



[查询B32778供应商](#)

Film Capacitors

Metallized Polypropylene Film Capacitors (MKP)

Series/Type: B32774 ... B32778

Date: May 2009

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Typical applications

For compact design of:

- Frequency converters
- Industrial and high-end power supplies
- Solar inverters

Climatic

- Max. operating temperature: 105 °C (case)
- Climatic category (IEC 60068-1): 40/85/56

Construction

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

Features

- Capacitance values up to 110 µF
- High CV product, compact
- Excellent self-healing properties
- Overvoltage capability
- Low losses with high current capability
- High reliability
- Long useful life

Terminals

- Parallel wire leads, lead-free tinned
- 2-pin and 4-pin versions
- Standard lead lengths: 6 – 1 mm
- Special lead lengths are available on request

Marking

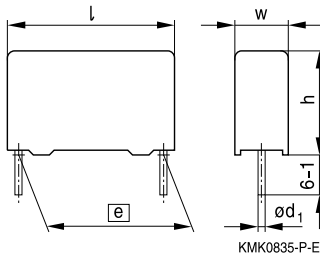
Manufacturer's logo, lot number, date code, rated capacitance (coded), capacitance tolerance (code letter), rated DC voltage

Delivery mode

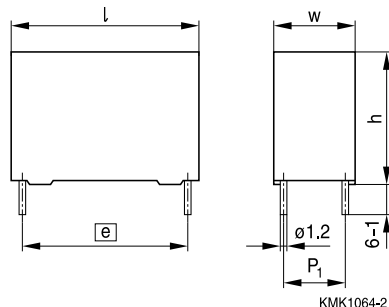
Bulk (untaped, lead length 6 – 1 mm)

Dimensional drawings

2-pin version

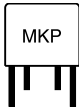


4-pin version



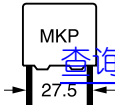
Dimensions in mm

| Version | Lead spacing [e] ±0.4 | Lead diameter d ₁ | Type |
|---------|--------------------------|---------------------------------|---------|
| 2-pin | 27.5 | 0.8 | B32774D |
| 2-pin | 37.5 | 1.0 | B32776E |
| 4-pin | 37.5 | 1.2 | B32776G |
| 4-pin | 52.5 | 1.2 | B32778G |



Overview of available types

| Lead spacing | 27.5 mm | | | | 37.5 mm | | | | 52.5 mm | | | |
|-----------------------|---------|-----|------|------|---------|-----|------|------|---------|-----|------|------|
| Type | B32774 | | | | B32776 | | | | B32778 | | | |
| Page | 4 | | | | 5 | | | | 7 | | | |
| V _R (V DC) | 450 | 800 | 1100 | 1300 | 450 | 800 | 1100 | 1300 | 450 | 800 | 1100 | 1300 |
| C _R (μF) | | | | | | | | | | | | |
| 1.5 | | | | | | | | | | | | |
| 2.0 | | | | | | | | | | | | |
| 3.0 | | | | | | | | | | | | |
| 5.0 | | | | | | | | | | | | |
| 7.0 | | | | | | | | | | | | |
| 8.0 | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | |
| 12 | | | | | | | | | | | | |
| 14 | | | | | | | | | | | | |
| 15 | | | | | | | | | | | | |
| 16 | | | | | | | | | | | | |
| 20 | | | | | | | | | | | | |
| 22 | | | | | | | | | | | | |
| 25 | | | | | | | | | | | | |
| 27 | | | | | | | | | | | | |
| 30 | | | | | | | | | | | | |
| 35 | | | | | | | | | | | | |
| 40 | | | | | | | | | | | | |
| 45 | | | | | | | | | | | | |
| 50 | | | | | | | | | | | | |
| 55 | | | | | | | | | | | | |
| 60 | | | | | | | | | | | | |
| 75 | | | | | | | | | | | | |
| 80 | | | | | | | | | | | | |
| 100 | | | | | | | | | | | | |
| 110 | | | | | | | | | | | | |



