TYPE NAME **ML6101A, ML6411A, ML6411C, ML6701A** T-41-05

DESCRIPTION

Mitsubishi ML6XX1A are AlGaAs laser diodes emitting light beams around 780nm wavelength. They lase by applying forward current exceeding threshold values, and emit light power of about 10mW/facet at an operating current of around 25mA in excess of the threshold current. They operate, under CW or pulse conditions according to input current, at case temperatures up to 60℃.

ML6XX1A are hermetically sealed devices having a Si photodiode for monitoring the light output. Output current of the photodiode can be used for automatic control of the operating currents or case temperatures of the lasers. They are well suited for optical information systems and other optical systems.

FEATURES

- High power (CW 20mW)
- Fundamental transverse mode oscillation
- Small astigmatism
- Low noise
- Low threshold current, low operating current
- Si photodiode is installed in the laser package
- High reliability, long operation life

APPLICATION

Writing and reading memory disks, laser beam printers

ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Conditions	Ratings	Unit
P_O	Light output	CW	20	mW
		Pulse (Note 1)	25	
V_{RL}	Reverse voltage (Laser diode)	—	2	V
V_{RD}	Reverse voltage (Photodiode)	—	15	V
I_{FD}	Forward current (Photodiode)	—	10	mA
T_C	Case temperature	—	−40～+60	℃
Tstg	Storage temperature	—	−55～+100	℃

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

ELECTRICAL/OPTICAL CHARACTERISTICS (T_C=25℃)

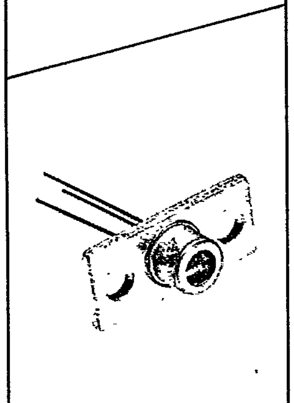
Symbol	Parameter	Test conditions	Limits Min.	Typ.	Max.	Unit
I_{th}	Threshold current	CW	15	40	60	mA
I_{OP}	Operating current	CW, P_O=10mW	—	65	100	mA
V_{OP}	Operating voltage (Laser diode)	CW, P_O=10mW	—	2.0	2.5	V
P_O	Light output	CW, $I_F=I_{th}+25mA$	—	10	—	mW
λ_P	Lasing wavelength	CW, P_O=10mW	765	780	795	nm
$\theta_{//}$	Full angle at half maximum	CW, P_O=10mW	10	12	17	deg.
$\theta_{\perp}$			20	30	35	deg.
I_m	Monitoring output current	CW, P_O=10mW V_{RD}=1V R_L=10Ω (Note 2)	0.3	0.8	1.7	mA
I_D	Dark current (Photodiode)	V_{RD}=10V	—	—	0.5	μA
C_t	Capacitance (Photodiode)	V_{RD}=0V, f=1MHz	—	7	—	pF

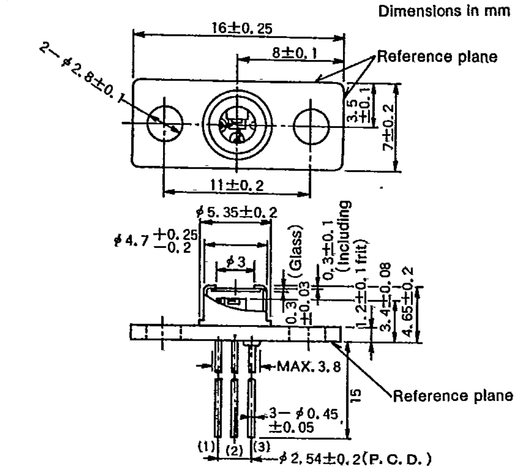
Note 2 : R_L is load resistance of the photodiode.

