



## Film Capacitors – AC Capacitors

### Metallized Polypropylene Film Capacitors (MKP)

**Series/Type:** B32354S  
**Ordering code:** B32354S3\*  
**Date:** January 2019  
**Version:** 1

**Typical applications**

- Output AC filtering for power converters, UPS, motor drives

**Climatic**

- Max. operating temperature: +85 °C
- Climatic category (IEC 60068-1:2013): 40/085/21

**Construction**

- Dielectric: polypropylene (PP)
- Electrode: metallized segmented film
- Dry type capacitor
- Plastic case (UL 94 V-0)
- Epoxy resin sealing (UL 94 V-0)

**Features**

- Humidity protected: +85°C / 85% rel. humidity (RH) at 350 V<sub>RMS</sub> for 1000 hour
- THB Grade III Test B
- (Refer to IEC60384-14:2013/AMD1:2016)
- Optimized AC voltage performance
- High ripple current/frequency handling capability
- Highest safety level 10 000 AFC to UL 810 <sup>1)</sup>
- For PCB mounting

**Terminals**

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

**Marking/Approval**

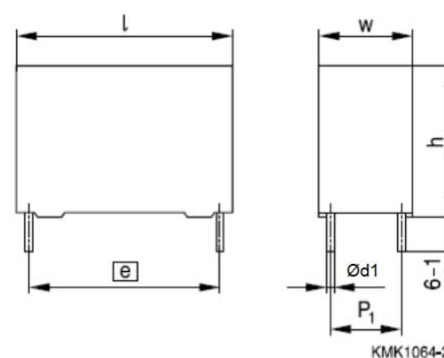
- See picture
- CE compliance to LV directive 2014/35/EU
- UL File E238746 <sup>1)</sup>

**Delivery mode**

- Bulk (untapped, lead length 6-1mm)


**Dimension drawing**

4-pin version


**Dimensions (in mm)**

Version	Lead space (e±0.4)	Lead diameter d1±0.05	Type
4 pins	52.5	1.2	B32354S

1) Certification ongoing and pending acc. to UL 810: Ed. 5

**Voltage ratings**

$V_{NDC}$	500 V DC
$V_{NAC}$	480 V AC
$V_{RMS}$	350 V AC

Note:  $V_{NAC}$  is maximum operating peak recurrent voltage of either polarity of a reversing type waveform, not an r.m.s value.

**Overview available types**

Lead spacing	52.5 mm
Type	B32354S
$V_{NDC}$ (V DC)	500
$V_{RMS}$ (V AC)	350
$C_R$ ( $\mu$ F)	
10	
15	
20	
22	
25	
30	
35	
40	

**Ordering codes and packing units (lead spacing 52.5 mm)**

V <sub>RMS</sub>	V <sub>NDC</sub>	C <sub>R</sub>	Ordering code	Max. dimensions w x h x l	P1	I <sub>max RMS</sub> <sup>1)</sup> 85 °C hot spot 80 °C case 10kHz	I <sub>peak</sub>	ESR (Typical) 10kHz	Packing units
V AC	V DC	μF		mm	mm	A	A	mΩ	pcs
350	500	10	B32354S3106K010	28.0 x 35.0 x 57.5	20.3	7	300	20	33
		15	B32354S3156K010	35.0 x 45.0 x 57.5	20.3	11	450	14	27
		20	B32354S3206K010	35.0 x 45.0 x 57.5	20.3	11	600	12	27
		22	B32354S3226K010	35.0 x 45.0 x 57.5	20.3	11	600	12	27
		25	B32354S3256K010	40.0 x 50.0 x 57.5	20.3	14	700	12	24
		30	B32354S3306K010	40.0 x 50.0 x 57.5	20.3	14	900	10	24
		35	B32354S3356K010	50.0 x 55.0 x 57.5	20.3	17	1000	10	18
		40	B32354S3406K010	50.0 x 55.0 x 57.5	20.3	17	1100	9	18

**Technical data**

Reference standard: IEC 61071:2007, all data given at T = +20 °C unless otherwise specified.

