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FlexiCap™ Termination

“An alternative termination material specifically designed to absorb greater levels of mechanical stress thereby reducing capacitor failures associated with mechanical cracking”

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Mechanical Cracking (The Reason for FlexiCap™ Termination)

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 bending of the printed circuit board (PCB) after solder attachment. Excessive bending will create mechanical crack(s) within the ceramic capacitor. Mechanical cracks, depending upon severity, may not cause capacitor failure during the final assembly test. Over time moisture penetration into the crack can cause a reduction in insulation resistance and eventual dielectric breakdown leading to capacitor failure in service.

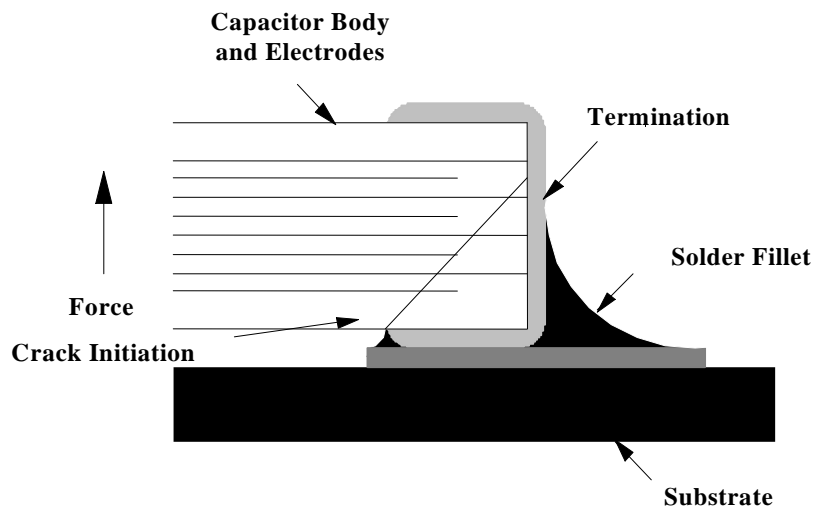


Fig 1. Mechanical Crack

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





What is FlexiCap™ Termination?

In order to reduce the possibility of mechanically cracking multilayer ceramic capacitors Syfer in conjunction with customers has been actively developing a new termination material. This termination is a silver loaded epoxy polymer that is flexible and absorbs some of the strain between the PCB and the ceramic capacitor. The termination is applied using conventional termination techniques, but instead of being sintered at approximately 800°C, the polymer is cured at 180°C.

The polymer material has very good adhesive and conductive properties that are obtained after curing. After the termination process stage the capacitors are plated with Nickel and Tin using the same methods as for the industry standard sintered Silver terminated capacitors.

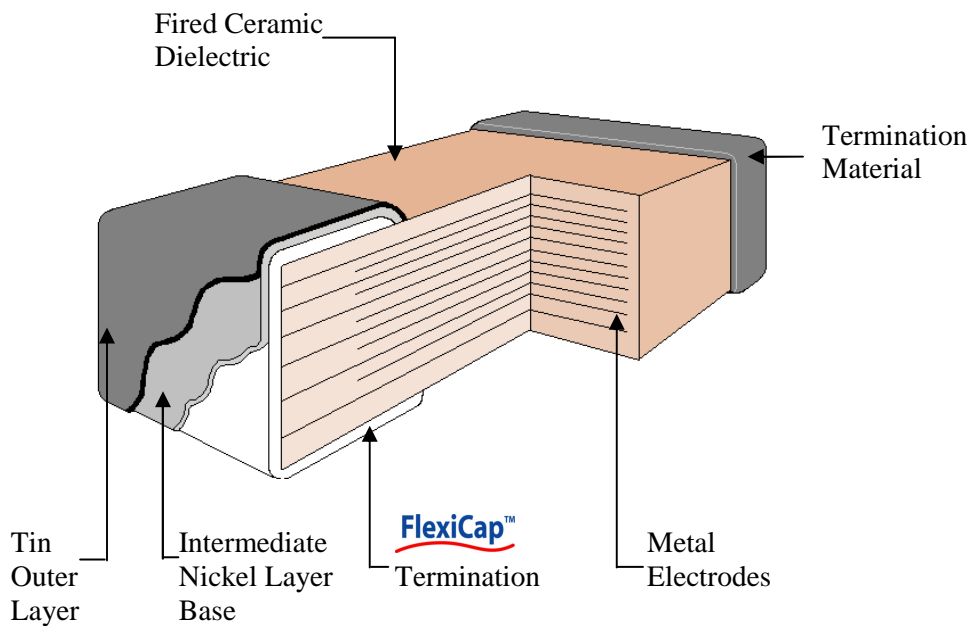
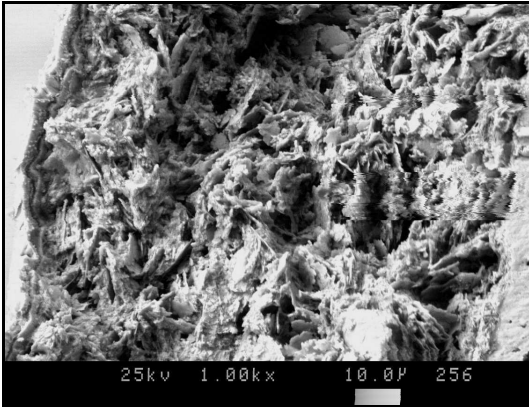


