

# ML7XX1 SERIES

MITSUBISHI (DISCRETE SC) 3LE D ■ 6249829 0014171 1 ■ MITS

FOR OPTICAL COMMUNICATION

TYPE  
NAME

**ML7011R, ML7701, ML7761,  
ML7781, ML7911**

T-41-05

## DESCRIPTION

Mitsubishi ML7XX1 series are InGaAsP laser diodes emitting light beams around 1300nm wavelength. They lase by applying forward current exceeding threshold values, and emit light power of about 5mW/facet at an operating current of around 15mA in excess of the threshold current. They operate, under CW or pulse conditions according to input current, at case temperatures up to 70°C.

The ML7XX1 series except for ML7911 are hermetically sealed devices having a InGaAs pin 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.

The ML7911 are specially designed for installation in fiber modules and are mounted on flat open packages. Rear output can be used for automatic control of the operating current or case temperature of the laser. They are well suited

for light sources in optical communication systems.

## FEATURES

- Stable fundamental transverse mode oscillation
- Low threshold current, low operating current
- Pin photodiode is installed in the laser package
- High reliability, long operation life
- 1300nm typical emission wavelength

## APPLICATION

Digital communication systems

## ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Conditions	Ratings	Unit
P <sub>O</sub>	Light output (peak)	CW	6	mW
		Pulse (Note 1)	10	
V <sub>RL</sub>	Reverse voltage	—	2	V
V <sub>RML</sub>	Peak reverse voltage	—	2	V
V <sub>RD</sub>	Reverse voltage (Photodiode)	—	20	V
V <sub>RMD</sub>	Peak reverse voltage (Photodiode)	—	20	V
I <sub>FD</sub>	Forward current (Photodiode)	—	2	mA
T <sub>C</sub>	Case temperature	—	-20~+70	°C
T <sub>stg</sub>	Storage temperature	—	-40~+100	°C

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

## ELECTRICAL/OPTICAL CHARACTERISTICS (T<sub>C</sub>=25°C)

Symbol	Parameter	Test conditions	Limits			Unit
			Min.	Typ.	Max.	
I <sub>th</sub>	Threshold current	CW	—	10	30	mA
I <sub>OP</sub>	Operating current	CW, P <sub>O</sub> =5mW	—	25	50	mA
V <sub>OP</sub>	Operating voltage (Laser diode)	CW, P <sub>O</sub> =5mW	—	1.2	1.6	V
P <sub>O</sub>	Light output	CW, I <sub>F</sub> =I <sub>th</sub> +15mA	3	5	—	mW
λ <sub>P</sub>	Peak wavelength	CW, P <sub>O</sub> =5mW	1280	1300	1330	nm
Δλ <sub>P</sub>	Spectral half width	CW, P <sub>O</sub> =5mW	—	3	—	nm
θ <sub>  </sub>	Full angle at half maximum (parallel)	CW, P <sub>O</sub> =5mW	—	25	—	deg.
θ <sub>⊥</sub>	Full angle at half maximum (perpendicular)	CW, P <sub>O</sub> =5mW	—	30	—	deg.
t <sub>r</sub> , t <sub>f</sub>	Rise and fall times	I <sub>F</sub> =I <sub>th</sub> , P <sub>O</sub> =5mW, 10%~90%	—	0.3	0.7	ns
I <sub>m</sub>	Monitoring output current	CW, P <sub>O</sub> =5mW, V <sub>RD</sub> =1V, R <sub>L</sub> =10Ω (Note 2)	0.2	0.5	—	mA
I <sub>D</sub>	Dark current (Photo diode)	V <sub>RD</sub> =10V	—	0.2	0.5	μA
C <sub>t</sub>	Capacitance (Photo diode)	V <sub>RD</sub> =10V, f=1MHz	—	8	20	pF
P <sub>m</sub> (Note 3)	Monitoring Light Output	CW, P <sub>O</sub> =5mW	0.5	1.0	—	mW

Note 2 : R<sub>L</sub> is load resistance of the photodiode.

Note 3 : P<sub>m</sub> only apply to ML7911.

