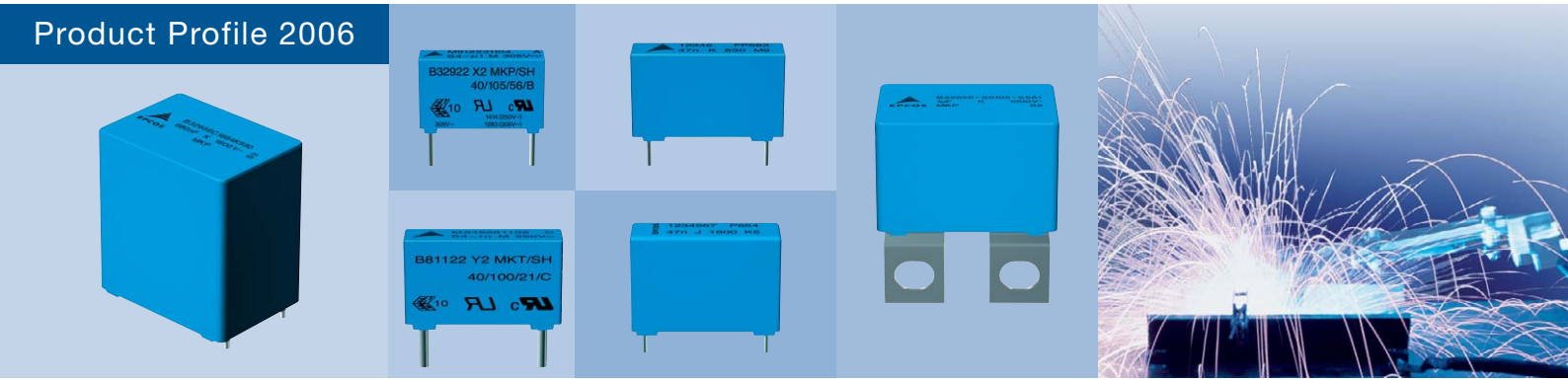
EPCOS

Product Profile 2006



Film Capacitors

for Industrial Applications

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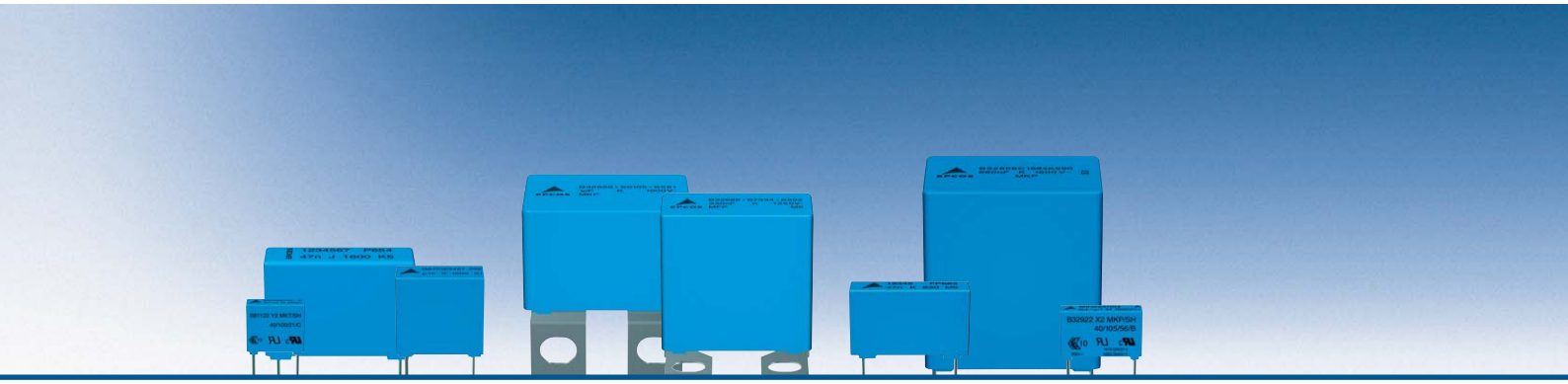
Film Capacitors for Industrial Applications



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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, EPCOS is 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 an EPCOS product with the properties described in the product specification is suitable for use in a particular customer application.
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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.epcos.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.

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Preview

Today, higher performance is expected of all the components used in new power electronics for industrial applications, from semiconductors to passive components, in terms of both electrical and climatic operating conditions. Capacitors are no exception and challenging standards are being set, in which the reliability of the product is becoming increasingly critical.

In this context, experience has shown that film capacitors offer many advantages over other capacitor technologies. High current capability, low inductance, flexible design, various mounting options, thermal and electrical stability, reliability and a long service life make them a suitable solution for these applications.

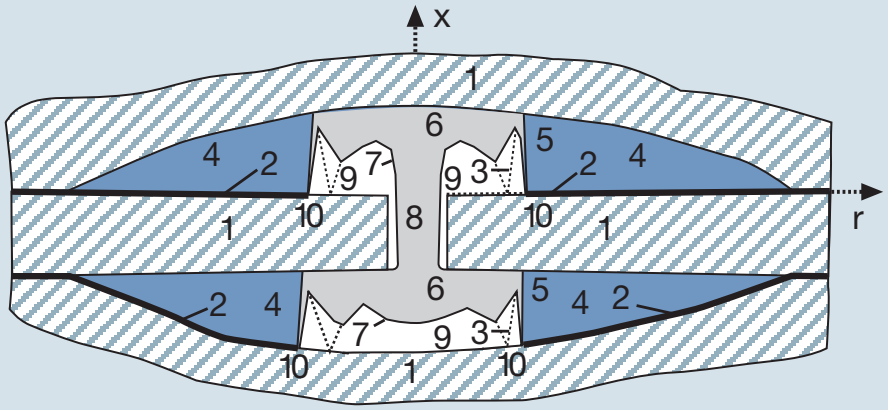
In addition, wherever much higher currents are required, 4-pin configurations are available, that further improve the current handling capability of the standard 2-pin capacitors.

In these highly demanding applications, new design concepts and advanced control systems for semiconductors with high switching frequencies allow designers to take advantage of the excellent performance of film capacitors in applications where other technologies were traditionally considered to be the preferred solution.

EPCOS has responded to this new trend and offers various series of film capacitors in a range of operating voltages designed to satisfy the technical requirements of every part of a circuit, mainly in medium size equipments from the point of view of the power range of the converter.

Self-healing Capability of Film Capacitors

Self-healing



1 Dielectric
2 Metallized electrodes
3 Material displacing shock wave
4 Air gap with metal vapor
5,6 Plasma zone
7 Boundary layer between gas phase dielectric and plasma
8 Breakdown channel
9 Gas phase dielectric
10 Zone of displaced metallization and dielectric (insulating region)

The self-healing capability of film capacitors may be defined as their ability to remedy defects (such as pores or impurities in the film) under the influence of a voltage.

The metal coatings, vacuum-deposited directly onto the plastic film, are only 20 ... 50 nm thick. If the dielectric breakdown field strength is exceeded locally at a weak point, a dielectric breakdown occurs. The high temperatures reached in the breakdown channel (up to 6000 K) transform the dielectric into a highly compressed plasma that forces its way out. The thin metal coating in the vicinity of the channel is totally evaporated by interaction with the plasma so that it escapes from the breakdown channel. The rapid expansion of the plasma causes it to cool after a few microseconds, thus quenching the discharge before a greater voltage drop takes place. The insulated region resulting around the former faulty area will cause the capacitor to regain its full operation ability.

Trends

1 Plant Malaga (Spain), **2** Plant Gravatai (Brazil), **3** Plant Zhuhai (China), **4** Plant Nashik (India)

Film capacitors as a reliable solution

The self-healing capability of film capacitors is one of their most important features. It protects them against catastrophic failures and makes them highly reliable compared with other technologies.

They also offer an excellent thermal stability. In addition, their key electrical parameters remain constant when the voltage is changed thanks to the high electrical stability of this technology.

Low ESR values and high I_{rms} handling capability are other important characteristics of film capacitors. They are needed in applications operating with high-frequency ripple currents (up to 100 kHz).

Applicable standards

In terms of its mechanical and electrical performance, IEC 60384-2, IEC 60384-16 and IEC 60384-14 are the sector standards for MKT, MKP and EMI suppression capacitors.

Capacitors designed to be used specifically in power electronic equipment must also comply with the international standard IEC 1071. The objective of this standard is to describe the basic performance, testing, rating and safety rules of all the capacitors used in semiconductor switching, protections applications, filtering and energy-storage applications.

RoHS compatibility

The components described as "RoHS-compatible" are in compliance with the requirements of the regulations listed below ("Regulations") and with the requirements of the provisions which will result from transformation of the Regulations into national law to the extent such provisions reflect the Regulations.

- Directive 2002/95/EC of the European Parliament and of the Council of 27 January 2003 on the restriction of the use of certain hazardous substances in electrical and electronic equipment ("Directive 2002/95/EC");
- Commission Decision of 18 August 2005 amending Directive 2002/95/EC (2005/618/EC);
- Commission Decision of 13 October 2005 and of 21 October 2005 amending the Annex to Directive 2002/95/EC (2005/717/EC; 2005/747/EC).

Application: Drives

General

The function of an adjustable electrical drive is to control the speed, torque, acceleration, deceleration and direction of rotation of the motor driving a machine. Drives may be of direct current or adjustable frequency type (DC and AC drives respectively).

Because of their simplicity, ease of use, reliability and favorable cost, DC drives have been the preferred solution for industrial applications for many years.

On the other hand, adjustable frequency AC motor drive controllers, frequently known as inverters, are typically more complex than DC controllers since they must perform two power-section functions: conversion from AC to DC and finally again from DC to AC.