Fig 2. Capacitor Construction



Picture taken at 1000x magnification using a SEM showing a fracture section through a capacitor termination.

The picture demonstrates the fibrous nature of the FlexiCap™ termination that absorbs greater levels of mechanical stress when compared with standard sintered silver termination.

Validation Tests Performed

Before any new material is approved for use, rigorous evaluation is conducted through Syfer's formal Design and Development process. The Design and Development process is used to ensure that new materials are evaluated, and where acceptable, introduced in a controlled and systematic manner.

- Bend Test Trials.
Method: Capacitor samples are mounted onto FR4 Test PCBs using 62/36/2 Sn/Pb/Ag solder and subjected to bend testing in accordance with IEC 60068-2-21. Environmental testing: Test U: Robustness of terminations and integral mounting devices.

Results:

- 1). Bend tests results from samples taken from Syfer batch number X09514 (2220 50 volt 1uF X7R).

Bend mm	Sintered % Crack	FlexiCap™ % Crack
2.5	0	Not tested
3	50	0
4	100	0
5	100	0
6	Not tested	50
Mean Bend mm	2.75	5.75



2). Multiple samples have been evaluated across Syfer's X7R 0805, 1206, 1812 and 2220 capacitor ranges with the following results:

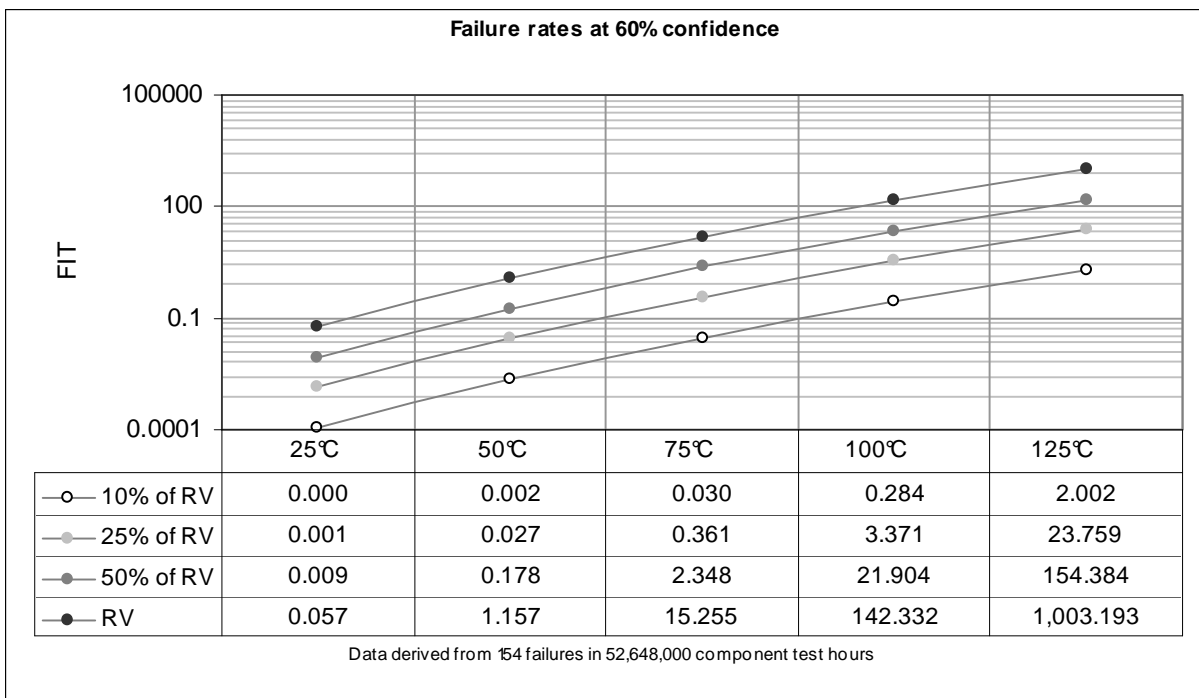
Product	Mean Bend (mm) Sintered Termination	Mean Bend (mm) FlexiCap™ Termination
0805 X7R	3.6	6.3
1206 X7R	3.4	6.4
1812 X7R	3.2	6.0
2220 X7R	3.2	6.1


The bend tests conducted have proved that the FlexiCap™ termination withstands a greater level of mechanical stress before mechanical cracking is created.

