Film Capacitors – AC Capacitors

Metallized Polypropylene Film Capacitors (MKP)

Series/Type: **B32354S**
Ordering code: **B32354S3***

Date: February 2019
Version: 2

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 RMS 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
- For PCB mounting

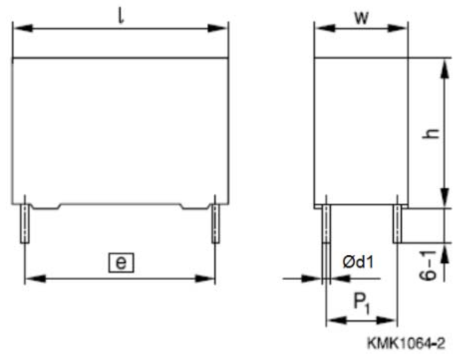
Terminals
- Parallel wire leads, lead-free tinned
- 4 pins version
- Special lead lengths available on request

Marking/Approval
- See picture
- CE compliance to LV directive 2014/35/EU
- UL approved (UL File E238746)

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

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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 (µF)	
10	
15	
20	
25	
30	
35	
40	

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Ordering codes and packing units (lead spacing 52.5 mm)

V_{RMS} V AC	V_{NDC} V DC	C_R µF	Ordering code	Max. dimensions w x h x l mm	P1 mm	I max RMS [1)] 10kHz A	I peak A	ESR (Typical) 10kHz mΩ	Packing units pcs
350	500	10	B32354S3106K010	28.0 x 35.0 x 57.5	10.2	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
		25	B32354S3256K010	40.0 x 50.0 x 57.5	20.3	14	700	12	24
		30	B32354S3306K010	42.0 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

1) Imax – Maximum RMS current for continuous operation defined for a hotspot of ≤ 85ºC, case temperature of ≤ 80ºC, at frequency of 10 kHz

Technical data

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

Upper category temperature T_{max}	+85 °C
Rated temperature T_R	+85 °C
Lower category temperature T_{min}	-40 °C
Dissipation factor tan δ (in 10^{-3}) at +20 °C and 1 kHz (upper limit values)	1.2
Insulation resistance R_{ins} after 1 min, given as time constant $\tau = C_R \bullet R_{ins}$, (Minimum as-delivered values with rel. humidity ≤ 65%) Measuring voltage: 100VDC	10000s
AC testing voltage between terminals	$1.65 \bullet V_{NAC}$ for 2 s
Testing voltage between terminal to case	2000 V AC at 50/60 Hz, 60 s (typical test)
Maximum peak current (A)	$I_{P,max}=C_R \bullet dv/dt$
THB to high robustness under high humidity, refer to IEC 60384-14:2013/AMD1:2016 Grade III Test B	Temperature T: +85 °C ±2 ºC Relative humidity: 85% ±2% Applied voltage: V_{RMS}(50/60 Hz) Test duration:1000 hrs
Criteria for passing THB test	Capacitance change $\|\Delta C/C_0\| \leq 10\%$ Dissipation factor change Δtanδ(1 kHz) ≤ 0.005 Insulation resistance R_{ins} ≥ 50% specified limit
Change of temperature	In accordance with IEC 60068-2-14:2009 (Test Nb)
Reliability: Failure rate λ Service life t_{SL} Failure criteria Total failure Failure due to variation of parameters	5 fit (≤ 5 x 10^{-9}/h) at $0.5 \bullet V_{RMS}$, +40 ºC ≥ 100 000 h at V_{RMS} (50/60 Hz) For conversion to other operating conditions, refer to chapter “Quality, 2 Reliability” Short circuit or open circuit Capacitance change $\|\Delta C/C_0\| \geq 10\%$ Dissipation factor Δtanδ > 4 upper limit values Insulation resistance R_{ins} or time constant $\tau = C_R \bullet R_{ins}$ < 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:

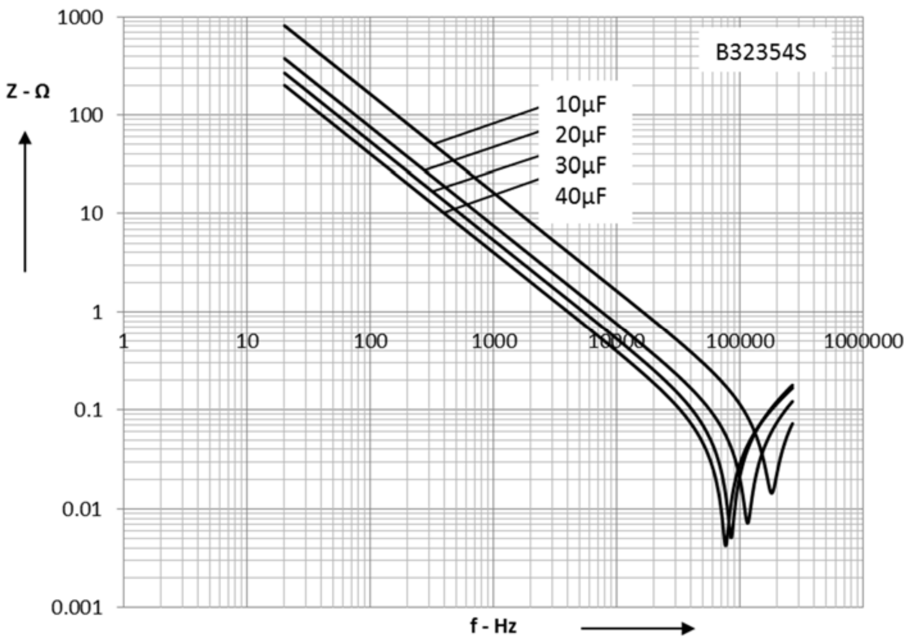
The values of dV/dt and k0 provided below must not be exceeded in order to avoid damaging the capacitor. These parameters are given for isolated pulses in such a way that the heat generated by one pulse will be completely dissipated before applying the next pulse. For a train of pulses, please refer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

dV/dt values

Lead spacing		52.5 mm
V_{RMS} V AC	V_{NDC} V DC	dV/dt in V/µs
350	500	30

Impedance Z versus frequency f

(typical values)



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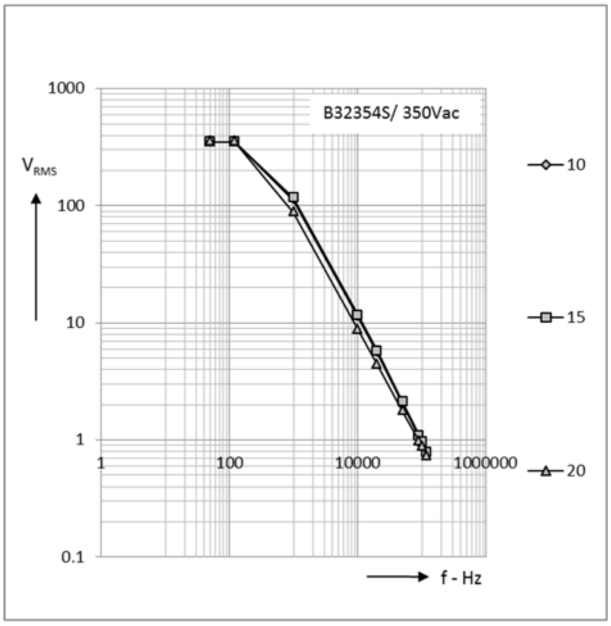
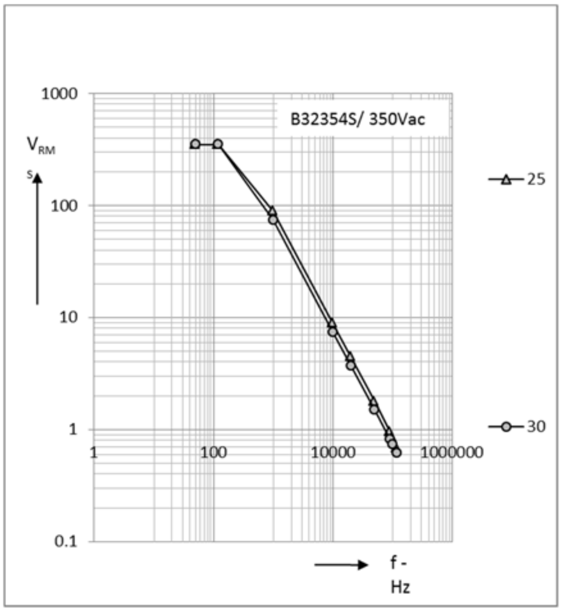
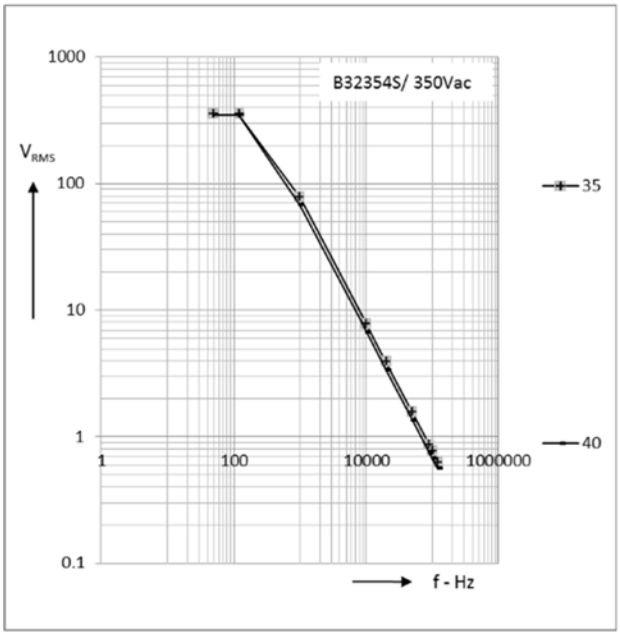
Permissible AC voltage V_{RMS} versus frequency f (for sinusoidal waveforms, $T_{case} \leq +80$ ºC)
For $T_{case} > +80$ ºC, please refer to de-rating factor F_T.

