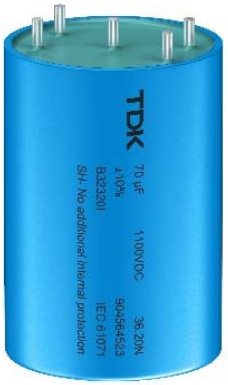
Film Capacitors

Metallized Polypropylene Film Capacitors (MKP)

Series/Type:	**B32320I**
Ordering code:	**B32320I***
Date:	October 2020
Version:	V1.0



Typical applications

- Frequency converters
- Inverter based home appliances
- Solar inverters
- Variable speed motor drives

Climatic

- Max. operating temperature: 105 °C (Hotspot)
- Climatic category (IEC 60068-1:2013): 40/085/56

Construction

- Dielectric: Polypropylene (MKP)
- Plastic case (UL 94 V-0)
- Epoxy resin sealing (UL 94 V-0)

Features

- Capacitance values 6.5 up to 260 µF
- High CV product, compact
- Good self-healing properties
- Over-voltage capability
- Low losses with high current capability
- High reliability
- Long useful life
- RoHS-compatible

Terminals

- Parallel wire leads, lead-free tinned
- 5-pin
- Standard lead lengths: 4.5 ±0.5 mm

Marking

Manufacturer's logo and lot number, date code, rated capacitance (coded), capacitance tolerance (code letter) and rated DC voltage

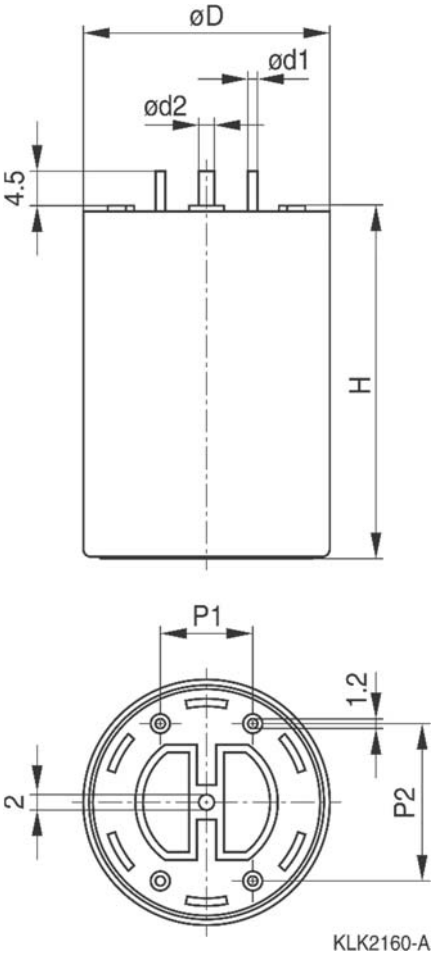
Delivery mode

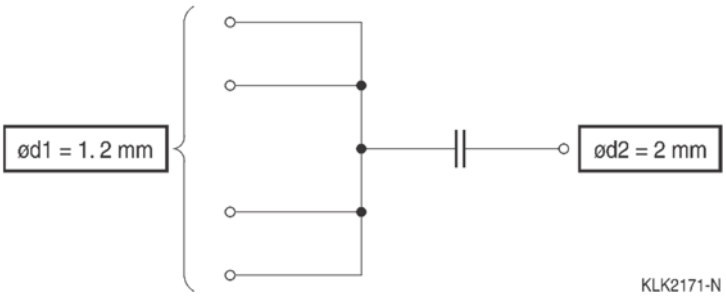
- Bulk (untaped)

Dimensional drawings

Number of wires	Lead spacing (P1) mm	Lead pacing (P2) mm	Lead diameter (d1) mm	Lead diameter (d2) mm	Type
5-pin	12.7 ±0.4	22.5 ±0.4	1.2 ±0.05	2.0 ±0.05	B32320I
5-pin	16 ±0.4	37.5 ±0.4	1.2 ±0.05	2.0 ±0.05	
5-pin	20.3 ±0.4	42.5 ±0.4	1.2 ±0.05	2.0 ±0.05	

Dimensional drawings 5-pin version





Note: 4 × 1.2 mm terminal-electrode (d1)
1 × 2 mm terminal-electrode (d2)

