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Performance and Reliability Report for 1.3um FP Laser Diode

UNION OPTRONICS CORP.

February.21.2003 (A Type)

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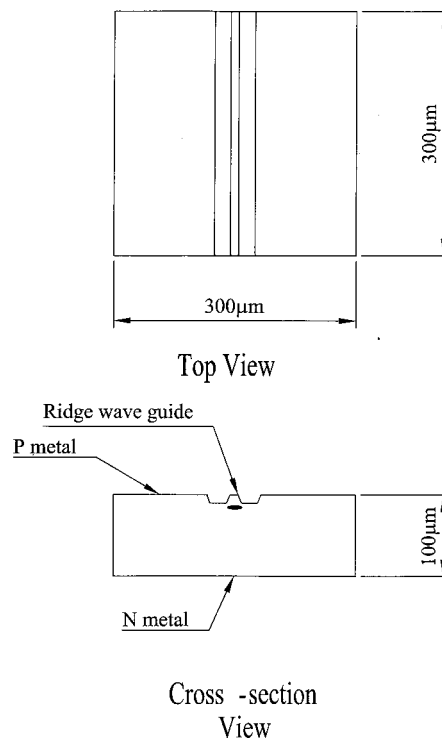
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• Chip Design

The U.O.C. 1.3 μ m FP laser diode chip uses a strained layer MQW structure based on the InP material system. The chip is a ridge waveguide (RWG) structure with HR/AR facet coatings. The design is optimized for high-speed operation in a P side(epi)-up configuration. The use of the MQW structure in the InP material system offers high temperature characteristics and successfully demonstrated the excellent performance and reliability even operated at 85 without TE cooler.

Chip Specification

External dimensions(Units : mm)



P-electrode and N-electrode are gold pad both.
Chip size : 300 μ m(W)x300 μ m(L)x100 μ m(H)

Absolute Maximum Ratings(Tc=25)

Parameter	Symbols	Value	Units
Optical Output	Po	5	mW
Reverse voltage	Vr	2	V
Operating Temperature	Top	-40 +85	
Storage Temperature	Tstg	-40 +125	

Electrical and optical Characteristics(Tc=25)

Parameter	Symbols	Conditions	Min.	Typ.	Max.	Units
Slope Efficiency	SE	CW,P0=5mW	0.2	0.4	-	mW/mA
Threshold Current	Ith	CW,P0=5mW	-	12	15	mA
Optical Output Power	Po	CW,Kink free	5	-	-	mW
Peak Wavelength		CW,P0=5mW	1290	1310	1330	nm
Spectral Width		CW,P0=5mW	-	3	5	nm
Forward Voltage	V	CW,P0=5mW	-	1.3	1.5	V
Beam Divergence		CW,P0=5mW,FWHM	-	18	-	deg.
			-	38	-	deg.

// and are defined as the angle within which the intensity is 50% of the peak value.

. Laser Diode Lot-to-Lot Controls

From each wafer lot, a sample of 25 devices are subjected to Burn-In at 100 and characterized the L-I performance later.

The conformity of the U.O.C. 1.3 μ m laser to specification is ensured by several stages of testing and controls. Devices are 100% tested and sorted by L-I characteristics and visually inspected at the bar level.

For lasers packaged in TO cans, 100% visual inspection is performed prior to die attachment, wire bonding and lid seal. Position of the laser in relation to the TO Base is 100% inspected. Shear strength results for the laser and monitor diode to the submount and submount to TO base are statistically monitored for control. After capping the TO cans are 100% fine leak tested according to MIL STD-883.

. Packaging

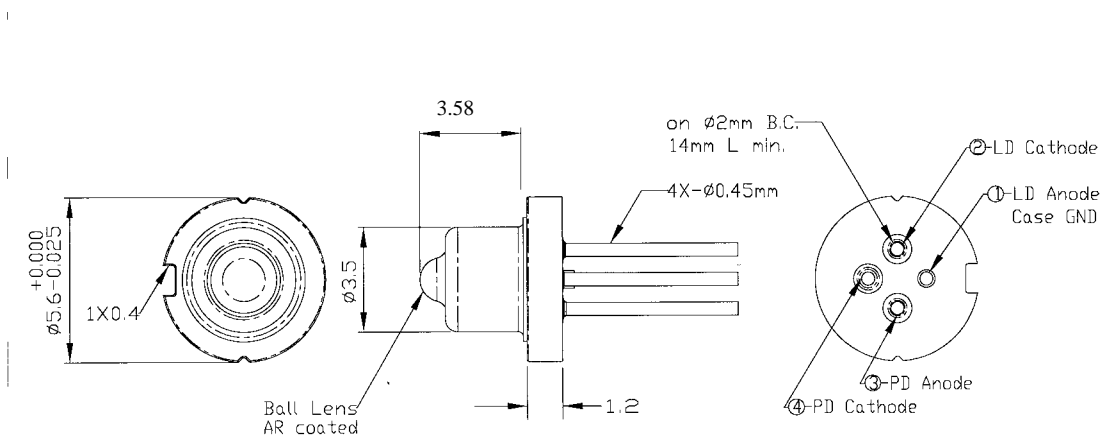
The chips are mounted on AlN submount using 80/20 Au/Sn solder. AlN submount with the laser chips are mounted to the header. The devices are hermetically sealed in nitrogen environment and leak checked to meet the specifications of MIL-STD-883.

