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iNEMI Statement of Work (SOW)
Board Assembly TIG
iNEMI Wiring Density for Organic Packaging Substrates

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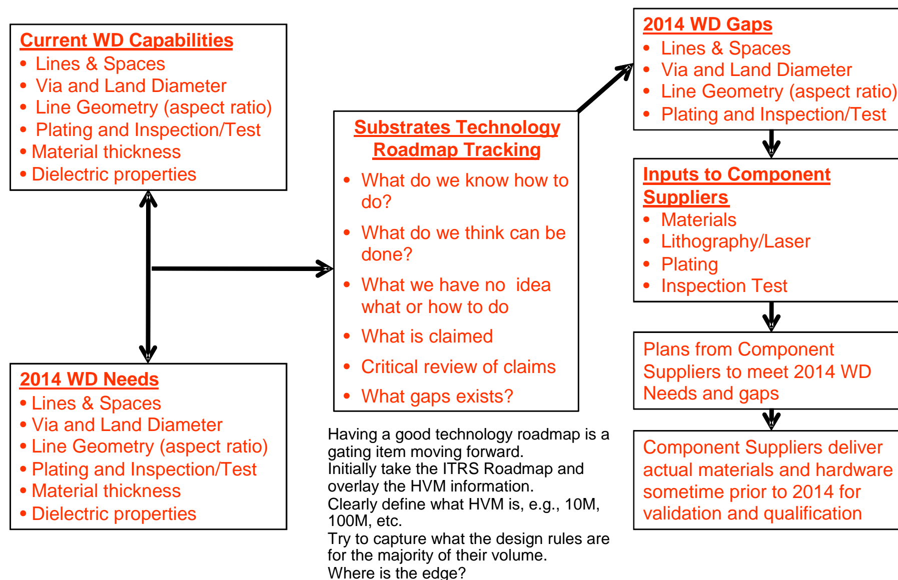
Basic Project Information

Scope of Work

This project will identify approaches that will meet wiring density needs for future generations of semiconductor packaging. Meeting these future needs will require radical improvements and innovations in all aspects of organic packaging substrates technology, for which a piecemeal approach will not be sufficient.



NOTE: All changes to this SOW must be approved by the Technical Committee for version control

Purpose of Project

The objective is to identify next generation packaging substrate technology that focuses on the following prioritized aspects(technology elements) to achieve maximized wiring density at minimal cost:

- Material Set
- Low Cost Patterning (Lithography/Laser/Imprinting/Printing)
- Plating
- Inspection and Test

These four elements apply to a wide range of package types

This Project IS:	This Project IS NOT:
A compilation of information that will be widely available throughout the general substrate industry	A repeat of prior work
Development of a roadmap applicable to multiple substrate technology spaces, able to accommodate future developments and advances, and inclusive of a variety of plated finishes and interconnect requirements	Intended to be static information that can be used indefinitely without further updates and input from the general semiconductor and substrate industries
An effective route to standardizing industry wiring density improvement efforts through accurate information communicated industry wide	
A communication of critical wiring density needs to the supplier industry	Physical development of a system of optimized next generation technologies to achieve maximized wiring density.
Addressing environmental safety and compliant with applicable standards and regulations	Biased towards specific laminate suppliers, geographies, or market segments

Business Impact

This project will provide the following benefits to participating companies and the industry in general (cost, quality, efficiency gained, resource reduction, and savings in people and equipment).

- Integrate available information on alternative approaches to meet roadmap wiring density requirements, with analysis by a group with wide industry knowledge, which is likely to provide the most accurate possible assessment.
- Provide an opportunity for analysis and resolution of interactions between different technology elements that might remain unaddressed without an integrated approach.
- Act as focal point for new technologies that might resolve roadmap barriers.

Changes in technology that justify this project are:

- Increasing higher component densities and shrinking Silicon [PCB] form factors that result in the need to increase wiring density through reduction in line space pitch on organic substrates.

- Cost adders using existing and/or future technologies such as:

  - Additional process development and specialized capital equipment may be required to ensure adequate yields
  - Significant increases [reduction] in wiring density lead to increased diagnosis of package defects resulting in:
    - Significant debug time added
    - Higher skilled debug technicians or engineers are required
    - Possible replacement of "good" devices ("shotgun debug")
    - Packages that are difficult to diagnose will accumulate as scrap ("bonepiles")
    - Additional capital equipment, production floor space and specially trained operators may be required

Previous Related Work

- Wiring density and design rules roadmaps are generated on a regular basis by entities such as ITRS, IPC and iNEMI.
- Both currently available and previous roadmaps provide design rule information, but without sufficient information on which rules are being used in production and which rules have wide industry acceptance and are used with a high degree of confidence
  - Based on review of substrate supplier's technology roadmaps, many currently consider 20/20 to 25/25 micron to be the most advanced line and space capability that can be manufactured in high volume production. In contrast, many industry generated roadmaps list line and space down to 10/10 microns, but provide insufficient information on target production levels, maturity and yield expectations

Prospective Participants -

- Phase 1 should include management, engineering, manufacturing, quality, equipment and procurement representatives from the entire supply chain as follows:
  - Raw material and chemistry suppliers to substrate manufacturers (direct and indirect materials)
  - Substrate manufacturers
  - Die to substrate assembly and test organizations (captive and contract entities)

- Phase 2 and 3 participants will be defined as Phase 1 progresses

Project Plan

Schedule with Milestones

Phase 1

The first phase will be to conduct an industry survey on current wiring density, design rule capabilities and future requirements.