Overview of available types

V_R (85 ºC)	450 V DC	800 V DC	1100 V DC	1300 V DC
C_R (µF)				
6.5				
9.5				
15				
20				
21				
27				
30				
50				
66				
70				
88				
100				
100				
110				
150				
150				
200				
200				
260				

Ordering codes and packing units

C_R[1)*)] µF	Max. dimensions D × H mm	P1/P2 mm	Ordering code (composition see below)	$I_{RMS,\ max.}$[2)] 60 °C Amb. 10 kHz A_{RMS}	$\hat{I}_{peak}$ kA	ESR_{typ} 10 kHz mΩ	ESL_{typ}[3)] nH	tanδ max. 1 kHz (10^{-3})	Pcs./ Pkg.
$V_{R,85\ °C}$ = 450 V DC									
20	35 × 53	22.5/12.7	B32320I4206K000	20	0.4	3.8	30	1.0	84
27	35 × 53	22.5/12.7	B32320I4276K000	20	0.54	4.0	30	1.2	84
88	50 × 57	37.5/16.0	B32320I4886K000	27.6	1.75	2.4	35	1.7	32
200	50 × 95	37.5/16.0	B32320I4207K000	25	1.4	4.0	60	5.5	32
260	50 × 120	37.5/16.0	B32320I4267K000	23	1.56	5.0	75	8.0	32
$V_{R,85\ °C}$ = 800 V DC									
15	35 × 53	22.5/12.7	B32320I8156K000	20	0.33	3.8	30	1	84
50	50 × 57	37.5/16.0	B32320I8506K000	26.5	1.1	3.2	35	1.5	32
110	50 × 95	37.5/16.0	B32320I8117K000	22	1.0	5.0	60	4.3	32
150	50 × 120	37.5/16.0	B32320I8157K000	23	1.1	5.0	75	6.15	32
200	60 × 120	42.5/20.3	B32320I8207K000	27.5	1.5	3.6	75	6.15	21
$V_{R,85\ °C}$ = 1100 V DC									
9.5	35 × 53	22.5/12.7	B32320I0955K000	16.4	0.38	5.2	30	1	84
30	50 × 57	37.5/16.0	B32320I0306K000	22.5	1.2	4.0	35	1.2	32
70	50 × 95	37.5/16.0	B32320I0706K000	23	1.4	4.7	60	3.5	32
100	50 × 120	37.5/16.0	B32320I0107K000	23	1.5	5.0	75	4.5	32
150	60 × 120	42.5/20.3	B32320I0157K000	22.4	2.2	4.3	75	5.3	21
$V_{R,85\ °C}$ = 1300 V DC									
6.5	35 × 53	22.5/12.7	B32320I1655K000	16.4	0.39	4.9	30	1.0	84
21	50 × 57	37.5/16.0	B32320I1216K000	20	1.26	5.0	35	1.2	32
50	50 × 95	37.5/16.0	B32320I1506K000	24	1.5	4.0	60	2.4	32
66	50 × 120	37.5/16.0	B32320I1666K000	23	1.65	5.0	75	3.9	32
100	60 × 120	42.5/20.3	B32320I1107K000	22.4	2.5	4.3	75	3.2	21

*) Intermediate capacitance values are available on request

Composition of ordering code

+ =	Capacitance tolerance code	*** =	Packing code
	K = ±10%		000 = Untapped (lead length 4.5 mm)
			Other lead lengths can be made available on request

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1) Capacitance value measured at 1 kHz
2) Max ripple current I_{RMS}@60 ºC Amb@10 kHz for a $\Delta T \leq 25$ ºC at $\Delta ESR_{typ} \leq \pm 5\%$
3) Typical ESL value are calculated out of the resonance frequency (See specific graphs of Z versus frequency)

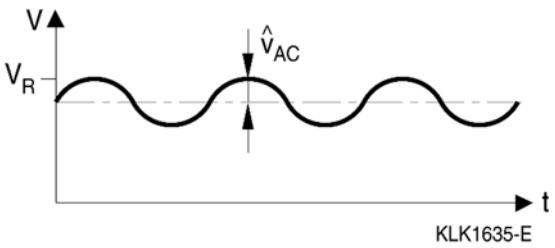
Technical data

Reference standard: IEC 61071: 2007.

