Film Capacitors

Metallized Polyester Film Capacitors (MKT)

Series/Type: **B32572, B32573**

Date: June 2018

Typical applications
- Ignition for gas, engines, generators
- Energy storage

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

Features
- Special dimensions available on request
- High pulse strength
- RoHS-compatible

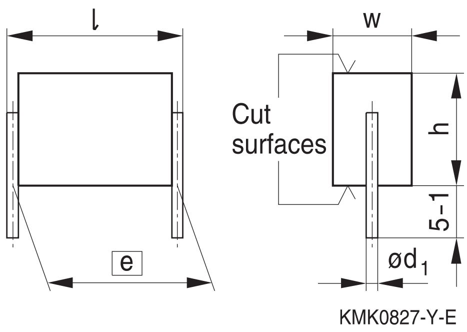
Construction
- Dielectric: polyethylene terephthalate (polyester, PET)
- Stacked-film technology
- Uncoated

Terminals
- Parallel wire leads, lead-free tinned

Marking
Rated capacitance (coded),
rated DC voltage

Delivery mode
Bulk (untaped)

Dimensional drawing



Dimensions in mm

Lead spacing e ±0.4	Lead diameter d_1 ±0.05	Type
15.0	0.8	B32572
22.5	0.8	B32573

Notes on mounting

When mounting these capacitors, take into account creepage distances and clearances to adjacent live parts. The insulating strength of the cut surfaces to other live parts of the circuit is 1.5 times the capacitors rated DC voltage, but is always at least 300 V DC.

Overview of available types

Lead spacing	15.0 mm	22.5 mm
Type	B32572	B32573
Page	4	5
V_R (V DC)	250	250
V_{RMS} (V AC)	160	160
C_R (µF)		
0.68		
1.0		
1.5		
2.2		

Ordering codes and packing units (lead spacing 15 mm)

V_R V DC	V_{RMS} f ≤60 Hz V AC	C_R µF	Max. dimensions w × h × l mm	Ordering code (composition see below)	Untaped pcs./MOQ
250	160	0.68	7.0 × 11.0 × 16.5	B32572A3684+000	1800
		1.0	9.1 × 11.7 × 16.5	B32572A3105+000	1200
		1.5	11.5 × 13.5 × 16.5	B32572A3155+000	800
		2.2	11.5 × 19.8 × 16.5	B32572A3225+000	600

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

Special dimensions available on request.
For corresponding design rules, refer to chapter "General technical information", section 1.3.2.

Composition of ordering code

+ = Capacitance tolerance code:
M = ±20%
K = ±10%
J = ±5%

Ordering codes and packing units (lead spacing 22.5 mm)

V_R V DC	V_{RMS} f ≤60 Hz V AC	C_R µF	Max. dimensions w × h × l mm	Ordering code (composition see below)	Untaped pcs./MOQ
250	160	0.68	5.6 × 9.2 × 24.0	B32573A3684+000	4720
		1.0	6.4 × 11.8 × 24.0	B32573A3105+000	4200
		1.5	7.6 × 14.3 × 24.0	B32573A3155+000	3720
		2.2	8.9 × 17.4 × 24.0	B32573A3225+000	2240

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

Special dimensions available on request.
For corresponding design rules, refer to chapter "General technical information", section 1.3.2.

Composition of ordering code

+ = Capacitance tolerance code:
M = ±20%
K = ±10%
J = ±5%

Technical data

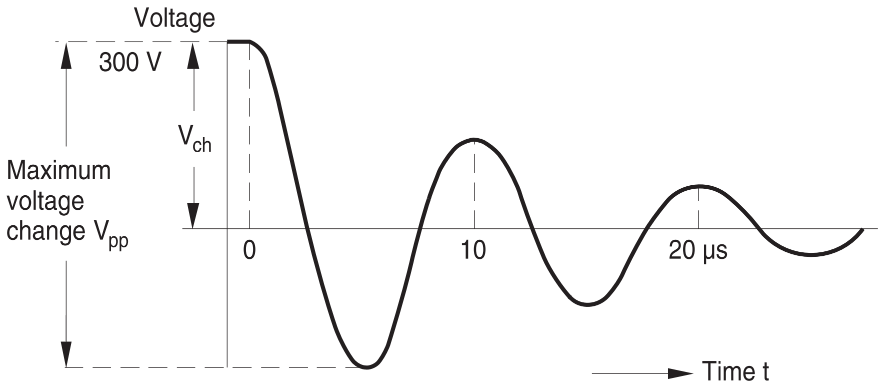
Reference standard: IEC 60384-2:2005. All data given at T = 20 ºC, unless otherwise specified.