Upper category temperature T <sub>max</sub>	+85 °C
Rated temperature T <sub>R</sub>	+85 °C
Lower category temperature T <sub>min</sub>	-40 °C
Dissipation factor tan δ (in 10 <sup>-3</sup> ) at +20 °C and 1 kHz (upper limit values)	1.2
Insulation resistance R <sub>ins</sub> after 1 min, given as time constant τ = C <sub>R</sub> • R <sub>ins</sub> , (Minimum as-delivered values with rel. humidity ≤ 65%) Measuring voltage: 100VDC	10000s
AC testing voltage between terminals	1.65 • V <sub>NAC</sub> for 2 s
Testing voltage between terminal to case	2000 V AC at 50/60 Hz, 60 s (typical test)
Maximum peak current (A)	I <sub>P,max</sub> = C <sub>R</sub> • dv/dt
THB to high robustness under high humidity, refer to IEC 60384-14:2013/AMD1:2016 Grade III Test B	Temperature T: +85 °C ±2 °C Relative humidity: 85% ±2% Applied voltage: V <sub>RMS</sub> (50/60 Hz) Test duration: 1000 hrs
Criteria for passing THB test	Capacitance change  ΔC/C <sub>0</sub>   ≤ 10% Dissipation factor change Δtanδ( 1 kHz) ≤ 0.005 Insulation resistance R <sub>ins</sub> ≥ 50% specified limit
Change of temperature	In accordance with IEC 60068-2-14:2009 (Test Nb)
Reliability: Failure rate λ Service life t <sub>SL</sub>	5 fit (≤ 5 x 10 <sup>-9</sup> /h) at 0.5 • V <sub>RMS</sub> , +40 °C ≥ 100 000 h at V <sub>RMS</sub> (50/60 Hz)  For conversion to other operating conditions, refer to chapter "Quality, 2 Reliability"
Failure criteria Total failure Failure due to variation of parameters	Short circuit or open circuit Capacitance change  ΔC/C <sub>0</sub>   ≥ 10% Dissipation factor Δtanδ > 4 upper limit values Insulation resistance R <sub>ins</sub> or time constant τ = C <sub>R</sub> • R <sub>ins</sub> < 500 s

### Pulse handling capability

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

*Note:*

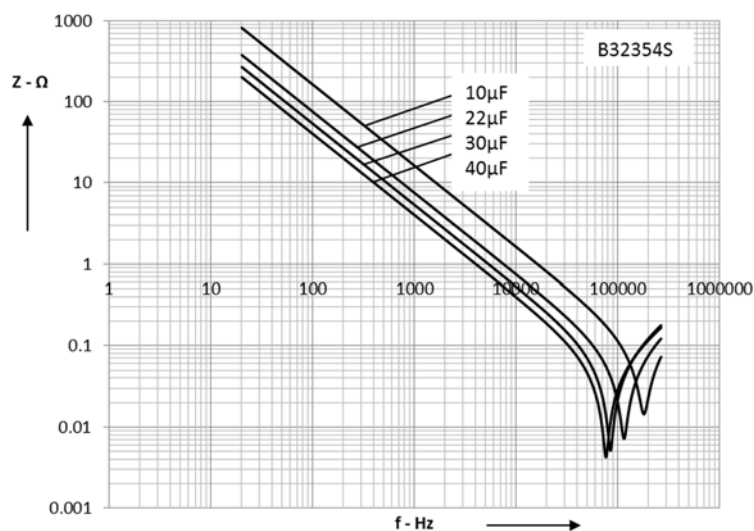
The values of dV/dt and k0 provided below must not be exceeded in order to avoid damaging the capacitor. These parameters are given for isolated pulses in such a way that the heat generated by one pulse will be completely dissipated before applying the next pulse. For a train of pulses, please refer to the curves of permissible AC voltage-current versus frequency

### dV/dt values

Lead spacing		52.5 mm
V <sub>RMS</sub>	V <sub>NDC</sub>	dV/dt in V/μs
V AC	V DC	
350	500	30

