Symbol and Term Definitions

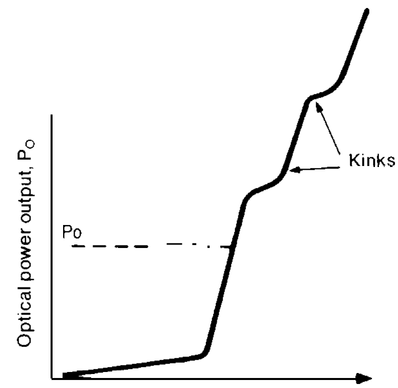
Below is an explanation of the symbols and terms used in the tables of laser diode characteristics.

Absolute Maximum Ratings

The absolute maximum ratings must not be exceeded even momentarily regardless of the external condition. The absolute maximum ratings are specified for a case temperature of Tc = 25°C

Parameter	Symbol	Definition
Optical power output	Po	Maximum allowable instantaneous optical power output in either continuous or pulse operation. Up to this output level, there are no kinks in the optical power output vs forward current curve (Fig. 9-1).
Reverse voltage	V_R	Maximum allowable voltage when reverse bias is applied to either the laser diode or photodiode.
Operating temperature	Topr	Range of case temperatures within which the device may be safety operated
Storage temperature	Tstg	Range of case temperatures within which the device maybe safely stored.
Case temperature	Tc	Device temperature measured at the base of the package

Fig. 9-1 Optical Power Output vs. Forward Current.



Electro-optical Characteristics

Parameter		Symbol	Definition
Forward current		I_F	Current through the forward biased laser diode
Threshold current		Ith	The boundary between spontaneous emission (region A) and stimulated emission (region B) on the optical power output vs. forward current curve (Fig 10-I). At this point the device begins to produce laser output.
Operating current		Iop	The forward current through the laser diode necessary for the device to produce its specified typical optical power output.
Operating voltage		Vop	The forward voltage across the laser diode when the device produces its specified typical optical power output,
Wavelength		λp	The wavelength of the light emitted by the laser diode For a single mode device, this is the wavelength of the single spectral line of the laser output For a multi-mode device, this is the wavelength of the spectral line with the greatest Intensity (Fig 10-2),
Monitor current		Im	The current through the photodiode, at a specified reverse bias voltage, when the laser diode is producing its specified typical power output
Radiation characteristics	Radiation angles	$\theta_{//}, \theta_{\perp}$	The laser beam's full angular at the half-maximum intensity points (FWHM), measured both parallel and perpendicular to the junction plane (Fig' 10-3a, b, c) $\theta_{//}, \theta_{\perp} = a + b$
	Ripple		The far-field patterns may have some Irregularities as shown in Fig 10-4. Any ripple occuring within 9 degrees of the beam's maximum intensity point in the parallel direction or within 10 degrees in the perpendicular direction, will have a maximum amplitude Of 25% Of the maximum intensity
Emission point accuracy	Angles	$\Delta\phi_{//}, \Delta\phi_{\perp}$	The deviation of the optical axis of the beam from the mechanical axis of the package, measured both parallel and perpendicular to the junction plane (Fig 10-3c). $\Delta\phi_{//}, \Delta\phi_{\perp} = \frac{(a-b)}{2}$
	Position	Ax, Ay, Az	Displacement of the laser diode chip with respect to the device package Ax and A y are measured as the planer displacement of the chip from the physical axis of the package. Az is measured perpendicular to the reference plane (Fig 10-5).
Differential efficiency		η	The mean value of the Incremental change in optical power output for an Incremental change in forward current (Fig. 10-6) $\eta = \frac{\Delta Po}{\Delta I_F}$
Coherence		-	Defined as the attenuation of the visibility of Interference fringes, as described on page 28. A value of 1 indicates infinite coherence, while a value of O Indicates no coherence

