International Electronics Manufacturing Initiative
Advancing manufacturing technology
Herndon, Virginia • Shanghai, China • Limerick, Ireland
2214 Rock Hill Road, Suite 110 • Herndon, VA 20170-4214
Tel: +1 703-834-0330 • Fax: +1 703-834-2735
www.inemi.org • info@inemi.org

Statement of Work (SOW)
Optoelectronics TIG
iNEMI Optical Device Inspection & Cleaning Program
iNEMI Connector Particle Thickness Investigation Project, Phase 1

Version 3.1

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Project Leader: Dave Fisher (Tyco Electronics)
Co-Project Leader:
TC Coach:

Program Scope of Work

This program is continuation of the iNEMI project "Fiber Optic Connector End-Face Inspection, Phase 2." The program will be focused on the research in the following three project areas:

<u>Project Areas / Priorities</u>

1. Investigate Impact of Connector Particle Thickness
2. Investigate Impact of Contamination and Scratches on 40G Optical Signal Transmission
    a. Phase 1 - Investigate Impact of Contamination and Polishing Scratches on 40G Optical Link Performance
    b. Phase 2 - Develop Recommendations on Connector End-Face Cleanliness Inspection Criteria for 40G Optical Signal Transmission
3. Develop Receptacle Lens Cleanliness Inspection Criteria
    a. Phase 1 - Modeling & Experimental Investigation of Receptacle Lens Cleanliness Inspection Criteria
    b. Phase 2 - Development of Inspection Criteria for Contamination on Lens-Based Modules

This program will collaborate with the International Electrotechnical Committee (IEC), Telecommunications Industry Association (TIA), and IPC to develop a cleanliness standard. The project will also focus on improving the cleaning process and prevention of fiber end-face contamination. Potential participants include, but are not limited to, OEM (original equipment manufacturers), EMS (electronics manufacturing services) providers, previous members of the iNEMI Fiber Connector End-face Inspection Project, suppliers of fiber optic cables and receptacle modules, inspection equipment suppliers and fiber optic connector cleaning solution suppliers.

iNEMI Connector Particle Thickness Investigation Project, Phase 1

Basic Project Information

Scope of Work

Transceiver modules with lensed receptacle remain the area where inspection criteria for contamination are to be developed. Unlike the receptacles with fiber stub, the receptacles with lens features vary significantly in design, technology, and material composition, which make the standardizing of inspection criteria based on the size of contaminants, as was implemented for fiber stub receptacle, unsuitable. Furthermore, due to the proprietary nature of each lens system design, a universal approach of the effect of the contamination based on the individual lens design information is out of reach. These are the main obstacles on the way to reach a standard across various receptacle designs.

Nonetheless, attempts have to be made. The primary goal of this project is to develop a method that can be used to determine the effect from lens contamination for a given transceiver module with a set of disclosed design parameters, such as wavelength, lens-fiber distance, effective optical area, etc.

Dependency

This work is predicated on the assumption that there is sufficient data available in the industry to make the decisions required within the scope of this project. If it is found during the course of this project that additional data is required, this Statement of Work would be modified to include a test phase. The new SOW would be submitted to the iNEMI Technical Committee for approval prior to committing the project team to the tasks identified in the new SOW.

Purpose of Project

Previous work by the iNEMI group on assessing the impact of end-face contamination on performance of mated connectors has shown increases in insertion loss and decreases in return loss (increase in reflectance). While a portion of this is explained by the fact that the contamination is directly over the fiber core(s), there are cases where the contamination surrounds the core but does not obstruct the optical path.

In presentation materials supplied by Molex, they showed the theoretical results of end-face separation (air gap between two fiber cores), where there is shown a strong dependence of insertion loss and return loss with longitudinal separation. Both measurements vary periodically with the amount of separation of a distance that is ½ the wavelength of the illuminating source.

The goal of this project is to better understand this impact through a practical experiment. We will purposely introduce contamination on the end-face of fiber optic connectors, mate them, and measure optical performance and record images of the end-faces. With the use of a confocal-type microscope, we will attempt to measure particle height to understand the amount of fiber separation. We will then relate the resultant optical performance to the theoretical Fabry-Perot effects due to fiber separation for each of four wavelengths (1310, 1490, 1550 and 1625nm).

Previous Related Work

- Molex: Previous presentation by Molex titled "Fiber Connector End-Face Inspection Project" summarized IL and RL performance due to fiber separation as a function of wavelength (850nm and 1300nm). Contention was that performance can be impacted by debris on the fiber core or by end-face geometry (fiber separation) and that it is difficult to discern the cause of transmittance degradation. Molex used Fabry-Perot and Airy equations to determine fiber separation at each wavelength and resultant (theoretical) IL and RL performance.
- iNEMI presentation (2003 timeframe): "Optical Connector Contamination and its Influence on Optical Signal Performance" mentions end-face separation as having an impact on optical loss.
- No other previous work has been identified that purposely induces end-face separation through contamination to understand the impact on optical performance.

