Multilayer ceramic capacitor

MLSC series

Series/Type: MLSC 0805, 50 V and 100 V
Ordering code: B37941X

Date: July 2005
Version: 1

Description

The MLSC series was designed for applications directly linked to a power source / voltage source (e.g. battery, clamp 30 in automotive applications) and safety relevant application without (integrated) current limitation.

Features

- The MLSC (Multi Layer Serial Ceramic Capacitor) consists of two serial connected capacitors in one component
- Due to the special design the probability of a short circuit is much reduced
  - in case of a bending crack
  - in many cases of an assembling crack
  - in many cases of a solder shock crack
- The MLSC meets the requirements of automotive manufacturers for a (redundant) serial connection of two capacitors, if the application is directly connected to the battery, in one component.
- Reduced number of components leads to
  - increased reliability
  - place saving on the PCB
  - reduced assembling time
- The MLSC is based on established MLCC technology, but with more robust design. This MLCC technology offers highest reliability (ppb-rate) and long term field experience.
- The MLSC offers high reliability due to more stringent process control and end of line testing, which enables the achievement of a 10 ppb level for the application failure rate (measure: 0 mileage and field), see chapter ppb – Level Assurance System page 12.
- The MLSC meets AEC-Q200 requirements, see pages 7 – 11.
- The specified bending strength is 2 mm according to piezo electric method (ΔI measurement)
- The MLSC is suitable for applications with temperature requirements up to 150 °C with respect to the voltage derating and short term temperature peaks up to 175 °C without load, see chapter High Temperature Application page 3.
- The MLSC is lead free in terms of RoHS.
- Nickel barrier termination
- BME technology
- The MLSC offers a selected range of capacitance in case size 0805 (rated voltage 50 V and 100 V).

Applications

Applications directly linked to a power source / voltage source and safety relevant application without (integrated) current limitation. Some examples:

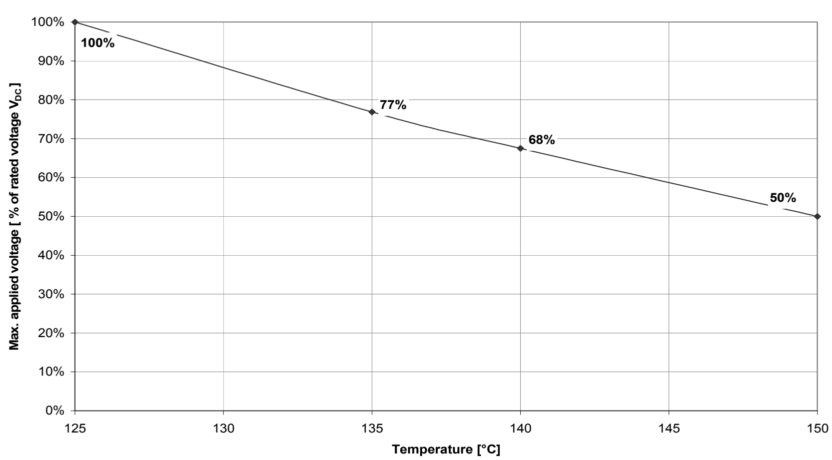
- Automotive electronics (e.g. clamp 30, RF filter in small power motors, security control systems or drive and engine control units)
- Power electronics (e.g. DC/DC converter)
- Mobile devices with battery / accumulator (e.g. filter at charging set)

Differentiation to Standard Series

- Special design of two capacitors serial connected
- Usage of the ppb – Level Assurance System
  - Statistical methods (e.g. six-sigma) for design and process control
  - Periodical testing for solder shock at 360 °C followed by HALT test
  - Periodical testing for bending strength by piezo-electric method
  - Usage of the Weibull method as statistical tool for data analysis
  - Dynamic test limits for at 100% electrical inspection
  - 100% automatic optical inspection – AOI
- An application failure rate (measure: 0 mileage and filed) of 10ppb is achievable.
- Suitable for High Temperature Applications with respect to voltage derating

High Temperature Application:

The maximum application temperature might increase 125 °C for the listed MLSC with respect to the following voltage derating (given in % of the rated voltage). A further reduction of the applied voltage is recommended as the reliability of MLSC follows an Arrhenius law. In addition a short time temperature increase up to 175 °C without load is allowed.