Operating temperature range	Max. operating temperature $T_{op,max}$ +125 °C Upper category temperature T_{max} +125 °C Lower category temperature T_{min} −55 °C Rated temperature T_R +85 °C		
Dissipation factor tan δ (in 10^{-3}) at 20 °C (upper limit values)	at	$C_R \leq 1\ \mu F$	$C_R > 1\ \mu F$
	1 kHz	8	10
	10 kHz	15	–
Time constant $\tau = C_R \cdot R_{ins}$ at 20 °C, rel. humidity ≤ 65% (minimum as-delivered values)	2500 s		
DC test voltage	$1.6 \cdot V_R$, 2 s		
Category voltage V_C (continuous operation with V_{DC} or V_{AC} at f ≤ 60 Hz)	T_{op} (°C)	DC voltage derating	AC voltage derating
	$T_{op} \leq 85$	$V_C = V_R$	$V_{C,RMS} = V_{RMS}$
	$85 < T_{op} \leq 125$	$V_C = V_R \cdot (165 - T_{op})/80$	$V_{C,RMS} = V_{RMS} \cdot (165 - T_{op})/80$
Max. charging voltage C_{ch}	$1.2 \cdot V_R$ for ≤ 1 s		
Reliability: Failure rate λ Service life t_{SL}	 2 fit ($\leq 2 \cdot 10^{-9}$/h) at $0.5 \cdot V_R$, 40 °C 100 000 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 Failure due to variation of parameters	 Short circuit or open circuit Capacitance change $\lvert\Delta C/C\rvert$ > 10% Dissipation factor tan δ > 2 · upper limit value Time constant $\tau = C_R \cdot R_{ins}$ < 50 s		

Pulse handling capability

The capacitors are especially manufactured and tested to suit their intended applications.

Typical permissible load:

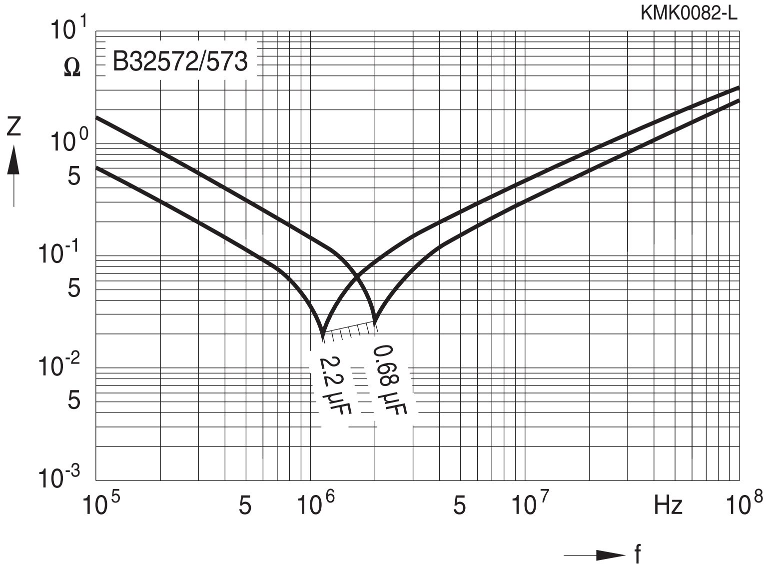


KMK0083-U-E

Lead spacing		15 and 22.5 mm
Max. rate of voltage rise V_{pp}/τ	(at V_{pp} = 500 V)	200 V/µs
Pulse characteristic k_0	(at $V_{pp} \leq$ 500 V)	200 000 V²/µs
Max. charging voltage V_{ch}	(≤1 s)	300 V DC
Max. voltage change V_{pp}	(at f = 100 kHz)	500 V

Unlimited number of pulses permitted.

