TECH NOTE

Repeatability of Laser Diode Threshold Current Measurement

OVERVIEW

This technical note presents the results of measurement repeatability of threshold current on three batches of laser diode samples performed using the LRS-9424 Laser Reliability and Burn-In Test System.

BACKGROUND

Change in threshold current is commonly used as pass/fail criteria for screening laser diodes during production burn-in. In a typical test, lasers with a shift in threshold of greater than 10% would be removed from the production run and scrapped. In order to maximize yield through the burn-in and test process, it is important to maximize the repeatability of threshold current measurement.

Ideally, repeated threshold current measurements performed on the same laser operated under the same conditions should yield identical results. In practice, measurement system noise and instability lead to some variation in measurement results. This variation can be characterized in terms of the standard deviation of repeated measurements. For good performance, the test system should be capable of measurement repeatability that is about 5 to 10 times better than the pass/fail screening criteria that will be used. In the case of a 10% screening criteria, the threshold measurement repeatability should be better than ±1% to ±2%.

There are three common analysis methods to calculate laser diode threshold current as defined by the Bellcore standard for Generic Reliability Assurance Requirements of Optoelectronic Devices used in Telecommunications Equipment (GR-468-CORE, Issue 1, December 1998). They are the two-segment fit, first derivative, and second derivative methods.

ILX Lightwave's LRS-9424 Laser Diode Reliability and Burn-In Test System

The LRS-9424 is capable of using any of the three methods. We chose the first derivative method to calculate the threshold current for this experiment. Using this method, threshold current is determined as the current at which the first derivative of the light vs. current curve reaches half of its peak value along the leading edge of the curve.

Figure 1 shows a typical L-I curve and first derivative curve used for calculating the threshold.

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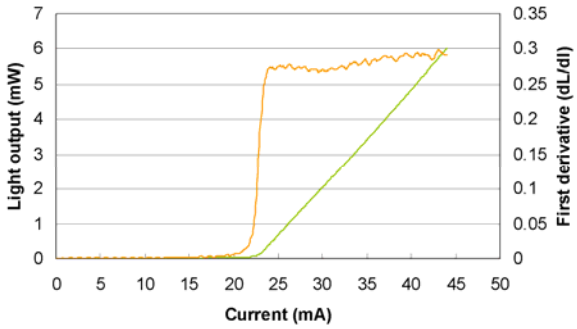

FIGURE 1 – Typical L-I curve and first derivative curve of a laser diode

MEASUREMENT SETUP

Repeatability measurements were performed using an ILX Lightwave LRS-9424 Laser Reliability and Burn-in Test system on three batches of laser diodes as shown in the following table:

	Part Number	Type of Laser	Nominal Output Power and Wavelength
Toshiba	TOLD9200(s)	InGaAIP	2mW, 670nm
Rohm	RLD78-MV	AlGaAs	3mW, 785nm
Sanyo	DL3149-057	AlGaInP	5mW, 670nm

TABLE 1 – Laser diodes used in repeatability measurements

For each measurement, a batch of 32 laser diode samples was mounted onto a fixture and placed inside the chamber of the LRS-9424 system. The 9424 system's ReliaTest software was used to set the experimental values. For each test the fixture temperature was maintained at 50°C.

L-I curve data was obtained by sweeping the laser diode current from 0 to maximum rated operating current in steps of 0.2mA. Other setup parameters were the following: temperature tolerance, 1°C; settling time, 120 sec; derivative calculation method, first derivative; number of averaging points, 35.

To measure repeatability, an *in-situ* L-I test was done, followed by a burn-in with the lasers operated at 1mA (essentially off). The burn-in ran for a period of 30 minutes. Five such L-I measurements and four burn-ins were performed in the following sequence:

- LIV at 50°C
- 30 minute ACC burn-in at 50°C and 1mA
- LIV at 50°C
- 30 minute ACC burn-in at 50°C and 1mA
- LIV at 50°C
- 30 minute ACC burn-in at 50°C and 1mA
- LIV at 50°
- 30 minute ACC burn-in at 50°C and 1mA
- LIV at 50°C

The resulting threshold currents and their standard deviations from the average for the three different laser diode batches are shown in Table 2 on page 3.

