

EXPERIMENT TEST PLAN FOR DETERMINING LOW VOLTAGE FAILURE
MECHANISMS IN CERAMIC CAPACITORS

Low voltage failures of multilayer ceramic capacitors was relatively a rare phenomenon, but now over many years these failures have become more evident with more usage of ceramic capacitors in low voltage circuit applications such as decoupling of logic circuitry. It can be defined as an insulation resistance failure occurring at a voltage well below the design and test voltage of the capacitor. This can be seen as a permanent or intermittent low insulation resistance and in a low impedance application, such as a power supply decoupling, where thermal runaway can result in a catastrophic burn-up of the capacitor.

It is thought that the low voltage failures are associated with mechanisms of failure such as thin spots in the dielectric, large grains in the dielectric, contamination in the dielectric, or metal dendrites and cracks, voids, knit line defects, or linked porosity such as shown in figure 1. It is believed that electrochemical dissolution and migration of electrode materials occurs when these defects/or failure mechanisms are exposed to humid environments, low voltages, and temperatures, which leads to low voltage failures.

Experiment Test Plan

1. Parts Description

Capacitor style CKR 06, unenpsulated, rated at 1.0uf, +/- 10% and 50 VDC, and rated at 0.33uf, +/- 10% 50 VDC will be used in the experiment. The parts will be procured from two manufacturers. Each manufacturer will provide two lots of parts of different date codes per each rating. Lots A₀, and A₁, from one manufacturer, and lots B₀, and B₁, from the other.

<u>Manufacturer</u>	<u>Rating</u>	<u>Date Code</u>	<u>Test quantity</u>
A ₀ AVX	0.33uf/50 VDC	9938-NZ	75
A ₁ AVX	1.0uf/50VDC	9936-RR/9937-PK	2/73
B ₀ Kemet	0.33uf/50VDC	9946R	75
B ₁ Kemet	1.0uf/50VDC	9947B	75

Note 1:

A balance of five lots totaling 101 capacitors are available for evaluation as described in table 1 and flow the chart.

2. Experiment Description, Table 1, and flow chart
Table 1

Title	Standard	Test Method	Test Condition
Cleaning			Wash in deionized water, rinse with alcohol and dry.
Serialize			Identify all parts with Serial numbers.
Visual inspection			@ 10X ---
Destructive Physical Analysis (DPA) on a five sample size from each of the five capacitor lots (from "note 1 above").			Using in-house procedures

Initial electrical (i. e.) @ 25 ⁰ C:			
Capacitance	MIL-STD-202F	305	1 KHz, 0.1 volt
Dissipation Factor	MIL-STD-202F	306	1 KHz, 0.1 volt
Insulation Resistance	MIL-STD-202F	302	3 volts, 2 minutes
Low voltage humidity test	MIL-C-123		Paragraph 4.6.16.1
For final electricals, repeat Initial electricals			
Failure analyze initial electrical and 85/85 test failures, then correlate the finding DPA results.			Using standard in-house procedures.
Report			Develop an abstract Report investigating The failure mechanisms (phenomena) and how they cause low voltage failures.

EXPERIMENT FLOW CHART

