Film Capacitors

Metallized Polypropylene Film Capacitors (MKP)

Series/Type: **B32613, B32614**

Date: September 2018

Typical applications
- Electronic ballasts
- Switch-mode power supplies

Climatic
- Max. operating temperature: 110 °C
- Climatic category (IEC 60068-1:2013): 55/100/56

Construction
- Dielectric: polypropylene (PP)
- Wound capacitor technology
- Epoxy resin coating (UL 94 V-0)

Features
- Very high pulse strength
- RoHS-compatible

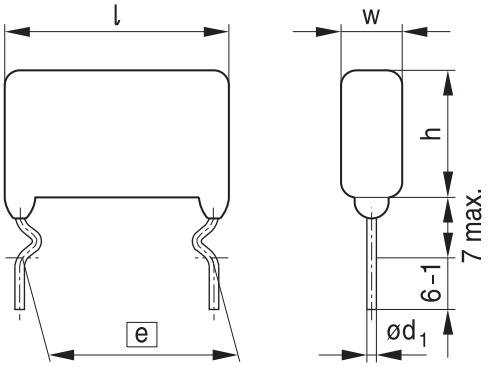
Terminals
- Crimped wire leads, lead-free tinned, lead length (6 −1) mm
- Double crimped wire leads, lead-free tinned
- Straight wire leads, lead-free tinned, lead length (17 ±3) mm
- Different lead spacings (reduced and enlarged) available, lead length (6 −1) mm

Marking
Manufacturer's logo, style and type (P61x),
rated capacitance (coded),
capacitance tolerance (code letter),
rated DC voltage, date of manufacture (code)

Delivery mode
Bulk (untaped)
Taped (Ammo pack or reel)
For notes on taping, refer to chapter "Taping and packing“.

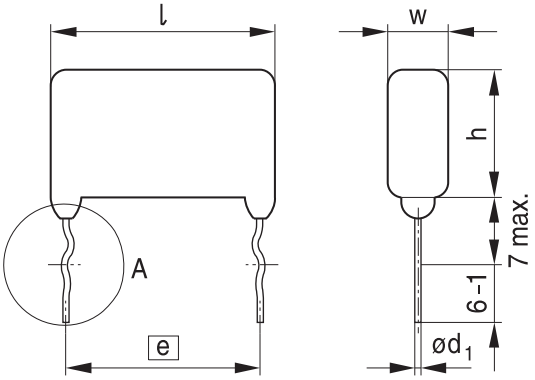
Dimensional drawings

Crimped leads



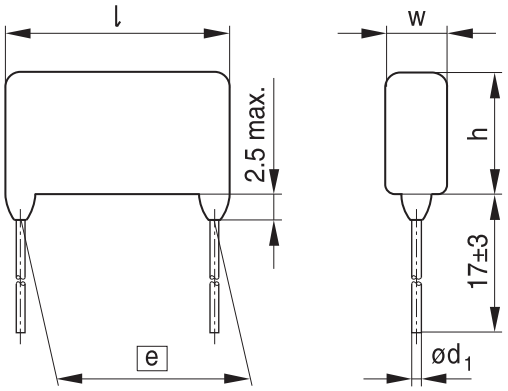
KMK0836-X-E

Double crimped leads



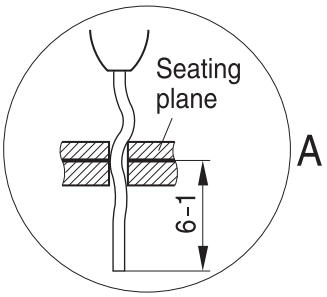
KMK0837-6-E

Straight leads



KMK1080-Z-E

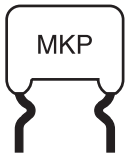
Detail of double crimped version



KMK0854-V-E

Dimensions in mm

Lead spacing e ±0.8	Lead diameter d_1 ±0.05	Type
22.5	0.8	B32613
27.5	0.8	B32614



B32613, B32614

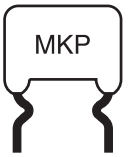
High pulse (wound)

Overview of available types

Lead spacing	22.5 mm						
Type	B32613						
Page	6						
V_R (V DC)	250	400	630	1000	1600	2000	2000
V_{RMS} (V AC)	160	200	250	250	500	700	1000
C_R (nF)							
3.3							
4.7							
6.8							
10							
15							
22							
33							
47							
68							
100							
150							
220							
330							
470							
680							
1000							

Lead configurations

Serie	Standard	Reduced	Enlarged	Straight	Double crimped
					
B32613	22.5 mm	15 / 17.5 / 20 mm	25 mm	22.5 mm	22.5 mm
B32614	27.5 mm	25 mm	–	27.5 mm	27.5 mm

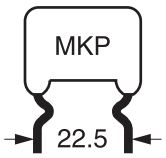


Overview of available types

Lead spacing	27.5 mm					
Type	B32614					
Page	8					
V_R (V DC)	250	400	630	1000	1600	2000
V_{RMS} (V AC)	160	200	250	250	500	700
C_R (nF)						
10						
15						
22						
33						
47						
68						
100						
150						
220						
470						
680						
1000						
1500						
2200						

Lead configurations

Serie	Standard	Reduced	Enlarged	Straight	Double crimped
					
B32613	22.5 mm	15 / 17.5 / 20 mm	25 mm	22.5 mm	22.5 mm
B32614	27.5 mm	25 mm	–	27.5 mm	27.5 mm



B32613

High pulse (wound)

Ordering codes and packing units (lead spacing 22.5 mm)

