

## Film Capacitors

### Metallized Polyester Film Capacitors (MKT-S)

**Series/Type:** B32537  
**Date:** May 2009

The following products presented in this data sheet are being withdrawn.

Ordering Code	Substitute Product	Date of Withdrawal	Deadline Last Orders	Last Shipments
B32537B8335J000		2012-10-19	2013-01-19	2013-04-19
B32537B8334K000		2012-10-19	2013-01-19	2013-04-19
B32537B8334J000		2012-10-19	2013-01-19	2013-04-19

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Ordering Code	Substitute Product	Date of Withdrawal	Deadline Last Orders	Last Shipments
B32537B8333K000		2012-10-19	2013-01-19	2013-04-19
B32537B8333J000		2012-10-19	2013-01-19	2013-04-19
B32537B8225K000		2012-10-19	2013-01-19	2013-04-19
B32537B8225J000		2012-10-19	2013-01-19	2013-04-19
B32537B8224K000		2012-10-19	2013-01-19	2013-04-19
B32537B8224J000		2012-10-19	2013-01-19	2013-04-19
B32537B8155K000		2012-10-19	2013-01-19	2013-04-19
B32537B8155J000		2012-10-19	2013-01-19	2013-04-19
B32537B8154K000		2012-10-19	2013-01-19	2013-04-19
B32537B8154J000		2012-10-19	2013-01-19	2013-04-19
B32537B8105K000		2012-10-19	2013-01-19	2013-04-19
B32537B8105J000		2012-10-19	2013-01-19	2013-04-19
B32537B8104K000		2012-10-19	2013-01-19	2013-04-19
B32537B8104J000		2012-10-19	2013-01-19	2013-04-19
B32537B5685K000		2012-10-19	2013-01-19	2013-04-19
B32537B5685J000		2012-10-19	2013-01-19	2013-04-19
B32537B5684K000		2012-10-19	2013-01-19	2013-04-19
B32537B5684J000		2012-10-19	2013-01-19	2013-04-19
B32537B5475K000		2012-10-19	2013-01-19	2013-04-19
B32537B5475J000		2012-10-19	2013-01-19	2013-04-19
B32537B5474K000		2012-10-19	2013-01-19	2013-04-19
B32537B5474J000		2012-10-19	2013-01-19	2013-04-19
B32537B2106J000		2012-10-19	2013-01-19	2013-04-19
B32537B2106K000		2012-10-19	2013-01-19	2013-04-19
B32537B5335J000		2012-10-19	2013-01-19	2013-04-19
B32537B5335K000		2012-10-19	2013-01-19	2013-04-19
B32537B5225K000		2012-10-19	2013-01-19	2013-04-19
B32537B5225J000		2012-10-19	2013-01-19	2013-04-19
B32537B5155K000		2012-10-19	2013-01-19	2013-04-19
B32537B5155J000		2012-10-19	2013-01-19	2013-04-19
B32537B5106K000		2012-10-19	2013-01-19	2013-04-19
B32537B5106J000		2012-10-19	2013-01-19	2013-04-19
B32537B5105K000		2012-10-19	2013-01-19	2013-04-19
B32537B5105J000		2012-10-19	2013-01-19	2013-04-19
B32537B3685K000		2012-10-19	2013-01-19	2013-04-19
B32537B3685J000		2012-10-19	2013-01-19	2013-04-19
B32537B3684K000		2012-10-19	2013-01-19	2013-04-19
B32537B3684J000		2012-10-19	2013-01-19	2013-04-19