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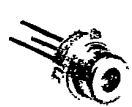
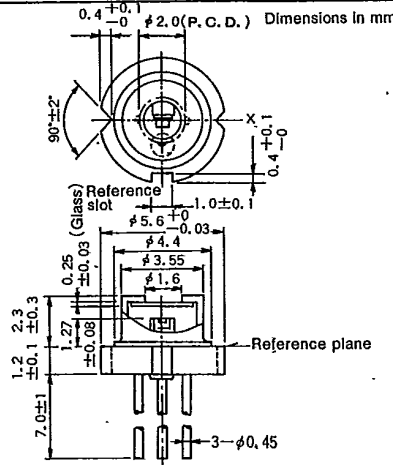
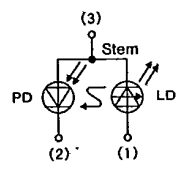
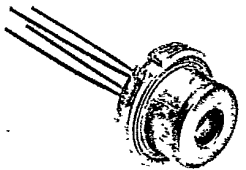
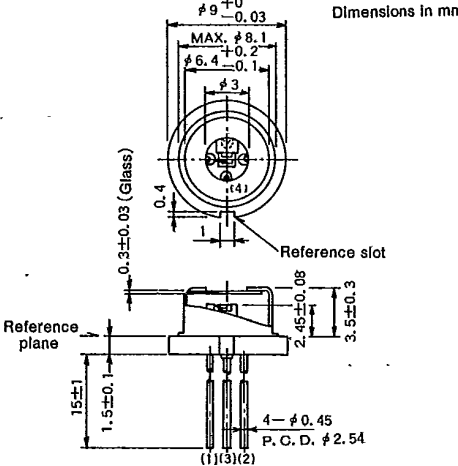
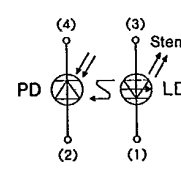
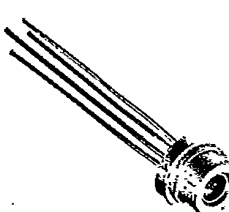
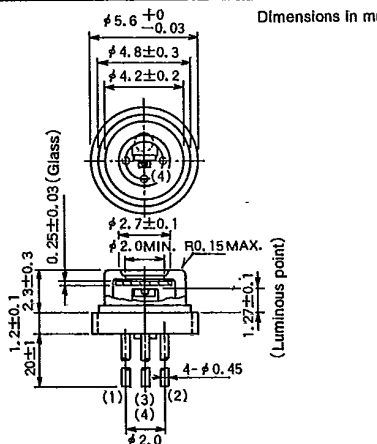
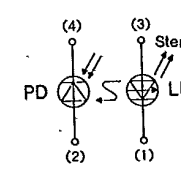
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OUTLINE DRAWINGS