A number of different types of AC motor controllers are currently in widespread use as general purpose drives, i.e. Pulse Width Modulated (PWM), Current Source Input (CSI), and, the Load Commutated Inverter (LCI) types. Each type offers specific benefits and characteristics, and the selection criterion is based on the final application requirements in terms of voltage and power.

EMC filters

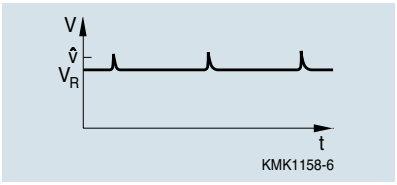
As a rule, across-the-line and line-to-ground capacitors are used in this filtering stage. In most of the cases they must be X2 and Y2 approved capacitors, in accordance to international regulations.

EPCOS has now launched the new upgraded **B32921 … B32926** series of its compact X2 capacitors with an excellent performance on the market. On the other hand, Y2 capacitors demand is satisfy by means of EPCOS series **B81122** (up to 0.33 µF in lead spacing 27.5 mm).

The corresponding international approvals to the EMI suppression capacitor standards (IEC 60384-14, EN 132400, UL 1414, UL 1283, CSA 22.2 No.1 and CSA 22.2 No.8) have been granted to both series by the most prestigious International Certification Institutes (VDE, UL, CSA).

DC link

Capacitors in the DC link module have to support the DC voltage after the AC/DC converter, by supplying high peaks of current when it is required.



EPCOS offers a wide range of MKP capacitors in various operating voltages, with its brand new series **B32674 … B32678**.

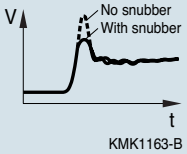
This series covers a spectrum of capacitance value up to 60 µF (lead spacing 27.5 … 52.5 mm), with very low ESR, high RMS current capability and continuous operating voltages from 450 VDC to 1050 VDC.
These capacitors can function at a maximum operating temperature of up to 100 °C.

Snubbering

Those capacitors are connected in parallel with semiconductor components in order to damp high peaks of voltages that are provoked by their switching operation.

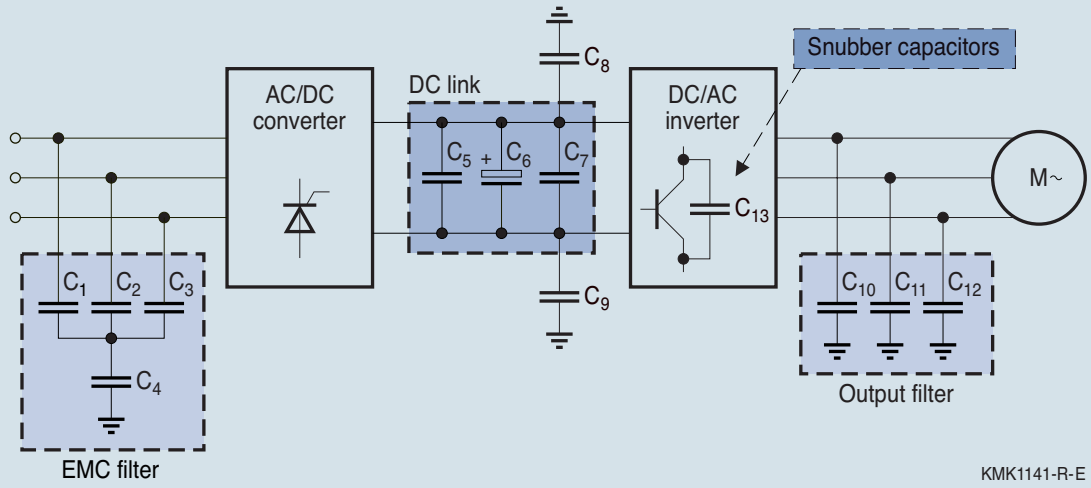
In this field, EPCOS is offering many different solutions that meet perfectly the wide variety of requirements for this particular product.

The **B32686A, B32686C, B32632 … B32634, B32656C and B32652 … B32656** series represent an extensive range of capacitors for high demanding applications, high dv/dt values and I_{rms} at high frequency.



Application: Drives

AC drive: example of block diagram



EPCOS solution

EMC and output filters			DC link	Snubbering			
Capacitor number							
C1, C2, C3	C4, C8, C9	C8, C9, C10, C11, C12	C5, C7	C13			
							
X2	Y2	MKP 2/4 pins	MKP 2/4 pins	MKP strap terminals	MFP strap terminals	MKP 2/4 pins	MFP 2/4 pins
B32921 … B32926	B81122	B32651 … B32656, B32674… B32678	B32674… B32678	B32656S	B32686S	B32652 … B32656, B32656C	B32632 … B32634, B32686A, B32686C
Voltage range							
310 VAC	250 VAC	160 VAC ... 1000 VAC	450 VDC ... 1050 VDC	850 VDC ... 2000 VDC	1000 VDC ... 2000 VDC	250 VDC ... 2000 VDC	630 VDC ... 2000 VDC
Capacitance range							
10 nF ... 10 µF	1 nF ... 330 nF	1 nF ... 60 µF	0.47 ... 60 µF	0.047... 2.2 µF	0.022 ... 0.68 µF	1 nF ... 4.7 µF	0.47nF... 0.68µF
Detailed data sheet							
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C6 = Aluminum electrolytic capacitor

Application: UPS

General

Uninterruptible Power Systems (UPS) are designed to insulate the load from any interruptions in the line, including spikes, over and under-voltages and blackouts, by supplying the needed voltage to the output.

In case of a blackout, the battery will feed the output from a few minutes to several hours depending on its size.

A UPS can also be understood as a system designed to protect the load against instabilities in the power line, which is the best way of ensuring the reliability of the load over its operating life.

Depending on their configuration, three major UPS topologies may be identified: *off-line*, *line interactive* and *on-line*.

EMC filters

The EMC filter is usually composed of approved X2 and Y2 capacitors suitable for use in across-the-line and line-to-ground positions respectively. These approvals must be granted in accordance with the corresponding international standards (IEC, UL, CSA) that describe the requirements of these safety components.

EPCOS series **B32921 … B32926** offers reduced size X2 capacitors, with a wide spectrum of capacitance values up to 10 µF (lead spacing 10 … 37.5 mm), 310 VAC (50 or 60 Hz) as a maximum operating voltage and a maximum operating temperature of 125 °C. In addition, with series **B81122**, EPCOS covers the Y2 capacitor demand, with a maximum capacitance value of 0.33 µF and 250 VAC as rated voltage. The robust construction of this series ensures a reliable electrical and mechanical performance.

Output filters

The basic purpose of the output filter is to protect the load connected to the output of the UPS by filtering the RF components coming from the inverter and to withstand the current peaks caused by pulses of rapidly changing voltage.

High pulse handling capability, with dv/dt values up to 8.000 V/µs, and very low self-heating characteristics make EPCOS series **B32652 … B32656** a suitable solution to be used in this filter. The range of capacitance values covered by this series goes up to 4.7 µF, with rated voltages up to 1000 VDC. In addition to that series, also **B32921 … B32926** and **B32674 … B32678** could be an alternative option, for those designs with softer electrical requirements.

Snubber capacitors

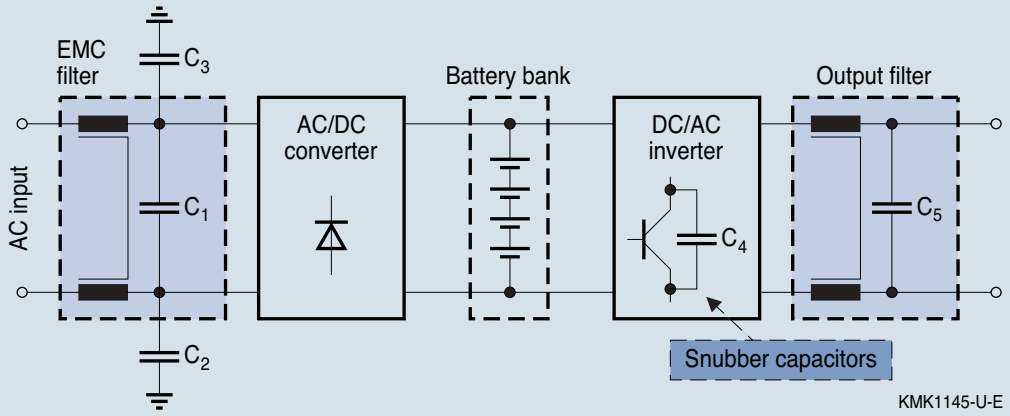
The switching operations of semiconductor components produce high voltage peaks. Snubber capacitors are typically connected in parallel with semiconductors in order to block these peaks.

With series **B32686A, B32686C** and **B32632 … B32634**, EPCOS offers a family of capacitors, which are able to withstand dv/dt values up to 18.000 V/µs and high I_{rms} currents with frequencies higher than 100 kHz, being specifically designed for this application.

Series **B32652 … B32656** and **B32656C**, which feature a very good self-healing characteristic, could be also an excellent alternative product to be used in this position of the circuit.

Application: UPS

UPS: example of block diagram



EPCOS solution

EMC and output filters			Snubbering			
Capacitor number						
C1, C5	C2, C3	C5	C4			
						
X2	Y2	MKP 2/4 pins	MKP strap terminals	MFP strap terminals	MKP 2/4 pins	MFP 2/4 pins
B32921 … B32926	B81122	B32651 … B32656, B32674… B32678	B32656S	B32686S	B32652 … B32656, B32656C	B32632 … B32634, B32686A, B32686C
Voltage range						
310 VAC	250 VAC	160 VAC ... 1000 VAC	850 VDC ... 2000 VDC	1000 VDC ... 2000 VDC	250 VDC ... 2000 VDC	630 VDC ... 2000 VDC
Capacitance range						
10 nF ... 10 µF	1 nF ... 330 nF	1 nF ... 60 µF	0.047... 2.2 µF	0.022 ... 0.68 µF	1 nF ... 4.7 µF	0.47 nF ... 0.68 µF
Detailed data sheet						
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Application: Electrical Welding Equipments

General

Electrical welding equipment uses electricity in order to generate the heat needed for joining metal parts.

