Multilayer ceramic capacitors

Chip, MLSC, X7R

Series/Type: **Chip**

Date: February 2009

The following products presented in this data sheet are being withdrawn.

Substitute Products: See www.epcos.com/withdrawal_mlcc

Ordering Code	Substitute Product	Date of Withdrawal	Deadline Last Orders	Last Shipments
B37941X5333K060		2009-06-26	2010-06-30	2010-12-31
B37941X5333K070		2009-06-26	2010-06-30	2010-12-31
B37941X5473K060		2009-06-26	2010-06-30	2010-12-31

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Ordering Code	Substitute Product	Date of Withdrawal	Deadline Last Orders	Last Shipments
B37941X5473K070		2009-06-26	2010-06-30	2010-12-31
B37941X5683K062		2009-06-26	2010-06-30	2010-12-31
B37941X5683K072		2009-06-26	2010-06-30	2010-12-31
B37941X5104K062		2009-06-26	2010-06-30	2010-12-31
B37941X5104K072		2009-06-26	2010-06-30	2010-12-31
B37941X1102K060		2009-06-26	2010-06-30	2010-12-31
B37941X1102K070		2009-06-26	2010-06-30	2010-12-31
B37941X1152K060		2009-06-26	2010-06-30	2010-12-31
B37941X1152K070		2009-06-26	2010-06-30	2010-12-31
B37941X1222K060		2009-06-26	2010-06-30	2010-12-31
B37941X1222K070		2009-06-26	2010-06-30	2010-12-31
B37941X1332K060		2009-06-26	2010-06-30	2010-12-31
B37941X1332K070		2009-06-26	2010-06-30	2010-12-31
B37941X1472K060		2009-06-26	2010-06-30	2010-12-31
B37941X1472K070		2009-06-26	2010-06-30	2010-12-31
B37941X1682K060		2009-06-26	2010-06-30	2010-12-31
B37941X1682K070		2009-06-26	2010-06-30	2010-12-31
B37941X1103K060		2009-06-26	2010-06-30	2010-12-31
B37941X1103K070		2009-06-26	2010-06-30	2010-12-31
B37941X1153K060		2009-06-26	2010-06-30	2010-12-31
B37941X1153K070		2009-06-26	2010-06-30	2010-12-31
B37941X1223K060		2009-06-26	2010-06-30	2010-12-31
B37941X1223K070		2009-06-26	2010-06-30	2010-12-31
B37931X5152K060		2009-06-26	2010-06-30	2010-12-31
B37931X5152K070		2009-06-26	2010-06-30	2010-12-31
B37931X5222K060		2009-06-26	2010-06-30	2010-12-31
B37931X5222K070		2009-06-26	2010-06-30	2010-12-31
B37931X5332K060		2009-06-26	2010-06-30	2010-12-31
B37931X5332K070		2009-06-26	2010-06-30	2010-12-31
B37931X5472K060		2009-06-26	2010-06-30	2010-12-31
B37931X5472K070		2009-06-26	2010-06-30	2010-12-31
B37931X5682K060		2009-06-26	2010-06-30	2010-12-31
B37931X5682K070		2009-06-26	2010-06-30	2010-12-31
B37931X5103K060		2009-06-26	2010-06-30	2010-12-31
B37931X5103K070		2009-06-26	2010-06-30	2010-12-31
B37931X1102K060		2009-06-26	2010-06-30	2010-12-31
B37931X1102K070		2009-06-26	2010-06-30	2010-12-31

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.

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General

The MLSC was developed for typical applications with a direct connection to the battery or generator in the automobile, as it satisfies the requirements of the automobile manufacturers for a series connection of two capacitors for battery applications in a single component.
It not only represents the only real alternative to the series connection of discrete capacitors, but also offers advantages over these and other possible solutions, which contain only a single capacitor.
Compared with a series circuit made up of conventional ceramic capacitors, it allows the number of components to be reduced. This reduces the space requirement on the circuit board and shortens the placement time. Because fewer components are used, the failure probability is additionally reduced.
The MLSC is based on proven MLCC technology, but has a more rugged design. This technology offers highest reliability (ppb rate) on the basis of long field experience. Both undamaged and typically cracked MLSCs are characterized by a high breakdown voltage and high ESD and pulse strength.
It may be used at temperatures of up to 150 °C with consideration of a voltage derating and with brief temperature peaks of up to 175 °C without electrical stressing.
The MLSC is also manufactured to the specifications of the ppb level assurance system, and a bending strength of 2 mm is assured on the basis of the rigorous piezoelectric method.