<p><b>ML7011R</b></p> 	<p>Dimensions in mm</p>  <p>Top view dimensions: <math>0.4^{+0.1}_0</math>, <math>\phi 2.0</math> (P.C.D.), <math>90^{\pm 2^\circ}</math>, <math>X</math>, <math>0.4^{+0.1}_0</math>.</p> <p>Side view dimensions: <math>1.0 \pm 0.1</math>, <math>\phi 5.6^{+0.03}_0</math> (Glass), <math>\phi 4.4</math>, <math>\phi 3.55</math>, <math>\phi 1.6</math>, <math>0.25</math>, <math>\pm 0.03</math>, <math>1.27</math>, <math>\pm 0.08</math>, <math>1.2</math>, <math>2.3</math>, <math>\pm 0.1</math>, <math>7.0 \pm 1</math>.</p> <p>Reference plane</p> <p>Bottom view dimensions: <math>3 - \phi 0.45</math>.</p>	<p>(<math>\phi 5.6</math>mm 3pin Small package)</p> 
<p><b>ML7701</b></p> 	<p>Dimensions in mm</p>  <p>Top view dimensions: <math>\phi 9^{+0.03}_0</math>, MAX. <math>\phi 8.1</math>, <math>\phi 6.4^{+0.2}_0</math>, <math>\phi 3</math>, <math>0.4</math>, <math>r4</math>.</p> <p>Side view dimensions: <math>0.3 \pm 0.03</math> (Glass), <math>0.4</math>, <math>1</math>, <math>2.45 \pm 0.08</math>, <math>3.5 \pm 0.3</math>.</p> <p>Reference plane</p> <p>Bottom view dimensions: <math>15 \pm 1</math>, <math>1.5 \pm 0.1</math>, <math>4 - \phi 0.45</math>, P.C.D. <math>\phi 2.54</math>, (1)(3)(2), (4).</p>	<p>(<math>\phi 9</math>mm 4pin Standard package)</p> 
<p><b>ML7761</b></p> 	<p>Dimensions in mm</p>  <p>Top view dimensions: <math>\phi 5.6^{+0.03}_0</math>, <math>\phi 4.8 \pm 0.3</math>, <math>\phi 4.2 \pm 0.2</math>, <math>\phi 2.7 \pm 0.1</math>, <math>\phi 2.0</math> MIN., <math>R0.15</math> MAX., <math>\phi 2.0</math> (Luminous point).</p> <p>Side view dimensions: <math>0.25 \pm 0.03</math> (Glass), <math>1.27 \pm 0.1</math>, <math>1.2</math>, <math>2.3</math>, <math>\pm 0.3</math>, <math>20 \pm 1</math>, <math>1.27 \pm 0.1</math>.</p> <p>Reference plane</p> <p>Bottom view dimensions: <math>4 - \phi 0.45</math>, (1), (3), (2), (4), <math>\phi 2.0</math> P.C.D.</p>	<p>(<math>\phi 5.6</math>mm 4pin Small package)</p> 

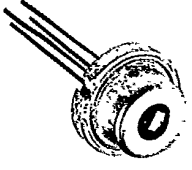
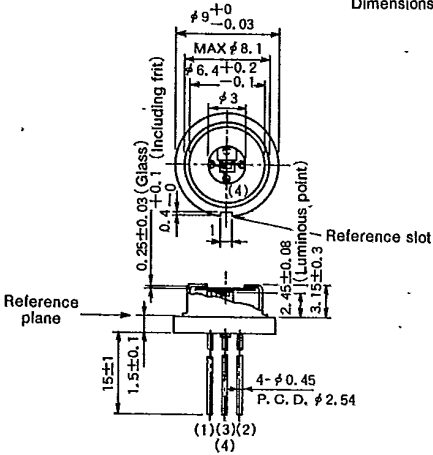
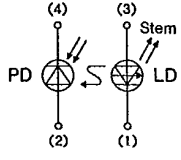

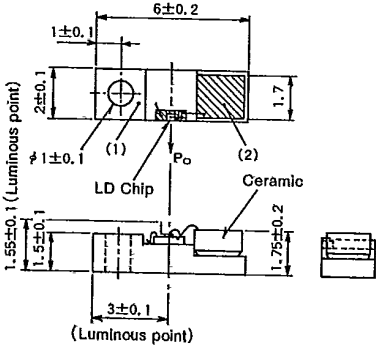

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OUTLINE DRAWINGS

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<p><b>ML7781</b></p> 	<p>Dimensions in mm</p>  <p>Reference plane</p> <p>Reference slot</p> <p>(1)(3)(2) (4)</p>	<p>(<math>\phi</math>9mm 4pin Low cap package)</p> 
<p><b>ML7911</b></p> 	<p>Dimensions in mm</p>  <p>(1) (2)</p> <p>LD Chip</p> <p>Ceramic</p> <p>(Luminous point)</p>	<p>(Chip carrier package)</p> 

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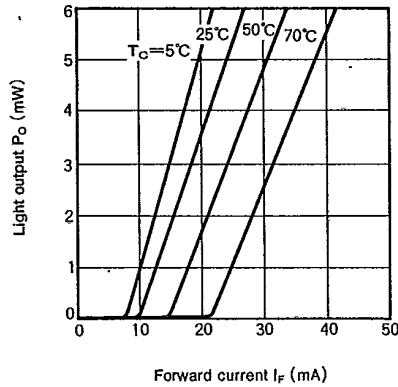
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**1** Light output vs. forward current

Typical light output vs. forward current characteristics are shown in Fig. 1. The threshold current for lasing is typically 10mA 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.