V_R V DC	V_{RMS} f ≤1 kHz V AC	C_R nF	Max. dimensions w × h × l mm	Ordering code (composition see below)	Ammo pack pcs./MOQ	Reel pcs./MOQ	Untaped pcs./MOQ
250	160	220	7.0 × 14.5 × 26.5	B32613A3224+***	2000	2800	2000
		330	7.0 × 14.5 × 26.5	B32613A3334+***	2000	2800	2000
		470	8.0 × 15.5 × 26.5	B32613A3474+***	1800	2400	2000
		680	9.5 × 16.0 × 26.5	B32613A3684+***	1400	2000	2000
		1000	11.0 × 19.0 × 26.5	B32613A3105+***	1200	1800	1000
400	200	150	7.0 × 13.5 × 26.5	B32613A4154+***	2000	2800	2000
		220	7.0 × 14.0 × 26.5	B32613A4224+***	2000	2800	2000
		330	8.0 × 16.0 × 26.5	B32613A4334+***	1800	2400	2000
		470	9.5 × 16.0 × 26.5	B32613A4474+***	1400	2000	1000
		680	11.5 × 17.5 × 26.5	B32613A4684+***	1200	1600	1000
630	250	100	7.0 × 12.5 × 26.5	B32613A6104+***	2000	2800	1000
		150	7.5 × 14.0 × 26.5	B32613A6154+***	1800	2600	1000
		220	9.0 × 15.5 × 26.5	B32613A6224+***	1600	2200	1000
		330	10.0 × 18.0 × 26.5	B32613A6334+***	1400	2000	1000
		470	11.0 × 20.0 × 26.5	B32613A6474+***	1200	1800	1000
1000	250	33	8.5 × 14.5 × 26.5	B32613A0333+***	1600	2200	2000
		47	10.0 × 15.5 × 26.5	B32613A0473+***	1400	2000	1000
		68	11.0 × 17.5 × 26.5	B32613A0683+***	1200	1800	1000
		100	10.0 × 16.5 × 26.5	B32613A0104+***	1400	2000	1000
		150	12.0 × 18.0 × 26.5	B32613A0154+***	1200	1600	1000
1600	500	10	7.0 × 13.5 × 26.5	B32613A1103+***	2000	2800	2000
		15	8.0 × 14.5 × 26.5	B32613A1153+***	1800	2400	2000
		22	9.0 × 17.0 × 26.5	B32613A1223+***	1600	2200	1000
		33	10.5 × 18.5 × 26.5	B32613A1333+***	1400	1800	1000

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

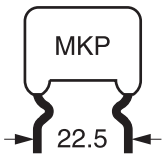
Composition of ordering code

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

*** = Packaging code:
- 289 = Ammo pack
- 189 = Reel
- 010 = Untaped crimped (lead length 6 −1 mm)
- 008 = Untaped straight (lead length 17±3 mm)
- 020 = Double crimped (lead length 6 −1 mm)

Packaging codes for further lead configurations (untaped):

Lead configuration (lead length 6 −1 mm)	Reduced	Reduced	Reduced	Enlarged
Lead spacing (mm)	15 mm	17.5 mm	20 mm	25 mm
Packaging code	055	060	070	080



Ordering codes and packing units (lead spacing 22.5 mm)

V_R V DC	V_{RMS} f ≤1 kHz V AC	C_R nF	Max. dimensions w × h × l mm	Ordering code (composition see below)	Ammo pack pcs./MOQ	Reel pcs./MOQ	Untaped pcs./MOQ
2000	700	3.3	7.0 × 13.0 × 26.5	B32613A2332+***	2000	2800	2000
		4.7	7.5 × 14.0 × 26.5	B32613A2472+***	1800	2600	2000
		6.8	8.5 × 16.0 × 26.5	B32613A2682+***	1600	2200	2000
		10	10.5 × 17.0 × 26.5	B32613A2103+***	1400	1800	1000
		15	12.0 × 20.5 × 26.5	B32613A2153+***	1200	1600	1000
2000	1000	3.3	8.0 × 14.5 × 26.5	B32613A8332+***	1800	2400	2000
		4.7	8.5 × 16.5 × 26.5	B32613A8472+***	1600	2200	1000
		6.8	10.0 × 18.5 × 26.5	B32613A8682+***	1400	2000	1000
		10	11.5 × 21.5 × 26.5	B32613A8103+***	1200	1600	1000

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

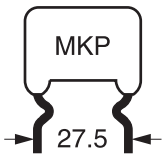
Composition of ordering code

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

*** = Packaging code:
289 = Ammo pack
189 = Reel
010 = Untaped crimped (lead length 6 −1 mm)
008 = Untaped straight (lead length 17±3 mm)
020 = Double crimped (lead length 6 −1 mm)

Packaging codes for further lead configurations (untaped):

Lead configuration (lead length 6 −1 mm)	Reduced	Reduced	Reduced	Enlarged
Lead spacing (mm)	15 mm	17.5 mm	20 mm	25 mm
Packaging code	055	060	070	080



B32614

High pulse (wound)

Ordering codes and packing units (lead spacing 27.5 mm)

V_R V DC	V_{RMS} f ≤1 kHz V AC	C_R nF	Max. dimensions w × h × l mm	Ordering code (composition see below)	Untaped pcs./MOQ
250	160	470	7.0 × 15.0 × 31.5	B32614A3474+***	2000
		680	8.0 × 16.5 × 31.5	B32614A3684+***	2000
		1000	9.5 × 17.5 × 31.5	B32614A3105+***	800
		1500	11.5 × 19.5 × 31.5	B32614A3155+***	800
		2200	14.0 × 22.0 × 31.5	B32614A3225+***	800
400	200	470	9.5 × 15.0 × 31.5	B32614A4474+***	800
		680	10.0 × 17.5 × 31.5	B32614A4684+***	800
		1000	11.5 × 19.5 × 31.5	B32614A4105+***	800
		1500	14.0 × 22.0 × 31.5	B32614A4155+***	800
		2200	16.5 × 24.5 × 31.5	B32614A4225+***	600
630	250	470	10.5 × 18.5 × 31.5	B32614A6474+***	800
		680	12.0 × 21.5 × 31.5	B32614A6684+***	800
		1000	14.0 × 24.0 × 31.5	B32614A6105+***	800
1000	250	100	11.5 × 17.5 × 31.5	B32614A0104+***	2000
		150	13.0 × 21.0 × 31.5	B32614A0154+***	800
		220	14.5 × 24.5 × 31.5	B32614A0224+***	800
1600	500	22	9.0 × 14.5 × 31.5	B32614A1223+***	2000
		33	10.5 × 16.0 × 31.5	B32614A1333+***	2000
		47	11.0 × 19.5 × 31.5	B32614A1473+***	800
		68	13.0 × 21.5 × 31.5	B32614A1683+***	800
2000	700	10	9.0 × 15.5 × 31.5	B32614A2103+***	2000
		15	11.0 × 17.5 × 31.5	B32614A2153+***	800
		22	13.0 × 19.5 × 31.5	B32614A2223+***	800
		33	14.5 × 23.0 × 31.5	B32614A2333+***	800
		47	16.5 × 25.5 × 31.5	B32614A2473+***	600

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

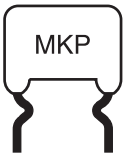
Composition of ordering code

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

*** = Packaging code:
- 010 = Untaped crimped (lead length 6 −1 mm)
- 008 = Untaped straight (lead length 17±3 mm)
- 020 = Double crimped (lead length 6 −1 mm)

Packaging codes for further lead configurations (untaped):

Lead configuration (lead length 6 −1 mm)	Reduced
Lead spacing (mm)	25 mm
Packaging code	090



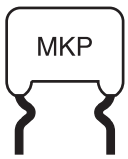
Technical data

Reference standard: IEC 60384-16:2005. All data given at T = 20 °C, unless otherwise specified.

