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Accelerated Aging Test of 1310 nm Laser Diodes

APPLICATION NOTE

ILX Lightwave®

A Newport Corporation Brand

Accelerated Aging Test of 1310 nm Laser Diodes

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This accelerated aging test was performed on telecommunications grade 1310 nm edge emitting laser diodes.

1. OBJECTIVE

Determine the median time to failure at 85°C.

2. DEVICES TESTED

This test was performed on a batch of 18 1310nm edge emitting laser diodes.

3. TEST SETUP

Tests were conducted in an ILX Lightwave LRS-9424 Laser Reliability and Burn-In Test system. Devices were mounted in a standard 32 device fixture with an external InGaAs photodiode array calibrated for 5mW full scale range.

The devices under test were subjected to two sequential 500 hour accelerated aging tests, the first at 60°C and the second at 85°C. Both tests were conducted in constant power (APC) mode at the laser diodes optical output power of 5 mW.

Pre and post LIVs data were collected at 40°C in order to identify any unusual device characteristics.

Control Mode: APC mode at 5mW optical output power.

Data Sampling: 30 minutes
Data Averaging: 30 minutes

Temperature: 60°C, 85°C
Aging Time: 500 hours, each test

Ongoing test results were reviewed periodically during the course of the test. No unusual behavior was observed.

4. DATA ANALYSIS

4.1 Pre and Post Burn-In LIV Results

Pre and post burn-in LIV tests at 40°C produced typical, well behaved parametric curves for output optical power and voltage vs laser drive current. These LIV tests were performed before and after the 85°C burn-in. The results of these tests are shown in Figures 1 and 2 below.