LD Specification

1310nm Infrared Laser Diode

SLD-1310-B2-P5(A type)

External dimensions(Units : mm)

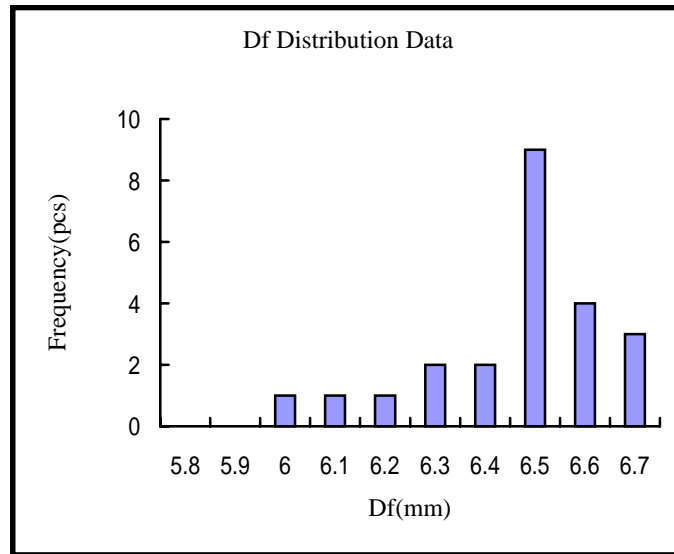


Absolute Maximum Ratings(Tc=25)

Parameter	Symbols	Condition	Value	Units		
Optical Output	Po	CW	7	mW		
Reverse Voltage	Laser (LD)	Vr	-	2	V	
	PIN (PD)	Vr(PIN)	-	10	V	
Operating Temperature	Top	-	-40 +85			
Storage Temperature	Tstg	-	-40 +125			

Electrical and optical Characteristics(Tc=25)

Parameter	Symbols	Conditions	Min.	Typ.	Max.	Units
Slope efficiency	SE	CW,Po=5mW	0.2	0.35	-	mW/mA
Threshold Current	Ith	CW,Po=5mW,Tc=25	-	12	15	mA
		CW,Po=5mW,Tc=-40~+85	-	-	45	
Optical Output Power	Po	CW,Kink free	5	-	-	mW
Peak Wavelength		CW,Po=5mW	1290	1310	1330	nm
Spectral Width		CW,Po=5mW	-	3	5	nm
Forward Voltage	V	CW,Po=5mW	-	1.3	1.5	V
Rise and fall Time	tr, tf	CW, Po=5mW, 10%~90%	-	-	0.7	ns
Monitor Current (PD)	Im	CW,Po=5mW,VRPD=2V	100	-	-	μ A
Dark Current (PD)	Id	VRD=10V	-	-	0.1	μ A
Capacitance (PD)	Ct	VRD=10V, f=1MHZ	-	-	20	pF
Tracking Error	TE	CW, Po=5mW, VRD=1V	-0.7	-	0.7	dB
P-I Kink	Ki	CW, Po<5mW	-	-	20	%



