SOLID TANTALUM CAPACITOR SURGE CURRENT FAILURE MECHANISM EXPERIMENT

Background

One element of the solid tantalum capacitor is the tantalum pellet, the anode. The pellet is fine powered metal that is compressed in molds forming a cylindrical coherent mass of a pellet with an embedded tantalum lead wire extending axially from the pellet.

The pellets are sintered at high temperature in vacuum furnaces that in combination with low furnace pressure vaporizes most impurity materials which are pump away in the vacuum system. Inevitably residual impurities that directly influence capacitor failures are left behind.

Sintered pellets are anodized in an acidic bath that forms a layer of dielectric, tantalum pentoxide ($Ta_2 O_5$). Wherever impurities are encountered during anodization, the $Ta_2 O_5$ dielectric layer produced is not continuous and of uniform thickness. The results are minute holes or thin spots in the dielectric layer which are failure mechanisms.

If the tantalum pentoxide layer was perfectly continuous and of uniform thickness throughout, leakage current would be several orders of magnitude lower than the best capacitor yet made. However, this is not the case, in the best of processing the impurities are not removed, leaving failure mechanisms that cause high leakage currents and failure of the capacitor.

Purpose

Purpose of the experiment is to determine solid tantalum capacitor failure mechanisms under surge current conditions. The experiment plan and flow chart are as follows:

Experiment plan

Test Items: A total 200 parts as described below will be used in the experiment.

Part Style	Voltage	Capacitance	Quantity
CSS13	75VDC	15uf	50
CSS33	50VDC	39uf	50
CSR13	50VDC	22uf	50
CSR09	75VDC	1.2uf	50

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Experiment procedure:

A 1.0 Serialize parts

1.2 External visual inspection to paragraph 4.7.1 of MIL-C-39003 specification.

1.3 Record all findings from visual inspection

B 2.0 Initial parameter measurements to paragraphs 4.7.6, 4.7.7, 4.7.8, and 4.7.9 of MIL-C-39003 specification.

2.1 Remove all failures and determine if they should be subjected to the surge current cycles along with the passing units.

2.2 If determination is yes, submit these parts to surge current testing. If no, submit balance of parts to failure analysis, as in paragraph 2.7 below.

2.3 Subject all parts to 10 charge-discharge surge current cycles of 1second each per cycle at 25^0 C, -55^0 C and $+85^0$ C and maximum rated voltage, using the attached surge current test circuit which complies with the following conditions:

a. A dc power supply with a minimum 15-ampere capacity shall be used.

b. 100[illegible]uf aluminum electrolyte capacitor shall be placed across the dc power supply.

c. Use a 30-ampere mercury relay to switch the capacitor under test to the energy bank for charge and into a short circuit for discharge.

d. Total series resistance including the energy bank, mercury relay, fuse and wire should be less than 0.25 ohms for each capacitor in test.

e. Use 1-ampere fast-blow fuse in series with each capacitor under test.

f. Capacitor under test shall be considered a failure either when a fuse blows or the dc leakage current is exceeded or both.

2.4 Record and remove all dc leakage current failures identified by blown fuses.

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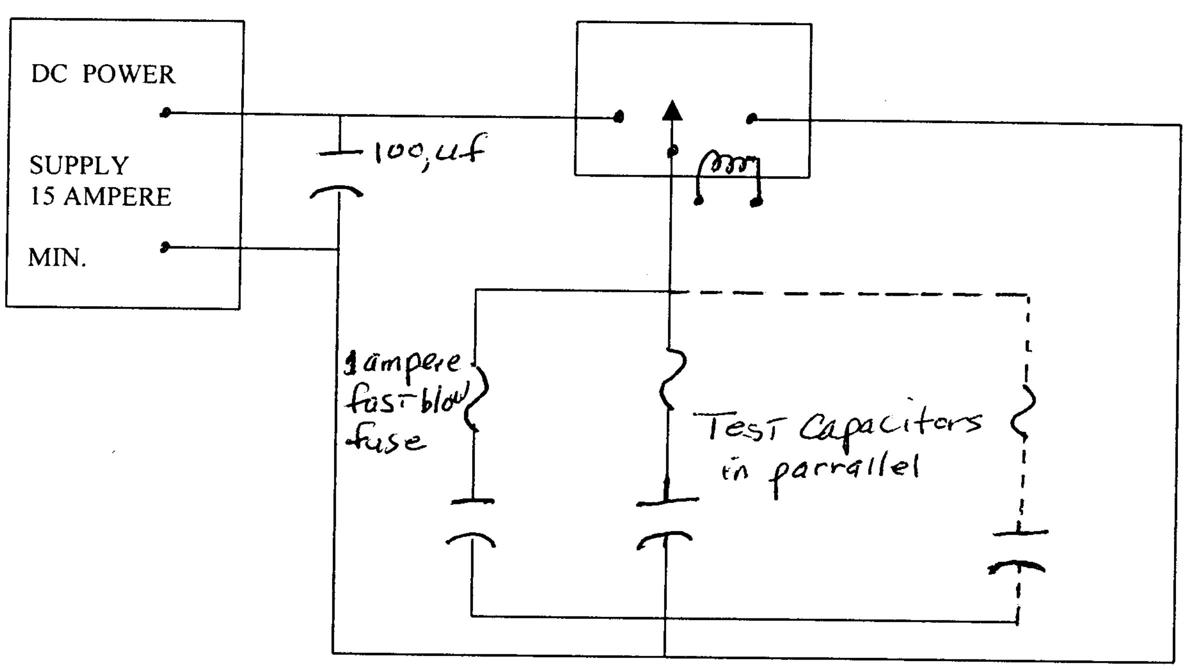
2.5 Repeat "B 2.0" above and record all data for failing and passing parts.

