



友嘉科技股份有限公司  
UNION OPTRONICS CORP.  
No.156,Kao-Shy Road,Yang-Mei,  
Tao-Yuan,Taiwan,R.O.C.  
TEL 886-3-485-2687 FAX 886-3-475-9862

# Performance and Reliability Report for 1.3um FP Laser Diode

UNION OPTRONICS CORP.

February . 21 . 2003 (C Type)

# Table of Contents

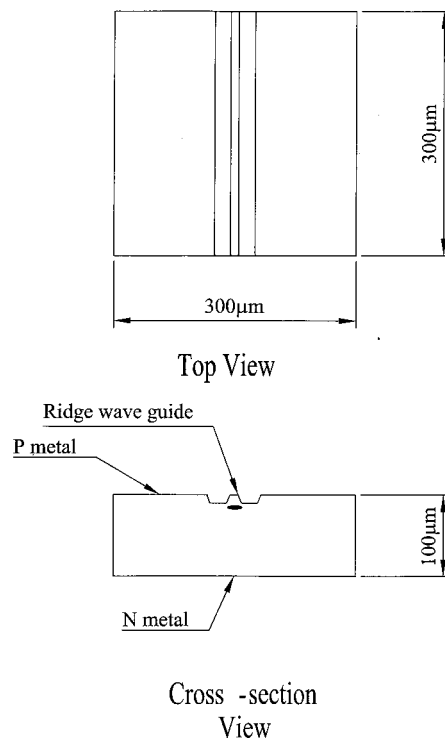
	<b>Page</b>
. Chip design.....	3
. Laser Diode Lot-to-Lot Controls.....	5
. Packaging.....	5
. Environment Test.....	8
. Temperature dependence of the L-I characteristics.....	10
. Spectrum.....	11
. Far fields.....	11
. Eye diagram plot.....	12
. Reliability.....	13
. Test conditions.....	13
. Regression Analysis of the data.....	13
. Conclusions.....	15

## • Chip Design

The U.O.C. 1.3 $\mu$ 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 °C without TE cooler.

### Chip Specification

**External dimensions(Units : mm)**



P-electrode and N-electrode are gold pad both.

Chip size : 300 $\mu$ m(W)x300 $\mu$ m(L)x100 $\mu$ m(H)

**Absolute Maximum Ratings(Tc=25 )**

Parameter	Symbols	Value	Units
Optical Output	Po	<b>5</b>	mW
Reverse voltage	Vr	<b>2</b>	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	<b>0.2</b>	<b>0.4</b>	-	mW/mA
Threshold Current	Ith	CW,P0=5mW	-	<b>12</b>	<b>15</b>	mA
Optical Output Power	Po	CW,Kink free	<b>5</b>	-	-	mW
Peak Wavelength		CW,P0=5mW	<b>1290</b>	<b>1310</b>	<b>1330</b>	nm
Spectral Width		CW,P0=5mW	-	<b>3</b>	<b>5</b>	nm
Forward Voltage	V	CW,P0=5mW	-	<b>1.3</b>	<b>1.5</b>	V
Beam Divergence		CW,P0=5mW,FWHM	-	<b>18</b>	-	deg.
			-	<b>38</b>	-	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 $\mu$ 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

