MITSUBISHI LASER DIODES

ML9XX1 SERIES

FOR OPTICAL COMMUNICATION

TYPE NAME

ML9701, ML974A1F, ML9911

DESCRIPTION

ML9XX1 series are InGaAsP laser diodes which provide a stable, single transverse mode oscillation with emission wavelength of 1550nm and standard continuous light output of 5mW.

ML9XX1 are hermetically sealed devices having the photodiode for optical output monitoring. This high-performance, high reliability, and long-life laser diode is suitable for such applications as the light source for long-distance optical communication systems.

FEATURES

- Stable fundamental transverse mode oscillation
- Low threshold current, low operating current
- Built-in photodiode (ML9701, ML974A1F)
- High reliability, long operation life
- 1550nm typical emission wavelength
- High speed of response

APPLICATION

Long-distance communication systems

ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Conditions	Ratings	Unit
P_O	Light output power	CW	6	mW
		Pulse (Note 1)	10	
V_{RL}	Reverse voltage (Laser diode)	–	2	V
V_{RD}	Reverse voltage (Photodiode)	–	20	V
I_{FD}	Forward current (Photodiode)	–	2	mA
T_C	Case Temperature	–	−20～+60	℃
T_{stg}	Storage temperature	–	−40～+100	℃

Note 1 : Duty less than 50 %, pulse width less than 1 μs.

ELECTRICAL/OPTICAL CHARACTERISTICS (T_C = 25℃)

Symbol	Parameter	Test Conditions	Limits			Unit
			Min.	Typ.	Max.	
I_{th}	Threshold current	CW	–	15	35	mA
I_{OP}	Operating currrent	CW, P_O = 5mW	–	40	60	mA
V_{OP}	Operating voltage	CW, P_O = 5mW	–	1.3	1.7	V
η	Slope efficiency	CW, P_O = 5mW	–	0.2	–	mW/mA
λ_P	Peak wavelength	CW, P_O = 5mW	1520	1550	1580	nm
$\Delta\lambda$	Spectral half width	CW, P_O = 5mW	–	5	–	nm
$\theta_{//}$	Beam divergence angle (parallel)	CW, P_O = 5mW	–	30	–	deg.
$\theta_{\perp}$	Beam divergence angle (perpendicular)	CW, P_O = 5mW	–	35	–	deg.
t_r, t_f	Rise and fall times	$I_F = I_{th}$, P_O = 5mW, 10 %～90 %	–	0.3	0.7	ns
I_m	Monitoring output current	CW, P_O = 5mW, V_{RD} = 1V, R_L = 10 Ω (Note 2)	0.2	0.5	–	mA
I_D	Dark current (Photodiode)	V_{RD} = 10V	–	0.2	0.5	μA
C_t	Capacitance (Photodiode)	V_{RD} = 10V, f = 1MHz	–	8	20	pF
P_m (Note 3)	Monitoring light output	CW, P_O = 5mW	–	1.0	–	mW

Note 2 : R_L is load resistance of the photodiode.
3 : P_m only apply to ML9911.

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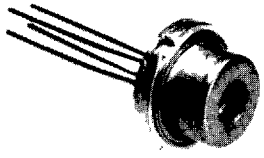
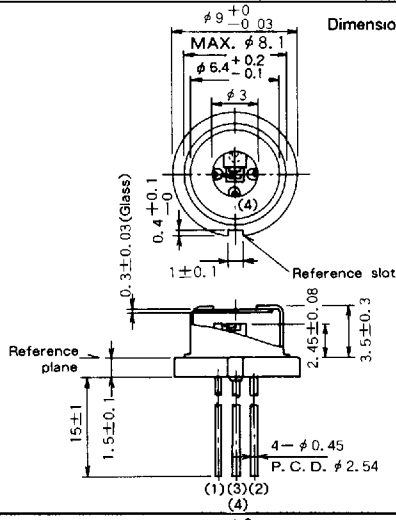
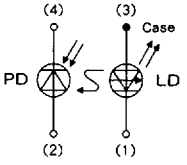
OUTLINE DRAWINGS

ML9701

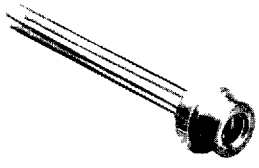


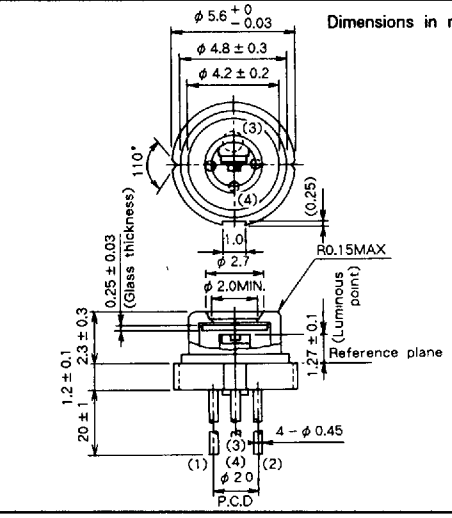


(φ 9mm 4pin Standard package)

