

**White Paper**  
**Opto-Electronics: The Secret to Success**

## Opto-Electronic Vendor Selection

### Introduction

Qualification of new technologies, new vendors, or new manufacturing locations is one of the most challenging issues for OEMs and component manufacturers. It is particularly problematic for opto-electronic devices, given their lower manufacturing maturity with respect to micro-electronics and typically more stringent reliability requirements. Furthermore, many OEMs and component manufacturers are reducing reliability staffing & capabilities to decrease costs, such that fewer engineers are forced to evaluate an ever wider array of technologies and suppliers. DfR Solutions can provide assistance to our customers in three key ways:

- Destructive physical analysis
- On-site vendor reliability audits
- Review of qualification, failure analysis, and corrective action reports

This white paper provides an overview of our services in each of the three areas.

### Destructive Physical Analysis (DPA)

DPA is an invaluable method of: (i) identifying process and design defects; (ii) evaluating potential lot-to-lot variation in subcomponent suppliers, materials, and process quality; and (iii) assessing competitive advantages and disadvantages between vendors. DfR has performed DPA for customers on the following opto-electronic components:

Category	Base Material System	Products	Form Factors
MMIC	SiGe GaAs InP	Laser amplifier Modulator driver MUX/DEMUX	Multi-pin butterfly Custom configuration
Sources/detectors	InP GaAs GaN Si	VCSEL DFB laser diode FP laser diode PIN APD TIA	TO can Multi-pin butterfly TOSA ROSA
Transceiver	InP GaAs Si	Integrated source/ detector + PCBA	SFP XFP
Tunable transponder	InP	Solid state & MEMS- based systems with integrated PCBA and modulator	300-pin

DPA of opto-electronic components places an emphasis on the following:

#### Packaged components

- Analytical tools: optical, X-ray, and acoustic inspection; cross-section analysis; residual gas analysis; non-volatile residue analysis with FTIR; ionic chromatography; SEM; EDX; FIB; Auger; SIMS
- Package sealing: methods (laser welding; seam welding; soldering; glass frit; epoxy); types (lid/header seal; optical feedthrough/window; electrical feedthrough); defect/delamination/cracking identification
- Volatile and non-volatile residue and contaminant analysis
- Particulate contamination (particularly for MEMS-based devices)
- Package, substrate, and subcomponent metallization: material and coating/plating analysis
- Subcomponent attachment (solder, epoxy, and laser welding): wetting/bondline filling; bondline delamination, voiding, and/or cracking; solder splash; intermetallic compound formation; bond strength
- Wire/ribbon bonding attachment: wire/ribbon deformation; heat affected zone (thermo-sonic); interface reactions/Kirkendall voiding; substrate cracking; pad lift-off; bond strength
- Optics, diode, and detector coatings: material composition analysis of complex AR/HR coatings as well as facet passivation layers

#### Integrated PCBA

- Methods: optical, X-ray, and acoustic inspection; cross-section analysis; ionic chromatography
- Solder joints: joint quality (wetting; fillet geometry; solder splash); delamination /cracking/voiding; strength
- Bond pads: plating material analysis (OSP, ENIG, HASL, etc.); pad corrosion (i.e. black pad); pad lift-off
- Ionic and organic residues: surfaces (by ionic chromatography) and interfaces (by cross-sectioning)
- PCB and flex materials: delamination; blistering; pad cratering
- Components: reflow/rework damage (outside and within); counterfeiting; case size and orientation assessment with respect to board strain and use;

#### **On-Site Reliability Audits**

Many companies use internal or external staff to perform quality audits of current or potential suppliers. However, the main goal of these audits are to evaluate documentation practices, vendor/process/design controls, and corporate structure/governance; basically, evaluating the stability and consistency of a product or vendor. As well as identifying where the vendor can be squeezed on cost...

DfR Solutions performs reliability audits of the entire manufacturing line (incoming material to finished goods) as well as associated test and qualification facilities. The intent is to identify designs, materials, components, processes, and practices that pose particular reliability risks for the customer. Recommendations will be made with respect to how to manage each of the risks, including particular qualification tests that should be highlighted for both the vendor and customer to screen for defective parts. These audits are best performed in conjunction with customer reliability or supply chain staff (the same that will potentially interact with the vendor), to train them and reduce the need for further assistance.

### **Review of Qualification, Failure Analysis, and Corrective Action Reports**

For engineers not directly familiar with a technology, product, or vendor, interpretation of vendor qualification reports can be challenging. This is compounded by the fact that many vendors do not perform all of the qualification tests required by industry standards (yes, this is quite common), generally due to prohibitive costs (but occasionally due to the fact that they do not want to report bad results!). Failure analysis and corrective action reports are even more difficult to evaluate, as they require specific knowledge of the design and assembly processes. Hence, the customer is exposed to unnecessary risks early in the development and deployment cycle, as well as through-out product lifetime.

DfR provides detailed commentary on all reports. Additional requests for information are made based on observed gaps in the reports, and recommendations are given on potential improvements by the vendor. The customer is provided with recommended screening tests and sampling levels, as well as on-going reliability test plans (for either party) and requirements for periodic reliability reporting from the vendor (reliability estimates, on-going failure analysis, and corrective action review).

### **DfR's Value Proposition**

DfR provides valuable perspective on opto-electronic reliability, gained from performing qualification testing and failure analysis at the component vendor level, as well as vendor assessment and system-level reliability evaluations at the OEM level. This perspective is further informed by DfR's success in performing reliability assessments for a wide range of customers serving other markets (military, commercial, industrial, medical, and automotive). Please give us a try!

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