In the past, welding power supplies were based on large and heavy metal transformers that operated at 50 or 60 Hz and were relatively inefficient.

The development and popularization of power supplies based on inverter technology has changed the design and capability of modern welding equipment.

This new equipment, operating with signals at 20 kHz, is much more efficient and can be even more compact and lightweight thanks to design optimization.

EMC filter

In accordance with international regulations, X2 and Y2 capacitors are used in EMC filters designed to suppress the RF interference that perturbs smooth operation.

X2 capacitor applications are covered by the EPCOS series **B32921 ... B32926** of compact capacitors. In the case of 50/60 Hz applications, 310 VAC is the maximum permissible operating voltage at operating temperatures of up to 125 °C. The B81122 series of Y2 capacitors from EPCOS offers a wide range of capacitance values for this application (from 1 nF to 0.33 µF in lead spacing 27.5 mm) with a rated voltage of 250 VAC.

The capacitors of these two series bear stamps declaring that they have been approved according to the EMI suppression capacitor standards (IEC 60384-14, EN 132400, UL 1414, UL 1283, CSA 22.2 No.1 and CSA 22.2 No.8).

DC link, switching and smoothing

DC link capacitors are used to smooth the DC voltage after the rectifier. In this application, they have to handle large RMS currents at high frequencies.

Peak voltages are also induced during operation by semiconductor switching and system disturbances. According to IEC 1071, these peaks could reach values of 50% above the rated voltage of the capacitor.

B32674 ... B32678 is a series of MKP capacitors developed by EPCOS specifically for this application. Their very low ESR values are a particular highlight and allow the product to operate with RMS currents of up to 25 A at 100 kHz.

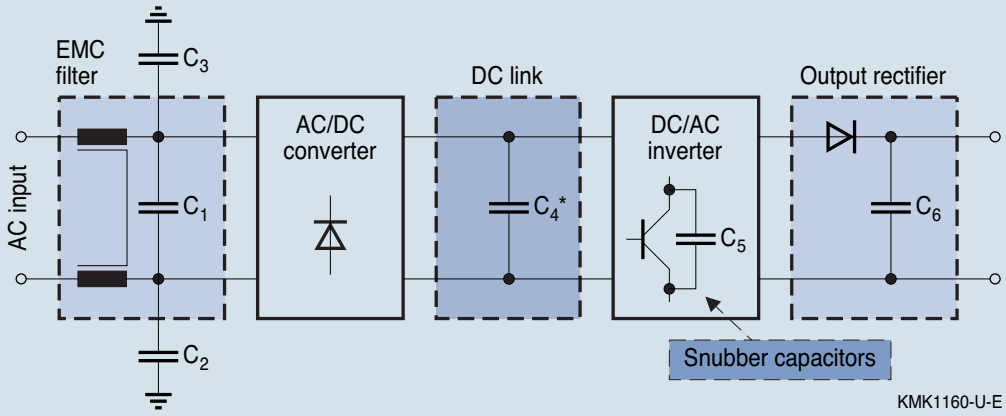
Output rectifier

An output rectifier is basically a half-wave rectifier. It converts the AC voltage (with the new frequency after the inverter) into a DC voltage. The positive semi-cycle is then used to carry out the welding process. The RF components are suppressed by the capacitor included in the output rectifier.

For this application, EPCOS offers the **B32652 ... B32656** series with capacitance values of up to 4.7 µF in lead spacing 37.5 mm and rated voltages of up to 1000 VDC. It has excellent characteristics for the requirements of this application: very high dv/dt values (up to 8000 V/µs) and good thermal behavior (very low self-heating when high-frequency AC voltages are applied).

Application: Electrical Welding Equipments

Welding equipment power supply: example of block diagram



EPCOS solution

EMC and output rectifier			DC link	Snubbering			
Capacitor number							
C1, C6	C2, C3	C6	C4*	C5			
							
X2	Y2	MKP 2/4 pins	MKP 2/4 pins	MKP strap terminals	MFP strap terminals	MKP 2/4 pins	MFP 2/4 pins
B32921 … B32926	B81122	B32651 … B32656, B32674… B32678	B32674… B32678	B32656S	B32686S	B32652 … B32656, B32656C	B32632 … B32634, B32686A, B32686C
Voltage range							
310 VAC	250 VAC	160 VAC ... 1000 VAC	450 VDC ... 1050 VDC	850 VDC ... 2000 VDC	1000 VDC ... 2000 VDC	250 VDC ... 2000 VDC	630 VDC ... 2000 VDC
Capacitance range							
10 nF ... 10 µF	1 nF ... 330 nF	1 nF ... 60 µF	0.47 ... 60 µF	0.047... 2.2 µF	0.022 ... 0.68 µF	1 nF ... 4.7 µF	0.47 nF... 0.68 µF
Detailed data sheet							
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* Can be also an Aluminum Electrolytic Capacitor.

Data Sheet: X2

X2/305 VAC capacitors for EMC filter

RoHS compatible

Climatic

- Maximum operating temperature of 125 °C
- Climatic category (IEC 60068-1): 40/105/56

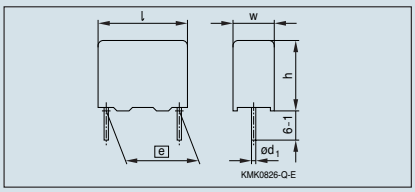
Construction

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

Terminals

- Parallel wire leads, lead-free tinned

Dimensional drawing



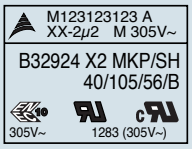
Dimensions in mm

Approvals

Marks of conformity	Standards	Certificate
	EN 132400, IEC 60384-14	40005536, 40010694
	UL 1414, UL1283	E97863, E157153
	CSA C22.2 No.1/No.8	E97863, E157153
	CQC (GB/T 14472-1998)	CQC001007-14859

For latest approval updates, please refer to www.epcos.com/film_capacitors

Marking example



KMK0822-S

37.5 ≥ e ≥ 22.5 mm
CR > 1µF

Technical data

Maximum operating temperature $T_{op,max}$	125 °C (for C ≤1 µF), B3292*A/B 110 °C (for C >1), B3292*C/D (miniaturized)		
Dissipation factor tan δ (in 10^{-3}) at 20 °C (upper limit values)		0.1 < C_R ≤ 2.2	C_R > 2.2
	at 1 kHz	1.0	2.0
	100 kHz	–	–
Time constant τ = C_R x R_{ins} at 20 °C, rel. humidity ≤ 65%	C_R > 0,33	30 000 s (minimum as-delivered values)	
DC test voltage	2121 V, 2 s		
Passive flammability category to IEC 40 (CO) 752	B		
Maximum continuous AC voltage (V_{AC})	310 V (50/60 Hz)		
Rated AC voltage (IEC 60384-14)	305 V (50/60 Hz)		
Maximum continuous DC voltage (V_{DC})	760 V (630 V for C/D version)		
Operating AC voltage V_{op} at high temperature	T_A ≤ 110 °C	V_{op} = V_{AC}	(continuously)
	T_A ≤ 110 °C	V_{op} = 1.25 x V_{AC}	(1000 h)
	110 °C < T_A ≤ 125 °C	V_{op} = V_{AC}	(1000 h) (only for A/B version)
Damp heat test	56 days / 40 °C / 93% relative humidity		≤ 5%
Limit values after damp heat test	Capacitance change (ΔC/C)		≤ 0.5 x 10^{-3} (at 1 kHz)
	Dissipation factor change (Δ tan δ)		≤ 1.0 x 10^{-3} (at 10 kHz)
	Insulation resistance R_{ins} or time constant τ = C_R x R_{ins}		≥ 50% of minimum as-delivered values

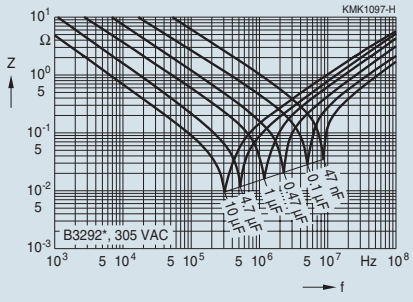
Pulse handling capability

"dv/dt" values 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/µs.

Note: The maximum values of dv/dt and k_0 must not be exceeded in order to avoid damaging the capacitor.