Ordering code system

B37941 X 5 473 K 0 60

Type and size:

941 = X7R 0805

X = Serial capacitor design
Ni-Barrier termination

Rated voltage:

1 = 100 V
5 = 50 V

Rated capacitance:
(example)

$104 = 10 \cdot 10^{4}$ pF = 100 nF

Capacitance tolerance:

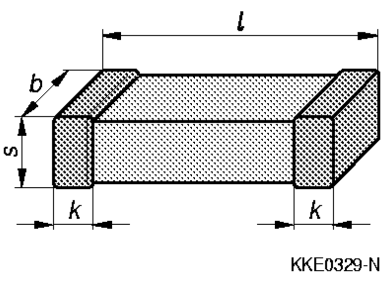
K = ±10% (standard for X7R)

Internal code: 0
or decimal place for
cap values < 10 pF

Packaging code:

60 = cardboard tape, 180-mm reel
70 = cardboard tape, 330-mm reel
62 = blister tape, 180-mm reel
72 = blister tape, 330-mm reel

Dimensional drawing



Size **inch** / mm	l mm	b mm	s mm	k mm
0805 / 2012	2.0 ±0.2	1.25 ±0.15	1.35 max.	0.13 – 0.75

see also “Ordering codes and chip thickness”, dimensions in accordance to CECC 32101-801

Electrical data

Capacitance[1)] and dissipation factor test conditions:

Test frequency:	1.0 kHz ±0.2 kHz
Test voltage:	1.0 V ±0.2 V
Dissipation factor tan δ (limit value):	$< 25 \cdot 10^{-3}$
Insulation resistance R_{ins} / time constant:	$> 10^5$ MΩ (25 °C) or τ > 1000 s, whichever is less
Temperature coefficient (tolerance):	±15%
Operating temperature range:	–55 °C ... +125 °C
Climatic category (IEC 60068-1):	55/125/56
Capacitance range (E6 series):	**100 V: 1 nF … 22 nF**
	50 V: 33 nF … 100 nF

1) Subject to aging, please see “General Technical Information” at

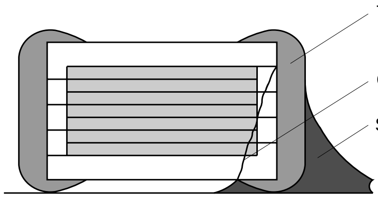
www.epcos.com/ceramic_capacitors

or the data book “Multilayer Ceramic Capacitors”.

MLSC design

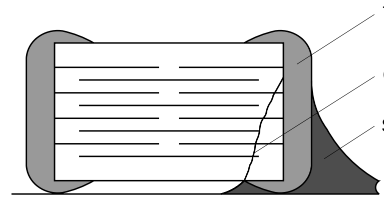
The MLSC is characterised by a serial capacitor design (see pictures below). The design of the components reduces drastically the probability of short circuits in case of flex cracks.

Crack formation in a standard MLCC:



KKE0383-H-E

Crack formation in a MLSC:



KKE0387-F-E

Features

- Two capacitors are serial connected in one multilayer ceramic capacitor
- Reduced probability of shorts after flex cracking
- Evaluation criteria: Insulation resistance >10 kΩ after the following treatment
    1. Bending till flex crack
    2. Humidity tests (85 °C/85% RH, rated voltage), 14 days
- The breakdown voltage of MLSC in case of typical flex cracking is still higher than 5 times the rated voltage.
- Both the un-damaged as well as flex cracked MLSC is capable to fulfil the requirements per ISO 7637 for 12V board systems, including load-dump and jump-start requirements (24V/1h and 36V/1h).
- BME technology

⚠ Caution

It is not possible to prevent a short circuits for 100%. That means the use of MLSC does not result in 100% failure safe mode, but in case of a crack the probability of a short cut can be much reduced.
In case of a not typical (bending) crack formation (e.g. double sided crack or extreme assembling crack) and other mechanical or thermal damage to the capacitor a low ohmic state of the capacitor will be the result.