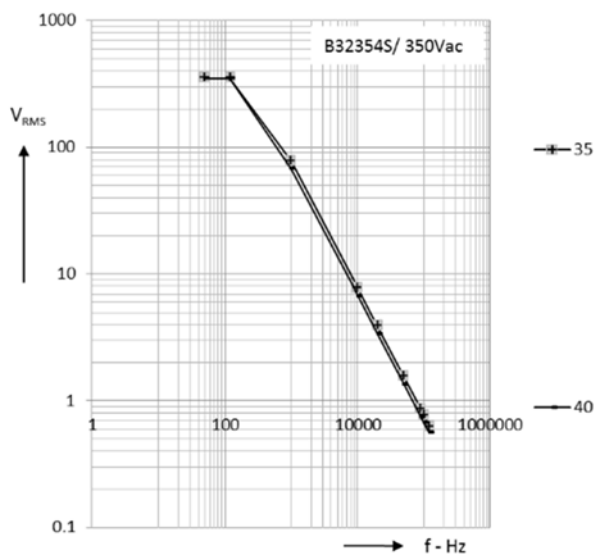
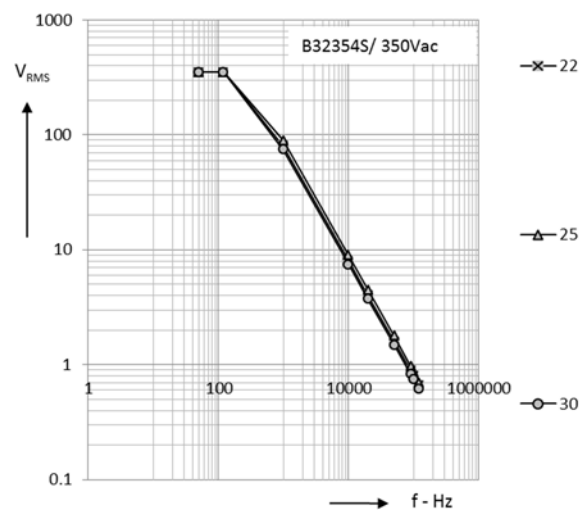
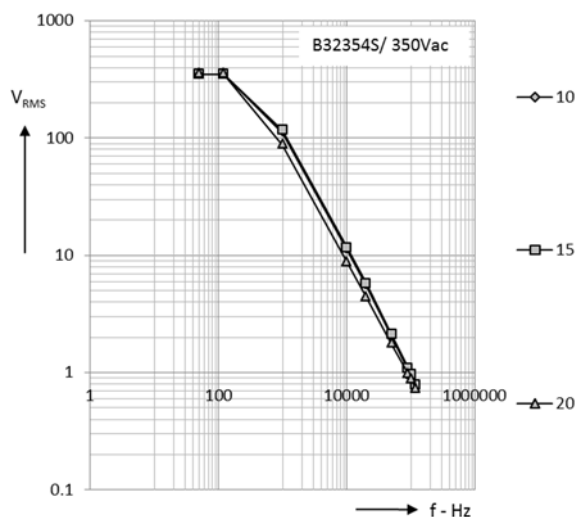
### Impedance Z versus frequency f

(typical values)



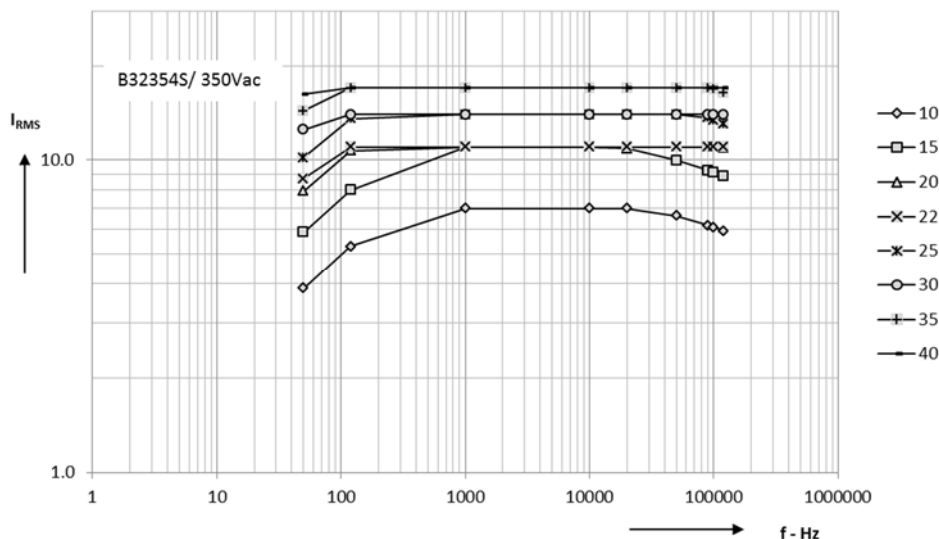
**Permissible AC voltage  $V_{RMS}$  versus frequency  $f$  (for sinusoidal waveforms,  $T_{case} \leq +80\text{ }^{\circ}\text{C}$ )**

 For  $T_{case} > +80\text{ }^{\circ}\text{C}$ , please refer to de-rating factor  $F_T$ .