Fig. 10-1 Optical Power Output vs. Forward Current

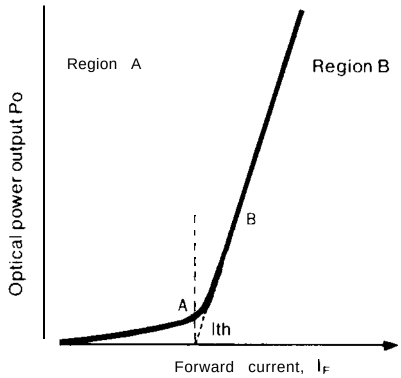


Fig. 10-2 Output Spectrum Characteristics

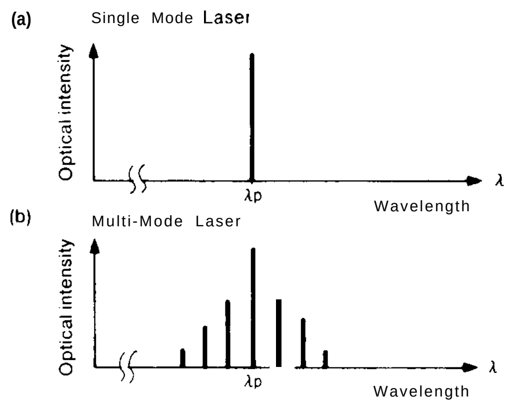


Fig. 10-3 Radiation Characteristic and Far-Field Patterns

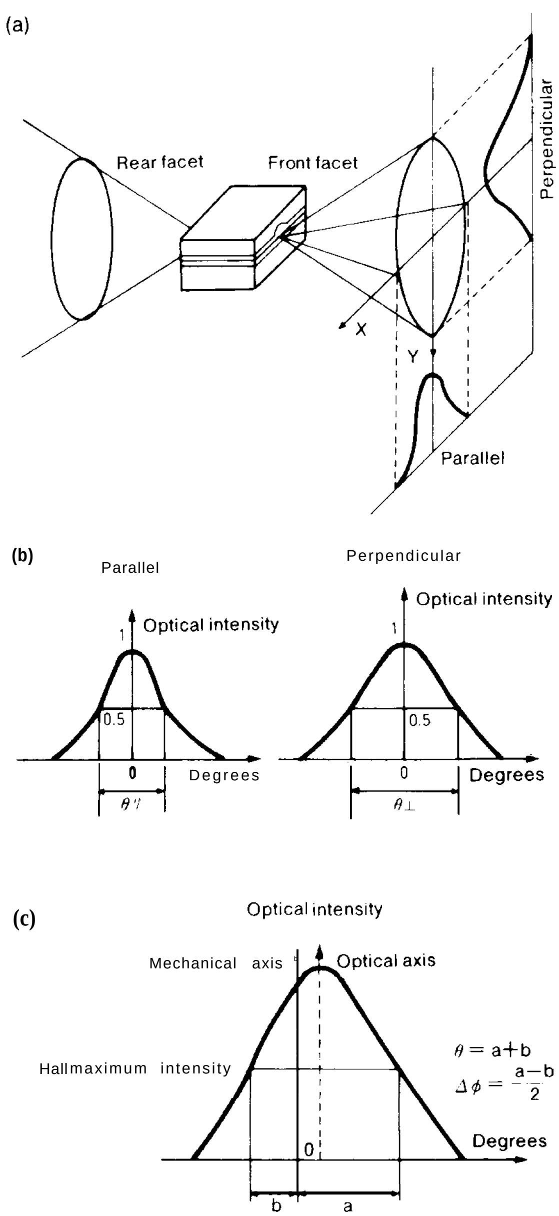


Fig. 10-4 Ripple

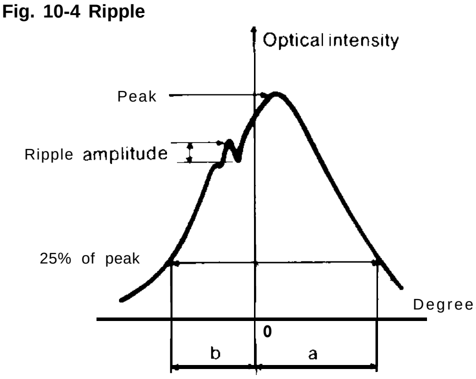


Fig. 10-5 Mechanical Reference Points

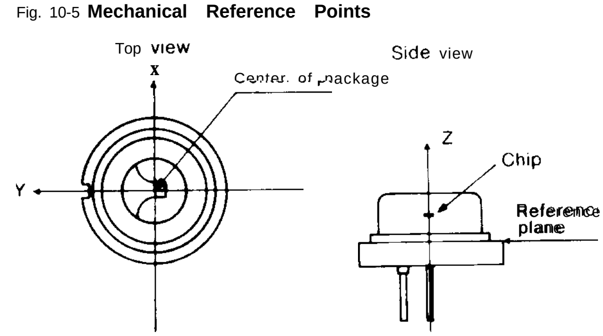
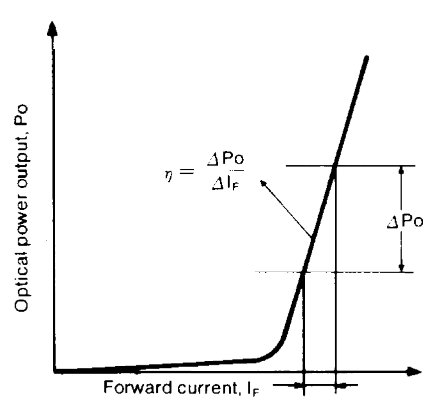