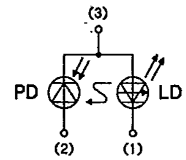
OUTLINE DRAWINGS

T-41-05

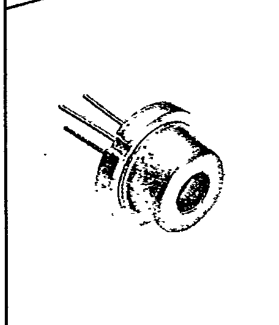
ML6101A

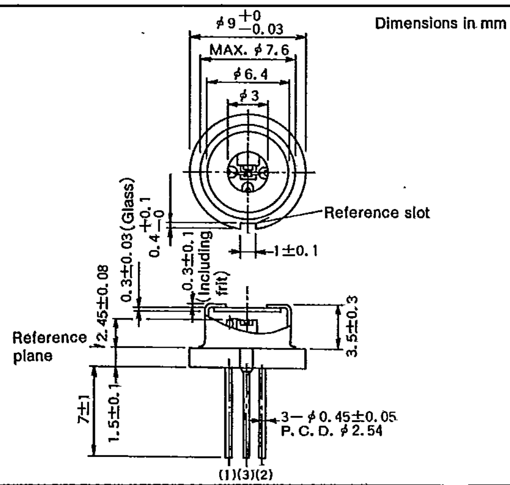


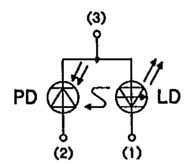




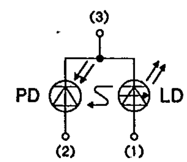
ML6411A/ ML6411C





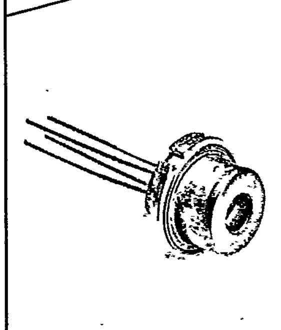


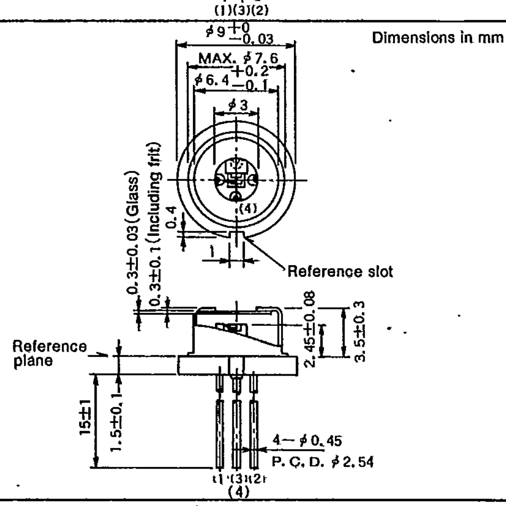
ML6411A

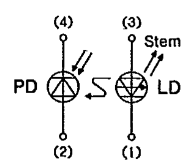


ML6411C

ML6701A







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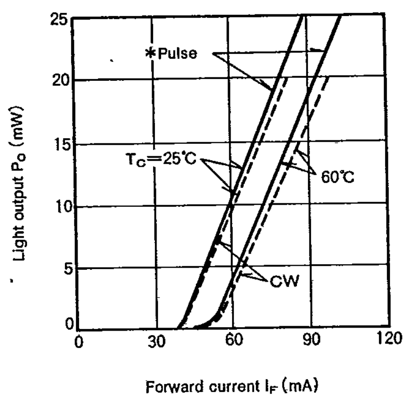
1 Light output vs. forward current

Typical light output vs. forward current characteristics are shown in Fig. 1. The threshold current for lasing is typically 40mA at room temperature. Above the threshold, the light output increases linearly with current, and no kinks are observed in the curves. As can be seen in Fig. 1, the threshold current and slope efficiency (dP_O/dI_F) depends on case temperature of the lasers. This suggests that automatic control of temperature or current is necessary to keep the light output constant since temperature variation is inevitable in practical systems. The automatic controls should be such that the maximum ratings for the light output and the case temperature are not exceeded. "OPERATING CONSIDERATIONS." gives an example of an automatic light output control circuit.

Fig. 1 Light output vs. forward current

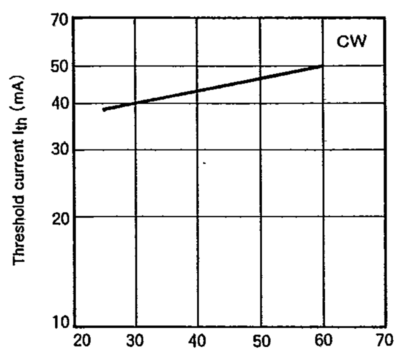


*Duty less than 50% pulse width less than 1μs.