Lead spacing 52.5 mm







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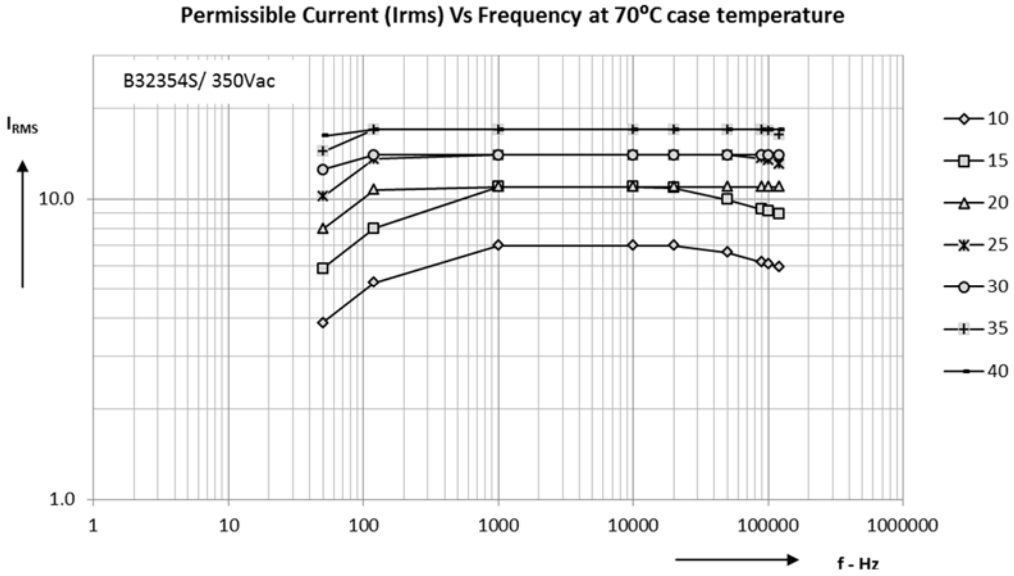
Permissible current I_{RMS} versus frequency f (for sinusoidal waveforms, $T_{case} \leq +80$ ºC)

For $T_{case} > +80$ ºC, please refer to de-rating curve.

