

ENGINEERING PRACTICE STUDY

PROJECT NUMBER: 5961–2016–108

TITLE:

MIL–STD–750–2, TEST METHOD 2038

PROPOSED REVISION TO ADD TEST CONDITIONS TO ADDRESS
CERAMIC BODY SMD PACKAGES AND REFORMAT CONTENT

28 FEBRUARY 2018

FINAL REPORT

STUDY CONDUCTED BY

DLA LAND AND MARITIME
DOCUMENT STANDARDIZATION DIVISION (VA)
ACTIVE DEVICE BRANCH (VAC)

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I. OBJECTIVES: The objective of this Engineering Practice (EP) study was to obtain comments or concurrence from the military services, device manufacturers, laboratories, OEMs, and the user community concerning a proposed revision to test method 2038 of MIL-STD-750-2 to add three new test conditions to evaluate pad mounted ceramic body surface mount device (SMD) packages and update the existing content.

II. BACKGROUND: The current test method 2038 only addresses the testing of SMD packages with end caps. A draft of test method 2038 with new test conditions for testing pad mounted ceramic body SMD packages was submitted to DLA –VAC by an OEM who has a need for testing these devices. After performing a review of the content of the current wording of test method 2038, additional consistency, editorial, and organization issues were noted and were included in the initial draft of the proposed test method revision.

III. RESULTS: Essential and technical comments were received regarding the content of both the new test conditions and the existing test conditions.

IV. CONCLUSIONS: The new test conditions should not be added to test method 2038. The preparing activity believes that these new test conditions need further clarification and development. Both the preparing activity and the OEM who proposed the new conditions believe that these new test conditions should be issued in a new test method that addresses only pad mounted ceramic body SMD packages.

V. RECOMMENDATIONS: Include a revision of test method 2038 which addresses the consistency, editorial, and organization issues in the next revision of MIL-STD-750-2 (see attachment). The preparing activity will organize a test method study group that consist of manufacturers and users to develop a new test method to address the testing of pad mounted ceramic body SMD packages.

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KEY to highlighting:

Text that was added for the initial draft is black text highlighted in yellow. Example: New text that was in the initial draft.

Text that DLA proposes to be added is black text highlighted in green. Example: New text added for the final report.

MIL-STD-750-2A

METHOD 2038.1

SURFACE MOUNT END CAP BOND INTEGRITY

1. Purpose. The purpose of this test method is to simulate stresses imposed on surface mount device (SMD) packages with end caps during installation, operation, removal, and rework.

1.1 Applicability. This test method is intended to be used on SMD packages with end caps. SMD packages with end caps include metal electrode leadless face (MELF and UR), surface mount device with square ends (US), and surface mount device with one round and one square endcap (URS).

1.2 Test classifications. Unless nondestructive limits are specified, all test conditions and end cap attachment stressors in this test method are considered destructive tests.

2. Test conditions. There are four types of stresses covered by this test method. The test condition identifier for each stress are listed below.

Test condition A: Coefficient of thermal expansion (CTE) mismatch.

Test condition B: Tab pull.

Test condition C: Tab shear axis X1, X2.

Test condition D: Tab shear axis Z1, Z2.

3. Definitions. The definitions for all terms used herein shall be as specified in MIL-PRF-19500.

4. General requirements.

4.1 Apparatus. Apparatus used in the SMD package with end caps integrity tests shall include the following:

- a. The apparatus for this test shall consist of suitable fixtures for applying specified stresses that may result in end cap attachment or package failure (see figures 2038-1 and 2038-2).
- b. Equipment used for soldering devices to the PCB test vehicle(s).
- c. Magnifier(s) 10X to 20X.

4.2 Materials. Unless otherwise specified, for test conditions A, C, and D the following materials shall be used when mounting of the SMD packages.