All data given at T=20 ºC, unless otherwise is specified.

Operating temperature range		Max. operating temperature, $T_{Hot\ Spot,\ max}$			+105 ºC
		Upper category temperature $T_{max.}$			+85 ºC
		Lower category temperature $T_{min.}$			-40 ºC
Insulation Resistance R_{INS}, given as time constant $\tau = C_R \cdot R_{INS}$, rel. humidity ≤65% (minimum as-delivered values)		τ >10 000 s (after 1 min) For V_R ≥500 V measured at 500 V For V_R <500 V measured at V_R			
DC voltage test between terminals (10 s)		1.5 • V_R			
Voltage test terminal to case (10 s)		2110 V AC, 50Hz			
Reliability:	Failure rate λ	75 fit (≤1 • 10-9) at 0.5 • V_R, 40 ºC For conversion to other operating conditions and temperatures, refer to chapter "Quality, 2 Reliability"			
	Service life t_{SL}	100 000 h at V_R, 70 ºC			
$V_{R\ (DC)}$		450 V	800 V	1100 V	1300 V
Continuous operation voltage (V_{op}) at T_{op} of 85 ºC		450 V	800 V	1100 V	1300 V
For temperatures between 85 ºC and 105 ºC		2.5% / ºC of V_{op} derating compared to V_{op} at 85 ºC			

Typical waveforms:



Restrictions

V_R: Maximum operating peak voltage of either polarity but of a non-reversing waveform, for which the capacitor has been designed for continuous operation.

$\hat{u}_{AC}$, max $\leqslant$0.2 • V_R

Overvoltage	Maximum duration within one day	Observation
1.1 • V_R	30 % of on-load duration	System regulation
1.15 • V_R	30 min	System regulation
1.2 • V_R	5 min	System regulation
1.3 • V_R	1 min	System regulation

NOTE 1
An overvoltage equal to 1.5 • V_R for 30 ms is permitted 1000 times during the life of the capacitor.

The amplitudes of the overvoltages that may be tolerated without significant reduction in the life time of the capacitor depend on their duration, the number of application and the capacitor temperature.

In addition, these values assume that the overvoltages may appear when the internal temperature of the capacitor is less than 0 °C but within the temperature category.

NOTE 2
The average applied voltage must not be higher than the specified voltage.

Pulse handling capability

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

Note:
The values of dV/dt provided below must not be exceeded in order to avoid damaging the capacitor.

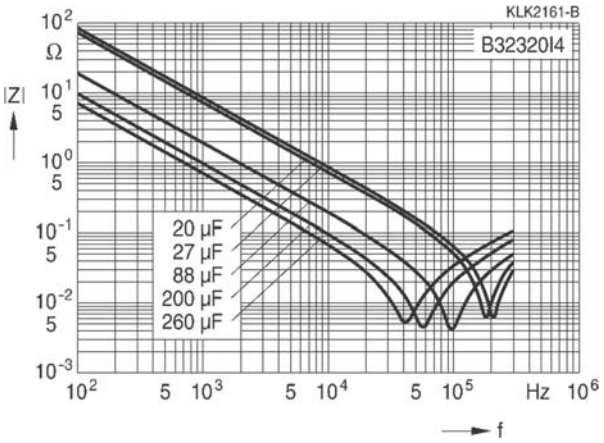
dV/dt values (available types)

Type	B32320I							
Capacitors height (mm)	53				57			
V_R (85 ºC)	450	800	1100	1300	450	800	1100	1300
dV/dt in V/µs	20	22	40	60	20	22	40	60
Capacitors height (mm)	95				120			
V_R (85 ºC)	450	800	1100	1300	450	800	1100	1300
dV/dt in V/µs	8	9	20	30	6	7.5	15	25

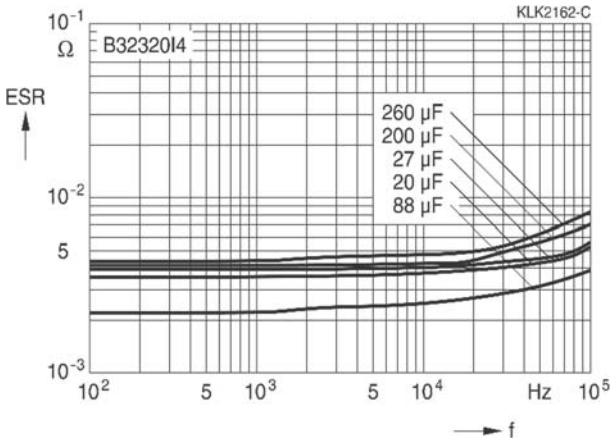
$\hat{I}_{peak}$ (Peak current that can be handled by capacitor) = C(µF) × dV/dt

