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Bend Testing

Methods and International Specifications

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Introduction

Due to its brittle nature, multilayer ceramic capacitors are more prone to excesses of mechanical stress than other components used in surface mounting. One of the most common causes of capacitor failures is directly attributable to the bending of the printed circuit board (PCB) after solder attachment. Excessive bending will create mechanical stress within the ceramic capacitor that, if sufficient, can result in mechanical cracks.

The purpose of this report is to provide details regarding:

- a. International Specifications that define bend test methods and acceptability.
- b. Methods employed by Syfer to measure the mechanical performance of the termination material.
- c. The shape of cracks created by PCB bending - mechanical stress.

International Requirements/ Specifications

The international requirement for bend testing is referred to in several different specifications.

- IEC 384-1 (now IEC 60384-1:2001) Fixed capacitors for use in electronic equipment Part 1: Generic Specification section 4.35 Substrate bending test refers to IEC 60068-2-21.
- IEC 60068-2-21:1999 Environmental testing: Test U: Robustness of terminations and integral mounting devices. Section 8 test Ue specifies the test required to assess the mechanical robustness of surface mounting device terminations when mounted on a substrate. Test Ue₁ specifies the substrate bend test.

The purpose of test Ue₁ is to verify that the capacitors can withstand bending loads that are likely to be applied during normal assembly or handling operations.

IEC 60068-2-21 refers to requirements such as deflection and acceptance criteria as being included in the “relevant specification”. Syfer maintains CECC (Cenelec Electronic Components Committee) product approval and the “relevant specification” is CECC 32101-801.

- CECC 32101-801 Detail Specification: Fixed Multilayer Ceramic Capacitors. Table 4B Periodic Group C2 specifies that:
 - a). The Capacitance measured with the board in the bent position should not change by $>10\%$.
 - b). There should be no external visible indication of damage.
 CECC 32101-801 is part of CECC 32100 Sectional Specification.
- CECC 32100 Sectional Specification clause 4.9 specifies that the test board shall be bent to a deflection depth of 1mm.

Capacitor Bend Tests Conducted on Syfer Product

Currently there are 2 methods employed by Syfer to measure the mechanical performance of capacitor termination when mounted on a substrate:

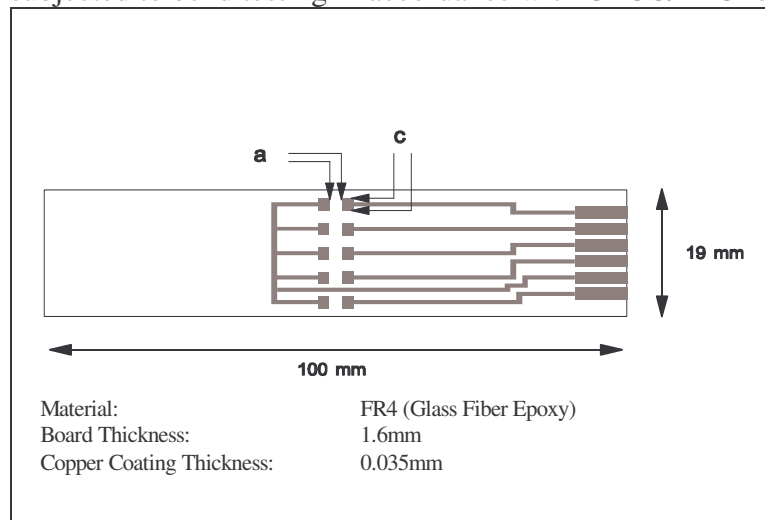
1. External Test Laboratory

To maintain CECC product approval (certified by BSI “British Standards Institute”) Syfer issues capacitor samples to an external test laboratory for a variety of tests to be conducted in accordance with CECC requirements. The external test laboratory is not part of Syfer and has full traceability to International Reference Standards.

Syfer has maintained CECC product approval for >10 years.

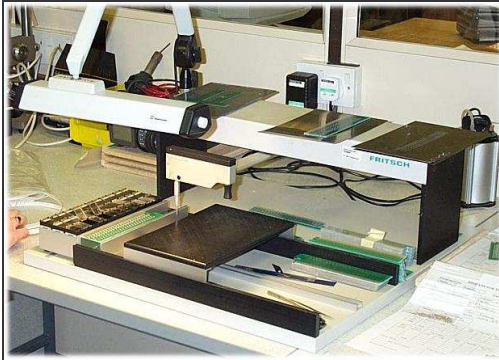
2. Syfer Bend Tests

In addition to the external test laboratory Syfer also conducts bend tests. Samples of capacitors are mounted onto FR4 Test PCBs using 62/36/2 Sn/Pb/Ag solder and subjected to bend testing in accordance with CECC/ IEC requirements.



Example of FR4
Test PCB Used

Capacitor Placement Method



Hand pick and place used to mount capacitors for bend tests.