Df is a distance between reference plane of the base to the fiber

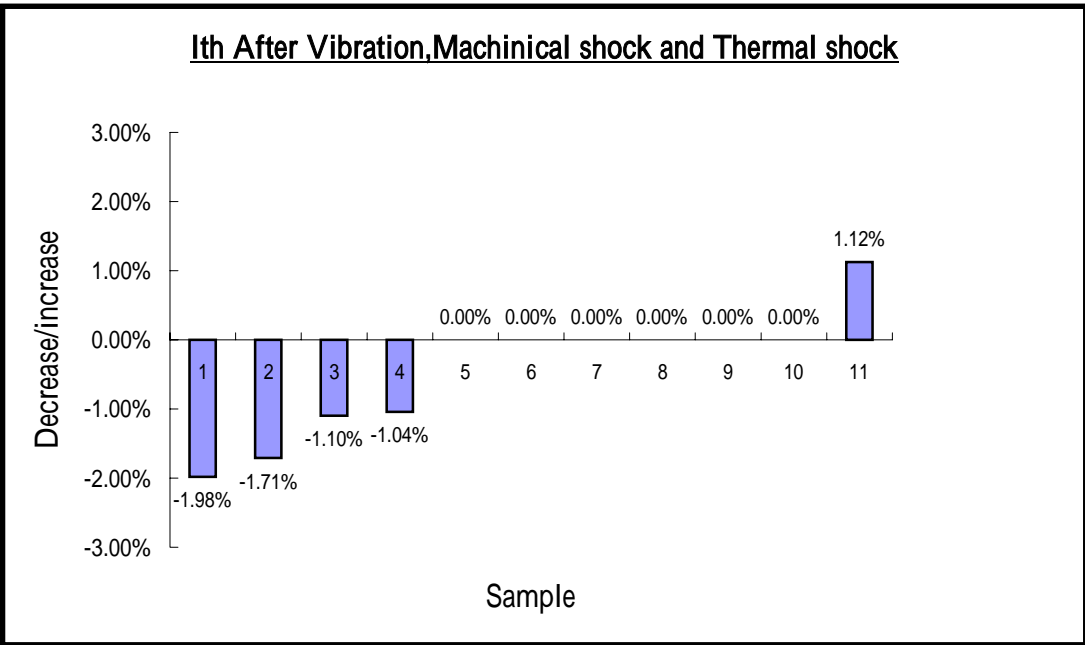
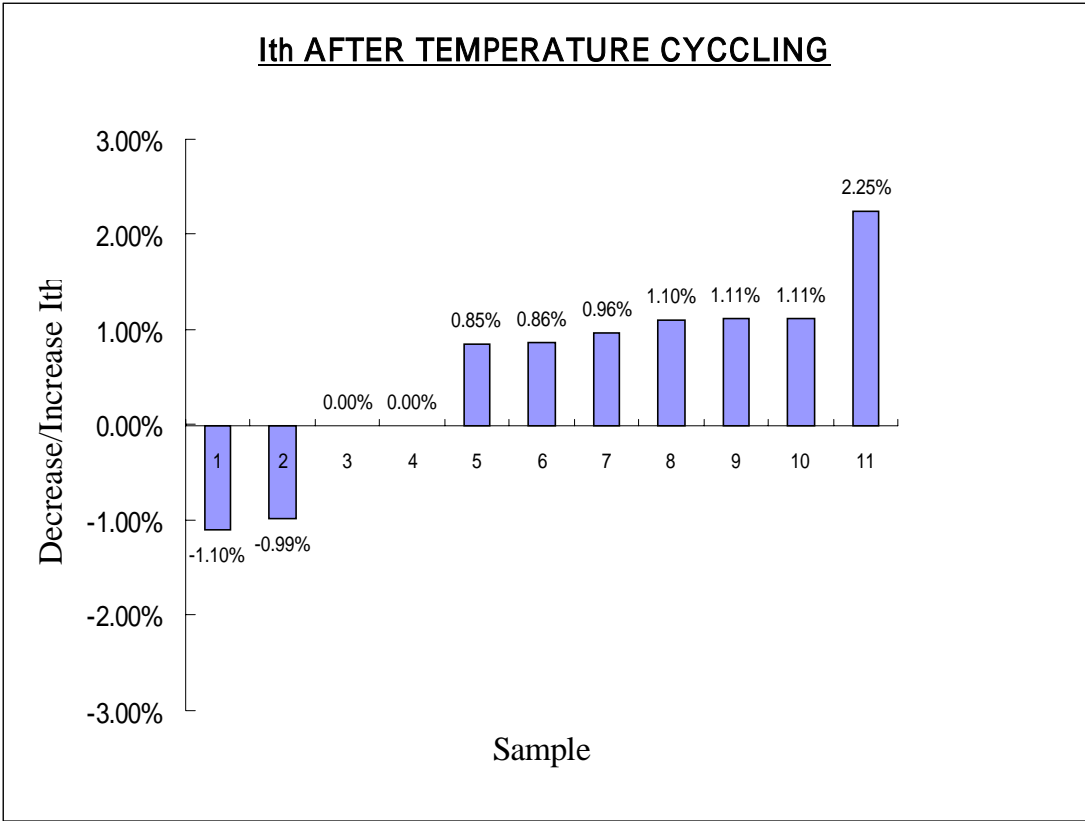
. Environment Test

The test plan for the characterization of the laser diodes was done following the recommendations of Bellcore TA-NWT-000983, with the following deviations.