The major goal of this phase is to get industry feedback on which substrate design features should be included in a roadmap that will accurately represent future wiring density needs from the perspective of Material Set, Low Cost Litho/Laser, Plating and Inspection/Test.

Task		Months																			
		M1				M2				M3				M4				M5			
	Phase 1 Survey	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
1.0	**Plan the survey**	■	■	■	■	■															
1.1	Design questionnaire (questions)	■	■	■	■	■															
1.2	Prepare survey recipient list				■	■															
2.0	**Prepare logistics of survey (post/host survey, notify recipients)**				■	■	■														
3.0	**Conduct survey / Distribute Questionnaire**						■	■	■	■	■	■									
4.0	**Collect and analyze data**										■	■	■	■	■						
5.0	**Review/Share survey data with project members**													■	■						
6.0	**Identify the key areas for further discussion**													■	■	■					
6.1	Identify data to support scope for items in Phase 2													■	■	■					
7.0	**Prepare report of the survey result**														■	■	■				
7.1	Internal report for iNEMI Project team														■	■	■	■			
7.2	Summary report for iNEMI membership														■	■	■	■			
8.0	**Phase 2 preparation, project plan, SOW**																	■	■	■	■

Phase 1 Wiring Density Survey - Tasks

1.0 Plan the survey

1.1 Define the questionnaire (questions)

What are the questions that will be asked? They must be such that they enable the tasks in Phase 2 to be clearly defined and scoped. Decide on the format of the questions to enable easy and clean data analysis.

1.2 Define survey hosting and data analysis method

The survey should be hosted using iNEMI's Survey Monkey account.

What tools will be needed to analyze the data? Task 1a defines what data should be collected.

1.3 Prepare survey recipient list

A list of recipients at relevant companies who design, use and run BIST needs to be compiled.

- Resources
  - Phase owner to lead gathering of questions for questionnaire
  - Prospective item owners to lead content of questionnaire per table below:
  - All team members need to contribute to the survey recipient list

- One or more team members need to propose how the survey will be hosted and the data analysis method

- Materials and processes
  - Software/server to host survey (iNEMI server, survey monkey etc.)
  - Software to perform data analysis

2.0 Prepare logistics of survey (post/host survey, notify recipients)

- Resources
  - Team members to post the survey and send notification to the recipient list

3.0 Conduct survey

- Resources
  - Team members (from Task 2) to send reminders to recipients and close out the survey

4.0 Collect and analyze data

- Resources
  - Team members to collect all survey replies and compile data
  - Team produces a report based on the data

5.0 Share survey data with project members

- Resources
  - Team member to share data with team

6.0 Identify the key areas for further discussion. Identify data to support scopes for phase 2 tasks.

6.1 Identify data to support scope for items in Phase 2

- Resources
  - Project Team to clarify scope for phase 2 based on the survey data

7.0 Prepare report of the survey result

7.1 Internal report for iNEMI Project team

7.2 Summary report for iNEMI membership

- Resources
  - Team members to share summary of survey results, give Webinar and report to general iNEMI membership and present results at an industry conference (e.g., International Test Conference)

8.0 Phase 2 preparation, Project Plan and SOW

- Resources
  - Team members to develop Phase 2 plan and recommendation for implementation

Phase 2

The second phase will consist of generating a representative and applicable roadmap based on industry feedback and identification of wiring density gaps.

Phase 3

The third phase will be the development of input to suppliers on needs for the four wiring density factors based on gaps identified in Phases 1 and 2:

- **Material Set**
- **Low Cost Litho/Laser**
- **Plating**
- **Inspection and Test**

Project monitoring plans

This project falls under the general category denoted as Research; i.e., given an idea or concept, research projects explore and investigate new processes. The outcome is a set of processes that could be used in a production environment if proven to be production worthy. These projects may include some preliminary reliability testing; however, the main focus is on identifying and demonstrating the feasibility of a process.

Project monitoring plans are as follows:

- Ensure open lines of communication among participants
  - Weekly conference calls
  - Meeting minutes provided through e-mail
  - Follow-up with individuals on an as-needed basis
  - Workshops and face-to-face meetings as appropriate
- Technical reviews and progress reports as requested (no more than one for Phase 1)
- Track and document approximate man-months per quarter per team member (this will require the active members of the team to provide estimates).
- Track and document approximate number of people on the project per quarter (this can be tracked through iNEMI's WebEx account.)
- Survey results, a Wiring Density roadmap, conference presentations, technical papers, end-of-project webinar, etc., will be published on the iNEMI website.

Outcome of the project

- Technical paper/whitepaper
  - Major components of the paper will be based on the results from the Phase 1 survey and the roadmap generated in Phase 2
  - The paper will facilitate peer review throughout the packaging industry
- Presentations at major packaging and test conferences
  - For example – ECTC. This would provide a forum for the WD activity work to be widely reviewed throughout the packaging industry

General and Administrative Guidelines

General and Administrative Guidelines for this project and all other iNEMI Projects are documented at http://thor.inemi.org/webdownload/join/gen_guidelines.pdf.