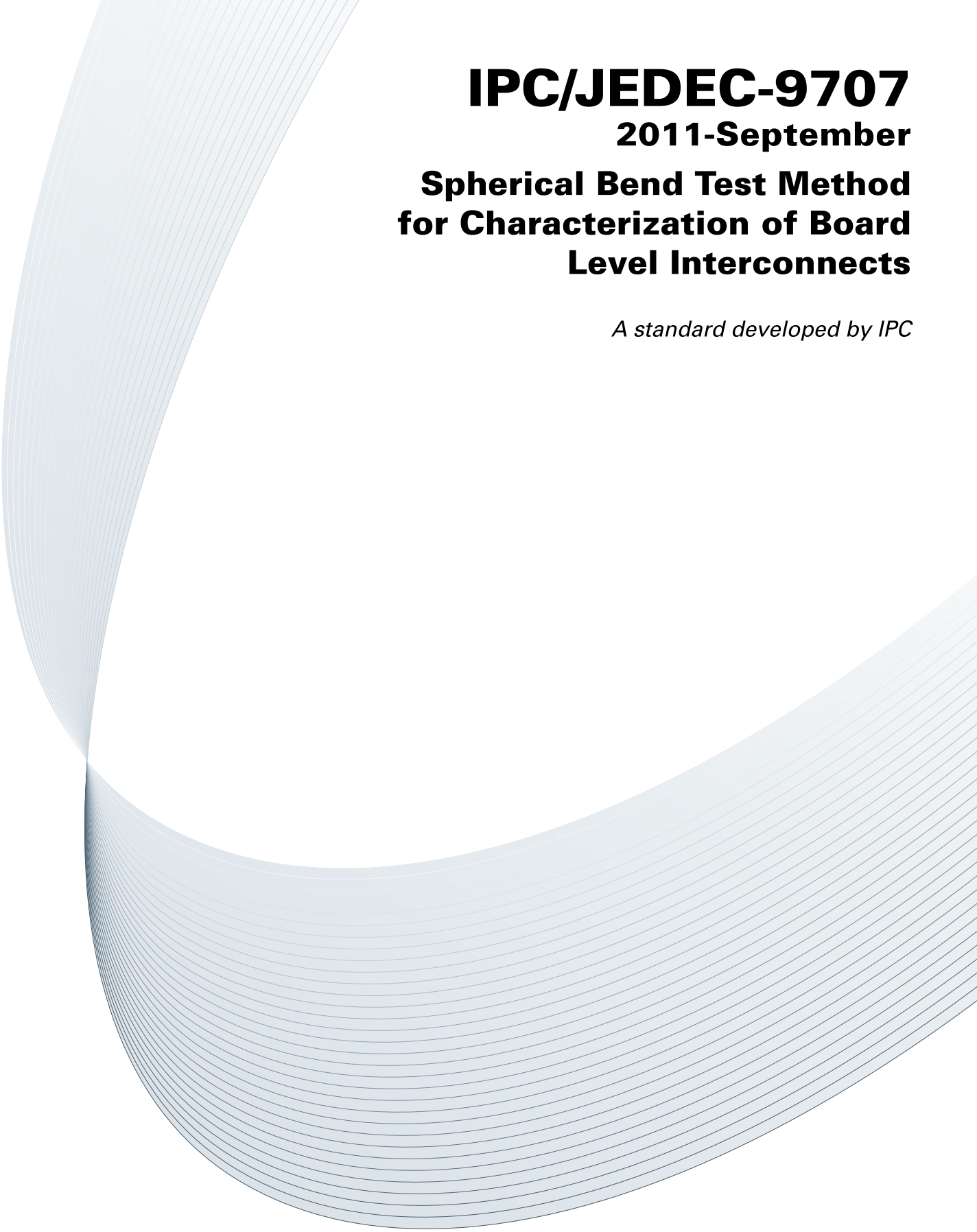




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Spherical Bend Test Method for Characterization of Board Level Interconnects

A standard developed by IPC

Association Connecting Electronics Industries



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Spherical Bend Test Method for Characterization of Board Level Interconnects

Developed by the SMT Attachment Reliability Test Methods Task
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Users of this publication are encouraged to participate in the
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Spherical Bend Test Method for Characterization of Board Level Interconnects

FOREWORD

This standard on spherical transient bend testing is intended to characterize the maximum allowable strain that a surface mount component's board level interconnects can withstand in flexural loading. This standard supplements existing standards that address mechanical shock or impact during shipping, handling, or field operation (including IPC/JEDEC-9702, a monotonic bend test method that cannot characterize maximum strain levels as described in this standard).

INTRODUCTION

Semiconductor devices are assembled in a variety of package configurations and are used in a multitude of applications. Given the diversity of package and printed board layouts, as well as end-use conditions, it is not feasible to establish a single strain limit requirement related to spherical transient bend testing for all package sets and printed board configurations. However, a maximum allowable strain limit specific to a particular Printed Circuit Assembly (PCA) may be established using the method discussed in this standard. In addition, non-experimental analysis techniques, such as finite element simulation, may also be used in conjunction with testing to define strain limits for an expanded envelope of printed board and package attributes.

