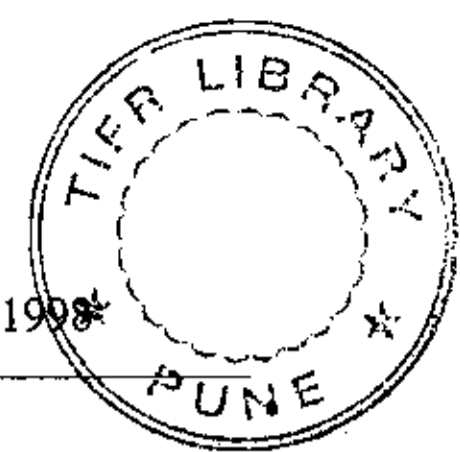


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A Study on Reliability, Safety and Linear operation of Laser diode at GMRT - to estimate useful lifetime of the fiber optic link.

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1. Introduction:

ect uses many Laser diodes for the fiber optic communication links. Since the device plays a major role in the GMRT Project. This report attempts to study the safe operation of LASER diode and the circuits implemented in the transmitter unit to guard and monitor the laser diode for its reliable operation.

The GMRT Project uses 60 fiber optic links. There are 60 fiber optic transmitter units. This report highlights the need for a safe transmitter unit to safe guard the laser diode.

LASER diode:

2 Safety of the LASER diode:

The absolute maximum rated forward current of 150 mA and the reverse current of 2 mA. Our systems operate well below this level, but continued operation at higher currents will result in failure of the laser diode.

The Laser has a maximum current of 2 mA. Our systems operate well below this level, but continued operation at higher currents will result in failure of the laser diode.

A surge from the power line or a spike appearing when the power supply is turned on or off, can result in a surge of current having a narrow pulse width may destroy the device. This is because the response speed of the laser diodes are high and an instant large current generates high output, destroying the reflective surface of the device. This is taken care in our GMRT transmitter system by providing a surge filter to the Laser diode. Hence any surge from the power supply will not affect the Laser diode.

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Through the modulation input is checked by a current limiting resistor to protect the Laser diode. This protective system seem to be working well and till now there are no failures of the laser diode due to high surge current or spike. There is also an RF switch placed in the RF input path of the Laser diode which cuts off any high modulation current. Thus safety of the laser is well ensured in GMRT.

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3. Reliability of the LASER diode:

The Laser used in the GMRT is a RWG (Ridge Waveguide) Laser diode. They have an MTTF of 194 years at 42 mA current and 25 degree Celsius.

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(Time to 4% Failure) **TT4%F of 46 years** under the same operating conditions. When temperature and current levels the MTTF and TT4%F reduces. GMRT ensures good life of the Laser diode at 42 mA current and 25 degree Celsius. Thus GMRT ensures good life of the Laser diode.

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The EOL (End Of Life) criteria is a 30 mA increase in the threshold current at 25 degree Celsius i.e. the existing 32 mA of threshold current should increase to 62 mA to reach EOL. Thus wear-out failure mode is a gradual increase in threshold current which can be measured with the existing system. The threshold current can increase with increase in operating temperature of the laser diode. Thus a failure may occur if the air-condition unit fails and raises the room temperature, but there is a cooler control circuit to cool the Laser diode when the Laser exceeds 25 degree Celsius. A failure in the cooler circuit may result in the failure of the Laser diode. Thus it is worth monitoring the cooler currents.

4. Linear Operation of the Laser diode.

The Laser biased at 42 mA current can have a current swing I_{pp} of 20 mA maximum and swings between I_{th} 32 mA and I_{rated} 52 mA current. The I_{rms} current will be 7.071 mA, and the equivalent RF input power is +3.979 dBm at 50 input impedance. Thus LASER diode can be operated linearly upto +3.979 dBm. Due to early saturation of Fiber optic Receiver unit the Laser is operated well below this level (-14 dBm).

If the RF input exceed 0 dBm it gets attenuated by the RF switch. If there is a failure in the switch and the amount of RF input increases to +10 dBm, then I_{rms} will be 14.14 mA and I_{pp} will be 40 mA. Thus the current swing will be between 22 mA and 62 mA with a bias at 42 mA. It is well below the absolute maximum rating, but the signal gets clipped here and hence becomes unusable. A continued operation and higher power levels requires further study.

5. Caution:

The Laser diode is ESD sensitive, hence safe handling of the device is required.

6. Conclusion:

Thus it is clear that the Laser diodes are safely implemented and operated in GMRT Fiber optic system. The system will be reliably working for many years.

7. Reference:

- a. Lasertron products catalog and device data sheet.