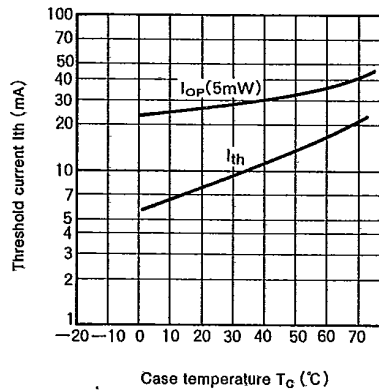
Fig. 1 Light output vs. forward current



**2** Temperature dependence of threshold current ( $I_{th}$ ), operating current ( $I_{op}$ ) and slope efficiency ( $\eta_o$ )

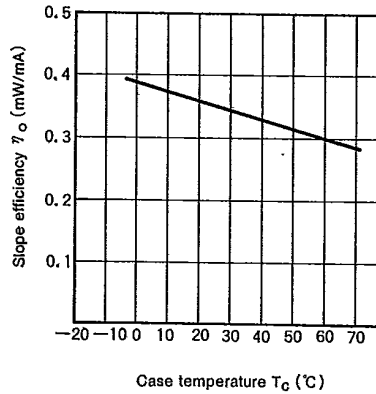
A typical temperature dependence of the threshold current and operating current is shown in Fig. 2. The characteristic temperature  $T_0$  of the threshold current is typically 55K in  $T_c \leq 50^\circ\text{C}$ , 45K in  $T_c > 50^\circ\text{C}$  where the definition of  $T_0$  is  $I_{th} \propto \exp(T_c/T_0)$ .

Fig. 2 Temperature dependence of threshold current



A typical temperature dependence of the slope efficiency  $\eta_o$  is shown in Fig. 3. The gradient is  $-0.0015\text{mW}/\text{mA}^\circ\text{C}$ .

Fig. 3 Temperature dependence of slope efficiency

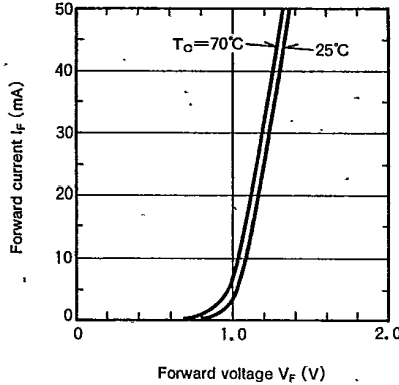


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**3 Forward current vs. voltage**

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  $-1.3\text{mV}/^\circ\text{C}$  and  $-1\text{mV}/^\circ\text{C}$  at  $I_F = 1\text{mA}$  and  $10\text{mA}$ , respectively.

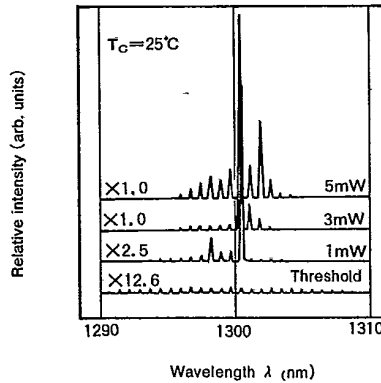
Fig. 4 Forward current vs. voltage characteristics



**4 Emission spectra**

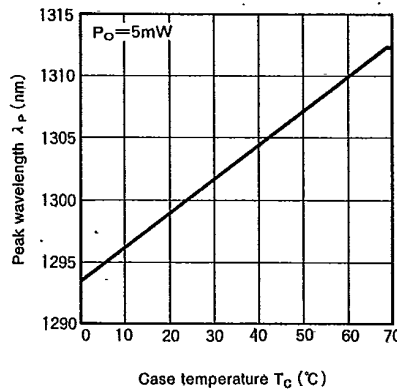
Typical emission spectra under CW operation are shown in Fig. 5. In general, at an output of  $5\text{mW}$ , several modes are observed. Longitudinal mode spacings are typically  $1\text{nm}$  and spectral width (FWHM) is typically  $3\text{nm}$  at an output of  $5\text{mW}$ . The peak wavelength depends 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  $5\text{mW}$  is shown in Fig. 6. The peak wavelength of the beam shifts to adjacent longitudinal mode by variation of operating temperature. Averaged temperature coefficient is about  $0.35\text{nm}/^\circ\text{C}$ .