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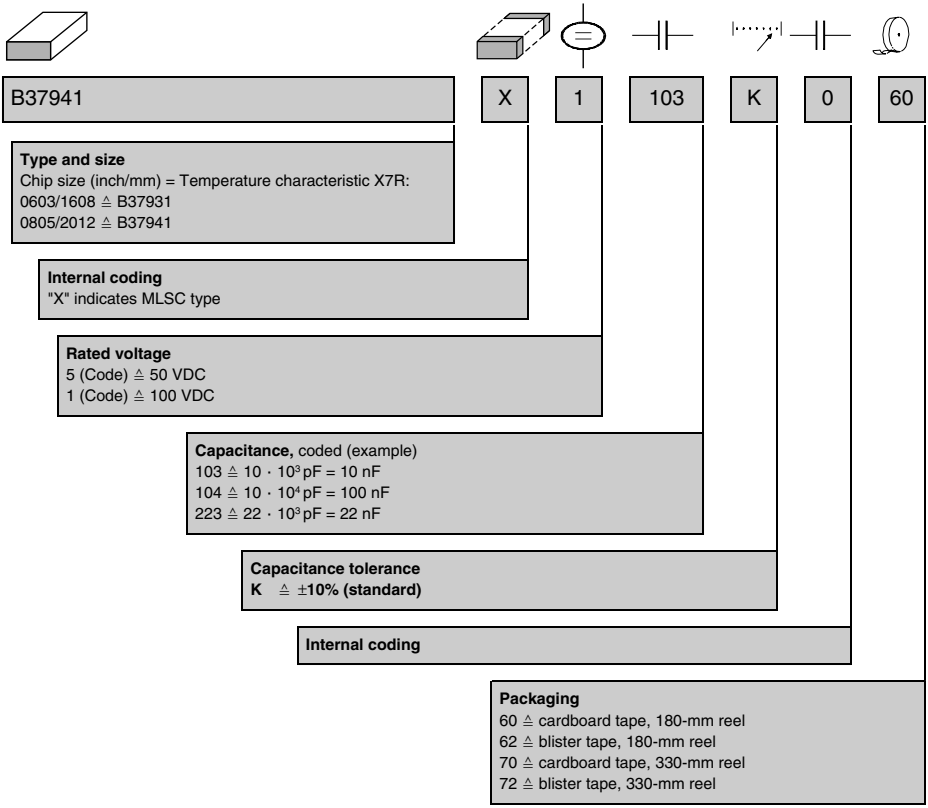
Ordering code system



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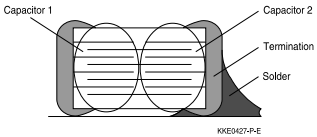
Features

- Two series-connected ceramic capacitors in a single component
- The MLSC thus satisfies the requirements of the automobile manufacturers for applications on the battery / generator (e.g. clamp 30 or clamp 15) in a single component.
- Reduction of the effects of a
  - bending fracture
  - placement fracture
  - solder-shock crack

  thanks to a lower probability of a short circuit.



- Evaluation criteria: Insulation resistance >10 k after the following treatment
  bending until crack
  humidity tests (85 °C/85% RH, rated voltage), 14 days
- The breakdown voltage of MLSCs in the case of a typical bending crack is still greater than five times the rated voltage.
- Both undamaged and cracked MLSCs are capable of fulfilling the requirements to ISO 7637 for 12 V automotive power systems, including load-dump and jump-start requirements (24 V/1 h and 36 V/1 h).
- Based on AEC-Q200 Rev-C

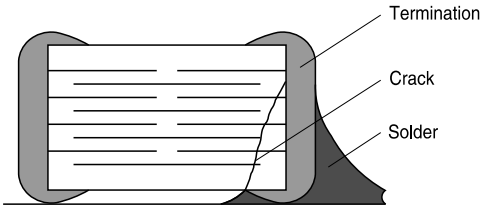
Applications

- Automobile electronics
  - for direct connection to the car battery or generator
  - at positions with “stranding potential”
  - as RF filters in small motors (e.g. electrically operated windows)
- Power electronics (e.g. DC/DC converters)
- Smoothing capacitors (e.g. on the rechargeable battery in mobile equipment)

Cautions

A short circuit cannot be completely excluded. The use of MLSCs does not therefore result in 100% fail-safe operation, but in the event of a crack the probability of a short circuit can be greatly reduced.

