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Test Guidelines for Acoustic Emission Measurement during Mechanical Testing

Developed by the 6-10d SMT Attachment Reliability Test Methods Task Group of the Product Reliability committee (6-10) of IPC

Users of this publication are encouraged to participate in the development of future revisions.

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Table of Contents

1 SCOPE	1	5.3 Calibration	4
1.1 Purpose	1	5.3.1 PLB Test, Effective Velocity, and Location Accuracy ..	4
1.2 Background	1	5.4 Basics on Linear and Planar Location	4
1.3 Performance Classification	1	5.5 Critical Metrics and Thresholds	5
1.4 Definition of Terms	1	6 MEASUREMENT ACCURACY AND EXPECTATIONS ..	5
1.4.1 Acoustic Emission (AE)	1	7 ANALYSIS AND REPORTING	6
1.4.2 Acoustic Emission Count	1	7.1 Correlation with Strain Value or Other Parameters ..	6
1.4.3 Acoustic Emission Signal	1	7.2 Analysis and Reporting	6
1.4.4 Average Signal Level	1	8 REFERENCES	6
1.4.5 Channel	1		
1.4.6 Couplant	1	Appendix A Typical Acoustic Instrumentation Output in a Four Point Bend Test	7
1.4.7 Effective Velocity	1	Appendix B Pencil Lead Break Test and the Accuracies associated with Source Location	8
1.4.8 Energy, Acoustic Emission Signal	1		
1.4.9 Evaluation Threshold	1		
1.4.10 Event (Emission event)	1		
1.4.11 Hit	1		
1.4.12 Location Accuracy	2		
1.4.13 Location, Computed	2		
1.4.14 Peak Amplitude	2		
1.4.15 Pencil Lead Break (PLB)	2		
1.4.16 Sensor	2		
1.4.17 Signature	2		
1.4.18 Absolute Energy	2		
2 APPLICABLE DOCUMENTS	2		
2.1 IPC (Normative)	2		
2.2 ASTM (Informative)	2		
2.3 ASNT (Informative)	2		
3 SAMPLE SIZE	2		
4 APPARATUS AND SETUP	2		
4.1 Data Acquisition Equipment	2		
5 TEST VEHICLES	3		
5.1 Sensor Layout	3		
5.2 Sensor Mounting	4		

Figures

Figure 5-1 Four Point Bend Set-up Schematic with Two AE Sensors to Locate Acoustic Emission Event using Linear Location Algorithm	3
Figure 5-2 Four Point Bending Set-up Schematic with Four AE Sensors to locate Acoustic Emission Event using Planar Location Algorithm	3
Figure 5-3 Spherical Bending Set-up Schematic with Four Sensor to locate An Acoustic Event using Planar Interpolation	4
Figure 5-4 Schematic of Bend Test Set-up	5
Figure A-1 Showing Typical Outputs for a Four Point Bend Test	7
Figure B-1 Example of Linear Source Location using PLB test; Linear Maximum Inaccuracies of 3.0 mm achieved in Testing	8
Figure B-2 Example of Spatial Source Location using PLB test; Spatial Inaccuracies of 5.0 mm achieved in Testing	8

Tables

Table 5-1 Velocity Measurement Range and other Parameters Observed through Various Four Point Bend Tests ..	4
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Test Guidelines for Acoustic Emission Measurement during Mechanical Testing

1 SCOPE

This guideline document establishes an Acoustic Emission (AE) method to evaluate the performance and reliability of surface mount attachments of electronic assemblies during mechanical loading. Mechanical loading may include stressors such as four-point bend test, spherical bend test, or back-end manufacturing steps post surface mount attachment. The initial focus for this test method is to identify the printed board pad cratering mechanism and printed board material performance. This approach may eventually be extended to examine other failure modes depending on the guideline's evolution and adoption, as this methodology remains in development.

1.1 Purpose

The purpose of this document includes:

- Identification of failure initiation time: this period may precede electrical detection of failures such as pad cratering damage during a mechanical stress test.
- Identification of the failure initiation location through detection of AE signals generated due to stress-induced physical damage.
- Estimation of the strain at which the acoustic failure event is observed, which can be utilized as a design guideline.
- Provision of standardized test guidelines and reporting procedures.

1.2 Background Pad cratering typically initiates prior to detection by existing electrical monitoring test methods. There are limited instrumentation techniques that are currently available that can identify non-electrical damage and its location to a high degree of accuracy. Alternative methodologies often require large sample sizes to estimate these virtually undetectable failure modes.

1.3 Performance Classification The specific reliability requirements need to be established by agreement between customer and supplier.

1.4 Definition of Terms The definition of all terms used herein **shall** be as specified in IPC-T-50, ASTM E1316, and as defined below.

1.4.1 Acoustic Emission (AE) The class of phenomena whereby transient stress/displacement waves are generated by the rapid release of acoustic energy from localized sources within a material, or the transient waves so generated.

1.4.2 Acoustic Emission Count The number of times the acoustic emission signal exceeds a preset threshold during any selected portion of a test.

1.4.3 Acoustic Emission Signal An electrical signal obtained by detection of one or more acoustic emission events.

1.4.4 Average Signal Level The rectified, time averaged AE logarithmic signal, measured on the AE amplitude logarithmic scale and reported in dB_{AE} units (where 0 dB_{AE} refers to 1 μV at the preamplifier input).

1.4.5 Channel An assembly of a sensor, preamplifier or impedance matching transformer, filters secondary amplifier or other instrumentation as needed, connecting cables, and detector or processor.

1.4.6 Couplant A material used at the structure-to-sensor interface to improve the transmission of acoustic energy across the interface during acoustic emission monitoring.

1.4.7 Effective Velocity Velocity calculated on the basis of arrival times and propagation distances determined by artificial AE generation. This quantity is used for computing the location of the AE.

1.4.8 Energy, Acoustic Emission Signal The energy contained in an acoustic emission signal, which is evaluated as the integral of the volt-squared function over time.

1.4.9 Evaluation Threshold A threshold value used for analysis of the examination data. Data may be recorded with a system examination threshold lower than the evaluation threshold.

1.4.10 Event (Emission event) An occurrence of a local material change or mechanical action resulting in acoustic emission.

1.4.11 Hit The detection and measurement of an AE signal on a channel.