Lead spacing 52.5 mm

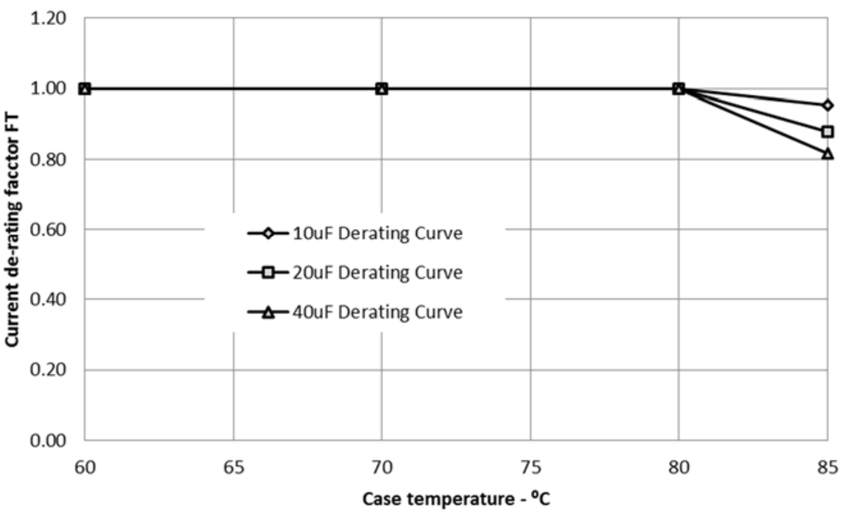


Maximum AC current (I_{RMS}) vs. temperature for $T_{case} > +80$ ºC

The graphs described in the previous section for the permissible AC voltage (V_{RMS}) or current (I_{RMS}) vs. frequency (f > 50/60 Hz) are given for a maximum case temperature $T_{case} \leq +80$ ºC. 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:

$I_{RMS}(T_{case}) = I_{RMS,Tcase \leq 80ºC} * F_T(T_{case})$

And F_T is given by the following curve:



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Typical test

<table>
<tr><th>Test description</th><th>Reference</th><th colspan="3">Test conditions</th><th>Performance requirements</th></tr>
<tr><td>Electricity parameters</td><td>IEC 61071: 2007</td><td colspan="3">Voltage between terminals: 1.5 V_{NAC}, 60 s;
Terminals and enclosure: 2000 V AC, 60 s;
Insulation resistance R_{INS}
Capacitance C_R
Dissipation factor tanδ</td><td>Within specified limits
No visible damage
No flashover</td></tr>
<tr><td rowspan="9">1 – Robustness of terminations</td><td rowspan="9">IEC 60068-2-21:2006</td><td colspan="3">Tensile strength (test V_a1)</td><td rowspan="9">Within specified limits</td></tr>
<tr><td>Wire diameter</td><td>Section</td><td>Tensile force</td></tr>
<tr><td>0.5 < d1 ≤ 0.8 mm
0.8 < d1 ≤ 1.25 mm</td><td>≤ 0.5 m^2
≤ 1.2 m^2</td><td>10 N
20 N</td></tr>
<tr><td colspan="3">Duration 10 s +/-1 s</td></tr>
<tr><td colspan="3">Bending V_b method 1</td></tr>
<tr><td>Wire diameter</td><td>Section</td><td>Tensile force</td></tr>
<tr><td>0.5 < d1 ≤ 0.8 mm
0.8 < d1 ≤ 1.25 mm</td><td>≤ 0.5 m^2
≤ 1.2 m^2</td><td>10 N
20 N</td></tr>
<tr><td colspan="3">4 • 90 °C, Duration 2 s to 3 s/bend</td></tr>
<tr></tr>
<tr><td>2 – Resistance to soldering heat</td><td>IEC 60068-2-20:2008</td><td colspan="3">Solder bath temperature at 260 ± 5 °C, immersion for 10 seconds</td><td>$|\Delta C/C_0| \leq 0.5\%$
Increase of tanδ (10 kHz) ≤ 0.005 compared to initial value</td></tr>
<tr><td>3 - Vibration</td><td>IEC 60068-2-6:2007</td><td colspan="3">10 Hz to 55 Hz
Amplitude ± 0.35mm or acceleration 98 m/s^2
Test duration: 10 frequency cycles, 3 axes offset from each other by 90°
1 octave/min
Visual examination</td><td>No visible damage</td></tr>
<tr><td>4 – Shocks or impact</td><td>IEC 60068-2-6:2007</td><td colspan="3">Pulse shape: half sine
Acceleration: 490 m/s^2
Duration of pulse: 11 ms
Visual examination</td><td>No visible damage
$|\Delta C/C_0| \leq 0.5\%$
Increase of tanδ (10kHz)≤0.005 compared to initial value</td></tr>
<tr><td>5 – THB test (Grade III Test B, high robustness under high humidity)</td><td>IEC 60384-14:2013/AMD1:2016</td><td colspan="3">85 °C/85% relative humidity/V_{RMS} /1000 h</td><td>No visible damage
$|\Delta C/C_0| \leq 10\%$
Δtanδ (1 kHz) ≤ 0.005
R_{INS} ≥ 50% specified limit</td></tr>
</table>