Impedance Z versus frequency f
(typical values)

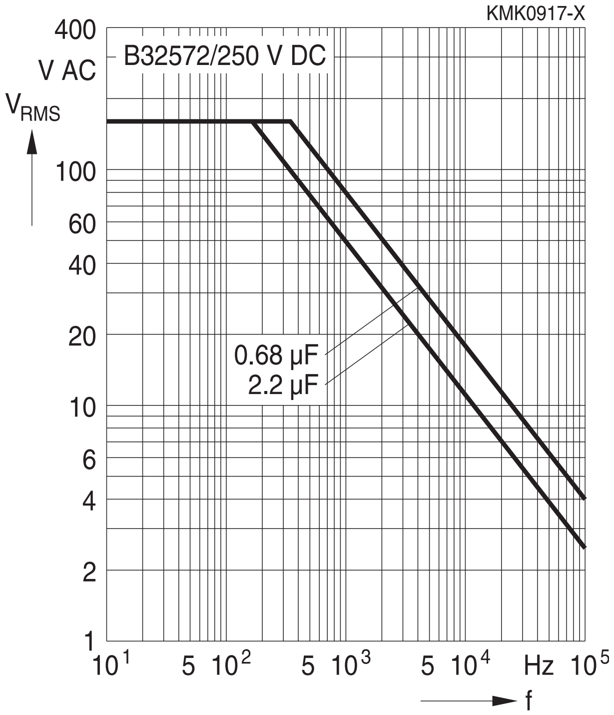


Permissible AC voltage V_{RMS} versus frequency f (for sinusoidal waveforms, $T_A \leq 55$ °C)

For $T_A > 55$ °C, please refer to "General technical information", section 3.2.3.

Lead spacing 15 mm

250 V DV/160 V AC

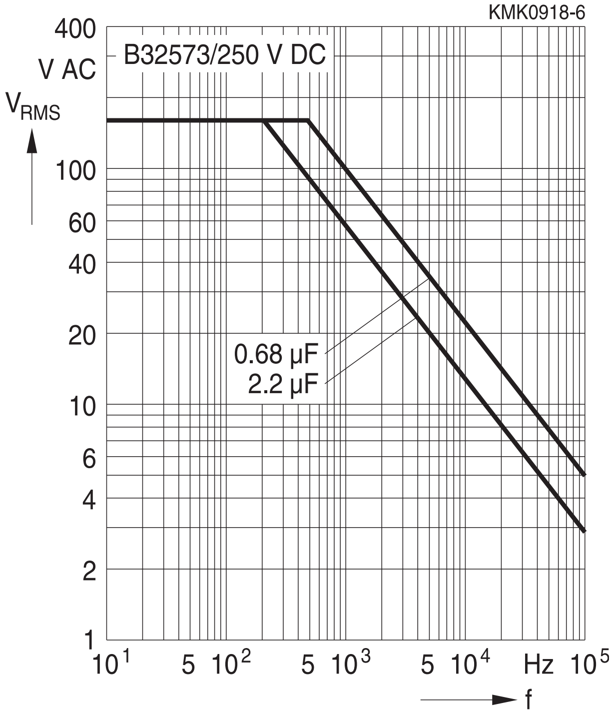


Permissible AC voltage V_{RMS} versus frequency f (for sinusoidal waveforms, $T_A \leq 55$ °C)

For $T_A > 55$ °C, please refer to "General technical information", section 3.2.3.