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 δ (in 10^{-3}) at 20 °C (upper limit values)	at	$C_R \leq 0.1$ µF	0.1 µF < $C_R \leq 1$ µF	$C_R > 1$ µF
	1 kHz	–	0.5	0.5
	10 kHz	–	0.8	1.5
	100 kHz	5.0	–	–
Insulation resistance R_{ins} or time constant $\tau = C_R \cdot R_{ins}$ at 20 °C, rel. humidity ≤ 65% (minimum as-delivered values)	$C_R \leq 0.33$ µF	$C_R > 0.33$ µF		
	100 GΩ	30000 s		
DC test voltage	1.6 · V_R, 2 s			
Category voltage V_C (continuous operation with V_{DC} or V_{AC} at f ≤ 1 kHz)	T_{op} (°C)	DC voltage derating	AC voltage derating	
	$T_{op} \leq 85$	$V_C = V_R$	$V_{C,RMS} = V_{RMS}$	
	$85 < T_{op} \leq 100$	$V_C = V_R \cdot (165 - T_{op})/80$	$V_{C,RMS} = V_{RMS} \cdot (165 - T_{op})/80$	
Operating voltage V_{op} for short operating periods (V_{DC} or V_{AC} at f ≤ 1 kHz)	T_{op} (°C)	DC voltage (max. hours)	AC voltage (max. hours)	
	$T_{op} \leq 100$	$V_{op} = 1.25 \cdot V_C$ (2000 h)	$V_{op} = 1.0 \cdot V_{C,RMS}$ (2000 h)	
	$100 < T_{op} \leq 110$	$V_{op} = 1.25 \cdot V_C$ (1000 h)	$V_{op} = 1.0 \cdot V_{C,RMS}$ (1000 h)	
Reliability:				
Failure rate λ	1 fit (≤ 1 · 10^{-9} /h) at 0.5 · V_R, 40 °C			
Service life t_{SL}	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	Short circuit or open circuit			
Failure due to variation of parameters	Capacitance change |ΔC/C|	> 10%		
	Dissipation factor tan δ	> 4 · upper limit value		
	Insulation resistance R_{ins}	< 1500 MΩ ($C_R \leq 0.33$ µF)		
	or time constant $\tau = C_R \cdot R_{ins}$	< 500 s ($C_R > 0.33$ µF)		

Characteristic voltages V_{DC}, V_{AC}, V_{pp}

V_{DC} V	V_{AC} V	V_{pp} V
1000	250	700
1250	500	1250
1600	500	1400
1600	700	1600
2000	700	1600
2000	1000	2000



Pulse handling capability

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

"k_0" represents the maximum permissible pulse characteristic of the waveform applied to the capacitor, expressed in $V^2/\mu s$.

Note:
The values of dV/dt and k_0 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.

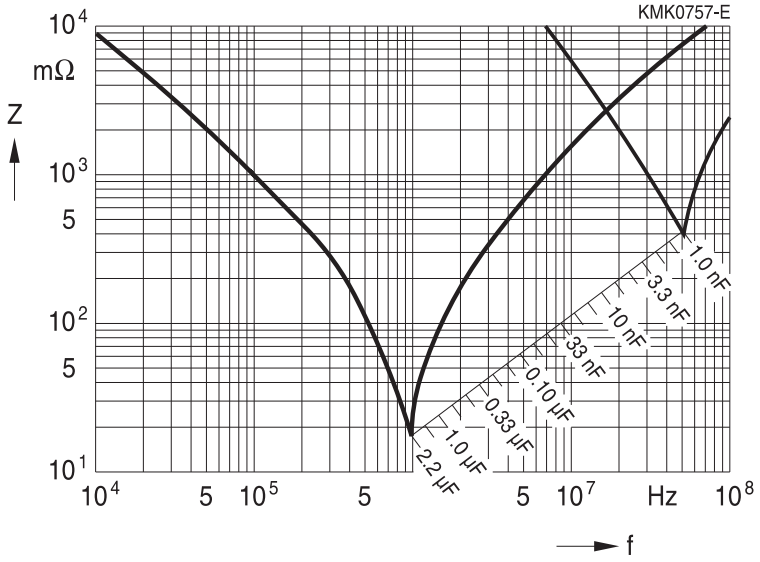
dV/dt values

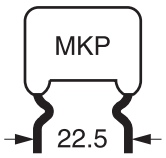
Lead spacing		22.5 mm	27.5 mm
V_R	V_{RMS}		
V DC	V AC	dV/dt in V/µs	
250	160	120	50
400	200	180	100
630	250	300	150
1000	250	600	300
1250	500	1150	600
1600	500	2400	1000
1600	700	–	–
2000	700	7000	2300
2000	1000	7500	–

k_0 values

Lead spacing		22.5 mm	27.5 mm
V_R	V_{RMS}		
V DC	V AC	k_0 in $V^2/\mu s$	
250	160	60 000	25 000
400	200	200 000	110 000
630	250	350 000	250 000
1000	250	1 500 000	1 000 000
1250	500	3 750 000	2 000 000
1600	500	10 000 000	4 000 000
1600	700	–	–
2000	700	40 000 000	15 000 000
2000	1000	50 000 000	–

Impedance Z versus frequency f
(typical values)





B32613

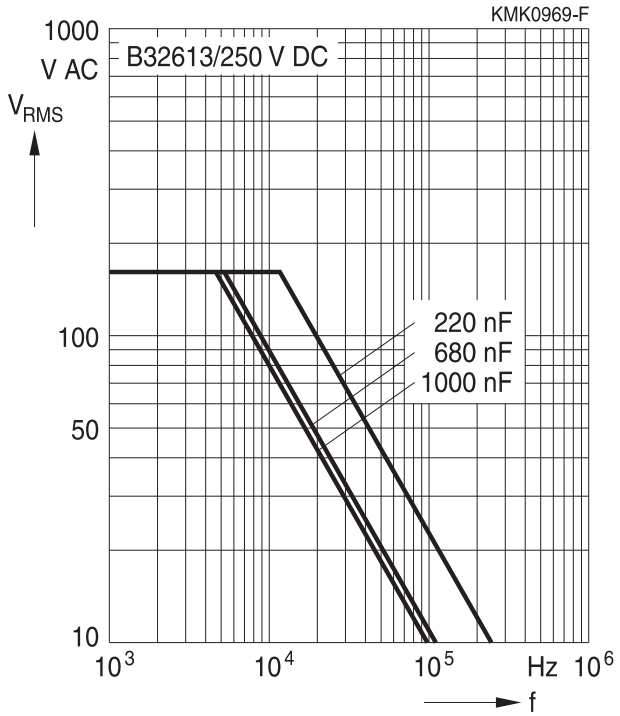
High pulse (wound)