CONCLUSIONS

Repeatability As can be seen from the results in Table 2, the average standard deviation of the threshold currents is (a) 0.2% for the RLD-78MV lasers, (b) 0.2% for the TOLD9200(s) lasers, and (c) 0.1% for the DL3149-057 lasers when all the laser diodes were tested at a temperature of 50°C. The threshold current measurements provided by the LRS-9424 are highly repeatable and easily satisfy the requirements for typical burn-in screening used in laser diode testing.

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Devices	Rohm RLD-78MV		Toshiba TOLD9200(s)		Sanyo DL3149-057	
	Average Ith (mA)	Std Dev (%)	Average Ith (mA)	Std Dev (%)	Average Ith (mA)	Std Dev (%)
Device 1	46.12	0.3%	84.12	0.1%	27.75	0.2%
Device 2	45.89	0.2%	84.36	0.2%	26.54	0.2%
Device 3	45.71	0.3%	84.21	0.2%	28.73	0.1%
Device 4	44.90	0.3%	86.09	0.2%	27.31	0.1%
Device 5	43.72	0.3%	80.70	0.2%	27.24	0.1%
Device 6	45.13	0.3%	81.38	0.2%	27.08	0.1%
Device 7	44.87	0.4%	81.28	0.2%	27.57	0.1%
Device 8	44.48	0.3%	80.64	0.2%	27.17	0.1%
Device 9	45.60	0.2%	82.88	0.3%	26.50	0.1%
Device 10	45.45	0.3%	81.64	0.1%	26.70	0.1%
Device 11	46.00	0.3%	81.84	0.1%	28.11	0.1%
Device 12	46.05	0.2%	80.92	0.3%	27.54	0.1%
Device 13	45.60	0.3%	83.89	0.2%	27.56	0.1%
Device 14	45.41	0.3%	81.04	0.1%	27.15	0.2%
Device 15	44.01	0.3%	84.74	0.1%	27.60	0.1%
Device 16	51.75	0.3%	80.88	0.2%	27.63	0.2%
Device 17	45.53	0.1%	85.22	0.3%	27.16	0.3%
Device 18	45.52	0.1%	81.05	0.1%	27.37	0.1%
Device 19	45.38	0.1%	87.24	0.1%	27.43	0.2%
Device 20	45.38	0.2%	81.78	0.2%	27.39	0.1%
Device 21	46.01	0.3%	79.39	0.1%	27.53	0.1%
Device 22	45.58	0.3%	80.94	0.1%	27.16	0.1%

Devices	Rohm RLD-78MV		Toshiba TOLD9200(s)		Sanyo DL3149-057	
	Average Ith (mA)	Std Dev (%)	Average Ith (mA)	Std Dev (%)	Average Ith (mA)	Std Dev (%)
Device 24	48.99	0.2%	79.62	0.1%	27.32	0.2%
Device 25	43.89	0.2%	81.72	0.2%	27.34	0.1%
Device 26	44.36	0.2%	84.66	0.2%	27.29	0.1%
Device 27	45.17	0.2%	81.80	0.1%	27.26	0.1%
Device 28	45.04	0.2%	82.18	0.2%	27.42	0.1%
Device 29	45.12	0.2%	85.73	0.3%	27.64	0.1%
Device 30	44.93	0.2%	80.58	0.1%	27.06	0.1%
Device 31	45.03	0.2%	83.67	0.1%	27.15	0.1%
Device 32	45.80	0.1%	82.21	0.2%	27.30	0.2%
Average Standard Deviation		0.2%		0.2%		0.1%

TABLE 2 – Average threshold current values and the standard deviations