Lead spacing 22.5 mm

250 V DC/160 V AC



Testing and Standards

Test	Reference	Conditions of test	Performance requirements
Electrical parameters	IEC 60384-2:2005	Voltage proof, 1.4 V_R, 1 minute Insulation resistance, R_{ins} Capacitance, C Dissipation factor, tan δ	Within specified limits
Robustness of terminations	IEC 60068-2-21:2006	Tensile strength (test Ua1) Wire diameter: $0.5 < d_1 \leq 0.8$ mm — Tensile force: 10 N	No visible damage Capacitance and tan δ within specified limits
Resistance to soldering heat	IEC 60068-2-20:2008, test Tb, method 1A	Solder bath temperature at 260 ±5 °C, immersion for 4 seconds (lead spacing ≤10mm) 10 seconds (lead spacing >10mm)	$\Delta C/C_0 \leq 2\%$ $\lvert\Delta \tan \delta\rvert \leq 0.003$ for $C \leq 1$ µF $\lvert\Delta \tan \delta\rvert \leq 0.002$ for $C > 1$ µF
Rapid change of temperature	IEC 60384-2:2005	T_A = lower category temperature T_B = upper category temperature Five cycles, duration t = 30 min.	$\Delta C/C_0 \leq 5\%$ $\lvert\Delta \tan \delta\rvert \leq 0.003$ for $C \leq 1$ µF $\lvert\Delta \tan \delta\rvert \leq 0.002$ for $C > 1$ µF $R_{ins} \geq 50\%$ of initial limit
Vibration	IEC 60384-2:2005	Test Fc: vibration sinusoidal Displacement: 0.75 mm Accleration: 98 m/s^2 Frequency: 10 Hz ... 500 Hz Test duration: 3 orthogonal axes, 2 hours each axe	No visible damage
Bump	IEC 60384-2:2005	Test Eb: Total 4000 bumps with 390 m/s^2 mounted on PCB Duration: 6 ms	$\Delta C/C_0 \leq 5\%$ $\lvert\Delta \tan \delta\rvert \leq 0.003$ for $C \leq 1$µF $\lvert\Delta \tan \delta\rvert \leq 0.002$ for $C > 1$µF $R_{ins} \geq 50\%$ of initial limit
Climatic sequence	IEC 60384-2:2005	Dry heat Tb / 16 h Damp heat cyclic, 1st cycle +55 °C / 24 h / 95% ... 100% RH Cold Ta / 2 h Damp heat cyclic, 5 cycles +55 °C / 24 h / 95% ... 100% RH	$\Delta C/C_0 \leq 5\%$ $\lvert\Delta \tan \delta\rvert \leq 0.005$ for $C \leq 1$ µF $\lvert\Delta \tan \delta\rvert \leq 0.003$ for $C > 1$ µF $R_{ins} \geq 50\%$ of initial limit
Damp heat, steady state	IEC 60384-2:2005	Test Ca 40 °C / 93% RH / 56 days	No visible damage $\lvert\Delta C/C_0\rvert \leq 5\%$ $\lvert\Delta \tan \delta\rvert \leq 0.005$ $R_{ins} \geq 50\%$ of initial limit

Test	Reference	Conditions of test	Performance requirements
Endurance A	IEC 60384-2:2005	85 °C / 1.25 V_R / 2000 hours	No visible damage $\lvert \Delta C/C_0 \rvert \leq 5\%$ $\lvert \Delta \tan \delta \rvert \leq 0.003$ for $C \leq 1\ \mu F$ $\lvert \Delta \tan \delta \rvert \leq 0.002$ for $C > 1\ \mu F$ R_{ins} ≥50% of initial limit
Endurance B	IEC 60384-2:2005	125 °C / 1.25 V_C / 2000 hours	No visible damage $\lvert \Delta C/C_0 \rvert \leq 5\%$ $\lvert \Delta \tan \delta \rvert \leq 0.003$ for $C \leq 1\ \mu F$ $\lvert \Delta \tan \delta \rvert \leq 0.002$ for $C > 1\ \mu F$ R_{ins} ≥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.