6 – Surge test	IEC 61071: 2007	$1.1 \bullet V_{NDC}$ 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, $1.5 \bullet V_{NAC}$ at $T_{amb.}$	No visible damage $\lvert \Delta C/C_0 \rvert \leq 1.0\%$ $\tan\delta$ (10 kHz) $\leq$ 1.2 initial $\tan\delta$ +0.0001
9 - Self-healing	IEC 61071: 2007	$1.5 \bullet V_{NAC}$ Duration 10 s Number of clearings $\leq$ 5 Increase the voltage at 100 V/s till 5 clearings occur with a max. of $2.5 \bullet V_{NAC}$ for a duration of 10 s	$\lvert \Delta C/C_0 \rvert \leq 0.5\%$ tan δ (10 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 °C $T_{min.}$ = -40 °C Transition time: 1 h, equivalent to 1 °C/min 5 cycles Damp heat steady state acc. to IEC 60068-2-78 Test C_a T = 40 °C ±2 °C RH = 93% ± 3 % Duration 56 days High voltage between terminal: $1.5 \bullet V_{NDC}$ at ambient temperature Duration 10 s	No puncturing or flashover Self-healing punctures permitted $\lvert \Delta C/C_0 \rvert \leq 2\%$ Increase of $\tan\delta$ (10 kHz) $\leq$ 0.015
11 – Thermal stability test under overload conditions	IEC 61071: 2007	Natural cooling Tamb ± 5 °C $1.21 \bullet P_{max.} = (U2/2) \bullet W2 \bullet C \bullet \tan\delta = 1.21 \bullet (I2_{max.}/W2 \bullet C) \bullet \tan\delta2$ $W2 = 2 \times \pi \bullet f2$ Imax. (see specific reference data) f2 = 10 kHz $\tan\delta2 = \tan\delta$ at 10 kHz Duration 48 h Measure the temperature every 1.5 h during the last 6 h	Temperature rise < 1°C $\lvert \Delta C/C0 \rvert \leq 2\%$ Increase of $\tan\delta$ (10 kHz) $\leq$ 1.2 initial $\tan\delta$ (10 kHz)+ 0.015

12 – Endurance test between terminal	IEC 61071: 2007	Sequence 1.25 • V_{RMS} at Tcase = 85 °C Duration 500 h 1000 x discharge cycles at 1.4 • I (maximum repetitive peak current in continuous operation 1.25 • V_{RMS} at Tcase = 85 °C Duration 500 h	IΔC/C0 I $\leq$ 3% Increase of tanδ (10kHz) $\leq$ 0.015 compared to initial value

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.

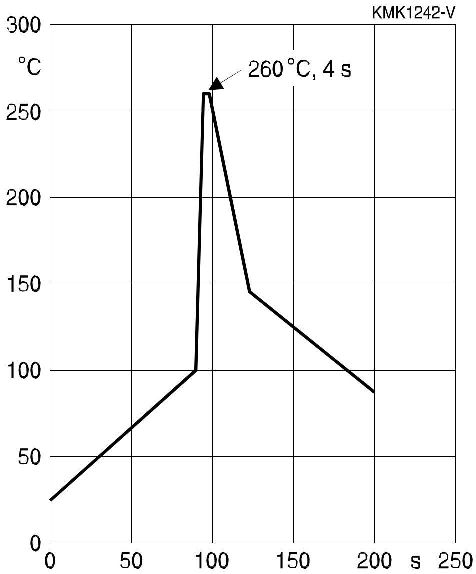
Before a solderability test is carried out, terminals are subjected to accelerated ageing (to IEC 60068-2-2:2007, test Ba: 4 h exposure to dry heat at 155 C). Since the ageing temperature is far higher than the upper category temperature of the capacitors, the terminal wires should be cut off from the 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 60068-2-20:2008, 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) 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