A four-point monotonic bend test methodology is detailed in IPC/JEDEC-9702; this methodology enables the characterization of the fracture strength due to flexural loading of a surface mount component's board level interconnects. The four-point bend test method only addresses simple planar bending and may not reflect more complex and damaging bend modes that a PCA undergoes in the manufacturing and assembly process. This standard establishes a spherical bend test method that envelopes maximum strain levels for manufacturing, assembly, and handling flexure events, enabling the determination of maximum strain levels to be used as guidance during those events.

1 SCOPE

This standard specifies a common method of establishing strain limits of board-level device interconnects under spherical bending conditions, the worst-case flexure condition that can occur during conventional printed board/system assembly, manufacturing, and test operations. This method is applicable to surface mounted Ball Grid Array (BGA) components larger than 15.0 mm on a side with organically based substrates, attached to printed boards using conventional solder reflow technologies. While it is possible to test alternate or smaller packages, some of the tests may need to be modified. Spherical bend test pass/fail requirements are typically specific to each device application and are outside the scope of this document. Applicability of this test method and its associated parameters should be based on expected manufacturing conditions.

2 APPLICABLE DOCUMENTS

The following normative documents contain provisions that, through reference in this text, constitute provisions of this standard. The latest edition of each normative document applies.

2.1 IPC¹

IPC-T-50 Terms and Definitions for Interconnecting and Packaging Electronic Circuits

IPC 9701 Performance Test Methods and Qualification Requirements for Surface Mount Solder Attachments

IPC/JEDEC-9702 Monotonic Bend Characterization of Board-Level Interconnects

IPC/JEDEC-9703 Mechanical Shock Test Guidelines for Solder Joint Reliability

IPC/JEDEC-9704 Printed Wiring Board Strain Gage Test Guideline

IPC-7093 Design and Assembly Process Implementation for Bottom Termination Components

IPC-TM-650 Test Methods Manual²

2.1.1 Microsectioning, Manual Method

1. www.ipc.org

2. IPC Test Methods are available on the IPC website (www.ipc.org/html/testmethods.htm)

3 TERMS AND DEFINITIONS

The definition of all terms used herein **shall** be as specified in IPC-T-50, except as otherwise specified in 3.1 through 3.3.

3.1 Terms Related to Strain and Strain Gages

3.1.1 BGA Peak Strain: The first diagonal strain peak measured on a BGA package corner.

3.1.2 Diagonal Strain (ϵ_d): The directional strain aligned with the e_2 of the strain gage or orthogonal to this direction, whichever is greater:

$$\epsilon_d = \text{Max} (|e_2|, |e_1 + e_3 - e_2|),$$

where e_1 , e_2 , and e_3 are defined in IPC/JEDEC-9704.

3.1.3 Inflection Strain: The printed board strain measured concurrently with the earliest BGA peak strain.

3.1.4 Microstrain ($\mu\epsilon$): A dimensionless unit, defined as 106 times the change in length divided by the original length, where both are expressed in the same units.

3.1.5 Principal Strain ($\mu\epsilon$): The maximum and minimum normal strains in a plane, always perpendicular to each other and oriented in directions for which the shear strains are zero.

3.1.6 Stacked Strain Gage Rosette: A triaxial strain gage rosette with the strain gage elements typically stacked concentrically, and radially oriented at 0°, 45°, and 90°.

3.1.7 Strain (ϵ): A dimensionless unit defined as the change in length divided by the original length, where both are expressed in the same units.

3.1.8 Strain Rate (ϵ'): The change in strain divided by the time interval during which this change is measured.

3.1.9 Strain Gage: A planar metallic foil pattern that is adhered to an underlying surface and exhibits a change in resistance when subjected to a strain.

3.1.10 Strain Gage Element: The sensing area of a strain gage defined by its serpentine metallic grid pattern.

3.1.11 Strain Limit: The maximum strain (diagonal or principal) a test vehicle can withstand without solder-joint damage.

3.1.12 Triaxial Strain Gage: A strain gage incorporating three strain gage elements, capable of detecting strain along three axes in a plane.

3.2 Terms Related to Mechanical Tests

3.2.1 Load Pin: A pin that applies load at the backside of the test vehicle, inducing board deformation.

3.2.2 Support Pin: One of several reaction pins along a circle that are concentric to the BGA component and support the test vehicle when the load pin applies force.

3.2.3 Spherical Span: The diameter of the circle formed by the support pins.

3.2.4 Transient Bend: The mechanical flexure induced during a dynamic event.

3.2.5 Universal Tester: A piece of test equipment capable of tensile or compressive loading using controlled linear motion of a crosshead assembly.

3.3 Terms Related to Electrical Test

3.3.1 Daisy Chain: A conductive path created by alternately connecting package and printed board conductive links in series, which together form a continuous electrical net.

3.3.2 In-situ Measurement: A measurement conducted during a test, i.e., in place, rather than during an interruption of the test condition.

4 SAMPLE SIZE

A statistically relevant sample size, which will depend on failure distribution, desired sensitivity, confidence limits, etc., is required. It is recommended that several manufacturing lots be sampled to evaluate lot-to-lot variability.