QUALITY AND RELIABILITY

Reliability Test Report
AOC Bellcore GR-468-CORE Qualification

850nm VCSEL LC TOSA
850nm Receiver LC ROSA
1300nm Receiver LC ROSA
LC-OFE Subassemblies

SCOPE AND OVERVIEW

This report summarizes the test assessment results for AOC LC TOSA and ROSA products to verify product reliability compliance with the Bellcore (Telcordia) GR-468-CORE standard.

The products qualified in this test include:

- 850nm Proton VCSEL LC TOSA
- 850nm Oxide VCSEL LC TOSA
- 1.25Gb 850nm Detector LC ROSA
- 2.5Gb 850nm Detector LC ROSA
- 2.5Gb 1300nm Detector LC ROSA

The LC TOSA/ROSA products used in the specific mechanical/environmental tests run for this report were HFE4191-541 (850nm oxide VCSEL) and HFD3141-103 (1300nm 2.5Gb receiver). The LC TOSA/ROSA components were assembled into AOC LC-OFE subassemblies for mechanical handling, fixturing, and testing. Qualification is by similarity for products of the same type construction for mechanical and environmental tests of mechanical integrity. Some Bellcore standard tests were conducted previously as part of AOC product qualification work and those results are included in this report.
The electrical/optical testing for pass/fail was done at dc conditions using AOC production test systems. Detectors were tested with 62.5µm fiber, VCSELs were tested with 50µm fiber.

Pass/fail decisions were based on a) meeting standard product test limits and b) meeting -2dB (-37%) delta optical response (coupled power for VCSEL and coupled responsivity for detectors).

Mechanical and environmental tests were done either internally at AOC’s Evaluation Lab in Richardson, Texas and externally at Environmental Test Lab (ETL) in Dallas, Texas and at one customer location. Reports were supplied for the external work.

MECHANICAL TESTS

Mechanical Test Overview

AOC has performed mechanical tests on the two mechanical packages utilized for this specific GR-468-CORE reliability qualification. See section 6 for test parameter and pass/fail criteria.

### Notes:

1. Mechanical shock, vibration, thermal shock done consecutively on same 11 unit sample, with testing pre/post for each mechanical test step.
2. Solderability done on 11 unit sample with no failures.
3. Die Shear done on 17 unit TO-Can sample of VCSEL laser chip and silicon back monitor chips with no failures for either chip.
4. Die Shear done on 18 unit TO-Can sample of receiver photodiode chip and TIA chip with no failures for either chip.
5. Wire Bond Pull done on 25 piece sample for 850nm Proton VCSEL TO-component with no failures. Sample data was taken over 2 month time period from production lots.
6. Wire Bond Pull done on 25 unit sample for 850nm receiver TO-component with no failures. Sample data was taken over 1 month time period from production lots.

<table>
<thead>
<tr>
<th>Test No</th>
<th>Test</th>
<th>Condition</th>
<th>TO-Can</th>
<th>850nm TOSA Failures</th>
<th>850nm ROSA Failures</th>
<th>1300nm ROSA Failures</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mechanical Shock</td>
<td>MIL-STD-883, Method 2002B, 1500G, 0.5ms: 5 cycles/axis</td>
<td>X</td>
<td>0 Note 1</td>
<td>0 Note 1</td>
<td>0 Note 1</td>
</tr>
<tr>
<td>2</td>
<td>Vibration Testing</td>
<td>MIL-STD-883, Method 2007A, 20G force random vibration from 20 to 2000 Hz</td>
<td></td>
<td>0 Note 1</td>
<td>0 Note 1</td>
<td>0 Note 1</td>
</tr>
<tr>
<td>3</td>
<td>Thermal Shock</td>
<td>MIL-STD-883, Method 1011 (\Delta T = 100^\circ C, \sim 25^\circ C/+75^\circ C, 100) cycles</td>
<td></td>
<td>0 Note 1</td>
<td>0 Note 1</td>
<td>0 Note 1</td>
</tr>
<tr>
<td>4</td>
<td>Solderability</td>
<td>MIL-STD-883, Method 2003</td>
<td>X</td>
<td>0 Note 2</td>
<td>0 Note 2</td>
<td>0 Note 2</td>
</tr>
<tr>
<td>5</td>
<td>Die Shear</td>
<td>MIL-STD-883, Method 2019 See Note 3 and 4</td>
<td>X</td>
<td>0 Note 3</td>
<td>0 Note 4</td>
<td>0 Note 4</td>
</tr>
<tr>
<td>6</td>
<td>Wire Bond Pull</td>
<td>MIL-STD-883, Method 2011 See Note 5 and 6</td>
<td>X</td>
<td>0 Note 5</td>
<td>0 Note 6</td>
<td>0 Note 6</td>
</tr>
</tbody>
</table>

