

ENGINEERING PRACTICE STUDY

TITLE: TERMINAL STRENGTH TESTING OF NON-LEADED MULTI-LAYER CERAMIC  
CAPACITORS (MLCCs)

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FINAL REPORT

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I. **OBJECTIVE:** This engineering practices study was conducted to determine the appropriate level of terminal strength testing for non-leaded multi-layer ceramic capacitors (MLCCs).

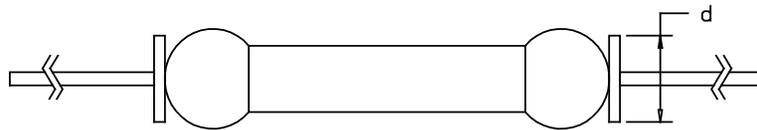
II. **BACKGROUND:** At the February 2012 G11 meeting in Las Vegas, NV, DLA Land and Maritime became aware that there are inconsistencies regarding terminal strength testing among the specifications and drawings covering non-leaded MLCCs. The G11 committee assigned a task (12-102) to investigate these inconsistencies and determine a resolution.

MIL-PRF-123D W/AMD 2 requires the following terminal strength testing for non-leaded MLCCs as part of the qualification and periodic group C inspections:

3.16 *Terminal strength.* When capacitors are tested as specified in 4.6.12, there shall be no loosening or rupturing of the terminals.

4.6.12.2 *Terminal strength (nonleaded capacitors) (see 3.16).* Capacitors shall be tested in accordance with *method 211 of MIL-STD-202.* The following details and exceptions shall apply:

- a. *Test condition A (pull test):*
  - (1) *Capacitors shall have nail head, lead wire (.020 inch to .025 inch) (.51 mm to .64 mm) attached as shown on figure 5, prior to pull test.*
  - (2) *Method of holding: Capacitors shall be held by one terminal and the load shall be applied gradually to the other terminal.*
  - (3) *Applied force: See figure 5.*
- b. *Examination after test: Capacitors shall be visually examined for evidence of loosening or rupturing of the terminals. Breakage of lead wire or solder interface, which does not expose ceramic, shall not constitute a failure.*



Style	Nail head diameter, <i>d</i> (inches)	Applied force	Inches	mm
			.005	0.13
CKS51	.040 ±.005	1 Kg ± .1	.040	1.02
CKS52	.040 ±.005	1 Kg ± .1	.045	1.14
CKS53	.040 ±.005	2 Kg ± .2		
CKS54	.040 ±.005	2 Kg ± .2		

FIGURE 5. *Lead attachment for chip pull test.*

All other specifications and drawings covering non-leaded MLCCs require no terminal strength testing. Applicable documents include: MIL-PRF-55681 and DLA Land and Maritime drawings 89089, 91019, 94006, 03028, 03029, 05001, 05002, 05003, 05006, 05007, 06019, 06022, and 09023-09027.

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

Have you experienced terminal strength related field failures on MLCCs?

Do you feel that the addition of a periodic terminal strength test in all applicable MLCC specifications would be a benefit? If so, is the requirement in [MIL-PRF-123](#) sufficient, or would another method be more appropriate?

None of the respondents had experienced terminal strength related field failures on MLCCs; however, most agreed that consistency of testing among the specs is important and the current test in [MIL-PRF-123](#) may not be representative of typical application stresses on surface mounted devices.

A manufacturer proposed the terminal strength test currently cited in [MIL-PRF-123](#) be deleted and replaced with a board flexure test. This proposal was discussed with the G11 committee at the October meeting in Columbus, OH. It was agreed that a board flexure test as well as a shear stress test would be more appropriate for verifying the terminal strength on MLCCs than the current pull test.

**IV. CONCLUSIONS:** The current pull test in [MIL-PRF-123](#) is not an appropriate test to verify terminal strength on MLCCs. A board flexure test and shear stress test would better simulate surface mount technology and typical application stresses.

**V. RECOMMENDATIONS:** Revise [MIL-PRF-123](#) to replace the pull test with a board flexure test and a shear stress test. Also, revise [MIL-PRF-55681](#) to add terminal strength testing consistent with [MIL-PRF-123](#).