Temperature range of Temperature cycling, Thermal shock was increased to -55 /125

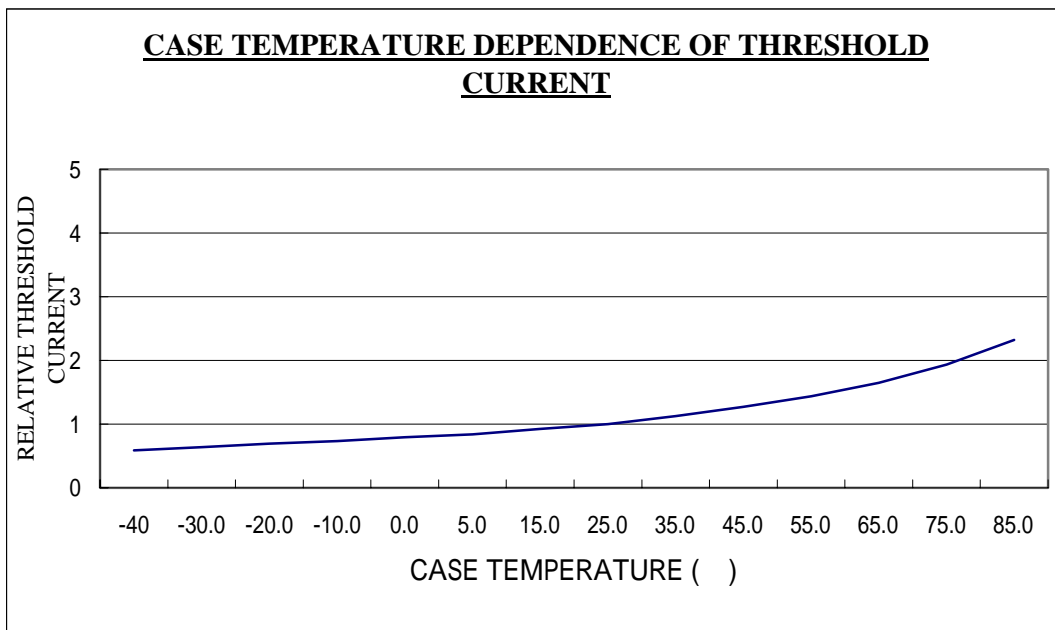
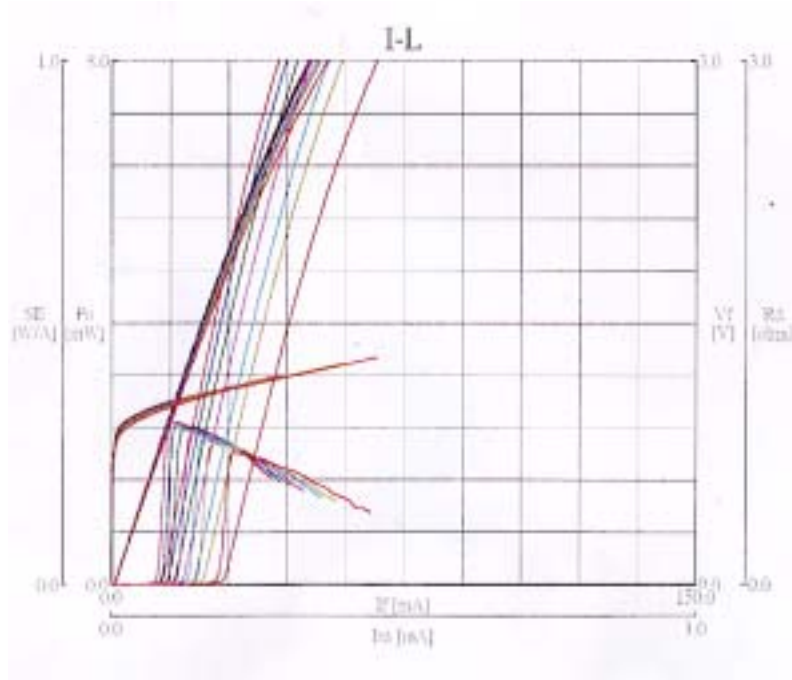
Time specified for the Mechanical Shock was shorted to 0.3ms.

Test	Standard	Condition	Sample Size	Criteria	Results
Temperature Cycling	MIL-STD-883 Method 1010.7	50 cycles -40 /85	11ea.		Mean Ith change: 0.55% Ith change: 0.99%
Mechanical Shock	MIL-STD-883 Method 2002	Condition B 1,500g 0.3ms	11ea		Mean Ith change: -0.45% Ith change: 0.92%
Vibration Test	MIL-STD-883 Method 2007	Condition A 20g peak 20 to 20kHz 4 min/cycle 4 cycles/axis			
Thermal Shock	MIL-STD-883 Method 1011.9	Condition B -55 / 125			
Wire Bonding strength	MIL-STD-883 Method 2011	Condition D Au wire 0.001” thick	25ea	Force > 3.0g	Mean force: 7.2g force: 0.90g
Die shear Laser/sm	MIL-STD-883 Method 2019.5		25ea	Wet<10%; force>0.080kg 10%<Wet<50%; force>0.050kg 50% Wet; force>0.040kg	Mean force: 0.281kg force: 0.080kg
Die shear sm/header	MIL-STD-883 Method 2019.5		25ea	Wet<10%; force>0.500kg 10%<Wet<50%; force>0.625kg 50%<Wet; force>1.000kg	Mean force: 3.965 kg force: 0.711kg



