# IPC-9709A

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# Guidelines for Acoustic Emission Measurement Method During Mechanical Testing

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- Focus on end product performance
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# Guidelines for Acoustic Emission Measurement during Mechanical Testing

Developed by the members of the SMT Attachment Reliability Test Methods Task Group (6-10d) of the IPC 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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# Guidelines for Acoustic Emission Measurement Method During Mechanical Testing

## 1.0 SCOPE

This guideline document establishes an Acoustic Emission (AE) method to enhance evaluation of 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, back-end manufacturing and test steps post surface mount attachment and drop/shock test. The current focus for this measurement 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 method remains in development.

**1.1 Purpose** The purpose of this document includes:

- Detection of crack/mechanical damage initiation: initial damage from strain may precede electrical detection of failures such as pad cratering damage during a mechanical stress test.
- Identification of the failure initiation location and propagation through detection of AE signals generated due to stress-induced physical damage.
- Estimation of the strain at which the mechanical failure event is observed acoustically, which can be used 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.

**1.4.12 Location Accuracy** A value determined by comparison of the actual position of an AE source (or simulated AE source) to the computed location.