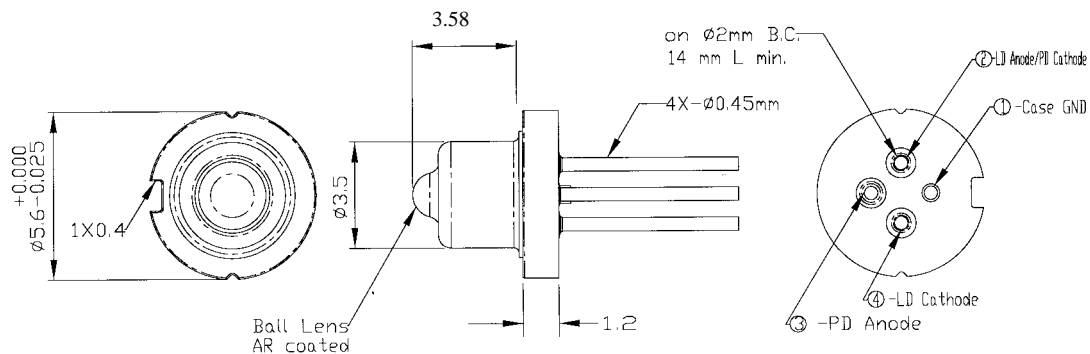
The chips are mounted on AlN submount using 80/20 Au/Sn solder. AlN submount with the laser chips are mounted to the header. The devices are hermetically sealed in nitrogen environment and leak checked to meet the specifications of MIL-STD-883.

### LD Specification

#### 1310nm Infrared Laser Diode

#### SLD-1310-B3-P5(C type)

External dimensions(Units : mm)

