Hitachi Optodevice Data Book

HITACHI

ADE-408-001E

Safety Considerations

Be sure to avoid direct exposure of human eyes to high power laser beams emitted from laser diodes. Even though barely visible and/or invisible to the human eye, they can be quite harmful. In particular, avoid looking directly into a laser diode or collimated beam along its optical axis when the diode is activated. One simple way to determine the optical path is to use a phosphor plate or infrared sensitive camera.

Hitachi certifies compliance with US Safety Regulations (21 CFR Subchapter J) on laser products, as stipulated by the U.S. Department of Health and Human Services. The Hitachi products shown here correspond to the category "CLASS IIIb LASER PRODUCT" in this regulation.

DANGER

"VISIBLE AND/OR INVISIBLE LASER RADIATION - AVOID DIRECT EXPOSURE TO BEAM"

PEAK POWER 60 mW

WAVELENGTH 625 ~ 1600 nm

"CLASS IIIb LASER PRODUCT"

This product conforms to FDA regulations 21 CRF Chapter 1, Subchapter J.

AVOID EXPOSURE : Visible and/or invisible laser radiation is emitted from glass window, fiber pigtail end or laser chip mounted on top of header. Before use, consult appropriate catalogs or manuals.

LASER SAFETY

This laser device in operation produces visible and/or invisible laser radiation which may be harmful to the human eye. Avoid directly looking into the device or the collimated beam along its optical axis when the device is in operation.

MANUFACTURED:

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Electronic Devices Group
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USER INSTRUCTIONS:

Be sure to avoid direct exposure of human eyes to high power laser beams emitted from laser diodes. Even though barely visible and/or invisible to the human eye, they can be quite harmful. In particular, avoid looking directly into a laser diode or collimated beam along its optical axis when the diode is activated. One simple way to determine the optical pate is to use a phosphor plate or infrared sensitive camera.

These devices are components to be used in producing complete laser systems. They do not emit radiation unless combined by the end user with other components. Please consult the Opto Data Book for some of the possible uses of these devices.

Because of the small size of the device, the required labels and these instructions are provided in this insert rather than printed on the device.

Contents

Product Lineup

Part Numbers

Hitachi optoelectronic device part numbers indicate the following:

H □ □ □ □ □ □ □

- Package type
- Chip structure, characteristics
- Emitting wavelength
  - Ex.; 780 nm band: 78
  - 1300 nm band: 13
- Product type
  - Laser diode: L
  - Infreared emitting diode: E
  - Photodiode: R

Examples are given below.

(1) Laser diode example

H L 1 3 2 6 M F

- MF-type package
- Chip structure, characteristics
- 1300 nm light emitted from the device
- laser diode

(2) Infrared emitting diode example

H E 8 8 0 7 F L

- FL-type package
- Chip structure, characteristics
- 880 nm light emitted from the device
- Infrared emitting diode

(3) Photodiode example

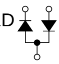
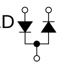
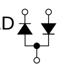
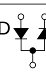
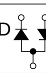
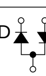
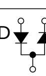
H R 1 1 0 4 C X

- CX-type package
- Chip structure, characteristics
- Photodetectable wavelength range
  - Short wavelengths: 8
  - Long wavelengths: 1
- Photodiode

Product Lineup

Visible and Infrared Laser Diodes

Visible and infrared laser diodes

Wavelength	Optical Output	Internal circuit	Part No.	Main application
633 to 635 nm	3 mW	LD  PD	HL6314MG HL6316G	Pointer
		LD  PD	HL6315G	Pointer
	5 mW	LD  PD	HL6312G	Bar code reader
		LD  PD	HL6313G	Bar code reader
670 to 685 nm	5 mW	LD  PD	HL6720G HL6724MG	Pointer
			HL6712G/MG HL6722G	Bar code reader
			HL6713G	Laser beam printer
			HL6727MG	Measurement
	10 mW	LD  PD	HL6714G	Bar code reader
	30 mW	LD  PD	HL6726MG†	Optical disc

† : Under development

Visible and Infrared Laser Diodes (cont)

Wavelength	Optical Output	Internal circuit	Part No.	Main application
785 nm	5 mW	LD PD	HL7836MG	Laser beam printer
		LD PD	HL7843MG	Laser beam printer
	35 mW	LD PD	HL7859MG†	Optical disc
	40 mW	LD PD	HL7853MG	Optical disc
	50 mW	LD PD	HL7851G	Optical disc
		LD PD	HL7852G	Optical disc
830 nm	40 mW	LD PD	HL8325G	Optical disc

† : Under development

Long Wavelength Laser Diodes

Long wave-length laser diodes

Structure	Wavelength	Optical output	Part No.	Package
Fabry-Pérot type	1310 nm	5 mW	HL1326MF	Can type
		2.0 mW*	HL1326CF HL1326CN HL1326PF HL1326SN	Cylindrical type
		0.4 mW*	HL1327CF HL1327CN HL1327PF HL1327SN	Cylindrical type
DFB-type	1310 nm	2.0 mW*	HL1352CN HL1352SN	Cylindrical type
	1550 nm	1.0 mW*	HL1541BF	Butterfly type
			HL1541DL	Dual in line type
λ/4 phase shifted DFB-type	1310 nm	12 mW	HL1362A/AC	Open air
	1550 nm	12 mW	HL1551A/AC	Open air
		1.5 mW	HL1553	Open air

* : Fiber optical output

Infrared Light Emitting Diodes

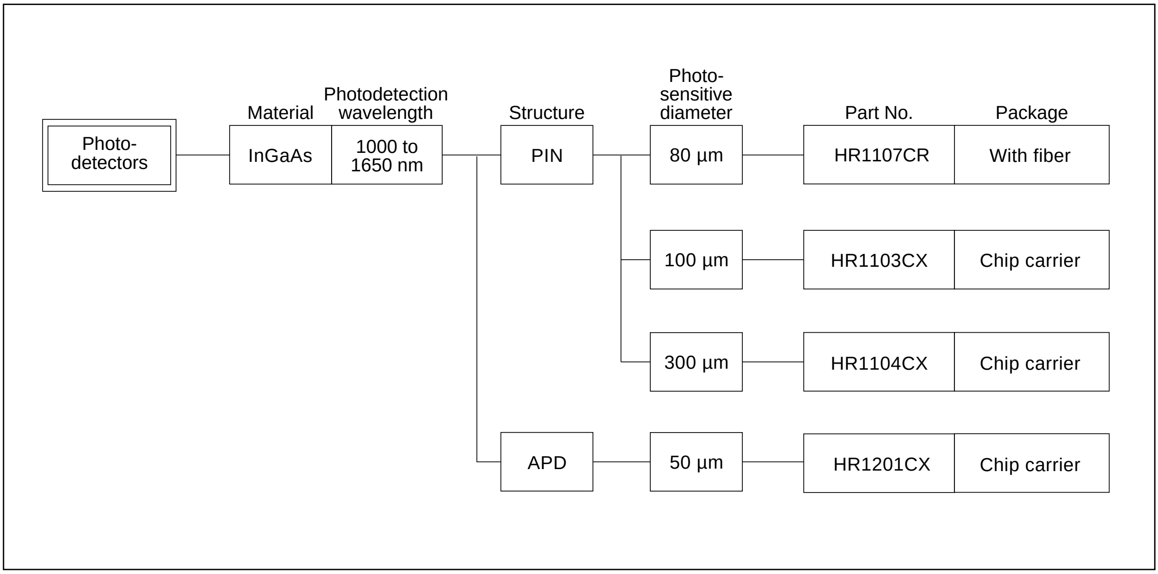
Infrared light emitting diodes

Main application	Wavelength	Optical output	Part No.	Package
Auto-focusing still camera	880 nm typ.	2.2 mW* min.	HE8813VG	Can type
Measurement and general	770 nm typ.	30 mW min.	HE7601SG	Can type
	820 nm typ.	40 mW min.	HE8404SG	Can type
		20 mW min.	HE8811	Can type
	870 nm typ.	40 mW min.	HE8812SG	Can type
Industry	880 nm typ.	10 mW min.	HE8807SG	Can type
		5 mW min.	HE8807CL	Can type with collimator lens
		0.5 mW** min.	HE8807FL	Can type with collimator lens

* : Value at 14 degrees of the acceptance angle

** : Test Condition at I_F = 20 mA

Photo Detectors



Main Characteristics

Laser Diodes (T_C = 25°C)

Part No.		Absolute Maximum Ratings				Optical and Electrical Characreristics					
		Optical Output Power, P_O (mW)	Reverse Voltage, $V_{R(LD)}$ (V)	Operating Temp., T_{opr} (°C)	Storage Temp., T_{stg} (°C)	Lasing Wave-length, λ_p (nm)			Beam Diver-gence, $\theta_{//} \times \theta_{\perp}$ (deg.)	Test Condition P_O (mW)	Ref-erence Page
						Min	Typ	Max	Typ		
HL6312 series	HL6312G	5	2	–10 to +50	–40 to +85	625	635	640	8 × 31	5	109
HL6313 series	HL6313G	5	2	–10 to +50	–40 to +85	625	635	640	8 × 31	5	109
HL6314 series	HL6314MG	3	2	–10 to +50	–40 to +85	630	635	640	8 × 30	3	114
HL6315 series	HL6315G	3	2	–10 to +50	–40 to +85	630	635	640	8 × 30	3	119
HL6316 series	HL6316G	3	2	–10 to +50	–40 to +85	630	635	640	8 × 30	3	119
HL6712 series	HL6712G	5	2	–10 to +50	–40 to +85	660	670	680	8 × 27	5	124
	HL6712MG										
HL6713 series	HL6713G	5	2	–10 to +50	–40 to +85	660	670	680	9 × 30	5	128
HL6714 series	HL6714G	10	2	–10 to +50	–40 to +85	660	670	680	8 × 22	10	132
HL6720 series	HL6720G	5	2	–10 to +50	–40 to +85	660	670	680	9 × 30	5	136
HL6722 series	HL6722G	5	2	–10 to +50	–40 to +85	660	670	680	8 × 30	5	140
HL6724 series	HL6724MG	5	2	–10 to +50	–40 to +85	660	670	680	8 × 30	5	144
HL6726 series	HL6726MG	30	2	–10 to +60	–40 to +85	680	685	695	9 × 20	30	148
HL6727 series	HL6727MG	5	2	–10 to +60	–40 to +85	680	690	695	8 × 33	5	150
HL7836 series	HL7836MG	5	2	–10 to +60	–40 to +85	770	785	795	11 × 27	5	154
HL7843 series	HL7843MG	5	2	–10 to +60	–40 to +85	775	785	795	10 × 24	5	158
HL7851 series	HL7851G	50	2	–10 to +60	–40 to +85	775	785	795	9.5 × 23	50	162
HL7852 series	HL7852G	50	2	–10 to +60	–40 to +85	775	785	795	9.5 × 23	50	166
HL7853 series	HL7853MG	40	2	–10 to +60	–40 to +85	775	785	795	9.5 × 23	40	170

Main Characteristics

Laser Diodes (T_C = 25°C) (cont)

Part No.		Absolute Maximum Ratings: Optical Output Power, P_O (mW)	Absolute Maximum Ratings: Reverse Voltage, $V_{R(LD)}$ (V)	Absolute Maximum Ratings: Operating Temp., T_{opr} (°C)	Absolute Maximum Ratings: Storage Temp., T_{stg} (°C)	Optical and Electrical Characreristics: Lasing Wave-length, λ_p (nm) Min	Typ	Max	Beam Diver-gence, $\theta_{//} \times \theta_{\perp}$ (deg.) Typ	Test Condition P_O (mW)	Ref-erence Page
HL7859 series	HL7859MG†	35	2	–10 to +60	–40 to +85	775	785	795	10.5 × 22	35	174
HL8325 series	HL8325G	40	2	–10 to +60	–40 to +85	820	830	840	10 × 22	40	176
HL1326 series	HL1326CF	2*	2	–40 to +85	–40 to +85	1280	1310	1340		1.5*	180
	HL1326CN										
	HL1326SN										
	HL1326PF										
	HL1326MF	5			–40 to +100				30 × 40	5	185
HL1327 series	HL1327CF	0.4*	2	–40 to +85	–40 to +85	1280	1310	1340		0.3*	191
	HL1327CN										
	HL1327SN										
	HL1327PF										
HL1352 series	HL1352CN	2*	2	–20 to +85	–40 to +85	1290	1310	1330		1.5*	196
	HL1352SN										
HL1362 series	HL1362A	12	2	0 to +60	0 to +80	1290	1310	1330	30 × 40	8	201
	HL1362AC										
HL1541 series	HL1541BF	1*	2	0 to +60	–40 to +70	1530	1550	1570		0.5*	206
	HL1541DL										
HL1551 series	HL1551A	12	2	0 to +60	0 to +80	1530	1550	1570	30 × 40	8	214
	HL1551AC										
HL1553 series	HL1553	3	2	+10 to +40	0 to +60	1530	1557	1570	30 × 40	3	219

† : Under development
* : Fiber optical output power, Pf

Infrared Emitting Diodes (T_C = 25°C)

Part No.	Absolute Maximum Ratings: Reverse Voltage, V_R (V)	Operating Temp., T_{opr} (°C)	Storage Temp., T_{stg} (°C)	Optical and Electrical Characreristics: Optical Output Power P_O (mW) Min	Peak Wave-length*, λ_p (nm)	Spectral Width, $\Delta\lambda$ (mA) Typ	Test Condition I_F (mA)	Capaci-tance, C_t (pF) Typ	Test Condition	Ref-erence Page
HE7601SG	3	–20 to +60	–40 to +90	30	740 to 800	50	200	30	V_R = 0 V f = 1 MHz	225
HE8404SG	3	–20 to +60	–40 to +90	40	790 to 850	50	200	30		228
HE8807SG	3	–20 to +85	–40 to +100	10	800 to 900	30	150	10		231
HE8807CL		–20 to +85	–40 to +100	5	800 to 900	30	150	10		
HE8807FL		–20 to +85	–40 to +100	0.5***	800 to 900	30	150	10		
HE8811	3	–20 to +60	–40 to +90	20	780 to 900	50	150	10		236
HE8812SG	3	–20 to +60	–40 to +90	40	840 to 900	50	200	30		239
HE8813VG	3	–20 to +60	–40 to +90	2.2**	800 to 900	50	150	10		242

*: Output power within 14 degrees of the acceptance angle

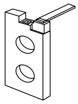
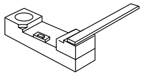
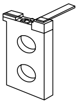
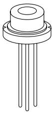
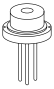
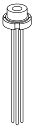
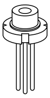
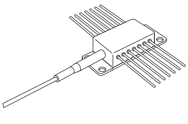
**: Output power within 9 degrees of the acceptance angle at I_F = 20 mA

Photodiodes (T_C = 25°C)

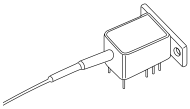
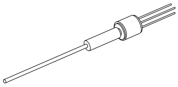
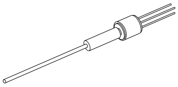
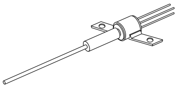
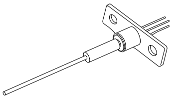
Part No.	Absolute Maximum Ratings: Photo-Detection Dia., ø (μm)	Reverse Voltage, V_R (V)	Operating Temp., T_{opr} (°C)	Storage Temp., T_{stg} (°C)	Optical and Electrical Characreristics: Dark Current, I_{DARK} (nA) Typ	Test Condition V_R (V)	Capaci-tance, C_t (pF) Typ	Test Condition	Sensi-tivity, S (mA/mW) Min	Test Condition	Ref-erence Page
HR1103CX	100	20	–40 to +85	–40 to +100	1	5	1.2	V_R = 5 V f = 1 MHz	0.9 Typ	V_R = 5 V λ_P = 1550 nm	247
HR1104CX	300	20	–40 to +85	–45 to +100	1	5	5	V_R = 5 V f = 1 MHz	0.9 Typ	V_R = 5 V λ_P = 1550 nm	251
HR1107CR	80	20	–20 to +70	–40 to +85	1	5	0.9	V_R = 5 V f = 1 MHz	0.8 Typ	V_R = 5 V λ_P = 1550 nm	255
HR1201CX	50	–	–40 to +80	–45 to +100	2	0.9 V_B	0.7	V_R = 0.9 V_B f = 1 MHz	0.9 Typ	M = 1 λ_P = 1550 nm	259

Package Variations

Laser diodes

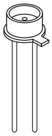
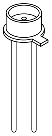
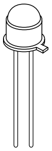
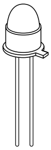
	Packages	Features	Applicable Products
Open-air type	 A1-type	• For experimental use • For module assembly	HL1362A, HL1551A
	 AC-type	• For module assembly • Chip carrier stem	HL1362AC, HL1551AC
	 AF-type	• For module assembly	HL1553
Can type	 G1-type	• With built-in monitor-photodiode •Three leads	HL6712G, HL6713G
	 G2-type	• With built-in monitor-photodiode • Three leads • Short lead length (9 mm)	HL6312G, HL6313G, HL6714G, HL6315G, HL6316G, HL6720G, HL6722G, HL7851G, HL7852G, HL8325G
	 MF-type	• With built-in monitor-photodiode • Four leads • Compact size	HL1326MF
	 MG-type	• With built-in monitor-photodiode • Three leads • Compact size	HL6712MG, HL7836MG, HL7853MG, HL6314MG, HL6724MG, HL6726MG, HL6727MG, HL7843MG, HL7859MG
Fiber-pigtail type	 BF-type	• Butterfly-type package • For high frequency • With single-mode fiber • With built-in cooler • With built-in monitor-photodiode	HL1541BF

Laser Diodes (cont)

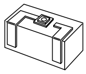
	Packages	Features	Applicable Products
Fiber-pigtail type	 DL-type	• Dual-in-line type package • With single-mode fiber • With built-in cooler • With built-in monitor-photodiode	HL1541DL
	 CF-type	• Compact, slim package • With single-mode fiber • With built-in monitor-photodiode	HL1326CF, HL1327CF
	 CN-type	• Compact, slim package • With single-mode fiber • With built-in monitor-photodiode • Different pin-out from CF-type	HL1326CN, HL1327CN, HL1352CN
	 PF-type	• Compact, slim package • With single-mode fiber • With built-in monitor-photodiode • CF-type pin-out	HL1326PF, HL1327PF
	 SN-type	• Compact, slim package • With single-mode fiber • With built-in monitor-photodiode • CN-type pin-out	HL1326SN, HL1327SN, HL1352SN

Package Variations

Infrared Emitting Diodes

	Packages	Features	Applicable Products
Can type	 SG1-type	• Flat glass window • Two leads	HE7601SG, HE8404SG, HE8807SG, HE8811, HE8812SG,
	 VG-type	• Flat glass window • Two leads	HE8813VG
Can type with lens	 FL-type	• Lens cap to collimate beam • Two leads	HE8807FL
	 CL-type	• Lens cap to collimate beam • Two leads	HE8807CL

Photodiodes

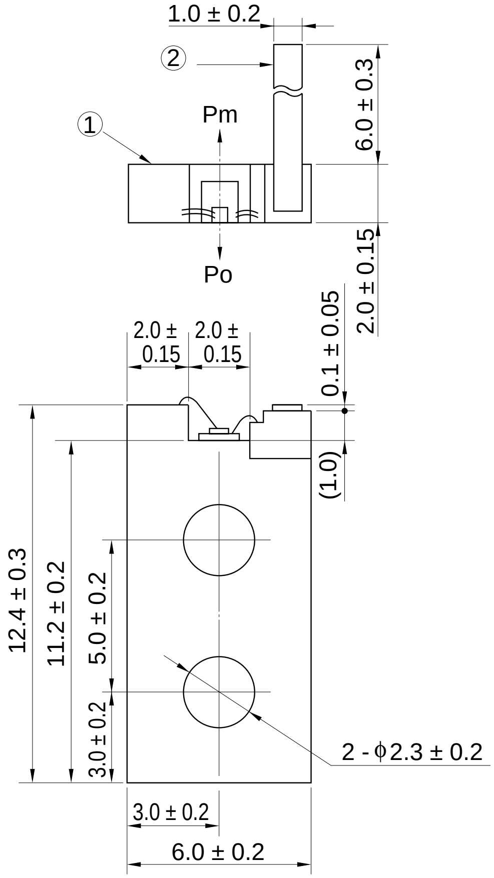
	Packages	Features	Applicable Products
Open-air type	 CX-type	• For module assembly • Chip carrier stem	HR1103CX, HR1104CX, HR1201CX
Fiber-pigtail type	 CR-type	• With multi-mode fiber • Three leads	HR1107CR

Package Dimensions

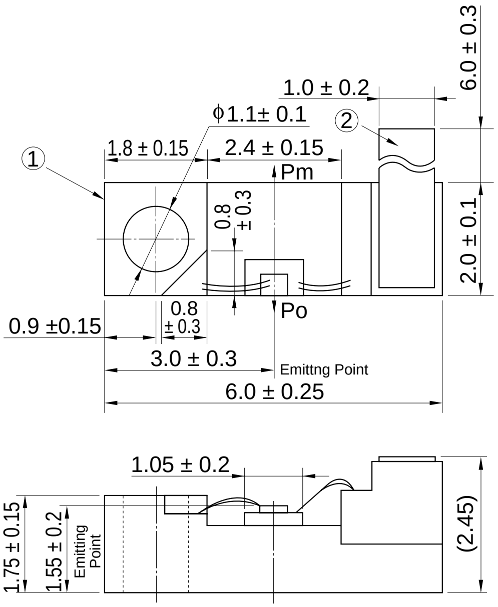
Laser Diodes

(Unit : mm)

A1 - Type



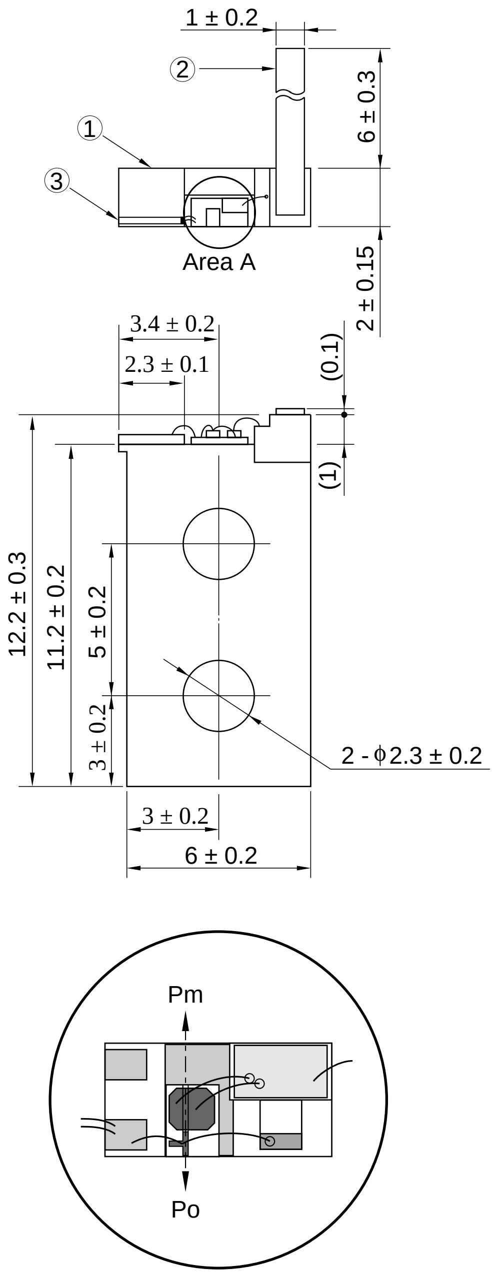
AC - Type



Laser Diodes (cont)