Ordering codes and chip thickness

Case size	Capacitance [nF]	Rated voltage [V]	Thickness [mm]	Ordering code [1)]	Packaging quantity [pcs]	Max. deflection [3)] [mm]
0805	1	100	0.8 ±0.1	B37941X1102K060	4000	2
	1.5	100	0.8 ±0.1	B37941X1152K060	4000	2
	2.2	100	0.8 ±0.1	B37941X1222K060	4000	2
	3.3	100	0.8 ±0.1	B37941X1332K060	4000	2
	4.7 [4)]	100	0.8 ±0.1	B37941X1472K060	4000	2
	6.8	100	0.8 ±0.1	B37941X1682K060	4000	2
	10 [4)]	100	0.8 ±0.1	B37941X1103K060	4000	2
	15	100	0.8 ±0.1	B37941X1153K060	4000	2
	22 [4)]	100	0.8 ±0.1	B37941X1223K060	4000	2
	33 [4)]	50	0.8 ±0.1	B37941X5333K060	4000	2
	47 [4)]	50	0.8 ±0.1	B37941X5473K060	4000	2
	68 [4)]	50	1.25 ±0.1	B37941X5683K062	3000 [2)]	2
	100 [4)]	50	1.25 ±0.1	B37941X5104K062	3000 [2)]	2

[1)] Ordering code example: Standard tolerance ±10%
Standard packaging Cardboard tape, 180-mm reel

[2)] Standard packaging: Blister tape, 180-mm reel

[3)] Detection by piezo-electric method

[4)] These capacitance values are preferred types. All other types on request.

Specification and stress test methods

No.	Stress test	Specification and acceptance criteria X7R	Test description in accordance to AEC-Q200
1	Pre- and post-stress electrical test	Initial values in accordance to chapter "Electrical data"	Initial and final measurements 24 ±2 h after test and / or heat treatment (only X7R dielectrics) @ room temperature
3	High temperature exposure	∆C/C within ±4.5% ∆C/C within ±7.5% for 25 V D.F. < $25 \cdot 10^{-3}$ D.F. < $50 \cdot 10^{-3}$ for 25 V I.R. > $1 \cdot 10^{5}$ MΩ or τ > 1000 s resp. 500 s for 25 V (whichever is less)	Capacitor fixed on PCB, apply 150 °C for 1000 ±12 h, measurements 24 ±2 h after tests @ room temperature
4	Temperature cycling	∆C/C within ±4.5% ∆C/C within ±7.5% for 25 V D.F. < $25 \cdot 10^{-3}$ D.F. < $50 \cdot 10^{-3}$ for 25 V I.R. > $1 \cdot 10^{5}$ MΩ or τ > 1000 s resp. 500 s for 25 V (whichever is less)	Capacitor fixed on PCB, apply 1000 cycles between -55 °C/150 °C, transfer time < 10 s, dwell time > 15 min, measurements 24 ±2 h after heat treatment (150 °C, 1 h) @ room temperature
5	Destructive physical analysis	No defects or abnormalities	Per EIA-469
6	Moisture resistance	∆C/C within ±10% ∆C/C within ±12.5% for 25 V D.F. < $25 \cdot 10^{-3}$ D.F. < $75 \cdot 10^{-3}$ for 25 V I.R. > $1 \cdot 10^{3}$ MΩ or τ > 50 s resp. 25 s for 25 V (whichever is less)	Apply the cycle given in MIL-STD-202 Method 106 (25 to 65 °C, 80 to 100% RH) 10 times, measurements 24 ±2 h after tests @ room temperature
7	Biased humidity	∆C/C within ±10% ∆C/C within ±12.5% for 25 V D.F. < $25 \cdot 10^{-3}$ D.F. < $75 \cdot 10^{-3}$ for 25 V I.R. > $1 \cdot 10^{3}$ MΩ or τ > 50 s resp. 25 s for 25 V (whichever is less)	Apply 85 °C/85% RH and rated voltage for 1000 ±12 h, surge current < 50 mA, measurements 24 ±2 h after heat treatment (150 °C, 1 h) @ room temperature