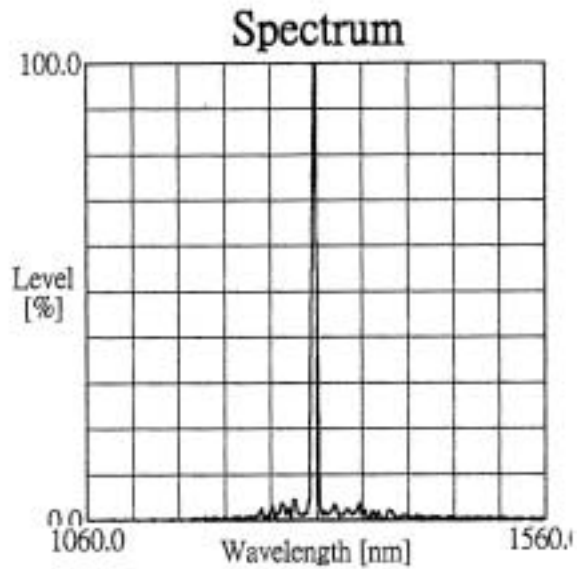
• **Temperature dependence of the L-I parameters**

The characterization tests were performed from 25 to 85 instead of -40 to 85 due to fixture limitations for low temperature testing. Below are shown L-I curves for 25, 35, 45, 55, 65, 75 and 85 for a typical device.



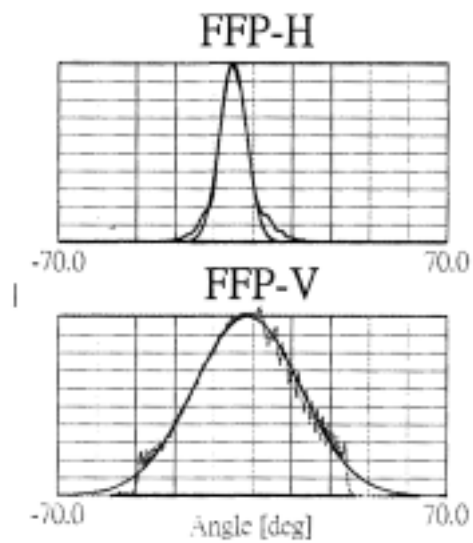
. Spectrum

The figure below shows a typical FP spectrum.



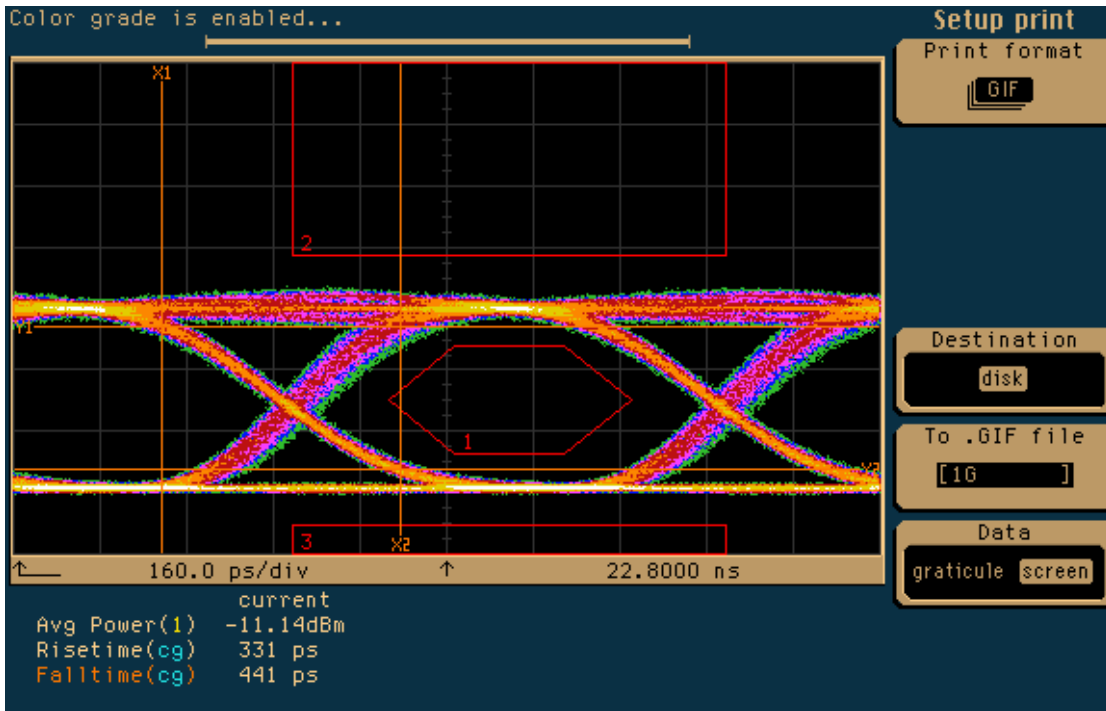
. Far fields

The figures below show typical far field results a result of a sample of 10 devices. FWHM for the parallel far field is typically 18° and the perpendicular far field 38° giving an aspect ratio of 2.11 to 1.