B32774

MKP DC link high density series

Ordering codes and packing units (lead spacing 27.5 mm)

| C_R | Max. dimensions $w \times h \times l$ | P_1 | Ordering code (composition see below) | $I_{RMS,max}$ 70 °C 10 kHz A | $I_{RMS,max}$ 70 °C 20 kHz A | ESR_{typ} 70 °C 10 kHz mΩ | Untaped pcs./MOQ |
|---|--|-------|---|---------------------------------------|---------------------------------------|--------------------------------------|-------------------------|
| μF | mm | mm | | | | | |
| $V_{R,70\text{ °C}} = 450\text{ V DC}, V_{op,85\text{ °C}} = 450\text{ V DC}$ | | | | | | | |
| 5.0 | 11.0 × 21.0 × 31.5 | — | B32774D4505+000 | 5.0 | 4.5 | 8.5 | 2352 |
| 10 | 15.0 × 24.5 × 31.5 | — | B32774D4106+000 | 6.5 | 6.0 | 7.5 | 1680 |
| 22 | 22.0 × 36.5 × 31.5 | — | B32774D4226+000 | 10.0 | 9.0 | 5.0 | 784 |
| $V_{R,70\text{ °C}} = 800\text{ V DC}, V_{op,85\text{ °C}} = 700\text{ V DC}$ | | | | | | | |
| 3.0 | 11.0 × 21.0 × 31.5 | — | B32774D8305+000 | 5.0 | 4.5 | 7.0 | 2352 |
| 5.0 | 14.0 × 24.5 × 31.5 | — | B32774D8505+000 | 5.0 | 4.5 | 7.0 | 1848 |
| 12 | 22.0 × 36.5 × 31.5 | — | B32774D8126+000 | 6.0 | 5.5 | 6.5 | 784 |
| $V_{R,70\text{ °C}} = 1100\text{ V DC}, V_{op,85\text{ °C}} = 920\text{ V DC}$ | | | | | | | |
| 2.0 | 12.5 × 21.5 × 31.5 | — | B32774D0205+000 | 4.0 | 3.5 | 7.0 | 2100 |
| 5.0 | 19.0 × 30.0 × 31.5 | — | B32774D0505+000 | 6.5 | 6.0 | 6.0 | 896 |
| 7.0 | 22.0 × 36.5 × 31.5 | — | B32774D0705+000 | 7.5 | 7.0 | 5.5 | 784 |
| $V_{R,70\text{ °C}} = 1300\text{ V DC}, V_{op,85\text{ °C}} = 1100\text{ V DC}$ | | | | | | | |
| 1.5 | 12.5 × 21.5 × 31.5 | — | B32774D1155+000 | 4.5 | 4.0 | 7.5 | 2100 |
| 3.0 | 18.0 × 27.5 × 31.5 | — | B32774D1305+000 | 6.0 | 5.5 | 6.5 | 1428 |
| 5.0 | 22.0 × 36.5 × 31.5 | — | B32774D1505+000 | 8.0 | 7.0 | 6.0 | 784 |

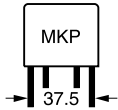
MOQ = Minimum Order Quantity, consisting of 4 packing units.
Further E series and intermediate capacitance values on request.

Composition of ordering code

+ = Capacitance tolerance code:

K = ±10%

J = ±5%



Ordering codes and packing units (lead spacing 37.5 mm)