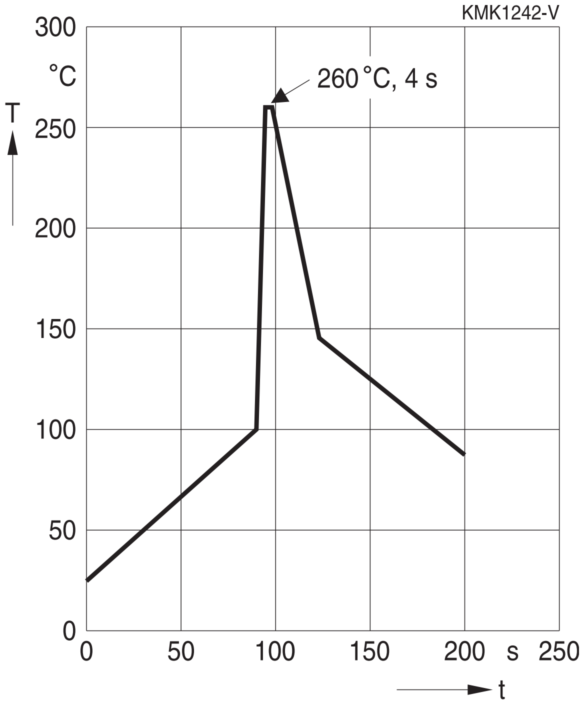
Before a solderability test is carried out, terminals are subjected to accelerated ageing (to IEC 60068-2-2, test Ba: 4 h exposure to dry heat at 155 °C). Since the ageing temperature is far higher than the upper category temperature of the capacitors, the terminal wires should be cut off from the capacitor 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)		5 ±1 s
MKP MKT	(lead spacing ≤7.5 mm) 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 δ	As specified in sectional specification

1.3 General notes on soldering

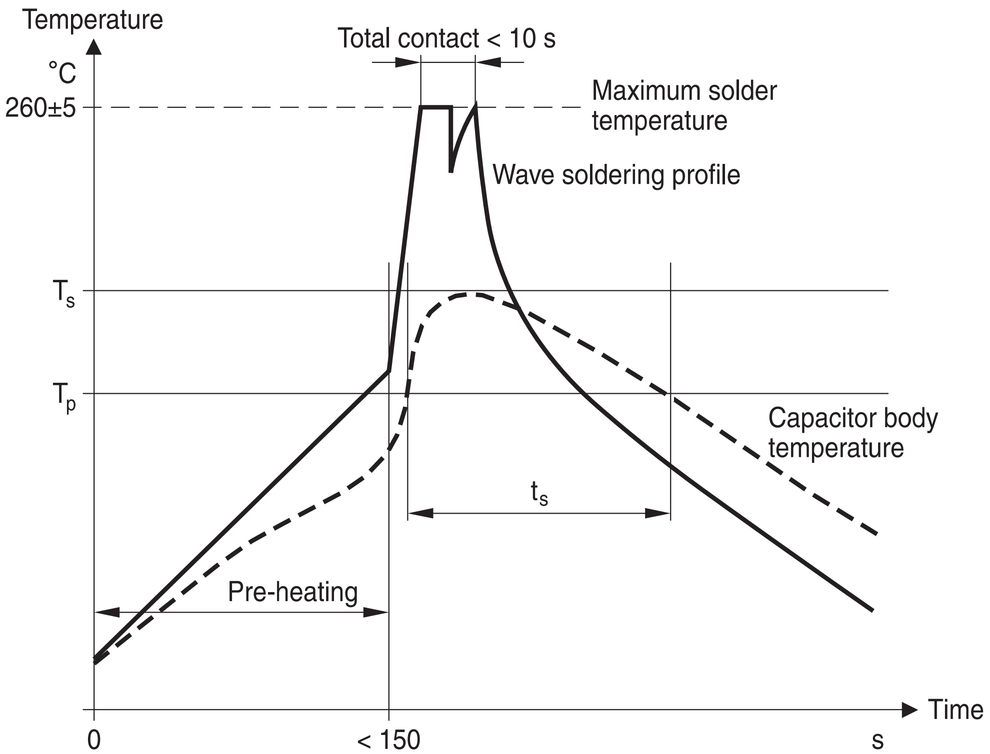
Permissible heat exposure loads on film capacitors are primarily characterized by the upper category temperature T_{max}. Long exposure to temperatures above this type-related temperature limit can lead to changes in the plastic dielectric and thus change irreversibly a capacitor's electrical characteristics. 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

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.

