



## Film Capacitors

### EMI Suppression Capacitors (MKP)

**Series/Type:** B32911 ... B32916

**Date:** August 2010

**Typical applications**

- X1 class for interference suppression
- "Across the line" applications
- For apparatus permanently connected to mains and isolated from direct contact with humidity

**Climatic**

- Max. operating temperature: 110 °C
- Climatic category (IEC 60068-1): 40/110/56

**Construction**

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

**Features**

- Very small dimensions
- Good self-healing properties
- High voltage capability

**Terminals**

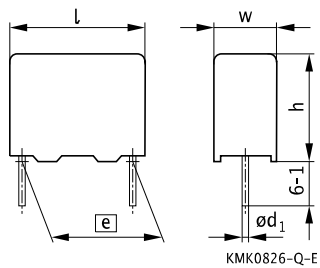
- Parallel wire leads, lead-free tinned
- Standard lead lengths: 6 – 1 mm
- Special lead lengths available on request

**Marking**

Manufacturer's logo, lot number, date code, rated capacitance (coded), capacitance tolerance (code letter), rated AC voltage (IEC), series number, sub-class (X1), dielectric code (MKP), climatic category, passive flammability category, approvals.

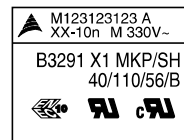
**Delivery mode**

Bulk (untaped)  
 Taped (Ammo pack or reel)  
 For taping details, refer to chapter "Taping and packing".

**Dimensional drawing**


Dimensions in mm

| Lead spacing<br>$e \pm 0,4$ | Lead diameter<br>$d_1$ | Type              |
|-----------------------------|------------------------|-------------------|
| 10                          | 0.6                    | B32911            |
| 15 ... 27.5                 | 0.8                    | B32912 ... B32914 |
| 37.5                        | 1.0                    | B32916            |

**Marking examples**
 $e = 10 \text{ mm}$ 


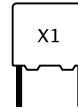
KMK1261-Z

 $15 \leq e \leq 27.5 \text{ mm}$   
 $(C_R \leq 1 \mu\text{F})$ 





KMK1262-P

 $22.5 \leq e \leq 37.5 \text{ mm}$   
 $(C_R > 1 \mu\text{F})$ 


KMK1263-7



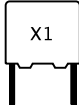
**Approvals**

| Approval marks   | Standards  | Certificate       |
|--|--|-------------------|
|     | EN 60384-14 / IEC 60384-14 (330 V AC)                    | 40019000          |
|     | UL1414 (250 V AC)<br>UL1283 (300 V AC)                   | E97863<br>E157153 |
|  1) | CSA C22.2 No. 1 (250 V AC)<br>CSA C22.2 No. 8 (300 V AC) | E97863<br>E157153 |

1) approved by UL

**Overview of available types**

| Lead spacing | 10 mm  | 15 mm  | 22.5 mm | 27.5 mm | 37.5 mm |
|--------------|--------|--------|---------|---------|---------|
| Type         | B32911 | B32912 | B32913  | B32914  | B32916  |
| $C_R$ (μF)   |        |        |         |         |         |
| 0.010        |        |        |         |         |         |
| 0.022        |        |        |         |         |         |
| 0.033        |        |        |         |         |         |
| 0.047        |        |        |         |         |         |
| 0.068        |        |        |         |         |         |
| 0.10         |        |        |         |         |         |
| 0.15         |        |        |         |         |         |
| 0.22         |        |        |         |         |         |
| 0.33         |        |        |         |         |         |
| 0.47         |        |        |         |         |         |
| 0.68         |        |        |         |         |         |
| 1.0          |        |        |         |         |         |
| 1.5          |        |        |         |         |         |
| 2.2          |        |        |         |         |         |
| 3.3          |        |        |         |         |         |
| 4.7          |        |        |         |         |         |
| 6.8          |        |        |         |         |         |