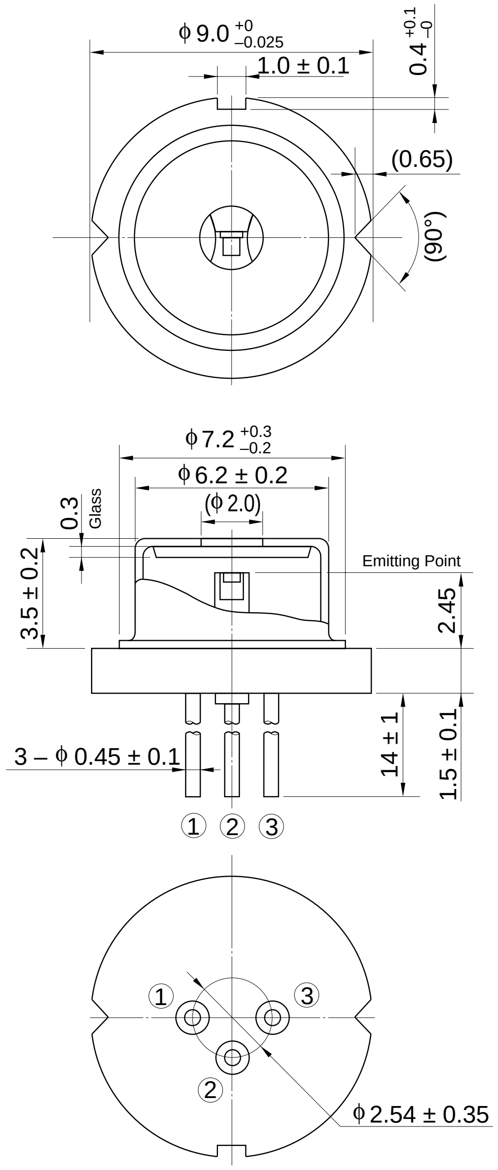
(Unit : mm)

AF - Type



Enlargement of Area A

G1 - Type

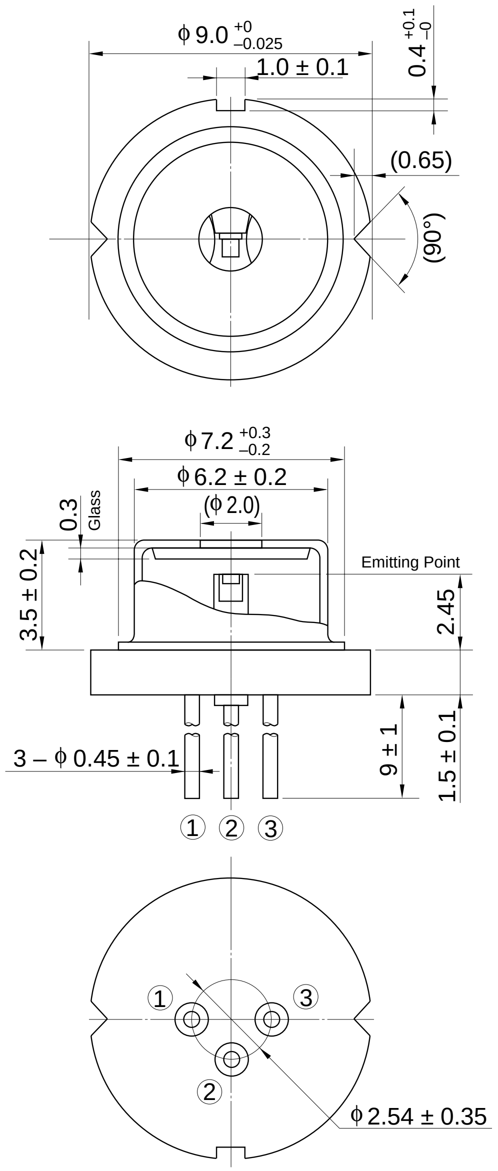


Package Dimensions

Laser Diodes (cont)

(Unit : mm)

G2 - Type



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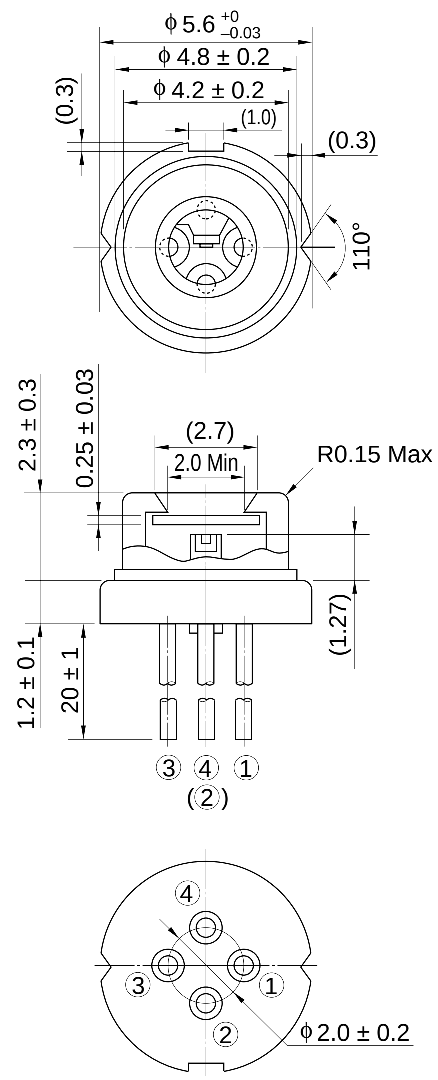
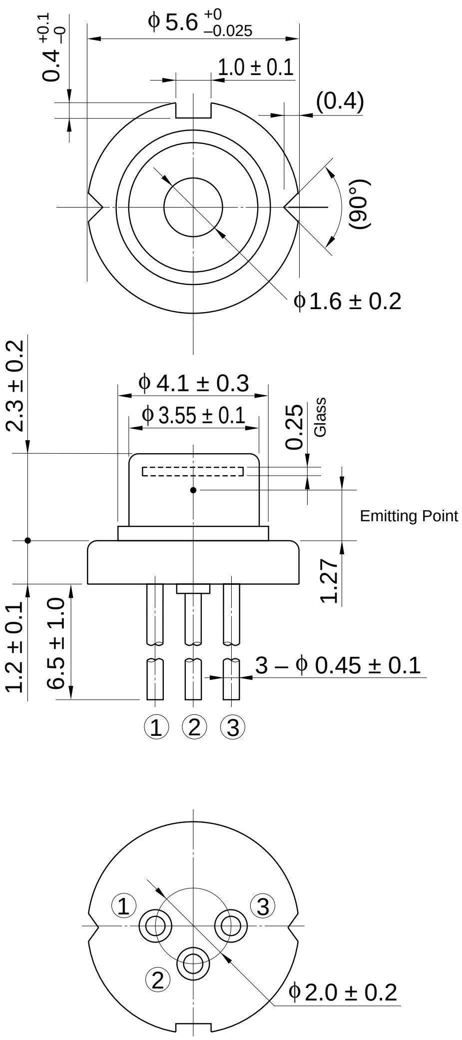


Laser Diodes (cont)

(Unit : mm)

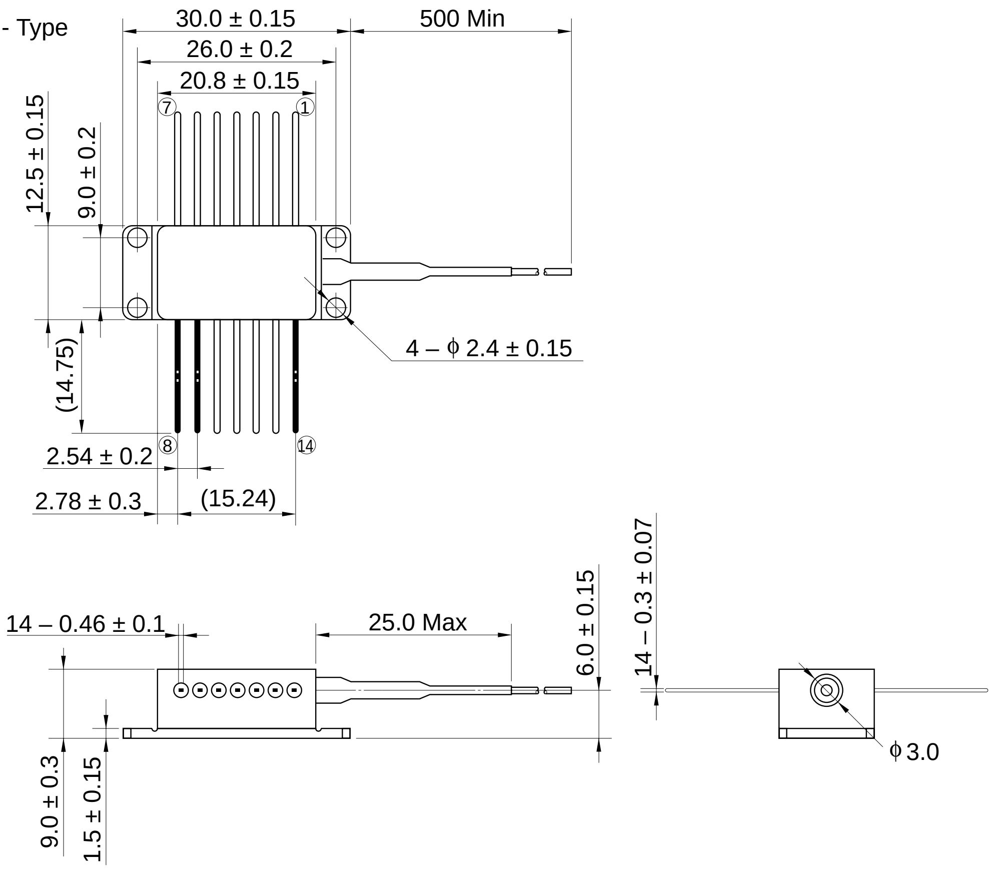
MG - Type



Laser Diodes (cont)

(Unit : mm)

BF - Type



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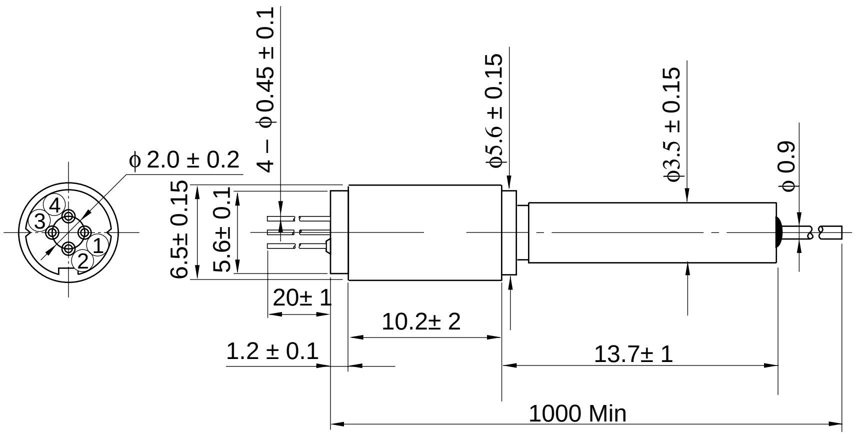

Laser Diodes (cont)

(Unit : mm)

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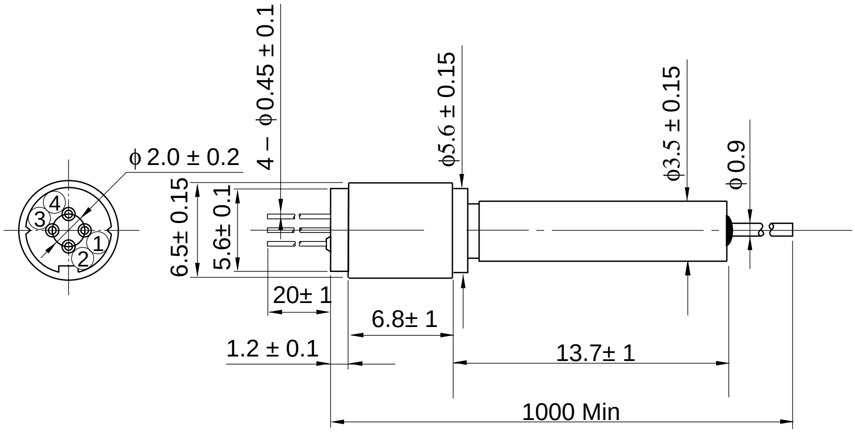

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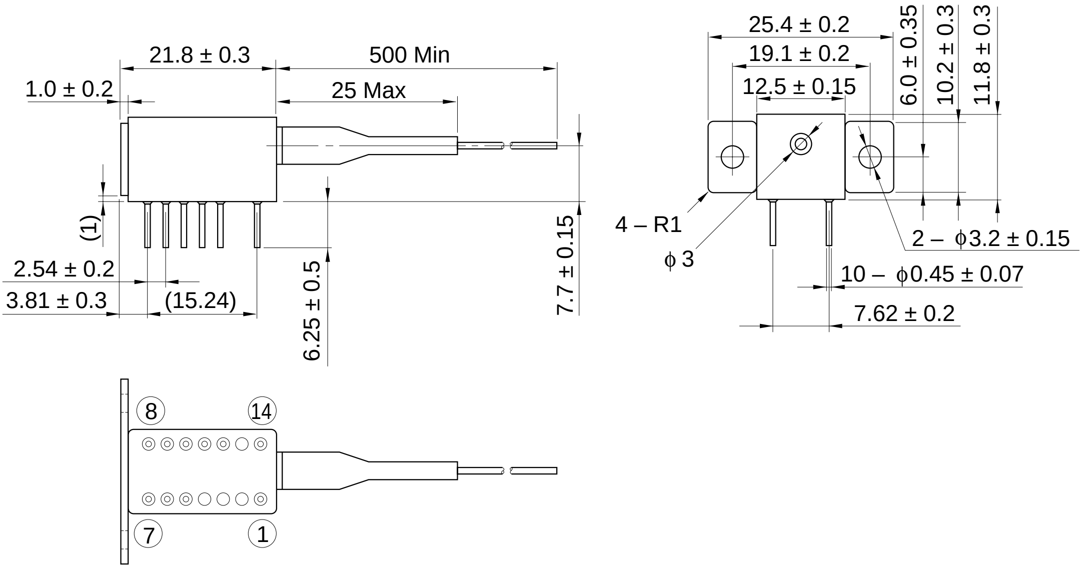
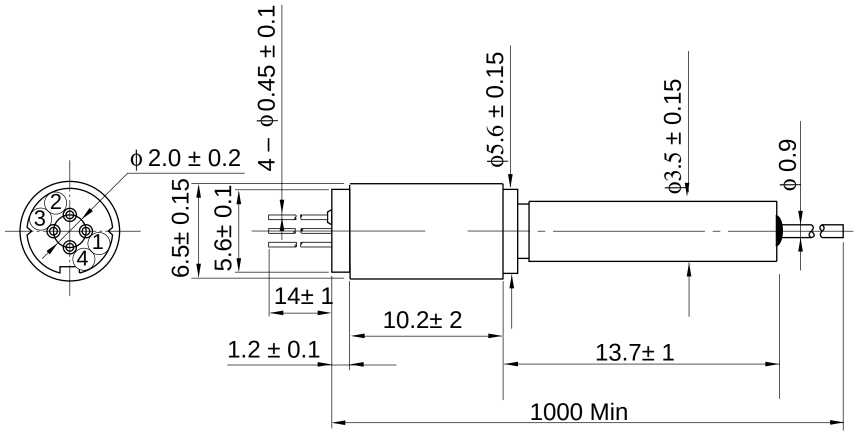


Package Dimensions

Laser Diodes (cont)

(Unit : mm)

CN1 - Type



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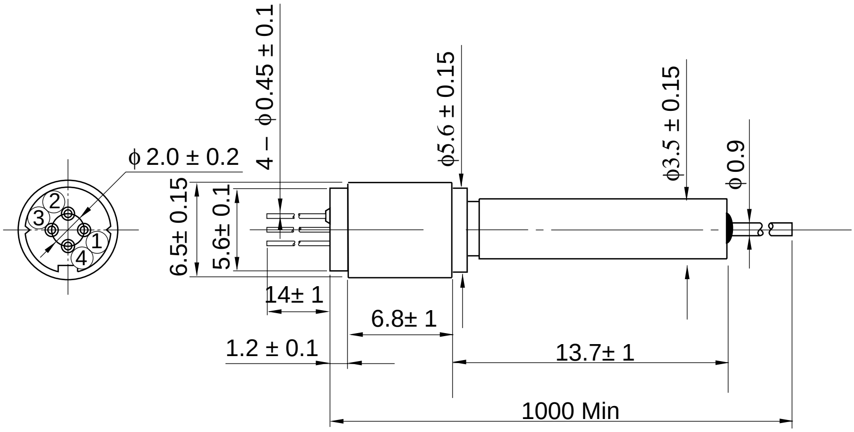

Laser Diodes (cont)

(Unit : mm)

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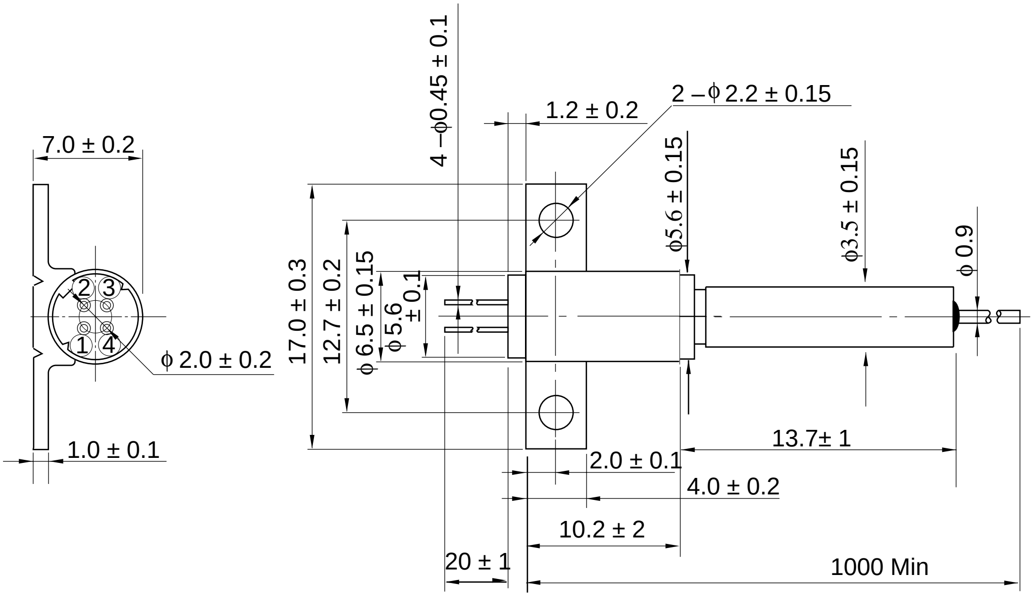

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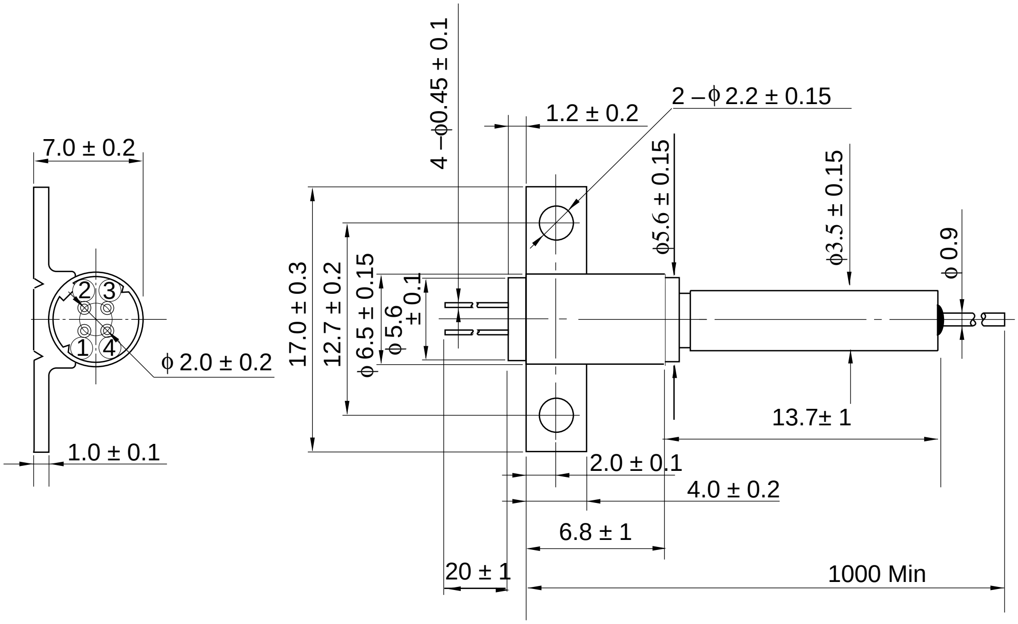

Package Dimensions

Laser Diodes (cont)

(Unit : mm)

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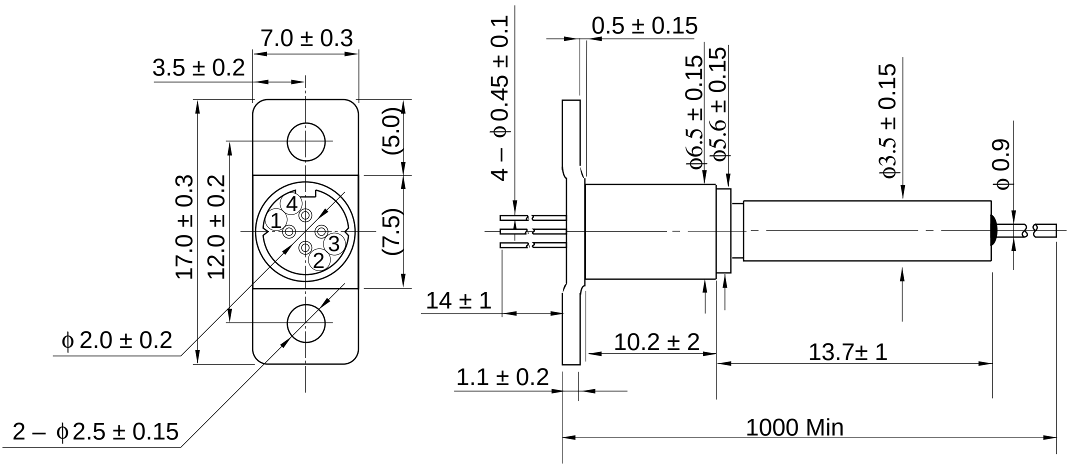

