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Guidelines for Acoustic Emission Measurement Method During Mechanical Testing

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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.

Contact:

IPC
3000 Lakeside Drive, Suite 309S
Bannockburn, Illinois
60015-1219
Tel 847 615.7100
Fax 847 615.7105

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Product Reliability Committee

Chair

Julie Silk

Keysight Technologies

Vice Chair

Vasu Vasudevan

Dell Corporation

SMT Attachment Reliability Test Methods Task Group

Chair

Reza Ghaffarian, Ph.D.

Jet Propulsion Laboratory

Vice Chair

Vasu Vasudevan

Dell Corporation

Technical Liaisons of the IPC Board of Directors SMT Attachment Reliability Test Methods Task Group

Mudasir Ahmad

Cisco Systems Inc

Aileen Allen

Hewlett-Packard Inc.

Dudi Amir

Intel Corporation

Martin K. Anselm

Rochester Institute of Technology

Michael Azarian

University of Maryland

Elizabeth Elias Benedetto

Hewlett-Packard Inc.

Nicole Butel

Broadcom Limited

William P. Cardinal

UTC Aerospace Systems

Beverly Christian

HDP User Group

Jean-Paul Clech

EPSI

Gino Cochella

Northrop Grumman Aerospace Systems

Richard J. Coyle

Nokia

William C. Dieffenbacher

BAE Systems

Harold O. Ellison

Quantum Corporation

Gerd Fischer

NASA Goddard Space Flight Center

Dennis D. Fritz

SAIC

Enrico Galbiati

SEM Communication & GESTLABS Srl

Phil Geng

Intel Corporation

Reza Ghaffarian

Jet Propulsion Laboratory

Cynthia A. Gomez

Continental Temic SA de CV

Allen Green

Acoustic Technology Group

Bill Hargin

Nan Ya Plastics Corporation

Kayleen Helms

Intel Corporation

Gaston Hidalgo

Toyota Motor North America

David Hillman

Collins Aerospace

Ife Hsu

Intel Corporation

Christopher Hunt

Pireta

Jeffrey ChangBing Lee

iST Integrated Service Technology

Anna Lifton

Alpha Assembly Solutions

Rene R. Martinez

Northrop Grumman Aerospace Systems

Daniel McCormick Naval Surface Warfare Center	Gnyaneshwar Ramakrishna Cisco Systems Inc.	Taylor J. Swanson Rochester Institute of Technology
Steve Minich Amphenol InterCon Systems	Edda Rivera Gables Engineering, Inc.	John Paul Thompson FCI USA, Inc.
Jim Mulvey Lockheed Martin Corporation	Jose A. Sanchez Gables Engineering, Inc.	Kristen K. Troxel Hewlett-Packard Inc.
David R. Nelson Raytheon Company	Martin Scionti Raytheon Missile Systems	Vasu S. Vasudevan Dell Inc.
Keith G. Newman AMD	Jose Ma Servin-Olivares Continental Temic SA de CV	Milena Vujosevic Intel Corporation
Clarence Nichols Gables Engineering, Inc.	Russell S. Shepherd NTS Anaheim	Michael Wolverton Raytheon Systems Company
David Oris Gables Engineering, Inc	Julie Silk Keysight Technologies	Fonda B. Wu Raytheon Company
Chandradip Patel Schlumberger Well Services	Bhanu Sood NASA Goddard Space Flight Center	Andy Zhang Texas Instruments
Jagadeesh Radhakrishnan Intel Corporation	Jorge Suarez Gables Engineering, Inc.	

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Julie Silk Keysight Technologies	Nicole Butel Broadcom	Keith Newman AMD
Elizabeth Benedetto HP	Mahdi Farahikia SUNY New Paltz	Jagadeesh Radhakrishnan Intel
	Greg Morsher University of Akron	Carter Ralph Southern Research Institute

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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 $1 \mu\text{V}$ 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.