

Reliability

Reliability Tests

Sharp laser diodes are designed to satisfy the following tests.

Tests

No.	Test	Test conditions
1	Solderability test	230 ± 5°C, 5sec.
2	Solder heat resistance test	260 ± 5°C, 5sec.
3	Temperature cycle test	- 40°C → 25°C → 85°C → 25°C (30 min 10 min 30 min 10 min X 5 cycles)
4	Moisture aging test	Ta = 40°C, 90% - 95% RH, t = 500 hours -20°C to 70°C 90 to 95% RH
5	Temperature-humidity cycle test	<p>70°C 40 cycles -20°C 2 hours 1 hour 2 hours 1 hour</p>
6	Shock test	100 G, 6 msec, 3 times each both ways in X, Y, and Z directions
7	Varied frequency vibration test	1.5 mm, 10 to 55 Hz → 10G, 55 to 500Hz/15 rein, 2 hours each in X, Y, and Z directions
8	Terminal pull test	500-g load, 30 sec./terminal
9	Terminal bend test	250-g load, 0° to 90° to 0°, each terminal twice
10	Heat aging test	Ta = 85°C, t = 500 h
11	Cold aging test	Ta = -40°C, t = 500 h
12	Operating life test*	Tc = 50°C, Po=3mW*, t=500h

* Variations with type of device

Model No.	Condition
LT030 series	Po=3mW
LT031 series	Po=10mW
LT022 series	Po=3mW
LT023 series	Po=3mW
LT024 MD/MF/PD	Po=20mW
LT024 AD/ED	Po=30mW
LT025 series	Po=30mW
LT026 series	Po=3mW
LT027 series	Po=7mW
LT002 series	Po=3mW
LT010 series	Po=3mW
LT011 series	Po=3mW
LT015 series	Po=30mW
LT017 series	Po=40mW
LT009 series	Po=80mW

Life of Laser Diodes

Laser diode reliability is closely related to the junction temperature during operation. An increase in temperature causes an exponential increase in the time rate of change of the operating current.

$$\frac{dI_{op}}{dt} \propto \exp\left(-\frac{E_a}{k_B T}\right)$$

E_a : Activation energy
 k_B : Boltzmann Constant
 (= $8.619 \times 10^{-5} \text{ eV} \cdot \text{K}^{-1}$)

Fig. 35-1 shows the relationship between case temperature and the rate of change of the operating current. Ample ventilation and heat radiation must be provided to control junction temperature,

Fig. 35-2 shows the accelerated life test data for a laser diode.

Using the data taken at $T_c = 70^\circ\text{C}$ and the activation energy $E_a = 0.58 \text{ eV}$, expected failure rates have been calculated at various temperatures

For LT022 series, the mean time to failure (MTTF) is 27,000 hours when $P_o = 3 \text{ mW}$ and $T_c = 70^\circ\text{C}$. The calculated MTTF at room temperature ($T_c = 20^\circ\text{C}$) is 770,000 hours.

Life expectancy data for wide temperature range laser diodes (LT022HC/HS/WD/WS and LT023HC/HS/WS) are presented in Fig 35-3. Using the data taken at $T_c = 85^\circ\text{C}$ and the activation energy $E_a = 0.58 \text{ eV}$, expected failure rates have been calculated at various temperatures

The MTTF (Mean Time To Failure) for LT022HC/HS/WD/WS and LT023HC/HS/WS at $P_o = 3 \text{ mW}$ and $T_c = 85^\circ\text{C}$ is 26,000 hours. The calculated MTTF at room temperature ($T_c = 25^\circ\text{C}$) with the activation energy was found to be approximately 1,100,000 hours.

MTTF
 $T_c = 70^\circ\text{C}$ 27,000 hours
 $T_c = 20^\circ\text{C}$ 770,000 hours

Fig. 35-1 Operating Current Rate of Change vs. Case Temperature (LT022 series)

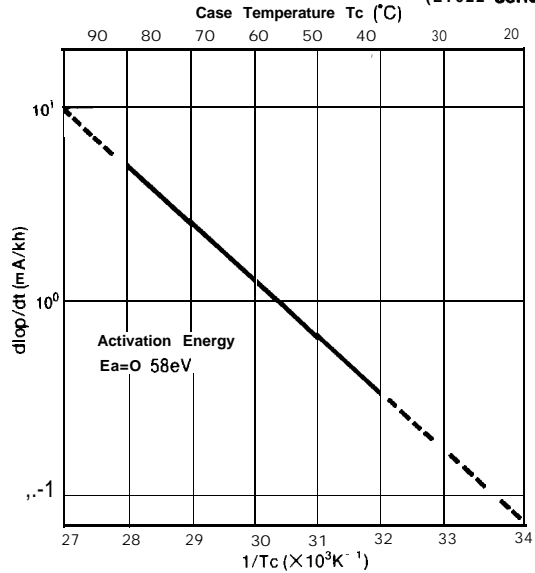


Fig. 35-2 Life Test Data (LT022 series)

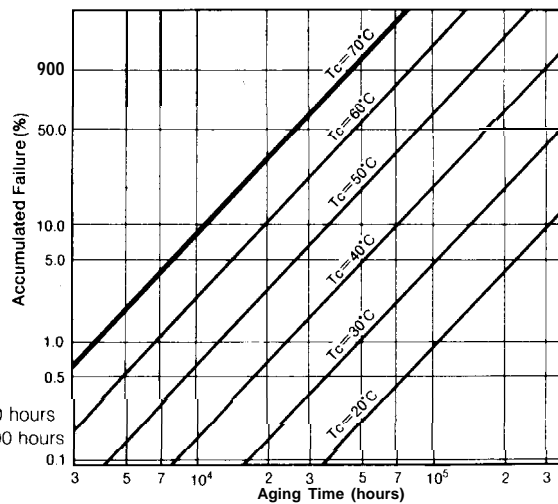


Fig. 35-3 Life Test Data (Wide temperature range laser diodes)