In the event of an untypical (bending) crack formation (e. g. double-sided crack or extreme mounting crack) and other mechanical or thermal damage to the capacitor, the capacitor may have a low ohmic state.



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Termination

- Nickel barrier terminations (Ni) for lead-free soldering

Options

- Alternative capacitance values and tolerances available on request

Delivery mode

- Cardboard and blister tape (blister tape for chip thickness ≥1.2 ±0.1 mm), 180-mm and 330-mm reel available

Electrical data

Temperature characteristic			X7R	
Max. relative capacitance change	within −55 ... +125 °C	$\Delta C/C$	±15	%
Climatic category	(IEC 60068-1)		55/125/56	
Standard			EIA	
Dielectric			Class 2	
Rated voltage[1)]		V_R	50, 100	VDC
Test voltage		V_{test}	$2.5 \cdot V_R$/5 s	VDC
Capacitance range		C_R	1 nF ... 100 nF (E6)	
Dissipation factor	(limit value)	tan δ	$< 25 \cdot 10^{-3}$	
Insulation resistance[2)]	(at +25 °C)	R_{ins}	$> 10^5$	MΩ
Insulation resistance[2)]	(at +125 °C)	R_{ins}	$> 10^4$	MΩ
Time constant[2)]	(at +25 °C)	τ	> 1000	s
Time constant[2)]	(at +125 °C)	τ	> 100	s
Operating temperature range		T_{op}	−55 ... +125	°C
Ageing[3)]			yes	

1) Note: No operation on AC line.
2) For C_R >10 nF the time constant $\tau = C \cdot R_{ins}$ is given.
3) Refer to chapter "General technical information", "Ageing".

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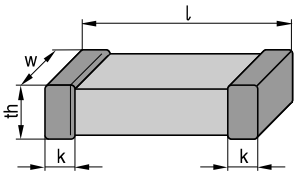
Capacitance tolerances

Code letter	K (standard)
Tolerance	±10%

Dimensional drawing



KKE0329-N

Dimensions (mm)

Case size (inch)	0603	0805
(mm)	1608	2012
l	1.60 ±0.15	2.00 ±0.20
w	0.80 ±0.10	1.25 ±0.15
th	0.80 ±0.10	1.35 max.
k	0.10 - 0.40	0.13 - 0.75

Tolerances to CECC 32101-801

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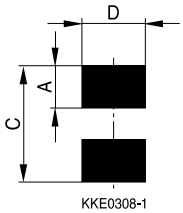
Recommended solder pad



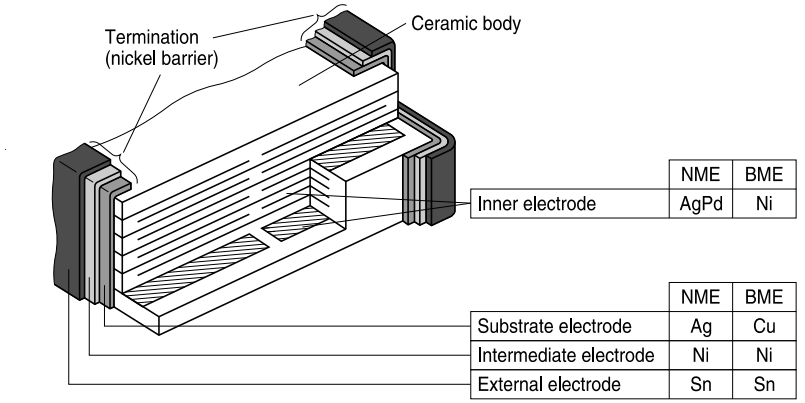
Recommended dimensions (mm) for reflow soldering

