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Advancing manufacturing technology
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iNEMI Statement of Work (SOW)
Board and Systems Manufacturing Test TIG
iNEMI Board Flexure Standardization Project

Version # 3.0
Date: May 8, 2008
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Co-Project Leader: Alan McAllister (Intel)
iNEMI Coach:

Basic Project Information

Damage can be induced in printed circuit assemblies (PCAs) by flexing during manufacturing and box assembly. Currently accepted board flex methods do not reflect the actual bending that PCAs undergo in the manufacturing and assembly processes. The transition to lead-free manufacturing has elicited this deficiency and made evident the need to find a new bend test method to properly evaluate risk and to assess the potential for induced damage.

To evaluate PCA risk, the bend-induced stress needs to be measured. Printed circuit board (PCB) surface strain is an indirect indicator of the stresses that solder joints experience. This PCB strain can be used to evaluate potential risk for damage by setting PCB strain limits. There are two strain metrics being used in the industry to assess the amount of board flexure: principal and diagonal strain. Both are based on PCB surface strain. Offering conflicting strain bend limits and recommendations regarding the use of these different metrics to contract and original design manufacturers can result in confusion and error during risk assessment of manufacturing processes.

Due to strain gradients across bent PCB surfaces, it is critical that the placement of strain gauges is consistent in order to properly evaluate stress conditions and risk levels. The use of alternate strain gauge placements, though permissible, would require additional correlation studies and thus make it more difficult to compare to a published strain limit.

The motivations for this work to update current board flexure standards are manifold. There is need for the standards to encompass the impact of changing to lead-free electronics and to encourage industry adoption of the spherical bend test method, which is closer to what PCBs experience in manufacturing and assembly than current bend test methods. Consistent strain measurement techniques are also needed to reduce confusion and error. These changes will minimize, help manage, and alloy consistent determination of the risk during manufacturing and assembly, while providing common metrics and methods to be followed within the industry.

Scope of Work

This project will steer the future direction of bend flex testing to include spherical bending and consistent strain gauge measurement techniques. The present views of companies regarding the present state and future focus of bend flex testing will be gathered and consolidated. Decisions on proposed changes to current standards will be based on these industry views. These proposed changes will be presented to the IPC/JEDEC committee, and feedback will demonstrate what will be done to update the standards 9702 and 9704 to reflect the current industry trends.

Purpose of Project

- The purpose of this project is to:
    - Promote the use of the spherical bend test method for determining PCA strain limits
        - Update IPC/JEDEC-9702 as required
        - Review the effectiveness of current failure analysis (FA) methods to determine PCA damage due to flexure
    - Promote the use of a standard metric (diagonal or principal) to measure PCA strain
    - Update IPC/JEDEC-9704 to clarify the necessity of using a standard gauge placement so that measurements are consistent and not impacted by strain gradients

Previous Related Work

IPC/JEDEC-9702: Monotonic Bend Characterization of Board-Level Interconnects (June 2004)

- Describes how to characterize the fracture strength of a component's board level interconnects using four-point bend testing
- Challenges:
    - Four point bend is typically less severe on PCAs than field conditions (ICT testing, manufacturing, assembly), and it is not the most severe, worst-case bend testing
    - Boards need to be flexed to substantially higher levels of strain before damage is observed during four-point bend than during spherical bend
    - There is no direct way to derive a safe bend strain limit with the four point bend method

IPC/JEDEC-9704: Printed Wiring Board (PWB) Strain Gage Test Guideline (June 2005)

- Describes how to perform strain gauge testing for PWBs in the board manufacturing process
- Challenges:
    - This standard allows for multiple gauge placement layouts, leading to ambiguity in data interpretation, since measurements cannot be directly compared between different gauge placements
    - Maximum allowable strain is defined for tin-lead PCAs only (see Appendix A)
    - Maximum allowable strain is based on principal strain measurements which may not be the most damaging, leading to more conservative limits
    - Criteria for defining and using a strain limit are component, board, and strain rate limited

Prospective Participants

- Semiconductor manufacturers
- Original equipment manufacturers
- Contract manufacturers
- Other: Reliability engineers, manufacturing engineers, test engineers, research and development, quality assurance, procurement, standards bodies

Project team members are expected to participate by sharing knowledge on board flexure and FA methods. The team will draft a recommendation for the IPC/JEDEC committee on proposed changes or additions to the current standards.