B32911 ... B32916

X1 / 330 V AC

**Ordering codes and packing units**

| Lead spacing<br>mm | C <sub>R</sub><br>μF | Max. dimensions<br>w × h × l<br>mm | Ordering code<br>(composition see<br>below) | Ammo<br>pack<br>pcs./MOQ | Reel<br>pcs./MOQ | Untaped<br>pcs./MOQ |
|--------------------|----------------------|------------------------------------|---|--------------------------|------------------|---------------------|
| 10                 | 0.010                | 4.0 × 9.0 × 13.0                   | B32911A3103+***                             | 4000                     | 6800             | 4000                |
|                    | 0.022                | 5.0 × 11.0 × 13.0                  | B32911B3223+***                             | 3320                     | 5200             | 4000                |
|                    | 0.033                | 6.0 × 12.0 × 13.0                  | B32911A3333M***                             | 2720                     | 4400             | 4000                |
| 15                 | 0.022                | 5.0 × 10.5 × 18.0                  | B32912A3223+***                             | 4680                     | 5200             | 4000                |
|                    | 0.033                | 5.0 × 10.5 × 18.0                  | B32912A3333+***                             | 4680                     | 5200             | 4000                |
|                    | 0.047                | 5.0 × 10.5 × 18.0                  | B32912A3473+***                             | 4680                     | 5200             | 4000                |
|                    | 0.068                | 6.0 × 11.0 × 18.0                  | B32912A3683+***                             | 3840                     | 4400             | 4000                |
|                    | 0.10                 | 7.0 × 12.5 × 18.0                  | B32912A3104+***                             | 3320                     | 3600             | 4000                |
|                    | 0.15                 | 7.0 × 12.5 × 18.0                  | B32912B3154M***                             | 3320                     | 3600             | 4000                |
|                    | 0.15                 | 8.5 × 14.5 × 18.0                  | B32912A3154+***                             | 2720                     | 2800             | 2000                |
|                    | 0.22                 | 8.5 × 14.5 × 18.0                  | B32912B3224M***                             | 2720                     | 2800             | 2000                |
|                    | 0.22                 | 9.0 × 17.5 × 18.0                  | B32912A3224+***                             | 2560                     | 2800             | 2000                |
|                    | 0.33                 | 9.0 × 17.5 × 18.0                  | B32912B3334M***                             | 2560                     | 2800             | 2000                |
| 22.5               | 0.15                 | 6.0 × 15.0 × 26.5                  | B32913A3154+***                             | 2720                     | 2800             | 2880                |
|                    | 0.22                 | 7.0 × 16.0 × 26.5                  | B32913A3224+***                             | 2320                     | 2400             | 2520                |
|                    | 0.33                 | 8.5 × 16.5 × 26.5                  | B32913A3334M***                             | 1920                     | 2000             | 2040                |
|                    | 0.47                 | 10.5 × 18.5 × 26.5                 | B32913A3474M***                             | 1560                     | 1600             | 2160                |
| 27.5               | 0.47                 | 11.0 × 21.0 × 31.5                 | B32914A3474+***                             | –                        | 1400             | 1280                |
|                    | 0.68                 | 11.0 × 21.0 × 31.5                 | B32914B3684+***                             | –                        | 1400             | 1280                |
|                    | 1.0                  | 13.5 × 23.0 × 31.5                 | B32914A3105+***                             | –                        | 1000             | 1040                |
|                    | 1.5                  | 18.0 × 27.5 × 31.5                 | B32914A3155+***                             | –                        | –                | 800                 |
|                    | 2.2                  | 19.0 × 30.0 × 31.5                 | B32914A3225M***                             | –                        | –                | 720                 |
| 37.5               | 3.3                  | 18.0 × 32.5 × 41.5                 | B32916A3335+***                             | –                        | –                | 720                 |
|                    | 4.7                  | 20.0 × 39.5 × 41.5                 | B32916A3475M***                             | –                        | –                | 640                 |
|                    | 6.8                  | 28.0 × 42.5 × 41.5                 | B32916A3685M***                             | –                        | –                | 440                 |

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

**Composition of ordering code**

+ = Capacitance tolerance code:

M = ±20%

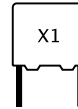
K = ±10%

\*\*\* = Packaging code:

289 = Ammo pack

189 = Reel

000 = Untaped (lead length 6 – 1 mm)


**Technical data**

|  |                                |                       |                    |
|--|--------------------------------|-----------------------|--------------------|
| Rated AC voltage ( IEC 60384-14 )  | 330 V (50/60 Hz)               |                       |                    |
| Maximum continuous DC voltage $V_{DC}$   | 760 V                          |                       |                    |
| Max. operating temperature $T_{op,max}$  | +110 °C                        |                       |                    |
| DC test voltage  | 2500 V, 2 s                    |                       |                    |
| Dissipation factor $\tan \delta$ (in $10^{-3}$ )<br>at 20 °C (upper limit values)  |                                | $C_R \leq 2.2 \mu F$  | $C_R > 2.2 \mu F$  |
|  | at 1 kHz                       | 1                     | 2                  |
| Insulation resistance $R_{ins}$<br>or time constant $\tau = C_R \cdot R_{ins}$<br>at 100 V DC, 20 °C,<br>rel. humidity $\leq 65\%$ and for 60 s<br>(minimum as-delivered values) |                                | $C_R \leq 0.33 \mu F$ | $C_R > 0.33 \mu F$ |
|  |                                | 100 000 M $\Omega$    | 30 000 s           |
| Passive flammability category<br>to IEC 40 (CO) 752  | B                              |                       |                    |
| Capacitance tolerances<br>(measured at 1 kHz)  | $\pm 10\%$ (K), $\pm 20\%$ (M) |                       |                    |

**Pulse handling capability**

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

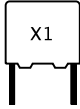
" $k_0$ " represents the maximum permissible pulse characteristic of the waveform applied to the capacitor, expressed in V<sup>2</sup>/ $\mu$ s.

