This is a preview of "IPC/JEDEC 9704A-2012". Click here to purchase the full version from the ANSI store.

IPC/JEDEC-9704A

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

Supersedes:
IPC/JEDEC-9704 - June 2005

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

This is a preview of "IPC/JEDEC 9704A-2012". Click here to purchase the full version from the ANSI store.

Table of Contents

1 SCOPE 1
1.1 Purpose 1
1.2 Background 1
1.3 Terms and Definitions 3
1.3.1 Area Array Component 3
1.3.2 Component 3
1.3.3 Interconnect 3
1.3.4 Non-Area Array Component 3
1.3.5 Diagonal Strain (ε_d) 3
1.3.6 Microstrain 3
1.3.7 Principal Strain (e_P) 3
1.3.8 Rosette 3
1.3.9 Pad Cratering 3
1.3.10 Stacked Rosette Strain Gage 3
1.3.11 Strain 3
1.3.12 Strain Guidance 3
1.3.13 Strain Metric 3
1.3.14 Strain-Rate 3
1.3.15 Strain Gage 3
1.3.16 Strain Gage Element 4
1.4 Revision Level Changes 4

2 APPLICABLE DOCUMENTS 4
2.1 IPC (Normative) 4
2.2 ASTM (Informative) 4
2.3 Other Publications (Informative) 4

3 GENERAL REQUIREMENTS/GUIDELINES 4
3.1 Boards 6
3.2 Components and Devices 8
3.2.1 Area Array Components 8
3.2.2 Non-Area Array Components 8
3.3 Strain Gage 9
3.3.1 Strain Gage Placement of Area Array Components 10
3.3.2 Strain Gage Placement for Non-Area Array Components 12
3.4 Gage Attachment 12
3.5 Lead Wires 13
3.6 Measurement Equipment 14
3.7 Measurement Calibration 14
3.8 Manual Simulation 14
3.9 Strain Metric 15

4 DATA ANALYSIS AND REPORTING 15
4.1 Analysis Requirements 15
4.2 Test Frequency 16
4.3 Strain Gage Test Report Template 16
4.3.1 Abstract 16
4.3.2 Introduction 16
4.3.3 Test Apparatus and Setup 16
4.3.4 Results 16

5 CONCLUSIONS 17

6 FUTURE STUDIES 17

APPENDIX A ICT DESIGN CONSIDERATIONS 18

APPENDIX B ACRONYMS 21

Figures

Figure 1-1 Examples of Solder Joint Damage (top: pad cratering, bottom left: bulk solder joint failure, bottom right: solder interfacial fracture) 2
Figure 1-2 Area Array Component 3
Figure 1-3 Diagonal strain metric is the maximum of e_2 or e_4, whichever strain is greater along these two directions, relative to the component. 3
Figure 3-1 Example Board Assembly Process Steps for Strain Measurement 5
Figure 3-2 Example System Assembly Process Steps for Strain Measurement 5
Figure 3-3 PCA with SMT Components Only (After SMT Reflow) 6
Figure 3-4 PCA with Both SMT and Through-Hole Components (After Wave Solder) 7
Figure 3-5 ICT Fixture Strain Gage Test Setup 7
Figure 3-6 Stacked Rosette Strain Gage 9
Figure 3-7 Strain Gage Dimensions (Inches) 9
Figure 3-8 Recommended Gage Placement for BGA Components 10
Figure 3-9 Interference Due to BGA Pushdown Block 11
Figure 3-10 Interference Due to ICT Probe 11
Figure 3-11 Centroid of Gage Placement Above Corner Land Pad 12
Figure 3-12 Component Removal to Facilitate Gage Placement 12
Figure 3-13 Uni-Axial Strain Gage Placement for MLCC packages (within 1.0 mm of solder fillets) 12
Figure 3-14 Lead Wire Routing Example 13
Figure 3-15 Example Gage Correlation Tool 14
Figure 4-1 Time History of the Strain Limit Criteria 15

This is a preview of "IPC/JEDEC 9704A-2012". Click here to purchase the full version from the ANSI store.

Figure A-1 Illustration of Support “skate” when a UUT’s Support is Overloaded with Upward Pressure, Causing it to Collide with a Component. 18

Figure A-2 Illustration of UUT Support Areas and Keep-out Areas around a BGA component 19

Figure A-3 Illustration of Component to Support Clearance and Proper Support Alignment 20

Tables

Table 4-1 Example Strain Report for a Strain Gaged Component that went through Various Handling and Assembly Processes 17

This is a preview of "IPC/JEDEC 9704A-2012". Click here to purchase the full version from the ANSI store.

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