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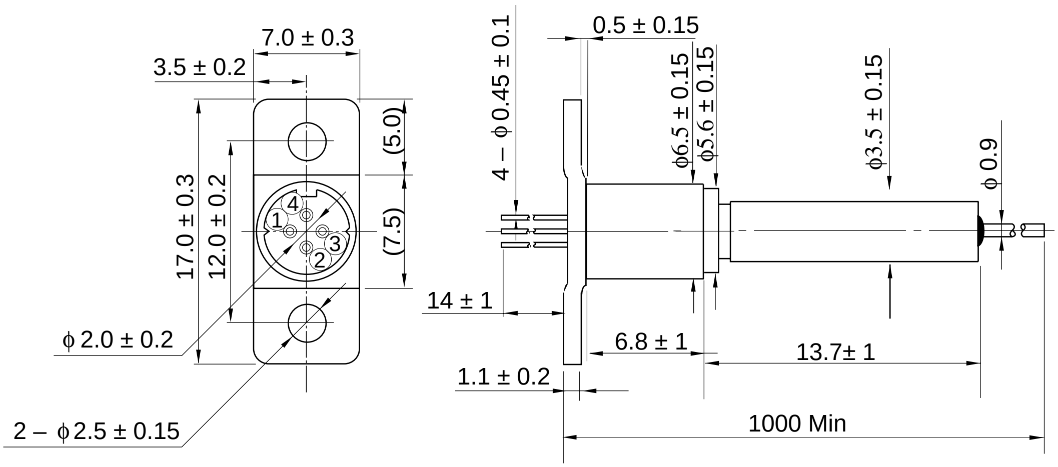

Infrared Emitting Diodes

(Unit : mm)

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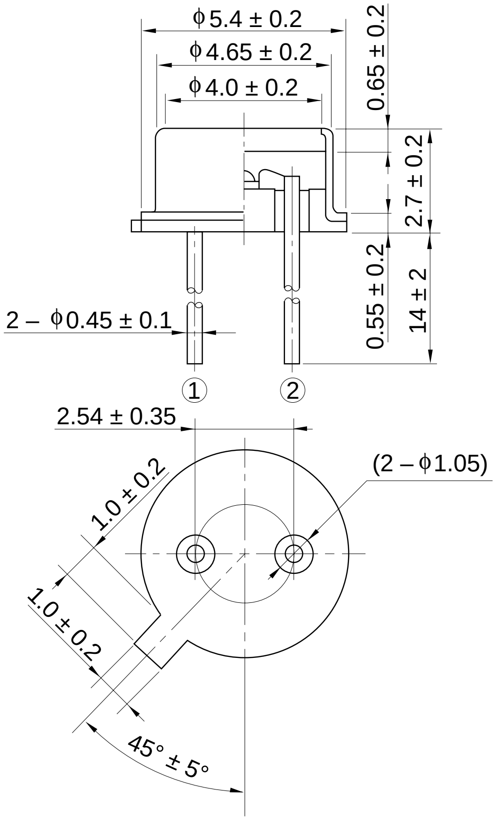
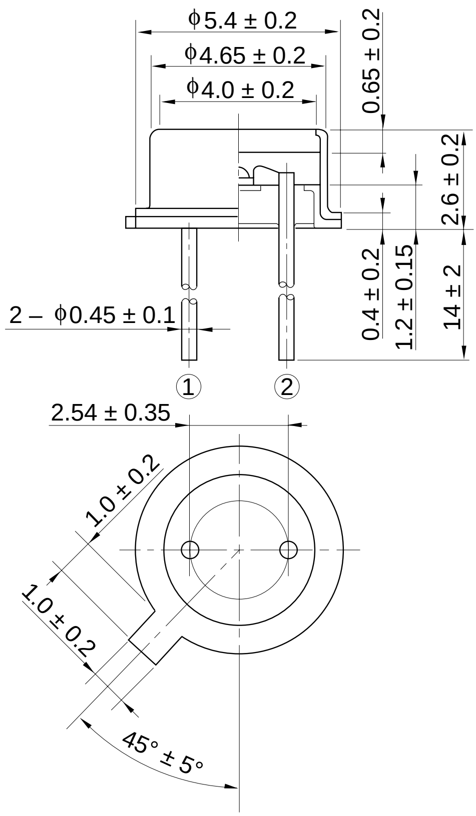


VG - Type

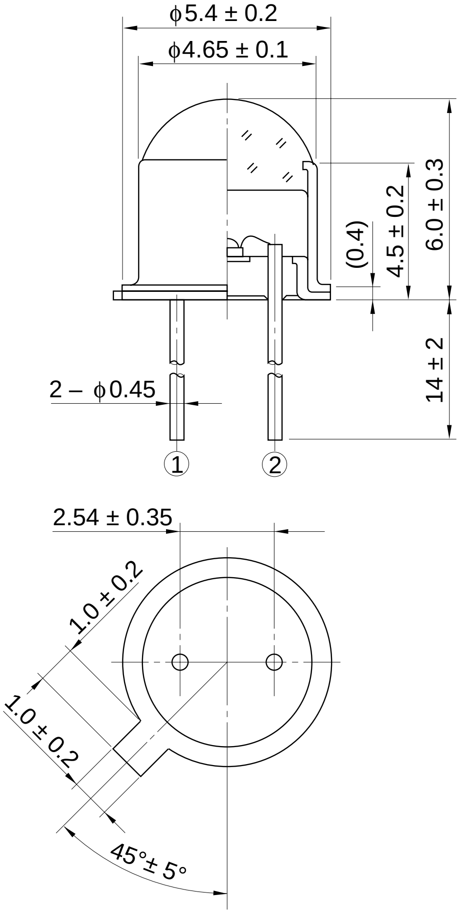


Package Dimensions

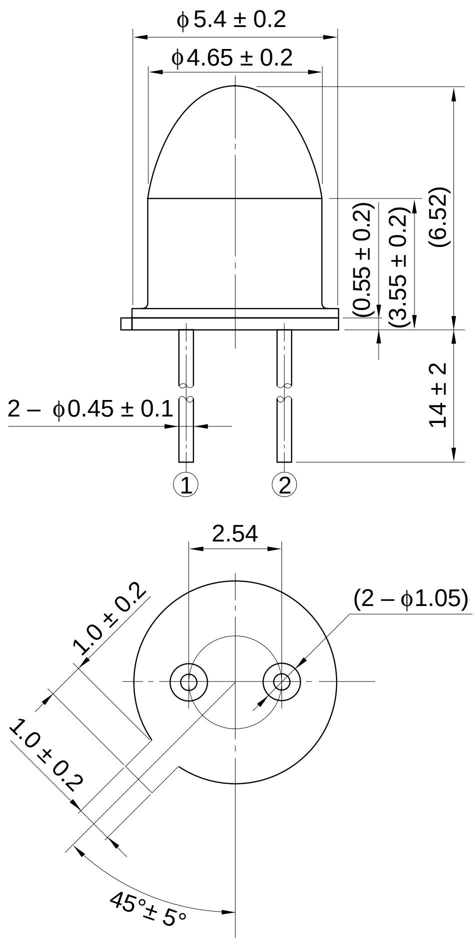
Infrared Emitting Diodes (cont)

(Unit : mm)

FL - Type



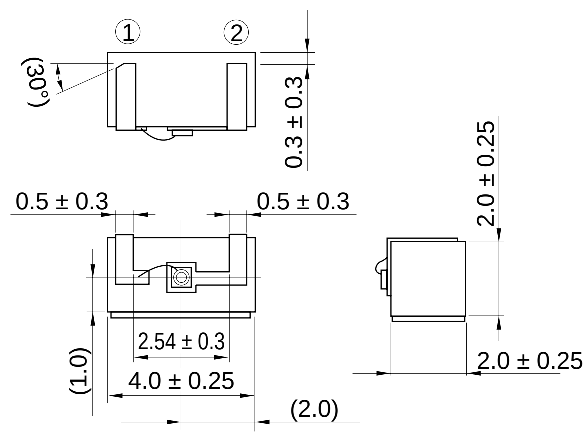
CL - Type



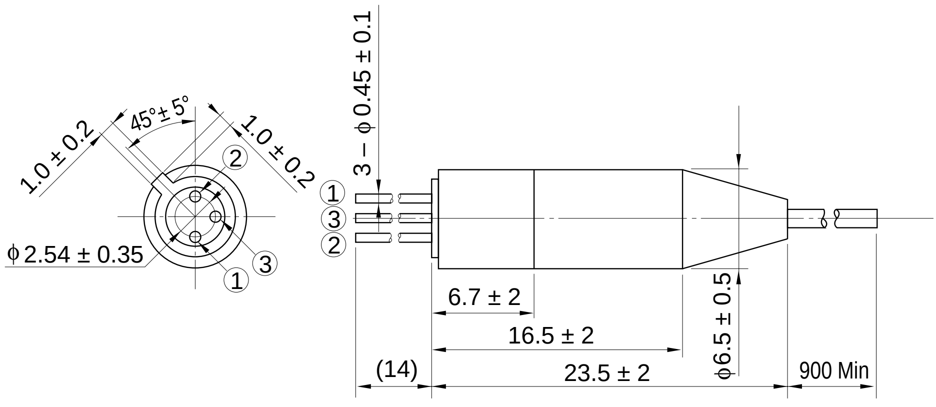
Photodiodes

(Unit : mm)

CX - Type



CR - Type



Section 1 Operating Principles

1.1 Operating Principles of Laser Diodes (LDs), Infrared Emitting Diodes (IREDs) and Photodiodes (PDs)

1.1.1 Emitting Principles

Each electron in an atom or molecule has a specific discrete energy level, as shown in figure 1-1. The transition of electrons between different energy levels is sometimes accompanied by light absorption or emission with the wavelength, λ, expressed as:

$$\lambda = \frac{C}{f_0} = \frac{C}{|E_2 - E_1|/h} = \frac{1.2398}{|E_2 - E_1|}$$

C: Light velocity

E_1: Energy level before transition

E_2: Energy level after transition

h: Planck constant (6.625×10^{-34} joul. sec.)

f_0: Emission frequency

There are three types of electron transitions, as shown in figure 1-2.

The first type of transition, shown in figure 1-2 (a), is known as resonant absorption. An electron transits from the stable low energy level, E_0, to the higher energy level, E_1, by absorbing light.

Figure 1-2 (b) shows spontaneous emission. An electron transits from the high energy level, E_1, to a more stable low energy level, E_0. At the same time, the energy balance of $|E_1 - E_0|$ is released in the form of light. Since each electron at level, E_1, transits independently, light is emitted at random and out of phase. Such light is referred to as incoherent light and is one of the typical characteristics of spontaneous emission. The light from an IRED is an example of such spontaneous emission light.

Under thermal equilibrium, the probability of an electron to exist in the lower level, E_0, is higher than that in the higher energy level, E_1. Therefore, electron transition to a higher energy level ($E_0 - E_1$) by light absorption is more likely to occur than light emission as shown in figure 1-2 (a). To emit light, electrons must exist at E_1 with high probability, which is referred to as inversed population.

The third type of transition, shown in figure 1-2 (c) is stimulated emission. The electrons in the higher energy level, E_1, are forcibly transferred to the lower energy level, E_0, by incident light. The light generated this time is referred to as stimulated emission light. Its phase is the same as that of incident light, because stimulated emission light is emitted resonant to the incident light. Such stimulated emission light is referred to as coherent light.

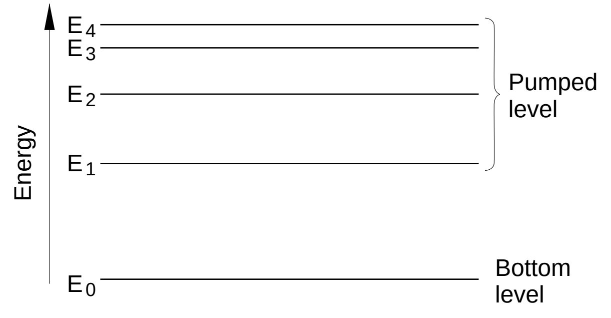


Figure 1-1 Energy Level

Similarly to an electric circuit, laser oscillation requires a feedback function in addition to a gain which exceeds its loss. A laser beam is oscillated by amplification of stimulated emission and positive feedback with mirrors.

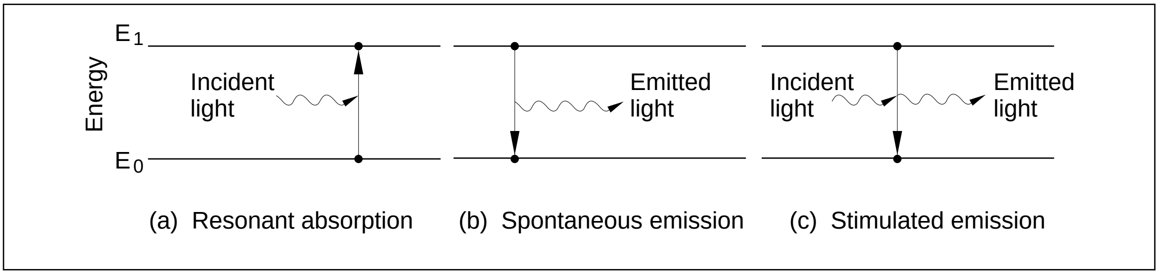


Figure 1-2 Transition Processes

Figure 1-3 shows a Fabry-Pérot resonator which is the most fundamental optical resonator.

The structure of an LD, in principle, is the same as shown in figure 1-3, which uses clearing to make the reflection mirrors of both surfaces. Incident spontaneous emission light heading to the reflection mirror is amplified by stimulated emission and comes back to the initial position after reflection. This process is subject to losses resulting from light passing through or diffracting at the reflection mirrors and scattering or absorption within the cavity. When the loss is higher than the amplification gain, the light attenuates. Injected current strengthens amplification gain in an LD and when the gain and the loss are balanced, initial light intensity becomes equal to returned light intensity. This condition is referred to as threshold. A laser oscillates above the threshold when the gain is high enough.

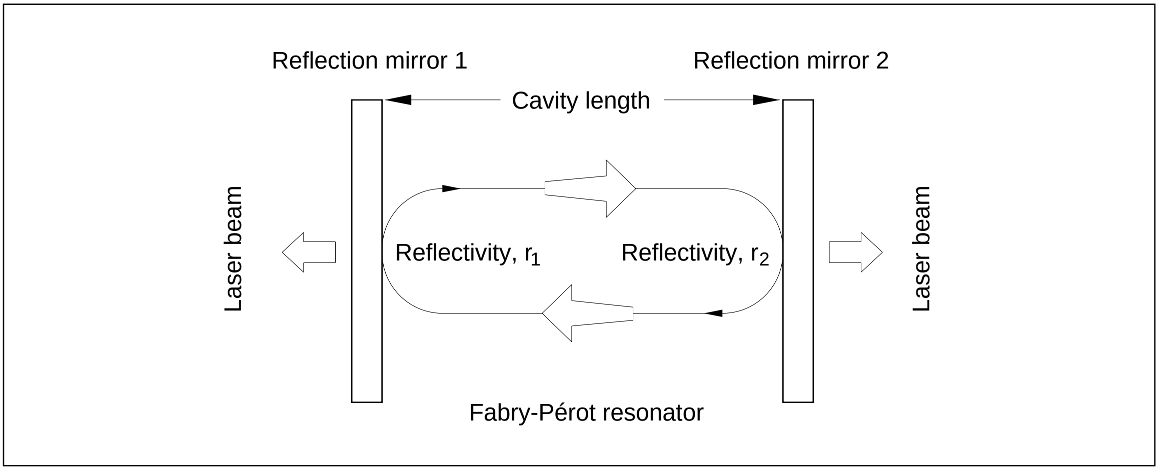


Figure 1-3 Fundamental Structure of Fabry-Pérot Resonator

Injection pumping is mainly taking place at the p-n junction in a semiconductor laser diode. A semiconductor crystal can obtain higher gain than a gas laser (HeNe for example) due to the higher density of atoms available within the cavity. Therefore, a laser can oscillate with a short resonant cavity of 300 µm and low reflectivity of 30%.

1.1.2 Photo-detection Principles

Photodiodes make use of a photovoltaic effect resulting from the application of voltage to both ends of a p-n junction at the time light exposes the junction. Under reverse-voltage conditions, a depletion region is generated to which an electric field has been applied (see figure 1-4). Incident light with the same energy as the bandgap energy is absorbed in the depletion region. This absorption of light produces electron-hole pairs. The electrons and holes then drift, under electric field action, in opposite directions across the depletion region. Electrons move forward to the cathode electrode, and holes move to the anode. As a result, a current flows through the load resister, and light signals are converted to electric signals. Carriers produced in the depletion region move at high speeds due to acceleration caused by the electric field. Carriers generated in the diffusion region, however, move slowly under the influence of diffusion in accordance with the concentration gradient.

In optical fiber or information-terminal equipment systems, a high-speed response and high quantum efficiency are essential photodiode capabilities. Accordingly, Hitachi has been employing PIN structures for photodiodes to achieve higher quantum efficiency and reduce junction capacitance for a faster response. "PIN" signifies a structural configuration whereby an intrinsic layer with high resistance is sandwiched between p-type and n-type semiconductors. The electric field is applied to the intrinsic region, and most incident light is absorbed in this region, producing a great many electron-hole pairs.

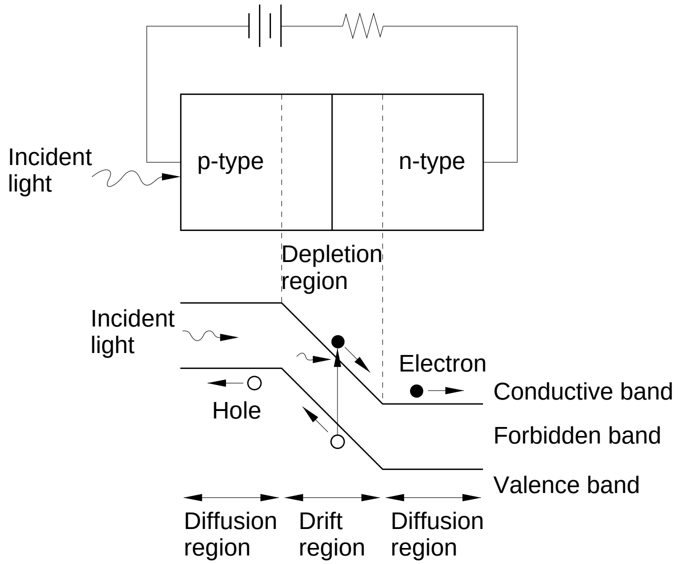


Figure 1-4 Photo-detection Principles

Section 2 Chip Structures

2.1 Laser Diodes Structures

2.1.1 GaAlAs LD Structure

The p-type active layer, in which stimulated emission enforces optical amplification (figure 2-1 (a)), is processed first. The p-n junction is made here for injecting minority carriers (the p-n heterojunction). With forward current applied to the junction, electrons in n-type region are injected into p-type region. With a p-type semiconductor of wide band gap on the other side of the p-n junction (heteroisolation junction), the injected carriers are mostly confined within the p-type active layer. This carrier confinement makes population inversion occur easily, increasing the light emission intensity.

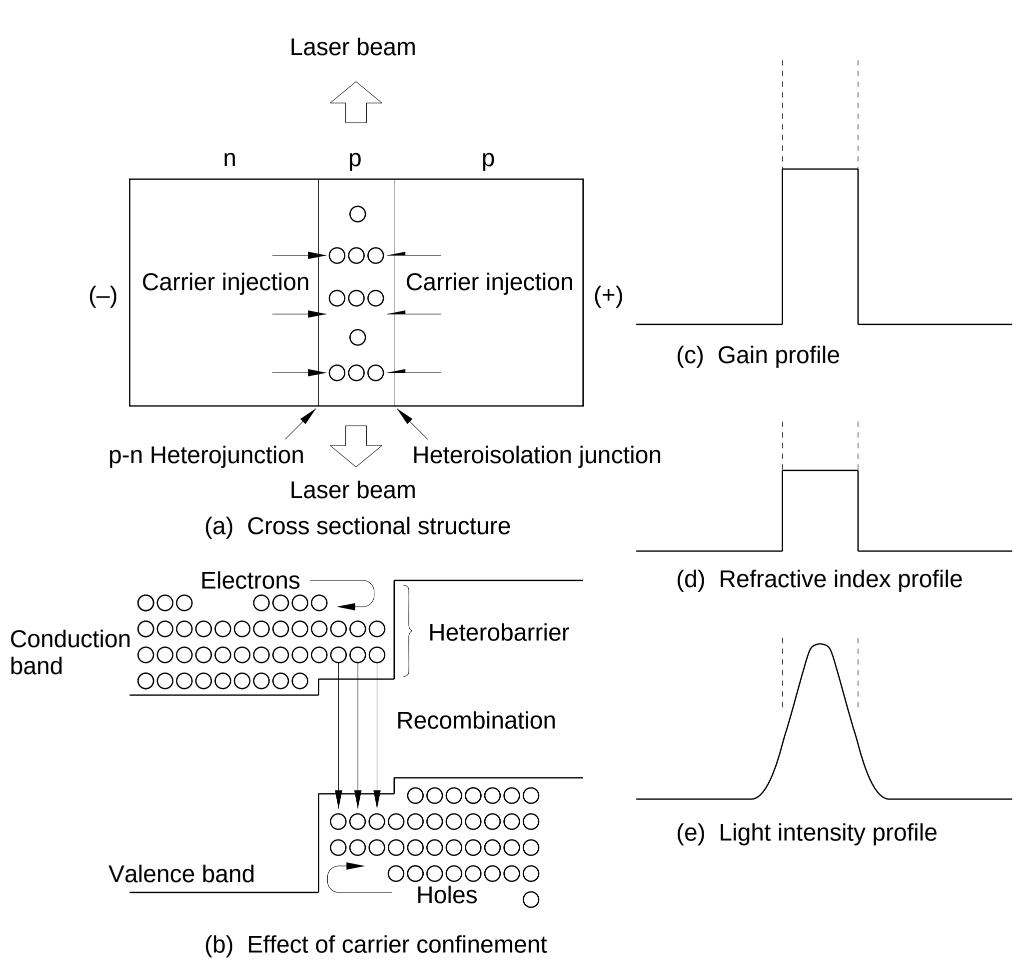


Figure 2-1 Operation Principles of Double-heterojunction LD

The active layer of the GaAlAs LD is made of GaAs or $Ga_{1-y}Al_yAs$ (figure 2-2). The thickness of the layer is 0.05 to 0.2 µm. p-type $Ga_{1-x}Al_xAs$ and n-type $Ga_{1-x}Al_xAs$ ($x > y$) sandwich the active layer (x and y here are the mixture ratio of aluminum). When x is 0.3, the band gap of the sandwich layers is 1.8 eV, and there is a balance of 0.4 eV against 1.4 eV of GaAs. When forward bias is applied here, the heterobarrier confines carriers within the 0.05 to 0.2 µm active layer, carrier population is inverted and the gain increases. The refractive index of GaAs is higher by some percent than that of $Ga_{1-x}Al_xAs$, which confines the generated light within the GaAs active layer. The light penetrating into the Al_xAs layer is not absorbed because of its wide band gap. So laser oscillates effectively there (figure 2-1). The thinner GaAs layer can make do with less threshold current density to achieve laser oscillation. At present, a threshold current density of as low as 1 to 2 kA/cm^2 can be achieved, realizing a stable continuous oscillation (CW) at room temperature.