- a. PCB test vehicle constructed of copper clad base material, NEMA grade FR-4 in accordance with ASTM D1867. The following details shall apply: The minimum dielectric thickness shall be .062 inch $\pm$.0075 inch (1.57 mm $\pm$.191 mm) and the starting foil weight of the copper cladding before processing shall be 1-oz/ft².
- b. Flux and solder, as appropriate to mount the SMD device to the copper pads of the PCB test vehicle.

4.3 **Mounting.** Unless otherwise specified in the performance specification sheet or acquisition document, the devices for test conditions A, C and D shall be mounted to a PCB test vehicle in accordance with the following.

4.3.1 **PCB test vehicle.** The device shall be attached to copper pads in the center of a 2 inch x 2 inch (50.8mm X 50.8 mm) square PCB test vehicle. The copper pads shall be of sufficient size to not allow the lifting of the device off of the PCB test vehicle. If double clad base materials are used, the cladding shall be etched to form a cross-hatch pattern on the back side of the PCB test vehicle.

4.3.2 **Device to PCB test vehicle attachment.** End cap attachments for test condition A, B, and test condition D, where there is any soldering, adhesive, or other material used to mount the device may not increase the apparent end cap attachment strength, and be restricted to just the end caps. The process used to attach the device to the PCB test vehicle shall be recorded.

5. Detailed requirements.

5.1 Examination and measurements prior to test.

5.1.1 **Visual criteria.** Prior to testing, the devices shall be inspected at a magnification of 10X. Any occurrence of damage (cracks, fissures or fractures) to the device body, end cap terminals, and body/terminal junction shall be noted and compared with post test visual inspection results.

5.1.2 **End point electrical measurements.** End-point electrical measurements equivalent to group A, subgroup 2 of the applicable specification sheet shall be recorded.

5.2 **Sampling.** Unless otherwise specified, the sample plan specified for the end cap attachment strength test shall determine the minimum sample size in terms of the minimum number of stresses to be accomplished rather than the number of complete devices in the sample. All end cap attachment strength tests shall be counted and the specified sampling, acceptance, and added sample provisions shall be observed.

5.3 **Procedure.** The end cap SMD package integrity test shall be conducted using the test conditions specified (see 6.a). The following details shall apply.

5.3.1 **Condition A – CTE mismatch.** The devices shall be subjected to temperature cycling in accordance with test method 1051 of MIL-STD-750-1 under the following conditions:

- a. **Special mounting:** In accordance with 4.3.
- b. **Number of cycles:** 10 cycles.
- c. **Temperature range:** –40°C to +125°C.
- d. **Dwell time at temperature extremes:** 10 minutes minimum.

5.3.2 **Condition B – tab pull (figure 2038–3).** The device shall be oriented along the Y axis. The fixed end cap shall be mounted so that only itself and no part of the device body is providing aid. The specified force shall be applied without shock to each end cap. Wire may be used as long as it is attached in a manner that will not aid in the force measurement. The devices shall be subjected to the tab pull using the following conditions:

- a. **Time:** 1 minute.
- b. **Force:** As specified in performance specification or acquisition document.

5.3.3 Condition C – tab shear axis X1, X2 (figure 2038-4). A mechanism that can hold the edges of the PCB test vehicle with the device mounted and oriented along the Y axis shall be used. A twisting motion shall be applied in a manner that results in diagonal corners rotating off axis at least .0625 inches (1.5875 mm). Unless otherwise specified (see 6.c), one twisting motion shall be applied to the PCB test vehicle.

5.3.4 Condition D – tab shear axis Z1, Z2 (figure 2038-5). A mechanism that can hold the edges of the PCB test vehicle with the device mounted and oriented along the Y axis shall be used. A flexing motion shall be applied in a manner that results in mounted edges to flex at least .0625 inches (1.5875 mm) off the axis. Unless otherwise specified (see 6.d), one flexing motion shall be applied to the PCB test vehicle.