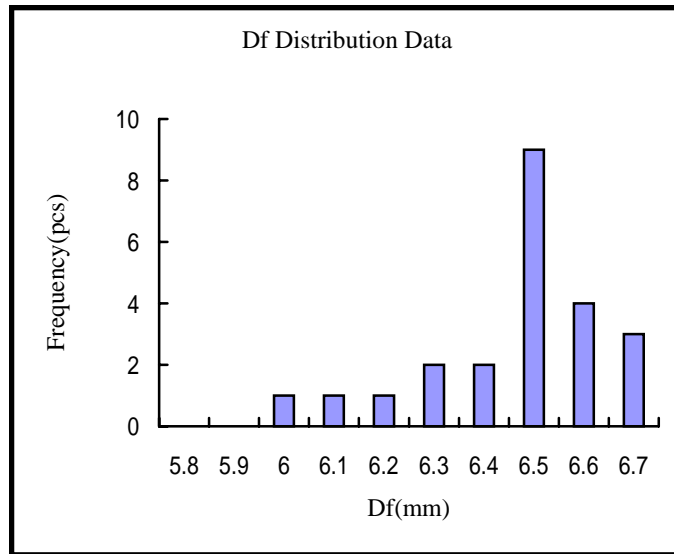


### Absolute Maximum Ratings(Tc=25 )

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

### Electrical and optical Characteristics(Tc=25 )

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



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

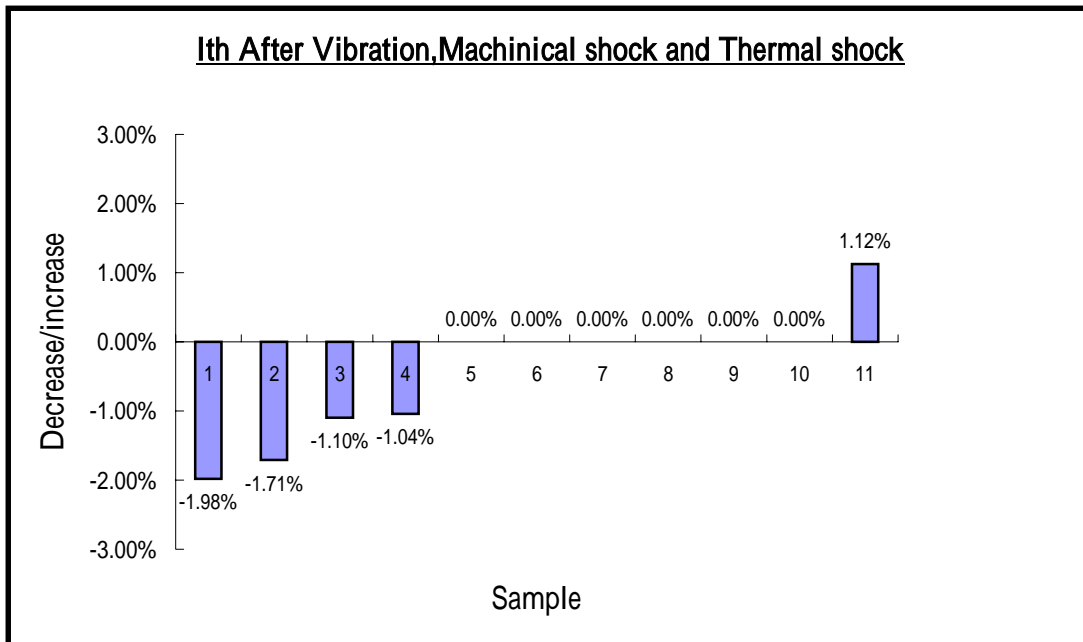
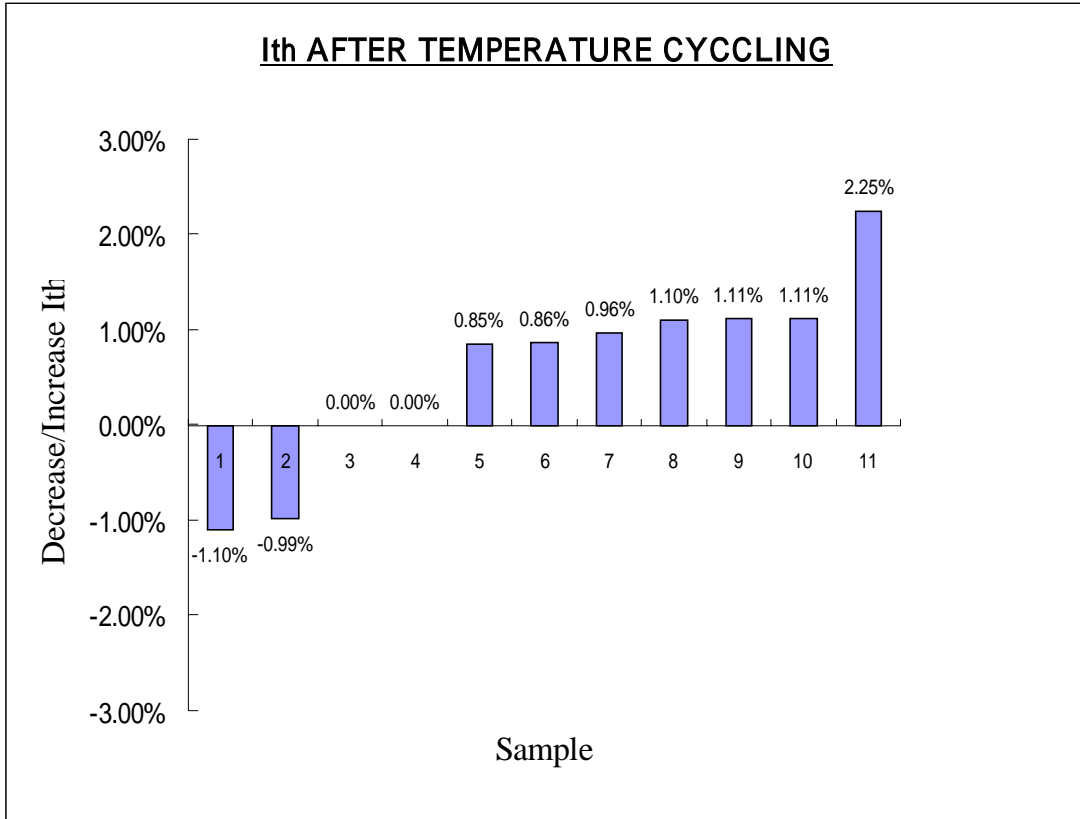
• **Environment Test**