2.1.2 Lasing Modes of GaAlAs LD

Under laser oscillation, a light standing wave created with its wavefront parallel to the mirror facets while light is traveling back and forth within the laser cavity. This standing wave consists of a longitudinal mode and a transverse mode (figure 2-3). The longitudinal mode expresses the condition of the standing wave in the direction of cavity length (z direction). The transverse mode expresses the condition of the axis perpendicular to the cavity length direction. The transverse mode is divided into a perpendicular transverse mode which is perpendicular to the active layer, and a parallel transverse mode which is parallel to the layer.

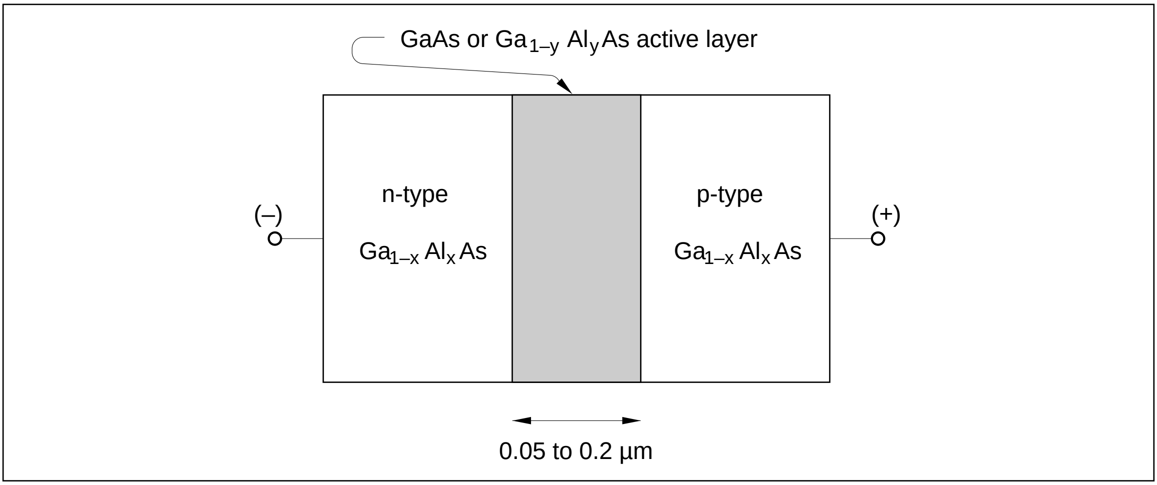


Figure 2-2 GaAlAs DH Structure LD

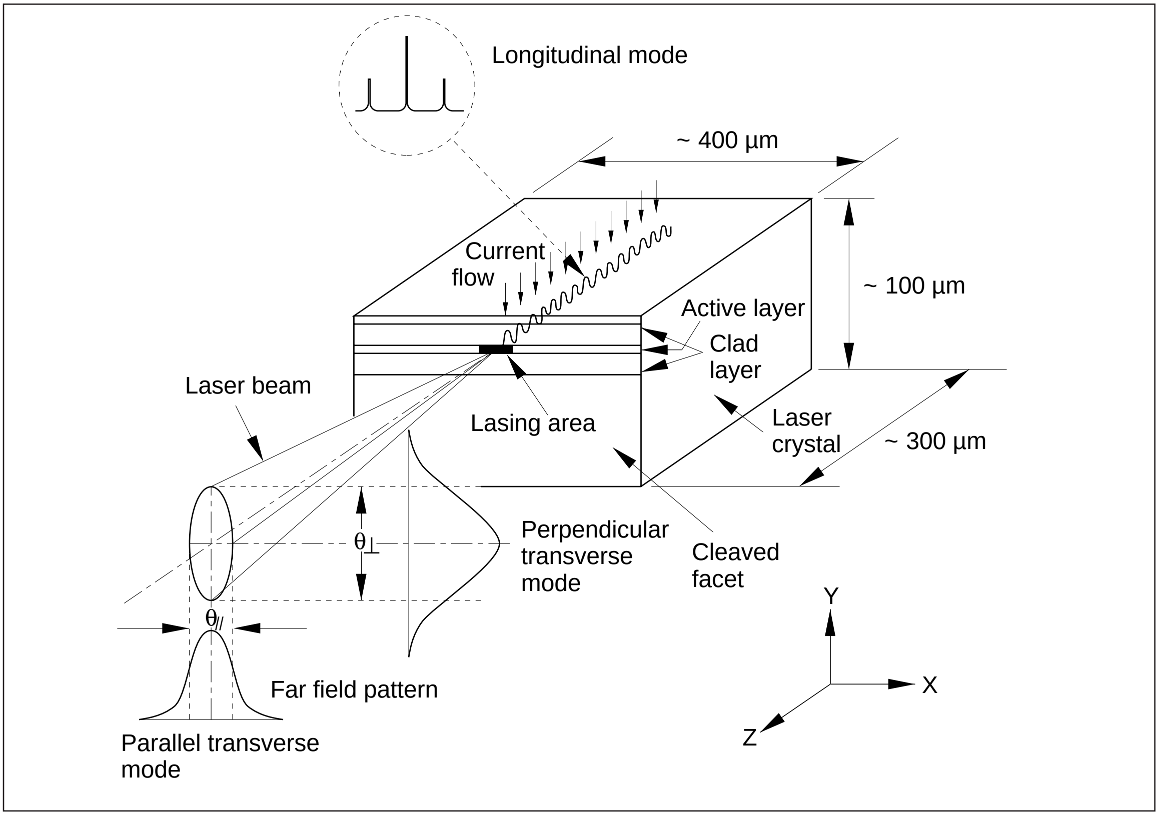


Figure 2-3 Lasing Mode of LD

Longitudinal mode

Figure 2-4 shows that a half-wavelength standing wave multiplied by an integer, q, forms in the direction of the laser cavity length (z direction). When the refractive index of the medium is n and the wavelength in a vacuum is λ, the wavelength of light λ' is expressed as:

$$\lambda' = \lambda/n$$

So the half wavelength is expressed as:

$$\frac{1}{2}\lambda' = \frac{\lambda}{2n}$$

As described above, the half wavelength multiplied by an integer, q, equals to the cavity length, L:

$$q \cdot \frac{\lambda}{2n} = L$$

For a semiconductor laser diode, when λ is 850 nm, n is 3.5, and L is 300 µm, q is about 2500. This q is referred as the mode number.

When the mode number, q, changes by 1, the wavelength change Δ λ, is expressed as:

$$|\Delta\lambda| = 0.34 \text{ nm}$$

Since a cavity length is incomparably longer than a wavelength, cavity resonance can take place at multiple wavelengths. The particular wavelength in which the cavity gain becomes maximum will then produce a stable standing wave.

In a semiconductor laser diode, when the temperature changes, the band gap energy changes causing the wavelength where the maximum gain is achieved to change. As for the GaAlAs DH structure laser, this temperature coefficient is about 0.25 nm/deg. So the temperature rise makes the oscillation wavelength jump upward at intervals of Δ λ (≈ 0.34 nm). The same phenomenon takes place because of temperature rise in the active layer when the injection current increases to achieve higher optical output power under continuous operation (CW).

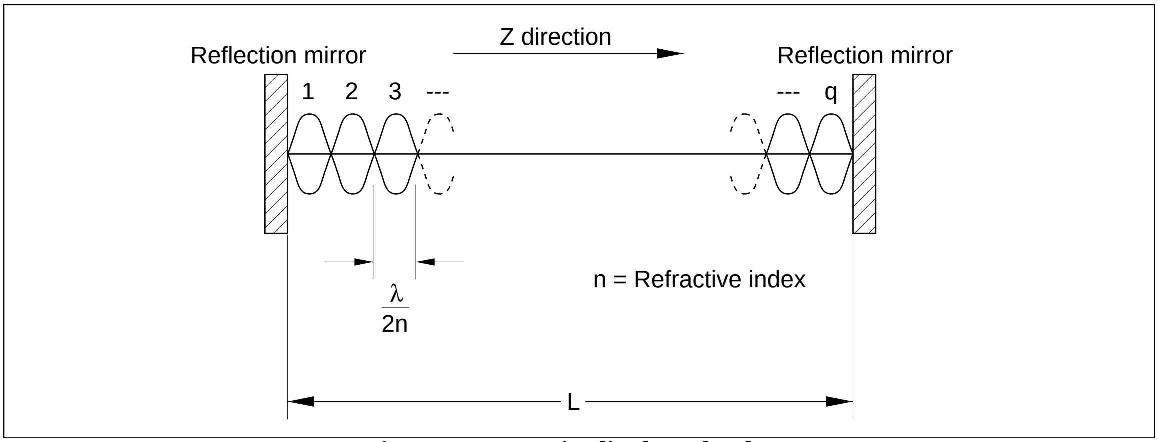


Figure 2-4 Longitudinal Mode of LD

Perpendicular transverse mode

In a GaAlAs laser diode, the active layer is sandwiched by heterojunctions (figure 2-5). Light is confined within the active layer because of the higher refractive index inside the layer than that of the outer GaAlAs layers. The amount of light confined within the active layer depends on its thickness. A thicker layer confines more light. Also, light penetrates into the outer layers when the active layer is too thin. The width of laser beam divergence depends on the thickness of the active layer, and when it is 0.3 to 0.4 µm, the width becomes narrowest. At this width, the radiation angle of laser beam emitted from the cleaved faced becomes widest (figure 2-6). In general, in a semiconductor laser, the radiation angle of the laser beam out of the device becomes very wide because the laser beam profile width in the device is the same as or less than the lasing wavelength. This is very different from what occurs in a conventional gas laser or solid state laser.

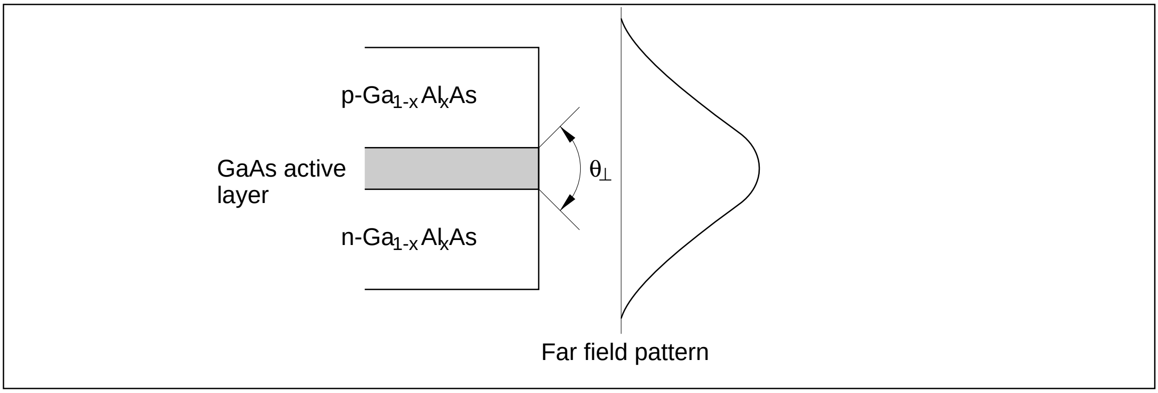


Figure 2-5 Perpendicular Transverse Mode

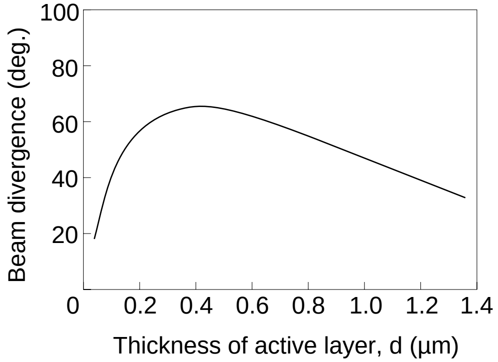


Figure 2-6   Thickness of Active Layer vs. Beam Divergence

Parallel transverse mode

A waveguide must be formed by some means because there is nothing to guide light in the active layer in a direction parallel to the junction. When current injection is limited to a narrow enough region with a full cavity length, laser oscillation can then take place in the region (figure 2-3). Figure 2-7 shows the basic stripe structure which can limit current pass only.

In order to control the transverse mode more effectively, the refractive index profile or the optical loss profile should also be built into the stripe structure. Figure 2-8 shows examples of this structure.

Figure 2-8 (a) describes a CSP (channeled substrate planar) laser. Outside of the channel fabricated in the base, the light penetrated from the active layer reaches the base and suppresses the lasing due to absorption loss. Figure 2-8 (b) describes a BH (buried heterostructure) laser. In both the perpendicular and parallel directions, the double-heterostructure is made.

These structural waveguides stabilize the single fundamental transverse mode. All of Hitachi LDs have a stable single transverse mode. A GaAlAs laser diode is described above.

The structure a DFB (distributed feedback) LD takes to realize a dynamic single mode is shown in figure 2-9.

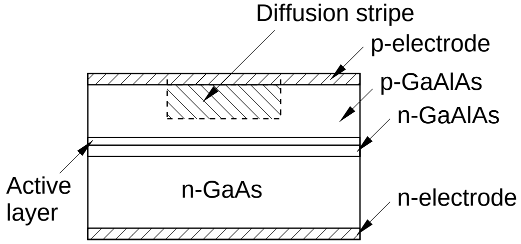


Figure 2-7   Basic Stripe LD

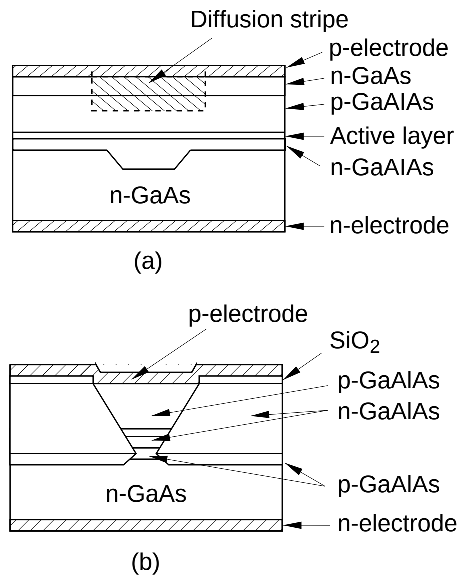


Figure 2-8 Stripe Lasers with Built-in Waveguide

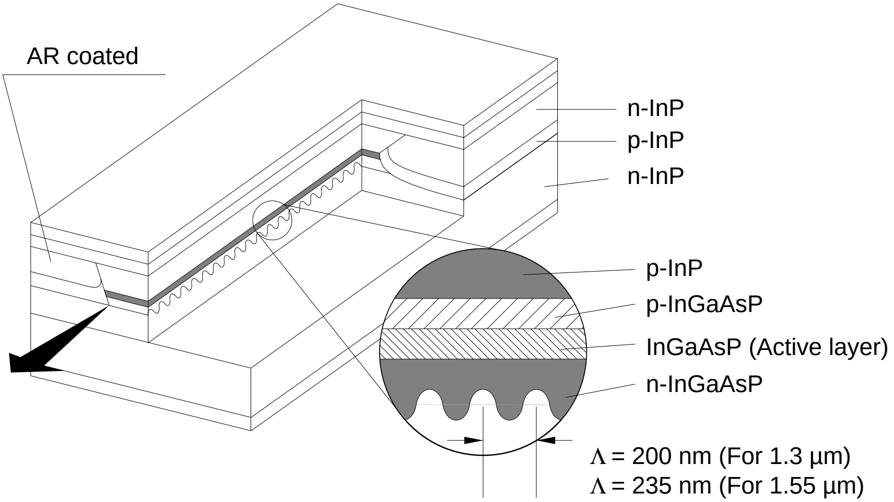


Figure 2-9 DFB-LD Structure

2.2 IRED Structures

2.2.1 Heterostructure

The p-n junction barrier of the diode confines the injected current to the active layer. The heterojunction (figure 2-10 (a)) consists of p-type and n-type whose band gap energy are different from each other. This heterojunction structure increases the confinement effect and realizes high-power output and high speed. Practically, $Ga_{1-x}Al_xAs$ is used the band gap energy is controlled by changing the mixture ratio, x.

Section 2 Chip Structures

Hitachi IREDs are divided into two structures: SH (Single Hetero) structure which has only one heterojunction and DH (Double Hetero) structure which has two heterojunctions (figure 2-10 (b)) capable of realizing high-power output and high speed. Table 2-1 shows the structure of each type.

High efficiency of current-light conversion is achieved using GaAs crystal, which is a direct transition material. Hitachi shapes the chip surface hemispherically to best utilize the emitted light out of a chip (figure 2-11).

Table 2-1 Hitachi IRED Structures

Part No.	Structure
HE8807 series	SH
HE7601SG	DH
HE8404SG	DH
HE8812SG	DH
HE8811	DH
HE8813VG	DH

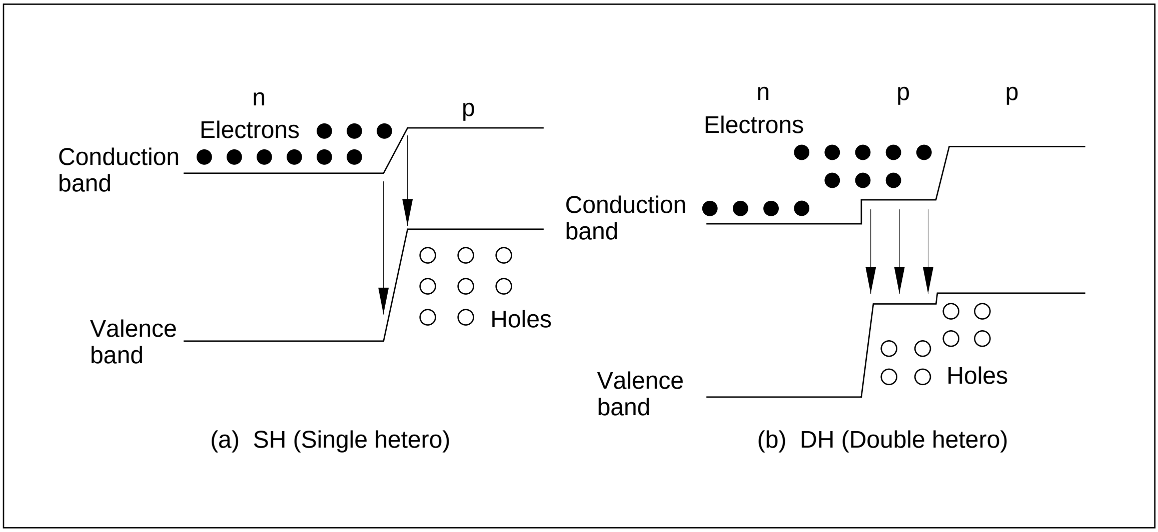


Figure 2-10 Junction Structure

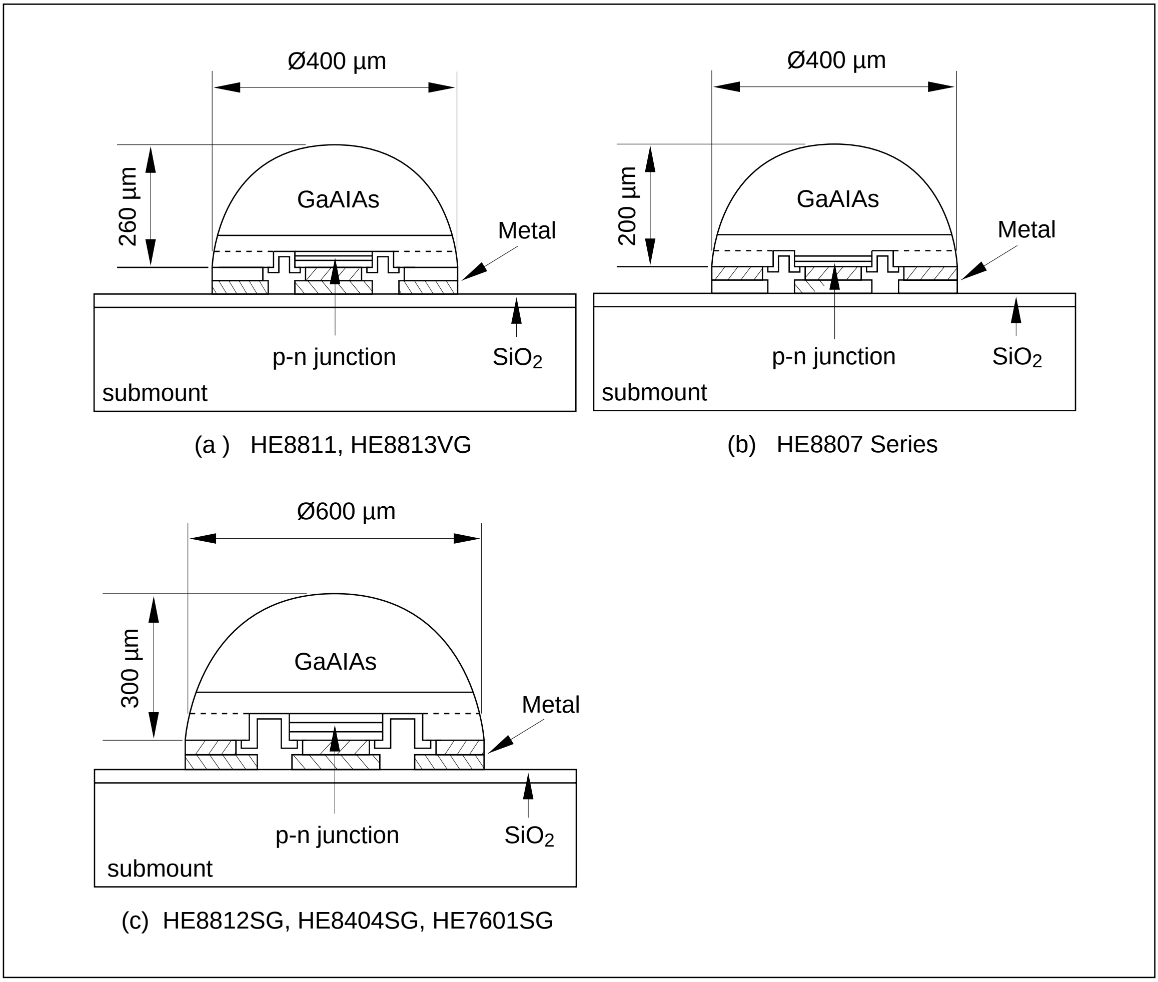


Figure 2-11 IRED Structures

2.2.2 Dome Shaped Chip

Refraction at the outer surface of the dome must be taken into account when considering light emission. Since the refractive index of GaAlAs is about 3.4, light projected to the surface of a flatshaped chip is unable to pass out at angles above 17 degrees and is reflected inside the chip, as shown in figure 2-12. Therefore, by making the chip dome-shaped, light from the center of the chip will hit the surface perpendicularly no matter what the angle and will almost all emit from the chip, as shown in figure 2-13. Also, the chip is designed so that the light emitting area is sizable in relation to overall chip diameter: about 25% for high output IREDs and 7.5% for high speed chips. As a result, light hitting around the dome periphery is refracted forward, increasing the amount of utilizable light.