2 Temperature dependence of threshold current (I_{th})

A typical temperature dependence of the threshold current is shown in Fig. 2. The characteristic temperature T_O of the threshold current is typically 140K in $T_C \leq 60°C$, where the definition of T_O is $I_{th} \propto \exp(T_C/T_O)$.

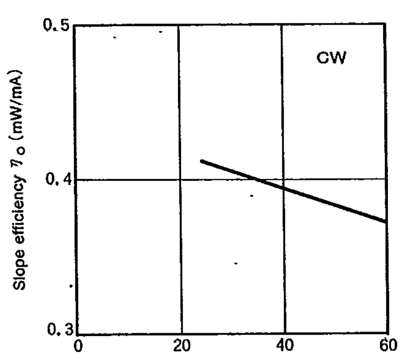
Fig. 2 Temperature dependence of threshold current



3 Temperature dependence of slope efficiency (η_o)

A typical temperature dependence of the slope efficiency η_o is shown in Fig. 3. The gradient is −0.001mW/mA/°C.

Fig. 3 Temperature dependence of slope efficiency



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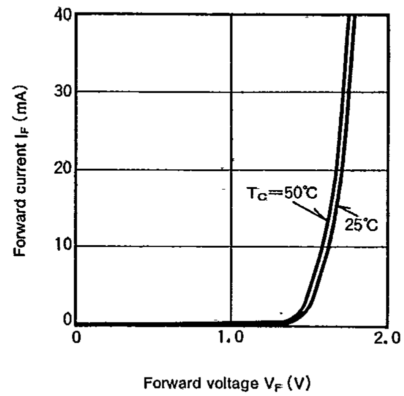
4 Forward current vs. voltage

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 $-2.0mV/℃$ at $I_F = 1mA$.

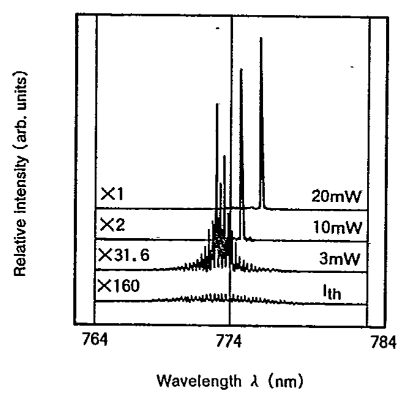
Fig. 4 Forward current vs. voltage characteristics



5 Emission spectra

Typical emission spectra under CW operation are shown in Fig. 5. In general, at an output of 10mW, single mode is observed. The peak wavelength depends on the operating case temperature and forward current (output level).

Fig. 5 Emission spectra under CW operation



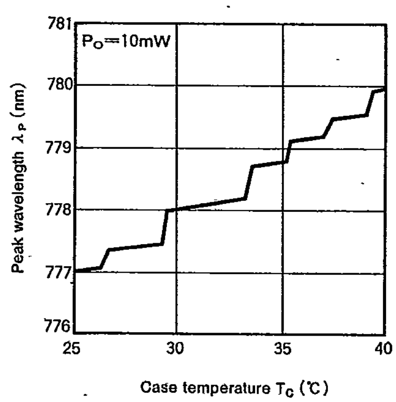
6 Temperature dependence of peak wavelength

A typical temperature dependence of the peak wavelength at an output of 10mW is shown in Fig.6.

The peak wavelength of the beam shifts and jumps to adjacent longitudinal mode by variation of operating temperature.

Averaged temperature coefficient which includes the shifts and jumps is about 0.25nm/℃.

Fig. 6 Temperature dependence of peak wavelength



7 Far-field radiation pattern

The ML6XX1A 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 $0.7 \times 2.0\mu m^2$. Fig. 7 and Fig. 8 show typical far-field radiation patterns in "parallel" and "perpendicular" planes.
The full angles at half maximum points (FAHM) are typically 12° and 30°.