. Eye diagram plot

The figure below shows an eye diagram plot for a chip mounted p-up on a submount showing operation at 1.2Gbit.



Reliability

Test conditions

A total of 22 lasers taken from normal production batches. The tests were conducted in a Sharetree life test system operating at heatsink temperature of 85 .

All the lasers used in the test were hermetically sealed in a nitrogen atmosphere in 5.6mm TO cans. Lasers were burned in prior to test for 96 hrs at 100 .

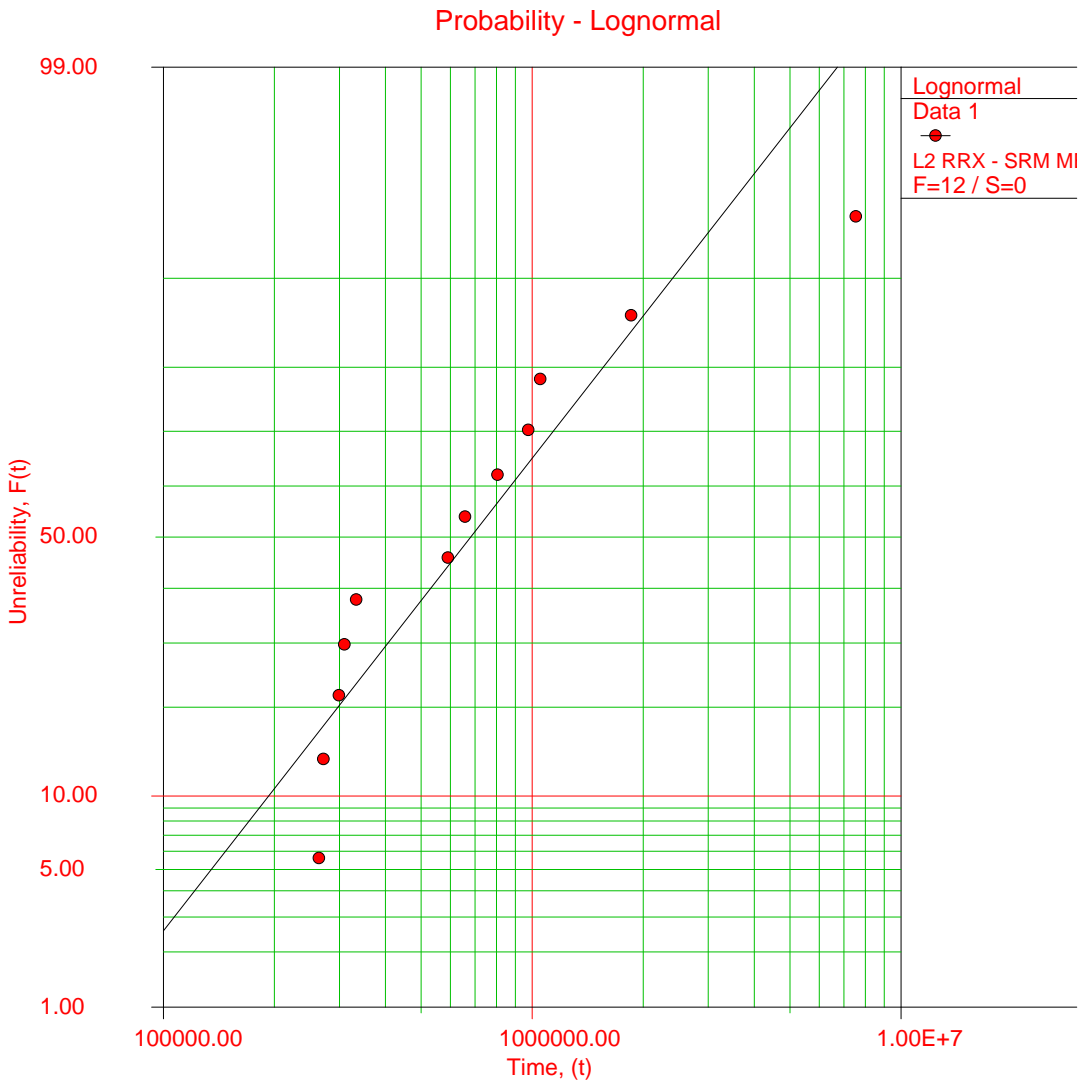
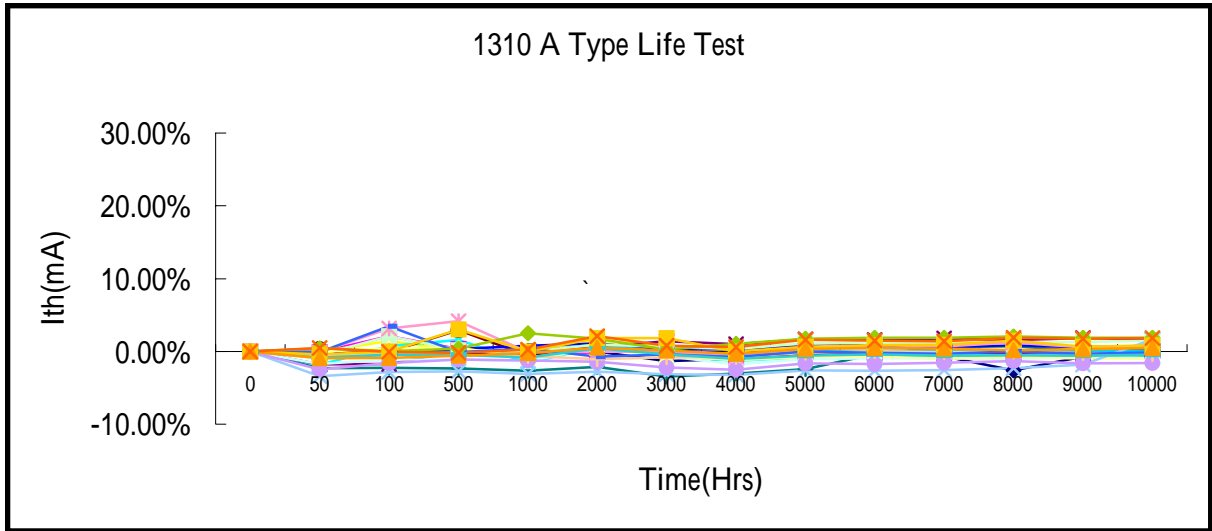
The lasers were monitored the output power from both front and rear facet power, drive current for 7mW and forward voltage at 1 hr intervals during the test.