**Lead spacing 52.5 mm**


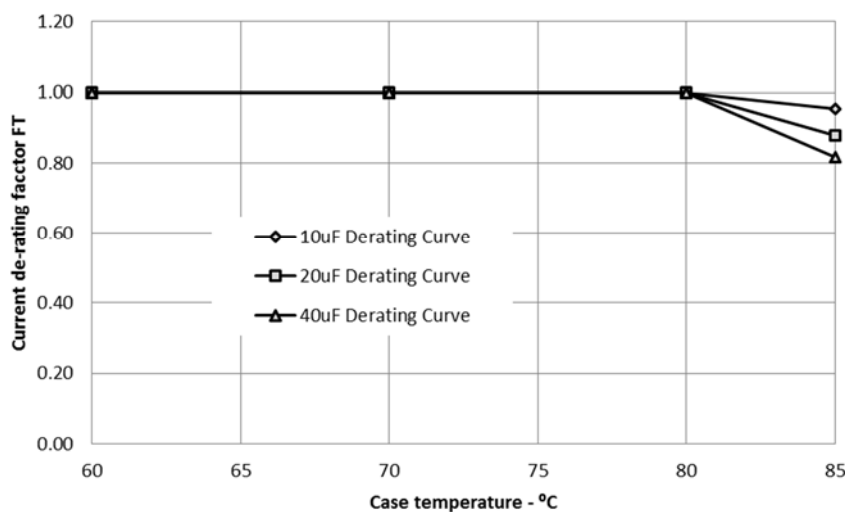
**Permissible current  $I_{RMS}$  versus frequency  $f$  (for sinusoidal waveforms,  $T_{case} \leq +80\text{ }^{\circ}\text{C}$ )**

 For  $T_{case} > +80\text{ }^{\circ}\text{C}$ , please refer to de-rating curve.

**Lead spacing 52.5 mm**

**Maximum AC current ( $I_{RMS}$ ) vs. temperature for  $T_{case} > +80\text{ }^{\circ}\text{C}$** 

The graphs described in the previous section for the permissible AC voltage ( $V_{RMS}$ ) or current ( $I_{RMS}$ ) vs. frequency ( $f > 50/60\text{ Hz}$ ) are given for a maximum case temperature  $T_{case} \leq +80\text{ }^{\circ}\text{C}$ . In case of higher capacitor surface temperatures ( $T_{case}$ ), to avoid the temperature of the hottest spot above maximum operating temperature, the de-rating factor  $F_T$  shall be applied in the following way:

$$I_{RMS}(T_{case}) = I_{RMS, T_{case} \leq 80^{\circ}\text{C}} * F_T(T_{case})$$

 And  $F_T$  is given by the following curve:




**Typical test**

Test description	Reference	Test conditions	Performance requirements		
Electricity parameters	IEC 61071:2007	Voltage between terminals: 1.5 V <sub>NAC</sub> , 60 s; Terminals and enclosure: 2000 V AC, 60 s; Insulation resistance R <sub>INS</sub> Capacitance C <sub>R</sub> Dissipation factor tanδ	Within specified limits No visible damage No flashover		
1 – Robustness of terminations	IEC 60068-2-21:2006	Tensile strength (test V <sub>a1</sub> )	Within specified limits		
		Wire diameter		Section	Tensile force
		0.5 < d1 ≤ 0.8 mm		≤ 0.5 m <sup>2</sup>	10 N
		0.8 < d1 ≤ 1.25 mm		≤ 1.2 m <sup>2</sup>	20 N
		Duration 10 s +/-1 s			
		Bending V <sub>b</sub> method 1			
		Wire diameter		Section	Tensile force
0.5 < d1 ≤ 0.8 mm	≤ 0.5 m <sup>2</sup>	10 N			
0.8 < d1 ≤ 1.25 mm	≤ 1.2 m <sup>2</sup>	20 N			
4 • 90 °C, Duration 2 s to 3 s/bend					
2 – Resistance to soldering heat	IEC 60068-2-20:2008	Solder bath temperature at 260 ± 5 °C, immersion for 10 seconds	ΔC/C <sub>0</sub>   ≤ 0.5% Increase of tanδ (10 kHz) ≤ 0.005 compared to initial value		
3 - Vibration	IEC 60068-2-6:2007	10 Hz to 55 Hz Amplitude ± 0.35mm or acceleration 98 m/s <sup>2</sup> Test duration: 10 frequency cycles, 3 axes offset from each other by 90° 1 octave/min Visual examination	No visible damage		
4 – Shocks or impact	IEC 60068-2-6:2007	Pulse shape: half sine Acceleration: 490 m/s <sup>2</sup> Duration of pulse: 11 ms Visual examination	No visible damage  ΔC/C <sub>0</sub>   ≤ 0.5% Increase of tanδ (10kHz) ≤ 0.005 compared to initial value		
5 – THB test (Grade III Test B, high robustness under high humidity)	IEC 60384-14:2013/AM D1:2016	85 °C/85% relative humidity/V <sub>RMS</sub> /1000 h	No visible damage  ΔC/C <sub>0</sub>   ≤ 10% Δtanδ (1 kHz) ≤ 0.005 R <sub>INS</sub> ≥ 50% specified limit		

6 – Surge test	IEC 61071: 2007	$1.1 \cdot V_{NDC}$ or $\hat{I}_{test} = 1.1 \hat{I}_{max}$ Number of discharges: 5 Time lapse: every 2 min (10 min total) Within 5 min after the surge discharge test Duration 10 s, $1.5 \cdot V_{NAC}$ at $T_{amb.}$	No visible damage $ \Delta C/C_0  \leq 1.0\%$ $\tan \delta (10 \text{ kHz}) \leq 1.2$ initial $\tan \delta +0.0001$
9- Self-healing	IEC 61071: 2007	$1.5 \cdot V_{NAC}$ Duration 10 s Number of clearings $\leq 5$ Increase the voltage at 100 V/s till 5 clearings occur with a max. of $2.5 \cdot V_{NAC}$ for a duration of 10 s	$ \Delta C/C_0  \leq 0.5\%$ $\tan \delta (10 \text{ kHz}) \leq 1.2$ initial $\tan \delta +0.0001$
10 – Environmental	IEC 61071: 2007	Change of temperature acc. to IEC 60068-2-14 Test $N_b$ $T_{max} = +105 \text{ }^\circ\text{C}$ $T_{min.} = -40 \text{ }^\circ\text{C}$ Transition time: 1 h, equivalent to $1 \text{ }^\circ\text{C}/\text{min}$ 5 cycles Damp heat steady state acc. to IEC 60068-2-78 Test $C_a$ $T = 40 \text{ }^\circ\text{C} \pm 2 \text{ }^\circ\text{C}$ $\text{RH} = 93\% \pm 3 \%$ Duration 56 days High voltage between terminal: $1.5 \cdot V_{NDC}$ at ambient temperature Duration 10 s	No puncturing or flashover Self-healing punctures permitted $ \Delta C/C_0  \leq 2\%$ Increase of $\tan \delta (10 \text{ kHz}) \leq 0.015$
11 – Thermal stability test under overload conditions	IEC 61071: 2007	Natural cooling $T_{amb} \pm 5 \text{ }^\circ\text{C}$ $1.21 \cdot P_{max.} = (U/2) \cdot W2 \cdot C \cdot \tan \delta = 1.21 \cdot (I_{2max.}/W2 \cdot C) \cdot \tan \delta^2$ $W2 = 2 \times \pi \cdot f2$ $I_{max.}$ (see specific reference data) $f2 = 10 \text{ kHz}$ $\tan \delta^2 = \tan \delta$ at 10 kHz Duration 48 h Measure the temperature every 1.5 h during the last 6 h	Temperature rise $< 1^\circ\text{C}$ $ \Delta C/C_0  \leq 2\%$ Increase of $\tan \delta (10 \text{ kHz}) \leq 1.2$ initial $\tan \delta (10 \text{ kHz}) + 0.015$