Ordering Code	Substitute Product	Date of Withdrawal	Deadline Last Orders	Last Shipments
B32537B3475K000		2012-10-19	2013-01-19	2013-04-19
B32537B3475J000		2012-10-19	2013-01-19	2013-04-19
B32537B3474K000		2012-10-19	2013-01-19	2013-04-19
B32537B3474J000		2012-10-19	2013-01-19	2013-04-19
B32537B3335K000		2012-10-19	2013-01-19	2013-04-19
B32537B3335J000		2012-10-19	2013-01-19	2013-04-19
B32537B3334K000		2012-10-19	2013-01-19	2013-04-19
B32537B3334J000		2012-10-19	2013-01-19	2013-04-19
B32537B3225K000		2012-10-19	2013-01-19	2013-04-19
B32537B3225J000		2012-10-19	2013-01-19	2013-04-19
B32537B3224K000		2012-10-19	2013-01-19	2013-04-19
B32537B3224J000		2012-10-19	2013-01-19	2013-04-19
B32537B3155K000		2012-10-19	2013-01-19	2013-04-19
B32537B3155J000		2012-10-19	2013-01-19	2013-04-19
B32537B3154K000		2012-10-19	2013-01-19	2013-04-19
B32537B3154J000		2012-10-19	2013-01-19	2013-04-19
B32537B3106K000		2012-10-19	2013-01-19	2013-04-19
B32537B3106J000		2012-10-19	2013-01-19	2013-04-19
B32537B3105K000		2012-10-19	2013-01-19	2013-04-19
B32537B3105J000		2012-10-19	2013-01-19	2013-04-19
B32537B3104K000		2012-10-19	2013-01-19	2013-04-19
B32537B3104J000		2012-10-19	2013-01-19	2013-04-19
B32537B2685K000		2012-10-19	2013-01-19	2013-04-19
B32537B2685J000		2012-10-19	2013-01-19	2013-04-19
B32537B2684K000		2012-10-19	2013-01-19	2013-04-19
B32537B2684J000		2012-10-19	2013-01-19	2013-04-19
B32537B2475K000		2012-10-19	2013-01-19	2013-04-19
B32537B2475J000		2012-10-19	2013-01-19	2013-04-19
B32537B2474K000		2012-10-19	2013-01-19	2013-04-19
B32537B2474J000		2012-10-19	2013-01-19	2013-04-19
B32537B2335K000		2012-10-19	2013-01-19	2013-04-19
B32537B2335J000		2012-10-19	2013-01-19	2013-04-19
B32537B2334K000		2012-10-19	2013-01-19	2013-04-19
B32537B2334J000		2012-10-19	2013-01-19	2013-04-19
B32537B2225K000		2012-10-19	2013-01-19	2013-04-19
B32537B2225J000		2012-10-19	2013-01-19	2013-04-19
B32537B2224K000		2012-10-19	2013-01-19	2013-04-19
B32537B2224J000		2012-10-19	2013-01-19	2013-04-19



Ordering Code	Substitute Product	Date of Withdrawal	Deadline Last Orders	Last Shipments
B32537B2155K000		2012-10-19	2013-01-19	2013-04-19
B32537B2155J000		2012-10-19	2013-01-19	2013-04-19
B32537B2154K000		2012-10-19	2013-01-19	2013-04-19
B32537B2154J000		2012-10-19	2013-01-19	2013-04-19
B32537B2105K000		2012-10-19	2013-01-19	2013-04-19
B32537B2105J000		2012-10-19	2013-01-19	2013-04-19
B32537B2104K000		2012-10-19	2013-01-19	2013-04-19
B32537B2104J000		2012-10-19	2013-01-19	2013-04-19
B32537B8684K000		2012-10-19	2013-01-19	2013-04-19
B32537B8684J000		2012-10-19	2013-01-19	2013-04-19
B32537B8683K000		2012-10-19	2013-01-19	2013-04-19
B32537B8683J000		2012-10-19	2013-01-19	2013-04-19
B32537B8475K000		2012-10-19	2013-01-19	2013-04-19
B32537B8475J000		2012-10-19	2013-01-19	2013-04-19
B32537B8474K000		2012-10-19	2013-01-19	2013-04-19
B32537B8474J000		2012-10-19	2013-01-19	2013-04-19
B32537B5335K000		2012-10-19	2013-01-19	2013-04-19
B32537B5335J000		2012-10-19	2013-01-19	2013-04-19
B32537B1685K000		2012-10-19	2013-01-19	2013-04-19
B32537B1685J000		2012-10-19	2013-01-19	2013-04-19
B32537B1684K000		2012-10-19	2013-01-19	2013-04-19
B32537B1684J000		2012-10-19	2013-01-19	2013-04-19
B32537B1476K000		2012-10-19	2013-01-19	2013-04-19
B32537B1476J000		2012-10-19	2013-01-19	2013-04-19
B32537B1475K000		2012-10-19	2013-01-19	2013-04-19
B32537B1475J000		2012-10-19	2013-01-19	2013-04-19
B32537B1474K000		2012-10-19	2013-01-19	2013-04-19
B32537B1474J000		2012-10-19	2013-01-19	2013-04-19
B32537B1335K000		2012-10-19	2013-01-19	2013-04-19
B32537B1335J000		2012-10-19	2013-01-19	2013-04-19
B32537B1334K000		2012-10-19	2013-01-19	2013-04-19
B32537B1334J000		2012-10-19	2013-01-19	2013-04-19
B32537B1226K000		2012-10-19	2013-01-19	2013-04-19
B32537B1226J000		2012-10-19	2013-01-19	2013-04-19
B32537B1225K000		2012-10-19	2013-01-19	2013-04-19
B32537B1225J000		2012-10-19	2013-01-19	2013-04-19
B32537B1224K000		2012-10-19	2013-01-19	2013-04-19
B32537B1224J000		2012-10-19	2013-01-19	2013-04-19