| C_R | Max. dimensions $w \times h \times l$ | P_1 | Ordering code (composition see below) | $I_{RMS,max}$ 70 °C 10 kHz A | $I_{RMS,max}$ 70 °C 20 kHz A | ESR_{typ} 70 °C 10 kHz mΩ | Untaped |
|--|--|-------|---|---------------------------------------|---------------------------------------|--------------------------------------|----------|
| μF | mm | mm | | | | | pcs./MOQ |
| $V_{R,70\text{ °C}} = 450\text{ V DC}, V_{op,85\text{ °C}} = 450\text{ V DC}$ | | | | | | | |
| 30 | $20.0 \times 39.5 \times 41.5$ | 10.2 | B32776G4306+000 | 12.5 | 11.5 | 8.0 | 640 |
| 30 | $20.0 \times 39.5 \times 41.5$ | – | B32776E4306+000 | 11.5 | 10.5 | 9.0 | 640 |
| 35 | $28.0 \times 37.0 \times 42.0$ | 10.2 | B32776G4356+000 | 13.5 | 12.5 | 8.0 | 440 |
| 35 | $28.0 \times 37.0 \times 42.0$ | – | B32776E4356+000 | 12.5 | 11.5 | 9.0 | 440 |
| 40 | $28.0 \times 37.0 \times 42.0$ | 10.2 | B32776G4406+000 | 14.5 | 13.5 | 5.0 | 440 |
| 40 | $28.0 \times 37.0 \times 42.0$ | – | B32776E4406+000 | 13.5 | 12.5 | 5.5 | 440 |
| 50 | $28.0 \times 42.5 \times 41.5$ | 20.3 | B32776G4506+000 | 16.0 | 15.0 | 4.0 | 440 |
| 50 | $28.0 \times 42.5 \times 41.5$ | – | B32776E4506+000 | 15.0 | 14.0 | 4.0 | 440 |
| 60 | $30.0 \times 45.0 \times 42.0$ | – | B32776E4606+000 | 16.5 | 15.0 | 3.0 | 400 |
| $V_{R,70\text{ °C}} = 800\text{ V DC}, V_{op,85\text{ °C}} = 700\text{ V DC}$ | | | | | | | |
| 14 | $18.0 \times 32.5 \times 41.5$ | – | B32776E8146+000 | 10.0 | 9.0 | 4.5 | 720 |
| 15 | $20.0 \times 39.5 \times 41.5$ | 10.2 | B32776G8156+000 | 10.5 | 9.5 | 7.0 | 640 |
| 20 | $28.0 \times 37.0 \times 42.0$ | 10.2 | B32776G8206+000 | 12.0 | 11.0 | 5.5 | 440 |
| 20 | $28.0 \times 37.0 \times 42.0$ | – | B32776E8206+000 | 11.5 | 10.5 | 6.5 | 440 |
| 22 | $28.0 \times 37.0 \times 42.0$ | 10.2 | B32776G8226+000 | 13.0 | 12.0 | 5.0 | 440 |
| 25 | $28.0 \times 42.5 \times 41.5$ | – | B32776E8256+000 | 13.5 | 12.5 | 4.5 | 440 |
| 30 | $30.0 \times 45.0 \times 42.0$ | 20.3 | B32776G8306+000 | 15.0 | 14.0 | 3.5 | 400 |
| 30 | $30.0 \times 45.0 \times 42.0$ | – | B32776E8306+000 | 14.0 | 13.0 | 5.0 | 400 |
| $V_{R,70\text{ °C}} = 1100\text{ V DC}, V_{op,85\text{ °C}} = 920\text{ V DC}$ | | | | | | | |
| 12 | $20.0 \times 39.5 \times 41.5$ | 10.2 | B32776G0126+000 | 11.0 | 10.0 | 6.5 | 640 |
| 12 | $20.0 \times 39.5 \times 41.5$ | – | B32776E0126+000 | 10.0 | 9.0 | 7.0 | 640 |
| 14 | $28.0 \times 37.0 \times 42.0$ | 10.2 | B32776G0146+000 | 13.0 | 12.0 | 5.5 | 440 |
| 14 | $28.0 \times 37.0 \times 42.0$ | – | B32776E0146+000 | 12.0 | 11.0 | 6.0 | 440 |
| 16 | $28.0 \times 42.5 \times 41.5$ | 10.2 | B32776G0166+000 | 13.0 | 12.0 | 5.0 | 440 |
| 16 | $28.0 \times 42.5 \times 41.5$ | – | B32776E0166+000 | 12.0 | 11.0 | 5.5 | 440 |
| 20 | $30.0 \times 45.0 \times 42.0$ | 20.3 | B32776G0206+000 | 15.0 | 13.0 | 3.0 | 400 |
| 20 | $30.0 \times 45.0 \times 42.0$ | – | B32776E0206+000 | 13.0 | 12.0 | 3.5 | 400 |

MOQ = Minimum Order Quantity, consisting of 4 packing units.

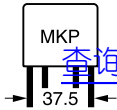
Further E series and intermediate capacitance values on request.

Composition of ordering code

+ = Capacitance tolerance code:

K = $\pm 10\%$

J = $\pm 5\%$



B32776

MKP DC link high density series

Ordering codes and packing units (lead spacing 37.5 mm)

| C_R | Max. dimensions $w \times h \times l$ | P_1 | Ordering code (composition see below) | $I_{RMS,max}$ 70 °C 10 kHz A | $I_{RMS,max}$ 70 °C 20 kHz A | ESR_{typ} 70 °C 10 kHz mΩ | Untaped pcs./MOQ |
|--|--|-------|---|---------------------------------------|---------------------------------------|--------------------------------------|-------------------------|
| μF | mm | mm | | | | | |
| $V_{R,70\text{ °C}} = 1300\text{ V DC}$, $V_{op,85\text{ °C}} = 1100\text{ V DC}$ | | | | | | | |
| 8.0 | 20.0 × 39.5 × 41.5 | 10.2 | B32776G1805+000 | 9.0 | 8.0 | 8.0 | 640 |
| 10 | 28.0 × 37.0 × 42.0 | 10.2 | B32776G1106+000 | 12.0 | 11.0 | 6.5 | 440 |
| 10 | 28.0 × 37.0 × 42.0 | – | B32776E1106+000 | 11.0 | 10.0 | 7.0 | 440 |
| 12 | 28.0 × 42.5 × 41.5 | 20.3 | B32776G1126+000 | 13.0 | 12.0 | 5.5 | 440 |
| 14 | 30.0 × 45.0 × 42.0 | – | B32776E1146+000 | 13.0 | 12.0 | 5.0 | 400 |

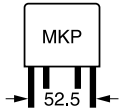
MOQ = Minimum Order Quantity, consisting of 4 packing units.
Further E series and intermediate capacitance values on request.

Composition of ordering code

+ = Capacitance tolerance code:

K = ±10%

J = ±5%



Ordering codes and packing units (lead spacing 52.5 mm)

| C_R | Max. dimensions $w \times h \times l$ | P_1 | Ordering code (composition see below) | $I_{RMS,max}$ 70 °C 10 kHz A | $I_{RMS,max}$ 70 °C 20 kHz A | ESR_{typ} 70 °C 10 kHz mΩ | Untaped |
|---|--|-------|---|---------------------------------------|---------------------------------------|--------------------------------------|----------|
| μF | mm | mm | | | | | pcs./MOQ |
| $V_{R,70\text{ °C}} = 450\text{ V DC}, V_{op,85\text{ °C}} = 450\text{ V DC}$ | | | | | | | |
| 75 | $30.0 \times 45.0 \times 57.5$ | 20.3 | B32778G4756+000 | 16.0 | 15.5 | 5.5 | 280 |
| 80 | $30.0 \times 45.0 \times 57.5$ | 20.3 | B32778G4806+000 | 16.5 | 16.0 | 5.0 | 280 |
| 100 | $35.0 \times 50.0 \times 57.5$ | 20.3 | B32778G4107+000 | 18.0 | 18.0 | 4.0 | 108 |
| 110 | $35.0 \times 50.0 \times 57.5$ | 20.3 | B32778G4117+000 | 19.0 | 19.0 | 4.0 | 108 |
| $V_{R,70\text{ °C}} = 800\text{ V DC}, V_{op,85\text{ °C}} = 700\text{ V DC}$ | | | | | | | |
| 45 | $30.0 \times 45.0 \times 57.5$ | 20.3 | B32778G8456+000 | 16.0 | 15.0 | 3.0 | 280 |
| 55 | $35.0 \times 50.0 \times 57.5$ | 20.3 | B32778G8556+000 | 17.0 | 16.0 | 3.5 | 108 |
| 60 | $35.0 \times 50.0 \times 57.5$ | 20.3 | B32778G8606+000 | 19.0 | 18.0 | 3.0 | 108 |
| $V_{R,70\text{ °C}} = 1100\text{ V DC}, V_{op,85\text{ °C}} = 920\text{ V DC}$ | | | | | | | |
| 30 | $30.0 \times 45.0 \times 57.5$ | 20.3 | B32778G0306+000 | 16.0 | 14.0 | 4.0 | 280 |
| 40 | $35.0 \times 50.0 \times 57.5$ | 20.3 | B32778G0406+000 | 20.0 | 20.0 | 3.5 | 108 |
| $V_{R,70\text{ °C}} = 1300\text{ V DC}, V_{op,85\text{ °C}} = 1100\text{ V DC}$ | | | | | | | |
| 20 | $30.0 \times 45.0 \times 57.5$ | 20.3 | B32778G1206+000 | 14.0 | 13.0 | 5.5 | 280 |
| 25 | $35.0 \times 50.0 \times 57.5$ | 20.3 | B32778G1256+000 | 17.0 | 16.0 | 4.5 | 108 |
| 27 | $35.0 \times 50.0 \times 57.5$ | 20.3 | B32778G1276+000 | 17.5 | 16.0 | 4.0 | 108 |

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%



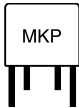
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MKP DC link high density series