5.3 Examinations and measurements after test.

5.3.1 Visual criteria. After testing, the devices shall be inspected at a magnification of 10X. Devices exhibiting the following conditions shall be counted as rejects:

- a. Radial cracks – either appearing or have propagated.
- b. Circumferential cracks - either appearing or have propagated.
- c. Brazing – showing fractures or fissures.

5.3.2 End point electrical measurements. Devices exceeding the following shall be counted as rejects.

- a. Failures exceeding 100 percent of initial value.
- b. Failures exceeding specification limit.

6. Notes.

6.1 Summary. The following details should be specified in the applicable performance specification sheet or acquisition document:

- a. Test condition letter.
- b. For test condition B, the force needed.
- c. For test conditions C, the number of twisting motions to apply to the PCB test vehicle if other than 1.
- d. For test conditions D, the number of flexing motions to apply to the PCB test vehicle if other than 1.
- f. Exceptions or additions to the visual inspection criteria.



FIGURE 2038-1. Sample apparatus fixture with force measuring gauge.

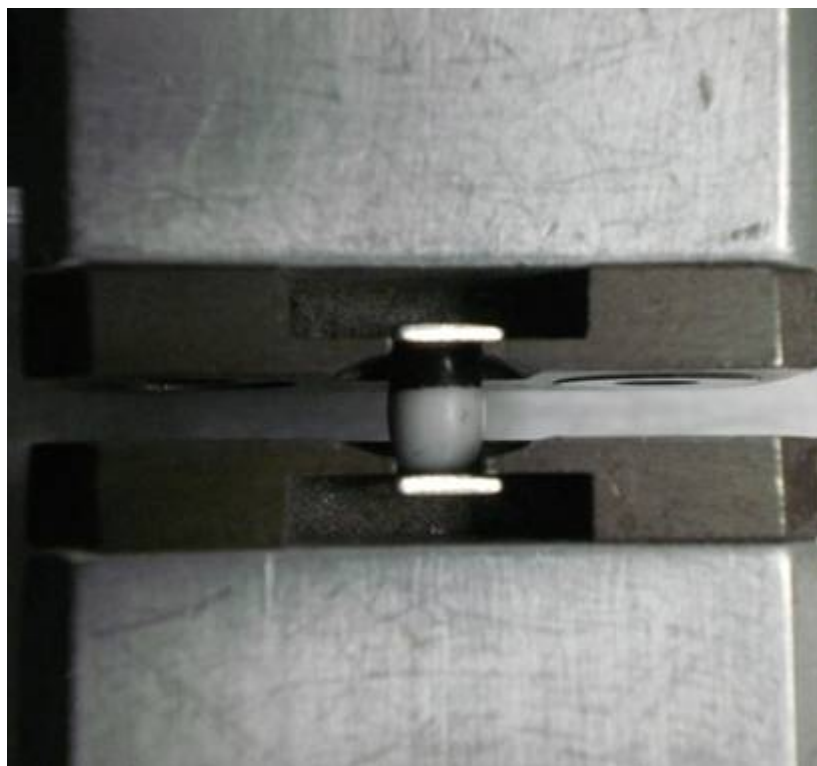


FIGURE 2038-2. Close up view of sample apparatus fixture.