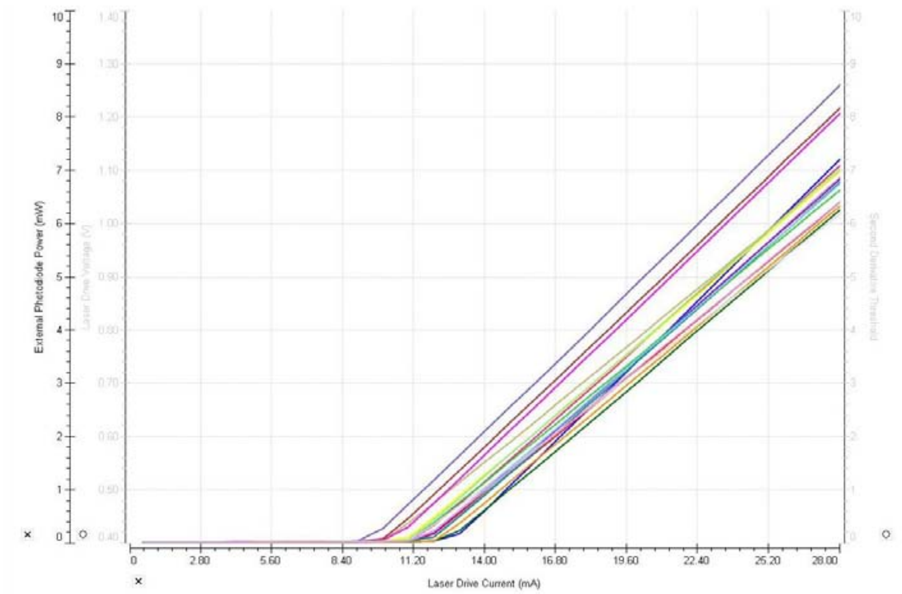

Figure 1 - Pre Burn-In LIV Test Results

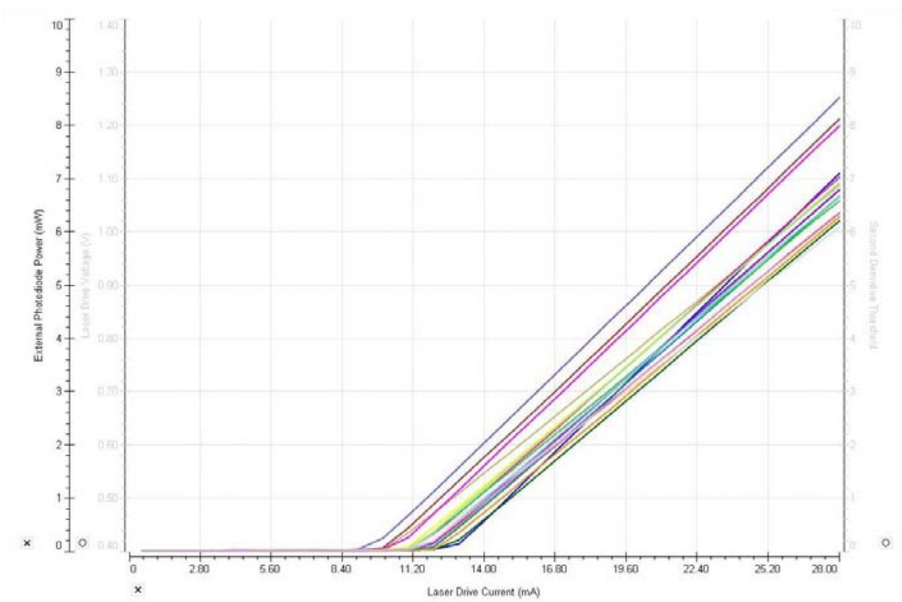

Figure 2 - Post Burn-In LIV Test Results

4.2 Accelerated Aging Test Results

In this APC mode test the light output of each laser is held at a constant 5mW by increasing the laser diode drive current (Iop) as the device ages. Initial drive currents to achieve 5 mW output ranged from approximately 29.2 mA to 38.2 mA as shown in Figure 3 below. No random (sudden) failures were observed during the test.

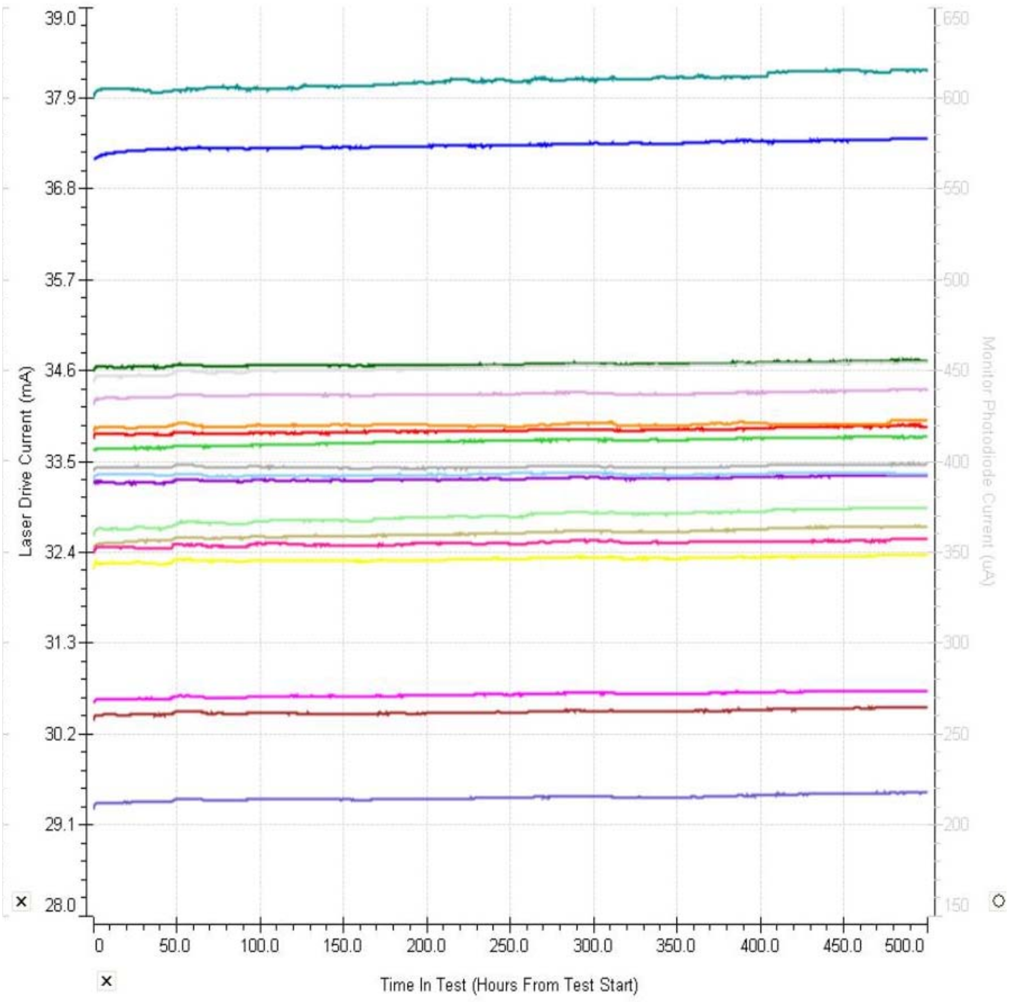

Figure 3 - Aging Trend

This first 500 hour test was performed at 60°C. The devices showed very little aging at this temperature during the short, 500 hour duration of the test. The second 500 hour test was performed at 85°C and a higher rate of aging was observed.