Fig. 10-6 Differential Efficiency



Electrical Characteristics of Monitor Photodiode

Parameter	Symbol	Definition
Sensitivity	S	The Incremental change in the monitor photo current for an Incremental change in the laser diode power output
Dark current	I_D	The current through the reverse biased monitor photodiode when the laser diode is not emitting

Other Terms

Parameter	Symbol	Definition
Signal to noise ratio	S/N	**Noise** is defined as the fluctuation over time of the Intensity of the laser diode output, when driven by a DC input. The signal to noise ratio is expressed in terms of the mean output power, P. and the fluctuation δP, as: $S/N = 10 \log \left(\frac{\delta P}{P}\right)^2$ [dB] Noise Includes, 1) mode hopping noise caused by temperature changes at the laser diode junction, and 2) optical feedback noise caused by the formation of a complex resonator when part of the laser beam is reflected back into the laser diode. (Page 27).
Astigmatic distance	AAs	The laser beam appears to-have different source points for the directions perpendicular and parallel to the junction plane (Fig 11 -1). The astigmatic distance is defined as the distance between the two apparent sources A large astigmatism must be corrected if the laser beam is to be accurately focused.
Coupling efficiency		The beam of the laser diode diverges as shown in Fig. 10-3. In coupling the laser to an external device, such as a lens or glass fiber. the coupling efficiency is defined as the percentage of the total power output of the laser which effectively enters the external device, (Fig 94-4).
Numerical aperture	NA	The numerical aperture describes the ability of a lens to collect light from a source placed at its focal point The maximum acceptance angle is 6, as shown in Fig. 11-2 NA = $\sin\theta$
Polarization ratio		The light from a laser diode emitting in an ideal single mode is linearly polarized parallel to the junction plane Spontaneous emission adds unpolarized light which has a component of polarization perpendicular to the junction plane The polarization ratio is defined as the ratio of the component of polarization parallel to the junction plane to the component perpendicular to the junction plane (Page 26).
Beam waist	ω_0	When a laser beam is focused by a lens, the beam becomes constricted at the focal point as shown in Fig. 11-3 The radius at this constricted point is referred to as the beam waist As the figure shows, the beam diameter forms a hyperbolic curve along the beam path The curves that intersect perpendicularly to this beam shape are equivalent to wavefronts The wavefront at the beam waist is planar and those at all other points are spherical The relationship between the beam waist and the wavelength is described by $\pi \omega_0 \theta = \lambda$, where the angel of divergence is 20 and the beam waist is $\omega_0 \theta$ can be made as large as possible to make ω_0 small, or ω_0 can be made as large as possible to make θ small Further, the shorter the wavelength, the smaller the beam waist will be
Characteristic temperature	To	Laser diodes are extremely sensitive to temperature. The threshold current Ith will increase with rises in temperature The dependence of threshold current on temperature has been observed as Ith (T) $\propto$ exp (T/To) To is referred to as the characteristic temperature. The larger To Is, the smaller the temperature dependence becomes.
Thermal Resistance		The Incremental change in the laser diode junction temperature for an incremental change in power dissipation

Fig. 11-1 Astigmatic Distance

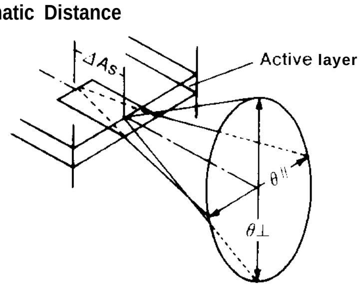


Fig. **11-2 Numerical Aperture**

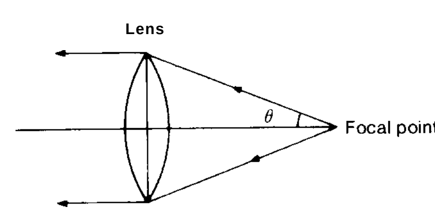


Fig. 11-3 **Beam Waist**