Statement of Work (SOW)
iNEMI Board Assembly TIG
Connector Reliability Test Recommendations Project, Phase 2

Version #3.0
Date: September 6, 2016

Project Leader: Shane Kirkbride, Keysight
Co-Project Leader: TBD
iNEMI Staff: David Godlewski

Summary

The iNEMI Connector Reliability Test Recommendations Project, Phase 1, was organized to address the need for a standardized reliability qualification method for connectors. The project team reviewed current standards pertaining to connector reliability and also conducted an industry-wide connector reliability survey to determine common metrics for connector reliability guidelines across the industry, resulting in the publication iNEMI Connector Reliability Test Recommendations Project Report white paper at SMTA 2016.

The iNEMI Connector Reliability Test Recommendations Project team recommends additional work to define specific test conditions to be used to evaluate the expected degradation of connectors used under different stress levels in the defined application classes. This could form the basis for standardized reliability test procedures for each application class. Such a system of standardized testing would allow designers to more easily compare connectors during their initial system design phase.

Phase 2 continues this work and further defines levels of connector stress. It then maps these stresses on to the tiers established in Phase 1. We also define a way to verify this research with a Phase 3 test vehicle.
**Basic Project Information**

One of the issues identified by the 2013 iNEMI connector survey was that test capabilities for socket reliability (such as temp cycle and shock, failure analysis) are different across socket/connector manufacturers. The associated criterion for ‘passing’ is not consistent. One of the interests shown from the survey was in the topic of Standard Reliability Qualification and the need to drive standard reliability test conditions and performance requirements across the industry.

To this end, Phase 2 proposes to research four main contributions to the connector industry reliability space. The first contribution will be an analysis of connector plating system technologies. This analysis will result in a mapping between plating systems to the connector tiers established in Phase 1 as well as a parametric comparison between plating system chemistries and performance. The second contribution will be an analysis of environmental and mechanical stress impacts on connector reliability; this will then become another tiered mapping to the original tiers established in Phase 1. This mapping will indicate which connectors may be impacted most by the environmental and mechanical stresses in the highly varying environments connectors are used in. Third, a set of test vehicles will verify these findings. The test vehicle will be realized in Phase 3, but the scope and definition will be given in Phase 2. Lastly, we will suggest a standard reporting format for connector reliability. This format will be easy for the industry to use and create a common way of communicating connector reliability. The contribution of the Phase 2 work will be documented in a white paper and presented as an end-of-project webinar.

**Scope of Work**

The proposed scope of work for this project will be to define a standard list of plating systems and stresses. This will be a 12-month project resulting in a white paper and technical webinar. Then these will be mapped to the connector levels from Phase 1. Based on the guidelines developed, the project will identify and document these for industry awareness and propose a test vehicle to verify the findings. Below contains the proposed scope of work.

**Phase 2:**

1. Develop test guidance for non-noble versus noble plating systems.
2. Review of test specifications used in Phase 1 and propose changes to test conditions for indoor/outdoor environmental stresses for the Phase 1 connector classes.
3. Review specification test sequences and propose updates/changes to stress testing for each group of tests to allow parts for the resulting degradation mechanism to interact as they do in the real world.
4. Propose a standard test report format for presentation of test results.
5. Align critical elements that will be included in the connector reliability report.
6. Better align connector reliability requirements between supplier OEMs.
**Purpose of Project**

The purpose of this Phase 2 project is to:

1. Scope/drive opportunity for industry level standard reliability test conditions and equipment capabilities, FA capability and criteria.
2. Drive common database/data formats of test results for suppliers/OEMs to use.
3. Primarily document the current state for a knowledge-based connector reliability certification.
4. Set foundation for a test vehicle in Phase 3.

**IS / IS NOT Analysis**

<table>
<thead>
<tr>
<th>This Project IS:</th>
<th>This Project IS NOT:</th>
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<tbody>
<tr>
<td><strong>Phase 2: Connector Reliability</strong></td>
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<tr>
<td>Drive standard test capabilities for connector reliability</td>
<td>Development of a specific standard(s)</td>
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<tr>
<td>Research and literature survey of the current and future types of connector plating technologies</td>
<td>Repeat of prior or existing work</td>
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<td>Create level of uniformity for how socket/connectors can be evaluated for reliability (stresses, interpretation of electrical targets, and test structure)</td>
<td>Biased towards specific suppliers, geographies, or market segments</td>
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<tr>
<td>Alignment of critical elements that will be included in connector reliability report</td>
<td>An attempt to document or infringe upon supplier specific IP</td>
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<td>Step toward aligning a knowledge-based connector certification process</td>
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<td>Align how to select the appropriate accelerated conditions</td>
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<tr>
<td>Align standard methods for failure analysis</td>
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<td>Align critical elements that will be included in connector reliability report</td>
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<td>Output:</td>
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<td>Tiers will be the result and all will have a relation to the original connector tiers:</td>
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<td>- Plating system tier</td>
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<td>- Environmental stress tier</td>
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<td>- Electro-mechanical stress tier</td>
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<td>Standard connector reliability report</td>
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<td>Definition of a test vehicle for Phase 3</td>
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**Business Impact**
This project will provide the following benefits to participating companies and the industry in general:

- Wider acceptance of data from various connector suppliers through transparency of the certification process.
- Facilitate the understanding between socket connector suppliers and customers industry as a whole.
- Develop and publish a standard list of levels for connectors and design a proposed test strategy for their specific application environment.

