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**iNEMI Statement of Work (SOW)**  
**Board Assembly TIG**  
**iNEMI Pb-Free Rework Optimization Project**  
**Phase 3 - Reliability Evaluation**

**Version 2.4**

**Date: August 28, 2009**

**Project Leader: Craig Hamilton (Celestica)**

**iNEMI Coach:**

**Basic Project Information**

***Scope of Work – Phase 3***

1. Surface Mount Assembly of iNEMI Payette board prior to rework of certain components prior to reliability testing
  - Assemble 60 iNEMI test boards of 125 mil thickness with board dimensions of 7 x 17 inch with lead-free Sn3Ag0.5Cu solder paste with the following lead-free components assembled on each board:
    1. 1 BGA604 I/O socket (1.27mm pitch),
    2. 1 CBGA937 component (1mm pitch),
    3. 2  $\mu$ BGA 256 components (1mm pitch),
    4. 1 QFN 40 component (0.5mm pitch),
    5. 1 QFN56 component (0.4mm pitch).
  - Develop the reflow profile for the board so that the lead-free component solder joint temperatures range from a minimum peak of 235 °C to a maximum of 250 °C. The time above liquidous should be between 45-90 seconds. Reflow profile to be provided by Flextronics.
  - The stencil will be provided by Flextronics.
  - The no-clean solder paste will be provided by Senju Comtek.
  - The boards will be provided by Sanmina-SCI.
  - The CBGA components have been provided by IBM.
  - The QFN components have been provided by TI.
  - The BGA socket components have been provided by Tyco.
  - Conduct solder paste inspection on the printed pads for the components being assembled with results recorded.
  - X-ray inspection after assembly with results recorded.

- Electrical continuity testing after assembly with results recorded. All the components are daisy chained with specific locations on the board to measure and validate electrical continuity of the components.
  - Only components on the topside of the board will be assembled; however, the board should be conditioned prior to the topside assembly with a lead-free reflow profile to simulate double sided assembly.
  - The reflow atmosphere should be in nitrogen with oxygen content < 100ppm.
  - The reflow oven used should be convection with at least 10 zones.
  - Write an assembly report describing the assembly conducted, the machine parameters used during assembly, the reflow profile used, and the results obtained.
2. Wave Soldering Assembly of Phase 3 iNEMI test vehicles
- Assemble 60 iNEMI test boards of 125 mil thickness with board dimensions of 7 x 17 inch with lead-free Sn3Ag0.5Cu wave solder with the following lead-free components assembled on each board: 2 DIMM278 connectors and 3 PDIP16 components.
  - The wave profile and wave fixture and DIP16 components will be provided by Flextronics.
  - The DIMM278 components have been provided by Tyco.
  - The no-clean wave flux will be provided by Senju.
  - Wave soldering to be done with Nitrogen over the lead-free wave.
3. Rework of Phase 3 Test Vehicles
- Rework iNEMI test boards of 125 mil thickness with board dimensions of 7 x 17 inch with the following lead-free components reworked on each board:
    1. 1 BGA socket (U28) reworked by Intel;
    2. 1  $\mu$ BGA component (U40) reworked by Flextronics;
    3. 1 DIMM278 component (J8) reworked by Celestica;
    4. 3 DIP16 (U1, U2, U18) components reworked by Plexus;
    5. SMT components reworked with Sn3Ag0.5Cu paste and PTH components reworked with Sn3Ag0.5Cu or SnCuNi.
4. Reliability Testing of Phase 3 Test Vehicles and Failure Analysis
- Reliability test 48 iNEMI test boards of 125 mil thickness with board dimensions of 7 x 17 inch at the following lead-free components locations on each board:
    1. 2 DIMM278 components (J7 and J8);
    2. 1 BGA604 socket location (U28);
    3. 3 DIP16 locations (U1, U2, U18);
    4. 2  $\mu$ BGA256 locations (U40 and U41);
    5. 1 CBGA937 location (U27).
  - Thermal cycle from 0C to 100C (40 minute cycles) according to IPC 9701 standard.
    1. Electrically monitor the daisy chained components using an event detector or data logger. Need around 600 channels for the event detector component testing.
    2. Thermal cycle to 6,000 cycles or until there is a 63% failure rate in the tested components. 16 boards are 1<sup>st</sup> pass assembled. 32 boards are 1<sup>st</sup> pass assembled followed by rework at specific component rework locations on the board.

## **Purpose of Project**

This group's goal is to evaluate and recommend best practices, rework equipment requirements, and procedures for best of breed lead-free rework processing in a manufacturing environment. The project is divided into 5 groups:

1. Rework repeatability: Using retrofit rework rider machine to determine temperature repeatability of rework machines.
2. Mini-pot wave rework: Mini-pot rework development of DIMM and DIP through-hole components on a 125mil thick iNEMI test board.
3. iNEMI BGA socket/ QFN group: BGA socket and QFN rework optimization on a 125mil thick test board.
4. Adjacent component rework group:  $\mu$ BGA rework process development to prevent adjacent component reflow causing reliability issues on a 125mil thick iNEMI test vehicle board.
5. Reliability tests: ATC Reliability testing (0 to 100C, 6,000 cycles) on a 125mil iNEMI test vehicle board which has been reworked at the DIMM, DIP, BGA socket and  $\mu$ BGA component locations. IST and CAF testing of 125mil iNEMI test vehicle board after assembly and rework.