Case size	(inch/mm)	Type	A	C	D
	0603/1608	single chip	0.60 ... 0.70	1.80 ... 2.20	0.60 ... 0.80
	0805/2012	single chip	0.60 ... 0.70	2.20 ... 2.60	0.80 ... 1.10

Recommended dimensions (mm) for wave soldering

Case size	(inch/mm)	Type	A	C	D
	0603/1608	single chip	0.80 ... 0.90	2.20 ... 2.80	0.60 ... 0.80
	0805/2012	single chip	0.90 ... 1.00	2.80 ... 3.20	0.80 ... 1.10

Termination



	NME	BME
Inner electrode	AgPd	Ni

	NME	BME
Substrate electrode	Ag	Cu
Intermediate electrode	Ni	Ni
External electrode	Sn	Sn

NME: Noble Metal Electrode
BME: Base Metal Electrode

KKE0407-Y-E

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Product range for MLSC chip capacitors, X7R

Size **inch (l x w)** mm (l x w)	**0603** 1608		**0805** 2012	
Type	B37931X		B37941X	
$C_R \setminus V_R$ (VDC)	50	100	50	100
1.0 nF				
1.5 nF				
2.2 nF				
3.3 nF				
4.7 nF				
6.8 nF				
10 nF				
15 nF				
22 nF				
33 nF				
47 nF				
68 nF				
100 nF				

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Ordering codes and packing for MLSC, X7R, 50 VDC, nickel barrier terminations

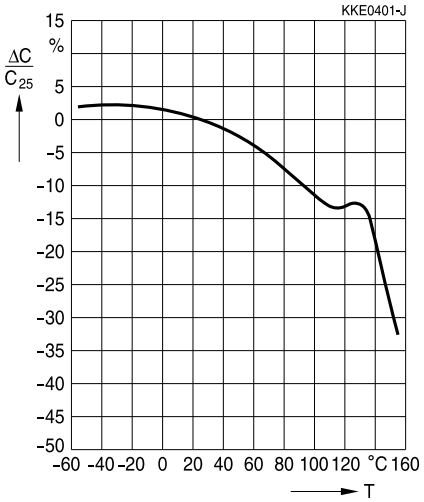
		Chip thickness	Cardboard tape, ∅180-mm reel	Cardboard tape, ∅330-mm reel	Blister tape, ∅180-mm reel	Blister tape, ∅330-mm reel
			** ≙ 60	** ≙ 70	** ≙ 62	** ≙ 72
C_R	Ordering code	mm	pcs./reel	pcs./reel	pcs./reel	pcs./reel
Case size 0603, 50 VDC						
1.5 nF	B37931X5152K0**	0.8 ±0.1	4000	16000		
2.2 nF	B37931X5222K0**	0.8 ±0.1	4000	16000		
3.3 nF	B37931X5332K0**	0.8 ±0.1	4000	16000		
4.7 nF	B37931X5472K0**	0.8 ±0.1	4000	16000		
6.8 nF	B37931X5682K0**	0.8 ±0.1	4000	16000		
10 nF	B37931X5103K0**	0.8 ±0.1	4000	16000		
Case size 0805, 50 VDC						
33 nF	B37941X5333K0**	0.8 ±0.1	4000	16000		
47 nF	B37941X5473K0**	0.8 ±0.1	4000	16000		
68 nF	B37941X5683K0**	1.2 ±0.1			3000	12000
100 nF	B37941X5104K0**	1.2 ±0.1			3000	12000