Permissible AC voltage V_{RMS} versus frequency f (for sinusoidal waveforms, $T_A \leq 90$ °C)

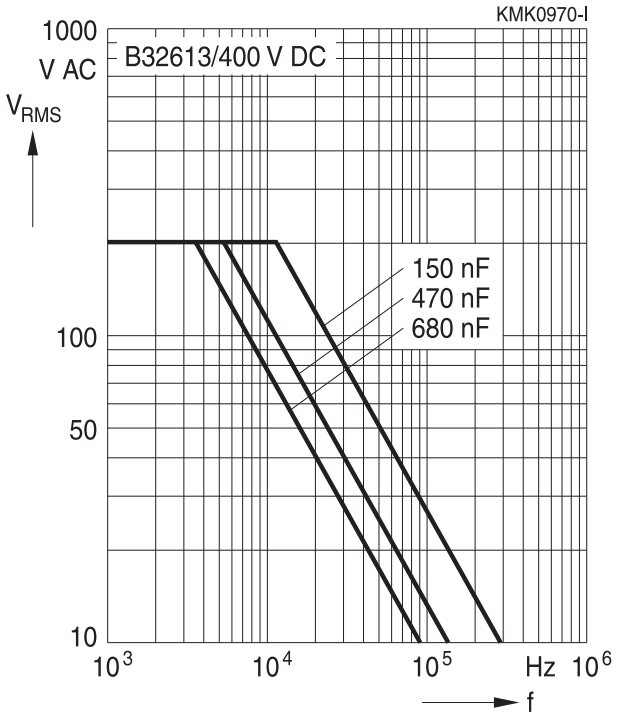
For T_A >90 °C, please use derating factor F_T.

Lead spacing 22.5 mm

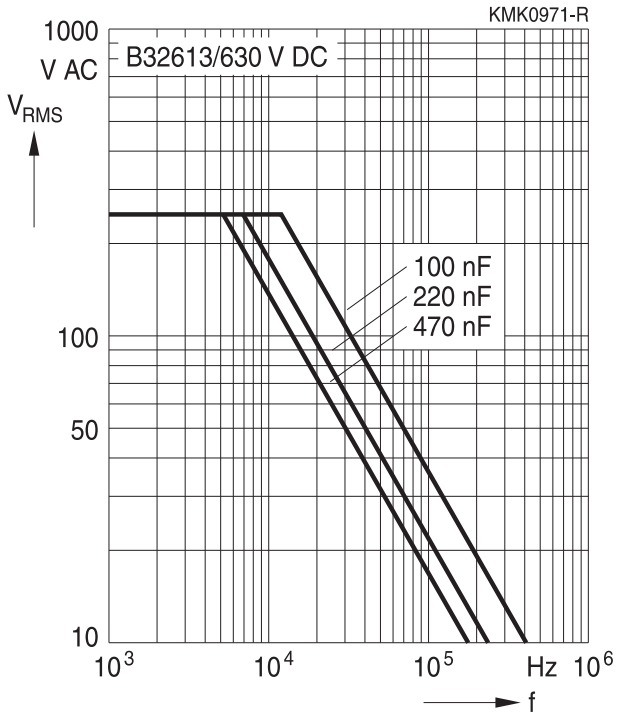
250 V DC/160 V AC



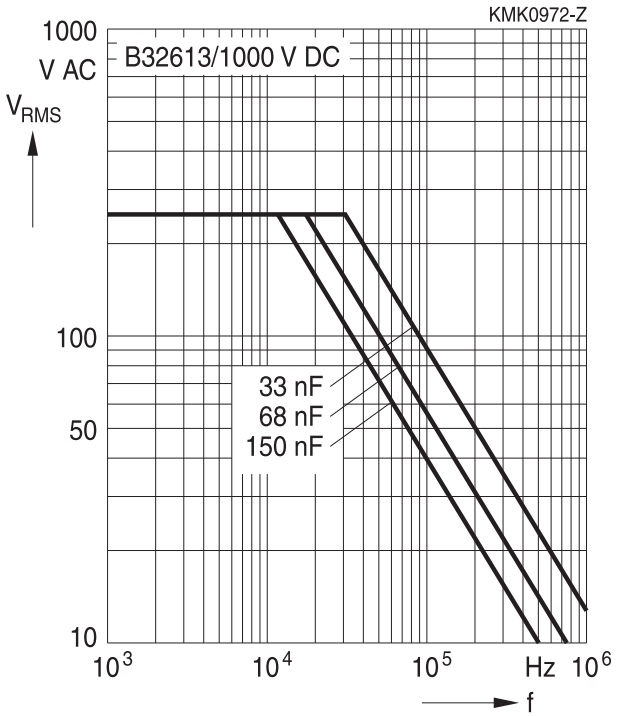
400 V DC/200 V AC

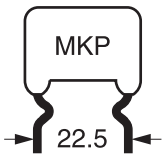


630 V DC/250 V AC



1000 V DC/250 V AC



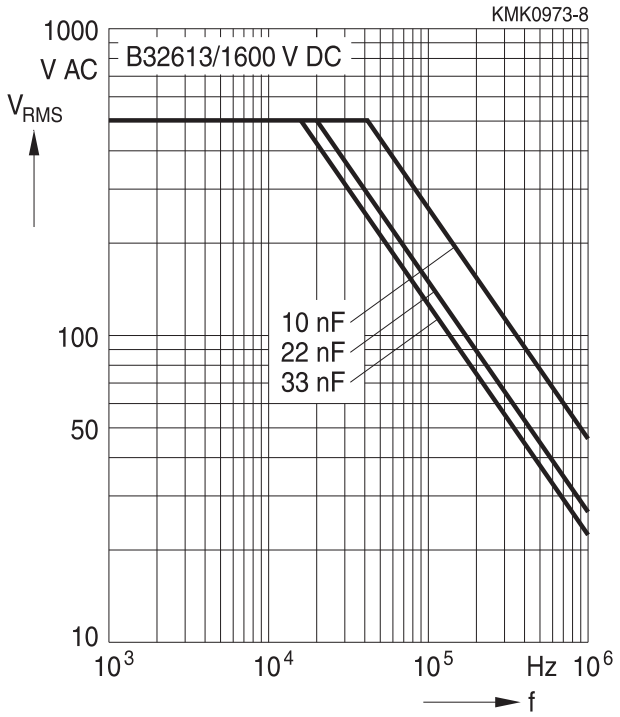


Permissible AC voltage V_{RMS} versus frequency f (for sinusoidal waveforms, $T_A \leq 90$ °C)