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

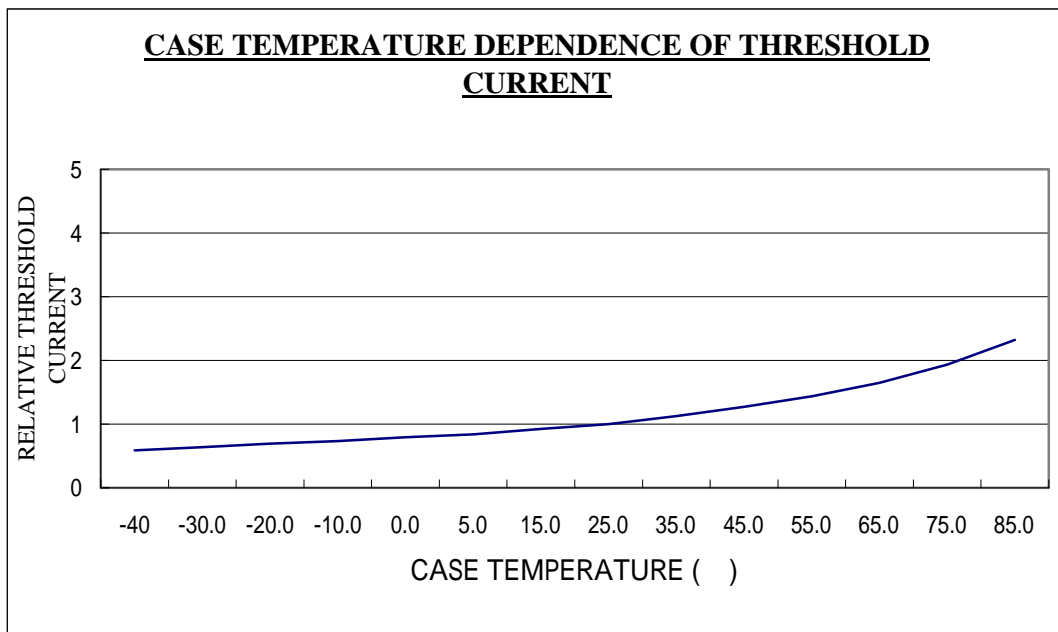
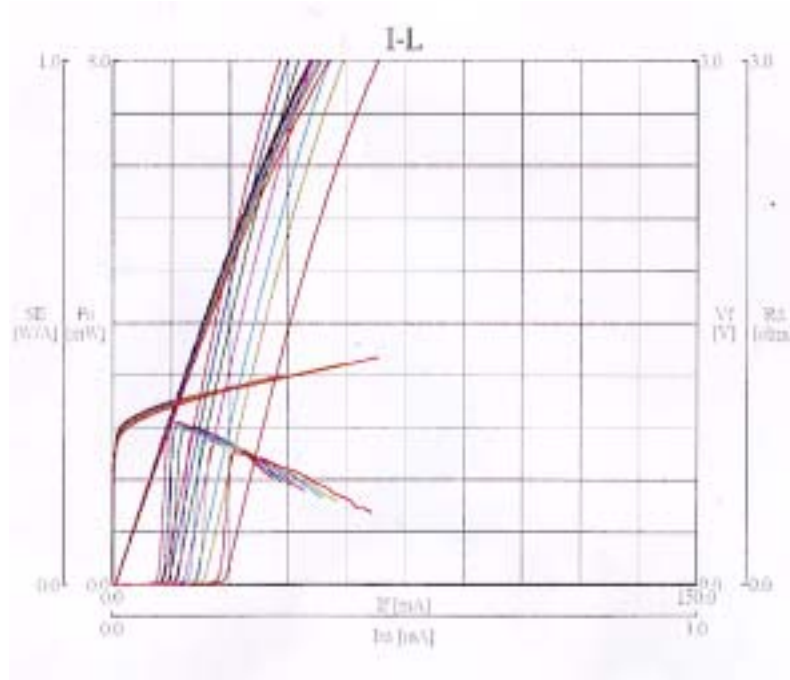
Time specified for the Mechanical Shock was shorted to 0.3ms.