Table 2-2 Dome Diameter and Junction Diameter of Each Part Number

Part No	Dome Dia. (μm)	Junction Dia. (μm)
HE7601SG	600	160
HE8404SG	600	160
HE8812SG	600	160
HE8807 series	400	100
HE8811	400	100
HE8813VG	400	100

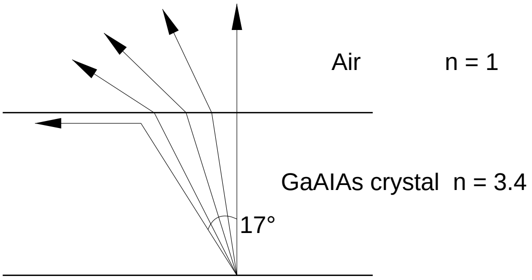


Figure 2-12 Light Refraction at Boundary Layer

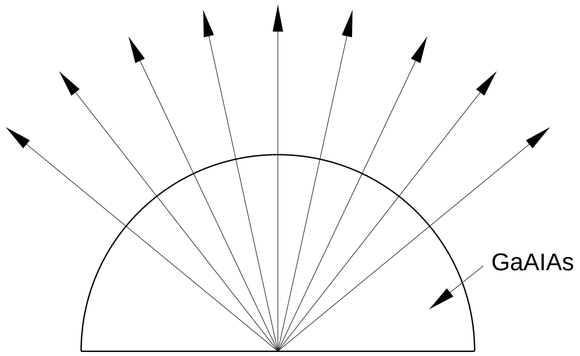


Figure 2-13 Hemispherical Shaped Light Radiation

2.3 Photodiode Structures

InGaAs/InP PIN Photodiodes

To optimize InP compound semiconductors for photodiode use, a unique light absorption structure is employed to gain high quantum efficiency. This is necessary because the absorption coefficient of InP compounds is very large for light with energy greater than the band gap energy. Electron hole pairs also recombine and are annihilated easily when there are defects on the chip surface.

Hitachi InGaAs/InP photodiodes make use of a planar structure (figure 2-14). In this structure, incident light is absorbed into the InGaAs layer through the InP diffusion layer.

The absorption edge of the InP has a wavelength of about 900 nm. Light with longer wavelengths can pass through the InP layer to the InGaAs layer.

Quantum efficiency is about 80% at 1300 nm when the spectrally sensitive region is set at 1000 nm to 1650 nm.

Frequency response is flat up to around 1 GHz. Thus, this area is suitable for signal detection use in high-speed fiberoptic transmission systems.

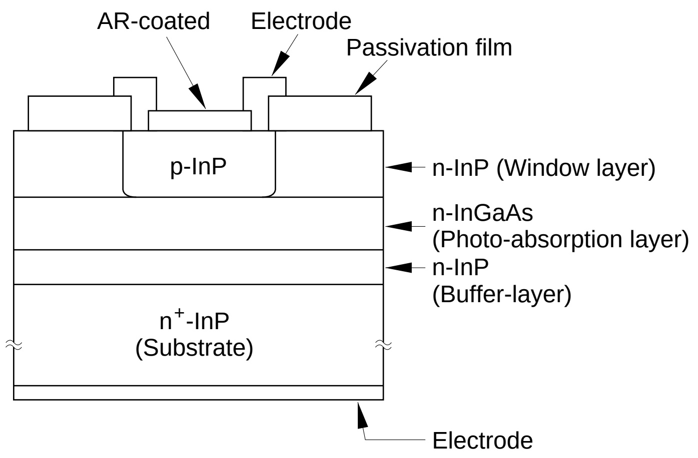


Figure 2-14 InGaAs/InP PIN Photodiode Structure

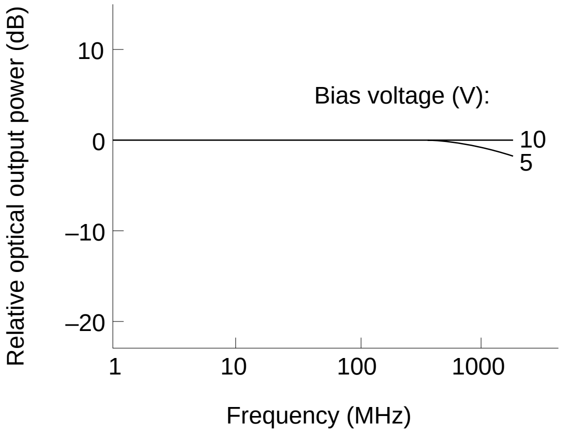


Figure 2-15 Frequency Response for InGaAs/InP PIN PhotodiodeFigure

Section 3 Symbols and Definitions

3.1 The Absolute Maximum Ratings

The absolute maximum ratings specified in this data book are the values which should not be exceeded under any condition. They are defined at the case temperature, T_C, of 25°C unless otherwise specified.

The absolute maximum ratings of laser diodes (LDs), infrared emitting diodes (IREDs) and photodiodes are defined individually as follows.

Table 3-1 Absolute Maximum Ratings

	Applicable Devices			
Items	**LDs**	**IREDs**	**Photo-diodes**	**Definitions**
Optical output power, P_O ,P_f	O			Maximum tolerable output power under continuous wave (CW) operation. The value with no kink phenomenon in light vs. current characteristics (figure 3-1). The power of device with a fiber pigtail is shown as fiber optical output power, P_f.
Forward current, I_F		O	O	Maximum tolerable current under CW operation.
Reverse current, I_R			O	Maximum permissable photocurrent when prescribed reverse voltage, V_R (but not exceeding breakdown voltage, V_B), and incident light are applied.
Reverse voltage, V_R	O	O	O	Maximum tolerable reverse bias applied to a device. For the LDs with a built-in photodiode, the reverse voltages of the photodiode, $V_{R\ (PD)}$, and of the LD, $V_{R\ (LD)}$, are specified respectively.
Tolerable power dissipation, P_d		O		Maximum tolerable power dissipation of diode under CW operation.
Operating temperature, T_{opr}	O	O	O	Case temperature range under which a device can safely operate. This value differs according to package type (open air vs. hermetic).
Storage temperature, T_{stg}	O	O	O	Ambient temperature range under which a device can be safely stored. This value also differs according to package type.

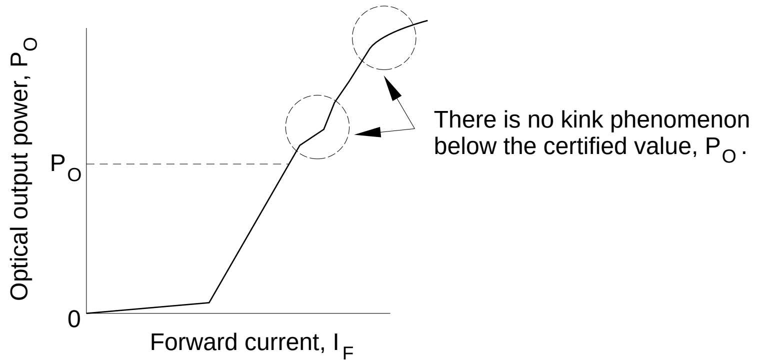


Figure 3-1 Light vs. Current Characteristics

3.2 Optical and Electrical Characteristics

The limit values and the typical values of optical and electrical characteristics are described in this data book as much as possible for the user's convenience for application to electrical circuits and optics.

The definitions of optical and electrical characteristics are listed below.

Table 3-2 LD Optical and Electrical Characteristics

Items	Definitions
Optical output power, P_O, P_f	Optical output power under the specified forward current, I_F or the value of the kink-free region. The power of device with a fiber pigtail is shown as the fiber optical output power, P_f.
Monitor power, P_m	Optical output power from the rear side of a chip at the specified forward current, I_F, or optical output power, P_O.
Threshold current, I_{th}	Forward current at which a diode starts to lase (figure 3-2). Practically, this value is specified as the crossing point of x axis and the extension of line B, where "A" is spontaneous emission region and "B" lasing region.
Lasing wavelength, λ_p	Maximum intensity wavelength in a spectral distribution (figure 3-3).
Beam divergence parallel to the junction, $\theta_{//}$ Beam divergence perpendicular to the junction, $\theta_{\perp}$	Divergence of light beam emitted from a laser diode is described in figure 3-4 (a). $\theta_{//}$ is the full angle at a half of the peak intensity in the parallel profile (figure 3-4 (b)). $\theta_{\perp}$ is the full angle at a half of the peak intensity in the perpendicular profile (figure 3-4 (c)).
Slope efficiency, η	Optical output power increment per unit drive current in lasing region (B region) of figure 3-2.

Table 3-2 LD Optical and Electrical Characteristics (cont)

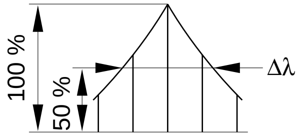
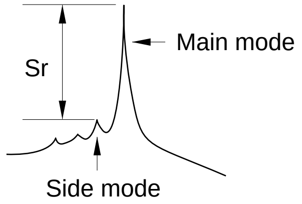
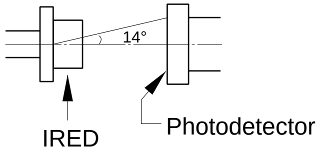
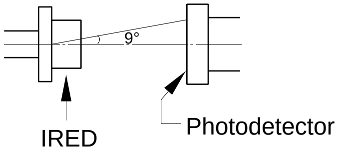
Items	Definitions
Monitor current, I_S	Current of photodiode operated at the specified optical output power, P_O or P_f . It applies only to a device with a built-in photodiode.
Dark current, I_{DARK}	Leakage current of photodiode when the specified reverse voltage is applied without any light input to the photodiode.
Rise time, t_r Fall time, t_f	Rise time, t_r, is time required for light intensity to rise from 10 to 90% of maximum output power when drive current is switched on. Fall time, t_f, is time required for light intensity to fall from 90 to 10% of maximum output power when current is switched off. (Figure 3-5)
Spectral width, $\Delta \lambda$	Full width at half maximum when the spectrum pattern has been approximated to envelop. 
Capacitance ,C_t	Junction capacitance when specified reverse bias voltage is applied.
Side-mode suppression ratio, Sr	These are parameters for evaluating laser diode spectral shape. Particulary with regard to single longitudinal mode generation like the distributed feedback (DFB) laser, it indicates the ratio between the highest spectral intensity (called main mode) and the second highest spectral intensity (called side mode). 
Cooling capacity, Δ T Cooler current , I_C Cooler voltage, V_C Thermistor resistance, R_{TM}	These are parameters used to evaluate the thermal characteristics of laser diode modules with built-in Peltier effect (cooling) elements. Δ T indicates, for cooler current, I_C, and cooler voltage, V_C, the cooling capacity as a temperature difference ($\Delta T = T_{LD} - T_C$). (Here T_{LD} is the temperature at the laser diode chip and T_C is the temperature of the module's case). R_{TM} indicates the resistance of the built in thermistor.

Table 3-3 IRED Optical and Electrical Characteristics

Items	Definitions
Optical output power, P_O, P_f	Total optical output power emitted from chip at specified forward current (figure 3-6). The power of device used in fiberoptic transmission is shown as fiber optical output power, P_f.
Forward optical output power, P_{FI}	Indicates forward optical output power emitted from chip for prescribed forward current, I_f. This measurement is carried out with NA = 0.25, as shown in the figure below. 
Forward optical output power, P_{F2}	Indicates forward optical output power emitted from chip for prescribed forward current, I_f. This measurement is carried out with NA = 0.16, as shown in the figure below. 
Peak wavelength, λ_P Spectral width, $\Delta\lambda$	Maximum intensity wavelength in a spectral distribution (figure 3-7). Wavelength width at half the peak intensity of the peak wavelength (figure 3-7). This differs according to junction structure, single vs. double heterojunction structure.
Beam divergence, θ_H	Full angle at a half of maximum peak intensity.
Forward voltage, V_F	Forward voltage at specified forward current input.
Reverse current, I_R	Leakage current when specified reverse voltage is applied.
Capacitance, C_t	Junction capacitance when specified reverse bias voltage is applied.
Rise time, t_r Fall time, t_f	Rise time, t_r, is time required for light intensity to rise from 10 to 90% of maximum output power when current is switched on. Fall time, t_f, is time required for light intensity to fall from 90 to 10% of maximum power when current is switched off (figure 3-5).

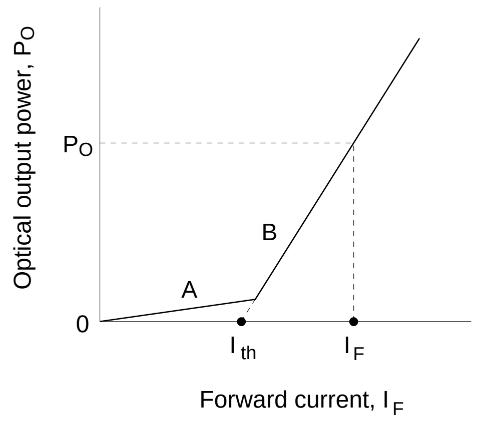


Figure 3-2 Light vs. Current Characteristics

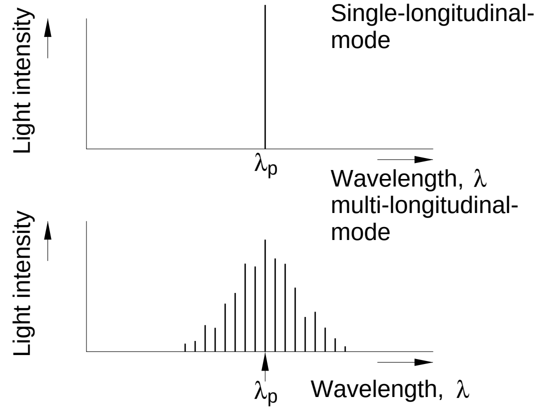


Figure 3-3 Lasing Spectrum

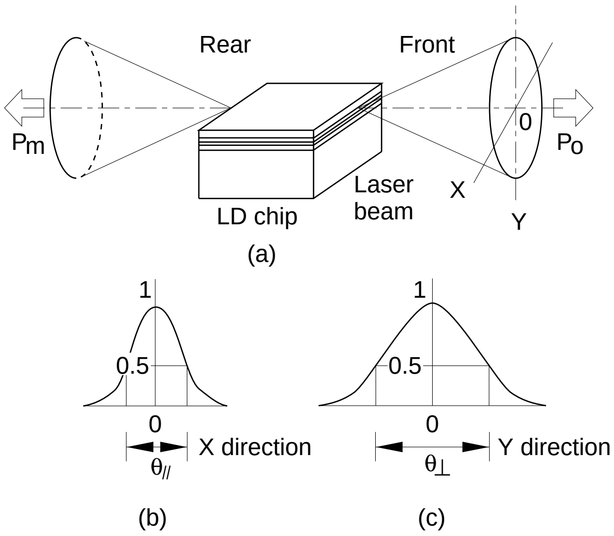


Figure 3-4   Beam Divergence

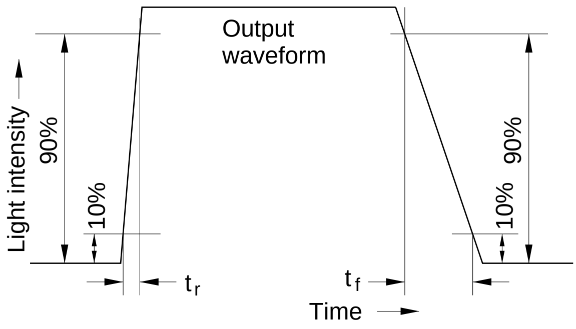


Figure 3-5   Definition of Rise & Fall Time

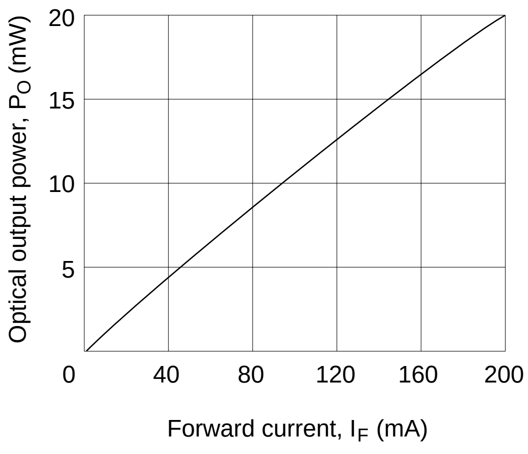


Figure 3-6 Light vs. Current Characteristics

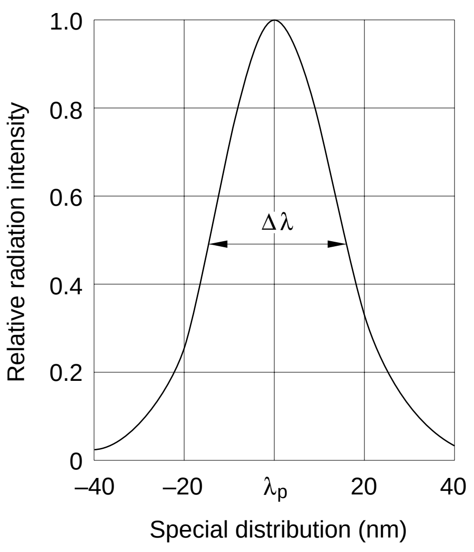


Figure 3-7 Spectral Characteristics for HLP30RG

Table 3-4 Photodiode Optical and Electrical Characteristics

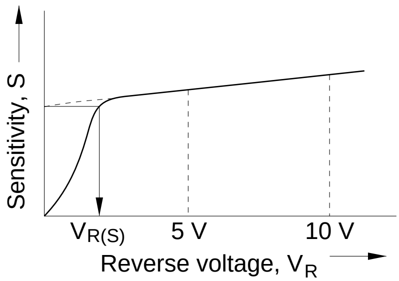
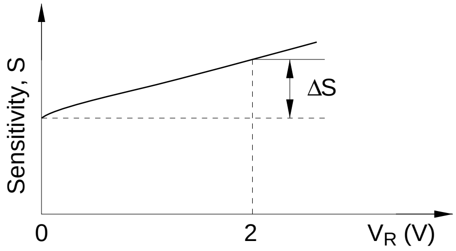
Items	Definitions
Dark current, I_{DARK}	Leakage current of photodiode when the specified reverse voltage is applied without any light input to the photodiode.
Capacitance, C_t	Junction capacitance when specified reverse voltage is applied.
Sensitivity, S	Photovoltaic current increment per unit light power input.
Rise time, t_r Fall time, t_f	Rise time, t_r, is time required for light intensity to rise from 10 to 90% of maximum output power when drive current is switched on. Fall time, t_f, is time required for light intensity to fall from 90 to 10% of maximum output power when current is switched off. (figure 3-5)
Photosensitivity saturation voltage, $V_{R\,(S)}$	Reverse voltage value corresponding to the point where the straight line connecting V_R = 5 V and V_R = 10 V crosses the S axis 
Amount of sensitivity change, ΔS	Amount of variation of photosensitivity with impressed reverse voltage V_R is defined below.  $\Delta S = \frac{S\,(V_R = 2V) - S\,(V_R = 0)}{S\,(V_R = 2V)} \times 100\%$ This section applies to PDs, which have large sensitive area, for measurement use.

Table 3-5 APD Optical and Electrical Characteristics

Items	Definitions
Breakdown voltage, V_B	The reverse voltage when the specified leak current is applied without any light input to the photodiode.
Multiplication factor, M	Defined as ratio of the number of carriers which reach the electrode due to avalanche phenomenon to the number of carriers generated just by light input . V_R as V_I at the turning point of the I_{ph} curve (figure 3-8) $M = \frac{I_{ph} - I_{DARK}}{I_{ph1} - I_{DARK1}}$ thus M = 1 when $V_R = V_I$
Maximum multiplication factor, Mm	Maximum multiplication factor for V_R.
Multiplicated dark current, I_{DM}	Dark current for $V_R = V_I$ (M = 1).
Cut-off frequency, f_C	Frequency at which output power becomes –3 dB of output power at the standard frequency.
Excess noise factor, F, X	Multiplied shot noise parameter for avalanche photodiode. Excess noise factor F defined as $F = M^X$

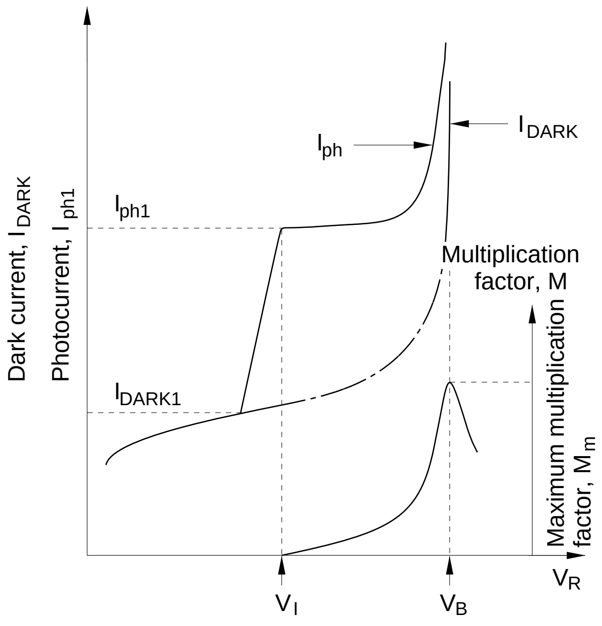


Figure 3-8 Definition of APD Symbols

Section 4 Fundamental Characteristics

4.1 LD Fundamental Characteristics

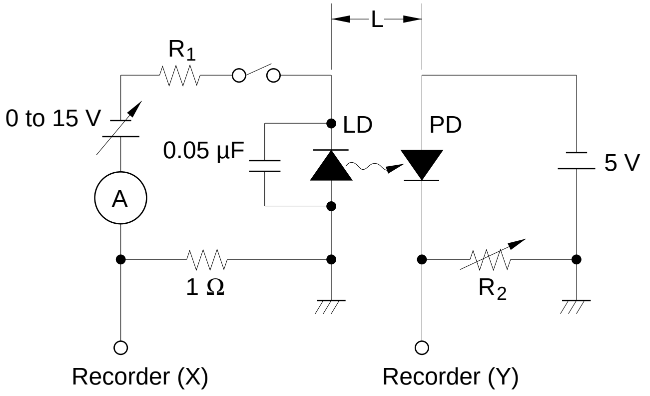
4.1.1 Light vs. Current Characteristics under CW Operation

One of the fundamental parameters of LDs is optical-output-power vs. forward-current (light vs. current) characteristic. Figure 4-1 shows a measuring setup for light vs. current characteristics under CW operation.

The photodetector with proper response and effective photosensitive area is first required for measuring the LD's optical characteristics. A photocell of more than 20 mm dia. is recommended providing enough photosensitive area to take-in the full light power without a lens. The suitable distance between the photocell and an LD chip is 5 to 10 mm. Since photovoltaic sensitivity varies with devices, each photocell must be calibrated with a standard cell and R_2 must be adjusted accordingly before this setup is actually used. The LD device must be mounted on a copper or aluminum heat radiator of about 30 × 40 × 2 mm^3, especially for CW testing, because the heat generated by the chip degrades its characteristics and lifetime.

Light vs. current characteristics for the HL1326MF is shown in figure 4-2.