12 – Endurance test between terminal	IEC 61071: 2007	Sequence $1.25 \cdot V_{RMS}$ at $T_{case} = 85 \text{ }^\circ\text{C}$ Duration 500 h 1000 x discharge cycles at $1.4 \cdot I$ (maximum repetitive peak current in continuous operation $1.25 \cdot V_{RMS}$ at $T_{case} = 85 \text{ }^\circ\text{C}$ Duration 500 h	$ \Delta C/C0  \leq 3\%$ Increase of $\tan\delta$ (10kHz) $\leq 0.015$ compared to initial value
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## Mounting guidelines

### 1. Soldering

#### 1.1 Solderability of leads

The solderability of terminal leads is tested to IEC 60068-2-20:2008, 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  $155 \text{ }^\circ\text{C}$ ). 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.

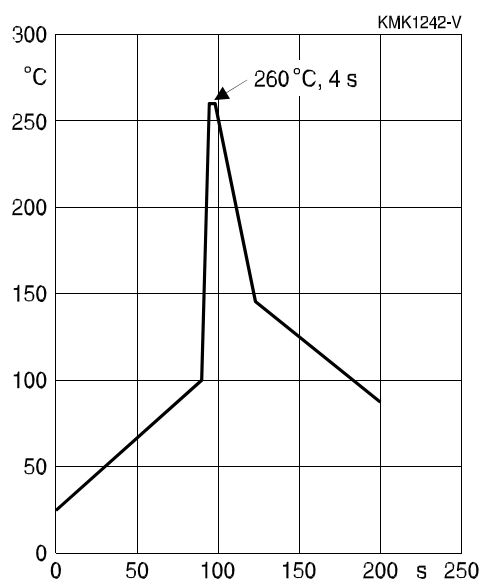
Solder bath temperature	$235 \pm 5 \text{ }^\circ\text{C}$
Soldering time	$2.0 \pm 0.5 \text{ s}$
Immersion depth	$2.0 +0/-0.5 \text{ mm}$ from capacitor body or seating plane
Evaluation criteria: Visual inspection	Wetting of wire surface by new solder $\geq 90\%$ , free-flowing solder

#### 1.2 Resistance to soldering heat

Resistance to soldering heat is tested to IEC 60068-2-20:2008, test Tb, method 1A.

Conditions:

Series	Solder bath temperature	Soldering time
MKT boxed (except $2.5 \times 6.5 \times 7.2 \text{ mm}$ ) coated, uncoated (lead spacing $> 10 \text{ mm}$ )	$260 \pm 5 \text{ }^\circ\text{C}$	$10 \pm 1 \text{ s}$
MFP MKP (lead spacing $> 7.5 \text{ mm}$ )		
MKT boxed (case $2.5 \times 6.5 \times 7.2 \text{ mm}$ )	$260 \pm 5 \text{ }^\circ\text{C}$	$5 \pm 1 \text{ s}$
MKP (lead spacing $\leq 7.5 \text{ mm}$ )		$< 4 \text{ s}$
MKT uncoated (lead spacing $\leq 10 \text{ mm}$ ) insulated (B32559)		recommended soldering profile for MKT uncoated (lead spacing $\leq 10 \text{ mm}$ ) and insulated (B32559)