Fig. 7 Far-field patterns in plane parallel to heterojunctions

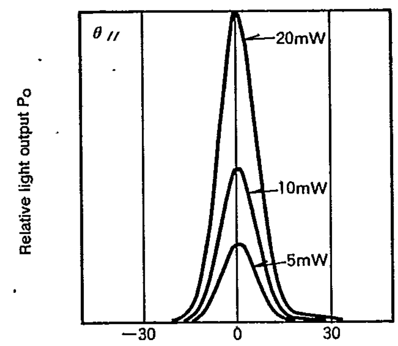
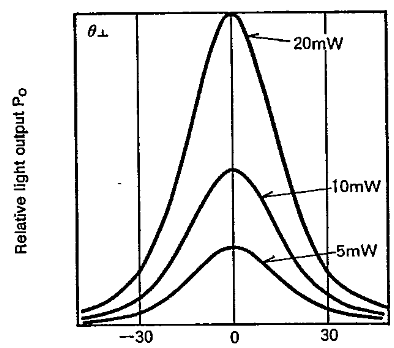


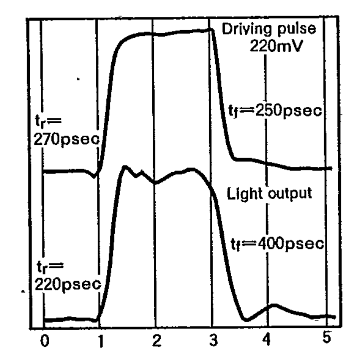
Fig. 8 Far-field patterns in plane perpendicular to heterojunctions



8 Pulse response waveform

In the digital optical transmission systems, the response waveform and speed of the light output against the input current pulse waveform (shown in Fig. 9 upper) is one of the main concerns.
The speed depends on the oscillation delay time, rise and fall times. In order to shorten the oscillation delay time, the laser diode is usually biased close to the threshold current since the delay time is a time for charging the junction up to the threshold. Fig. 9 shows the typical response waveform when rectangular pulse current is applied.
The output power is 10mW and bias current $I_b = I_{th}$. The rise time and the fall time in Fig. 9 are typically 0.3ns and 0.4ns, respectively. They are limited by response speed of the detecter.

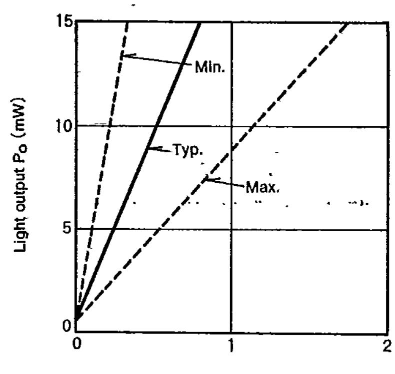
Fig. 9 Pulse response waveform



9 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 front beam since the rear beam is proportional to the front one. In the case of ML6XX1A lasers, the rear beam powers are changed into photocurrent by the monitoring photodiodes. Fig. 10 shows an example of light output vs. monitoring photocurrent characteristics. Above the threshold current, the monitored photocurrent linearly increases with the light output.

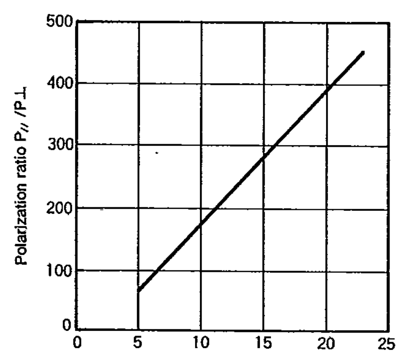
Fig. 10 Light output vs. monitoring output current



10 Polarization ratio

The polarization ratio ($P_{//}/P_{\perp}$), which is the ratio of the parallel polarized light output and the perpendicular polarized one, vs. total light output characteristics is shown in Fig. 11. The polarization ratio increases with the light power.