Regression Analysis of the data

After 10000hours of the life test, the regression analysis yields the following Ith ratio as a function of time for the individual devices in test.

Time 變化率	0	50	100	500	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
1	0.00%	-0.27%	0.05%	-0.27%	-0.38%	-0.03%	-1.32%	-1.03%	-0.45%	-0.46%	-0.66%	-2.62%	-0.73%	-0.68%
2	0.00%	-0.10%	2.09%	0.36%	-0.52%	-0.09%	0.56%	-0.88%	-0.02%	-0.17%	-0.23%	-0.18%	-0.27%	0.07%
3	0.00%	-0.05%	1.43%	0.06%	0.16%	1.47%	0.72%	0.12%	0.67%	0.72%	0.82%	0.62%	0.77%	0.51%
4	0.00%	-1.84%	0.76%	1.57%	-1.56%	0.61%	-0.62%	-1.29%	-0.81%	-0.56%	-0.62%	-0.48%	-0.75%	-0.67%
5	0.00%	-1.76%	-1.71%	0.07%	-0.37%	0.64%	1.41%	1.01%	1.67%	1.57%	1.80%	1.56%	1.83%	1.62%
6	0.00%	0.34%	-0.04%	2.93%	-0.58%	0.48%	-0.38%	-0.96%	-0.10%	-0.14%	-0.24%	-0.10%	-0.24%	-0.53%
7	0.00%	-2.28%	-2.25%	-2.32%	-2.63%	-2.12%	-3.44%	-3.07%	-2.44%	-0.37%	0.57%	0.75%	0.02%	0.27%
8	0.00%	-0.29%	-0.29%	0.36%	0.78%	1.11%	0.23%	0.32%	0.74%	0.86%	0.61%	0.88%	0.56%	0.76%
9	0.00%	-0.70%	-0.51%	-0.06%	-0.01%	0.94%	-0.10%	-0.61%	0.02%	0.09%	0.12%	0.07%	0.12%	-0.01%
10	0.00%	-1.71%	-1.13%	-1.10%	-1.37%	0.59%	-0.67%	-1.77%	-1.07%	-0.93%	-0.99%	-0.96%	-0.89%	-0.91%
11	0.00%	-0.50%	2.09%	0.15%	-0.07%	0.96%	0.59%	0.34%	1.14%	1.24%	1.20%	1.12%	1.29%	1.50%
12	0.00%	-0.05%	0.45%	0.54%	-0.89%	0.43%	-0.61%	-1.20%	-0.77%	-0.74%	-0.99%	-0.78%	-0.93%	-1.00%
13	0.00%	-3.41%	-2.82%	-2.72%	-3.08%	-2.78%	-3.13%	-3.20%	-2.59%	-2.66%	-2.56%	-2.28%	-1.80%	1.67%
14	0.00%	-0.12%	3.18%	4.17%	-0.09%	-0.07%	-0.03%	-0.72%	0.17%	0.86%	0.67%	1.23%	0.56%	0.62%
15	0.00%	-2.47%	-1.60%	-1.09%	-1.26%	-1.42%	-2.20%	-2.52%	-1.65%	-1.74%	-1.56%	-1.32%	-1.64%	-1.61%
16	0.00%	-0.69%	-0.13%	-0.56%	-0.64%	-1.08%	-0.81%	-0.74%	-0.20%	0.04%	-0.09%	-0.03%	-0.25%	-0.35%
17	0.00%	-0.10%	3.45%	-0.10%	0.40%	-0.71%	-0.40%	-0.75%	-0.01%	-0.17%	-0.30%	0.00%	-0.30%	-0.15%
18	0.00%	-0.85%	-0.44%	-0.46%	-0.86%	0.42%	-0.40%	-1.03%	-0.59%	-0.42%	-0.58%	-0.53%	-0.58%	-0.45%
19	0.00%	0.44%	0.05%	0.39%	2.49%	1.75%	0.26%	1.03%	1.73%	1.89%	1.89%	2.04%	1.87%	1.89%
20	0.00%	-0.40%	0.00%	3.03%	0.00%	1.85%	1.84%	0.00%	0.66%	0.85%	0.90%	1.50%	0.65%	0.85%
21	0.00%	-0.95%	-0.88%	-0.57%	-0.24%	0.52%	0.12%	-0.34%	0.33%	0.48%	0.37%	0.15%	0.28%	0.48%
22	0.00%	0.48%	-0.05%	-0.17%	0.27%	2.09%	0.79%	0.63%	1.63%	1.47%	1.42%	1.89%	1.77%	1.84%