1.3 General notes on soldering

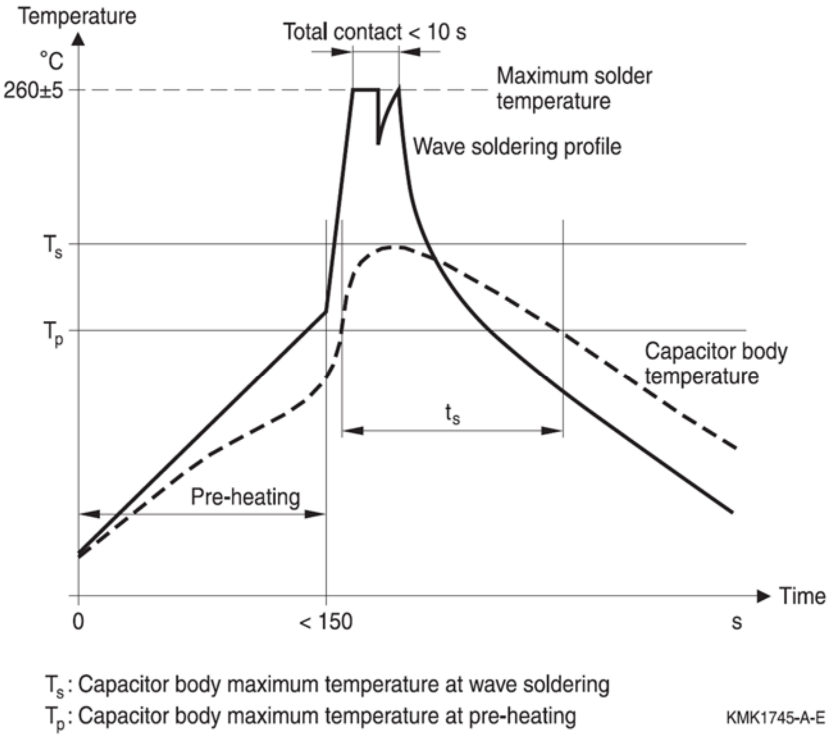
Permissible heat exposure loads on film capacitors are primarily characterized by the upper category temperature T_{max}. Long exposure to temperatures above this type-related temperature limit can lead to changes in the plastic dielectric and thus change irreversibly a capacitor's electrical characteristics.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

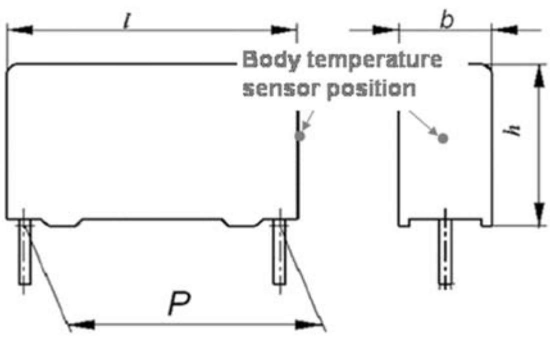
- Pre-heating temperature and time
- Forced cooling immediately after soldering Terminal characteristics:
- diameter, length, thermal resistance, special configurations (e.g. crimping) Height of capacitor above solder bath
- Shadowing by neighboring components
- Additional heating due to heat dissipation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





Body temperature should follow the description below:

- MKP capacitor:

  During pre-heating: $T_p \leq 110\ ^oC$

  During soldering: $T_s \leq 120\ ^oC$, $t_s \leq 45$ s

- MKT capacitor:

  During preheating: $T_p \leq 125\ ^oC$

  During soldering: $T_s \leq 160\ ^oC$, $t_s \leq 45$ 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 (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 spacing <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 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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