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



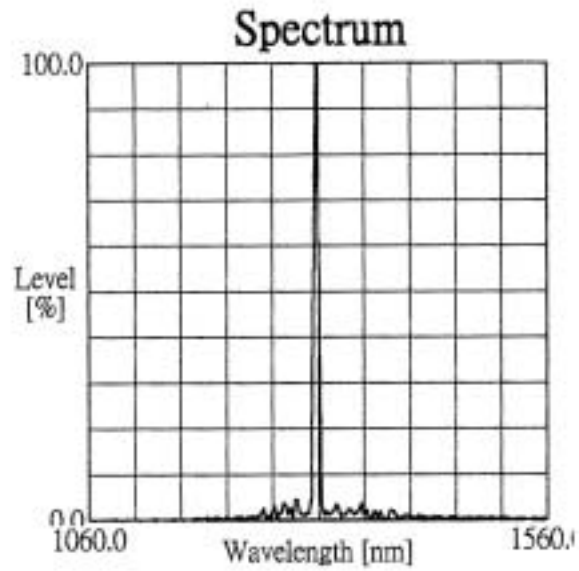
• **Temperature dependence of the L-I parameters**

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.



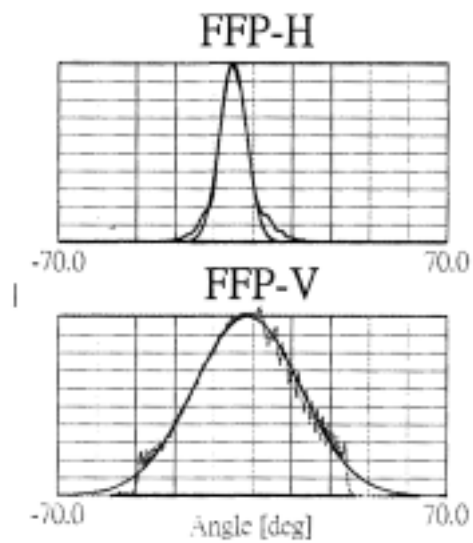
## . Spectrum

The figure below shows a typical FP spectrum.