*Note:*

The values of dV/dt and  $k_0$  provided below must not be exceeded in order to avoid damaging the capacitor.

**dV/dt and  $k_0$  values**

| Lead spacing                      | 10 mm   | 15 mm   | 22.5 mm | 27.5 mm | 37.5 mm |
|-----------------------------------|---------|---------|---------|---------|---------|
| dV/dt in V/ $\mu$ s               | 550     | 400     | 200     | 150     | 100     |
| $k_0$ in V <sup>2</sup> / $\mu$ s | 473 000 | 344 000 | 172 000 | 129 000 | 86 000  |



B32911 ... B32916

X1 / 330 V AC

## 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.

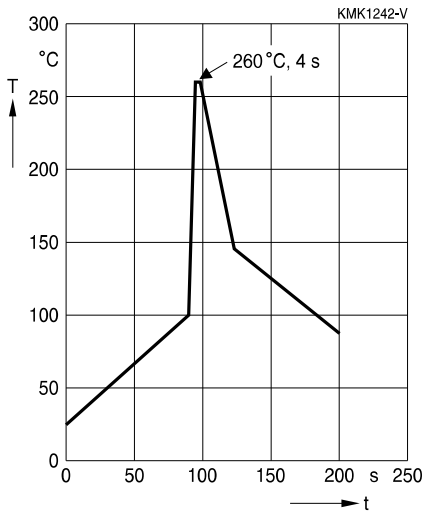
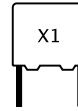
|                         |   |
|-------------------------|---|
| Solder bath temperature | 235 ±5 °C   |
| Soldering time          | 2.0 ±0.5 s  |
| Immersion depth         | 2.0 +0/-0.5 mm from capacitor body or seating plane             |
| Evaluation criteria:    |   |
| Visual inspection       |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

#### 1.2 Resistance to soldering heat

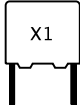
Resistance to soldering heat is tested to IEC 60068-2-20, test Tb, method 1A.

Conditions:

| Series   | Solder bath temperature | Soldering time  |
|--|-------------------------|---|
| MKT boxed (except 2.5 × 6.5 × 7.2 mm)<br>coated<br>uncoated (lead spacing > 10 mm) | 260 ±5 °C               | 10 ±1 s   |
| MFP<br>MKP (lead spacing > 7.5 mm)   |                         |   |
| MKT boxed (case 2.5 × 6.5 × 7.2 mm)  |                         | 5 ±1 s  |
| MKP (lead spacing ≤ 7.5 mm)  |                         | < 4 s   |
| MKT uncoated (lead spacing ≤ 10 mm)<br>insulated (B32559)                          |                         | recommended soldering<br>profile for MKT uncoated<br>(lead spacing ≤ 10 mm) and<br>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<br>5% for EMI suppression capacitors                             |
| $\tan \delta$        | As specified in sectional specification   |



B32911 ... B32916

X1 / 330 V AC

### 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.

EPCOS recommends the following conditions:

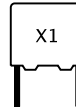
- Pre-heating with a maximum temperature of 110 °C
- Temperature inside the capacitor should not exceed the following limits:
  - MKP/MFP 110 °C
  - MKT 160 °C
- When SMD components are used together with leaded ones, the leaded film capacitors should not pass into the SMD adhesive curing oven. The leaded components should be assembled after the SMD curing step.
- Leaded film capacitors are not suitable for reflow soldering.

#### Uncoated capacitors

For uncoated MKT capacitors with lead spacings  $\leq 10$  mm (B32560/B32561) the following measures are recommended:

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





## 2 Cleaning

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

| Type                         | Ethanol, isopropanol, n-propanol | n-propanol-water mixtures, water with surface tension-reducing tensides (neutral) | Solvent from table A (see next page) | Solvent from table B (see next page) |
|------------------------------|----------------------------------|---|--------------------------------------|--------------------------------------|
| MKT (uncoated)               | Suitable                         | Unsuitable  | In part suitable                     | Unsuitable                           |
| MKT, MKP, MFP (coated/boxed) |                                  | Suitable  | Suitable                             |                                      |