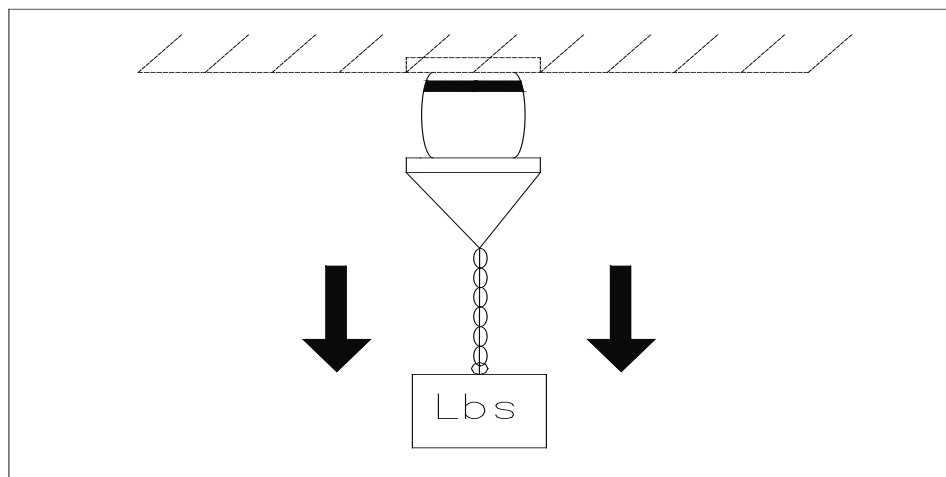


FIGURE 2038-3. Condition B.

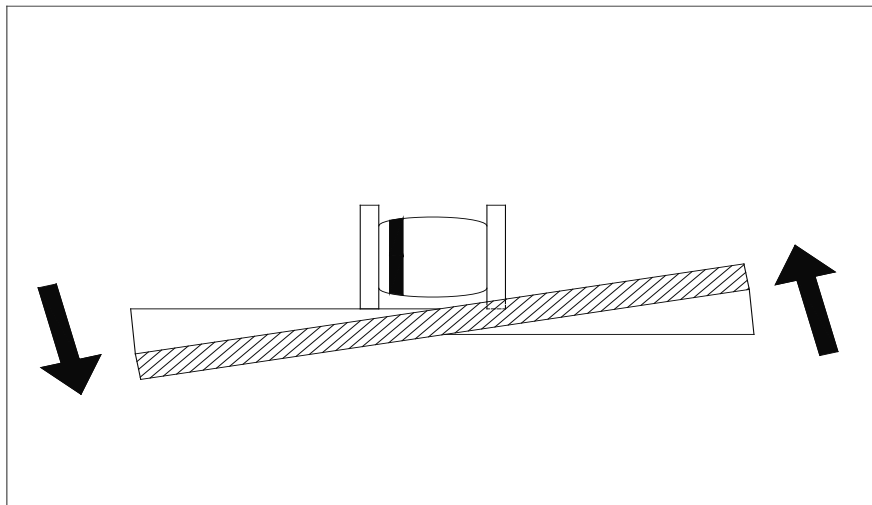


FIGURE 2038–4. Condition C.

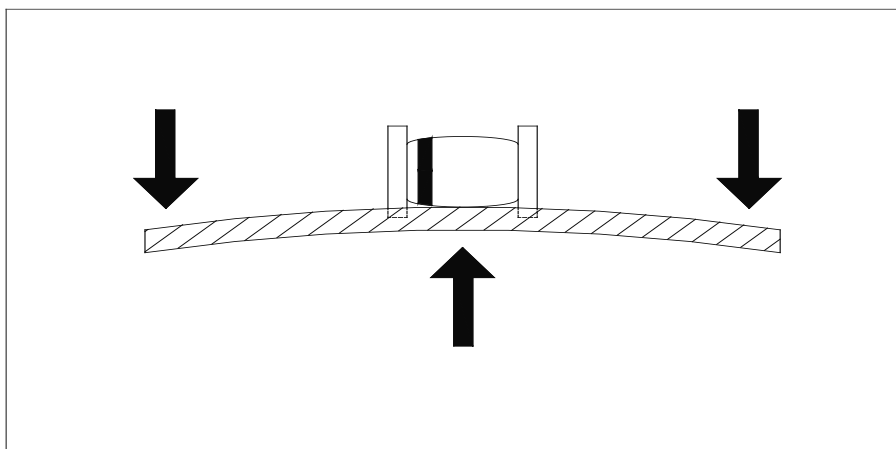


FIGURE 2038–5. Condition D.