Ordering Code	Substitute Product	Date of Withdrawal	Deadline Last Orders	Last Shipments
B32537B1155K000		2012-10-19	2013-01-19	2013-04-19
B32537B1155J000		2012-10-19	2013-01-19	2013-04-19
B32537B1154K000		2012-10-19	2013-01-19	2013-04-19
B32537B1154J000		2012-10-19	2013-01-19	2013-04-19
B32537B1107K000		2012-10-19	2013-01-19	2013-04-19
B32537B1107J000		2012-10-19	2013-01-19	2013-04-19
B32537B1106K000		2012-10-19	2013-01-19	2013-04-19
B32537B1106J000		2012-10-19	2013-01-19	2013-04-19
B32537B1105K000		2012-10-19	2013-01-19	2013-04-19
B32537B1105J000		2012-10-19	2013-01-19	2013-04-19
B32537B1104K000		2012-10-19	2013-01-19	2013-04-19
B32537B1104J000		2012-10-19	2013-01-19	2013-04-19
B32537B8473K000		2012-10-19	2013-01-19	2013-04-19
B32537B8473J000		2012-10-19	2013-01-19	2013-04-19
B32537B8335K000		2012-10-19	2013-01-19	2013-04-19

For further information please contact your nearest EPCOS sales office, which will also support you in selecting a suitable substitute. The addresses of our worldwide sales network are presented at [www.epcos.com/sales](http://www.epcos.com/sales).

**High reliability (wound)**
**Typical applications**

- Measurement equipment
- Rough environments
- High-rel circuits in industrial electronics

**Climatic**

- Max. operating temperature: 125 °C
- Climatic category (IEC 60068-1): 55/100/56

**Features**

- Optimum self-healing capability
- Excellent short circuit protection
- Very high reliability

**Construction**

- Dielectric: polyethylene terephthalate (polyester, PET)
- Construction with structured metallization
- Tubular winding
- Encapsulated in metal tube
- Insulating sleeve
- Face ends sealed with epoxy resin

**Terminals**

- Central axial leads, lead-free tinned

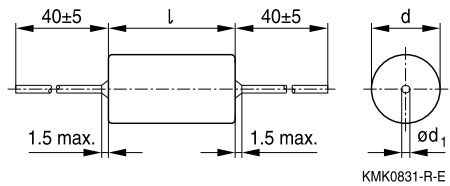
**Marking**

Manufacturer's logo, style (MKT-S),  
 rated capacitance (coded)  
 capacitance tolerance (code letter)  
 rated voltage, date of manufacture (coded)

**Delivery mode**

Bulk (untaped)

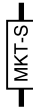
For notes on taping, refer to chapter "Taping and packing".

**Dimensional drawing**


Dimensions in mm

Diameter d	<8.5	8.5 ... 16	>16
Lead diameter d <sub>1</sub>	0.6	0.8	1.0

When bending leads take care to leave a clearance of 1 mm to the capacitor body.


**Overview of types**

Type	B32537				
$V_R$ (V DC)	50	100	160	250	630
$V_{RMS}$ (V AC)	20	35	60	90	200
$C_R$ ( $\mu$ F)					
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					
10					
22					
47					
100					