Impedance versus frequency curve (typical values)



Characteristics and ordering codes

Lead spacing	C_R	Max. dimensions w x h x l	Ordering code	Ød$_1$	dv/dt	k_0	Ammo pack	Reel	Untaped
mm	µF	mm		mm	V/µs	V²/µs	pcs./unit	pcs./unit	pcs./unit
22.5	1.0	11.0 x 20.5 x 26.5	B32923C3105+***	0.8	170	146200	370	350	510
	1.0	12.0 x 22.0 x 26.5	B32923A2105M***	0.8	200	172000	–	–	450
	1.5	12.0 x 22.0 x 26.5	B32923C3155M***	0.8	170	146200	–	–	450
	1.5	14.5 x 29.5 x 26.5	B32923D3155+***	0.8	170	146200	–	–	260
	2.2	14.5 x 29.5 x 26.5	B32923C3225+***	0.8	170	146200	–	–	260
27.5	1.0	11.0 x 19.0 x 31.5	B32924C3105+***	0.8	120	103200	–	350	320
	1.0	11.0 x 21.0 x 31.5	B32924A2105+***	0.8	150	129000	–	350	320
	1.5	12.5 x 21.5 x 31.5	B32924C3155+***	0.8	120	103200	–	300	280
	1.5	13.5 x 23.0 x 31.5	B32924A2155M***	0.8	150	129000	–	250	260
	1.5	14.0 x 24.5 x 31.5	B32924B2155+***	0.8	150	129000	–	–	260
	2.2	14.0 x 24.5 x 31.5	B32924C3225+***	0.8	120	103200	–	–	260
	2.2	18.0 x 27.5 x 31.5	B32924A2225+***	0.8	150	129000	–	–	200
	3.3	18.0 x 27.5 x 31.5	B32924C3335M***	0.8	120	103200	–	–	200
	3.3	16.0 x 32.0 x 31.5	B32924D3335+***	0.8	120	103200	–	–	220
	3.3	21.0 x 31.0 x 31.5	B32924A2335M***	0.8	150	129000	–	–	180
	4.7	18.0 x 33.0 x 31.5	B32924C3475M***	0.8	120	103200	–	–	200
	4.7	21.0 x 31.0 x 31.5	B32924D3475M***	0.8	120	103200	–	–	180
	4.7	22.0 x 36.5 x 31.5	B32924A2475M***	0.8	150	129000	–	–	160
	5.6	22.0 x 36.5 x 31.5	B32924C3565+***	0.8	120	103200	–	–	160
37.5	2.2	14.0 x 25.0 x 41.5	B32926C3225+***	1.0	80	68800	–	–	115
	3.3	16.0 x 28.5 x 41.5	B32926C3335+***	1.0	80	68800	–	–	100
	3.3	18.0 x 32.5 x 41.5	B32926A2335+***	1.0	100	86000	–	–	90
	4.7	18.0 x 32.5 x 41.5	B32926C3475+***	1.0	80	68800	–	–	90
	4.7	20.0 x 39.5 x 41.5	B32926A2475M***	1.0	100	86000	–	–	75
	5.6	18.0 x 32.5 x 41.5	B32926C3565+***	1.0	80	68800	–	–	90
	5.6	20.0 x 39.5 x 41.5	B32926A2565M***	1.0	100	86000	–	–	75
	6.8	20.0 x 39.5 x 41.5	B32926C3685+***	1.0	80	68800	–	–	75
	6.8	28.0 x 42.5 x 41.5	B32926A2685M***	1.0	100	86000	–	–	55
	8.2	20.0 x 39.5 x 41.5	B32926C3825M***	1.0	80	68800	–	–	75
	8.2	28.0 x 42.5 x 41.5	B32926A2825M***	1.0	100	86000	–	–	55
	10	28.0 x 42.5 x 41.5	B32926C3106+***	1.0	80	68800	–	–	55

For capacitance values between 10 nF and 1.0 µF, please refer to data book 2005 "Film Capacitors".
Further E series and intermediate capacitance values on request.

NEW: Preferred type.

+ = Capacitance tolerance code
M = ±20%
K = ±10%
(Closer tolerances on request)

*** = Packing code
289 = Ammo pack
189 = Reel pack
000 = Untaped (lead length 6–1mm)

Y2/250 VAC capacitors

RoHS compatible

Climatic

- Maximum operating temperature of 100 °C
- Climatic category (IEC 60068-1):
  40/100/21 e = 10 mm
  40/085/21 e ≥ 15 mm

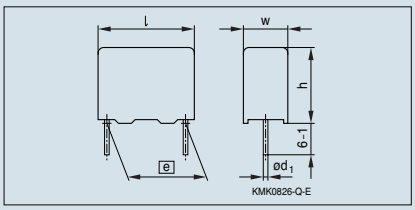
Construction

- Dielectric: Polypropylene (MKP) film
- Internal series connection
- Plastic case (UL 94 V-0)
- Epoxy resin sealing, flame-retardant

Terminals

- Parallel wire leads, lead-free tinned

Dimensional drawing



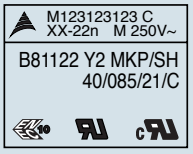
Dimensions in mm

Approvals

Marks of conformity	Standards	Certificate
	EN 132400, IEC 60384-14	138603
	UL 1414	E97863
	CSA C22.2 No.1	E97863

For latest approval updates, please refer to www.epcos.com/film_capacitors

Marking example



KMK0824-9

Characteristics and ordering codes

Lead spacing	C_R	Max. dimensions w x h x l	Ordering code	Ød1	dv/dt	k_0	Ammo pack	Reel	Untaped
mm	µF	mm		mm	V/µs	V²/µs	pcs./unit	pcs./unit	pcs./unit
10	0.0010	4.0 x 9.0 x 13.0	B81122C1102M***	0.6	550	388000	1000	1700	1000
	0.0015	4.0 x 9.0 x 13.0	B81122C1152M***	0.6	550	388000	1000	1700	1000
	0.0022	5.0 x 11.0 x 13.0	B81122C1222M***	0.6	550	388000	830	1300	1000
	0.0033	5.0 x 11.0 x 13.0	B81122C1332M***	0.6	550	388000	830	1300	1000
	0.0047	6.0 x 12.0 x 13.0	B81122C1472M***	0.6	550	388000	680	1100	1000
	0.0056	6.0 x 12.0 x 13.0	B81122C1562M***	0.6	550	388000	680	1100	1000
	0.0068	6.0 x 12.0 x 13.0	B81122C1682M***	0.6	550	388000	680	1100	1000
15	0.010	6.0 x 11.0 x 18.0	B81122A1103M***	0.8	400	282000	960	1100	1000
	0.015	7.0 x 12.5 x 18.0	B81122A1153M***	0.8	400	282000	830	900	1000
	0.022	8.5 x 14.5 x 18.0	B81122A1223M***	0.8	400	282000	680	700	500
	0.027	8.5 x 14.5 x 18.0	B81122A1273M***	0.8	400	282000	680	700	500
	0.033	9.0 x 17.5 x 18.0	B81122A1333M***	0.8	400	282000	640	700	500
22.5	0.047	7.0 x 16.0 x 26.5	B81122A1473M***	0.8	200	141000	580	600	630
	0.056	8.5 x 16.5 x 26.5	B81122A1563M***	0.8	200	141000	480	500	510
	0.068	10.5 x 16.5 x 26.5	B81122A1683M***	0.8	200	141000	390	400	540
	0.10	10.5 x 20.5 x 26.5	B81122A1104M***	0.8	200	141000	390	400	540
27.5	0.15	11.0 x 21.0 x 31.5	B81122A1154M***	0.8	150	106000	–	350	320
	0.22	13.5 x 23.0 x 31.5	B81122A1224M***	0.8	150	106000	–	250	260
	0.33	18.0 x 27.5 x 31.5	B81122A1334M***	0.8	150	106000	–	–	200

Further E series and intermediate capacitance values on request.

+ = Capacitance tolerance
M = ±20%
(Closer tolerances on request)

*** = Packing code
289 = Ammo pack
189 = Reel pack
000 = Untaped (lead length 6–1mm)

Technical data

Maximum operating temperature $T_{op,max}$	100 °C		
Dissipation factor tan δ (in 10^{-3}) at 20 °C (upper limit values)		$C_R \leq 0.1$ µF	$C_R > 0.1$ µF
	1 kHz	1.0	1.0
	100 kHz	5	–
Insulation resistance R_{ins} or time constant $\tau = C_R \times R_{ins}$ at 20 °C, rel. humidity ≤ 65% (minimum as-delivered values)	30 000 MΩ		
DC test voltage	2700 V, 2 s		
Passive flammability category to IEC 40 (CO) 752	C		
Maximum continuous AC voltage (V_{AC})	405 V (50/60 Hz)		
Rated AC voltage (IEC 60384-14)	250 V (50/60 Hz)		
Maximum continuous DC voltage (V_{DC})	1200 V		
Operating AC voltage V_{op} at high temperature	$T_A \leq 110$ °C	$V_{op} = V_{AC}$	(continuously)
	$T_A \leq 110$ °C	$V_{op} = 1.25 \times V_{AC}$	(1000 h)
Damp heat test	56 days / 40 °C / 93% relative humidity		≤ 5%
Limit values after damp heat test	Capacitance change (ΔC/C)		≤ 0.5 x 10^{-3} (at 1 kHz)
	Dissipation factor change (Δ tan δ)		≤ 1.0 x 10^{-3} (at 10 kHz)
	Insulation resistance R_{ins} or time constant $\tau = C_R \times R_{ins}$		≥ 50% of minimum as-delivered values

Pulse handling capability

"dv/dt" values 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/µs.

Note: The maximum values of dv/dt and k_0 must not be exceeded in order to avoid damaging the capacitor.