- Load Test Trials

As part of the development process fifty capacitors from over 10 lots of FlexiCap™ terminated X7R product were subjected to 1.5x Rated Voltage @ 125°C for 1000 hours. No capacitors failed as a result of FlexiCap™ termination failure.

From June 2001 to June 2007, a total of 52,648,000 components test hours @ 125°C have accumulated. The component failures have not been attributed to FlexiCap™ termination. FIT = Failures in 10⁹ Hours.



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Reliability Unit Conversion Factors:

From FITs to Failures in 10^6 Hours: Divide FITs by 10^3
From FITs to % failures in 10^3 Hours: Divide FITs by 10^4

By using the FIT rate data customers can evaluate the expected failure rate of capacitors (calculated at 60% confidence level) by comparing the % of RV (Rated Volts) being applied with the operating temperature. For example, if a customer uses a 100V rated capacitor at 10V (10% of RV) @ 75°C then by using the table the FIT rate is 0.0362.

Note: The table has been calculated using a variety of product codes terminated with FlexiCap™ termination.

- Termination Endurance Testing

A sample of FlexiCap™ terminated X7R capacitors has been subjected to 20,000 hours at 125°C. Tests conducted after 20,000 hours indicated no deterioration in the electrical or mechanical performance of the FlexiCap™ termination.

A sample of FlexiCap™ terminated X8R capacitors has been subjected to 5,000 hours at 150°C. Tests conducted after 5,000 hours indicated no deterioration in the electrical performance.

- Humidity Tests

From June 2001 to June 2007, a total of 13208 components (2,218,944 component test hours) have been tested at 85°C @ 85RH for either 168hours or 1000hours. There have been 3 failures that have not been attributed to FlexiCap™.

- Temperature Cycling


Temperature Cycle Profile: 40-minute cycle consisting of 10 minute ramp and 10 minute dwell at temperature extremes.

Temperature Extremes: -55°C to +125°C.

Number of Cycles: 1000.

Method: Samples of FlexiCap™ terminated capacitors were soldered onto FR4 test PCB's and subjected to temperature cycling. After 1000 cycles, the capacitors were sectioned mounted on the test PCBs for internal visual examination.

Results: There were no cracks within the capacitors.

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- Passive Flammability Test

Method: A sample of FlexiCap™ terminated capacitors were subjected to a needle flame test in accordance with IEC 60384-1.

Requirement: Burning droplets of glowing parts falling down shall not ignite the tissue paper (placed underneath the specimen being tested).

Results: The sample passed the Passive Flammability Test.

- Customer Trials.

Samples of FlexiCap™ terminated capacitors have been supplied to customers for assembly trials.

The trials conducted by customers have been successful and customer reaction to the introduction of FlexiCap™ termination has been extremely favorable. Demand for FlexiCap™ terminated capacitors has been rapidly increasing as customers realize the advantages provided.

FlexiCap™ terminated capacitors are supplied to many blue chip companies, O.E.M's, E.M.S's and international component distributors.

In addition to the validation tests performed, standard tests conducted at Syfer include:-

- Each production batch tested for solderability and termination leach.
- FlexiCap™ termination lot testing prior to production use. This includes samples being subjected to bend tests and endurance tests.
- Routine load testing, humidity testing and bend testing on samples of production capacitor batches manufactured. FlexiCap™ termination has not caused any capacitor failures.



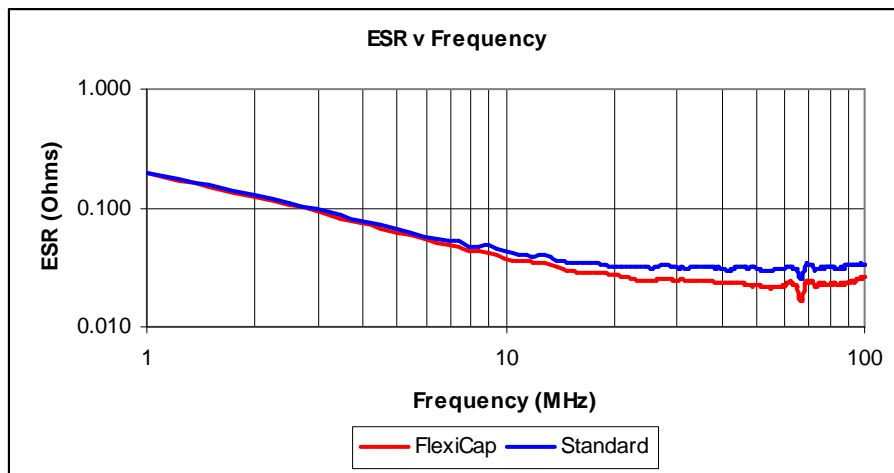
Key Electrical Characteristics


FlexiCap™ terminated capacitors have equivalent electrical characteristics when compared with sintered terminated capacitors.