No.	Stress test	Specification and acceptance criteria X7R	Test description in accordance to AEC-Q200
8	Operational life	∆C/C within ±10% ∆C/C within ±12.5% for 25 V D.F. < 25 · 10^{-3} D.F. < 75 · 10^{-3} for 25 V I.R. > 1 · 10^{3} MΩ or τ > 50 s resp. 25 s for 25 V (whichever is less)	Apply 125 °C and 1.5 times rated voltage for 1000 ±12 h, surge current < 50 mA, measurements 24 ±2 h after heat treatment (150 °C, 1 h) @ room temperature
9	External visual	No defects or abnormalities	Visual inspection
10	Physical dimensions	Criteria in accordance to chapter "Dimensional drawing and part dimensions"	-
12	Resistance to solvents	∆C/C within ±4.5% ∆C/C within ±7.5% for 25 V D.F. < 25 · 10^{-3} D.F. < 50 · 10^{-3} for 25 V I.R. > 1 · 10^{5} MΩ or τ > 1000 s resp. 500 s for 25 V (whichever is less)	Immerse the components in solvents (as per MIL-STD-202 Method 215) for 3 min each (25 °C, or 63 to 70 °C) Solvents: a) Isoporpyl alcohol (1 part) and mineral spirit (3 parts) b) Terpene defluxer c) Water (42 parts), propylene glycol monomethyl ether (1 part) and monomethanolamine (1 part)
13	Mechanical shock	∆C/C within ±4.5% ∆C/C within ±7.5% for 25 V D.F. < 25 · 10^{-3} D.F. < 50 · 10^{-3} for 25 V I.R. > 1 · 10^{5} MΩ or τ > 1000 s resp. 500 s for 25 V (whichever is less)	Fix the component on PCB and perform 3 shocks in each direction along the 3 mutually perpendicular axes of the MLCC (in total 18 shocks), half-sine puls form, 1500 g peak value, 0.5 ms duration
14	Vibration	∆C/C within ±4.5% ∆C/C within ±7.5% for 25 V D.F. < 25 · 10^{-3} D.F. < 50 · 10^{-3} for 25 V I.R. > 1 · 10^{5} MΩ or τ > 1000 s resp. 500 s for 25 V (whichever is less)	Fix the component on PCB and perform 12 cycles in each of the 3 mutually perpendicular axes of the MLCC (in total 36 cycles). Subject the MLCC to a simple harmonic motion variing the frequency logarithmically between 10 and 2000 Hz and return to 10 Hz (duration approx. 20 min) with an amplitude of 1.5 mm

No.	Stress test	Specification and acceptance criteria X7R	Test description in accordance to AEC-Q200
15	Resistance to soldering heat	ΔC/C within ±4.5% ΔC/C within ±7.5% for 25 V D.F. < 25 · 10^{-3} D.F. < 50 · 10^{-3} for 25 V I.R. > 1 · 10^5 MΩ or τ > 1000 s resp. 500 s for 25 V (whichever is less)	Immerse the MLCC in and eutectic solder at 260 ±5 °C for 10 ±1 s, measurements 24 ±2 h after test @ room temperature
16	Thermal shock	-	Covered by more severe tests No. 4
17	ESD	ΔC/C within ±4.5% ΔC/C within ±7.5% for 25 V D.F. < 25 · 10^{-3} D.F. < 50 · 10^{-3} for 25 V I.R. > 1 · 10^5 MΩ or τ > 1000 s resp. 500 s for 25 V (whichever is less)	Test setup and performance as per AEC-Q200-002. **Note: Test and classification only for information. For ESD protection the use of MLV is recommended.**
18	Solderability	Covering of 95% of end terminations, checked by visual inspection. No leaching of contacts.	Conditions: a) Preconditioning at 155 °C for 4 h, immerse the MLCC in eutectic solder (60/40 SnPb) at 235 °C ±5 °C for 5 +0/-0.5 s. b) Preconditioning by steam aging for 8 h ± 15 min, immerse the MLCC in eutectic solder (60/40 SnPb) at 235 °C ±5 °C for 5 +0/-0.5 s. c) Preconditioning by steam aging for 8 h ±15 min, immerse the MLCC in eutectic solder (60/40 SnPb) at 260 °C ±5 °C for 120 ±5 s.