**B32537**
**High reliability (wound)**
**Ordering codes and packing units**

$V_R$	$V_{RMS}$ $f \leq 60$ Hz	$C_R$	Max. dimensions $d \times l$	Ordering code (composition see below)	Untaped pcs./MOQ
V DC	V AC	$\mu F$	mm		
50	20	0.47	$7.4 \times 18.5$	B32537B5474+000	200
		0.68	$7.4 \times 18.5$	B32537B5684+000	200
		1.0	$7.4 \times 18.5$	B32537B5105+000	200
		1.5	$7.4 \times 18.5$	B32537B5155+000	200
		2.2	$8.4 \times 21.0$	B32537B5225+000	200
		3.3	$9.4 \times 21.0$	B32537B5335+000	80
		4.7	$10.7 \times 21.0$	B32537B5475+000	80
		6.8	$11.7 \times 21.0$	B32537B5685+000	80
		10	$12.7 \times 21.0$	B32537B5106+000	80
100	35	0.10	$7.4 \times 18.5$	B32537B1104+000	200
		0.15	$7.4 \times 18.5$	B32537B1154+000	200
		0.22	$7.4 \times 18.5$	B32537B1224+000	200
		0.33	$7.4 \times 18.5$	B32537B1334+000	200
		0.47	$7.4 \times 18.5$	B32537B1474+000	200
		0.68	$7.4 \times 18.5$	B32537B1684+000	200
		1.0	$8.4 \times 21.0$	B32537B1105+000	200
		1.5	$8.4 \times 21.0$	B32537B1155+000	200
		2.2	$9.4 \times 21.0$	B32537B1225+000	80
		3.3	$9.4 \times 21.0$	B32537B1335+000	80
		4.7	$11.7 \times 21.0$	B32537B1475+000	80
		6.8	$10.7 \times 34.0$	B32537B1685+000	80
		10	$10.7 \times 34.0$	B32537B1106+000	80
		22	$15.7 \times 34.0$	B32537B1226+000	80
		47	$20.7 \times 34.0$	B32537B1476+000	80
		100	$29.7 \times 34.0$	B32537B1107+000	80

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 =  $\pm 5\%$

**Ordering codes and packing units**

$V_R$	$V_{RMS}$ $f \leq 60$ Hz	$C_R$	Max. dimensions $d \times l$ mm	Ordering code (composition see below)	Untaped pcs./MOQ
V DC	V AC	$\mu F$			
160	60	0.10	7.4 × 18.5	B32537B2104+000	200
		0.15	7.4 × 18.5	B32537B2154+000	200
		0.22	7.4 × 18.5	B32537B2224+000	200
		0.33	7.4 × 18.5	B32537B2334+000	200
		0.47	8.4 × 21.0	B32537B2474+000	200
		0.68	8.4 × 21.0	B32537B2684+000	200
		1.0	9.4 × 21.0	B32537B2105+000	80
		1.5	10.7 × 21.0	B32537B2155+000	80
		2.2	11.7 × 21.0	B32537B2225+000	80
		3.3	10.7 × 34.0	B32537B2335+000	80
		4.7	12.7 × 34.0	B32537B2475+000	80
		6.8	12.7 × 34.0	B32537B2685+000	80
		10	15.7 × 34.0	B32537B2106+000	80
250	90	0.10	7.4 × 18.5	B32537B3104+000	200
		0.15	7.4 × 18.5	B32537B3154+000	200
		0.22	7.4 × 18.5	B32537B3224+000	200
		0.33	8.4 × 21.0	B32537B3334+000	200
		0.47	9.4 × 21.0	B32537B3474+000	80
		0.68	9.4 × 21.0	B32537B3684+000	80
		1.0	11.7 × 21.0	B32537B3105+000	80
		1.5	12.7 × 21.0	B32537B3155+000	80
		2.2	13.7 × 21.0	B32537B3225+000	80
		3.3	12.7 × 34.0	B32537B3335+000	80
		4.7	15.7 × 34.0	B32537B3475+000	80
		6.8	17.7 × 34.0	B32537B3685+000	80
		10	20.7 × 34.0	B32537B3106+000	80

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%


**B32537**
**High reliability (wound)**
**Ordering codes and packing units**

$V_R$	$V_{RMS}$ $f \leq 60$ Hz	$C_R$	Max. dimensions $d \times l$ mm	Ordering code (composition see below)	Untaped pcs./MOQ
V DC	V AC	$\mu F$			
630	200	0.033	$7.4 \times 18.5$	B32537B8333+000	200
		0.047	$7.4 \times 18.5$	B32537B8473+000	200
		0.068	$8.4 \times 21.0$	B32537B8683+000	200
		0.10	$9.4 \times 21.0$	B32537B8104+000	80
		0.15	$9.4 \times 21.0$	B32537B8154+000	80
		0.22	$11.7 \times 21.0$	B32537B8224+000	80
		0.33	$12.7 \times 21.0$	B32537B8334+000	80
		0.47	$13.7 \times 21.0$	B32537B8474+000	80
		0.68	$12.7 \times 34.0$	B32537B8684+000	80
		1.0	$15.7 \times 34.0$	B32537B8105+000	80
		1.5	$17.7 \times 34.0$	B32537B8155+000	80
		2.2	$20.7 \times 34.0$	B32537B8225+000	80
		3.3	$25.7 \times 34.0$	B32537B8335+000	80
4.7	$29.7 \times 34.0$	B32537B8475+000	80		