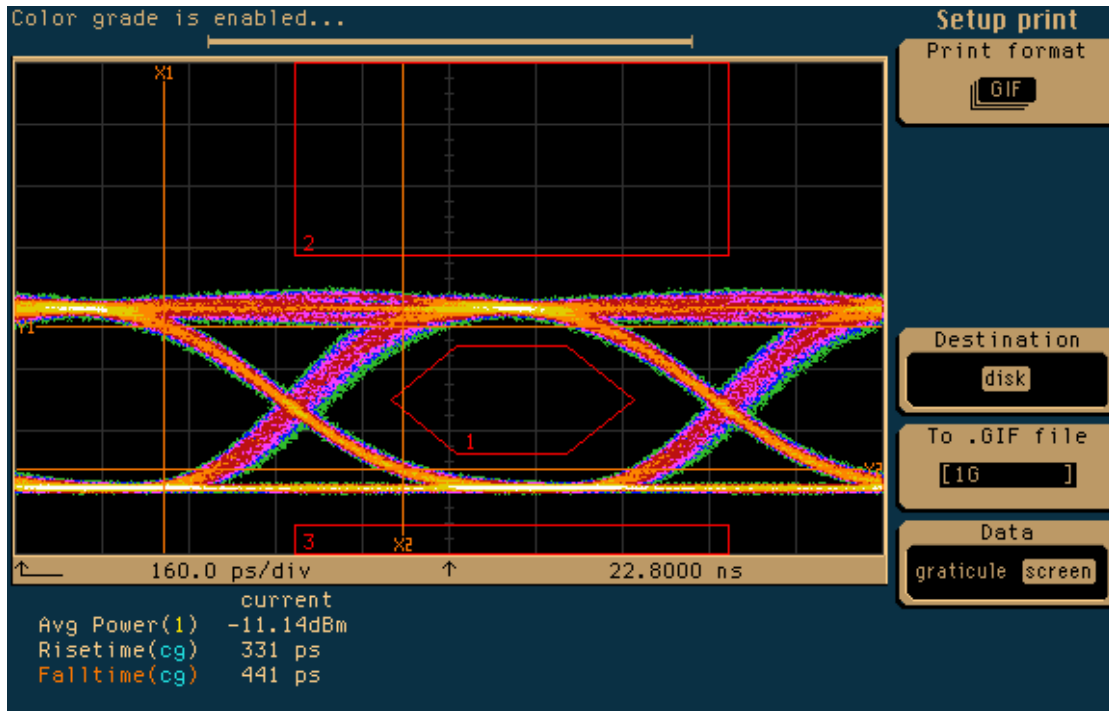
## . Far fields

The figures below show typical far field results a result of a sample of 10 devices. FWHM for the parallel far field is typically  $18^\circ$  and the perpendicular far field  $38^\circ$  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 °C.

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 °C.

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

Table 1

變化率 Time	0	50	100	500	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
1	0.00%	-0.60%	-0.25%	-0.18%	-0.18%	0.80%	2.73%	2.02%	3.50%	4.33%	3.80%	3.75%	3.67%	3.68%
2	0.00%	-2.56%	-2.13%	-2.34%	-0.81%	-0.68%	-2.24%	-2.69%	-2.18%	-1.16%	-2.02%	-2.37%	-2.21%	-2.13%
3	0.00%	-0.78%	-0.67%	-0.61%	-0.92%	0.34%	-0.61%	-1.25%	-0.60%	0.16%	-0.70%	-0.71%	-0.88%	-0.82%
4	0.00%	1.72%	0.94%	0.57%	0.35%	1.29%	0.73%	0.35%	0.88%	1.46%	1.13%	1.27%	1.06%	1.07%
5	0.00%	-1.40%	-1.14%	-1.43%	-1.42%	-1.11%	-1.53%	-1.90%	-0.80%	-1.26%	-1.37%	-1.55%	-1.49%	-1.38%
6	0.00%	0.15%	0.93%	0.86%	0.70%	0.92%	0.76%	0.36%	1.00%	1.11%	1.58%	0.94%	1.05%	1.16%
7	0.00%	0.52%	0.47%	-0.38%	-0.49%	0.05%	-0.75%	-1.21%	-0.78%	-0.35%	-0.35%	-1.01%	-1.51%	-1.28%
8	0.00%	-2.40%	-0.19%	0.10%	0.26%	0.82%	0.74%	0.31%	1.90%	2.43%	1.77%	1.49%	1.28%	1.27%