No.	Stress test	Specification and acceptance criteria X7R	Test description in accordance to AEC-Q200
19	Electrical characterization	Electrical characteristics should meet values as given chapter "Electrical data".	- The capacitance and the dissipation factor should meet the specification at 25 °C. - Capacitance must fulfil the X7R characteristics within the range of -55 to 125 °C. - Insulation resistance must meet specification at 25 and 125 °C where defined. - MLCC must pass dielectric strength test (2.5 times rated voltage, 5 s, surge current < 50 mA).
21	Board flex	ΔC/C within ±4.5% ΔC/C within ±7.5% for 25 V D.F. < 25 · 10^{-3} D.F. < 50 · 10^{-3} for 25 V I.R. > 1 · 10^5 MΩ or τ > 1000 s resp. 500 s for 25 V (whichever is less)	Fix the capacitor on PCB and apply a force until a deflection of 2 mm is reached for 5 ±1 s, 1 mm jig radius, 90 mm supporting span, speed 1 mm/s. for land pattern design and drawing of the test setup please see appendix "Effects of mechanical stress".
22	Terminal strength (SMD)	ΔC/C within ±4.5% ΔC/C within ±7.5% for 25 V D.F. < 25 · 10^{-3} D.F. < 50 · 10^{-3} for 25 V I.R. > 1 · 10^5 MΩ or τ > 1000 s resp. 500 s for 25 V (whichever is less)	Fix the capacitor on PCB and apply a force of 18 N in width direction of the MLCC. Note: Tests only performed for case sizes greater or equal 0603.
23	Beam load test, breaking strength test	Breaking force must exceed 10 N.	Test setup and performance as per AEC-Q200-003.

ppb - level assurance system

The tests given in the table below will result in a quality system to assure component reliability as necessary for automotive use.

Item	Description	Frequency
Destructive physical analysis	Increased margins	Every lot
Solder shock test followed by burn-in or HALT test	360 °C solder shock followed by 24 h 125 °C / 1.5 x rated voltage burn-in (for NME types) or 150 °C / 3 x rated voltage HALT test (for BME types)	Skip lot
Bending strength test	Deflection up to 10 mm, detection per piezo-electric method	Skip lot
100% electrical inspection including the use of dynamic IR test limits, minimum 3 x rated voltage for IR testing	-	Every lot and dynamic testing limits only for X7R 0603 and 0805
100% AOI	-	Every lot
Periodical reliability monitoring and fit-rate estimation acc. to Arrhenius law and the basis of life testing	According to the stress tests specified	Family representatives per year

Further information

Please see General Technical Information at www.epcos.com/ceramic_capacitors or the data book “Multilayer Ceramic Capacitors” for further information on:

- Soldering directions
- Taping and packing
- Surface mounting instructions
- Effects of mechanical stress

Cautions

- Derating: A “state of the art” application design is essential to achieve failures rates at ppb level. Do not use designs based on 100% of specified rated values.
- AC applications may damage MLSC on a much lower level than DC voltage due to power dissipation losses.
- Mechanical stress - Please note EPCOS “General Technical Information”, “Surface mounting instructions” and information about the effect of mechanical stress.
- ESD - EPCOS recommends the use of varistors.
- Further processing - care must be taken using moulding processes.
- Combined stresses - the total stress (e.g. DC voltage, AC ripple, pulses and temperature) has to be taken into account to estimate reliability of MLSC.

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The following applies to all products named in this publication:

1. Some parts of this publication contain **statements about the suitability of our products for certain areas of application**. These statements are based on our knowledge of typical requirements that are often placed on our products in the areas of application concerned. We nevertheless expressly point out **that such statements cannot be regarded as binding statements about the suitability of our products for a particular customer application.** As a rule, EPCOS is either unfamiliar with individual customer applications or less familiar with them than the customers themselves. For these reasons, it is always ultimately incumbent on the customer to check and decide whether an EPCOS product with the properties described in the product specification is suitable for use in a particular customer application.
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