Technical data

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

| | | | |
|---|------------------------------|--|---|
| Operating temperature range (case) | | Max. operating temperature, T _{op,max} | +105 °C |
| | | Upper category temperature T _{max} | +85 °C |
| | | Lower category temperature T _{min} | -40 °C |
| ESR (at 10 kHz) | LS 27.5 | < 3.0 · ESR _{typ} | |
| | LS 37.5 | < 2.5 · ESR _{typ} | |
| | LS 52.5 | < 1.5 · ESR _{typ} | |
| Insulation Resistance R _{ins} given as time constant $\tau = C_R \cdot R_{ins}$, rel. humidity ≤ 65% (minimum as-delivered values) | | 30 000 s | |
| DC test voltage between terminals (10 s) | | 1.5 · V _R | |
| DC test voltage terminal to case (10 s) | | 2110 V AC, 50 Hz | |
| Maximum peak current (A) | | $I_{p,max} = C_R \cdot \frac{dV}{dt}$ | |
| Damp heat test | | 56 days/40 °C/93% relative humidity | |
| Limit values after damp heat test | | Capacitance change $\Delta C/C$ | ≤ 5% |
| | | Dissipation factor change $\Delta \tan \delta$ | ≤ 1.5 · 10 ⁻³ (at 1 kHz) |
| | | Insulation resistance R _{ins} | ≥ 50% of minimum as-delivered values |
| Reliability: | Failure rate λ | 50 fit (≤ 1 · 10 ⁻⁹ /h) at 0.5 · V _R , 40 °C | |
| | Service life t _{SL} | 100 000 h at V _R and 70 °C | |
| | | For conversion to other operating conditions, refer to chapter "Quality, 2 Reliability". | |
| V _R (V DC) | | 450 | 800 1100 1300 |
| Continuous operation voltage | | | |
| V _{op} (V DC) at 70 °C | | 450 | 800 1100 1300 |
| Continuous operation voltage | | | |
| V _{op} (V DC) at 85 °C | | 450 | 700 920 1100 |
| For temperatures between 70 °C and 85 °C | | 1%/°C of derating respect V _{op} at 70 °C (no derating at 450 V DC series) | |



Pulse handling capability

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

Note:

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

dV/dt values

| Lead spacing | 27.5 mm | | | | 37.5 mm | | | | 52.5 mm | | | |
|---------------------------|---------------------|-----|------|------|---------|-----|------|------|---------|-----|------|------|
| Type | B32774 | | | | B32776 | | | | B32778 | | | |
| V _R (V DC) | 450 | 800 | 1100 | 1300 | 450 | 800 | 1100 | 1300 | 450 | 800 | 1100 | 1300 |
| C _R (μ F) | dV/dt in V/ μ s | | | | | | | | | | | |
| 1.5 | — | — | — | 100 | — | — | — | — | — | — | — | — |
| 2.0 | — | — | 75 | — | — | — | — | — | — | — | — | — |
| 3.0 | — | 40 | — | 100 | — | — | — | — | — | — | — | — |
| 5.0 | 30 | 40 | 75 | 100 | — | — | — | — | — | — | — | — |
| 7.0 | — | — | 75 | — | — | — | — | — | — | — | — | — |
| 8.0 | — | — | — | — | — | — | — | 73 | — | — | — | — |
| 10 | 30 | — | — | — | — | — | — | 73 | — | — | — | — |
| 12 | — | 40 | — | — | — | — | 54 | 73 | — | — | — | — |
| 14 | — | — | — | — | — | 22 | 54 | 73 | — | — | — | — |
| 15 | — | — | — | — | — | 22 | — | — | — | — | — | — |
| 16 | — | — | — | — | — | — | 54 | — | — | — | — | — |
| 20 | — | — | — | — | — | 22 | 54 | — | — | — | — | 50 |
| 22 | 30 | — | — | — | — | 22 | — | — | — | — | — | — |
| 25 | — | — | — | — | — | 22 | — | — | — | — | — | 50 |
| 27 | — | — | — | — | — | — | — | — | — | — | — | 50 |
| 30 | — | — | — | — | 21 | 22 | — | — | — | — | 35 | — |
| 35 | — | — | — | — | 21 | — | — | — | — | — | — | — |
| 40 | — | — | — | — | 21 | — | — | — | — | — | 35 | — |
| 45 | — | — | — | — | — | — | — | — | — | 15 | — | — |
| 50 | — | — | — | — | 21 | — | — | — | — | — | — | — |
| 55 | — | — | — | — | — | — | — | — | — | 15 | — | — |
| 60 | — | — | — | — | 21 | — | — | — | — | 15 | — | — |
| 75 | — | — | — | — | — | — | — | — | 14 | — | — | — |
| 80 | — | — | — | — | — | — | — | — | 14 | — | — | — |
| 100 | — | — | — | — | — | — | — | — | 14 | — | — | — |
| 110 | — | — | — | — | — | — | — | — | 14 | — | — | — |