Syfer's Bend Test Facility

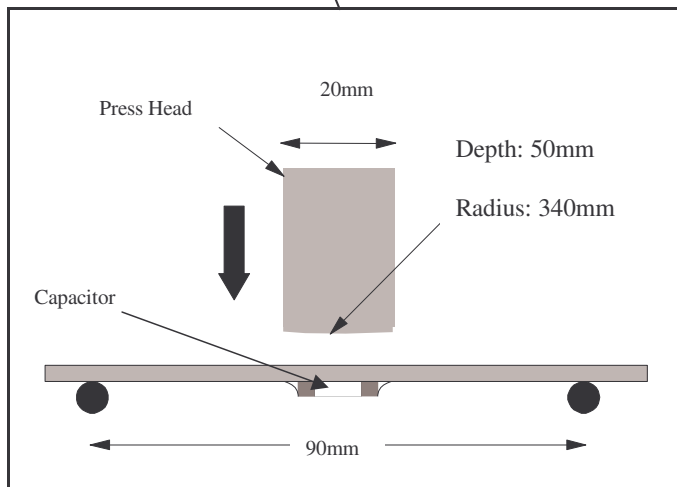


Fig 1. Bend Test Method

A total of 16 Test PCBs are used for each bend test. Each PCB is mounted with either 2, 3 or 5 capacitors depending upon capacitor size and 4 Test PCBs are used for each deflection depth.

In addition to Capacitance measurements, after deflection capacitors are carefully removed using a hot air pencil and then micro-sectioned to determine the presence of mechanical cracks. The reason for performing the micro-section is that extensive trials conducted by Syfer have demonstrated that measuring Capacitance does not provide a clear indication if the capacitors are cracked.

Typical results for Syfer X7R 0805, 1206, 1812 and 2220 capacitor ranges:

PRODUCT	MEAN BEND (mm)
0805 X7R	3.6
1206 X7R	3.4
1812 X7R	3.2
2220 X7R	3.2

Mechanical Crack Shape

By conducting extensive bend testing capacitor manufacturers including Syfer have demonstrated that mechanical stress applied by bending the PCB results in a distinctive type of crack within the capacitor.

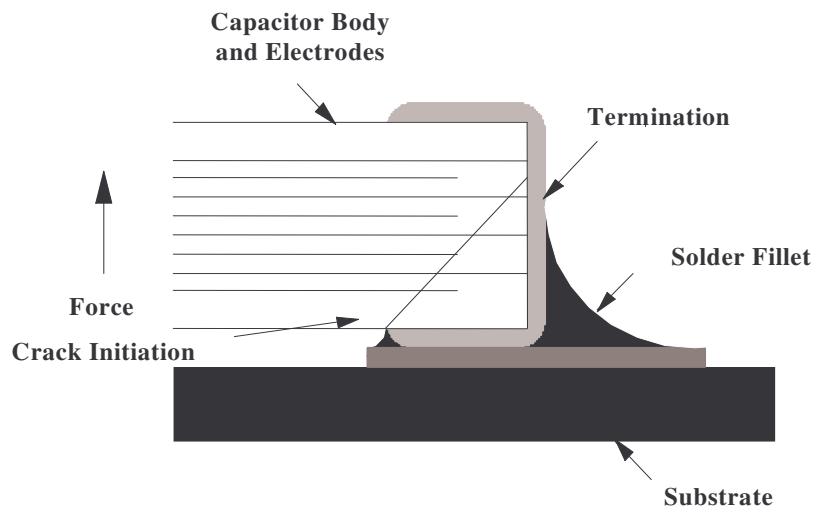
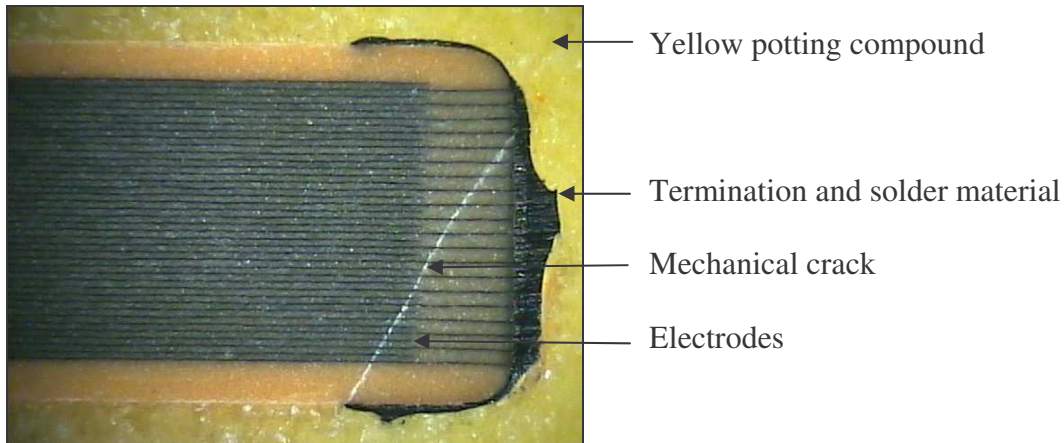


Fig 2. Mechanical Crack

During Syfer’s investigation into mechanical cracking over 15000 capacitors were subjected to bend testing.

Example of capacitors issued by customers to Syfer for failure investigation:



Summary

- Syfer capacitors pass the International Specifications for bend testing. In addition to routine tests conducted at Syfer an external test laboratory conducts periodic CECC tests on Syfer product including bend testing.
- The crack created by mechanical stress during PCB bending is a distinctive type of crack.

For further information regarding:

- a). Potential causes for mechanical cracking refer to Syfer application note “mc-potential causes”.
- b). An alternative termination material that withstands higher levels of mechanical stress refer to Syfer application note “Polymer Termination”.

Information is also available on Syfer’s web site www.syfer.com