Ordering codes and packing for MLSC, X7R, 100 VDC, nickel barrier terminations

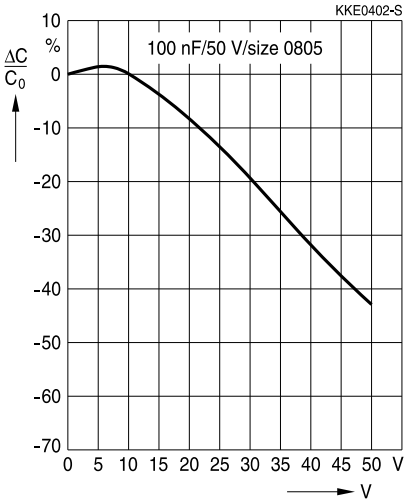
		Chip thickness	Cardboard tape, ∅180-mm reel	Cardboard tape, ∅330-mm reel
			** ≙ 60	** ≙ 70
C_R	Ordering code	mm	pcs./reel	pcs./reel
Case size 0603, 100 VDC				
1.0 nF	B37931X1102K0**	0.8 ±0.1	4000	16000
Case size 0805, 100 VDC				
1.0 nF	B37941X1102K0**	0.8 ±0.1	4000	16000
1.5 nF	B37941X1152K0**	0.8 ±0.1	4000	16000
2.2 nF	B37941X1222K0**	0.8 ±0.1	4000	16000
3.3 nF	B37941X1332K0**	0.8 ±0.1	4000	16000
4.7 nF	B37941X1472K0**	0.8 ±0.1	4000	16000
6.8 nF	B37941X1682K0**	0.8 ±0.1	4000	16000
10 nF	B37941X1103K0**	0.8 ±0.1	4000	16000
15 nF	B37941X1153K0**	0.8 ±0.1	4000	16000
22 nF	B37941X1223K0**	0.8 ±0.1	4000	16000

Typical characteristics[1)]

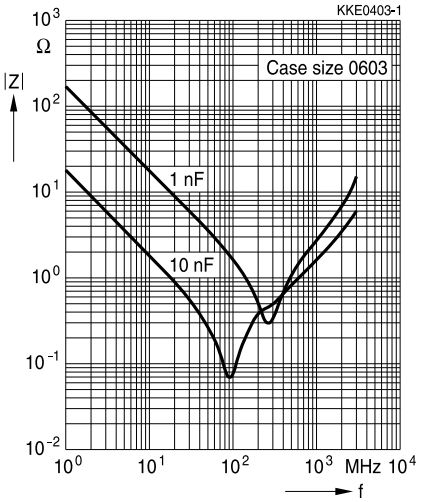
Capacitance change $\Delta C/C_{25}$ versus temperature T



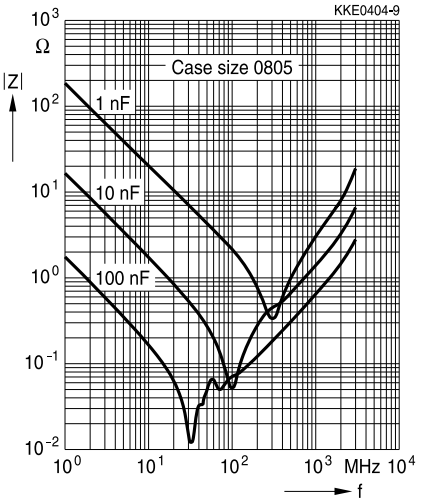
Capacitance change $\Delta C/C_0$ versus superimposed DC voltage V



Impedance |Z| versus frequency f for case size 0603



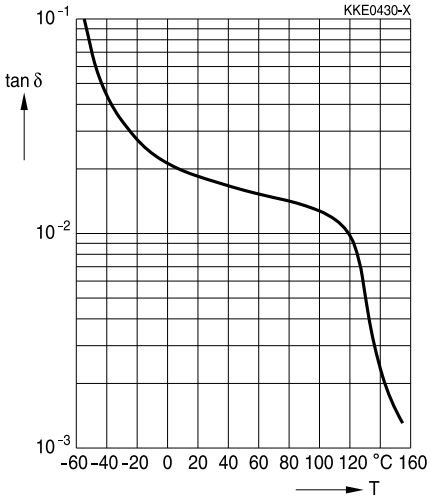
Impedance |Z| versus frequency f for case size 0805



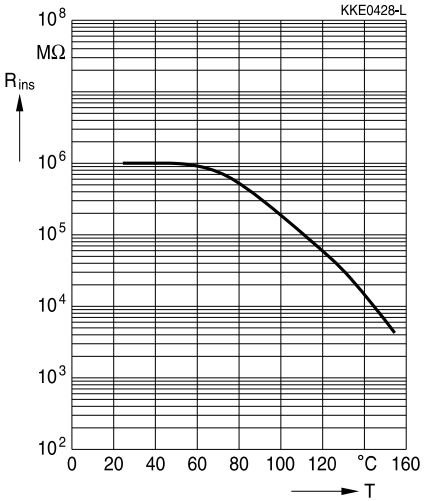
1) For more detailed information on frequency behavior and characteristics see www.epcos.com/mlcc_impedance.