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 =  $\pm 5\%$

**Technical data**

Operating temperature range	Max. operating temperature $T_{op,max}$ +125 °C				
	Upper category temperature $T_{max}$ +100 °C				
	Lower category temperature $T_{min}$ -55 °C				
	Rated temperature $T_R$ +85 °C				
Dissipation factor $\tan \delta$ (in $10^{-3}$ ) at 20 °C (upper limit values)	$C_R$ ( $\mu F$ )	$\leq 0.47$	$0.47 < C_R \leq 4.7$	$4.7 < C_R \leq 10.0$	$> 10.0$
	at 1 kHz	7	8	8	10
	at 10 kHz	15	22	25	—
Insulation resistance $R_{ins}$ or time constant $\tau = C_R \cdot R_{ins}$ at 20 °C, rel. humidity $\leq 65\%$ (minimum as-delivered values)	$C_R$				
	$\leq 0.33 \mu F$	$> 15000 M\Omega$			
	$> 0.33 \mu F$	$> 5000 s$			
DC test voltage	$1.4 \cdot V_R, 2 s$				
Category voltage $V_C$ (continuous operation with $V_{DC}$ or $V_{AC}$ at $f \leq 60 Hz$ )	$T_A$ (°C)	DC voltage derating	AC voltage derating		
	$T_A \leq 85$	$V_C = V_R$	$V_{C,RMS} = V_{RMS}$		
	$85 < T_A \leq 100$	$V_C = V_R \cdot (165 - T_A)/80$	$V_{C,RMS} = V_{RMS} \cdot (165 - T_A)/80$		
Operating voltage $V_{op}$ for short operating periods ( $V_{DC}$ or $V_{AC}$ at $f \leq 60 Hz$ )	$T_A$ (°C)	DC voltage (max. hours)	AC voltage (max. hours)		
	$T_A \leq 100$	$V_{op} = 1.25 \cdot V_C$ (2000 h)	$V_{op} = 1.0 \cdot V_{C,RMS}$ (2000 h)		
	$100 < T_A \leq 125$	$V_{op} = 0.5 \cdot V_R$ (1000 h)	$V_{op} = 0.5 \cdot V_{RMS}$ (1000 h)		
Damp heat test	56 days/40 °C/93% relative humidity				
Limit values after damp heat test	Capacitance change $ \Delta C/C $	$\leq 5\%$			
	Dissipation factor change $\Delta \tan \delta$	$\leq 5 \cdot 10^{-3}$ (at 1 kHz)			
	Insulation resistance $R_{ins}$	$\geq 50\%$ of minimum as-delivered values			
Reliability:					
Failure rate $\lambda$	1 fit ( $\leq 1 \cdot 10^{-9}/h$ ) at $0.5 \cdot V_R, 40$ °C				
Service life $t_{SL}$	200 000 h at $1.0 \cdot V_R, 85$ °C				
	For conversion to other operating conditions and temperatures, refer to chapter "Quality, 2 Reliability".				
Failure criteria:					
Total failure	Short circuit or open circuit				
Failure due to variation of parameters	Capacitance change $ \Delta C/C $	$> 10\%$			
	Dissipation factor $\tan \delta$	$> 1.5 \cdot$ upper limit value			
	Insulation resistance $R_{ins}$ or time constant $\tau = C_R \cdot R_{ins}$	$< 150 M\Omega$ ( $C_R \leq 0.33 \mu F$ ) $< 50 s$ ( $C_R > 0.33 \mu F$ )			



**B32537**

**High reliability (wound)**

**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<sub>0</sub>" represents the maximum permissible pulse characteristic of the waveform applied to the capacitor, expressed in V<sup>2</sup>/ $\mu$ s.