Temperature dependencies of I_{th} and η for the HL1326MF are shown in figures 4-3 and 4-4 respectively.



PD: Large area Si-solar cell for short-wavelength range LD
Large area Ge-photodiode for long-wavelength range LD

R_1 = 10 to 50 Ω for short-wavelength range LD
= 100 to 300 Ω for long-wavelength range LD

R_2 ≅ 20 Ω for 10 mV output at 1 mW optical power

L ≅ 10 mm for short-wavelength range LD
≅ 6 mm for long-wavelength range LD

Figure 4-1 Measuring Setup for Light vs. Current Characteristics under CW Operation

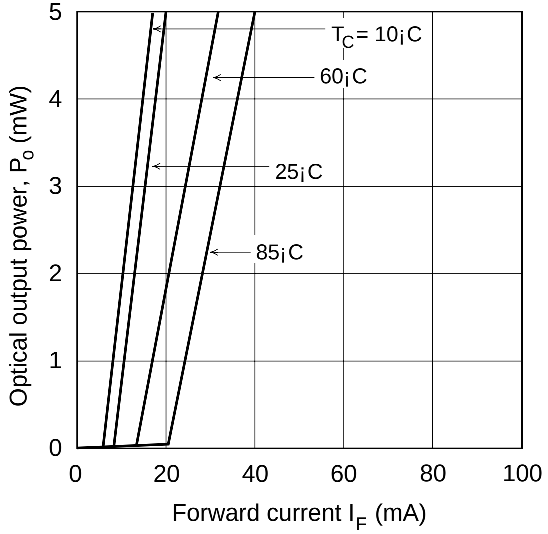


Figure 4-2 Light vs. Current Characteristics for HL1326MF

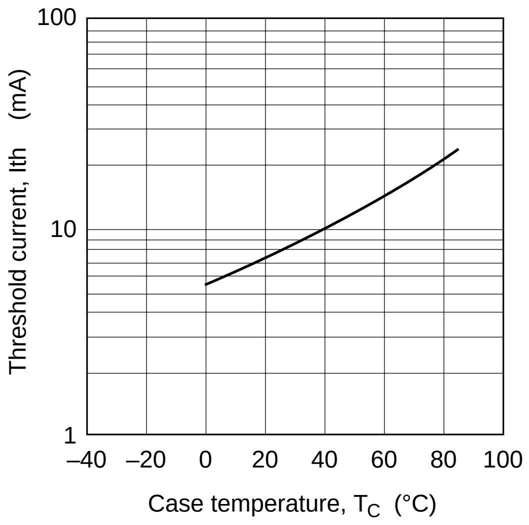


Figure 4-3 Temperature Dependency of I_{th} for HL1326MF

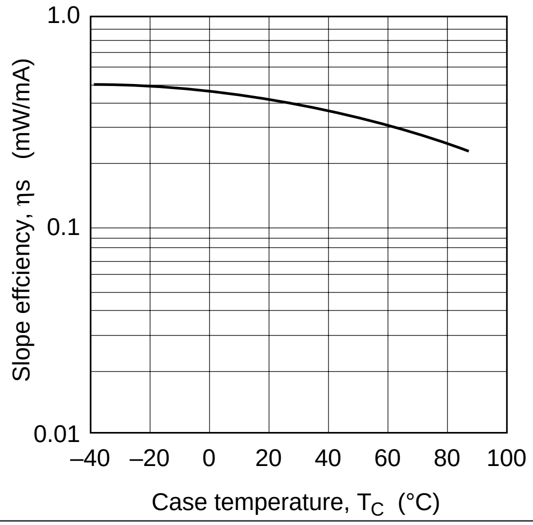


Figure 4-4 Temperature Dependency of η for HL1326MF

4.1.2 Light vs. Current Characteristics under Pulse Operation

A measuring setup example for light-current characteristics under low frequency (up to several 10 kHz) with low duty (about 1%) pulse operation is shown in figure 4-5, which employs a PIN photodiode as a photodetector. Sampling measurement of the photovoltaic current is made after it becomes stabilized.

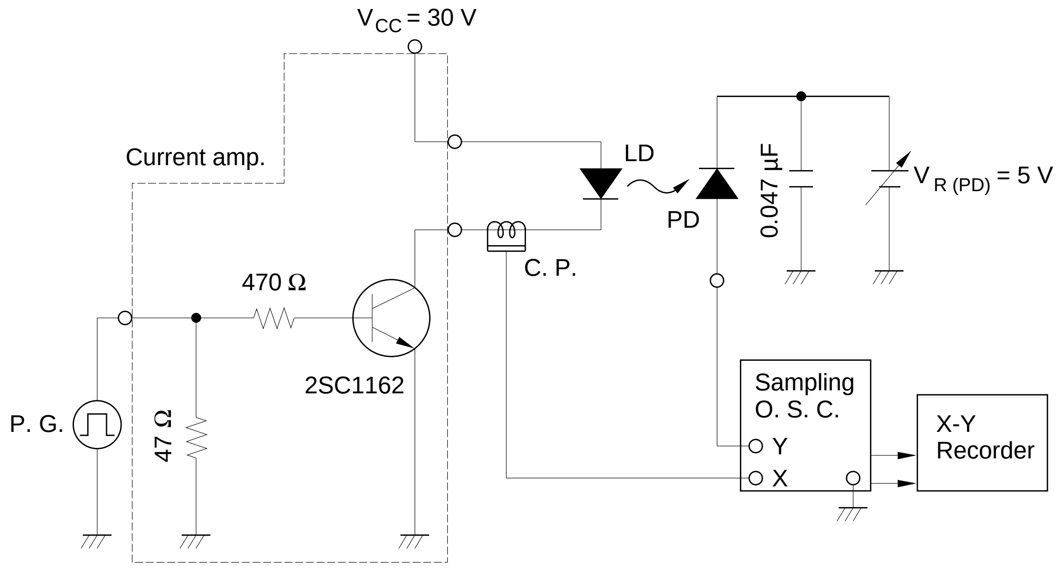


Figure 4-5 Measuring Setup for Light vs. Current Characteristics under Low-frequency Pulse Operation

4.1.3 Lasing Spectrum

The lasing spectrum (longitudinal mode) is a fundamental LD characteristic. The spectrum at modulation is an important factor for transmission use. Derivative characteristics such as the spectral width (Δ λ) for Fabry-Pérot LDs and the side-mode suppression ratio for DFB (distributed feedback) LDs are particularly important for transmission applications. Temperature dependency and optical-output dependency of the spectrum should also be taken into consideration. A measuring setup for the spectrum with modulation is shown in figure 4-6.

For high frequency modulation, the same precautions for measurements described in "section 1.5 Pulse Response Characteristics" must be observed. Also, if the fiber pierces a portion of the human body, it can cause injury, so appropriate care must be exercised in its handling.

Figure 4-7 shows temperature dependency of lasing spectrum for the HL1326MF, Fabry-Pérot LD. The temperature coefficient of the wavelength is about 0.3 nm/°C.

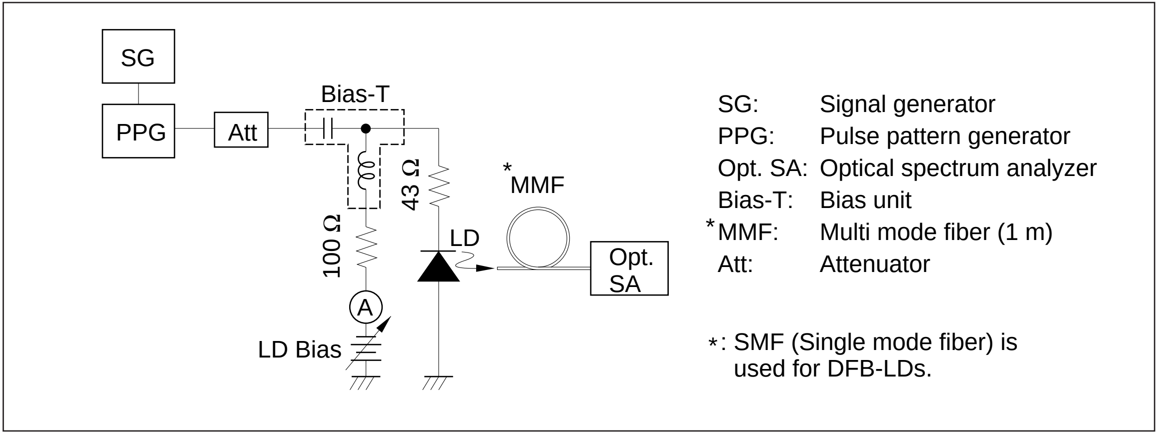


Figure 4-6 Measuring Setup for Spectrum under Modulation

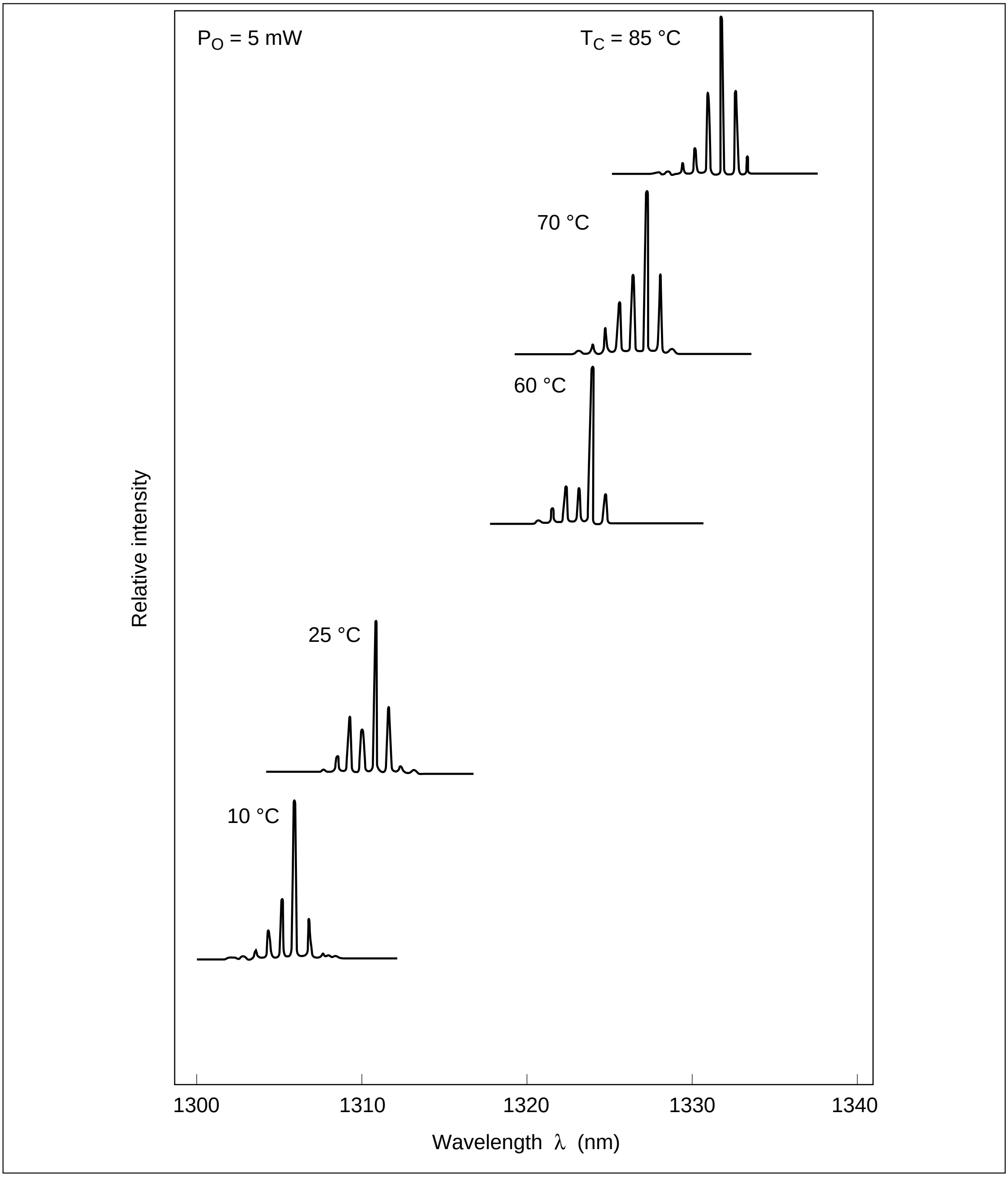


Figure 4-7 Temperature Dependency of Wavelength for HL1326MF

Figure 4-8 shows the dependency of the generated spectrum on optical output power. At currents above the threshold current, Ith, a single mode is generated, but the generated wavelength exhibits almost no dependence upon optical output power.

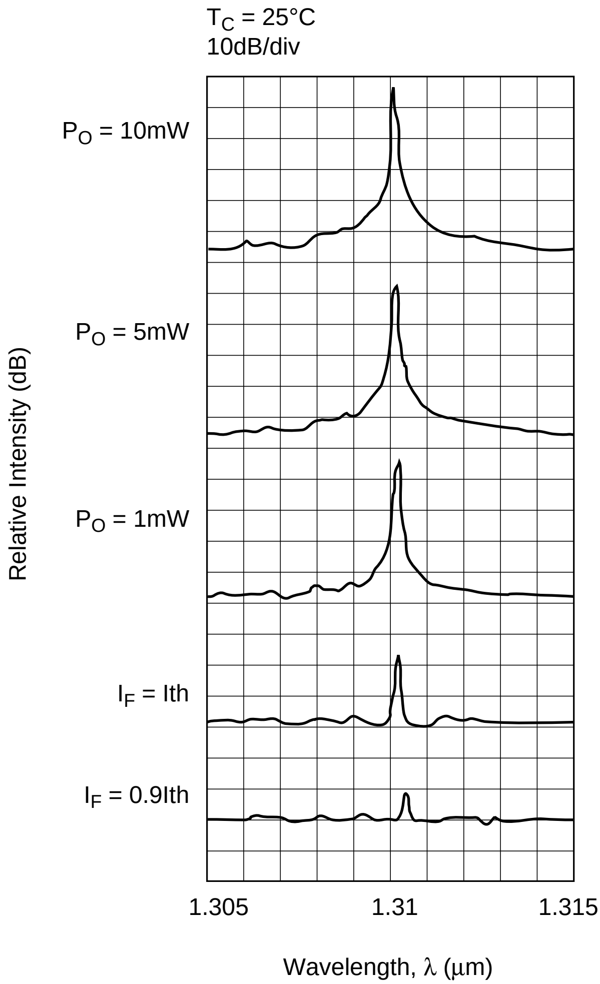


Figure 4-8 Optical Output Power Dependence of Spectrum for HL1362AC

Figure 4-9 shows the dependency of the generated spectrum on bias with 2.5 Gbps modulation. The side mode suppression ratio, Sr, is stable even the bias is below threshold current.

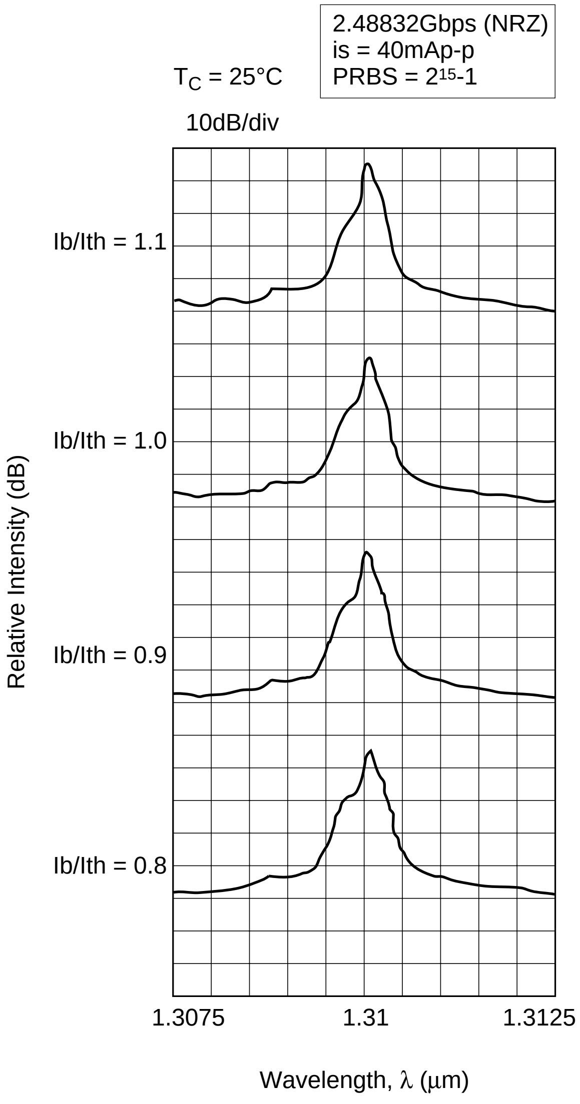


Figure 4-9 Bias Dependence of Spectrum for HL1362AC

4.1.4 Far Field Pattern (FFP)

The FFP is the light intensity profile measured in two directions as a function of angle: parallel and perpendicular to the device (the active layer of an LD and arbitrary for IRED). The measuring setup for the FFP, shown in figure 4-10, employs the same drive circuit as that for light vs. current characteristics measurement under CW operation. Use a PIN photodiode with a small photosensitive area or an avalanche photodiode (APD) as a photodetector. The distance between the detector and the LD is about 10 cm. Set the emitting point of the LD at the center of the turn table. Use a potentiometer to translate the rotation angle to voltage.

The FFP of the HL7836MG is shown in figure 4-11 for various power outputs.

The HL7836MG lases at a stable transverse fundamental mode with a single peak in the FFP approximating a gaussian curve. The FFP grows in height proportionally to the optical output power and has no peak point steering or no light distribution width change within the maximum ratings.

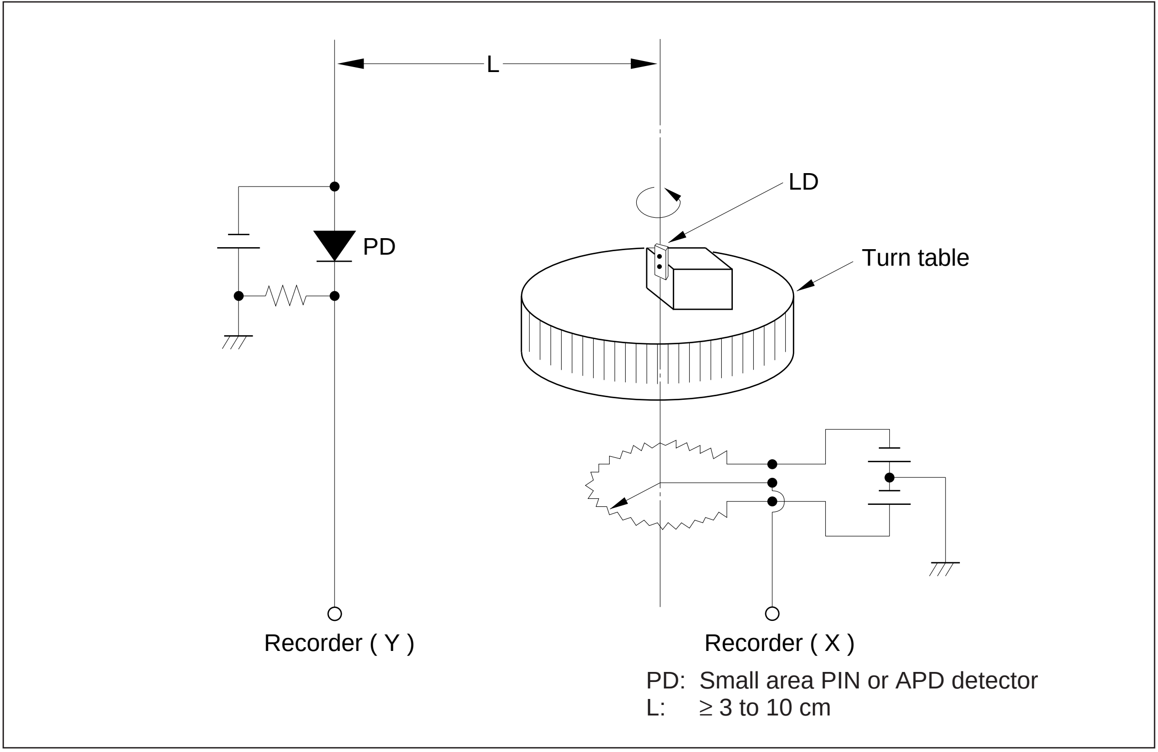


Figure 4-10 Measuring Setup for Far Field Pattern

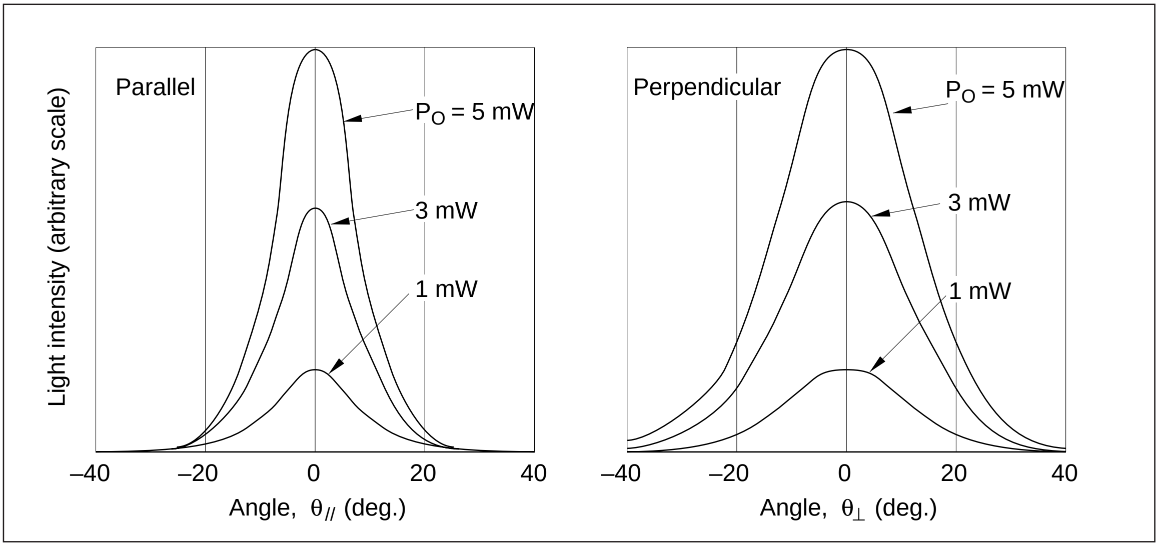


Figure 4-11 Optical-output-power Dependency of Far Field Pattern for HL7836MG

4.1.5 Pulse-response Characteristics

A measuring setup for pulse-response characteristics is shown in figure 4-12. Pulse signals are generated with a PPG (pulse signals generator). A fast-pulse-response PIN photodiode or APD (avalanche photodiode) is suitable for this setup.

When operating the LD in pulse mode, if the DC bias falls below the threshold current, a delay will develop between the drive current pulse and the optical output pulse. The exact value of the delay depends upon the bias point and the temperature. An example is given in figure 4-13.