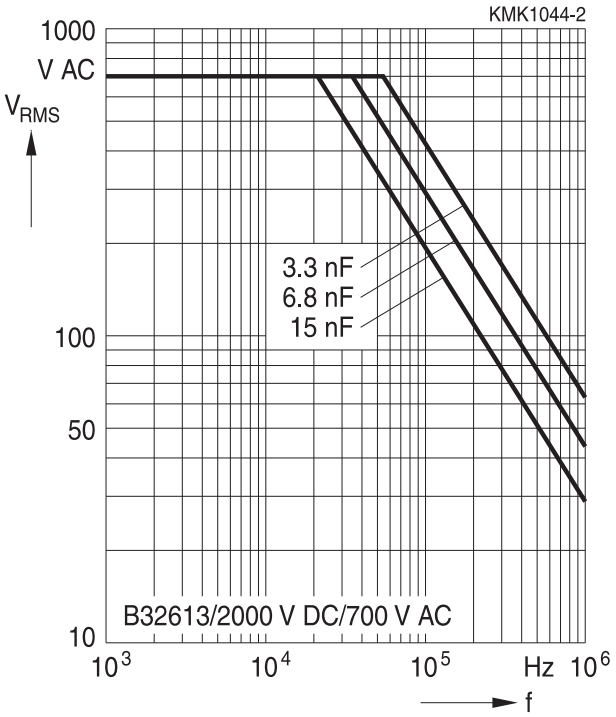
For T_A >90 °C, please use derating factor F_T.

Lead spacing 22.5 mm

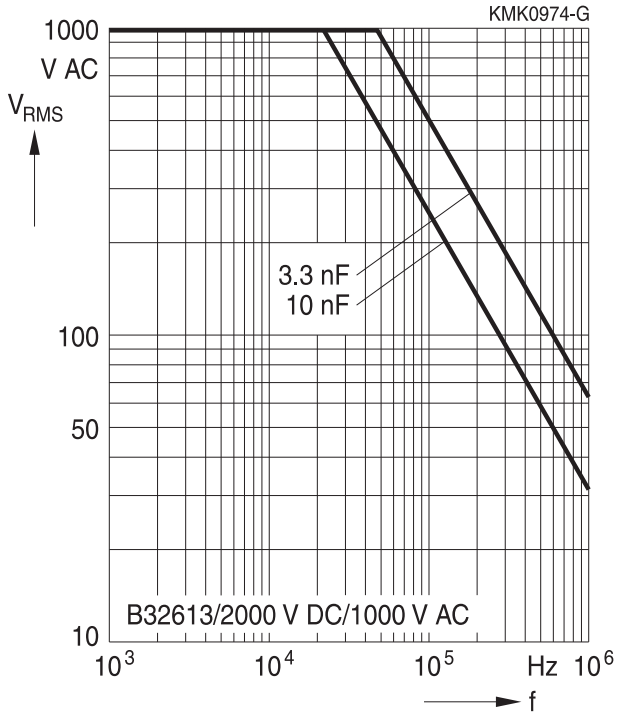
1600 V DC/500 V AC

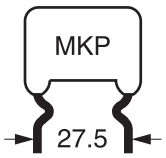


2000 V DC/700 V AC



2000 V DC/1000 V AC





B32614

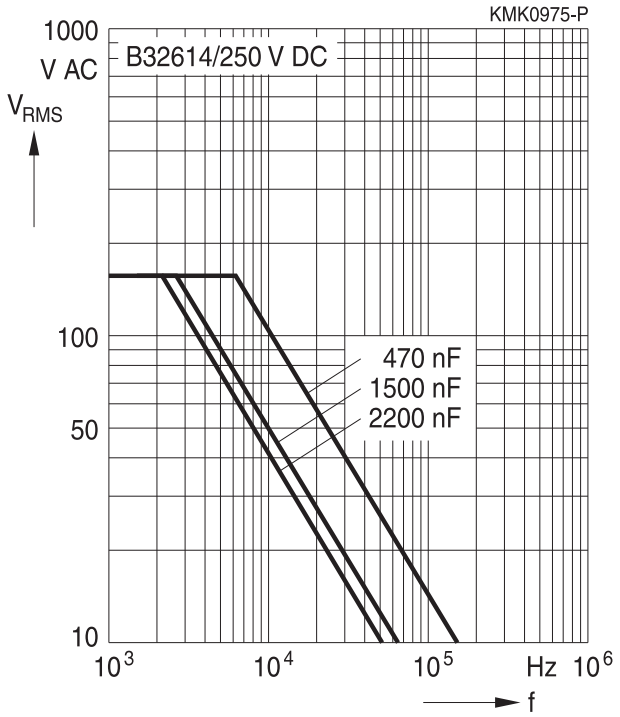
High pulse (wound)

Permissible AC voltage V_{RMS} versus frequency f (for sinusoidal waveforms, $T_A \leq 90$ °C)

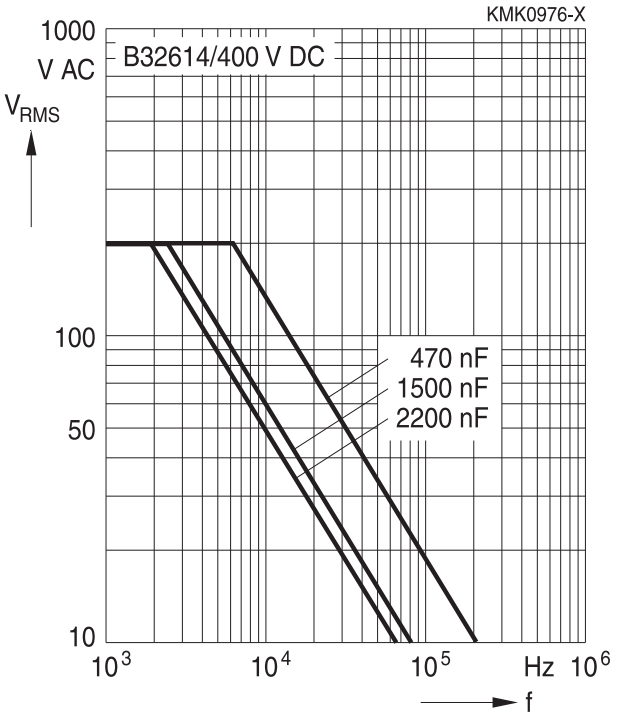
For T_A >90 °C, please use derating factor F_T.