Characteristics curves (Z / ESR vs freq)

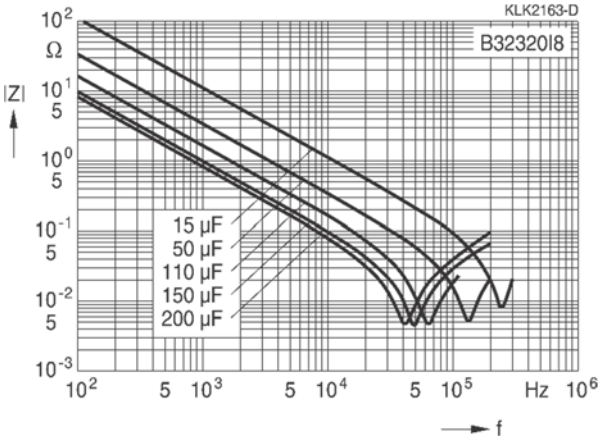
Impedance Z versus frequency f
(Typical values)
450 V DC



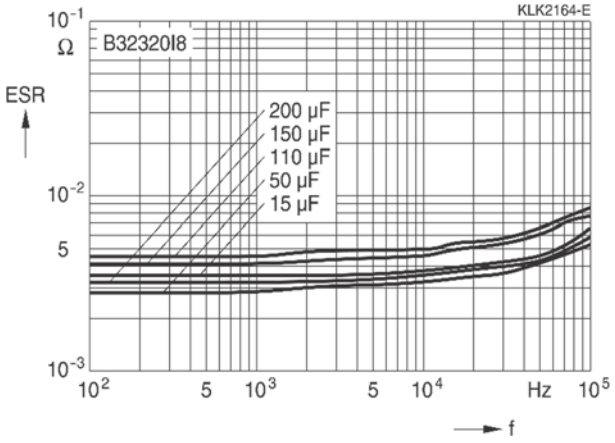
ESR versus frequency f
(Typical values)
450 V DC



Impedance Z versus frequency f
(Typical values)
800 V DC

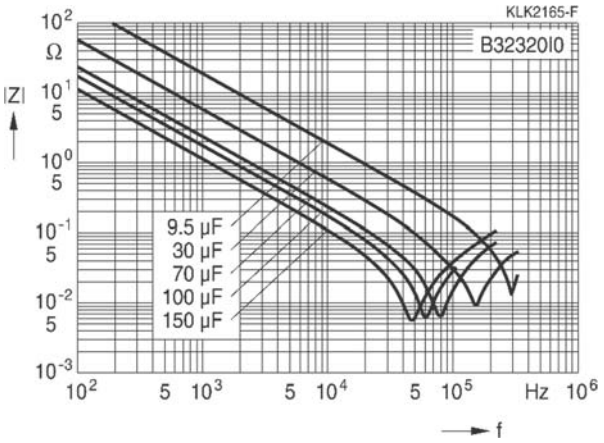


ESR versus frequency f
(Typical values)
800 V DC

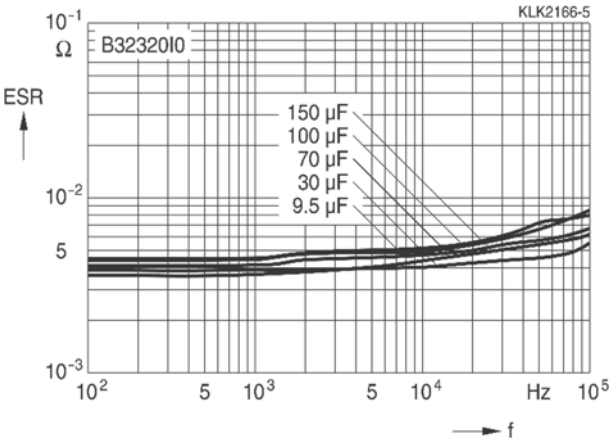


Characteristics curves (Z / ESR vs freq)