Phase 1 and 2 of the project have:

1. Determined rework machine temperature repeatability on a range of rework equipment
2. Developed rework processes for mini-pot rework
3. Optimized BGA socket and QFN rework process
4. Developed rework process for  $\mu$ BGAs to prevent adjacent component reflow

The final Phase (Phase 3) is to assemble; rework boards with the developed rework processes; and perform reliability tests on these boards to validate the rework processes developed.

## **Previous Related Work**

This project builds on the results of the iNEMI Lead-Free Assembly and Rework. The previous iNEMI lead-free assembly and rework project identified a need for development of Pb-free area array rework capabilities and mini-pot rework processes. When working with thicker boards (93-135mil) they found it was difficult to rework the lead-free area array packages and also difficult to obtain adequate holefill during mini-pot rework. Reliability testing found issues with lead-free reworked area array and adjacent components and dissolved copper traces and pads during mini-pot rework. The current project is addressing the need for improved rework equipment tolerances and repeatability, and to optimize/reduce heat transfer into boards to minimize component and board temperatures as well as developing procedures for lead-free mini-pot rework.

The output of the current Phase 3 work will be to develop and demonstrate optimized rework processes on the iNEMI 125mil thick test board.

## Summary of Effort and Support

Effort	Phase	Status	Supporting Company
Determine rework machine repeatability	1, 2	Completed	VJ, Ersal, Finetech, O.K.
BGA socket optimization	2	Completed	Intel
PTH development	1	Completed	Flextronics
PDIP rework optimization	2	Completed	Plexus
DIMM rework optimization	2	Completed	Celestica
Provide No-Clean Solder Materials (flux and paste)	3	Open	Senju Comtek
Printed Circuit Boards	3	Open	Sanmina-SCI
SMT assembly	3	Open	Creation
Wave solder assembly	3	Open	Creation
SMT Rework	3	Open	BGA socket (Intel), $\mu$ BGA (Flextronics)
PTH Rework	3	Open	DIP (Celestica), DIMM (Celestica)
ATC reliability testing	3	Open	Alcatel-Lucent
Failure analysis (lab work, x-sections, etc.)	3	Open	Project Team

Note: See Schedule for time commitments for Phase 3.

## Participants

Company	Lead Contact	Project Participant	Commitment Confirmation
Alcatel-Lucent	Holly-Dee Rubin	Adjacent component group chair, ATC, cross-sections	
Celestica	Craig Hamilton	Chair: Pb-Free Rework Optimization - Phase 3 – Reliability Evaluation; DIMM and DIP rework, cross-sections	
Cisco	Guhan Subbarayan	Test vehicle support, cross-sections	
Flextronics	Leo Anderson	Adjacent component ( $\mu$ BGA) rework	
HP	Jian Merimadi	Test vehicle support, cross-sections	
Intel	Alan Donaldson	BGA socket rework, cross-sections	
Nihon Superior	Keith Howell	Materials support	
Plexus	Denis Jean	DIP Rework, Board Design, cross-sections	
Sanmina-SCI	Dana Korf	Board supply	
Senju Comtek	Derek Daily	Materials support	
TI	Steven Kummerl	Component supply	
Tyco	Bob Hilty	Component supply	
SUN Microsystems	Karl Sauter	CAF and IST Board testing, Reliability test matrix	
Creation Technologies (Non-Member)	Khalid Mahmood	SMT and Wave Assembly	

# Project Plan

## Schedule with Milestones

### Phase 3 - Duration

Task	Phase 3 - Project Start / Project Duration	3Q09	4Q09	1Q10	2Q10	3Q10
1.	Surface Mount Assembly of Phase 3 iNEMI Test Vehicles (1 month)	X				
2.	Wave Soldering Assembly of Phase 3 iNEMI Test Vehicles (1 month)	X				
3.	Rework of Phase 3 Test Vehicles ( 2 months)	X	X			
4.	Reliability Testing of Phase 3 Test Vehicles and Failure Analysis (9 months)			X	X	X

### Project monitoring plans

- How will you ensure open lines of communication among participants?
  - Fortnightly conference calls
  - Meeting minutes provided through e-mail
  - Follow-up with individuals on an as needed basis
  - Face-to-face meetings as appropriate
- Planned teleconference schedule
  - Fortnightly conference calls
- Quarterly progress reports will be issued for the Technical Committee to review.

### Outcome of the project:

- Successful completion of this project will include the publication and presentation of the assembly and rework process development with reliability testing results.
- Deliverables of this project include the following:
  - Workshop for project members summarizing results of work.
  - Final written report and slides and publication of the test results.
  - Project results will be shared with the industry in order to promote results and best rework practices and drive area array and mini-pot rework machine changes throughout the supply chain.
  - Results will be shared through presentations and industry meetings and publication in an archival journal subject to group participant approval process.
  - Updated standards will be shared through publication of the new standards.

Companies who participated in Phase 1 and 2 are encouraged to sign-up to assist in the analytical work on failure modes and summarizing the reliability evaluations.

***iNEMI Member Company Participants from Phase 1 and 2***

<b>Company</b>	<b>Lead Contact</b>
Cisco	Guhan Subbarayan
HP	Jian Merimadi
Plexus	Denis Jean
Nihon Superior	Keith Howell
Sun Microsystems	Karl Sauter
TI	Steven Kummerl
Tyco	Bob Hilty