Quantify Impact of Board Design and Process Control to SMT Performance

Call for Project Formation
July 1-2, 2015

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Agenda

• Participants Introduction
• iNEMI Project Process
• Project Formation Team Objective
• Project Preliminary Definition
  – Initial Proposal
  – IS / IS NOT analysis
  – Discussion
• Next Step & Meetings
Successful iNEMI Projects

• Address knowledge gap(s) of industry:
  – Common problem
  – Best solved by working together
  – Timed success that aligns to business needs
  – Best manifested on complex far reaching issues
  – Often includes reliability testing & verification

• Requires teamwork across multiple levels of the supply chain:
  – Ensures efficient alignment of goals and investments of the varied team players;
  – Supports the company’s commercial interests.

• Delivers a coordinated industry wide response and capability set.
  – OEM/ODM/EMS/Suppliers at multiple levels.
The Project Development Process - 5 Steps

0. INPUT
1. SELECTION
2. DEFINITION
3. PLANNING
4. EXECUTION / REVIEW
5. CLOSURE

“Initiative”
Open for Industry input

“Project”
Limited to committed Members
- Organization
- Stakeholders
- Background
- Objectives
- Deliverables
- Benefits
- Skills required
- Risks
- Scope
- Costs

Decision after Review

- Is it still valid?
- Is the market forecast valid?
- Do we have resources?
- What is current priority?
- What are the consequences of aborting now?

APPROVAL TO PROCEED
Planning

- Time estimates
- Initial schedule
- Resource analysis
- Optimization
- Risk review
- Issue resolution
- Prepare to implement

Decision after Review

- Is the schedule acceptable to participating member companies?
- Are resources committed?
- Do we still want to do it?
- Is current priority correct?

APPROVAL TO PROCEED
3 Output of Planning Process

- Project Leadership
- SOW (Statement of Work)
  - Document Describing the Project
- PS (Project Statement)
  - Document Defining:
    - What each Firm Will Contribute
    - The rules for the Project
    - Firm Commitment from Management

SOW and PS are described at www.inemi.org
Project Formation Team
Objective
Project Formation Team Objective

• Plan the project with manageable/achievable scope to benefit the membership/industry

  – Define the project goals and scope
  – Identify tasks and resources required
  – Plan the project schedule
  – Develop the SOW and PS
  – Identify key players to form the project team
Outline of Statement of Work (SOW)

1. Background to work
2. Scope of project
3. Purpose of project
4. What the project IS/IS NOT
5. Business Impact
6. Previous/current related work
7. Outcome of project
8. Prospective Participants
   - (Generic – nonspecific list)
9. Project Schedule with Milestones
10. Resources required from project participants
11. Project monitoring plan
12. General and administrative guidelines
Project Proposal

The Starting Point
Background: Warpage & SMT Yield

• Key Gaps
  – SMT yield depends on many factors including package warpage, board warpage, SMT materials, process, etc.
  – For package warpage: JEDEC SPP-024 used and/or customer driven specifications are leveraged
    • Package warpage spec is not keeping aligned with industry trends
  – Board Warpage (iNEMI PCB coplanarity study led by John Davigon/Intel)
    – Used Hi-end Boards for study. Suggest this new initiative to use thin board for smart phone.
    – Work on design concept (fine pitch, configuration, print process)
  – Need to understand board warpage & correlation to SMT yield

• Expected members: OEM, ODM/EMS, IC Makers, materials and equipment suppliers
Project Proposal

• Objective: To understand interaction of board design/pallet on board warpage & paste print variability on SMT yield

• Proposed Steps
  – Step 1:
    • Measure paste print quality in terms of paste volume variability as a function of key board parameters such as board design (top layer), board pallets, board thickness and panel type (2-up, 4-up)
    • Metrology requirements
      – Golden standard to ensure measurements across different metrologies is consistent
      – Use existing metrology technique available to measure paste volume @ BGA pad (nominal + variations). Number of measurements per board type ~40
    • Expected out-put: Board type vs. paste volume (nominal + variability)
  – Step 2:
    • Board warpage using HVM (high volume manufacturing) pallet design as a function of temperature.
    • Metrology: TBD (likely candidate Shadow Moire)
    • Expected out-put: board warpage as function of temperature
## Project Proposal - Continued...

### Step 3:
- Propose use of product boards to emulate warpage behavior
- TV (test vehicle) could be product or thermal mechanical TV
- Expected Output: SMT yield vs. TV vs. board

<table>
<thead>
<tr>
<th>Package type</th>
<th>Board Types</th>
<th>Characterization</th>
<th>SMT data</th>
<th>Failure Analysis</th>
<th>SMT yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>TV1: (0.3-0.35mm BGA pitch, 17x17, or suggested TV form factor from other participants)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TV2 (0.4mm BGA pitch, 17x17mm)</td>
<td>Board 1 Board 2 Board 3</td>
<td>Paste vol and board warpage Paste material fixed</td>
<td>300 unit/board</td>
<td>X-ray and DnP</td>
<td>?</td>
</tr>
<tr>
<td>TV3 (0.5mm BGA pitch, 22x25mm or 30x18mm)</td>
<td>Board 1 Board 2 Board 3</td>
<td>Paste vol and board warpage Paste material fixed</td>
<td>300 unit/board</td>
<td>X-ray and DnP</td>
<td>?</td>
</tr>
<tr>
<td>TV4 (0.65mm BGA pitch, 24x40mm)</td>
<td>Board 1 Board 2 Board 3</td>
<td>Paste vol and board warpage Paste material fixed</td>
<td>300 unit/board</td>
<td>X-ray and DnP</td>
<td>?</td>
</tr>
</tbody>
</table>