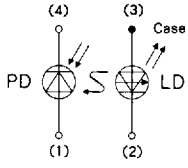


ML974A1F

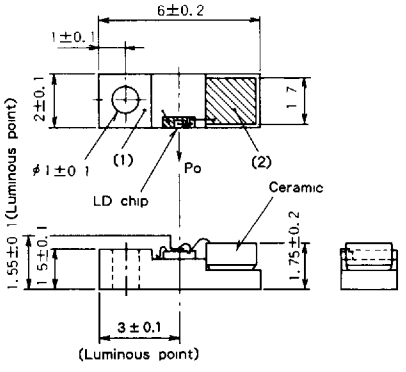




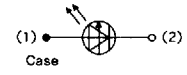
(φ 5.6mm 4pin with thick cap)



ML9911



(Chip carrier package)



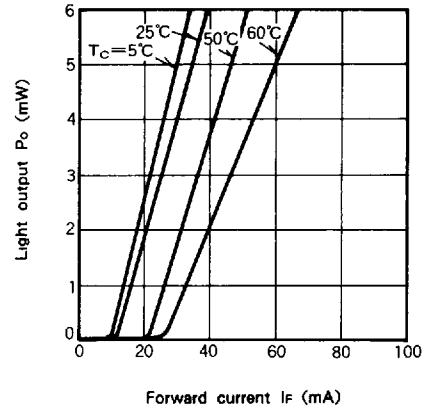
SAMPLE CHARACTERISTICS

1 Light output vs. forward current

Typical light output vs. forward current characteristics are shown in Fig. 1. The threshold current for lasing is typically 15mA at room temperature. Above the threshold, the light output increases linearly with current, and no kinks are observed in the curves. An optical power of about 5mW is obtained at I_{th} + 25mA.

As can be seen in Fig. 1. I_{th} and slope efficiency η (dP_O / dI_F) depends on case temperature, obtaining a constant output at varying temperatures requires to control the case temperature T_C or the laser current. (Control the case temperature or laser current such that the output current of the built-in monitor PD becomes constant.)

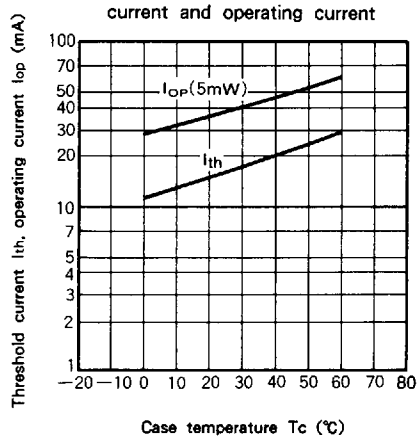
Fig. 1 Light output vs. forward current



2 Temperature dependence of threshold current (I_{th}), operating current (I_{op}) and slope efficiency (η)

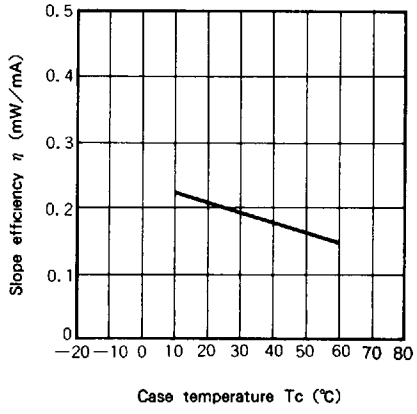
A typical temperature dependence of the threshold current and operating current (5mW) is shown in Fig. 2. The characteristic temperature T_O of the threshold current is typically 65k in $T_C \leq 40$℃, 50k in $T_C > 40$℃.

Fig. 2 Temperature dependence of threshold current and operating current



A typical temperature dependences of the slope efficiency η is shown in Fig. 3. The gradient is -0.0015mW/mA/℃ typ.

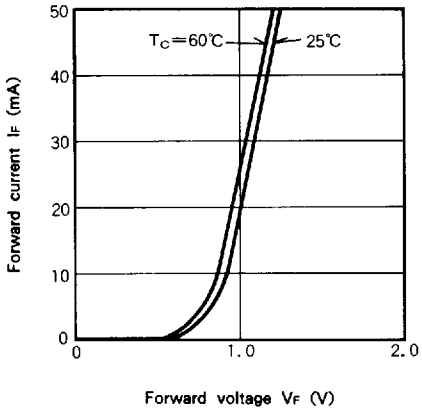
Fig. 3 Temperature dependence of slope efficiency



3 Forward current vs. voltage

Typical forward current vs. voltage characteristics are shown in Fig. 4. In general, as the case temperature rises, the forward voltage V_F decreases slightly against the constant current I_F. V_F varies typically at a rate of $-1mV/℃$ at $I_F = 1mA$ and 10mA.