*Note:*

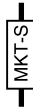
*The values of dV/dt and k<sub>0</sub> provided below must not be exceeded in order to avoid damaging the capacitor.*

**dV/dt values**

Length of capacitor		18.5 mm	21 mm	34 mm
V <sub>R</sub> V DC	V <sub>RMS</sub> V AC	dV/dt in V/ $\mu$ s		
50	20	2.5	1.5	–
100	35	13	9	6
160	60	20	12	8
250	90	23	16	10
630	200	40	26	18

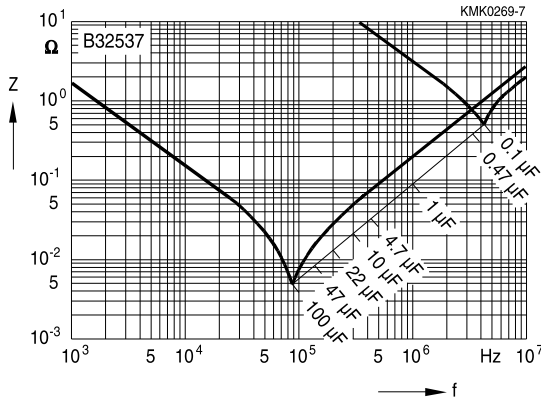
**k<sub>0</sub> values**

Length of capacitor		18.5 mm	21 mm	34 mm
V <sub>R</sub> V DC	V <sub>RMS</sub> V AC	k <sub>0</sub> in V <sup>2</sup> / $\mu$ s		
50	20	250	150	–
100	35	2 600	1 800	1 200
160	60	6 400	3 840	2 560
250	90	11 500	8 000	5 000
630	200	50 400	32 800	22 700



**Impedance Z versus frequency f**

(typical values)



**Permissible AC voltage  $V_{RMS}$  versus frequency f**

Values can be obtained on request. In specific cases please provide a scaled voltage/ time graph and state operating conditions.



**B32537**

**High reliability (wound)**

## 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.

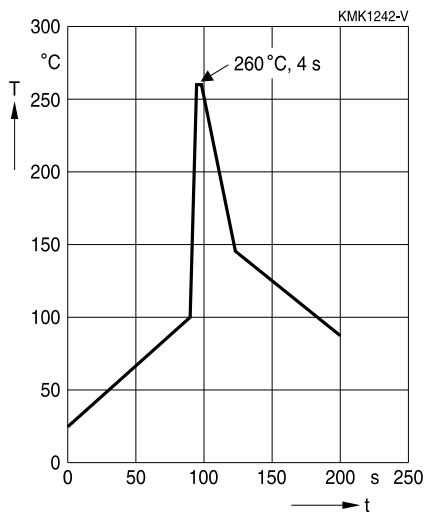
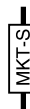
Solder bath temperature	235 ±5 °C
Soldering time	2.0 ±0.5 s
Immersion depth	2.0 +0/−0.5 mm from capacitor body or seating plane
Evaluation criteria: Visual inspection	Wetting of wire surface by new solder ≥90%, free-flowing solder

#### 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) MKT uncoated (lead spacing ≤ 10 mm) insulated (B32559)		< 4 s recommended soldering profile for MKT uncoated (lead spacing ≤ 10 mm) and insulated (B32559)



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



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High reliability (wound)

### 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.

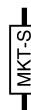
EPCOS recommends the following conditions:

- 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



**B32537**

**High reliability (wound)**

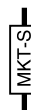
### **3 Embedding of capacitors in finished assemblies**

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"



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**High reliability (wound)**

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**

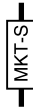
Symbol	English	German
$\alpha$	Heat transfer coefficient	Wärmeübergangszahl
$\alpha_C$	Temperature coefficient of capacitance	Temperaturkoeffizient der Kapazität
A	Capacitor surface area	Kondensatoroberfläche
$\beta_C$	Humidity coefficient of capacitance	Feuchtekoeffizient der Kapazität
C	Capacitance	Kapazität
$C_R$	Rated capacitance	Nennkapazität
$\Delta C$	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
$\Delta t$	Time interval	Zeitintervall
$\Delta T$	Absolute temperature change (self-heating)	Absolute Temperaturänderung (Selbsterwärmung)
$\Delta \tan \delta$	Absolute change of dissipation factor	Absolute Änderung des Verlustfaktors
$\Delta V$	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)



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**High reliability (wound)**

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	Impuls Kennwert
$L_S$	Series inductance	Serieninduktivität
$\lambda$	Failure rate	Ausfallrate
$\lambda_0$	Constant failure rate during useful service life	Konstante Ausfallrate in der Nutzungsphase
$\lambda_{test}$	Failure rate, determined by tests	Experimentell ermittelte Ausfallrate
$P_{diss}$	Dissipated power	Abgegebene Verlustleistung
$P_{gen}$	Generated power	Erzeugte Verlustleistung
$Q$	Heat energy	Wärmeenergie
$\rho$	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 (Feuchtest)
$t$	Time	Zeit
$T$	Temperature	Temperatur
$\tau$	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



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	Betriebssspannung
$V_p$	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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