ENGINEERING PRACTICE STUDY

TITLE: RESISTANCE TO SOLDERING HEAT (RSH) TESTING OF NONLEADED MULTI-LAYER CERAMIC CAPACITORS (MLCCS)

6 SEPTEMBER 2013

PROJECT NUMBER 5910-2013-016

FINAL REPORT

Study conducted by John A. Bonitatibus
Electronics Engineer
Electronics Component Branch
DLA Land and Maritime-VAT

Prepared by:

//Signed//

John A. Bonitatibus
Electronics Engineer
Electronics Components Branch

Approved by:

//Signed//

Michael A. Radecki
Chief
Electronics Components Branch

I. **OBJECTIVE:** This engineering practices study was conducted to determine the appropriate level of resistance to soldering heat (RSH) testing for non-leaded multi-layer ceramic capacitors (MLCCs) in an attempt to achieve consistency of testing between MIL-PRF-55681 and MIL-PRF-123.

II. BACKGROUND: MIL-PRF-55681 and MIL-PRF-123 are currently under review by DLA Land and Maritime. One of the goals of this review is to identify and resolve, if applicable, inconsistencies between these specifications. The RSH requirement for ceramic chip capacitors is one area of inconsistency.

The MIL-PRF-55681 requirement is as follows:

4.8.13 Resistance to soldering heat (see 3.16). Capacitors shall be tested in accordance with method 210 of MIL-STD-202. The following details and exceptions shall apply:

a. Mounting of specimens: The capacitors shall be mounted on a substrate using the methods of 4.8.1~~, with the following exception: The post preheat hot-plate temperature shall be +260°C ±5°C for a duration of 5 seconds ±0.5 second. Tunnel ovens shall not be used to provide the soldering heat, since an observation is recommended during the test~~.
b. Test condition: Leaded capacitors: B
Unleaded capacitors: J, except with only one heat cycle.
c. Measurements after test: After completion of the cleaning process and following a minimum 10-minute to maximum 24-hour cooling period, the capacitance, DF, and IR shall be measured as specified in 4.8.4, 4.8.5, and 4.8.6, respectively.
d. Examination after test: Capacitors shall be examined for evidence of mechanical damage.

The intent of this test is to mount the parts to a substrate (this constitutes one heat cycle) and then expose the parts to one reflow cycle per test condition J.

Note: The latter part of 4.18.13a (shown with strikethrough) is verbiage left over from previous revisions. It will be deleted in the next revision, pending the outcome of this study.

The MIL-PRF-123 requirement is as follows:

4.6.14.2 Resistance to soldering heat (nonleaded capacitors) (see 3.18.2). Capacitors shall be tested in accordance with method 210 of MIL-STD-202. The following details shall apply:

a. Capacitors shall be immersed ~~using procedure 1,~~ two times.
b. Test condition B: Except the solder temperature shall be +230°C, +5°C, -0°C, and the duration shall be 5, +1, -0 seconds.
c. Cooling time prior to measurement after test: 10 minutes minimum and up to 24 hours maximum.
d. Measurements before test: Capacitance, dissipation factor, and insulation resistance at +25°C shall be measured and recorded as specified in 4.6.7, 4.6.8, and 4.6.10, respectively.
e. Examination and measurement after test: Capacitors shall meet the requirements of 3.18.2. Capacitance, dissipation factor, and insulation resistance at +25°C shall be measured and recorded as specified in 4.6.7, 4.6.8, and 4.6.10, respectively.

The intent of this test is to expose to the parts to a hot solder dip process 2 times.

Note: The reference to procedure 1 in 4.6.14.2a (shown with strikethrough) is outdated and will be deleted pending the outcome of this study.

III. RESULTS: Recipients of the study were asked to comment on the following:

Which of the above test do you feel is the more appropriate RSH test for ceramic chip capacitors?

Do you feel that it is beneficial for the RSH requirement to be consistent among the 2 specifications?

All of the respondents feel that consistency among the 2 specifications is important. And, although the results were mixed, the majority of the respondents feel that the RSH test as specified in MIL-PRF-55681 is the more appropriate method for verifying a MLCC's resistance to soldering heat.

IV. CONCLUSIONS: Manufacturers and users of MIL-PRF-123 and MIL-PRF-55681 feel that the RSH test should be consistent among the 2 specifications and that the reflow RSH test as specified in MIL-PRF-55681 is the more appropriate test.

V. RECOMMENDATIONS: Revise MIL-PRF-123 to replace the current solder dip RSH test with the reflow RSH test as specified in MIL-PRF-55681. Also, revise MIL-PRF-55681 to make the needed corrections to the RSH test as described above.