Project Formation Participants:

Agilent Technologies	Julie	Silk
Cisco Systems Inc.	Mudasir	Ahmad
Hewlett Packard Company	Alexander	Leon
Hewlett Packard Company	Jaime	LLinas
Hewlett Packard Company	Aileen	Maloney
Hewlett Packard Company	Carlos	Michel
Hewlett Packard Company	Rosa	Reinosa
Hewlett Packard Company	Raymundo	Vazquez
Intel	Ruben	Rodríguez
Intel Corporation	Joe	Fuller
Intel Corporation	Frank	Joyce
Intel Corporation	Alan	McAllister
IPC	David	Torp
National Instruments	Adam	Gage
Soltec	Gary	Schivley
Stress Engineering Services	Daniel	Pitts
Stress Investigators Engineering Inc.	Jeffrey	Dillinger
Sun	Jorge	Martinez
Sun	Jun	Ma
Test Research Inc	Floyd	Conner
Vishay	Sawh	Chandradeo
Vishay	Darryl	Peterson
Sanmina-SCI Corp.	Robert	Kinyanjui
Sanmina-SCI Corp.	Jorge	Arellano

Project Plan: Schedule with Milestones

	June-08	**July-08**	**Aug-08**	**Sept-08**	**Oct-08**	**Nov-08**	**Dec-08**	**Jan-08**	**Feb-08**	**March-08**	**April-08**
Task 1 – Complete project definition	**X**										
Task 2 – Gather ideas/brainstorm: assess current bend test methods and metrics used to measure PCA strain		**X**	**X**	**X**							
Task 3 – Gather and consolidate the views of each company on the current practices			**X**	**X**							
Task 4 – Identify areas where modifications are needed in the current standards				**X**	**X**						
Task 5 – Develop and approve proposal with recommendations to the IPC/JEDEC Committee						**X**	**X**				
Task 6 – Present recommendations to the IPC/JEDEC Committee								**X**			

Task 7 – Follow through with IPC/JEDEC Committee to determine path forward								**X**	**X**	**X**	
Task 8 – iNEMI Membership Report - Webinar										**X**	
Task 9 – APEX 2008 Report Presentation											**X**

Key Milestones

IPC/JEDEC-9702

- Task 1: Complete project definition
- Task 2: Gather ideas/brainstorm in project meetings: assess current bend test methods
    - Present assessment of board flex methods to project team
    - Summary of project findings: *Assessment of Current Bend Test Methods*
        - Determine correlation between spherical and four-point bend test methods
        - Assess variables affecting strain during bend testing
        - Review material property influences (such as laminate or board thickness) on strain limits
    - Share findings with iNEMI and industry
- Task 3: Gather and consolidate the views of each company on the current practices
    - Report industry viewpoints to project team
        - Determine the definition of bend 'failure' for each company
- Task 4: Identify areas where modifications are needed in the current standard
    - Project team proposes changes on the focus areas
        - Revisit guidelines for failure criteria in current methods
        - Describe the impact of the transition to lead-free solder on safe bend limits
        - Spherical bend testing
- Task 5: Develop and approve proposal with recommendations to the IPC/JEDEC Committee
    - Complete draft proposal
- Task 6: Present recommendations to the IPC/JEDEC Committee
    - Gather feedback from IPC/JEDEC regarding proposed updates to standard 9702
- Task 7: Follow through with IPC/JEDEC Committee to determine path forward
    - Draft list of technical and non-technical issues to track
    - Review and correct draft
    - Final list of technical and non-technical issues to track

IPC/JEDEC-9704

- Task 1: Complete project definition
- Task 2: Gather ideas/brainstorm during project meetings: assess metrics used to measure PCA strains
    - Present summary of project findings: *Assessment of Current Metrics used to Measure PCA Strain*
    - Share findings with iNEMI and industry
- Task 3: Gather and consolidate the views of each company on the current practices
    - Report industry viewpoints to project team
        - Deciding which strain metrics is better suited to bend testing

- Task 4: Identify areas where modifications are needed in the current standard
    - Project team proposes changes on the focus areas
        - Review the effect of strain rate in Appendix A
        - Review use of optical fiber gauges
        - Remove items that do not pertain to board handling
- Task 5: Develop and approve proposal with recommendations to the IPC/JEDEC Committee
    - Complete draft proposal
- Task 6: Present recommendations to the IPC/JEDEC Committee
    - Gather feedback from IPC/JEDEC regarding proposed updates to standard
- Task 7: Follow through with IPC/JEDEC Committee to determine path forward
    - Draft list of technical and non-technical issues to track
    - Review and correct draft
    - Final list of technical and non-technical issues to track

IPC/JEDEC-9702 and IPC/JEDEC-9704

- **Task 8 –** iNEMI Membership Report - Webinar
- **Task 9 –** APEX 2008 Report Presentation

NOTE: All changes to SOW must be approved by the TC (version control)