Data Sheet: MKP 2/4 Pins

MKP 2/4 pins

RoHS compatible

Construction

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

Marking

Manufacturer's logo,
rated capacitance, tolerance,
rated DC voltage,
type number

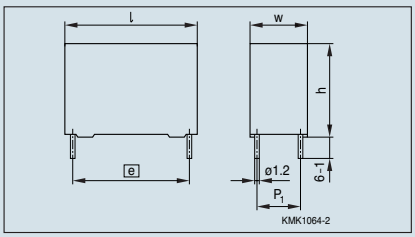
Terminals

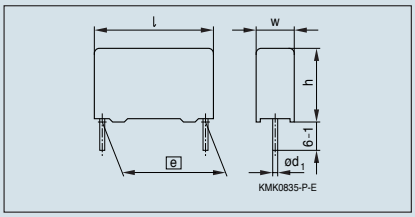
- Parallel wire leads, lead-free tinned
- Lead executions

Number of Wires	Lead Ød1 (mm)	e (mm) 27.5	37.5	52.5
2-pin	0.8	D	–	–
	1.0	E	E	–
	1.2	F	F	–
4-pin	1.2	–	G	G

Preferred lead execution

Dimensional drawing





Dimensions in mm

Characteristics and ordering codes

C_R	dv/dt	Max. dimensions w x h x l	e	P_1 4-pin	Ordering code	ESR (mΩ), 100 kHz 2-pin			4-pin	I_{rms} (A), 100 kHz, 70 °C 2-pin			4-pin	PU (pcs.)
µF	V/µs	mm	mm	mm		Ø0.8	Ø1.0	Ø1.2	Ø1.2	Ø0.8	Ø1.0	Ø1.2	Ø1.2	
V_R = 300 VDC / V_{op} = 450 VDC / V_{rms} = 160 VAC / V_p = 450 VDC														
2.2	40	11.0 x 19.0 x 31.5	27.5	–	B32674*3225+	12.0	11.5	11.0	–	7	7	8	–	320
3.3	40	12.5 x 21.5 x 31.5	27.5	–	B32674*3335+	9.0	8.4	7.8	–	7	8	10	–	280
3.3	22	12.0 x 22.0 x 42.0	37.5	–	B32676*3335+	–	13.1	12.2	–	–	7	9	–	135
4.7	40	14.0 x 24.5 x 31.5	27.5	–	B32674*3475+	7.0	6.5	6.0	–	7	10	12	–	260
4.7	22	12.0 x 22.0 x 42.0	37.5	–	B32676*3475+	–	12.2	11.5	–	–	8	10	–	135
5.6	40	15.0 x 24.5 x 31.5	27.5	–	B32674*3565+	6.6	6.2	5.8	–	7	8	12	–	240
5.6	22	14.0 x 25.0 x 42.0	37.5	–	B32676*3565+	–	11.6	10.8	–	–	9	10	–	115
6.5	22	14.0 x 25.0 x 42.0	37.5	–	B32676*3655+	–	10.8	10	–	–	9	10	–	115
6.8	40	18.0 x 27.5 x 31.5	27.5	–	B32674*3685+	6.4	5.9	5.5	–	7	9	12	–	200
6.8	22	16.0 x 28.5 x 42.0	37.5	–	B32676*3685+	–	10.4	9.4	–	–	9	11	–	100
8.0	40	16.0 x 32.0 x 31.5	27.5	–	B32674*3805+	6.0	5.5	5.0	–	7	9	12	–	220
8.2	40	18.0 x 33.0 x 31.5	27.5	–	B32674*3825+	6.0	5.2	4.8	–	7	9	12	–	200
10	40	21.0 x 31.0 x 31.5	27.5	–	B32674*3106+	5.3	4.6	4.2	–	7	10	12	–	180
10	22	18.0 x 32.5 x 42.0	37.5	–	B32676*3106+	–	7.7	6.9	–	–	10	12	–	90
12	40	22.0 x 36.5 x 31.5	27.5	–	B32674*3126+	5.2	4.5	4.0	–	7	10	12	–	160
12	22	18.0 x 32.5 x 42.0	37.5	–	B32676*3126+	–	6.8	6.1	–	–	10	12	–	90
15	22	20.0 x 39.5 x 42.0	37.5	10.2	B32676*3156+	–	5.8	5.2	4.0	–	10	12	20	75
20	22	28.0 x 37.0 x 42.0	37.5	10.2	B32676*3206+	–	5	4.3	3.1	–	10	12	22	55
22	22	28.0 x 42.5 x 42.0	37.5	20.3	B32676*3226+	–	4.8	4.1	3.0	–	10	12	22	55
25	22	28.0 x 42.5 x 42.0	37.5	20.3	B32676*3256+	–	4.6	3.8	2.8	–	10	12	22	55
30	22	30.0 x 45.0 x 42.0	37.5	20.3	B32676*3306+	–	4.4	3.7	2.6	–	10	12	22	54

Other executions and intermediate upon request.
Preferred lead execution

+ = Tolerance
J = ± 5%
K = ± 10%

* = Diameter
D = Ø 0.8 mm
E = Ø 1.0 mm
F = Ø 1.2 mm
G = Ø 1.2 mm, 4-pin

PU = Packing unit

Data Sheet: MKP 2/4 Pins

Characteristics and ordering codes

C_R	dv/dt	Max. dimensions w x h x l	e	P_1 4-pin	Ordering code	ESR (mΩ), 100 kHz 2-pin			4-pin	I_{rms} (A), 100 kHz, 70 °C 2-pin			4-pin	PU (pcs.)
µF	V/µs	mm	mm	mm		Ø0.8	Ø1.0	Ø1.2	Ø1.2	Ø0.8	Ø1.0	Ø1.2	Ø1.2	
V_R = 300 VDC / V_{op} = 450 VDC / V_{rms} = 160 VAC / V_p = 450 VDC														
30	15	30.0 x 45.0 x 57.5	52.5	20.3	B32678*3306+	–	–	–	4	–	–	–	22	36
35	15	30.0 x 45.0 x 57.5	52.5	20.3	B32678*3356+	–	–	–	3.4	–	–	–	22	36
40	15	30.0 x 45.0 x 57.5	52.5	20.3	B32678*3406+	–	–	–	3	–	–	–	22	36
47	15	35.0 x 50.0 x 57.5	52.5	20.3	B32678*3476+	–	–	–	2.7	–	–	–	22	28
60	15	35.0 x 50.0 x 57.5	52.5	20.3	B32678*3606K	–	–	–	2.6	–	–	–	22	28
V_R = 450 VDC / V_{op} = 630 VDC / V_{rms} = 275 VAC / V_p = 675 VDC														
1.5	75	11.0 x 19.0 x 31.5	27.5	–	B32674*4155+	7.9	7.5	7.1	–	8	9	10	–	320
2.2	75	12.5 x 21.5 x 31.5	27.5	–	B32674*4225+	6.3	6.0	5.7	–	9	10	11	–	280
2.2	54	12.0 x 22.0 x 42.0	37.5	–	B32676*4225+	–	14.0	13.1	–	–	9	10	–	135
3	54	12.0 x 22.0 x 42.0	37.5	–	B32676*4305+	–	13.7	12.7	–	–	10	11	–	135
3.3	75	15.0 x 24.5 x 31.5	27.5	–	B32674*4335+	4.7	4.3	4.0	–	9	10	12	–	240
3.3	54	14.0 x 25.0 x 42.0	37.5	–	B32676*4335+	–	13.2	12.2	–	–	10	11	–	115
4	54	14.0 x 25.0 x 42.0	37.5	–	B32676*4405+	–	12.2	11.1	–	–	11	12	–	115
4.7	75	18.0 x 27.5 x 31.5	27.5	–	B32674*4475+	4.8	4.1	3.5	–	9	11	14	–	200
4.7	54	16.0 x 28.5 x 42.0	37.5	–	B32676*4475+	–	11.5	10.3	–	–	12	13	–	100
5.0	75	16.0 x 32.0 x 31.5	27.5	–	B32674*4505+	4.8	4.1	3.5	–	9	11	14	–	220
5.6	75	18.0 x 33.0 x 31.5	27.5	–	B32674*4565+	4.2	3.6	3.1	–	9	12	14	–	200
5.6	54	16.0 x 28.5 x 42.0	37.5	–	B32676*4565+	–	10.2	9.5	–	–	12	14	–	100
6	75	21.0 x 31.0 x 31.5	27.5	–	B32674*4605+	4.1	3.5	3.0	–	9	12	14	–	180
6.8	75	22.0 x 36.5 x 31.5	27.5	–	B32674*4685+	3.8	3.3	2.8	–	9	12	14	–	160
6.8	54	18.0 x 32.5 x 42.0	37.5	–	B32676*4685+	–	8.6	7.7	–	–	12	14	–	90
7.5	75	22.0 x 36.5 x 31.5	27.5	–	B32674*4755+	3.7	3.2	2.8	–	9	12	14	–	160
8.2	54	20.0 x 39.5 x 42.0	37.5	10.2	B32676*4825+	–	7.2	6.4	3.3	–	12	14	24	75
10	54	20.0 x 39.5 x 42.0	37.5	10.2	B32676*4106+	–	6.0	5.3	2.2	–	12	14	27	75
15	54	28.0 x 42.5 x 42.0	37.5	10.2	B32676*4156+	–	4.1	3.3	1.8	–	12	14	29	55
20	54	30.0 x 45.0 x 42.0	37.5	20.3	B32676*4206K	–	3.3	2.6	1.4	–	12	14	29	54
20	35	30.0 x 45.0 x 57.5	52.5	20.3	B32678*4206+	–	–	–	2.2	–	–	–	29	36
25	35	30.0 x 45.0 x 57.5	52.5	20.3	B32678*4256+	–	–	–	2	–	–	–	29	36
30	35	35.0 x 50.0 x 57.5	52.5	20.3	B32678*4306+	–	–	–	1.7	–	–	–	29	28
35	35	35.0 x 50.0 x 57.5	52.5	20.3	B32678*4356+	–	–	–	1.4	–	–	–	29	28
V_R = 630 VDC / V_{op} = 800 VDC / V_{rms} = 350 VAC / V_p = 950 VDC														
1	100	11.0 x 19.0 x 31.5	27.5	–	B32674*6105+	10.5	9.9	9.4	–	7	8	9	–	320
1.5	100	12.5 x 21.5 x 31.5	27.5	–	B32674*6155+	7.7	7.4	7.1	–	9	12	12	–	280
2	73	12.0 x 22.0 x 42.0	37.5	–	B32676*6205+	–	12.2	11.5	–	–	10	11	–	135
2.2	100	15.0 x 24.5 x 31.5	27.5	–	B32674*6225+	6.0	5.5	5.0	–	9	12	13	–	240
2.7	73	14.0 x 25.0 x 42.0	37.5	–	B32676*6275+	–	10.5	9.8	–	–	10	12	–	115
3.3	100	16.0 x 32.0 x 31.5	27.5	–	B32674*6335+	5.0	4.5	4.0	–	9	12	14	–	220
3.3	73	16.0 x 28.5 x 42.0	37.5	–	B32676*6335+	–	9.3	8.5	–	–	10	13	–	100
4	73	16.0 x 28.5 x 42.0	37.5	–	B32676*6405+	–	7.2	6.4	–	–	11	13	–	100
4.7	100	22.0 x 36.5 x 31.5	27.5	–	B32674*6475+	4.7	4.0	3.4	–	9	12	14	–	160
4.7	73	18.0 x 32.5 x 42.0	37.5	–	B32676*6475+	–	5.8	5.1	–	–	12	14	–	90
5	100	22.0 x 36.5 x 31.5	27.5	–	B32674*6505+	4.7	4.0	3.4	–	9	12	14	–	160