In order to estimate lifetimes it is necessary to establish a definition of end-of-life. For this analysis we have defined end-of-life as a 20% rise in laser diode drive current (Iop) over the initial value. Using this definition the aging trend for each laser was extrapolated to end-of-life. The following table provides a summary of the aging rates and estimated lifetimes based on this analysis.

Device #	Aging Rate (%/KHr)	Lifetime (Hrs)
1	0.7	27,297
2	0.6	31,175
3	0.4	50,173
4	1.0	19,664
5	0.2	82,536
6	0.5	42,217
7	0.5	42,127
8	0.2	84,331
9	1.4	14,124
10	0.6	35,920
11	0.8	26,477
12	0.7	30,346
13	0.6	34,668
14	0.8	25,100
15	0.5	41,239
16	1.3	14,974
17	0.2	88,922
18	0.4	48,815

5. LIFETIME ANALYSIS

The lifetimes reported above have a lognormal probability distribution as is typical for most laser diodes exhibiting a wear out failure mode. Results of the reliability analysis based on the lifetime data is provided in the table below:

Lifetime Results			
	Lifetime (Hrs)	Upper Bound (Hrs)	Lower Bound (Hrs)
50% Cumulative Failures	35,900	44,600	28,900
2% Cumulative Failures	11,500	17,300	7,602

Note that the lifetime at which cumulative failures reach 50% is also referred to as the median life or MTTF. The upper and lower bounds reported above correspond to 90% confidence bounds based on the number of samples in this test. The lognormal probability plot for the lasers in this test is shown in Figure 4 below.

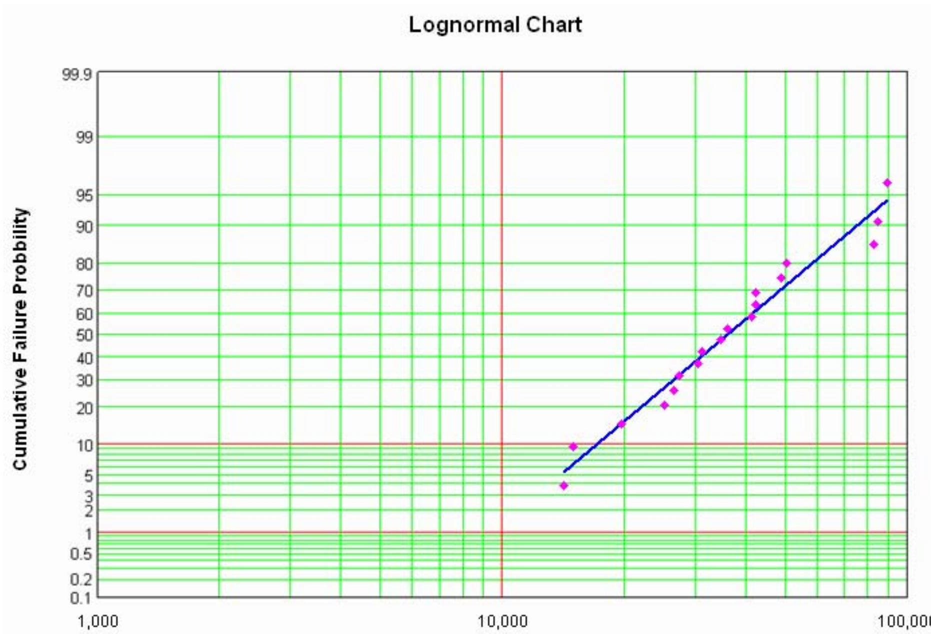

Figure 4 Lognormal Probability Plot of Lifetime Data

The lifetimes reported above correspond to a case temperature of 85°C. Longer lifetimes can be achieved by lowering the operating case temperature of the lasers or designing drive circuitry that can accommodate a larger increase in current than the 20% increase that was used to define end-of-life in this analysis.