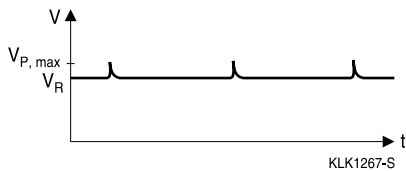
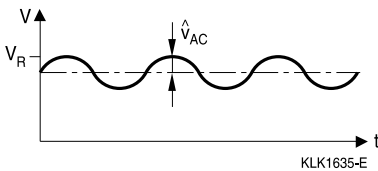
B32774 ... B32778

MKP DC link high density series

ESL values

| | | ESL |
|-------|---------|-------|
| 2-pin | B32774D | 25 nH |
| | B32776E | 10 nH |
| 4-pin | B32776G | 15 nH |
| | B32778G | 15 nH |

Typical waveforms

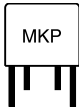


Restrictions:

V_R : Maximum operating peak voltage of either polarity but of a non-reversing waveform, for which the capacitor has been designed for continuous operation.

$\hat{V}_{AC} \leq 0.2 \cdot V_R$

$V_{P, max}$: Maximum permissible recurrent voltage that may appear for 2% of the period.



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:

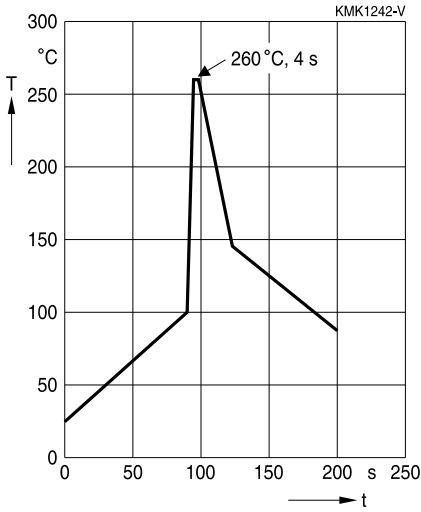
| Series | Solder bath temperature | Soldering time |
|--|-------------------------|---|
| MKT boxed (except 2.5 × 6.5 × 7.2 mm) coated uncoated (lead spacing > 10 mm) | 260 ±5 °C | 10 ±1 s |
| MFP | | |
| MKP (lead spacing > 7.5 mm) | | |
| MKT boxed (case 2.5 × 6.5 × 7.2 mm) | | 5 ±1 s |
| MKP (lead spacing ≤ 7.5 mm) | | < 4 s |
| MKT uncoated (lead spacing ≤ 10 mm) insulated (B32559) | | recommended soldering profile for MKT uncoated (lead spacing ≤ 10 mm) and insulated (B32559) |



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



1.3 General notes on soldering

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

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

The overheating associated with some of these factors can usually be reduced by suitable countermeasures. For example, if a pre-heating step 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 ≤ 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



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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 |

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!



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 "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. 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 "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" |



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 |
| $\tan \delta$ | Dissipation factor | Verlustfaktor |
| $\tan \delta_D$ | Dielectric component of dissipation factor | Dielektrischer Anteil des Verlustfaktors |
| $\tan \delta_P$ | Parallel component of dissipation factor | Parallelanteil des Verlustfaktors |
| $\tan \delta_S$ | Series component of dissipation factor | Serienanteil des Verlustfaktors |
| T_A | Ambient temperature | Umgebungstemperatur |
| 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 | Betriebstemperatur |
| T_R | Rated temperature | Nenntemperatur |
| T_{ref} | Reference temperature | Referenztemperatur |
| t_{SL} | Reference service life | Referenz-Lebensdauer |
| V_{AC} | AC voltage | Wechselspannung |



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| Symbol | English | German |
|-------------|---|---|
| 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 | Ausgangssspannung |
| 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 |

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