Other executions and intermediate upon request.
Preferred lead execution

+ = Tolerance
J = ± 5%
K = ± 10%

* = Diameter
D = Ø 0.8 mm
E = Ø 1.0 mm
F = Ø 1.2 mm
G = Ø 1.2 mm, 4-pin

PU = Packing unit

Data Sheet: MKP 2/4 Pins

Characteristics and ordering codes

C_R	dv/dt	Max. dimensions w x h x l	e	P_1 4-pin	Ordering code	ESR (mΩ), 100 kHz 2-pin			4-pin	I_{rms} (A), 100 kHz, 70 °C 2-pin			4-pin	PU (pcs.)
µF	V/µs	mm	mm	mm		Ø0.8	Ø1.0	Ø1.2	Ø1.2	Ø0.8	Ø1.0	Ø1.2	Ø1.2	
V_R = 630 VDC / V_{op} = 800 VDC / V_{rms} = 350 VAC / V_p = 950 VDC														
6.8	73	20.0 x 39.5 x 42.0	37.5	10.2	B32676*6685+	–	4.9	4.2	2.5	–	12	14	22	75
7.5	73	20.0 x 39.5 x 42.0	37.5	10.2	B32676*6755+	–	4.6	3.9	2.3	–	12	14	27	75
8.2	73	28.0 x 37.0 x 42.0	37.5	10.2	B32676*6825+	–	4.3	3.6	2.1	–	12	14	29	55
10	73	28.0 x 42.5 x 42.0	37.5	20.3	B32676*6106+	–	3.9	3.1	1.9	–	12	14	29	55
12	73	28.0 x 42.5 x 42.0	37.5	20.3	B32676*6126+	–	3.8	3	1.8	–	12	14	29	55
14	73	30.0 x 45.0 x 42.0	37.5	20.3	B32676*6146+	–	3.7	2.9	1.7	–	12	14	29	54
15	50	30.0 x 45.0 x 57.5	52.5	20.3	B32678*6156+	–	–	–	2.7	–	–	–	29	36
20	50	35.0 x 50.0 x 57.5	52.5	20.3	B32678*6206+	–	–	–	2	–	–	–	29	28
25	50	35.0 x 50.0 x 57.5	52.5	20.3	B32678*6256+	–	–	–	1.8	–	–	–	29	28
V_R = 750 VDC / V_{op} = 900 VDC / V_{rms} = 375 VAC / V_p = 1125 VDC														
0.68	125	11.0 x 19.0 x 31.5	27.5	–	B32674*1684+	12.0	11.4	10.8	–	7	8	8	–	320
1	125	12.5 x 21.5 x 31.5	27.5	–	B32674*1105+	9.0	8.4	7.8	–	9	9	10	–	280
1.5	125	14.0 x 24.5 x 31.5	27.5	–	B32674*1155+	6.9	6.3	5.8	–	9	12	13	–	260
1.5	85	12.0 x 22.0 x 42.0	37.5	–	B32676*1155+	–	15.2	12.2	–	–	9	11	–	135
2	85	14.0 x 25.0 x 42.0	37.5	–	B32676*1205+	–	12.2	10.9	–	–	10	12	–	115
2.2	125	18.0 x 27.5 x 31.5	27.5	–	B32674*1225+	5.3	4.8	4.4	–	9	12	14	–	200
3.3	125	21.0 x 31.0 x 31.5	27.5	–	B32674*1335+	5.0	4.4	3.9	–	9	12	14	–	180
3.3	85	18.0 x 32.5 x 42.0	37.5	–	B32676*1335+	–	9.6	8.4	–	–	11	14	–	90
4.0	125	22.0 x 36.5 x 31.5	27.5	–	B32674*1405+	4.9	4.1	3.5	–	9	12	14	–	160
4.7	85	20.0 x 39.5 x 42.0	37.5	10.2	B32676*1475+	–	5.7	4.7	3.8	–	12	14	22	75
5.6	85	20.0 x 39.5 x 42.0	37.5	10.2	B32676*1565+	–	5.2	4.2	3.6	–	12	14	24	75
6.8	85	28.0 x 37.0 x 42.0	37.5	20.3	B32676*1685+	–	4.9	4	3.2	–	12	14	28	55
9	85	28.0 x 42.5 x 42.0	37.5	20.3	B32676*1905+	–	4.4	3.3	2.5	–	12	14	29	55
10	85	30.0 x 45.0 x 42.0	37.5	20.3	B32676*1106+	–	4.2	3	2.3	–	12	14	29	54
15	60	30.0 x 45.0 x 57.5	52.5	20.3	B32678*1156K	–	–	–	2.7	–	–	–	29	36
20	60	35.0 x 50.0 x 57.5	52.5	20.3	B32678*1206K	–	–	–	1.9	–	–	–	29	28
V_R = 875 VDC / V_{op} = 1050 VDC / V_{rms} = 400 VAC / V_p = 1300 VDC														
0.47	150	11.0 x 19.0 x 31.5	27.5	–	B32674*8474+	14.0	13.5	13.0	–	7	7	7	–	320
0.68	150	11.0 x 21.0 x 31.5	27.5	–	B32674*8684+	11.5	11.0	10.5	–	8	8	8	–	320
1	150	13.5 x 23.0 x 31.5	27.5	–	B32674*8105+	8.4	8.0	7.6	–	9	9	10	–	260
1	100	12.0 x 22.0 x 42.0	37.5	–	B32676*8105+	–	14.1	13.3	–	–	10	11	–	135
1.5	150	18.0 x 27.5 x 31.5	27.5	–	B32674*8155+	5.5	5.0	4.6	–	9	12	14	–	200
1.5	100	14.0 x 25.0 x 42.0	37.5	–	B32676*8155+	–	12.2	11.1	–	–	10	11	–	115
2.2	150	18.0 x 33.0 x 31.5	27.5	–	B32674*8225+	5.3	4.8	4.4	–	9	12	14	–	200
2.2	100	16.0 x 28.5 x 42.0	37.5	–	B32676*8225+	–	10.5	9.5	–	–	11	12	–	100
3	150	22.0 x 36.5 x 31.5	27.5	–	B32674*8305+	4.5	4.0	3.6	–	9	12	14	–	160
3.3	100	20.0 x 39.5 x 42.0	37.5	10.2	B32676*8335+	–	6.5	5.5	4.8	–	12	14	25	75
4	100	20.0 x 39.5 x 42.0	37.5	10.2	B32676*8405+	–	5.8	4.7	4	–	12	14	26	75
4.7	100	28.0 x 37.0 x 42.0	37.5	20.3	B32676*8475+	–	5.1	4.1	3.3	–	12	14	27	55
6.8	100	28.0 x 42.5 x 42.0	37.5	20.3	B32676*8685+	–	4.9	3.7	3.1	–	12	14	28	55
7.5	100	30.0 x 45.0 x 42.0	37.5	20.3	B32676*8755+	–	4.7	3.5	2.9	–	12	14	29	54
10	70	30.0 x 45.0 x 57.5	52.5	20.3	B32678*8106+	–	–	–	2.5	–	–	–	29	36
15	70	35.0 x 50.0 x 57.5	52.5	20.3	B32678*8156K	–	–	–	2	–	–	–	29	28

Other executions and intermediate upon request.
Preferred lead execution

+ = Tolerance
J = ± 5%
K = ± 10%

* = Diameter
D = Ø 0.8 mm
E = Ø 1.0 mm
F = Ø 1.2 mm
G = Ø 1.2 mm, 4-pin

PU = Packing unit.