For example (type 1812 100nF):

	Capacitance @ 1kHz	DF @ 1kHz	Resonant Frequency (RF)	Inductance @ RF
Sintered Termination	100.02nF	0.01167	14.468MHz	1.1965nH
FlexiCap™ Termination	101.14nF	0.01173	14.468MHz	1.2099nH

The ESR characterisation of a 18nF 1825 X7R capacitor was undertaken to a frequency of 100MHz. FlexiCap™ and sintered termination were tested in parallel to determine the relative ESR performance. From the graph below it can be seen that there is a reduction in ESR at high frequencies when capacitors are terminated using FlexiCap™ termination.



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AEC-Q200 Stress Test Qualification

FlexiCap™ terminated capacitors have been qualified to the rigorous automotive stress tests detailed in AEC-Q200. These test include increased bend performance requirements and increased temperature cycling requirements.

Note: As a result of the increased bend performance and temperature cycling requirements, X7R capacitors are only qualified to AEC-Q200 if terminated with FlexiCap™. For further information refer to Syfer application note reference AN0009 Automotive Electronics Council-Q200 Stress Test Qualification for Passive Components

Application Notes

FlexiCap™ terminated capacitors should be handled, stored and transported in the same manner as standard terminated capacitors. The requirements for mounting and soldering FlexiCap™ terminated capacitors are the same as for sintered terminated capacitors.

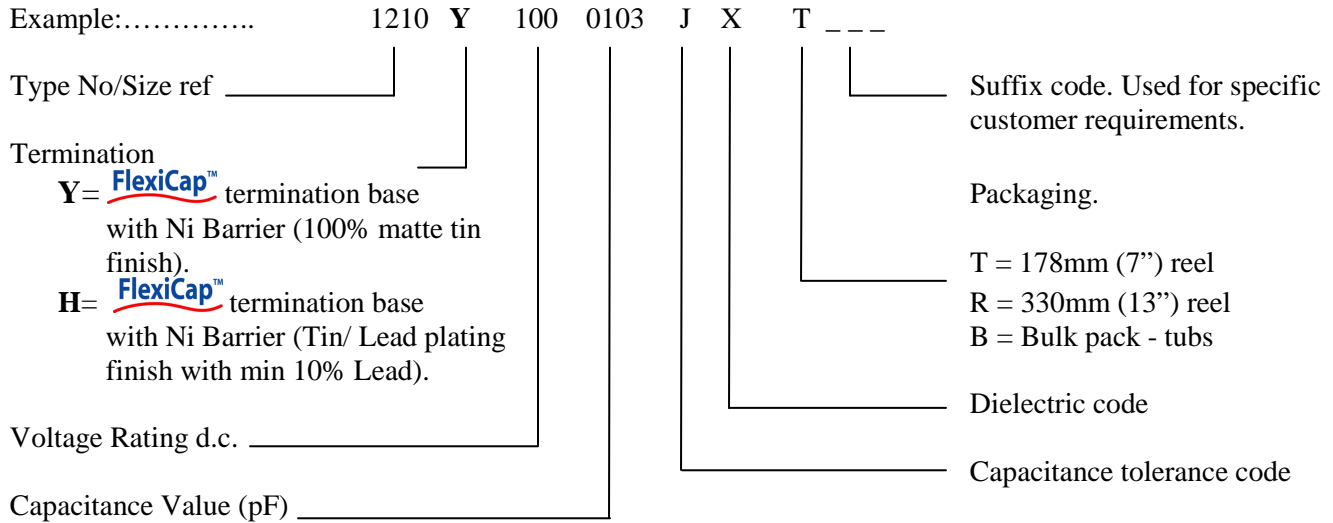
For customers currently using sintered terminated capacitors there should be no requirement to change the assembly process when converting to FlexiCap™ termination.

Based upon board bend tests in accordance with IEC 60384-1/ IEC 60068-2-21 the level of stress required to mechanically crack a FlexiCap™ terminated capacitor is effectively double when compared with a sintered terminated capacitor.

It must be stressed however, that capacitor users must not assume that the use of FlexiCap™ terminated capacitors will totally eliminate mechanical cracking. Process controls are still required for this objective to be achieved.

Ordering Requirements

Syfer product code construction:-



For further information please contact Syfer Sales Department.