2.6 Passing parts define as control samples.

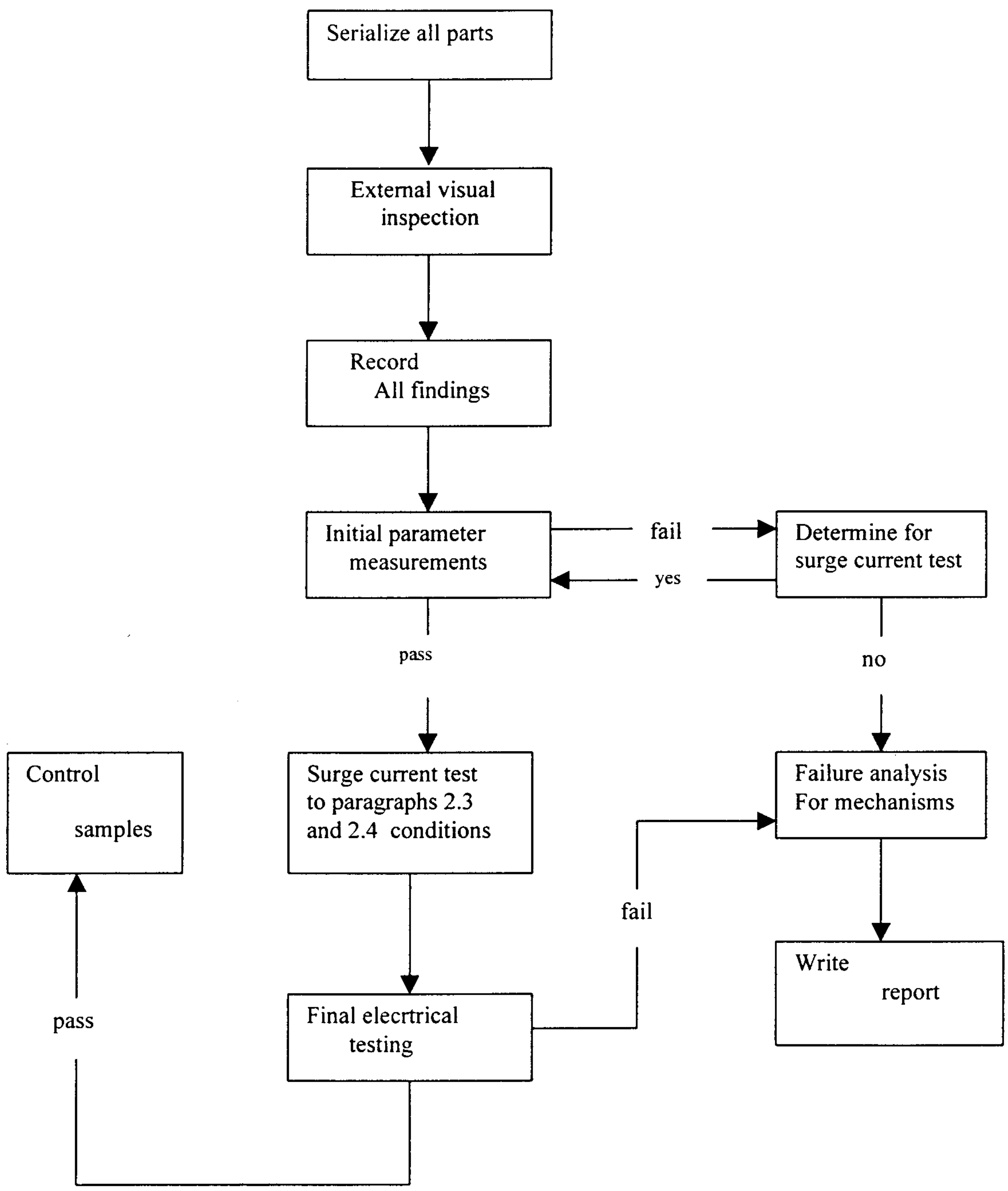
2.7 Failing parts submit to failure analysis along with the failures from paragraph 2.2 above for determining and evaluating the failure mechanisms.

C 3.0 Write report based on findings from the analysis.

30 AMPERE MERCURY RELAY



SURGE CURRENT TEST CIRCUIT



Serialize all parts
External visual inspection
Record All findings
Initial parameter measurements
fail
yes
Determine for surge current test
pass
no
Control samples
Surge current test to paragraphs 2.3 and 2.4 conditions
Failure analysis For mechanisms
fail
Write report
pass
Final elecrtrical testing

FLOW CHART