**Participating Organizations**

iNEMI member companies
Industry as a whole

**Project Formation Team Participants**

- Philip Conde, Dell
- Benson Chan, ExSys Technology, Inc.
- Li Siah Tai, Keysight
- Shane Kirkbride, Keysight
- Ife Hsu, Intel
- Christian Dandl, Rosenberger
- Vince Pascucci, TE Connectivity
- Bob Martinson, Lotes

**Outcome of Project**

Project outputs provided by the team that will be of value to the industry are:

- 3 tiers will be the result and all will have a relation to the original connector tiers:
  - Plating system tier
  - Environmental stress tier
  - Electro-mechanical stress tier
- Standard connector reliability report
- Definition of a test vehicle for Phase 3
- Develop and publish a technical white paper
- Develop and broadcast project webinar
- Define Phase 3 project milestones and timeline
- Sharing Project Results: To be determined by the project team on what information will be shared outside of the team
**Previous Related Work**

Connector Test Recommendations Phase 1 Project Results:

- Review current classes of connectors and identify gaps
- Develop survey for industry review
- Survey of suppliers/OEMs for current list of levels
- Based on results of industry survey, define a standard list of levels for each class/packaging type (for example the list below – but this list varies industry wide)
- Review of Specifications/Standards
  - EIA 364F: Electrical connector/socket test procedures including environmental classifications
  - EIA 364-1000: Environmental test methodology for assessing the performance
  - ISO/IEC TR 29106: Introduction to MICE environmental classification
  - IEC 61586-TS: Estimation of the reliability of electrical connectors
- Described a knowledge-based test approach for connector evaluation that includes technology risk assessment and test strategy
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**Phase 1 White Paper – Published SMTA International 2016 Conference: September 2016**

**Project Plan**

<table>
<thead>
<tr>
<th>Phase 2</th>
<th>Q1</th>
<th>Q2</th>
<th>Q3</th>
<th>Q4</th>
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<tbody>
<tr>
<td>1. Develop a design guidance on plating systems</td>
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<td>2. Propose updates to specifications for indoor/outdoor applications</td>
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<td>3. Propose an updated sequence method of stress testing for each group of tests</td>
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<td>4. Propose a standard test report format</td>
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<td>5. Plan definition for Phase 3</td>
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<td>6. White paper</td>
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<td>7. End-of-project webinar</td>
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Phase 2 – Detailed Information

Task 1 Develop a design guidance on plating systems

Resources
- Representatives from participant companies and their work peers

Materials and Processes – 1-2 months
- Survey of current and upcoming plating systems in connector industry
  - This survey will be research conducted by the committee
    - May check with suppliers as needed
  - Describe general (non-IP) process of plating
  - Pros/cons of each
  - Parametric comparison table
- Create tiers of plating systems
- Map plating systems tiers to connector type tiers

Task 2 Propose updated test conditions for indoor/outdoor environment connector classes

Resources
- Representatives from participant companies and their work peers

Materials and Processes – 3-6 months
- Choose specifications to review
- Project leader and co-leaders will lead the efforts to review and document proposed changes to existing specifications
  - Map appropriate specifications/changes to plating and connector classes
  - Example: Std-X sect. 1 does not align with plating class a connector type 1
    - Why?
    - What should be?
- Project leader and co-leaders and team will document conditions for indoor and outdoor environments
  - Review current environmental tiers in the specifications
  - Map appropriate environmental tiers to connector tiers
- Begin definition of Phase 3 test vehicle:
  - Review and define initial environment/application specific connector level as an example of test requirements and associated performance criteria
    - Define types of connectors
    - Define multiple stresses on single stress group
    - Define criteria for passing

Task 3 Propose updates to sequence method of stress testing for each group of tests

Resources
- Representatives from participant companies and their work peers

Materials and Processes – 1 month
- Project leader and co-leaders will lead the efforts to review and document proposed changes to existing specifications
- Map stresses in a similar way to environmental testing as in Task 2
Task 4 Propose a standard test report format

Resources
- Representatives from participant companies and their work peers

Materials and Processes – 1 Month
- Extract a way to highlight exceptions and failure mechanisms
- Project leader and co-leaders will lead the efforts to design a format of presentation of test results for ease of review and comparison

Task 5 Plan definition for Phase 3

Resources
- Representatives from participant companies and their work peers

Materials and Processes – 1 month
- Project leader and co-leaders will lead the efforts to define the Phase 3 plan
- This phase will take those items defined in Tasks 2 and 3 and build a test vehicle for them

Task 6 White paper

Resources
- Representatives from participant companies and their work peers

Materials and Processes
- Project leader and co-leaders will lead the efforts to document all the progress in Phase 2 by including the survey data, project directions and testing features design status

Task 7 End-of-project webinar

Resources
- Representatives from participant companies and their work peers

Materials and Processes
- Project leader and co-leaders will host the necessary meetings with all participants and key iNEMI coordinators/officials to report out the project status in iNEMI required formats

General and Administrative

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