Lead spacing 27.5 mm

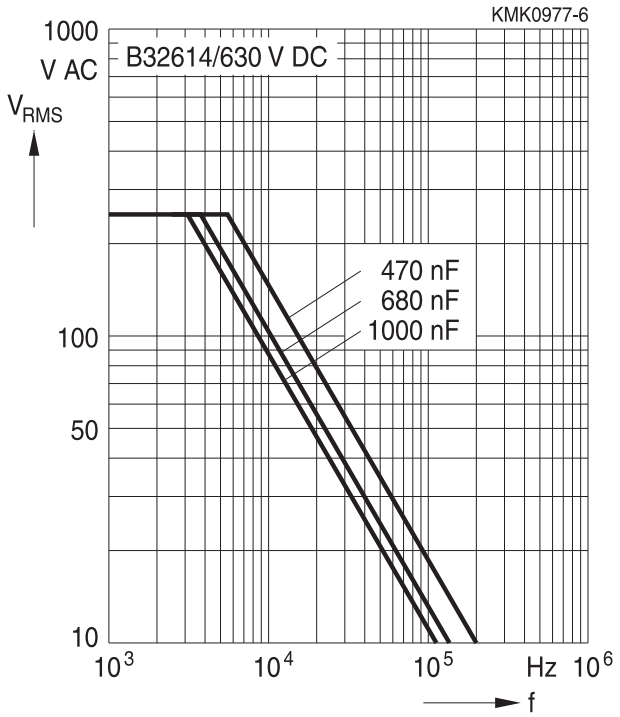
250 V DC/160 V AC



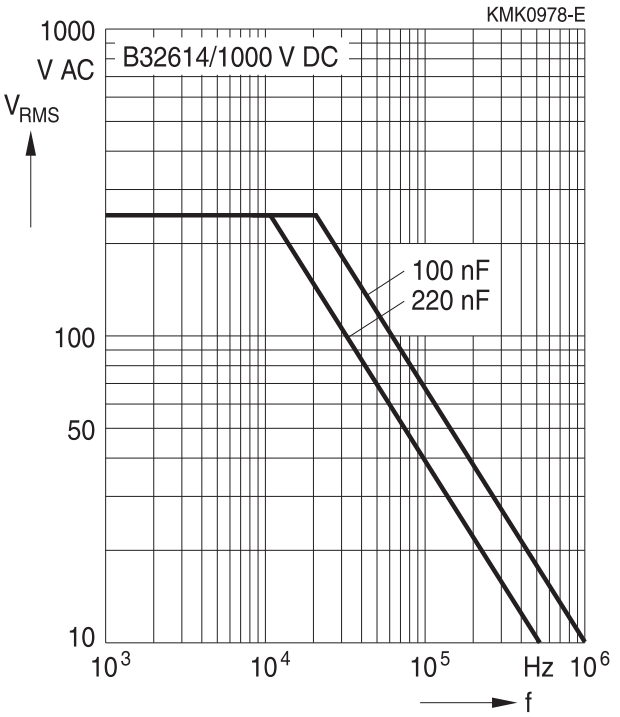
400 V DC/200 V AC

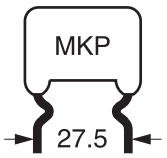


630 V DC/250 V AC



1000 V DC/250 V AC



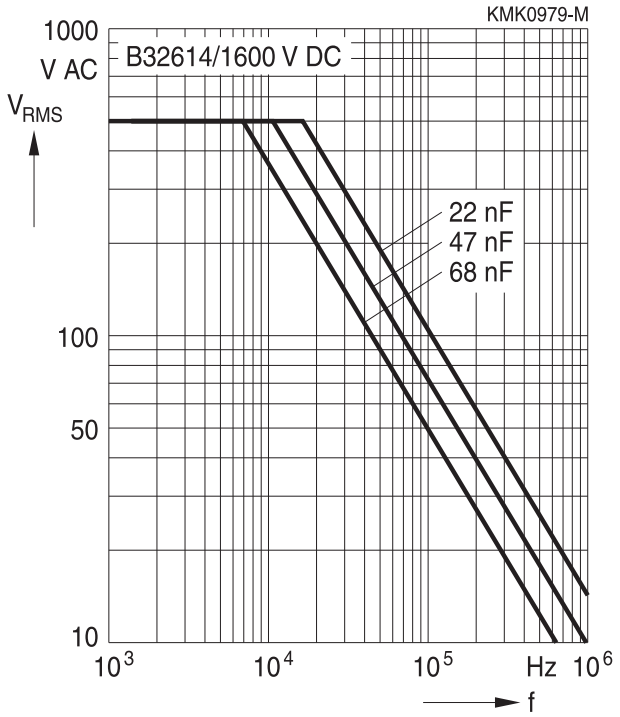


Permissible AC voltage V_{RMS} versus frequency f (for sinusoidal waveforms, $T_A \leq 90$ °C)

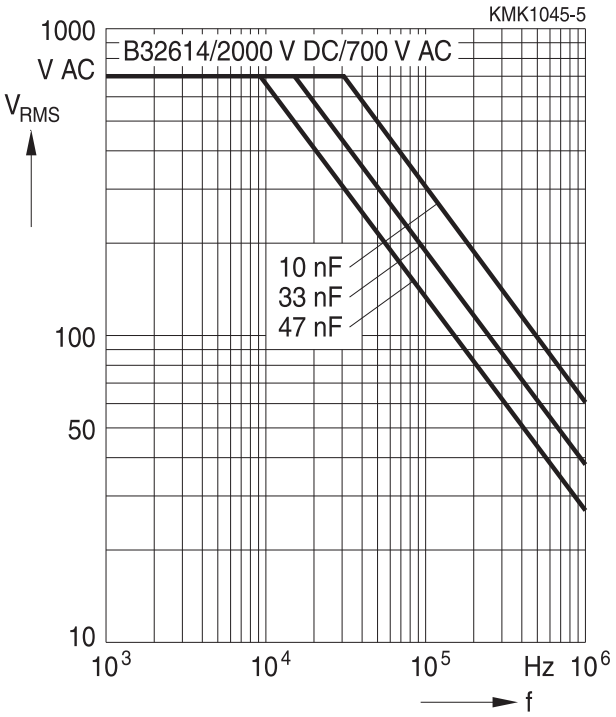
For T_A >90 °C, please use derating factor F_T.