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

**Table A**

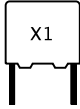
Manufacturers' designations for trifluoro-trichloro-ethane-based cleaning solvents (selection)

| Trifluoro-trichloro-ethane | Mixtures of trifluoro-trichloro-ethane with ethanol and isopropanol | Manufacturer |
|----------------------------|---|--------------|
| Freon TF                   | Freon TE 35; Freon TP 35; Freon TES                                 | Du Pont      |
| Frigen 113 TR              | Frigen 113 TR-E; Frigen 113 TR-P; Frigen TR-E 35                    | Hoechst      |
| Arklone P                  | Arklone A; Arklone L; Arklone K                                     | ICI          |
| Kaltron 113 MDR            | Kaltron 113 MDA; Kaltron 113 MDI; Kaltron 113 MDI 35                | Kali-Chemie  |
| Flugene 113                | Flugene 113 E; Flugene 113 IPA                                      | Rhone-Progil |

**Table B (worldwide banned substances)**

Manufacturers' designations for unsuitable cleaning solvents (selection)

| Mixtures of chlorinated hydrocarbons and ketones with fluorated hydrocarbons | Manufacturer |
|--|--------------|
| Freon TMC; Freon TA; Freon TC  | Du Pont      |
| Arklone E  | ICI          |
| Kaltron 113 MDD; Kaltron 113 MDK   | Kali-Chemie  |
| Flugene 113 CM   | Rhone-Progil |



B32911 ... B32916

X1 / 330 V AC

### 3 Embedding of capacitors in finished assemblies

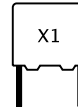
In many applications, finished circuit assemblies are embedded in plastic resins. In this case, both chemical and thermal influences of the embedding ("potting") and curing processes must be taken into account.

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

**Caution:**

Consult us first if you wish to embed uncoated types!

Application note for X1 / X2 EMI capacitors



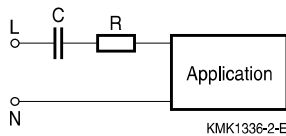
**Application note for the different possible X1 / X2 positions**

**In series with the powerline  
(i.e. capacitive power supply)**

Typical Applications:

- Power meters
- ECUs for white goods and household appliances
- Different sensor applications
- Severe ambient conditions

**Basic circuit**



**Required features**

- High capacitance stability over the lifetime
- Narrow tolerances for a controlled current supply

**Recommended EPCOS product series**

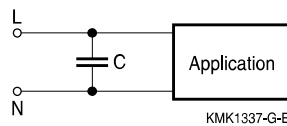
- B3293\* (305 V AC) heavy duty with EN approval for X2 (UL Q1/2010)
- B3292\*7 (305 V AC) improved standard series, approved as X2
- B3291\* (330 V AC), approved as X1
- B3265\* MKP series standard MKP capacitor without safety approvals
- B3267\*L MKP series standard MKP capacitor without safety approvals

**In parallel with the powerline**

Typical Applications:

Standard X2 are used parallel over the mains for reducing electromagnetic interferences coming from the grid. For such purposes they must meet the applicable EMC directives and standards.

**Basic circuit**

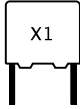


**Required features**

- Standard safety approvals (ENEC, UL, CSA, CQC)
- High pulse load capability
- Withstand surge voltages

**Recommended EPCOS product series**

- B3292\*C/D (305 V AC) standard series, approved as X2
- B3292\*E/F (305 V AC) miniaturized series (> 2.2 µF), approved as X2
- B3291\* (330 V AC), approved as X1



B32911 ... B32916

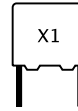
X1 / 330 V AC

### Cautions and warnings

- Do not exceed the upper category temperature (UCT).
- Do not apply any mechanical stress to the capacitor terminals.
- Avoid any compressive, tensile or flexural stress.
- Do not move the capacitor after it has been soldered to the PC board.
- Do not pick up the PC board by the soldered capacitor.
- Do not place the capacitor on a PC board whose PTH hole spacing differs from the specified lead spacing.
- Do not exceed the specified time or temperature limits during soldering.
- Avoid external energy inputs, such as fire or electricity.
- Avoid overload of the capacitors.

The table below summarizes the safety instructions that must always be observed. A detailed description can be found in the relevant sections of the chapters "General technical information" and "Mounting guidelines".

| Topic                   | Safety information  | Reference chapter<br>"General technical information" |
|-------------------------|---|--|
| Storage conditions      | Make sure that capacitors are stored within the specified range of time, temperature and humidity conditions.   | 4.5<br>"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<br>"Flammability"                                |
| Resistance to vibration | Do not exceed the tested ability to withstand vibration. The capacitors are tested to IEC 60068-2-6.<br>EPCOS offers film capacitors specially designed for operation under more severe vibration regimes such as those found in automotive applications. Consult our catalog "Film Capacitors for Automotive Electronics". | 5.2<br>"Resistance to vibration"                     |



| Topic  | Safety information  | Reference chapter<br>"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.<br>Caution: Consult us first, if you also wish to embed other uncoated component types! | 3 "Embedding of capacitors in finished assemblies" |