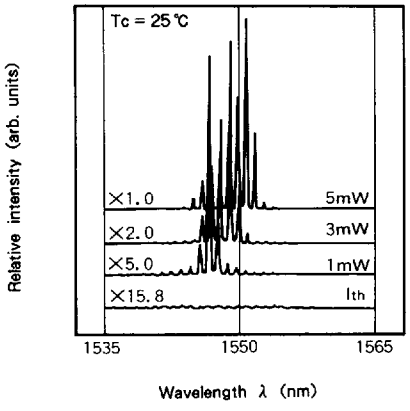
Fig. 4 Forward current vs. voltage



4 Emission Spectra

Typical emission spectra under CW operation are shown in Fig. 5. In general, at an output of 5mW, several modes are observed. Longitudinal mode spacings are typically 1nm and spectral width (FWHM) is typically 5nm at an output of 5mW. The peak wavelength depends on the operating case temperature and the forward current (output level).

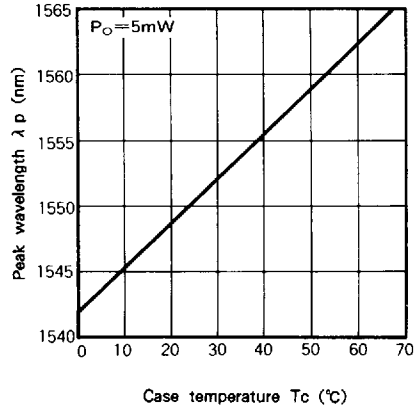
Fig. 5 Emission spectra under CW operation



A typical temperature dependence of the peak wavelength at an output of 5mW is shown in Fig. 6.

As the temperature rises, the peak wavelength shifts to the long-wavelength side at a rate of about 0.35nm/℃.

Fig. 6 Temperature dependence of peak wavelength



5 Far-field pattern

The ML9XX1 laser diodes lase in fundamental transverse (TE_{00}) mode and the mode does not change with the current. They have a typical emitting area (size of near-field pattern) of 1.0X1.25 μm^2. Fig. 7 and 8 show the typical far-field patterns. The full angles at half maximum points (FAHM) are typically 30deg. and 35deg., respectively.

Fig. 7 Far-field patterns in plane parallel to heterojunctions $\theta //$

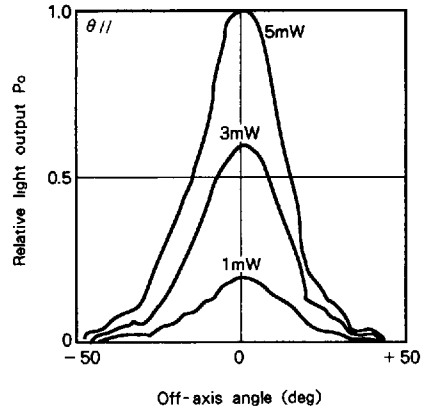
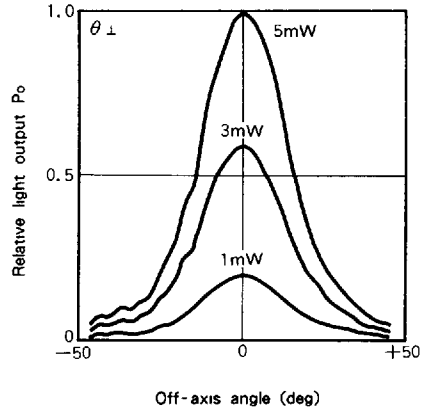


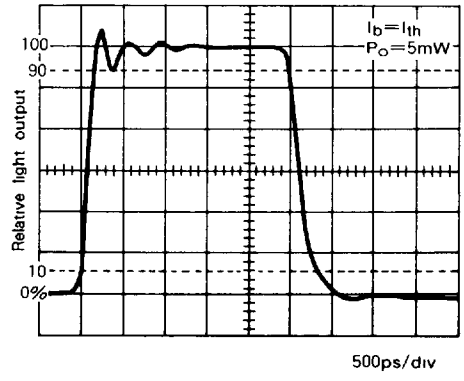
Fig. 8 Far-field patterns in plane perpendicular to heterojunctions $\theta \perp$



6 Pulse response

In digital optical transmission systems, the response waveform and speed of the light output against the input pulse current waveform is a main concern. In order to shorten the oscillation delay time, the laser diode is usually biased close to the threshold current. Fig. 9 shows a typical response waveform when a rectangular pulse current (rise/fall time is shorter than 0.2ns) is applied. Rise/fall time is typically 0.3ns at $I_b = I_{th}$ and $P_O = 5mW$.

Fig. 9 Pulse response waveform



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7 Monitoring output

The laser diodes emit beams from both of their mirror surfaces, front and rear surfaces (see the outline drawing). The rear beam can be used for monitoring power of the front beam since the power of the rear beam is proportional to the frontone. The rear-side beam is received by the built-in monitoring PD to be output as the monitoring current. Fig. 10 shows typical light output vs. monitoring photocurrent characteristics. Above the threshold current, the monitoring photocurrent increases linearly with the front light output. The monitoring current is typically 0.5mA when the front light output is 5mW.

In the ML9911, monitor photodiodes is not installed in the laser package. Monitoring output is emitted from the back of package.

Monitoring output is typically 1mW when the front light output is 5mW.

Fig. 10 Light output vs. monitoring output current