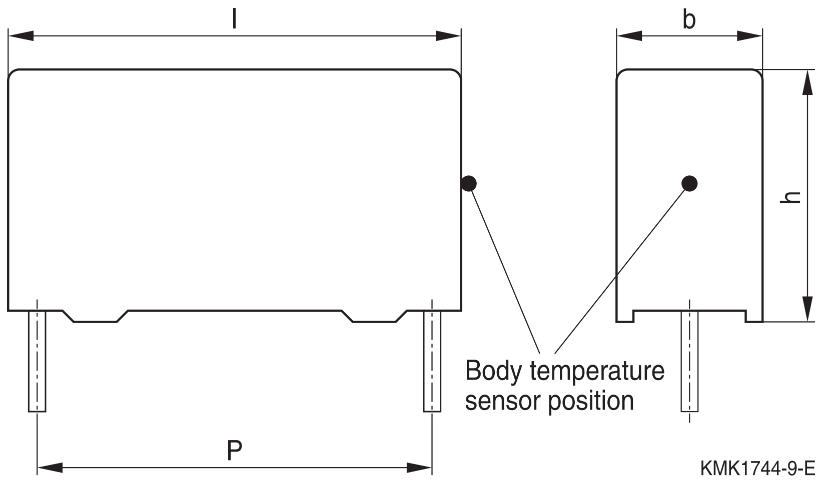
Recommendations

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



Body temperature should follow the description below:

- MKP capacitor
  During pre-heating: T_p ≤110 °C
  During soldering: T_s ≤120 °C, t_s ≤45 s
- MKT capacitor
  During pre-heating: T_p ≤125 °C
  During soldering: T_s ≤160 °C, t_s ≤45 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 ≤120 °C.

One recommended condition for manual soldering is that the tip of the soldering iron should be <360 °C and the soldering contact time should be no longer than 3 seconds.

For uncoated MKT capacitors with lead spacings ≤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

Please refer to our Film Capacitors Data Book in case more details are needed.

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"

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Detailed information can be found on the Internet under
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.

Symbols and terms

Symbol	English	German
α	Heat transfer coefficient	Wärmeübergangszahl
α_C	Temperature coefficient of capacitance	Temperaturkoeffizient der Kapazität
A	Capacitor surface area	Kondensatoroberfläche
β_C	Humidity coefficient of capacitance	Feuchtekoeffizient der Kapazität
C	Capacitance	Kapazität
C_R	Rated capacitance	Nennkapazität
ΔC	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
Δt	Time interval	Zeitintervall
ΔT	Absolute temperature change (self-heating)	Absolute Temperaturänderung (Selbsterwärmung)
$\Delta \tan \delta$	Absolute change of dissipation factor	Absolute Änderung des Verlustfaktors
ΔV	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	Impulskennwert
L_S	Series inductance	Serieninduktivität
λ	Failure rate	Ausfallrate
λ_0	Constant failure rate during useful service life	Konstante Ausfallrate in der Nutzungsphase
λ_{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
ρ	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
τ	Time constant	Zeitkonstante
tan δ	Dissipation factor	Verlustfaktor
tan δ_D	Dielectric component of dissipation factor	Dielektrischer Anteil des Verlustfaktors
tan δ_P	Parallel component of dissipation factor	Parallelanteil des Verlfustfaktors
tan δ_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, $T_A + \Delta T$	Beriebstemperatur, $T_A + \Delta T$
T_R	Rated temperature	Nenntemperatur
T_{ref}	Reference temperature	Referenztemperatur
t_{SL}	Reference service life	Referenz-Lebensdauer

Symbol	English	German
V_{AC}	AC voltage	Wechselspannung
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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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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6. Unless otherwise agreed in individual contracts, **all orders are subject to our General Terms and Conditions of Supply**.

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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