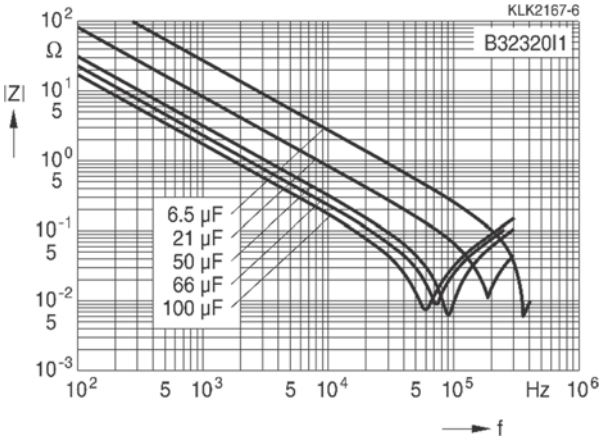
Impedance Z versus frequency f
(Typical values)
1100 V DC



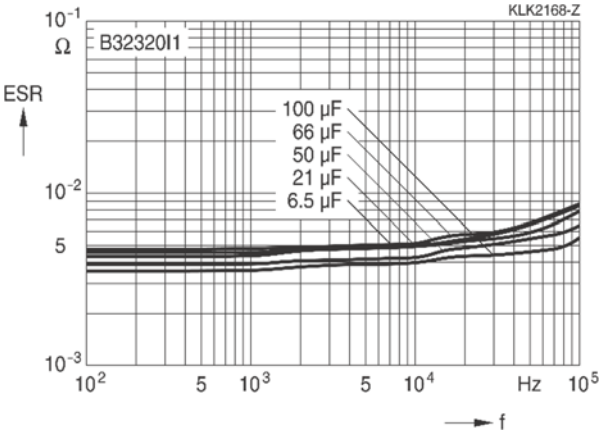
ESR versus frequency f
(Typical values)
1100 V DC



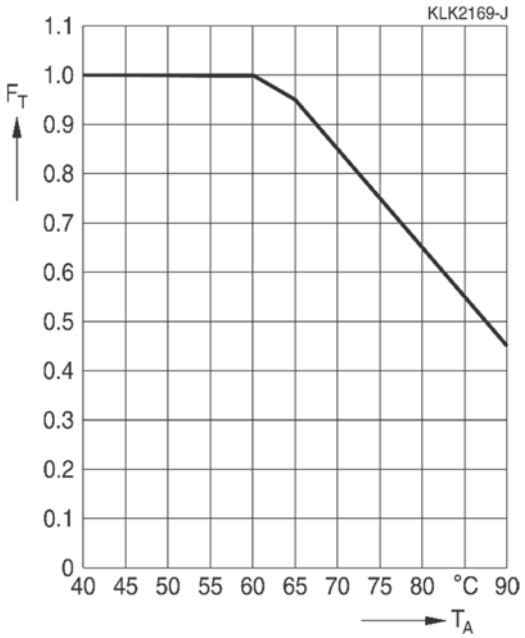
Impedance Z versus frequency f
(Typical values)
1300 V DC



ESR versus frequency f
(Typical values)
1300 V DC



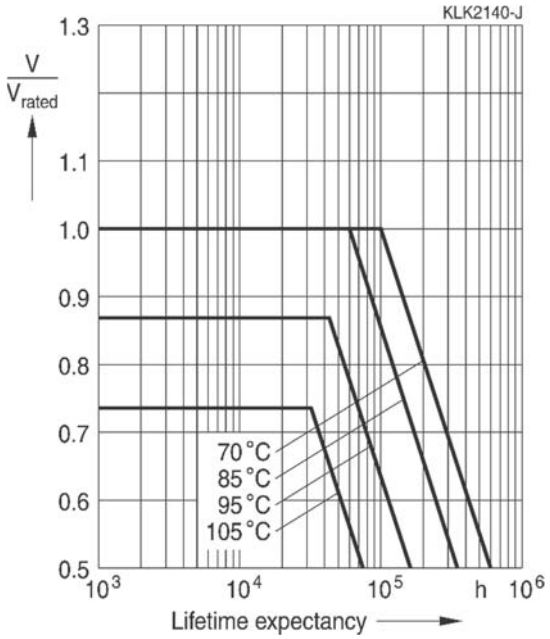
I_{RMS} derating vs T_A



Maximum I_{RMS} current as function of the ambient temperature: I_{RMS} (T_A) = Factor × I_{RMS} (60 ºC)