Business Impact

This project proposes to justify the changes to the current standard listed above by demonstrating a tangible return on investment. To this end we will present an ROI estimate using the following criteria:
Criteria:
Impact if work is not done

- Possible over-engineering and under-engineering of products and industry specifications
- Benefit to industry, as well as participating companies (cost, quality, yield, efficiency gained, process or test time, quicker diagnoses of issues, other resource savings, prevention of class failures)

Prospective Participants

- Optical component manufacturers
- Original equipment manufacturers
- Contract manufacturers
- Other:

Celestica, Inc.
Cisco Systems, Inc.
Juniper Networks
PVI Systems, Inc.
MicroCare
Tellabs
Tyco Electronics Corporation

Project Plan

Schedule with Milestones	Q1	Q2	Q3	Q4	Q5
Phase 1					
Task 1 Define and acquire samples	■				
Task 2 Test method development / refinement		■			
Task 3 Conduct practical experiment			■		
Task 4 Conduct the experiment				■	
Task 5 Present Results OFC/NFOEC 2012					■

Methodology and Resources

Phase 1 – Detailed Information

Resources: Team members from participating companies

Task 1 – Define and acquire samples

- Resources
  - iNEMI team determined that the sample connectors were to be SC/PC style—consistent with type used in previous experiments—terminated to at least 2 meters of single mode cable. Connectors on the opposite ends to be of style convenient to Tyco Electronics for test equipment interfacing.
- Materials and processes
  - Samples to be supplied by Tyco Electronics. Twenty (20) cable assemblies required—to create 10 mated pair samples.
  - Confirm sample end-faces have acceptable visual/dimensional characteristics (e.g., meet end-face quality criteria, EFG).
- Testing procedures – N/A

Task 2 – Test method development/refinement

- Resources
  - Tyco Electronics will provide personnel and equipment resources for required measurements.
- Materials and processes
  - Need to develop reliable/repeatable means of applying contamination on end-face so as not to block the core on the initial (and subsequent) mating.
  - Technician needs to work with the confocal microscope measurement utilities to determine which are most suitable for this experiment.
- Test procedures
  - Contaminate end-face.
  - Measurement of insertion loss and return loss at 4 wavelengths (1310, 1490, 1550, 1625nm).
  - Recording of end-face images so that particle dimension can be measured.
  - Collecting/analyzing images from interferometer.
  - Review data to validate method. Repeat if necessary to refine process.

Task 3 – Conduct practical experiment to understand/confirm physical distance and wavelength relationship to IL and RL performance

- Resources
  - Tyco Electronics and PVI Systems
- Materials and processes
  - Integrate system hardware, develop software for displacement control and data collection
- Testing procedures
  - Measure Insertion Loss changes and Return Loss as a function of displacement (separation of mated fiber optic connectors).
  - Review data to confirm theory.

Task 4 – Conduct the experiment

- Resources
  - Tyco Electronics
- Materials and Processes
  - 20 cable assembly samples provided by Tyco Electronics
- Testing Procedures
  - Record images of clean connectors.
  - Mate and record IL and RL. Repeat ten times.
  - Apply contamination on DUT end-face.
  - Record end-face images on Confocal microscope, standard microscope and interferometer.
  - Mate with reference connector, measure IL and RL.
  - Uncouple and record end-face images again.
  - Re-mate, measure IL and RL.
  - Repeat this for a total of five mating cycles.
  - Analyze and report results.

Project Monitoring Plans

This project falls under the general category denoted as a Standards Development (i.e., given a set of materials and/or processes, these projects define a usable range for each set). The projects would also identify an appropriate standards body to which a proposal could be submitted to make the sets part of the published standards. The purpose of specification projects may also be to prepare "white papers" for industry distribution with the ultimate goal of making new specifications into de facto standards.

Project monitoring plans are as follows:

- Ensure open lines of communication among participants
  - Bi-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
- Mid-project technical review and progress reports at regularly scheduled iNEMI meetings.

- 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).
- Project results, including conference presentations, technical papers, end-of-project webinar, etc., will be published on the iNEMI website.

Outcome of the Project

- Facilitate the development of new industry tools, processes and specifications
- Technical paper/whitepaper
  - Present recommendations to the OFC/NFOEC 2012
- Presentations at major test conferences
  - Industry Report Presentation at OFC/NFOEC 2012

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.