9	0.00%	0.58%	0.41%	0.03%	-0.20%	-0.12%	-0.82%	-1.11%	-0.75%	-0.63%	-0.51%	-0.85%	-1.09%	-1.13%
10	0.00%	1.03%	0.97%	0.16%	-0.06%	1.73%	0.37%	-0.05%	0.87%	0.81%	2.02%	0.70%	0.43%	0.32%
11	0.00%	-0.80%	0.30%	-0.10%	-0.35%	1.38%	-0.10%	-0.70%	0.47%	-0.10%	2.30%	-0.22%	-0.45%	-0.35%
12	0.00%	-0.68%	-0.38%	-0.80%	0.10%	0.73%	0.51%	0.29%	1.15%	1.34%	1.54%	1.87%	1.24%	1.58%
13	0.00%	-0.94%	-0.25%	-0.38%	-0.23%	1.61%	-0.29%	0.24%	1.17%	1.30%	0.93%	0.94%	0.93%	0.76%
14	0.00%	0.38%	1.94%	0.13%	0.05%	0.53%	-0.10%	-0.61%	0.09%	1.17%	3.80%	-0.44%	-0.23%	-0.10%
15	0.00%	-0.36%	-0.12%	-0.40%	-0.15%	1.90%	0.79%	-0.67%	-0.04%	-0.03%	0.07%	0.18%	0.00%	-0.58%
16	0.00%	0.59%	1.12%	0.54%	0.16%	0.35%	0.06%	-0.42%	0.19%	0.49%	0.23%	0.22%	0.28%	-0.09%
17	0.00%	0.66%	1.22%	0.71%	0.20%	0.04%	-0.46%	-0.91%	-0.56%	1.18%	-0.56%	-0.66%	-0.16%	-0.82%
18	0.00%	-0.31%	0.60%	0.92%	0.81%	1.97%	2.20%	2.18%	2.91%	4.69%	4.45%	5.04%	5.41%	5.12%
19	0.00%	0.10%	0.00%	-0.06%	-0.57%	-0.32%	1.73%	-0.98%	-0.39%	0.00%	-0.09%	-0.27%	-0.28%	-0.33%
20	0.00%	-1.16%	0.45%	0.63%	1.16%	2.33%	1.56%	0.93%	1.79%	2.66%	2.01%	1.96%	2.32%	2.39%
21	0.00%	1.05%	1.45%	0.86%	0.61%	2.36%	1.86%	0.71%	1.22%	1.87%	2.07%	1.20%	1.29%	1.16%
22	0.00%	-0.05%	0.52%	0.94%	0.65%	2.35%	-0.96%	1.02%	1.77%	2.21%	1.80%	1.45%	1.54%	1.69%

