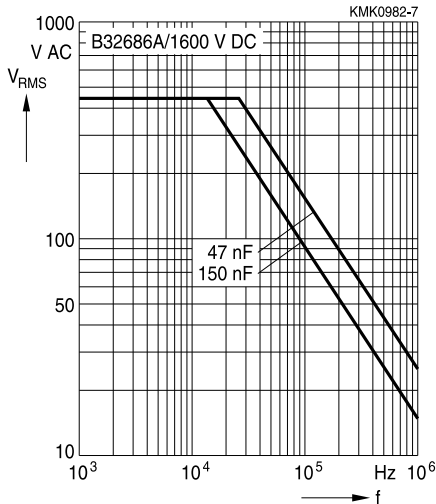
1000 V DC/400 V AC



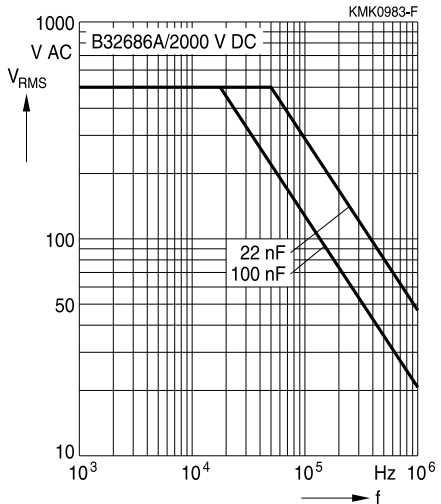
1250 V DC/450 V AC

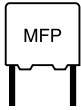


1600 V DC/450 V AC



2000 V DC/500 V AC





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Very high pulse (wound)

## 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.

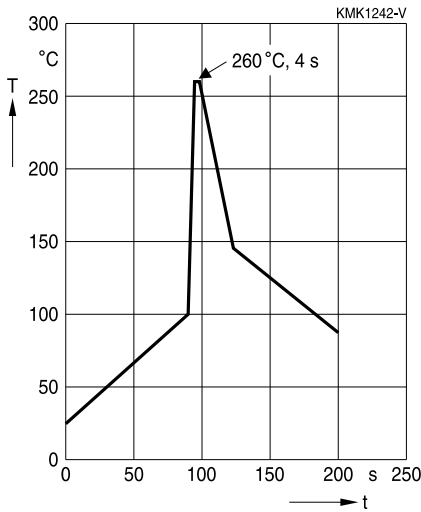
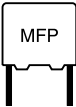
Solder bath temperature	235 ±5 °C
Soldering time	2.0 ±0.5 s
Immersion depth	2.0 +0/ -0.5 mm from capacitor body or seating plane
Evaluation criteria:	
Visual inspection	Wetting of wire surface by new solder ≥ 90%, free-flowing solder

#### 1.2 Resistance to soldering heat

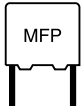
Resistance to soldering heat is tested to IEC 60068-2-20, test Tb, method 1A.

Conditions:

Series	Solder bath temperature	Soldering time
MKT boxed (except 2.5 ´ 6.5 ´ 7.2 mm) coated uncoated (lead spacing > 10 mm)	260 ±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
MKP (lead spacing £ 7.5 mm)		< 4 s
MKT uncoated (lead spacing £ 10 mm) insulated (B32559)		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
DC/C <sub>0</sub>	2% for MKT/MKP/MFP 5% for EMI suppression capacitors
tan δ	As specified in sectional specification



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### 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.

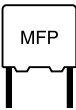
EPCOS recommends the following conditions:

- 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  $\geq 10$  mm (B32560/B32561) the following measures are recommended:

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

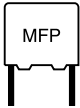


Cautions and warnings

- 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".

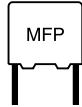
Topic	Safety information	Reference chapter "General technical information"
Storage conditions	Make sure that capacitors are stored within the specified range of time, temperature and humidity conditions.	4.5 "Storage conditions"
Flammability	Avoid external energy, such as fire or electricity (passive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



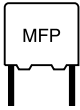
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Topic	Safety information	Reference chapter "Mounting guidelines"
Soldering	Do not exceed the specified time or temperature limits during soldering.	1 "Soldering"
Cleaning	Use only suitable solvents for cleaning capacitors.	2 "Cleaning"
Embedding of 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
a	Heat transfer coefficient	Wärmeübergangszahl
$a_C$	Temperature coefficient of capacitance	Temperaturkoeffizient der Kapazität
A	Capacitor surface area	Kondensatoroberfläche
$b_C$	Humidity coefficient of capacitance	Feuchtekoeffizient der Kapazität
C	Capacitance	Kapazität
$C_R$	Rated capacitance	Nennkapazität
DC	Absolute capacitance change	Absolute Kapazitätsänderung
DC/C	Relative capacitance change (relative deviation of actual value)	Relative Kapazitätsänderung (relative Abweichung vom Ist-Wert)
DC/ $C_R$	Capacitance tolerance (relative deviation from rated capacitance)	Kapazitätstoleranz (relative Abweichung vom Nennwert)
dt	Time differential	Differentielle Zeit
Dt	Time interval	Zeitintervall
DT	Absolute temperature change (self-heating)	Absolute Temperaturänderung (Selbsterwärmung)
Dtan d	Absolute change of dissipation factor	Absolute Änderung des Verlustfaktors
DV	Absolute voltage change	Absolute Spannungsänderung
dV/dt	Time differential of voltage function (rate of voltage rise)	Differentielle Spannungsänderung (Spannungsflankensteilheit)
DV/Dt	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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Very high pulse (wound)

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
$l$	Failure rate	Ausfallrate
$l_0$	Constant failure rate during useful service life	Konstante Ausfallrate in der Nutzungsphase
$l_{test}$	Failure rate, determined by tests	Experimentell ermittelte Ausfallrate
$P_{diss}$	Dissipated power	Abgegebene Verlustleistung
$P_{gen}$	Generated power	Erzeugte Verlustleistung
$Q$	Heat energy	Wärmeenergie
$r$	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 (Feuchtestest)
$t$	Time	Zeit
$T$	Temperature	Temperatur
$t$	Time constant	Zeitkonstante
$\tan d$	Dissipation factor	Verlustfaktor
$\tan d_b$	Dielectric component of dissipation factor	Dielektrischer Anteil des Verlustfaktors
$\tan d_p$	Parallel component of dissipation factor	Parallelanteil des Verlustfaktors
$\tan d_S$	Series component of dissipation factor	Serienanteil des Verlustfaktors
$T_A$	Ambient temperature	Umgebungstemperatur
$T_{max}$	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	Betriebstemperatur
$T_R$	Rated temperature	Nenntemperatur
$T_{ref}$	Reference temperature	Referenztemperatur
$t_{SL}$	Reference service life	Referenz-Lebensdauer
$V_{AC}$	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	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	Ausgangssspannung
$V_{op}$	Operating voltage	Betriebsspannung
$V_p$	Peak pulse voltage	Impuls-Spitzenspannung
$V_{pp}$	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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