



IPC/JEDEC-9702-WAM1 with Amendment 1



# Monotonic Bend Characterization of Board-Level Interconnects

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

Supersedes:  
IPC/JEDEC-9702 -  
June 2004

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

Contact:

**IPC**  
3000 Lakeside Drive, Suite 105N  
Bannockburn, Illinois  
60015-1249  
Tel 847 615.7100  
Fax 847 615.7105

**JEDEC**  
**Solid State Technology Association**  
3103 North 10th Street, Suite 240-S  
Arlington, VA 22201-2107  
Tel 703 907.7559  
Fax 703 907.7501

## Table of Contents

|  |   |  |    |
|--|---|--|----|
| <b>1 FOREWORD</b> .....                              | 1 | <b>ANNEX A</b> .....   | 10 |
| <b>2 INTRODUCTION</b> .....                          | 1 | <b>ANNEX B</b> .....   | 13 |
| <b>3 SCOPE</b> .....                                 | 1 |  |    |
| <b>4 TERMS AND DEFINITIONS</b> .....                 | 1 |  |    |
| <b>5 SYMBOLS AND ABBREVIATED TERMS</b> .....         | 2 |  |    |
| <b>6 SAMPLING</b> .....                              | 2 |  |    |
| <b>7 APPARATUS</b> .....                             | 3 |  |    |
| 7.1 Universal Tester .....                           | 3 |  |    |
| 7.2 Strain Measurement Equipment .....               | 4 |  |    |
| 7.3 Continuity Monitoring Equipment .....            | 4 |  |    |
| <b>8 PROCEDURE</b> .....                             | 4 |  |    |
| 8.1 Component Sample .....                           | 4 |  |    |
| 8.2 Test Board Material .....                        | 4 |  |    |
| 8.3 Test Board Thickness and Metal Layer Count ..... | 4 |  |    |
| 8.4 Test Board Surface Finish .....                  | 5 |  |    |
| 8.5 Test Board Land Pads .....                       | 5 |  |    |
| 8.6 Test Board Layout .....                          | 5 |  |    |
| 8.7 Test Board Daisy-Chain Links .....               | 5 |  |    |
| 8.8 Board Assembly .....                             | 6 |  |    |
| 8.9 Storage .....                                    | 7 |  |    |
| 8.10 Strain Gages .....                              | 7 |  |    |
| 8.11 Set-Up Test Board .....                         | 8 |  |    |
| 8.12 Four-Point Bend Test .....                      | 8 |  |    |
| <b>9 FAILURE CRITERIA AND ANALYSIS</b> .....         | 9 |  |    |
|  |   | <b>Figures</b>   |    |
|  |   | Figure 7-1 Universal Tester .....  | 3  |
|  |   | Figure 8-1 Test Board Layout .....                                       | 5  |
|  |   | Figure 8-2 Rectangular Package Orientation .....                         | 6  |
|  |   | Figure 8-3 Single Package Daisy-Chain Configuration (Example) .....      | 7  |
|  |   | Figure 8-4 Strain Gage Placement .....                                   | 8  |
|  |   | Figure 9-1 Interconnect Fracture Modes (Solder Ball Array Devices) ..... | 9  |
|  |   | Figure A.1 Example Configuration (PWB Thickness = 1.00 mm) .....         | 10 |
|  |   | Figure A.2 Example Configuration (PWB Thickness = 1.25 mm) .....         | 11 |
|  |   | Figure A.3 Example Configuration (PWB Thickness = 0.35 mm) .....         | 12 |
|  |   | <b>Tables</b>  |    |
|  |   | Table 7-1 Universal Tester Requirements .....                            | 3  |
|  |   | Table 8-1 Recommended Test Board Thickness & Layer Count .....           | 5  |
|  |   | Table 8-2 Test Board Layout Requirements .....                           | 6  |
|  |   | Table 8-3 Monotonic Bend Test Requirements .....                         | 8  |
|  |   | Table B.1 Test Report Recommendations (Equipment & Materials) .....      | 13 |
|  |   | Table B.2 Test Report Recommendations (Board Assembly) .....             | 13 |
|  |   | Table B.3 Test Report Recommendations (Test Results) .....               | 13 |

# Monotonic Bend Characterization of Board-Level Interconnects

## 1 FOREWORD

This publication on monotonic bend testing is intended to characterize the fracture strength of a component's board-level interconnects. The document is applicable to surface mount components attached to printed wiring boards using conventional solder reflow technologies. The monotonic bend characterization results provide a measure of fracture resistance to flexural loading that may occur during conventional non-cyclic board assembly and test operations, and supplements existing standards that address mechanical shock or impact during shipping, handling or field operation.

## 2 INTRODUCTION

Semiconductor devices are assembled in a variety of package configurations, and are used in a multitude of applications. Given the diversity of package constructions and end-use conditions, it is not feasible to establish a single qualification requirement relating to bend testing; however, definition of a uniform test methodology and a standard reliability characterization reporting process are increasingly necessary to ensure adequate product quality.

## 3 SCOPE

This publication specifies a common method of establishing the fracture resistance of board-level device interconnects to flexural loading during non-cyclic board assembly and test operations. Monotonic bend test qualification pass/fail requirements are typically specific to each device application and are *outside* the scope of this document.

## 4 TERMS AND DEFINITIONS

For the purposes of this standard, the selected terms and definitions listed below apply.

### General Terms

**Component:** Packaged semiconductor device

**Interconnect:** Conductive element used for electrical interconnection, e.g., solder ball, lead, etc.

**Monotonic Test:** Non-reversing, test to fail

### Strain Related Terms

**Global PWB Strain:** Four-point bending strain of uniform printed wiring board, ignoring any effects due to the package(s)

**Microstrain:** Dimensionless unit,  $10^6 \times (\text{change in length}) \div (\text{original length})$

**Strain:** Dimensionless unit,  $(\text{change in length}) \div (\text{original length})$

**Strain-Rate:** Change in strain divided by the time interval during which this change is measured

**Strain Gage:** Planar copper foil pattern that is adhered to an underlying surface and exhibits a change in resistance when subjected to a strain

**Strain Gage Element:** Sensing area of strain gage defined by the serpentine copper grid pattern

**Uniaxial Strain Gage:** Strain gage incorporating a single strain gage element, i.e., capable of detecting strain along a single axis

### Mechanical Test Equipment Terms

**Anvil:** Four-point assembly fixture support with a rounded contact surface

**Crosshead Assembly:** Clamping/attachment assembly of universal tester that moves relative to the base of the test equipment, and creates the forces necessary for specimen testing

**Four-Point Bending Fixture:** Test assembly that supports a specimen on two anvils or rollers, and symmetrically loads the specimen on the opposite surface with two anvils or rollers

**Load Span:** Distance between the two anvils or rollers that load the test specimen

**Roller:** Four-point assembly fixture support that incorporates a cylindrical bar as the contact surface