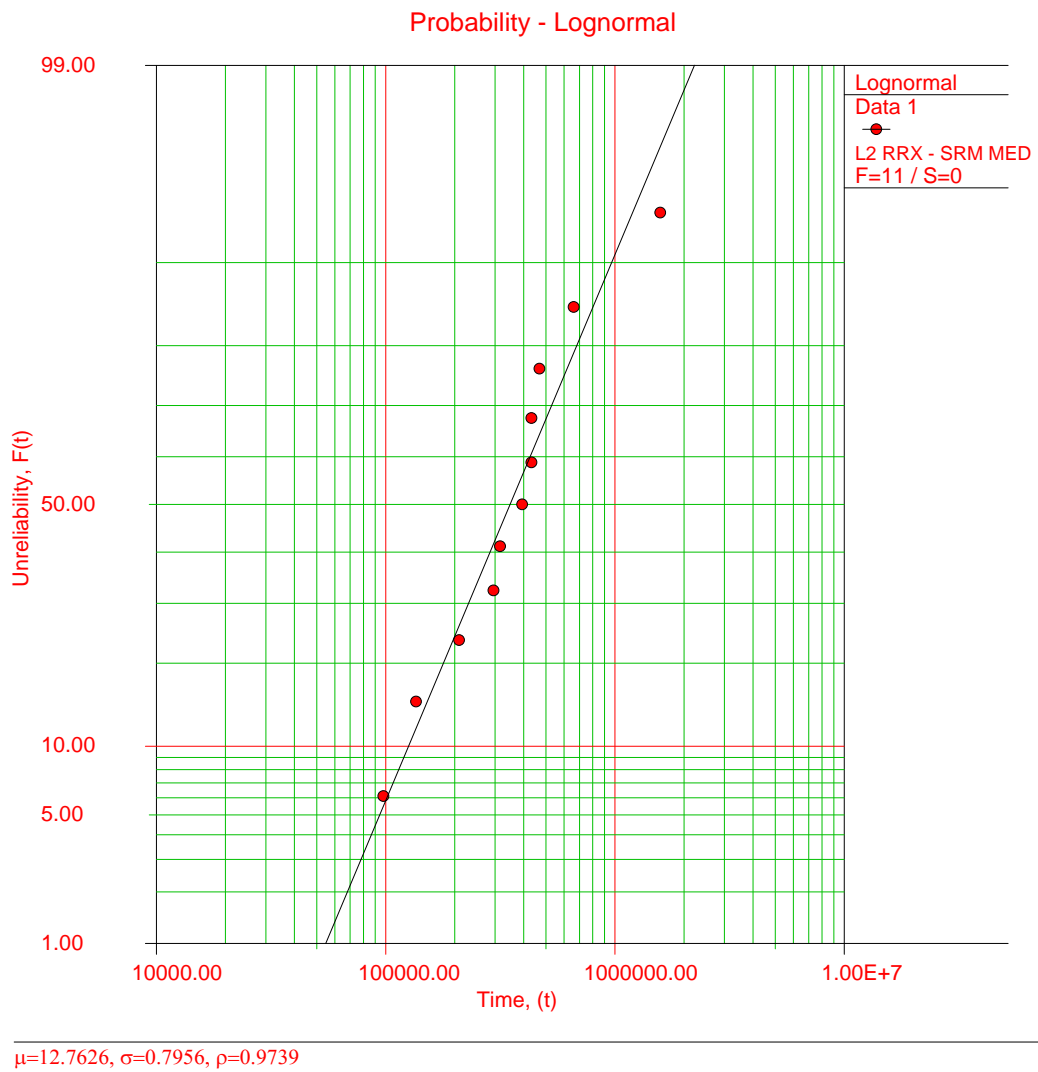
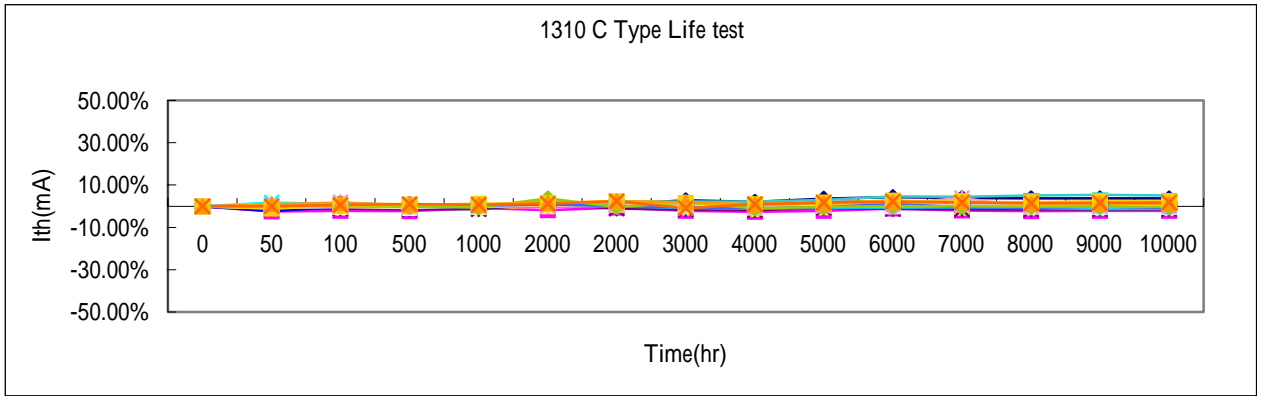


figure 1

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  $4.8 \times 10^5$

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:

Time(hrs)

Temperature	85	75	65	55	45
Life time (hrs)	$4.8 \times 10^5$	$6.6 \times 10^5$	$9.4 \times 10^5$	$1.3 \times 10^6$	$2.0 \times 10^6$

Temperature	35	25
Life time (hrs)	$3.0 \times 10^6$	$4.7 \times 10^6$

## . 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  $4.8 \times 10^5$  hours at maximum operating temperature of  $85$  .


**ETC**

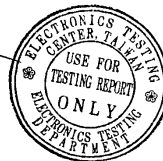
ELECTRONICS TESTING CENTER, TAIWAN  
TEST REPORT

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



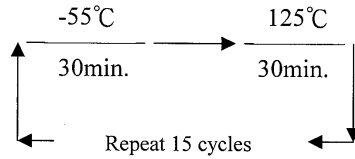


# TEST REPORT

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