Lead spacing 27.5 mm

1600 V DC/500 V AC



2000 V DC/700 V AC



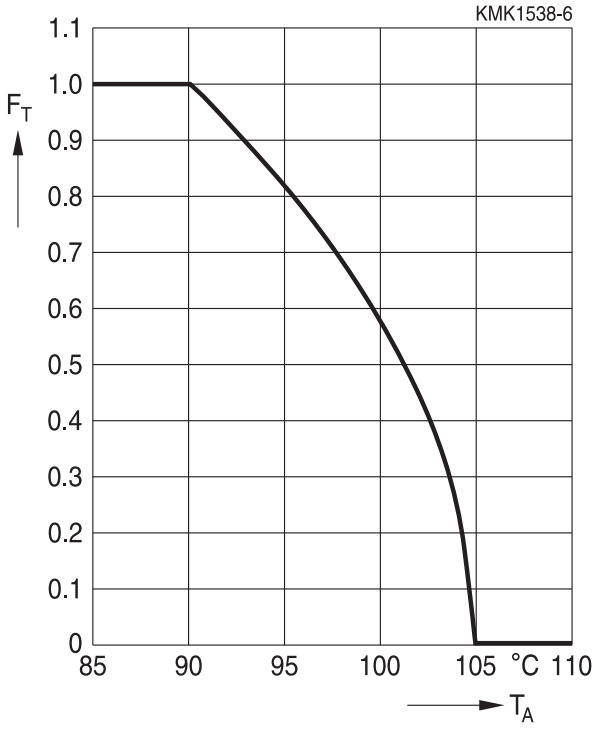
Maximum AC voltage (V_{RMS}), current (I_{RMS}) versus frequency and temperature for T_A >90 °C

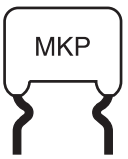
The graphs described in the previous section for the permissible AC voltage (V_{RMS}) or current (I_{RMS}) versus frequency are given for a maximum ambient temperature $T_A \leq 90$ ºC. In case of higher ambient temperatures (T_A), the self-heating (ΔT) of the component must be reduced to avoid that temperature of the component ($T_{op} = T_A + \Delta T$) reaches values above maximum operating temperature.The factor F_T shall be applied in the following way:

$$I_{RMS}\,(T_A) = I_{RMS,T_A \leq 90\,^{\circ}C} \cdot F_T\,(T_A)$$

$$V_{RMS}\,(T_A) = V_{RMS,T_A \leq 90\,^{\circ}C} \cdot F_T\,(T_A)$$

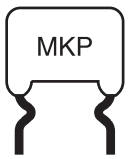
And F_T is given by the following curve:





Testing and Standards

Test	Reference	Conditions of test	Performance requirements
Electrical parameters	IEC 60384-16:2005	Voltage proof, 1.6 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: Tensile force $0.5 < d_1 \leq 0.8$ mm: 10 N	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 10 seconds	$\Delta C/C_0 \leq 2\%$ $\lvert\Delta \tan \delta\rvert \leq 0.002$
Rapid change of temperature	IEC 60384-16:2005	T_A = lower category temperature T_B = upper category temperature Five cycles, duration t = 30 min.	$\lvert\Delta C/C_0\rvert \leq 2\%$ $\lvert\Delta \tan \delta\rvert \leq 0.002$ $R_{ins} \geq 50\%$ of initial limit
Vibration	IEC 60384-16:2005	Test F_C: vibration sinusoidal Displacement: 0.75 mm Accleration: 98 m/s² Frequency: 10 Hz ... 500 Hz Test duration: 3 orthogonal axes, 2 hours each axe	No visible damage
Bump	IEC 60384-16:2005	Test Eb: Total 4000 bumps with 390 m/s² mounted on PCB Duration: 6 ms	No visible damage $\lvert\Delta C/C_0\rvert \leq 2\%$ $\lvert\Delta \tan \delta\rvert \leq 0.002$ $R_{ins} \geq 50\%$ of initial limit
Climatic sequence	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 / 24 h / 95% ... 100% RH	No visible damage $\lvert\Delta C/C_0\rvert \leq 3\%$ $\lvert\Delta \tan \delta\rvert \leq 0.001$ $R_{ins} \geq 50\%$ of initial limit
Damp heat, steady state	IEC 60384-16:2005	Test Ca 40 °C / 93% RH / 56 days	No visible damage $\lvert\Delta C/C_0\rvert \leq 3\%$ $\lvert\Delta \tan \delta\rvert \leq 0.001$ $R_{ins} \geq 50\%$ of initial limit
Endurance A	IEC 60384-16:2005	85 °C / 1.25 V_R / 2000 hours	No visible damage $\lvert\Delta C/C_0\rvert \leq 5\%$ $\lvert\Delta \tan \delta\rvert \leq 0.002$ $R_{ins} \geq 50\%$ of initial limit



Test	Reference	Conditions of test	Performance requirements
Endurance B	IEC 60384-16:2005	100 °C / 1.25 V_C / 2000 hours	No visible damage $\|\Delta C/C_0\| \leq 5\%$ $\|\Delta \tan \delta\| \leq 0.002$ $R_{ins} \geq 50\%$ of initial limit

Mounting guidelines

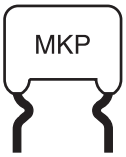
1 Soldering

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.