Technical data

Reference standards IEC 61071 / IEC 60068 / IEC 60384-16						
Maximum operating temperature $T_{op,max}$	100 °C					
Climatic category	40/100/56					
Dissipation factor tan δ (in 10^{-3}) at 1 kHz and 20 °C (upper limit values)	≤ 1					
Insulation resistance R_{ins} or time constant $\tau = C_R \times R_{ins}$ at 20 °C, rel. humidity ≤ 65% (minimum as-delivered values)	30 000 s					
DC test voltage between terminations (to IEC 61017)	1.5 x V_R, 10 s / 1.65 x V_R, 2 s					
Continuous operation voltage (V_{op})	70 °C	450	630	800	900	1050
Nominal operation voltage (V_R)	85 °C	300	450	630	750	875
Maximum peak voltage ($V_{P,max}$)		450	675	950	1125	1300
Category voltage V_C (continuous operation with V_{DC} or V_{AC} at f ≤ 1kHz)	T_A (°C)	DC voltage derating		AC voltage derating		
	$T_A \le 85$ $85 < T_A \le 100$	$V_C = V_R$ $V_C = V_R \times (165 - T_A) / 80$		$V_{C,rms} = V_{R,rms}$ $V_{C,rms} = V_{R,rms} \times (165 - T_A) / 80$		
Operating voltage U_{op} for short operating periods (V_{DC} or V_{AC} at f ≤ 1kHz)	T_A (°C)	DC voltage (max. hours)		AC voltage (max. hours)		
	$T_A \le 85$ $85 < T_A \le 100$	$V_{op} = 1.25 \times V_C$ (2000 h) $V_{op} = 1.25 \times V_C$ (1000 h)		$V_{op} = 1.0 \times V_{C,rms}$ (2000 h) $V_{op} = 1.0 \times V_{C,rms}$ (1000 h)		
Pulse rise time (dv/dt)	Refer to table					
Maximum peak current (I_P,max)	C (µF) x dv/dt (V/µs)					
Peak non-repetitive current	1.5 x I_P					
Damp heat test	56 days / 40 °C / 93% relative humidity			≤ 5%		
Limit values after damp heat test	Capacitance change (ΔC/C)			≤ 0.5 x 10^{-3} (at 1 kHz)		
	Dissipation factor change (Δ tan δ)			≤ 1.0 x 10^{-3} (at 10 kHz)		
	Insulation resistance R_{ins} or time constant $\tau = C_R \times R_{ins}$			≥ 50% of minimum as-delivered values		
Reliability:						
Failure rate λ	1 fit (≤ 1 x 10^{-9}/h) at 0.5 V_R, 40 °C					
Service life t_{SL}	200 000 h at 1.0 x V_R, 40 °C					
	For conversion to other operating conditions and temperatures refer to chapter “Quality assurance”, data book 2005 “Film Capacitors”, page 390.					
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 x upper limit value		
	Insulation resistance R_{ins} or time constant $\tau = C_R \times R_{ins}$			< 500 s		
Delivery mode	Bulk					

MKP capacitors for snubbering

RoHS compatible

Climatic

- Maximum operating temperature 100 °C
- Climatic category (IEC 60068-1): 55/100/56

Construction

- Dielectric: Polypropylene (MKP) film
- Wound technology with internal series connection
- Plastic case (UL 94 V-0)
- Epoxy resin sealing (UL 94 V-0)

Terminals

- Strap terminals, tinned copper (maximum torque 10 Nm)

Marking

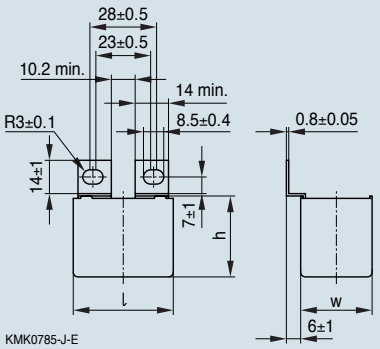
Manufacturer's logo, ordering code, style (MKP), rated capacitance (coded), cap. tolerance (code letter), rated DC voltage, date of manufacture (coded)

Delivery mode

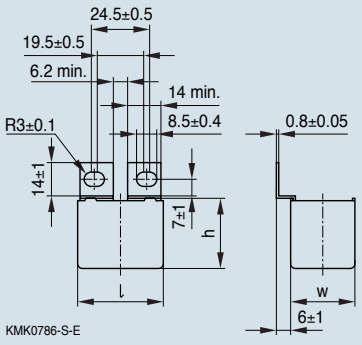
Bulk

Dimensional drawing

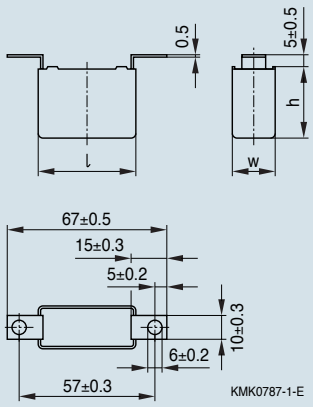
T1 (code no. 561)



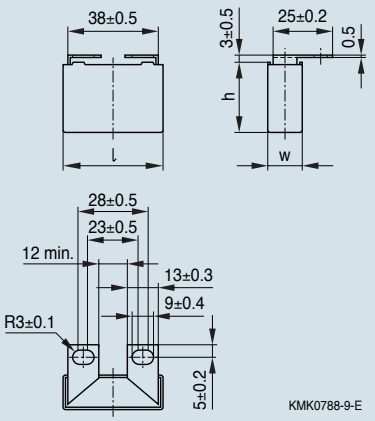
T2 (code no. 562)



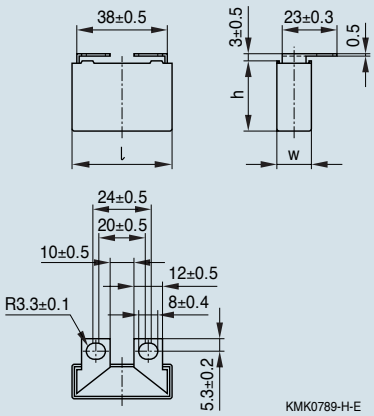
T3 (code no. 563)



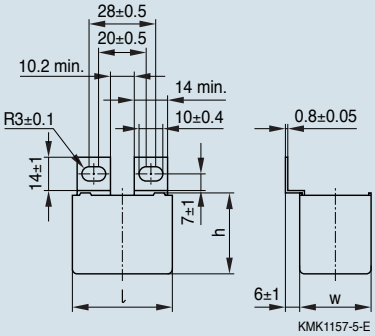
T4 (code no. 564)



T5 (code no. 565)



T6 (code no. 566)



Data Sheet: MKP Snubbers

Characteristics and ordering codes

C_R	Max. dimensions w x h x l	Ordering code	Terminals						dv/dt	ESR 100 kHz	I_{rms} 100 kHz
µF	mm		T1	T2	T3	T4	T5	T6	V/µs	mΩ	A
V_R = 850 VDC / V_{rms} = 450 VAC											
0.22	12 x 22.5 x 42	B32656S8224+***			■	■			400	10	5
0.27	12 x 22.5 x 42	B32656S8274+***			■	■			400	9	6
0.33	12 x 22.5 x 42	B32656S8334+***			■	■			400	9	6
0.39	12 x 22.5 x 42	B32656S8394+***			■	■			400	8	7
0.47	12 x 22.5 x 42	B32656S8474+***			■	■			400	8	8
0.56	14 x 25 x 42	B32656S8564+***			■	■			400	7	8
0.68	16 x 28.5 x 42	B32656S8684+***			■	■	■		400	6	9
0.82	16 x 28.5 x 42	B32656S8824+***			■	■	■		400	6	10
1.00	18 x 32.5 x 42	B32656S8105+***			■	■	■		400	6	11
1.20	18 x 32.5 x 42	B32656S8125+***			■	■	■		400	5	11
1.50	31 x 26.5 x 43.6	B32656S8155+***	■	■	■			■	400	5	13
1.80	28 x 37 x 42	B32656S8185+***	■	■	■			■	400	4.5	15
2.20	30 x 45 x 42	B32656S8255+***	■	■	■			■	400	3.5	17
V_R = 1000 VDC / V_{rms} = 480 VAC											
0.22	12 x 22.5 x 42	B32656S0224+***			■	■			450	10	6
0.27	12 x 22.5 x 42	B32656S0274+***			■	■			450	9	7
0.33	14 x 25 x 42	B32656S0334+***			■	■	■		450	9	7
0.39	14 x 25 x 42	B32656S0394+***			■	■	■		450	8	8
0.47	14 x 25 x 42	B32656S0474+***			■	■	■		450	8	9
0.56	16 x 28.5 x 42	B32656S0564+***			■	■	■		450	7	9
0.68	16 x 28.5 x 42	B32656S0684+***			■	■	■		450	6	10
0.82	18 x 32.5 x 42	B32656S0824+***			■	■	■		450	6	11
1.00	20 x 39.5 x 42	B32656S0105+***	■	■	■	■	■	■	450	6	12
1.20	20 x 39.5 x 42	B32656S0125+***	■	■	■	■	■	■	450	5	13
1.50	30 x 45 x 42	B32656S0155+***	■	■	■			■	450	5	15
1.80	30 x 45 x 42	B32656S0185+***	■	■	■			■	450	4.5	16
V_R = 1250 VDC / V_{rms} = 500 VAC											
0.12	12 x 22.5 x 42	B32656S7124+***			■	■			500	15	5
0.15	12 x 22.5 x 42	B32656S7154+***			■	■			500	15	6
0.22	14 x 25 x 42	B32656S7224+***			■	■	■		500	10	8
0.27	14 x 25 x 42	B32656S7274+***			■	■	■		500	9	8
0.33	16 x 28.5 x 42	B32656S7334+***			■	■	■		500	9	8
0.39	18 x 32.5 x 42	B32656S7394+***			■	■	■		500	8	9
0.47	18 x 32.5 x 42	B32656S7474+***			■	■	■		500	8	9
0.56	20 x 39.5 x 42	B32656S7564+***	■	■	■	■	■	■	500	7	10
0.68	20 x 39.5 x 42	B32656S7684+***	■	■	■	■	■	■	500	6	10
0.82	28 x 37 x 42	B32656S7824+***	■	■	■	■	■	■	500	6	11
1.00	28 x 37 x 42	B32656S7105+***	■	■	■	■	■	■	500	6	13
1.20	30 x 45 x 42	B32656S7125+***	■	■	■	■	■	■	500	5	14