Service life

Life time expectancy-typical curve B32320I (450 V DC / 800 V DC / 1100 V DC / 1300 V DC)



Note: Confidence level of 70%

Testing and standards

Test	Reference	Conditions of test	Performance requirements
Electrical parameters (Routine test)	IEC61071: 2007	Voltage between terminals, 1.5 V_R, during 10 s Insulation resistance, R_{INS} at V_R if V_R <500 V or 500 V if V_R ≥500 V Capacitance, C at 1 kHz (room temperature) Dissipation factor, tan d at 1/10 kHz (room temperature)	Within specified limits
Robustness of terminations (Type test)	IEC 60068-2-21: 2006	Tensile strength (test Ua1) Wire diameter: Tensile force 0.8 <d1 ≤1.25 mm: 20 N >1.25 mm: 40 N	Capacitance and tan δ within specified limits
Resistance to soldering heat (Type test)	IEC 60068-2-20: 2008, test Tb, method 1A	Solder bath temperature at 260 ±5 °C, immersion for 10 seconds	$\lvert\Delta C/C_0\rvert$ ≤2% $\lvert\Delta\tan\delta\rvert$ ≤0.002 R_{INS} ≥50% of initial limit Mechanical: No visible damage
Rapid change of temperature (Type test)	IEC 61071: 2007	TA = lower category temperature TB = upper category temperature Five cycles, duration t = 30 min	$\lvert\Delta C/C_0\rvert$ ≤2% $\lvert\Delta\tan\delta\rvert$ ≤0.002 R_{INS} ≥50% of initial limit Mechanical: No visible damage
Vibration and shocks (Type test)	IEC 61071: 2007	In accordance with IEC 60068-2-6 f = 10 Hz to 55 Hz a = ±0.35 mm Test duration per axis = 10 frequency cycles (3 axes offset from each other by 90°), 1 octave/min. Mounting conditions: The leads shall fix the capacitor and the body must be properly clamped.	Electrical: $\lvert\Delta C/C_0\rvert$ ≤0.5% at 1 kHz Mechanical: No visible damage
Climatic sequence (Type test)	IEC 60384-16: 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 / 24h / 95% ... 100% RH	No visible damage $\lvert\Delta C/C_0\rvert$ ≤3% $\lvert\Delta\tan\delta\rvert$ ≤0.001 R_{INS} ≥ 50% of initial limit

Test	Reference	Conditions of test	Performance requirements
Damp heat Steady state (Type test)	IEC 60384-16: 2005	Test Ca 40 °C / 93% RH / 56 days	No visible damage $\|\Delta C/C_0\| \leq 5\%$ $I\Delta\tan\delta\| \leq 0.005$ $R_{INS} \geq 50\%$ of initial limit
Endurance (Type test)	IEC 61071: 2007	+85 °C / 1.3 V_R / 500 hours and 1000 discharges at 1.4 I_R and +85 °C / 1.3 V_R / 500 hours	No visible damage $\|\Delta C/C_0\| \leqslant 3\%$ $\|\Delta\tan\delta\|$ 0.015 (10 kHz) $R_{INS} \geq 50\%$ of initial limit Mechanical: No visible damage

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"
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"