Typical characteristics[1)]

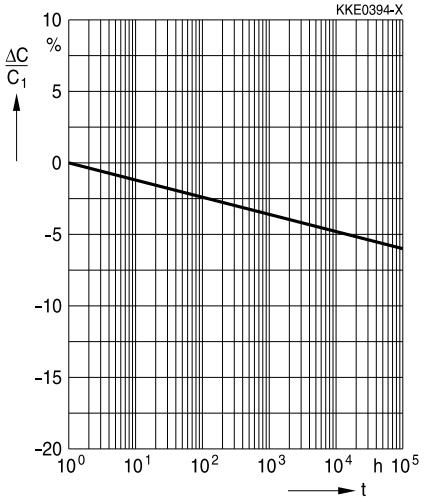
Dissipation factor tan δ versus temperature T



Insulation resistance R_{ins} versus temperature T



Capacitance change $\Delta C/C_1$ versus time t



1) For more detailed information on frequency behavior and characteristics see www.epcos.com/mlcc_impedance.

Cautions and warnings

How to select ceramic capacitors

Remember the following when selecting ceramic capacitors:

1. Ceramic capacitors that must fulfill high quality requirements must be qualified based on AEC-Q200 Rev-C.
2. When ceramic capacitors are used at the connection to a battery or power supply (e.g. clamp 15 or 30 in an automobile) or for safety-relevant applications, two single ceramic capacitors should be connected in series. Alternatively a ceramic capacitor with integrated series circuits should be used in order to reduce the possibility of a short circuit caused by a fracture. The MLSC from EPCOS contains such a series circuit in a single component.
3. The use of multilayer varistors (MLVs) is recommended for ESD protection (see chapter “Effects on mechanical, thermal and electrical stress”, section 1.4).
4. Additional stress factors such as continuous operating voltage or application-specific derating must be taken into account in the selection of components (refer to chapter “Reliability”).

Recommendations for the circuit board design

1. Components with an optimized geometrical design are preferable where permitted by the application.
2. Use at least FR4 circuit board material.
3. Geometrically optimized circuit boards are preferable, especially those that cannot be deformed.
4. Ceramic capacitors should be placed with a sufficient minimum distance from the edge of a circuit board. High bending forces may be exerted there when boards are separated and during further processing of a board (e.g. when incorporating it in a housing).
5. Ceramic capacitors should always be placed parallel to the possible bending axis of a circuit board.
6. Screw connections should not be used to fix a board or connect several boards. Components should not be placed near screw holes. If screw connections are unavoidable, they should be cushioned, for instance using rubber pads.

Recommendations for processing

1. Ensure correct positioning of a ceramic capacitor on the solder pad.
2. Be careful when using casting, injection-molded and molding compounds and cleaning agents. They can damage a capacitor.
3. Support a circuit board and reduce placement forces.
4. Do not straighten a board (manually) if it is distorted by soldering.
5. Separate boards with a peripheral saw, or preferably with a milling head (no dicing or breaking).
6. Be careful when subsequently placing heavy or leaded components (e.g. transformers or snap-in components) because of the danger of bending and fracture.
7. When testing, transporting, packing or inserting a board, avoid any deformation of it so that components are not damaged.
8. Avoid excessive force when plugging a connector into a device soldered onto a board.
9. Only mount ceramic capacitors using the soldering process (reflow or wave) that is permissible for them (see chapter “Soldering directions”).
10. When soldering, select the softest solder profile possible (heating time, peak temperature, cooling time) to avoid thermal stress and damage.
11. Ensure the correct solder meniscus height and solder quantity.
12. Ensure correct dosing of the cement.
13. Ceramic capacitors with external silver-palladium terminations are intended for conductive adhesion - they are not suited for lead-free soldering processes.

This listing does not claim to be complete, but merely reflects the experience of EPCOS AG.