Table 1: Mechanical Tests (Sample size = 11 minimum, see notes for details)
LEAK TEST

AOC has done a hermetic seal (fine and gross leak) check before and after mechanical integrity tests on TO-Can samples of VCSEL and receiver. Samples were pulled from stock (11 samples of each) of 850nm proton VCSEL and 1300nm receiver. The 850nm oxide VCSEL TO-Can package is qualified by similarity to the 850nm proton VCSEL TO-Can package. The 850nm receiver TO-Can package is qualified by similarity to the 1300nm receiver.

<table>
<thead>
<tr>
<th>Test No</th>
<th>Test</th>
<th>Condition</th>
<th>VCSEL Failures</th>
<th>Receiver Failures</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Hermetic Seal</td>
<td>MIL-STD-883, Method 1014.10</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>Mechanical Shock</td>
<td>MIL-STD-883, Method 2002B, 1500G, 0.5ms, 5 cycles/axis</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>Thermal Shock</td>
<td>MIL-STD-883, Method 1011, ΔT=100C, -25C/+75C</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>Hermetic Seal</td>
<td>MIL-STD-883, Method 1014.10</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 2: Leak Tests for TO-Can (Sample size = 11 for each test)

Notes:
1. Tests were run on HFE4088-904P and HFD3041-103 TO-46 components. A sample of 11 units for each product were run consecutively through test steps #1-5 without failure.

ACCELERATED LIFE TESTS

AOC has published extensive reliability reports for its VCSEL and receiver products on the VCSEL Optical Products Division website. Refer to those reports for accelerated lifetimes and information about tests conducted. Tests were conducted for TO components. The information is applicable to the LC TOSA and LC ROSA level assembly products.

ENVIRONMENTAL TESTS

Test Overview

Environmental tests were done in this specific qualification for Low Temp Storage and Cyclic Moisture Resistance, on LC TOSA/ROSA samples assembled into a AOC LC-OFE product assembly for mechanical handling, fixture, and optical test purposes. The other three environmental tests, Temp Cycling, T&H, and High Temp Storage, were previously done as part of AOC standard product qualifications, with those results reported here.

Notes:
1. Temp Cycling (AOC qual # 999013) was 500 cycles, -40C to +85C, 30 units, with no failures. Test was for 850nm proton VCSEL LC TOSA. The 850nm oxide VCSEL LC TOSA is qualified by similarity (same package).
2. Temp Cycling (AOC qual #009035) was 500 cycles, -40C to +85C, 29 units, with no failures. Test was for 850nm LC ROSA. The 1300nm LC ROSA is qualified by similarity (same package).
3. Temp & Humidity Storage (AOC qual #019001) was 1092 hours, 85C/85%RH, 30 units, with no failures. Test was for 850nm proton VCSEL LC TOSA. The 850nm oxide VCSEL LC TOSA is qualified by similarity (same package).
4. Temp & Humidity Storage (AOC qual #009035) was 1000 hours, 85C, 85%RH, 30 units, with no failures. Test was for 850nm LC ROSA. The 1300nm LC ROSA is qualified by similarity (same package).
5. Low temperature storage readings were at 2000 hours, with 11 units. There were no failures.
6. High Temp Storage (AOC qual #019001) was 1092 hours, with bias at 20mA, 35 units, with no failures. Test was for 850nm proton VCSEL LC TOSA. The 850nm oxide VCSEL LC TOSA is qualified by similarity (same package).
7. High Temp Storage (AOC qual #019002) was 1092 hours, with bias at 3.3Volts, 30 units, with no failures. Test was for 850nm receiver LC ROSA. The 1300nm receiver LC ROSA is qualified by similarity (same package).