Fig. 11 Polarization ratio vs. light output

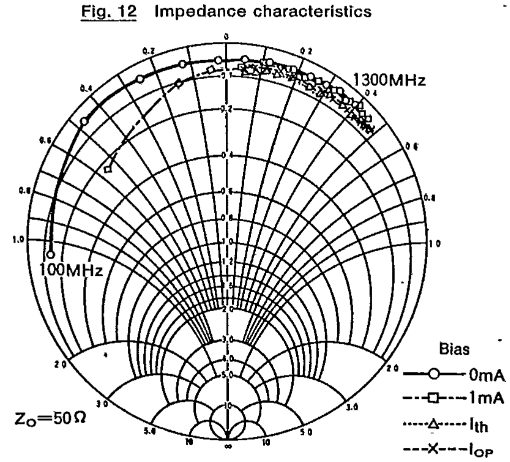


11 Impedance characteristics

Typical impedance characteristics of the ML6XX1A, with lead lengths of 2mm, are shown in Fig. 12 with the bias currents as the parameter. Test frequency is swept from 100MHz to 1300MHz with 100MHz steps.

Above the threshold, the impedance of the ML6XX1A is nearly equal to a series connection of a resistance of 3 ohm and an inductance of 3nH.

Fig. 12 Impedance characteristics



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12 S/N vs. optical feedback ratio

S/N vs. optical feedback ratio, where the frequency is 20kHz and the bandwidth is 300Hz is shown in Fig. 13.
That where the frequency is 10MHz and the bandwidth is 300kHz is shown in Fig. 14.
S/N ratio is worst on CW driving and on HF superimposed driving, when case temperature is 25～50℃ and atmosphere temperature is 25℃ respectively. The frequency and input level of HF superimposition are about 700MHz, $35mA_{P-P}$.

Fig. 13 S/N vs. optical feedback ratio

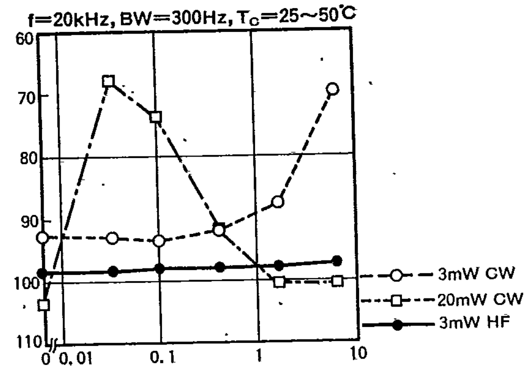
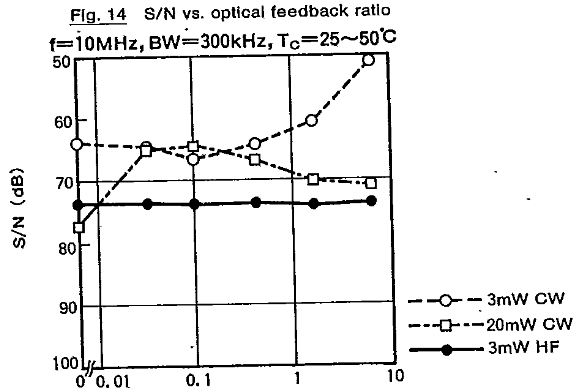


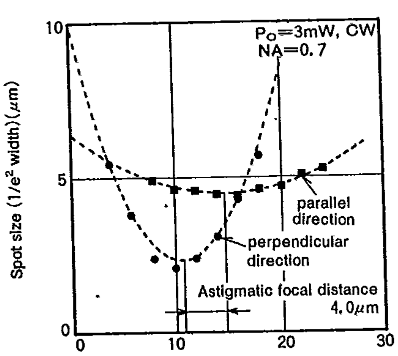
Fig. 14 S/N vs. optical feedback ratio



13 Astigmatic focal distance

There seems to be a difference in luminous point in the parallel and perpendicular direction with the laser beam. This distance between the two points is the astigmatic focal distance. Therefore, when the laser beam is focused, there is a difference in focal point in the two directions.
The typical astigmatic focal distance at NA = 0.7 of ML6XX1A is shown in Fig. 15.

Fig. 15 Astigmatic focal distance



14 Wave front distortion characteristics

Typical wave front distortion (mainly astigmatism) of ML6XX1A is shown in Fig. 16. This figure shows wave front (phase front) when laser beam is collimated.

Various aberrations are calculated by Zernike's polynomial approximation for the interference fringes observed by the Mach-Zehnder interferometer.

Fig. 16 Wave front distortion