Estimation of lifetime at other operating case temperatures can be accomplished by using the Arrenhius equation (see for example the NIST/SEMATECH e-Handbook of Statistical Methods, http://www.itl.nist.gov/div898/handbook/, June 2005). Use of the Arrhenius equation requires a value for the activation energy for the failure mechanism of the lasers. The value of the activation energy may be estimated by collecting and analyzing aging data at two or more temperatures.

The following publications are available for download at www.ilxlightwave.com.

White Papers

- A Standard for Measuring Transient Suppression of Laser Diode Drivers
- Degree of Polarization vs. Poincaré Sphere Coverage
- Improving Splice Loss Measurement Repeatability
- Laser Diode Burn-In and Reliability Testing
- Power Supplies: Performance Factors Characterize High Power Laser Diode Drivers
- Reliability Counts for Laser Diodes
- Reducing the Cost of Test in Laser Diode Manufacturing

Technical Notes

- Attenuation Accuracy in the 7900 Fiber Optic Test System
- Automatic Wavelength Compensation of Photodiode Power
- Measurements Using the OMM-6810B Optical Multimeter
- Bandwidth of OMM-6810B Optical Multimeter Analog Output
- Broadband Noise Measurements for Laser Diode Current Sources
- Clamping Limit of a LDX-3525 Precision Current Source
- Control Capability of the LDC-3916371 Fine Temperature Resolution Module
- Current Draw of the LDC-3926 16-Channel High Power Laser Diode Controller
- Determining the Polarization Dependent Response of the FPM-8210 Power Meter
- Four-Wire TEC Voltage Measurement with the LDT-5900 Series Temperature Controllers
- Guide to Selecting a Bias-T Laser Diode Mount
- High Power Linearity of the OMM-6810B and OMH-6780/6790/6795B Detector Heads
- Large-Signal Frequency Response of the 3916338 Current Source Module
- Laser Wavelength Measuring Using a Colored Glass Filter
- Long-Term Output Drift of a LDX-3620 Ultra Low-Noise Laser Diode Current Source
- Long-Term Output Stability of a LDX-3525 Precision Current Source
- Long-Term Stability of an MPS-8033/55 ASE Source
- LRS-9424 Heat Sink Temperature Stability When Chamber Door Opens
- Measurement of 4-Wire Voltage Sense on an LDC-3916 Laser Diode Controller
- Measuring the Power and Wavelength of Pulsed Sources Using the OMM-6810B Optical Multimeter
- Measuring the Sensitivity of the OMH-6709B Optical Measurement Head
- Measuring the Wavelength of Noisy Sources Using the OMM-6810B Optical Multimeter
- Output Current Accuracy of a LDX-3525 Precision Current Source
- Pin Assignment for CC-305 and CC-505 Cables
- Power and Wavelength Stability of the 79800 DFB Source Module
- Power and Wavelength Stability of the MPS-8000 Series Fiber Optic Sources
- Repeatability of Wavelength and Power Measurements Using the OMM-6810B Optical Multimeter
- Stability of the OMM-6810B Optical Multimeter and OMH-6727B InGaAs Power/Wavehead
- Switching Transient of the 79800D Optical Source Shutter
- Temperature Controlled Mini-DIL Mount
- Temperature Stability Using the LDT-5948
- Thermal Performance of an LDM-4616 Laser Diode Mount
- Triboelectric Effects in High Precision Temperature Measurements
- Tuning the LDP-3840 for Optimum Pulse Response
- Typical Long-Term Temperature Stability of a LDT-5412 Low-Cost TEC
- Typical Long-Term Temperature Stability of a LDT-5525 TEC
- Typical Output Drift of a LDX-3412 Loc-Cost Precision Current Source
- Typical Output Noise of a LDX-3412 Precision Current Source
- Typical Output Stability of the LDC-3724B
- Typical Output Stability of a LDX-3100 Board-Level Current Source
- Typical Pulse Overshoot of the LDP-3840/03 Precision Pulse Current Source
- Typical Temperature Stability of a LDT-5412 Low-Cost Temperature Controller
- Using Three-Wire RTDs with the LDT-5900 Series Temperature Controllers
- Voltage Drop Across High Current Laser Interconnect Cable
- Voltage Drop Across High Current TEC Interconnect Cable
- Voltage Limit Protection of an LDC-3916 Laser Diode Controller
- Wavelength Accuracy of the 79800 DFB Source Module

Application Notes

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- App Note 30: Measuring High Power Laser Diode Junction Temperature and Package Thermal Impedance

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