- Package warpage as a function of temperature characterized;
- SMT paste: fixed
- Different board design/pallet
- Different SMT line (aka: different participants)
Discussion
Is/Is Not Analysis

The Starting Point
### IS / IS NOT Analysis

<table>
<thead>
<tr>
<th>This Project <strong>IS:</strong></th>
<th>This Project <strong>IS NOT:</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Provide initial analysis of what the Project <strong>IS</strong> and <strong>IS NOT</strong></td>
<td></td>
</tr>
</tbody>
</table>
Guidelines for SOW Development
Outline of Statement of Work (SOW)

1. Background to work
2. Scope of project
3. Purpose of project
4. What the project IS/IS NOT
5. Business Impact
6. Previous/current related work
7. Outcome of project
8. Prospective Participants
   - (Generic – nonspecific list)
9. Project Schedule with Milestones
10. Resources required from project participants
11. Project monitoring plan
12. General and administrative guidelines
iNEMI Statement of Work – Basic Information

• Scope of Work – definition of what is to be done
  – Describe what work will be done
  – State the major goals of the project at the end of project deliverables
  – Provide an approximate timeframe for major phases of the project and for completion

• Purpose of Project
  – Explain how the project aligns to the roadmap and what gaps will be filled
  – Will the project provide a complete solution or be part of a complex solution?
  – List anticipated benefits to participants, to the iNEMI membership in general, and the industry
iNEMI Statement of Work (SOW)

• Business Impact
  – Provide information on what impact this project will have on
    • Participating organization
    • iNEMI member companies
    • Industry as a whole

• Outcome of Project
  – List addressed issues that are expected to addressed and/or resolved, e.g., identify gaps, report(s) on results of any testing, etc.
  – List expected deliverables and project milestones
  – Sharing Project Results: To be determined by the project team on what information will be shared outside of the team.

NOTE: All changes to SOW must be approved by TC
Statement of Work – Resources

- Detailed list of resource needs and expenditures expected for the project, including:
  - Human resources
  - Equipment
  - Money
- List of committed resources from participating companies
- State source of funding for any components, assembly, design, and testing needs
  - Funding alternatives include
    - Participant donation
    - Supplier donation
    - iNEMI direct funding
Statement of Work – Materials and Processes

- Identify materials to be used
- Describe any processes to be used, including applicable standards and specifications
- Identify specific suppliers or technologies required and reasons for the requirement
- When custom components are necessary, state which project participant is responsible for assuming this cost
- Standard processes and materials should be used whenever possible to reduce costs, improve yields, and assure widest applicability of results within the industry
- Justification is needed if non-standard materials or processes are to be used
- Specify and describe any non-standard materials or processes (Specification Projects)
Statement of Work – Testing Procedures

• State anticipated number of parts to be tested
• Use IPC 9701 0-100C as baseline ATC unless justification can be given for alternate test parameters
• For test vehicle design and fabrication, recommend using reference components that have been ATC tested on previous projects be used to provide a baseline and facilitate comparison of results
• Use standard design practices and commonly used software to reduce costs and widen applicability of results
• At what stages will testing be done along with time needed
Statement of Work – Schedules With Milestones

• Project plan with
  – Identified tasks
  – Intermediate check points
  – End dates

• A detailed timeline, including each project activity

• Content and dates for:
  – Technical reviews (2 per year)
  – Progress reports
Statement of Work – Project Monitoring

Plans

• Plan to ensure open lines of communication among participants?
  – Provide planned teleconference schedule
  – Request progress reports as tasks are completed
• Practice risk analysis by anticipating problems and having alternate solutions ready
• Use opportunity analysis to identify new areas or topics that might be addressed in additional projects
  – To prevent scope of the current project from expanding
  – keep project focused on original goals
• Review project requirements with suppliers before the project begins
• Provide monthly updates to TIG and TC coach
• Provide information as needed to assist in completing Project Summary Chart
Possible Project Phases

• Definition (Phase 1)
  – Draft test plan
  – Fix test parameter
  – DOE Design
  – Test Vehicle Design
  – Phase 1 Interim/Final Report
  – Revised SOW for Phase 2
  – ...

• Fabrication (Phase 2)
  – Test vehicle fabrication
  – Test vehicle verification

• Test vehicle assembly
  – Phase 2 Interim/Final Report
  – Revised SOW for Phase 3
  – ...

• Testing and Analysis (Phase 3)
  – Perform tests
  – Analyze test results
  – Phase 3 Final Report
    • Summary
    • Lessons Learned
  – Final Summary Report
  – ...

• Summary
• Lessons Learned
  – Final Summary Report
  – ...

• Revised SOW for Phase 2
  – Revised SOW for Phase 3
Initiative Timeline - Next Meetings

- 1st meeting – kick off and introduction
- 2nd meeting – Is/Is not analysis, preliminary definition
- 3rd meeting – experiment design (materials; reliability; test method options; test vehicles; etc.)
- 4th meeting – review the draft SOW, potential resource requirement and high level schedule
- 5th meeting - refine the SOW, prepare the PS;
- Submit to TC for approval (2 weeks)
- Target to open for sign-up before the end of September

Propose meeting at:
8am China on Thursday
5pm PDT US on Wednesday