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

### 1.3 General notes on soldering

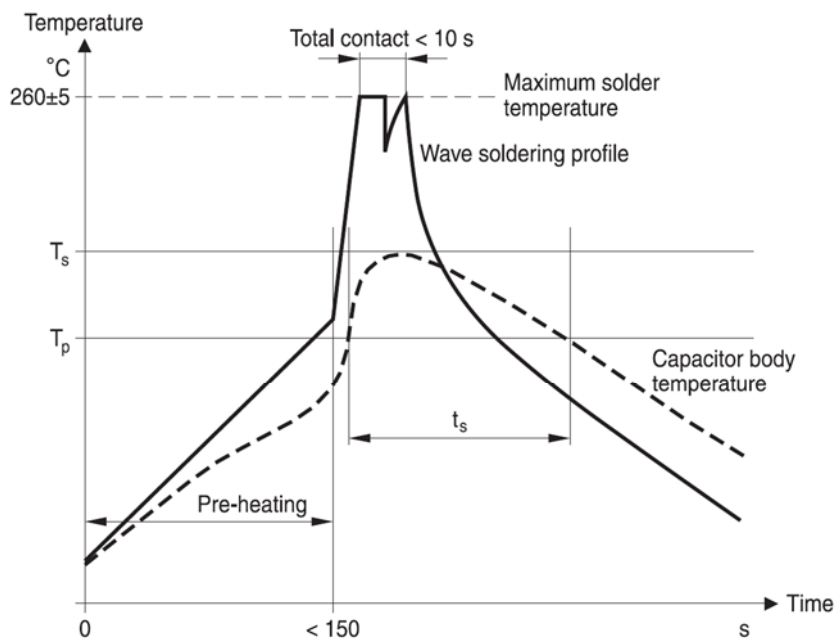
Permissible heat exposure loads on film capacitors are primarily characterized by the upper category temperature  $T_{max}$ . Long exposure to temperatures above this type-related temperature limit can lead to changes in the plastic dielectric and thus change irreversibly a capacitor's electrical characteristics. For short exposures (as in practical soldering processes) the heat load (and thus the possible effects on a capacitor) will also depend on other factors like:

- Pre-heating temperature and time
- Forced cooling immediately after soldering Terminal characteristics:
- diameter, length, thermal resistance, special configurations (e.g. crimping) Height of capacitor above solder bath
- Shadowing by neighboring components
- Additional heating due to heat dissipation by neighboring components Use of solder-resist coatings

The overheating associated with some of these factors can usually be reduced by suitable countermeasures. For example, if a pre-heating step can't be avoided, an additional or reinforced cooling process may possibly have to be included.

### Recommends

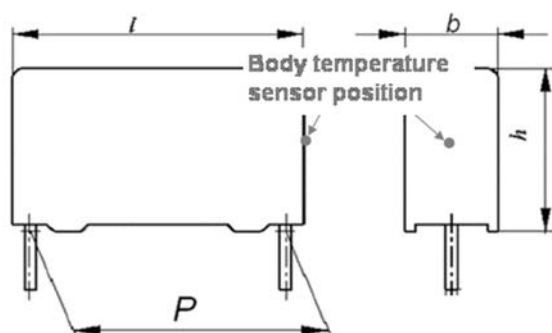
As a reference, the recommended wave soldering profile for our film capacitors is as follows:



$T_s$ : 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:  $T_p \leq 110 \text{ }^\circ\text{C}$

During soldering:  $T_s \leq 120 \text{ }^\circ\text{C}$ ,  $t_s \leq 45 \text{ s}$

■ MKT capacitor:

During preheating:  $T_p \leq 125 \text{ }^\circ\text{C}$

During soldering:  $T_s \leq 160 \text{ }^\circ\text{C}$ ,  $t_s \leq 45 \text{ s}$

When SMD components are used together with leaded ones, the film capacitors should not pass into the SMD adhesive curing oven. The leaded components should be assembled after the SMD curing step.

Leaded film capacitors are not suitable for reflow soldering.

In order to ensure proper conditions for manual or selective soldering, the body temperature ( $T_s$ ) must be  $\leq 120^\circ\text{C}$ .

One recommended condition for manual soldering is that the tip of the soldering iron should be  $< 360 \text{ }^\circ\text{C}$  and the soldering contact time should be no longer than 3 seconds.

For uncoated MKT capacitors with lead spacing  $< 10 \text{ mm}$  (B32560/B32561) the following measures are recommended:

- Pre-heating to not more than  $110 \text{ }^\circ\text{C}$  in the preheater phase
- Rapid cooling after soldering

Please refer to the Film Capacitor 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.
- Component is non-serviceable/non-repairable.

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. We offer 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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## Important notes

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[QXL2E473KTPT](#) [445450-1](#) [B25669A3996J375](#) [46KI322000M1M](#) [46KR415050M1K](#) [4BSNBX4100ZBFJ](#) [MKP383510063JKP2T0](#)  
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