Soldering

Solderability of leads

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

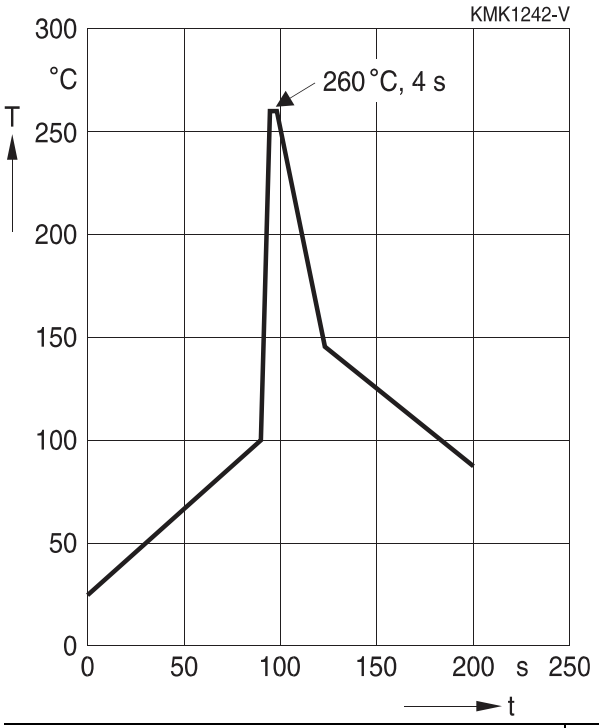
Before a solderability test is carried out, terminals are subjected to accelerated ageing (to IEC 60068-2-2:2007, test Ba: 4 h exposure to dry heat at 155 °C). Since the ageing temperature is far higher than the upper category temperature of the capacitors, the terminal wires should be cut off from the 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

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 round can		
MKT boxed (case 2.5 × 6.5 × 7.2 mm)		5 ±1 s
MKP (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 δ	As specified in sectional specification

General notes on soldering

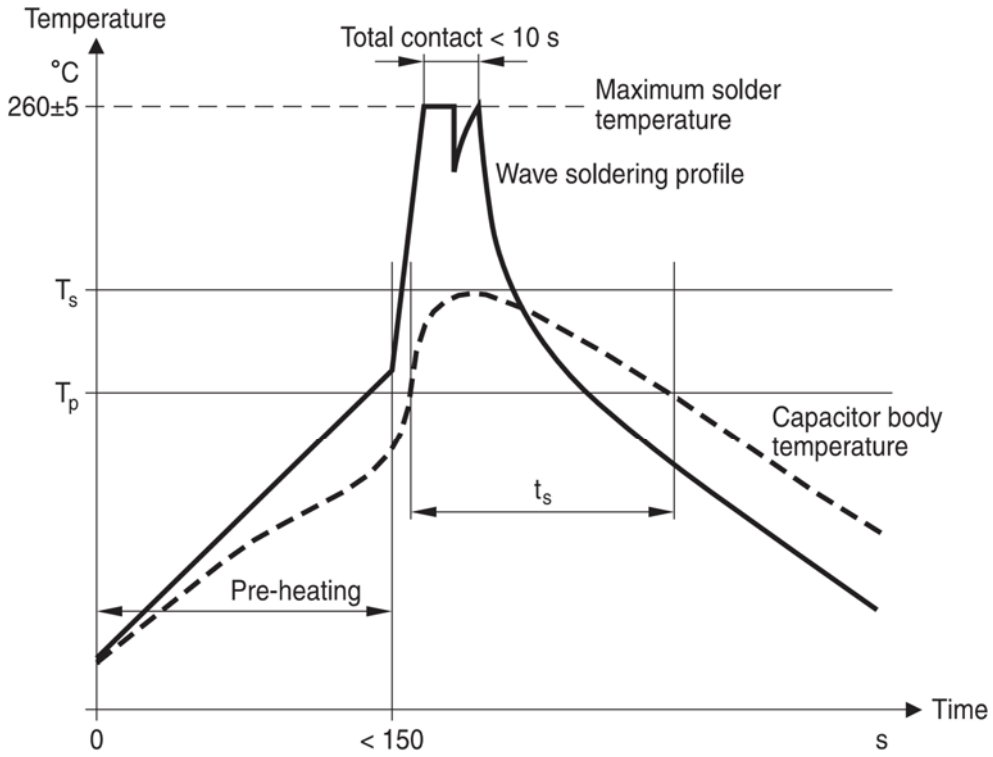
Permissible heat exposure loads on film capacitors are primarily characterized by the upper category temperature T_{max}. Long exposure to temperatures above this type-related temperature limit can lead to changes in the plastic dielectric and thus change irreversibly a capacitor's electrical characteristics. 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: $T_p \leq 110$ °C
  - During soldering: $T_s \leq 120$ °C, $t_s \leq 45$ s
- MKT capacitor
  - During pre-heating: $T_p \leq 125$ °C
  - During soldering: $T_s \leq 160$ °C, $t_s \leq 45$ 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, the following measures are recommended:

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

Cleaning

To determine whether the following solvents, often used to remove flux residues and other substances, are suitable for the capacitors described, refer to the table below:

Type	Ethanol, isopropanol, n-propanol	n-propanol-water mixtures, water with surface tension-reducing tensides (neutral)
MKT (uncoated)	Suitable	Unsuitable
MKT, MKP, MFP (coated/boxed)		Suitable

Even when suitable solvents are used, a reversible change of the electrical characteristics may occur in uncoated capacitors immediately after they are washed. Thus it is always recommended to dry the components (e.g. 4 h at 70 °C) before they are subjected to subsequent electrical testing.

Caution:
Consult us first if you wish to use new solvents!

Embedding of capacitors in finished assemblies

In many applications, finished circuit assemblies are embedded in plastic resins. In this case, both chemical and thermal influences of the embedding ("potting") and curing processes must be taken into account.

Our experience has shown that the following potting materials can be recommended: non-flexible epoxy resins with acid-anhydride hardeners; chemically inert, non-conducting fillers; maximum curing temperature of 100 °C.

Caution:
Consult us first if you wish to embed uncoated types!

Marking

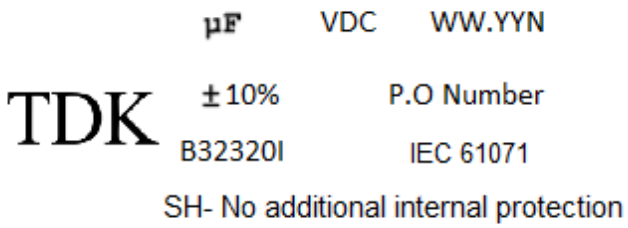
Capacitor markings

Depending on the capacitor size, the markings are positioned either on the side and/or the top of the component. The coded forms specified in IEC 60062:2004 are used to indicate the rated capacitance, capacitance tolerance and date of manufacture.

The lot number (production batch number) ensures unique identification of a particular capacitor and allows, together with the date of manufacture, exact assignment to the process data of the entire production run (traceability).

Marking examples

Canned capacitors (without EMI suppression capacitors)

Style	Type	Marking example	Marking
MKP	B32320I		Side stamping: Manufacturer's logo, C_R, tolerance, V_R

Marking types

The capacitors may have either an ink-jet marking or a laser marking. The main advantage of laser marking is that it cannot be removed by solvents, which ensures the reliable identification of the capacitor. Moreover, because the laser marking process reduces the amount of chemicals used, it is an environmentally friendly marking solution.

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.

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 life-saving 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.**
4. In order to satisfy certain technical requirements, **some of the products described in this publication may contain substances subject to restrictions in certain jurisdictions (e.g. because they are classed as hazardous)**. Useful information on this will be found in our Material Data Sheets on the Internet (www.tdk-electronics.tdk.com/material). Should you have any more detailed questions, please contact our sales offices.
5. We constantly strive to improve our products. Consequently, **the products described in this publication may change from time to time**. The same is true of the corresponding product specifications. Please check therefore to what extent product descriptions and specifications contained in this publication are still applicable before or when you place an order.

   We also **reserve the right to discontinue production and delivery of products**. Consequently, we cannot guarantee that all products named in this publication will always be available. The aforementioned does not apply in the case of individual agreements deviating from the foregoing for customer-specific products.
6. Unless otherwise agreed in individual contracts, **all orders are subject to our General Terms and Conditions of Supply.**
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.

Important notes

8. The trade names EPCOS, CarXield, CeraCharge, CeraDiode, CeraLink, CeraPad, CeraPlas, CSMP, CTVS, DeltaCap, DigiSiMic, ExoCore, FilterCap, FormFit, LeaXield, MiniBlue, MiniCell, MKD, MKK, ModCap, MotorCap, PCC, PhaseCap, PhaseCube, PhaseMod, PhiCap, PowerHap, PQSine, PQvar, SIFERRIT, SIFI, SIKOREL, SilverCap, SIMDAD, SiMic, SIMID, SineFormer, SIOV, ThermoFuse, WindCap, XieldCap are **trademarks registered or pending** in Europe and in other countries. Further information will be found on the Internet at www.tdk-electronics.tdk.com/trademarks.

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