Fig. 6 Temperature dependence of peak wavelength



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**5 Far-field radiation pattern**

The ML7XX1 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  $1.25 \times 1.0 \mu m^2$ . 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  $25^\circ$  and  $30^\circ$ .

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

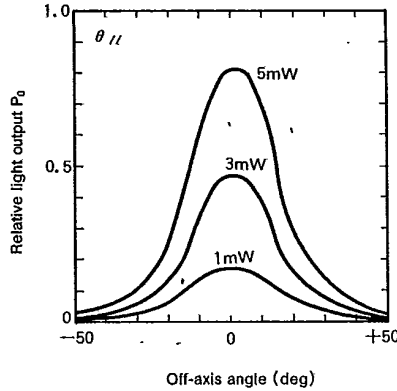
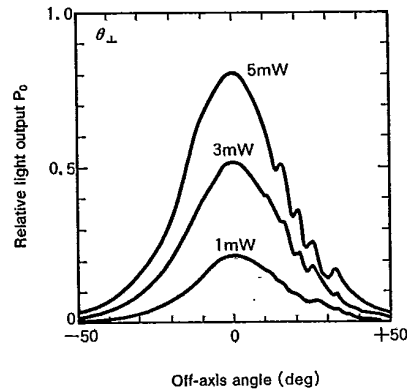


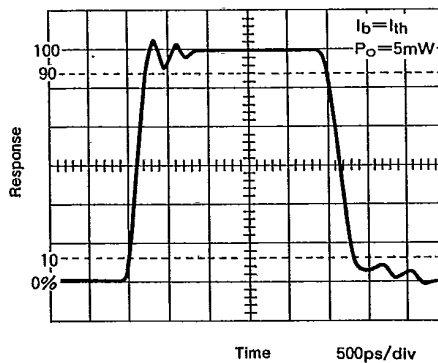
Fig. 8 Far-field patterns in plane perpendicular to heterojunctions



**6 Pulse response**

In digital transmission systems, the response waveform and speed of the light output against the input pulse current waveform is a main concern. The speed depends on the oscillation delay time and rise and fall times. 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. The output power is  $5mW$  and bias current  $I_b = I_{th}$ . Rise/fall time is typically  $0.3ns$ .

Fig. 9 Pulse response waveform



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**7 Monitoring output**

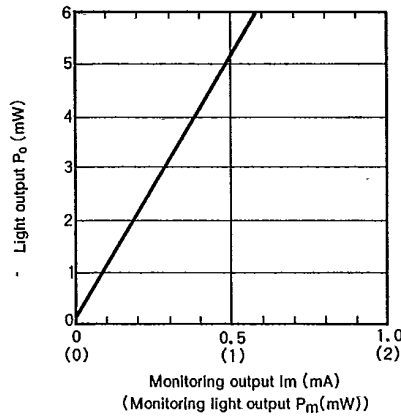
The laser diodes emit beams from both of their mirror surfaces, front and rear surfaces (see the outline drawing). The rear beam can be used for monitoring the power of the front beam since the power of the rear beam is proportional to the front one.

In the ML7XX1 series, the rear beam power is changed into photocurrents by monitor photodiodes. 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 output current is typically 0.5mA when the front light output is 5mW.

In the ML7911, monitor photodiodes are not installed in the laser package. Monitoring output is emitted from the back of package.

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

Fig. 10 Light output vs. monitoring output current



**8 Impedance characteristics**

Typical impedance characteristics of the ML7XX1, with lead lengths of 2mm, is shown in Fig. 11 with the bias currents as the parameter. Test frequency is swept from 100MHz to 1300MHz with 100MHz step.

Fig. 11 Impedance characteristics