■ Available terminal types

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

*** = Terminal configuration
T1 = 561
T2 = 562
T3 = 563
T4 = 564
T5 = 565
T6 = 566

Characteristics and ordering codes

C_R	Max. dimensions w x h x l	Ordering code	Terminals						dv/dt	ESR 100 kHz	I_{rms} 100 kHz
µF	mm		T1	T2	T3	T4	T5	T6	V/µs	mΩ	A
V_R = 1600 VDC / V_{rms} = 750 VAC											
0.068	12 x 22.5 x 42	B32656S1683+***			■	■			600	25	5
0.10	12 x 22.5 x 42	B32656S1104+***			■	■			600	20	6
0.12	14 x 25 x 42	B32656S1124+***			■	■	■		600	15	6
0.15	14 x 25 x 42	B32656S1154+***			■	■	■		600	15	7
0.22	16 x 28.5 x 42	B32656S1224+***			■	■	■		600	10	9
0.27	18 x 32.5 x 42	B32656S1274+***			■	■	■		600	9	10
0.33	20 x 39.5 x 42	B32656S1334+***	■	■	■	■	■	■	600	9	10
0.39	28 x 37 x 42	B32656S1394+***	■	■	■			■	600	8	11
0.47	28 x 37 x 42	B32656S1474+***	■	■	■			■	600	8	12
0.56	30 x 45 x 42	B32656S1564+***	■	■	■			■	600	7	13
0.68	30 x 45 x 42	B32656S1684+***	■	■	■			■	600	6	14
V_R = 2000 VDC / V_{rms} = 800 VAC											
0.047	12 x 22.5 x 42	B32656S2473+***			■	■			700	35	5
0.068	14 x 25 x 42	B32656S2683+***			■	■	■		700	25	6
0.10	14 x 25 x 42	B32656S2104+***			■	■	■		700	20	7
0.12	16 x 28.5 x 42	B32656S2124+***			■	■	■		700	15	7
0.15	18 x 32.5 x 42	B32656S2154+***			■	■	■		700	15	8
0.22	20 x 39.5 x 41.5	B32656S2224+***	■	■	■	■	■	■	700	10	10
0.27	28 x 37 x 42	B32656S2274+***	■	■	■			■	700	9	11
0.33	28 x 37 x 42	B32656S2334+***	■	■	■			■	700	9	12
0.39	30 x 45 x 42	B32656S2394+***	■	■	■			■	700	8	13
0.47	30 x 45 x 42	B32656S2474+***	■	■	■			■	700	8	15

■ Available terminal types

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

*** = Terminal configuration
T1 = 561
T2 = 562
T3 = 563
T4 = 564
T5 = 565
T6 = 566

Technical data

Operating temperature range	Max. operating temperature $T_{op,max}$	+ 100 °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 kHz and 20 °C (upper limit values)	at	$C_R \le 0.1$ µF	0.1 µF < $C_R \le 1$ 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 $\tau = C_R \times R_{ins}$ at 20 °C, rel. humidity ≤ 65% (minimum as-delivered values)	$C_R \le 0.33$ µF	$C_R \le 0.33$ µF		
	100 GΩ	30 000 s		
DC test voltage	1.6 x V_R, 2 s			
Category voltage V_C (continuous operation with V_{DC} or V_{AC} at f ≤ 1 kHz)	T_A (°C)	DC voltage derating	AC voltage derating	
	$T_A \le 85$ $85 < T_A \le 100$	$V_C = V_R$ $V_C = V_R \times (165 - T_A) / 80$	$V_{C,rms} = V_{R,rms}$ $V_{C,rms} = V_{R,rms} \times (165 - T_A) / 80$	
Operating voltage V_{op} for short operating periods (V_{DC} or V_{AC} at f ≤ 1 kHz)	T_A (°C)	DC voltage (max. hours)	AC voltage (max. hours)	
	$T_A \le 85$ $85 < T_A \le 100$	$V_{op} = 1.25 \times V_C$ (2000 h) $V_{op} = 1.25 \times V_C$ (1000 h)	$V_{op} = 1.0 \times V_{C,rms}$ (2000 h) $V_{op} = 1.0 \times V_{C,rms}$ (1000 h)	
Damp heat test **Limit values after damp heat test**	56 days / 40 °C / 93% relative humidity		≤ 3%	
	Capacitance change (ΔC/C)		≤ 0.3 x 10^{-3} (at 1 kHz)	
	Dissipation factor change (Δ tan δ)		≤ 1.0 x 10^{-3} (at 10 kHz)	
	Insulation resistance R_{ins} or time constant $\pi = C_R \times R_{ins}$		≥ 50% of minimum as-delivered values	
Reliability:				
Failure rate λ	1 fit (≤ 1 x 10^{-9}/h) at 0.5 x V_R, 40 °C			
Service life t_{SL}	up to 200 000 h at 1.0 x V_R, 40 °C			
	For conversion to other operating conditions and temperatures refer to chapter “Quality assurance”, data book 2005 “Film Capacitors”, page 390.			
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 x upper limit value		
	Insulation resistance R_{ins} or time constant $\tau = C_R \times R_{ins}$	< 1500 MΩ ($C_R \le 0.33$ µF) < 500 s ($C_R \le 0.33$ µF)		

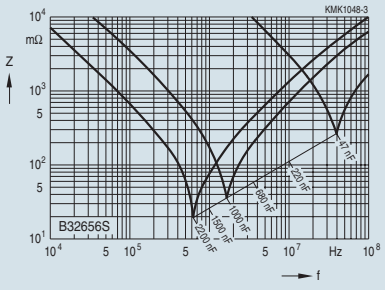
Pulse handling capability

“dv/dt” values 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/µs.

Note: The maximum values of dv/dt and k_0 must not be exceeded in order to avoid damaging the capacitor.

Impedance versus frequency curve (typical values)



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 hole space differs from the specified lead space.
- 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.

Resistance to soldering heat

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

Series	Solder bath temp.	Soldering time
MKT boxed (except 2.5 x 6.5 x 7.2 mm); coated; MKP/MFP	260 ± 5 °C	10 ± 1 s
MKT boxed (case 2.5 x 6.5 x 7.2 mm)	260 ± 5 °C	5 ± 1 s

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 irreversibly change a capacitor's electrical characteristics. For short exposure times (as in practical soldering processes), the heat load (and thus the possible effects on the capacitor) will also depend on other factors such as:

- The pre-heating temperature and time.
- The forced cooling immediately after soldering.
- The terminal characteristics: diameter, length, thermal resistance, special configurations (e.g. crimping).
- The height of the capacitor above the solder bath.
- Shadowing by neighboring components.
- Additional heating due to heat dissipation by neighboring components.
- Use of solder-resistant 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 have to be included.

Cleaning

To determine whether a particular solvent, often used to remove flux residues and other substances, is suitable for the capacitors described, please refer to data book 2005 “Film Capacitors”, in which this information is available. Even when suitable solvents are used, a reversible change of the electrical characteristics may occur in uncoated capacitors immediately after they have been 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.

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 considering maximum curing temperature 100 °C:

- Non-flexible epoxy resins with acid-anhydride hardeners
- Chemically inert, non-conducting fillers

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

Storage conditions

All capacitors listed in this product profile can be stored for short periods at any temperature within the entire range of category temperatures . For long storage periods, however, the following conditions should be observed:

- Storage temperature –40 to +40 °C
- Maximum relative humidity 80%, no dew allowed on the capacitor
- Maximum duration 24 months (12 months for taped components)

Resistance to vibration

A capacitor's ability to withstand vibration (e.g. such as that occurring in applications involving rotating machinery) is tested to IEC 60068-2-6. The test procedure used here involves continuous sinusoidal vibration along three orthogonal axes, with a continuously varying frequency (10 … 500 Hz), an acceleration amplitude of 10 *g*, a displacement amplitude of 0.75 mm and a duration of 360 minutes for each axis. 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”.

Passive flammability

The passive flammability test is applied to ensure that components bearing the corresponding qualification contribute less energy to the combustion behavior of their immediate vicinity than is required to ignite them. This measure is designed to contain any localized fire that may occur. In the respective tests, the capacitors are subjected to a standardized flame to evaluate their combustion behavior by checking whether the flame persists for longer than a maximum permissible period or not. The severity of the test is determined essentially by the test flame and exposure time in accordance with various international standards (IEC 60040 CO 752 (amendment to IEC 60384-1), IEC 60695-2-2 and UL 1414). Unless the detail specifications stipulate otherwise, EMI suppression capacitors are tested to IEC 60384-14, section 4.17, test severity categories B and C.

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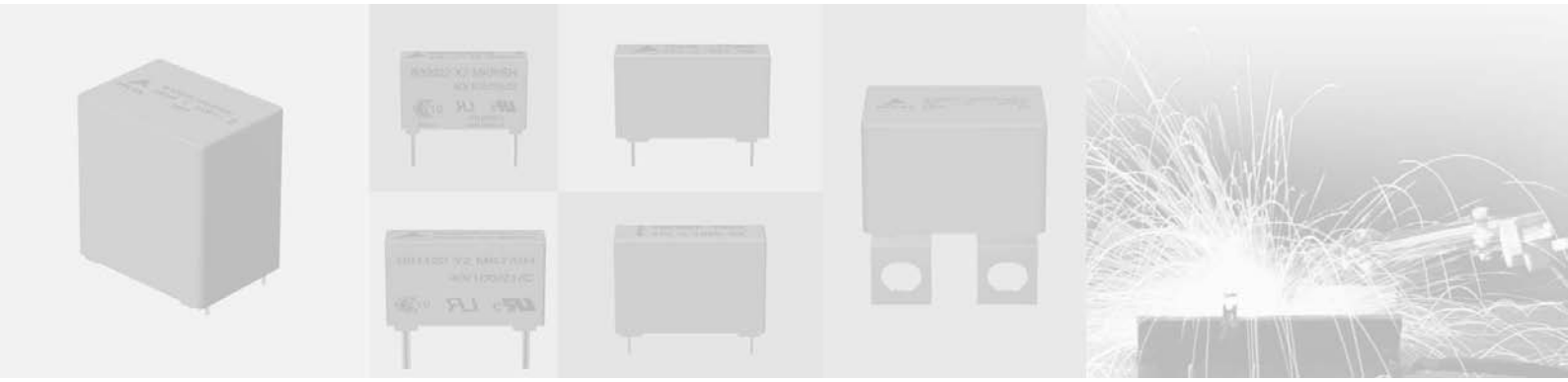

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