8. Cyclic Moisture Resistance was done on 850nm oxide VCSEL LC TOSA and 1300nm receiver LC ROSA assembled into LC-OFE product. Test was for 11 units with no failures. The 850nm proton VCSEL LC TOSA and 850nm receiver LC ROSA are qualified by similarity (same package).

**ELECTROSTATIC DISCHARGE (ESD)**

Standard ESD testing has previously been conducted for AOC proton and oxide VCSEL, 850nm receiver, and 1300nm receiver TO-components. The results are reported here. ESD testing was to MIL-STD-883, Method 3015.7, Human Body Model, with 3 pulses forward/reverse applied to the signal leads. Failure is defined as a measurable (>5%) change in a key parameter, optical power output for VCSEL, optical responsivity for receiver. ESD limitation is the opto-electronic chip, not the package, so TO-component data applies to the LC connectorized component.

The 850nm proton VCSEL TOSA fails at 700 Volts for damage to the laser chip, with a decrease in optical power output. The silicon back monitor photodiode fails at 2200 Volts, with an increase in dark leakage current.

The 850nm oxide VCSEL TOSA fails at 450 Volts for damage to the laser chip, with a decrease in optical power output. The silicon back monitor photodiode fails at 2200 Volts, with an increase in dark leakage current.

The 850nm ROSA fails at 6000 Volts for damage to the output signal leads (either one).

The 1300nm ROSA fails at 6000 Volts for damage to the output signal leads (either one).

**TEST PARAMETER AND PASS/FAIL CRITERIA**

The product parameter tracked in these mechanical and environmental tests for delta change was optical response, VCSEL coupled power output and receiver responsivity. Failure was defined as a shift or change greater than -2dB (-37%). In addition the standard product production testing on AOC test systems was done, with performance within product test limits for a number of other parameters required for pass/fail decision.

**REQUALIFICATION/SURVEILLANCE PLAN**

AOC will requalify these three product families per the GR-468-CORE standard (every two years maximum) if continued product demand and business conditions provide justification.

**REFERENCE STANDARDS**

**MIL-STD-883E**


**GR-468-CORE**

ADVANCED OPTICAL COMPONENTS

Finisar’s ADVANCED OPTICAL COMPONENTS division was formed through strategic acquisition of key optical component suppliers. The company has led the industry in high volume Vertical Cavity Surface Emitting Laser (VCSEL) and associated detector technology since 1996. VCSELs have become the primary laser source for optical data communication, and are rapidly expanding into a wide variety of sensor applications. VCSELs’ superior reliability, low drive current, high coupled power, narrow and circularly symmetric beam and versatile packaging options (including arrays) are enabling solutions not possible with other optical technologies. ADVANCED OPTICAL COMPONENTS is also a key supplier of Fabrey-Perot (FP) and Distributed Feedback (DFB) Lasers, and Optical Isolators (OI) for use in single mode fiber data and telecommunications networks.

LOCATION

- Allen, TX - Business unit headquarters, VCSEL wafer growth, wafer fabrication and TO package assembly.
- Fremont, CA – Wafer growth and fabrication of 1310 to 1550nm FP and DFB lasers.
- Shanghai, PRC – Optical passives assembly, including optical isolators and splitters.

SALES AND SERVICE

Finisar’s ADVANCED OPTICAL COMPONENTS division serves its customers through a worldwide network of sales offices and distributors. For application assistance, current specifications, pricing or name of the nearest Authorized Distributor, contact a nearby sales office or call the number listed below.

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- 1, 2, 4, 8, and 10Gbps serial SW DETECTOR solutions
- VCSEL and detector arrays
- 1, 2, 4, 8, and 10Gbps FP and DFB solutions at 1310 and 1550nm
- 1, 2, 4, 8, and 10Gbps serial LW DETECTOR solutions
- Optical Isolators from 1260 to 1600nm range
- Laser packaging in TO46, TO56, and Optical subassemblies with SC, LC, and MU interfaces for communication networks
- VCSELs operating at 670nm, 780nm, 980nm, and 1310nm in development
- Sensor packages include surface mount, various plastics, chip on board, chipscale packages, etc.
- Custom packaging options

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