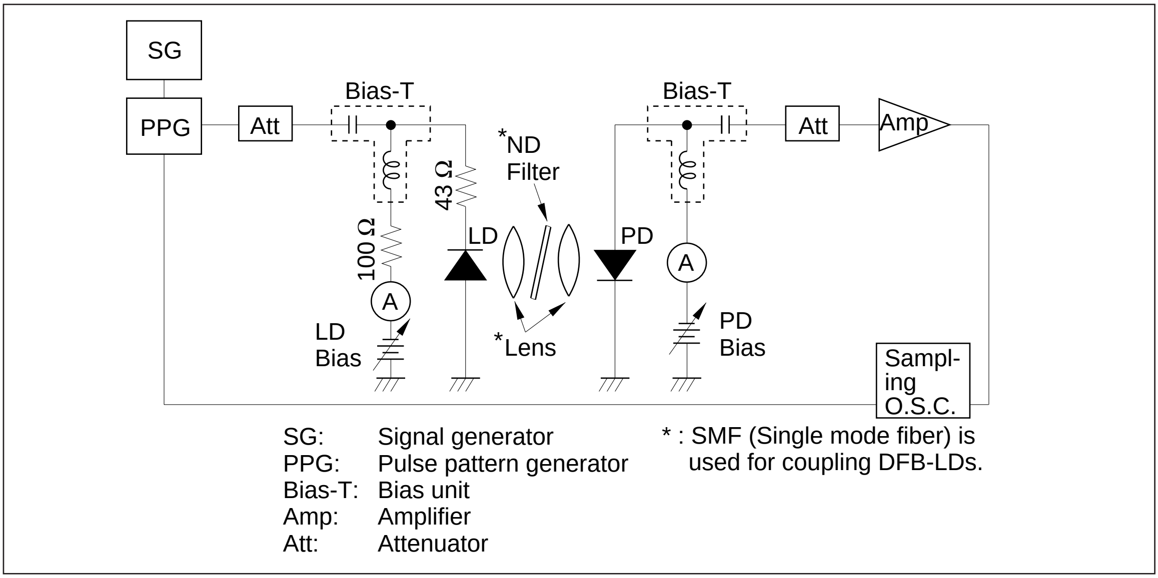


Figure 4-12 Measuring Setup for Pulse-response Characteristics

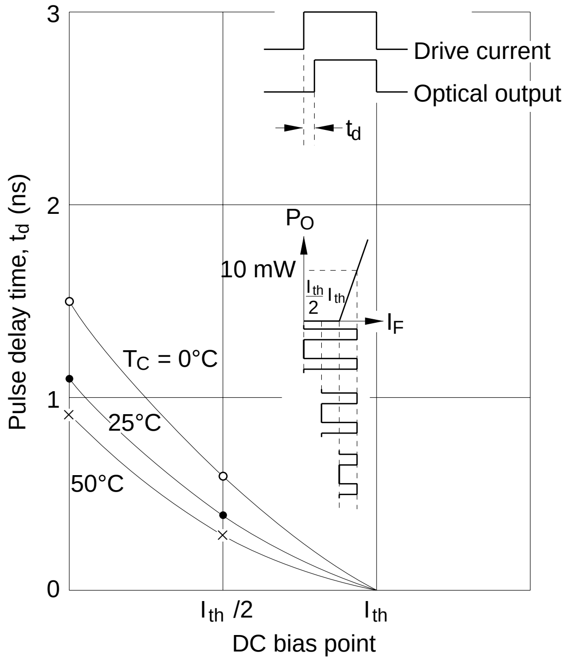


Figure 4-13 Bias Point Dependency of Pulse Delay Time for HL7836MG

Precautions when Making Measurements.

(1) Select a lens for light emitted from the LD with numerical aperture (NA) and magnification which concentrates adequate light on the active optical surface of the PD.

(2) Cut the lead of the LD as short as possible, and solder to a 50 Ω strip.

(3) For the LD impedance, because the LD gives rise to dispersion, select a ship resistance for which the LD impedance and chip resistance are 50 Ω (approx. 43 Ω is optimal).

(4) Because this is a GHz order measurement, the cable must be kept as short as possible, and all connections should be verified for soundness.

To determine the pulse response characteristics, the rise and fall time and the eye pattern of the digital transmission must be evaluated.

Figure 4-14 shows an example of eye patterns for the HL1551A. As seen from this figure, the HL1551A responds at 2.5 Gb/s.

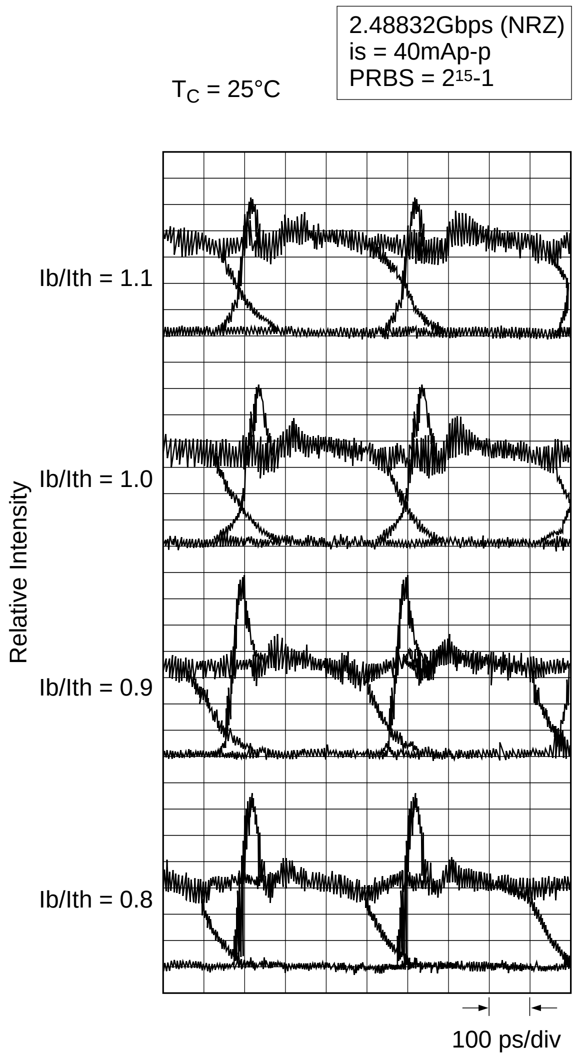


Figure 4-14 Eye-pattern Characteristics at Pulse Modulation for HL1551A

4.1.6 Frequency Characteristics

A measuring setup for frequency characteristics is shown in figure 4-15.

A measurement example of frequency for the HL1551A is shown in figure 4-16.

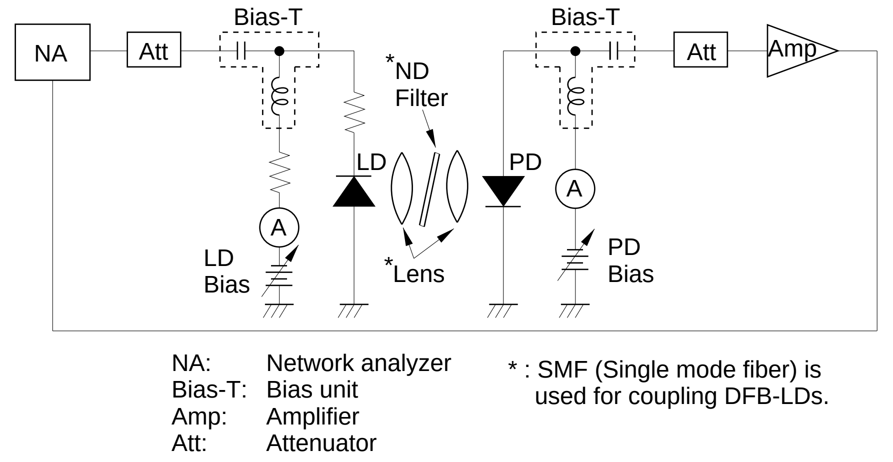


Figure 4-15 Measuring Setup for Frequency-response Characteristics

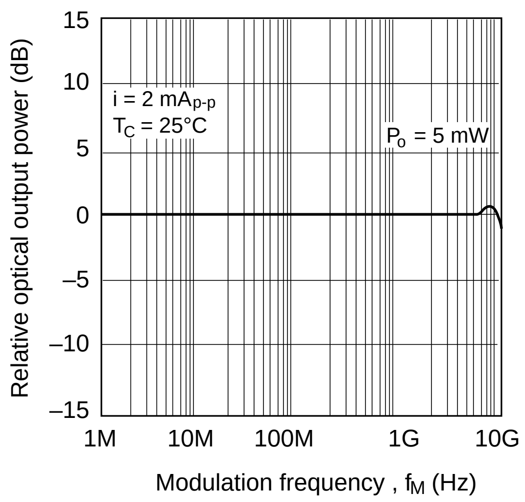


Figure 4-16 Frequency Characteristics for HL1551A

4.1.7 Mode Hopping Noise

A measuring setup for LD noise is shown in figure 4-17. Set the frequency range to be measured to a level suitable for the device application.

Measurement should be carried out after eliminating external noise. For measurement at temperatures below room temperature, take cake not to cut off the optical path due to condensation. Measurement in dry air or dry nitrogen is recommended.

Figure 4-18 shows an example of noise vs. case temperature.

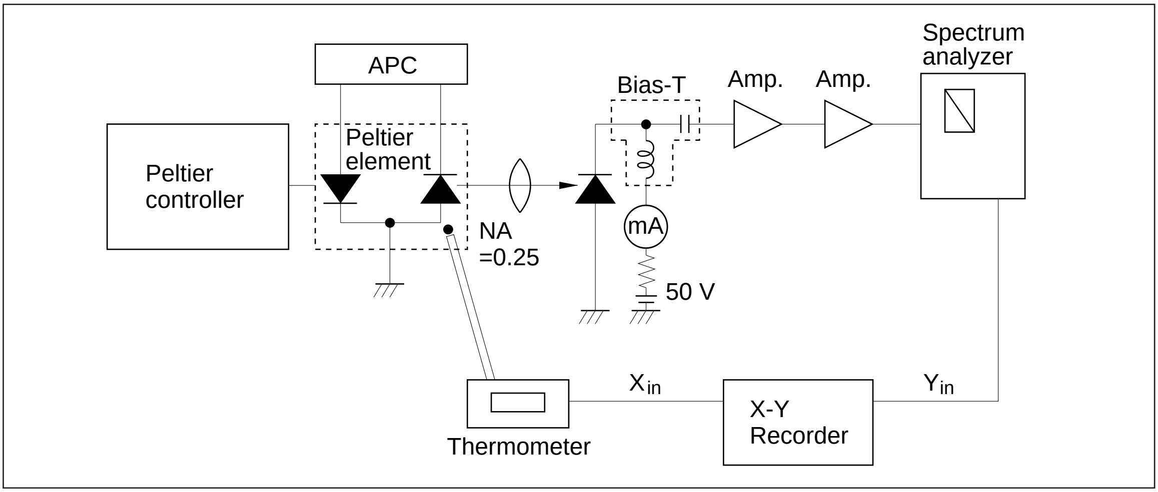


Figure 4-17 Measuring Setup for Noise

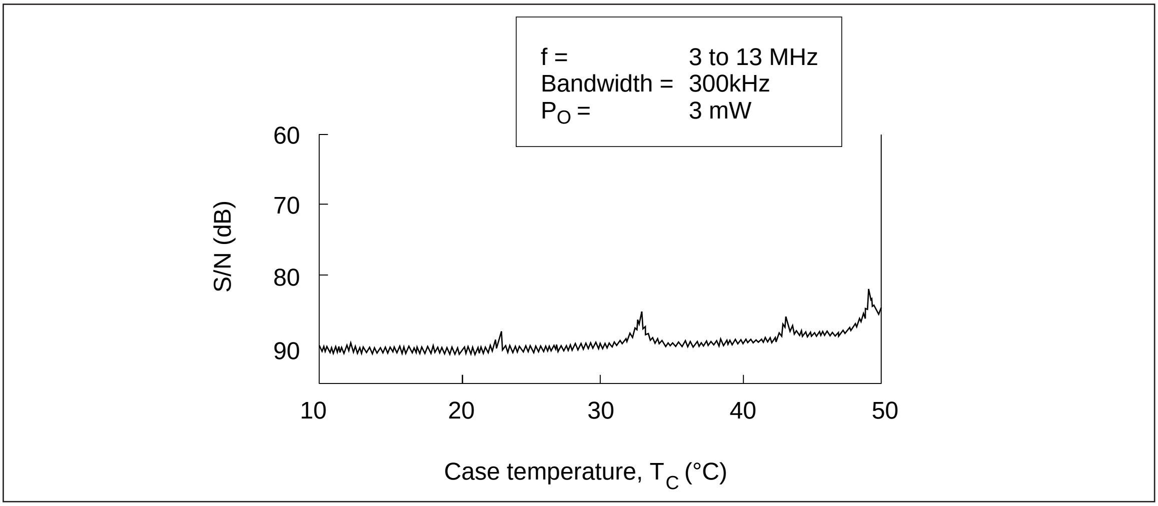


Figure 4-18 Noise Measurement Example

4.1.8 Polarization Ratio of LDs

The measuring setup for determining the polarization ratio is shown in figure 4-19. An objective lens collimates the light emitted from the LD to form parallel beam. In this case, use of an infrared phosphor plate is helpful in detecting light. Choose measuring equipment with appropriate aperture and photosensitive area so as not to disturb the parallel beam input. The polarization ratio is calculated with the maximum and minimum values of a power meter while turning a polarization prism.

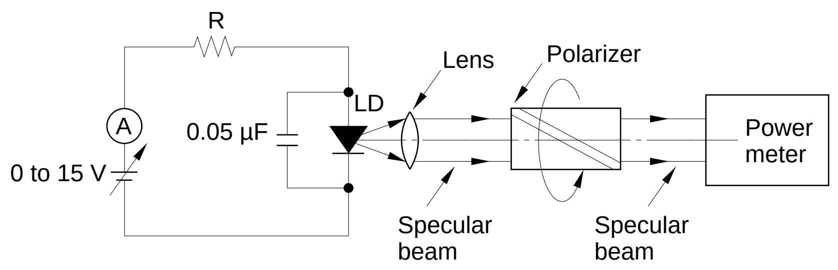


Figure 4-19 Measuring Setup for Polarization Ratio

The polarization phenomenon of an LD is illustrated in figure 4-20. The electric field oscillates parallel to the active layer, and the magnetic field oscillates perpendicular to the active layer.

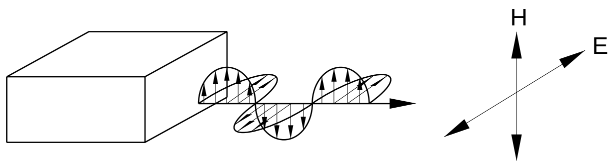


Figure 4-20 Polarization Ratio of LD

The polarization ratio depends on the optical output power and the numerical aperture. The polarization ratio vs. power output for the HL6312 series and HL7853 series are shown in figure 4-21 (a) and (b) respectively. The polarization ratio is larger when the optical output power is higher or NA (numerical aperture) of the objective lens is smaller.

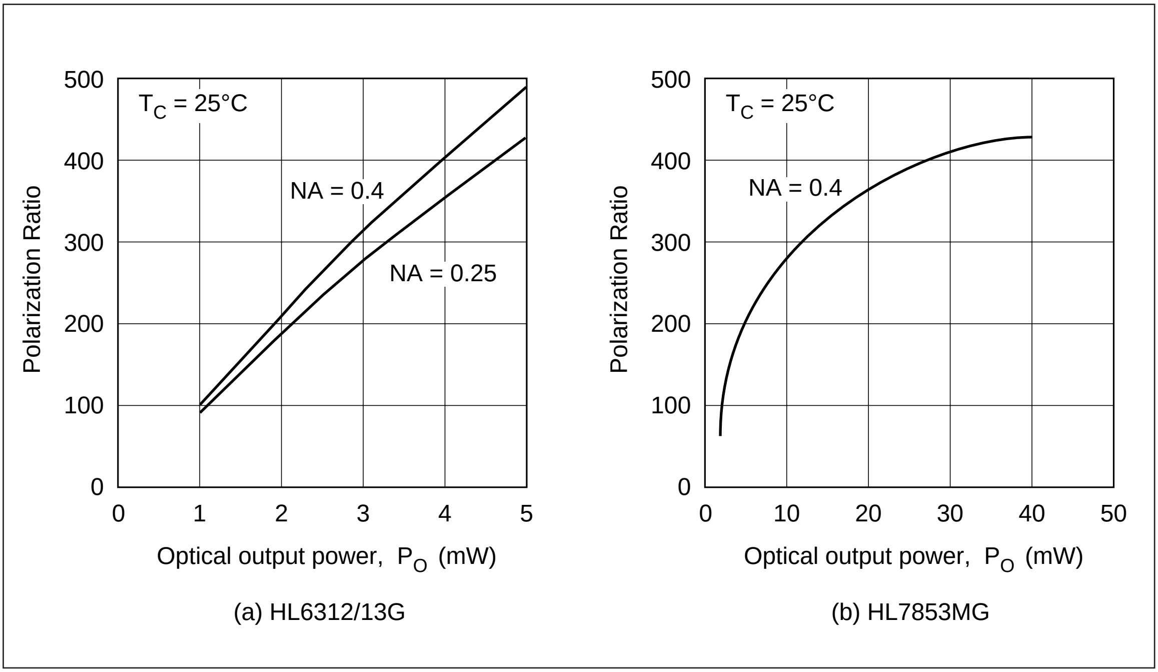


Figure 4-21 Optical-output-power Dependency of Polarization Ratio

4.2 IRED Fundamental Characteristics

4.2.1 Optical Output Power

Optical output-power measuring method under CW operation

An optical cone is used for measuring optical output power under CW operation. The optical cone gathers all light from the IRED and leads it to a photocell (see figure 4-22). Photocells should be calibrated beforehand against a standard cell, since their photovoltaic current will vary from cell to cell. Under CW operation, optical output will fluctuate significantly during the measurement due to heat generated by the chip therefore, a copper or aluminum heat radiator larger than $30 \times 40 \times 2$ mm^3 should be attached to the IRED before testing. An example of the optical output-power measuring setup is shown in figure 4-23.

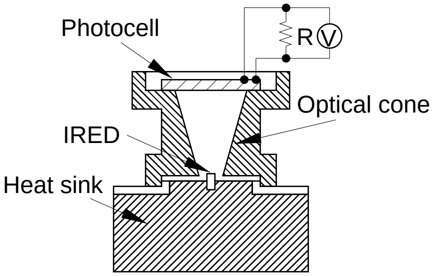


Figure 4-22   Optical Output-power Measuring Method under CW Operation

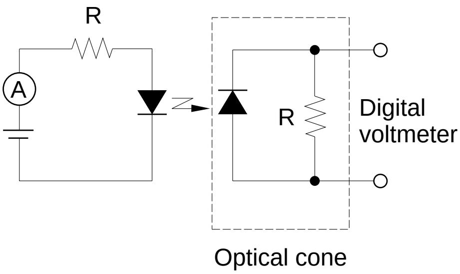


Figure 4-23   Measuring Setup for Optical Output Power under CW Operation

Optical output-power measuring method under pulse operation

An example of the measuring setup for optical output-power under low pulse operation (1-10 kHz range) is illustrated in figure 4-24. The light vs. current characteristics of the HE8807SG are shown in figure 4-25.

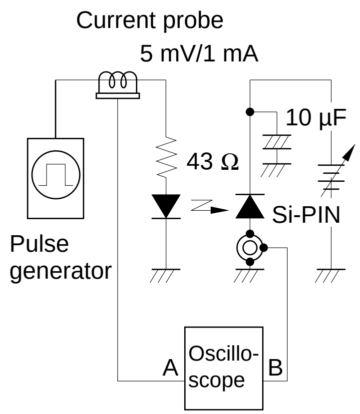


Figure 4-24   Measuring Setup for Light vs. Current Characteristics under Low Frequency Pulse Operation

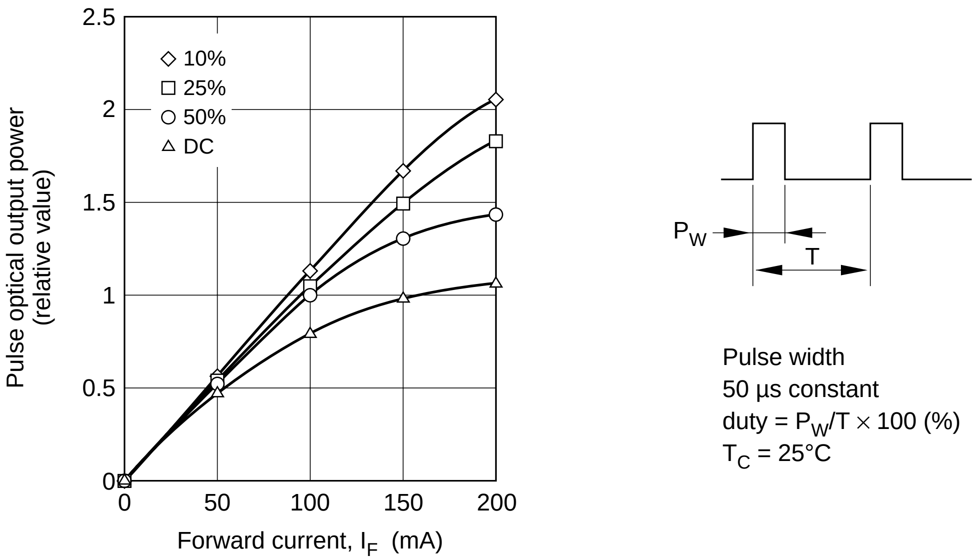


Figure 4-25   Light vs. Current Characteristics for HE8807SG

Under pulse operation, light vs. current linearity and peak values of optical output power are more favorable than under CW operation due to lower average current and less temperature increase at the junction. However, care should be taken not to exceed maximum ratings during operation, measuring, or mounting.

A setup example for measuring the high-speed pulse response is given in figure 4-26. It is recommended that a high-speed PIN photodiode or avalanche photodiode able to respond to several GHz be used as the photodetector in this measurement.

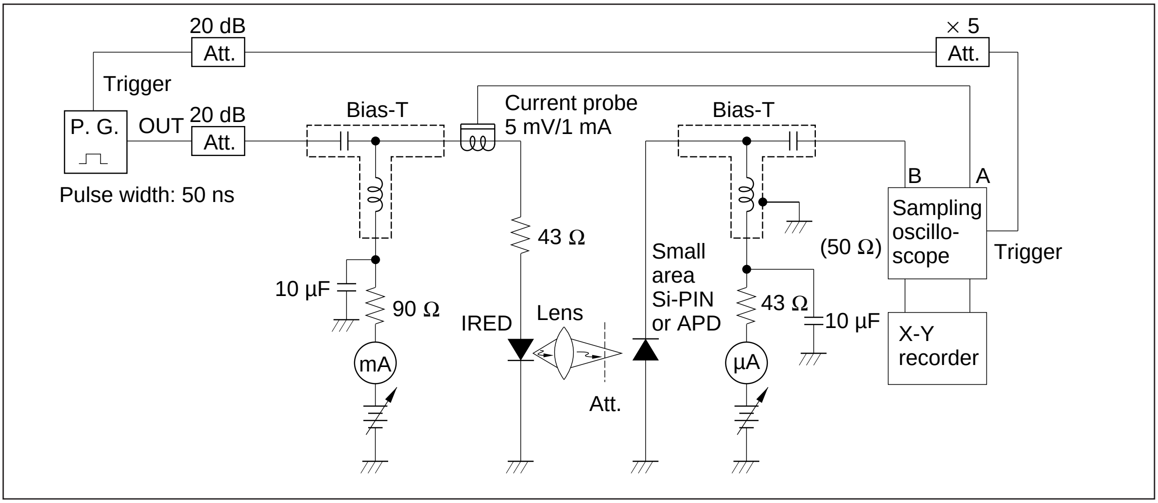


Figure 4-26 Measuring Setup for Fast Pulse Response Characteristics

Temperature dependency of optical output power

Optical output power from IREDs fluctuates along with temperature change in the p-n junction. Figure 4-27 gives a measurement example of optical output fluctuation when IRED case temperature is varied. Temperature coefficients of optical output power are –0.8%/°C (typ.) for the HE8807 series and –0.5%/°C (typ.) for the HE8811.