Symbols and terms

Symbol	English	German
A	Area	Fläche
C	Capacitance	Kapazität
C_0	Initial (original) capacitance	Anfangskapazität
C_1	Capacitance value after one hour's use	Kapazitätswert nach einer Stunde
C_R	Rated capacitance	Nennkapazität
C_{20}	Capacitance at 20 °C	Kapazität bei 20 °C
C_{25}	Capacitance at 25 °C	Kapazität bei 25 °C
ΔC	Capacitance change	Kapazitätsänderung
D	Bending displacement	Durchbiegung
E_a	Activation energy	Aktivierungsenergie
ESR	Equivalent series resistance	Ersatzserienwiderstand
F	Force	Kraft
f	Frequency	Frequenz
f_{meas}	Measuring frequency	Messfrequenz
f_{res}	Self-resonant frequency	Eigenresonanzfrequenz
I_{test}	Test current	Prüfstrom
k	Ageing constant	Alterungskonstante
L	Inductance	Induktivität
N	Quantity (integer values)	Anzahl (ganzzahliger Wert)
P_{loss}	Power dissipation or loss	Verlustleistung
Q_{el}	Electrical charge	Elektrische Ladung
Q	Quality	Güte
R_{ins}	Insulation resistance	Isolationswiderstand
R_P	Parallel resistance	Parallelwiderstand
R_S	Series resistance (circuit resistance)	Serienwiderstand
S_V	Rate of rise of a voltage pulse	Flankensteilheit eines Spannungsimpulses
T	Temperature	Temperatur
T_{meas}	Measuring temperature	Messtemperatur
T_{op}	Operating temperature	Betriebstemperatur
T_{ref}	Reference temperature	Bezugstemperatur
T_{test}	Test temperature	Prüftemperatur
t	Time	Zeit
t_r	Rise time of a voltage pulse	Anstiegszeit eines Spannungsimpulses
t_{test}	Test duration	Prüfdauer
tan δ	Dissipation factor	Verlustfaktor

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Symbol	English	German
V	Voltage	Spannung
V_0	Initial (original) voltage (basic voltage level)	Anfangsspannung (Spannungsgrundpegel)
V_{meas}	Measuring voltage	Messspannung
V_R	Rated voltage	Nennspannung
V_S	Amplitude of a voltage pulse	Hub des Spannungsimpulses
V_{RMS}	Measuring (root-mean-square or effective) AC voltage	Effektivspannung
V_{test}	Test voltage	Prüfspannung
|Z|	Magnitude of impedance (AC resistance)	Betrag der Impedanz (Wechselstromwiderstand)
α	Temperature coefficient	Temperaturkoeffizient
ε_0	Absolute dielectric constant	Absolute Dielektrizitätskonstante
ε_r	Relative dielectric constant	Relative Dielektrizitätskonstante
λ	Failure rate	Ausfallrate
τ	Time constant	Zeitkonstante

Abbreviations / Notes

Symbol	English	German
e	Lead spacing (in mm)	Rastermaß (in mm)
SMD	Surface-mounted devices	Oberflächenmontierbares Bauelement
*	To be replaced by a number in ordering codes, type designations etc.	Platzhalter für Zahl im Bestellnummern-code oder für die Typenbezeichnung.
+	To be replaced by a letter.	Platzhalter für einen Buchstaben.
	All dimensions are given in mm.	Alle Maße sind in mm angegeben.
	The commas used in numerical values denote decimal points.	Verwendete Kommas in Zahlenwerten bezeichnen Dezimalpunkte.

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.
2. We also point out that **in individual cases, a malfunction of electronic components or failure before the end of their usual service life cannot be completely ruled out in the current state of the art, even if they are operated as specified**. In customer applications requiring a very high level of operational safety and especially in customer applications in which the malfunction or failure of an electronic component could endanger human life or health (e.g. in accident prevention or lifesaving systems), it must therefore be ensured by means of suitable design of the customer application or other action taken by the customer (e.g. installation of protective circuitry or redundancy) that no injury or damage is sustained by third parties in the event of malfunction or failure of an electronic component.
3. **The warnings, cautions and product-specific notes must be observed.**
4. In order to satisfy certain technical requirements, **some of the products described in this publication may contain substances subject to restrictions in certain jurisdictions (e.g. because they are classed as hazardous)**. Useful information on this will be found in our Material Data Sheets on the Internet (www.epcos.com/material). Should you have any more detailed questions, please contact our sales offices.
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