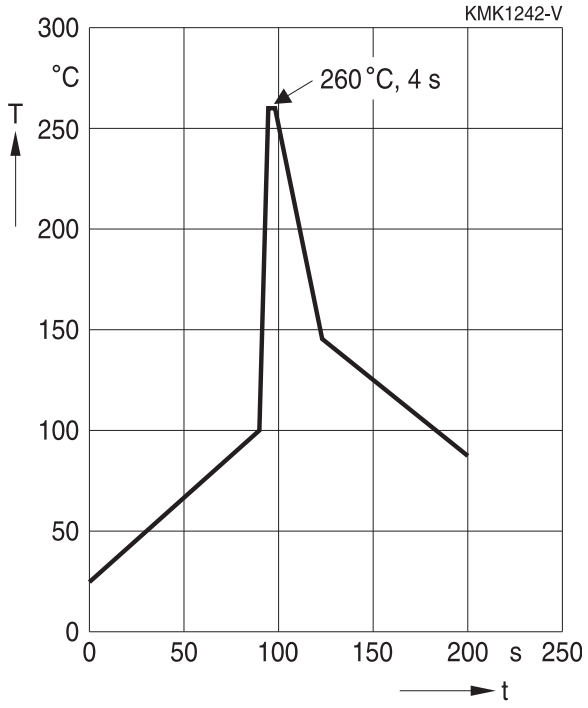
Solder bath temperature	235 ±5 °C
Soldering time	2.0 ±0.5 s
Immersion depth	2.0 +0/−0.5 mm from capacitor body or seating plane
Evaluation criteria: Visual inspection	Wetting of wire surface by new solder ≥90%, free-flowing solder



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

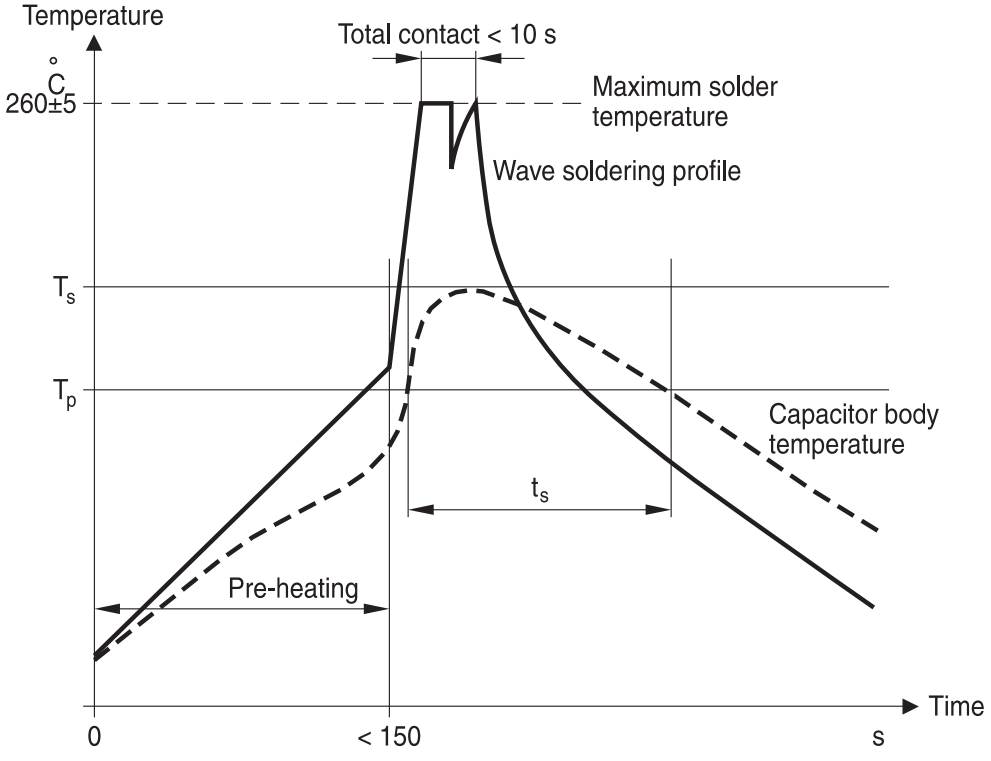
Permissible heat exposure loads on film capacitors are primarily characterized by the upper category temperature T_{max}. Long exposure to temperatures above this type-related temperature limit can lead to changes in the plastic dielectric and thus change irreversibly a capacitor's electrical characteristics.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

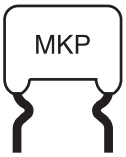
Recommendations

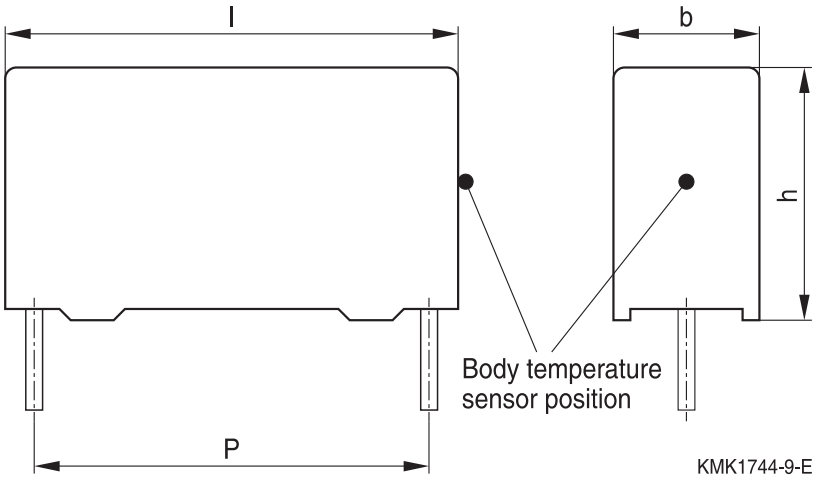
As a reference, the recommended wave soldering profile for our film capacitors is as follows:



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: $T_p \leq 110$ °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.

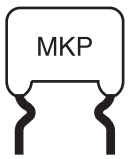
In order to ensure proper conditions for manual or selective soldering, the body temperature of the capacitor (T_s) must be ≤120 °C.

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 (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.



B32613, B32614

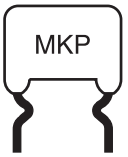
High pulse (wound)

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"



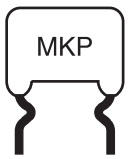
Topic	Safety information	Reference chapter "Mounting guidelines"
Soldering	Do not exceed the specified time or temperature limits during soldering.	1 "Soldering"
Cleaning	Use only suitable solvents for cleaning capacitors.	2 "Cleaning"
Embedding of capacitors in finished assemblies	When embedding finished 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"

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.

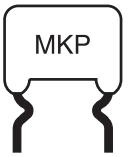
Correlation of data sheet values and modelling tool outputs

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.

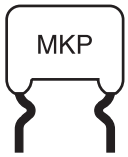


Symbols and terms

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



B32613, B32614

High pulse (wound)

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	Ausgangsspannung
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

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 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.**
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.
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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.
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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