Table 1



$\mu=13.4312, \sigma=0.9841, \rho=0.9253$

figure 1

As all the devices show a decrease in operating current for constant power the end of life cannot be estimated at this point in Table 1. According to Lognormal distribution in figure 1 the estimated MTTF at $T_c=85$ and $P_o=5mW$ is 1.1×10^6

According to Bellcore TA-NWT-000993 if experimental data for activation energies is not available, an activation energy of 0.4 eV shall be assumed for wear out failures and 0.35 eV for sudden failures. Assuming a conservative value of 0.35 eV we can construct the following table of minimum lifetime predictions:

Temperature	85	75	65	55	45
Life time (hrs)	1.1×10^6	1.52×10^6	2.15×10^6	3.11×10^5	4.59×10^6

Temperature	35	25
Life time (hrs)	6.95×10^6	1.08×10^7

. Conclusions

At this stage in the test, the data indicates that the UOC 1.3um FP Laser Diode will meet the target specification of MTTF of 1.1×10^6 hours at maximum operating temperature of 85 .




ELECTRONICS TESTING CENTER, TAIWAN
TEST REPORT

Ind. Ser. No. : ET90T-04-024-E00
Applicant : UNION OPTRONICS CORP.
Commodity : LASER DIODE
Model : 1310 nm LD
Quantity : 11 pcs
Date of Receipt : Apr. 9, 2001
Date of Testing : Apr. 9, 2001 ~ Apr. 11, 2001
Measuring Environment : Temp. $21 \pm 2^\circ\text{C}$, R.H. $60 \pm 2\%$
Testing Item :

1. Vibration test
2. Shock test
3. Thermal shock test

Dept. Manager :


Andrew Y. Lin





TEST REPORT

Ind. Ser. No. ET90T-04-024-E00

Testing Conditions : According to applicant's specifications.

1. Vibration test

Waveform : Sine wave

Frequency : 20 ~ 2000 ~ 20Hz / 4min.

Amplitude : 1.5mm (20 ~ 82Hz)

Acceleration : 20g (82 ~ 2000Hz)

Orientation : X , Y , Z (3 axes)

Test time : 16 min. in each axis

Sample condition : Un-packed , Non-operating



2. Shock test

Pulse shape : Half-sine wave

Peak acceleration : 1500g

Duration of pulse : 0.5ms

Orientation : $\pm X$, $\pm Y$, $\pm Z$ (3Axes)

Number of shocks : 5 shocks / each direction

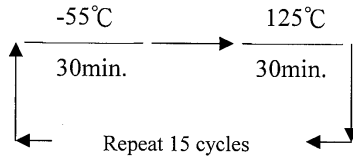
Sample condition. : Un-packed , Non-operating



TEST REPORT

Ind. Ser. No. ET90T-04-024-E00

3. Thermal shock test



Sample condition : Un-packed , Non-operating

Testing Equipment :

NAME	MODEL
VIBRATION TEST SYSTEM	IMV VS-3203
SHOCK TESTER	AVCO SM-110-MP
THERMAL SHOCK TEST CHAMBER	YASHIMA-TSER 2252

Testing Result :

Visual appearance check : Normal

Function check : Checked by the applicant


Tester