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Printed Circuit Assembly Strain Gage Test Guideline

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Printed Circuit Assembly Strain Gage Test Guideline

Developed by the JEDEC Reliability Test Methods for Packaged Devices Committee (JC-14.1) and the SMT Attachment Reliability Test Methods Task Group (6-10d) of the Product Reliability Committee (6-10) of IPC

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

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Printed Circuit Assembly Strain Gage Test Guideline

1 SCOPE

This document is meant to be used as a methodology for strain gage placement and subsequent testing of Printed Circuit Assemblies (PCAs) using strain gages. The method describes specific guidelines for strain gage testing of PCAs during the printed board manufacturing process, including assembly, test, system integration, and other types of operations that may induce board flexure.

The suggested procedure enables printed board assemblers to conduct strain gage testing independently, and provides a quantitative method for measuring board flexure, and assessing risk levels.

The topics covered include:

- Test setup and equipment requirements
- Strain measurement
- Report format

This document assumes the methodology is being used to test a surface mount device such as Ball Grid Array (BGA), Small Outline Package (SOP), Chip Scale (Size) Package (CSP), and area-array surface mount (SMT) connectors/sockets. In certain cases, the described test approach may be used for non-area-array discrete SMT devices such as capacitors or resistors.

1.1 Purpose Strain gage testing allows objective analysis of the strain and strain rate levels to which a surface mount component may be subjected during PCA assembly, test, and operation.

Characterization of worst-case PCA strain is critical due to the susceptibility of component interconnects to strain-induced failures. Excessive strain can result in various failure modes for different solder alloys, package types, surface finishes, or laminate materials. Such failures include solder ball cracking, trace damage, laminate related adhesive failure (pad lifting) or cohesive failure (pad cratering) and package substrate cracking (see Figure 1-1).

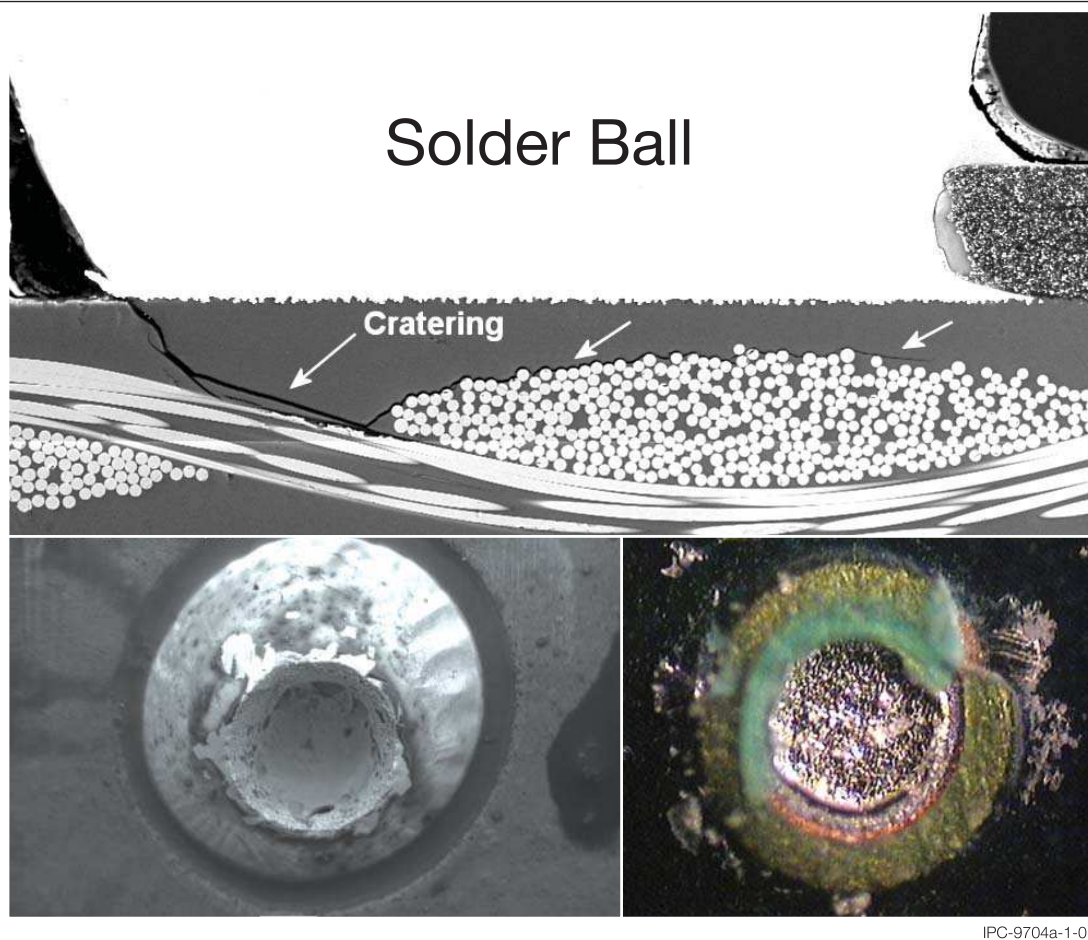
1.2 Background Board flexure control using strain gage measurement has proven beneficial to the electronics industry, and continues to gain acceptance as a method to identify and improve manufacturing operations that can pose a high risk for interconnect damage. However, with the rapid transition to lead-free assembly technology, increased interconnect densities, and new laminate materials, the potential for flexure-induced damage has increased. Many board assemblers are now required to operate under strain levels specified by their customers or component suppliers.

As strain measurement technology has matured, different methodologies have developed. Variations in strain gage methodology inhibit reliable data collection and prevent data comparison across the industry. This document provides a standardized set of guidelines to address variations in gage mounting, gage placement, experiment design, data acquisition system variables, and strain metrics.

PCA strain measurement includes application of strain gages to the printed board near specified components, followed by subjecting the instrumented board to various test, assembly, and handling operations. Steps which exceed strain limits are deemed excessive and are identified so that corrective actions can be made. Strain limits may come from the customer, component supplier or internal best known practices. Examples of strain measurement criteria are shown in the www.ipc.org/IPC-WP-011 white paper.

By identifying areas sensitive to manufacturing variation, strain gage testing provides insight into the effects of a production ramp. Strain gage measurements become the baseline for future process improvement activities, and quantify the effectiveness of adjustments. Manufacturing steps that are typically characterized are listed below:

1. SMT assembly process:
 - Printed board depanelization processes
 - All manual handling processes
 - All rework and retouch processes
 - Connector installation
 - Component installation



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Figure 1-1 Examples of Solder Joint Damage (top: pad cratering, bottom left: bulk solder joint failure, bottom right: solder interfacial fracture)

2. Printed board test processes:
 - In-Circuit Test (ICT), or equivalent “shorts and opens” type test
 - Board Functional Test (BFT), or equivalent functional test
3. Mechanical assembly:
 - Heat sink assembly
 - Printed board support/stiffener assembly
 - System board integration, or system assembly
 - Peripheral Component Interconnect (PCI) or daughter card installation
 - Dual In-line Memory Module (DIMM) installation
4. Shipping and Handling

Assembly processes for different printed boards and assemblers vary. Tests such as ICT and BFT are referred to generically in this document; nomenclature can vary at different manufacturing sites. In such cases, apply the same requirements to the equivalent test processes. However, the goal is to characterize all assembly steps involving mechanical loading. Do not constrain testing to the steps listed above, or only to perceived high risk areas. The data from these tests can serve as a base-line for future reference.