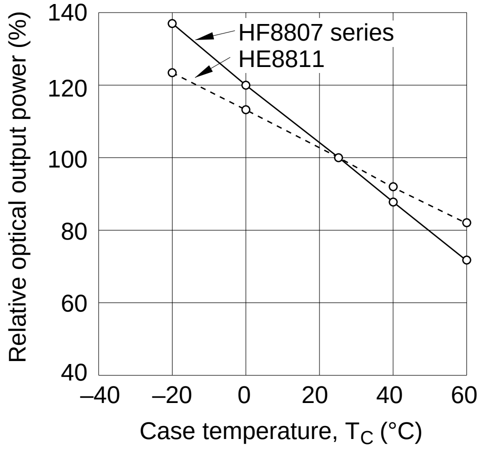


Figure 4-27 Temperature Dependency of Optical Output Power

4.2.2 Emitting Wavelength

Spectral distribution measuring method

A spectroscope is normally used to measure the spectrum of the emitted wavelength. To draw light emitted from the IRED into the spectroscope, either a bundle fiber is used or light is coupled with a condenser lens. Figure 4-28 shows the bundle fiber measuring method.

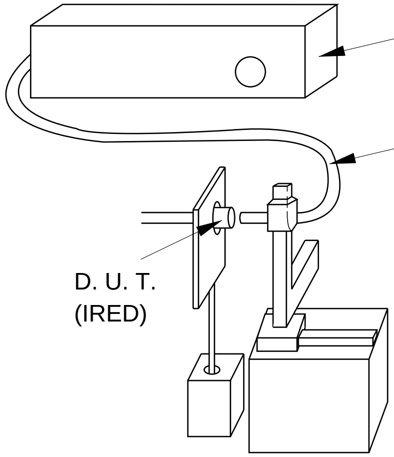


Figure 4-28   Spectral Distribution Measuring Method

Temperature dependency of wavelength

In the same way as with optical output power, temperature changes cause the wavelength distribution to fluctuate. Therefore, appropriate heat dissipation measures should be taken for the device. Figure 4-29 shows the temperature dependency of the wavelength for HE8807 series devices.

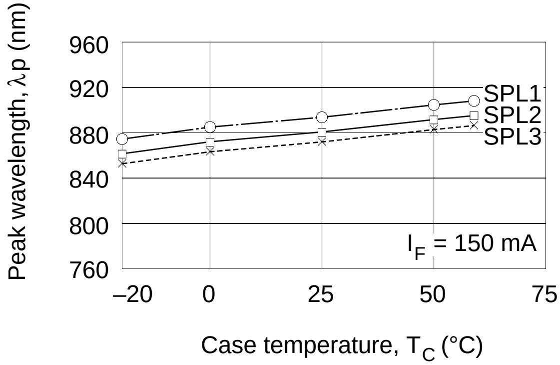


Figure 4-29   Temperature Dependency of Wavelength for HE8807 Series

As shown in figure 4-30, the peak wavelength becomes longer, spectral width wider, and optical output power lower when the temperature rises.

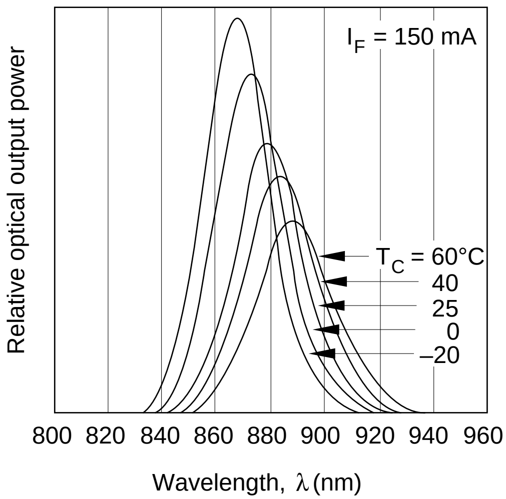


Figure 4-30 Temperature Dependency of Optical Output Power for HE8807 Series

4.2.3 Far Field Pattern (FFP)

A FFP is the light intensity profile used to obtain the relation between the angle and optical output when a photodetector is placed far enough away that the size of the IRED emitting area can be neglected. Figure 4-31 illustrates the FFP measuring method. This method employs the same driving circuit as is used with the measuring setup for light-current characteristics under CW operation. It uses a PIN photodiode or an avalanche photodiode (APD) with a minute sectional area as its photodetector. The IRED is fixed so that emitting area is aligned with the center of the turntable. Light intensity input into the photodetector is measured by rotating the turntable to obtain the relationship between the light intensity and the turning angle.

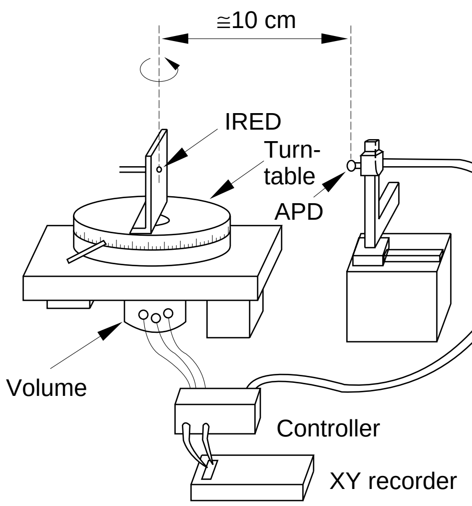


Figure 4-31 FFP Measuring Method

Since the chip surface of Hitachi IREDs is dome-shaped, uniform optical output is maintained at each angle. However, devices in RG and SG packages have different light intensity profiles than those in R packages due to interference or reflection from their sidewalls. FFP measurement examples are shown in figure 4-32.

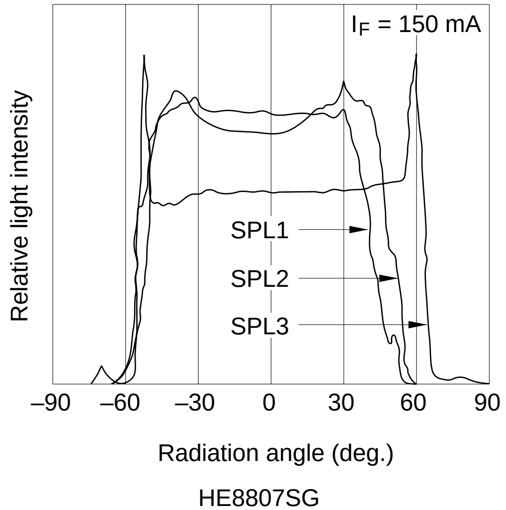


Figure 4-32 FFP Examples

4.2.4 Near Field Pattern (NFP)

A NFP can be observed with an infrared camera by operating the IRED under continuous waves (CW) and collimating the emitted light to a parallel beam with a lens (see figure 4-33). The amount of incident light into the infrared camera should be controlled with an optical attenuator, since too much incident light causes halation.

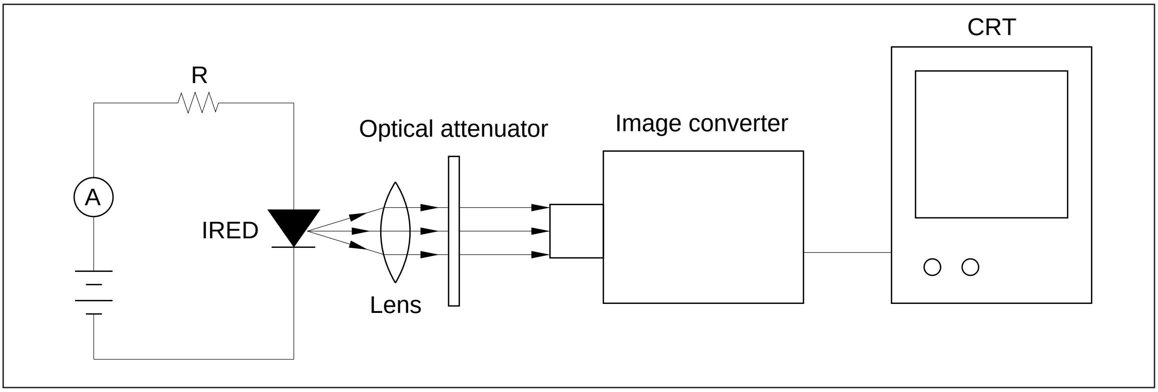


Figure 4-33 NFP Measuring Method

The emitting area is an enlarged area on the upper surface of the IRED chip and it appears larger than its actual size, due to the lens effect of the domeshaped GaAlAs crystal layer. At this time, the apparent diameter (effective diameter) will differ according to chip structure. Effective diameter is defined as half of the peak light intensity of the NFP, as shown in figure 4-34. The effective diameters are 360 µm (type) for the HE8807 and HE8811 of 400 µm dome diameters. Figure 4-35 shows an example measurement of effective diameters for the HE8807.

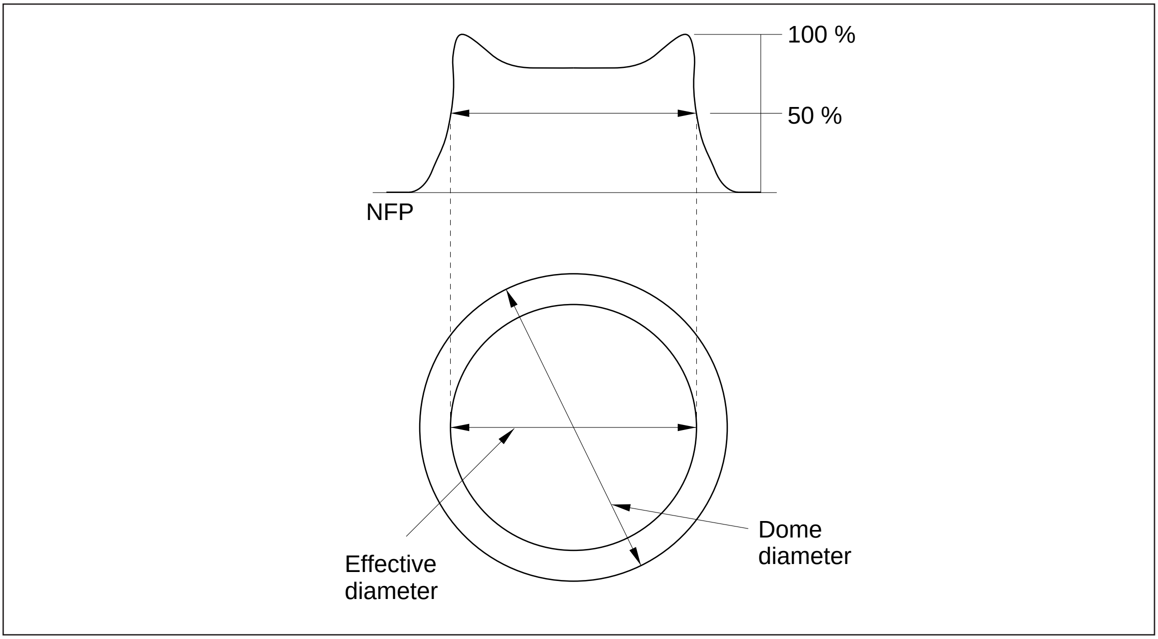


Figure 4-34 Effective Diameter and NFP

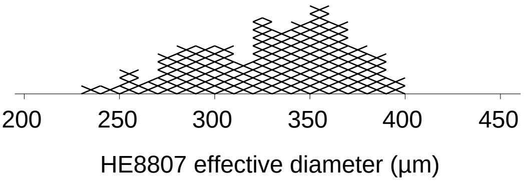


Figure 4-35 Effective Diameter Examples for HE8807

4.2.5 Current Destruction

Sufficient care should be taken when switching on the power or carrying out pulse operation to not create an excessive current flow that may destroy a IRED. Measurement values of destructive current are shown in figure 4-36. IREDs should be operated at value less than half this destruction current and in a region where the light-output-current characteristic is not saturated.

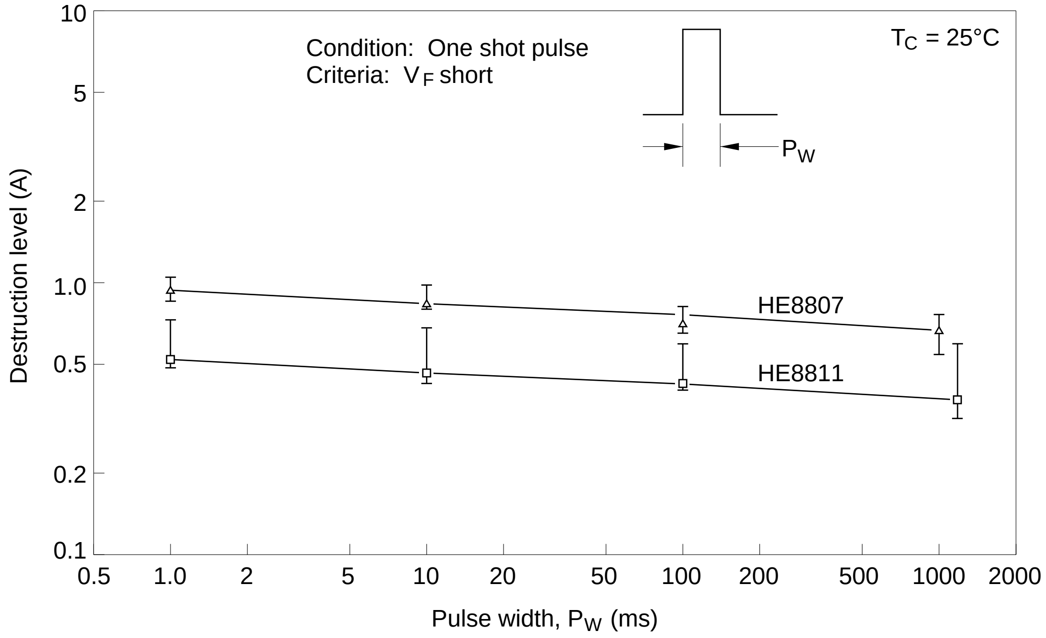
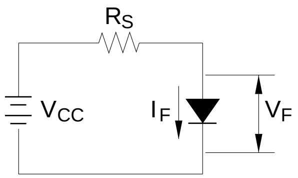


Figure 4-36 Destructive Current

A serial protection resistor, R_S, should be inserted in the drive circuit for CW operation to prevent excessive current flow (see figure 4-37). When using a constant voltage supply, the supply voltage, V_{CC}, should be set as high as possible to avoid current fluctuation due to forward voltage variation from device to device and temperature changes. When using a constant current supply, be careful to set the resistance value, R_S, high enough that excessive current does not flow before the current limiter starts functioning after the power source is switched on.



a) When using constant voltage supply

$$R_S = \frac{V_{CC} - V_F}{I_F} \quad (\Omega)$$

V_{CC}: Supply voltage (V)
V_F: Forward voltage (V)
I_F: Forward current (A)

b) When using constant current supply

$$R_S = \frac{V_{CO} - V_F}{I_F \max}$$

V_{CO}: Unloaded supply voltage (V)
V_F: Forward voltage (V)
I_F max: Forward current maximum rating (A)

Figure 4-37 Power Supply for CW Operation

4.2.6 Transient Thermal Resistance

The lifetime of IREDs depends heavily on their junction temperature. Adequate heat release should be designed. Figure 4-38 shows examples of transient thermal resistance characteristics.

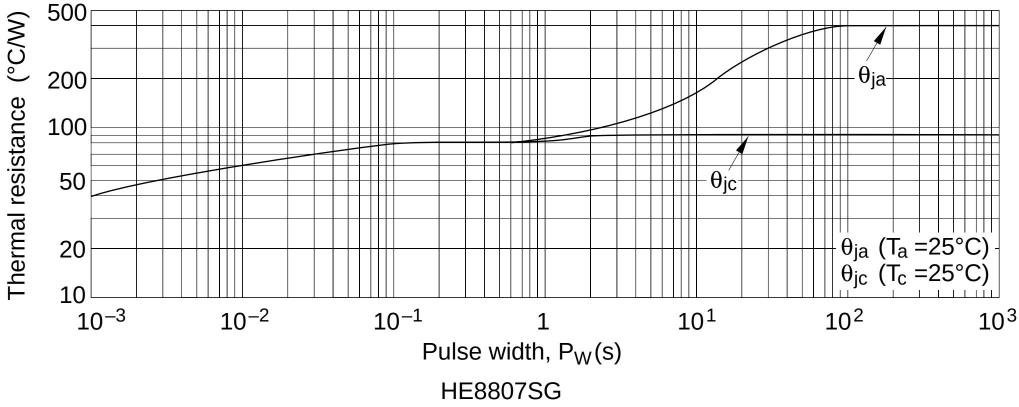


Figure 4-38 Transient Thermal Resistance Examples

4.2.7 Optical Fiber Coupling Efficiency

Figure 4-39 shows the coupling efficiency when connecting various types of optical fiber with IREDs.

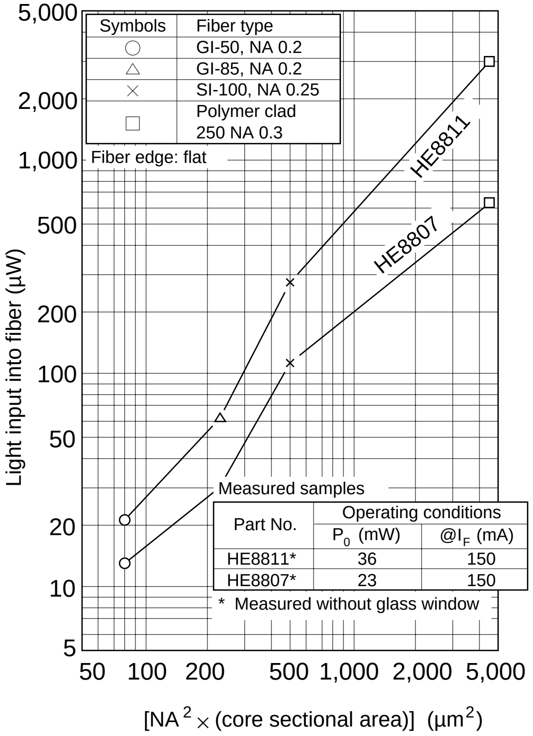


Figure 4-39 Optical Fiber Coupling Efficiency

The fiber can either be processed or a lens used to obtain a larger optical output. Optical output can be increased as much as 1.2 times by using fibers with tips made hemispherical through an electric discharge process.

By using a parabolic-rod or similar lens (see figure 4-40), almost the same fiber output can be obtained as with direct coupling method (figure 4-41) even when some distance separates the chip surface and the fiber tip. Therefore, SG-type devices with caps are expected to realize about the same fiber output as the case of without cap.

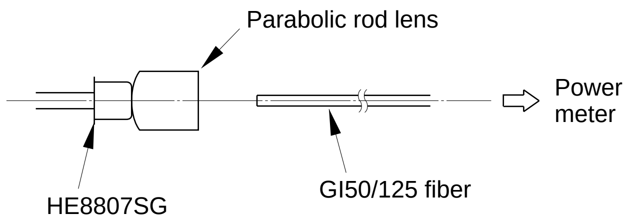


Figure 4-40 Parabolic Rod-lens Coupling Method

4.2.8 Precision of Chip Position

In most practical applications, the optical output of an IRED is condensed by placing a lens over its face. When doing so, it is important to adjust the relative position of the light source and the center of the lens such that no offset problem arises. Figure 4-41 gives the amount of chip position offset to the center of the stem, which is useful for designing optical systems.Figure 4-42 shows the distances between the glass window of the cap and the chip.

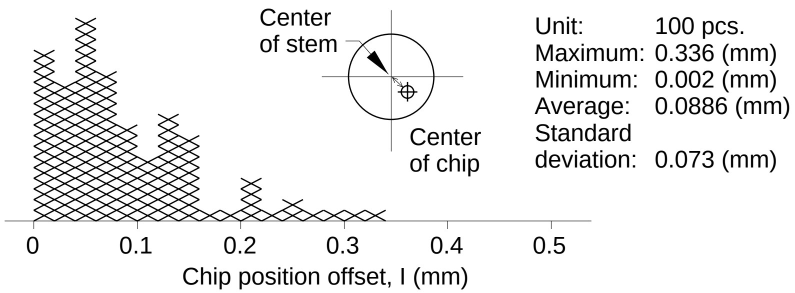


Figure 4-41 Chip Position Offset Examples

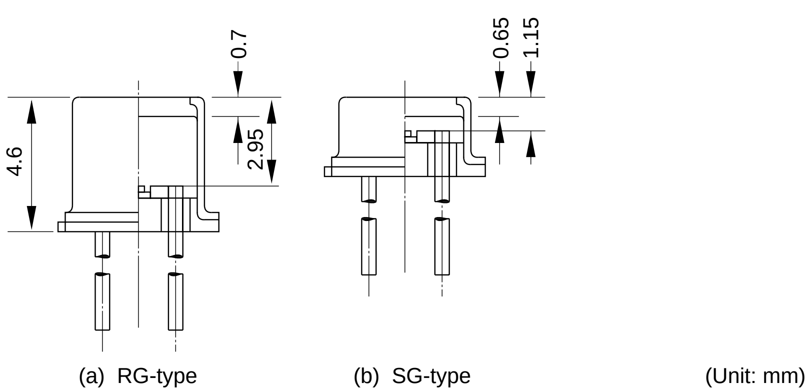


Figure 4-42 Distances between Glass Window of Cap and Chip

4.3 Photodiode Fundamental Characteristics

4.3.1 Photo-detection Sensitivity (S)

An example is given in figure 4-43 of a method for measuring photo-detection sensitivity. A laser beam of a specified wavelength is input from an LD into an optical fiber. The optical axis is adjusted so that the light quantity is maximum at the photodiode surface. The APC circuit is then adjusted so that there is a specified level, P_{in}, of optical input power into the photodiode. It is also necessary to adjust the position of the photodiode so as not to change the saturation current, I_S. The photo-detection sensitivity, S, can then be calculated using the formula:

$S = I_S/P_{in}$ (mA/mW)

When measuring spectral sensitivity characteristics, values calculated for spectral sensitivity are usually compared against wavelengths. Here, several wavelengths that have issued from monochromatic light sources and have the same spectral width are usually employed.

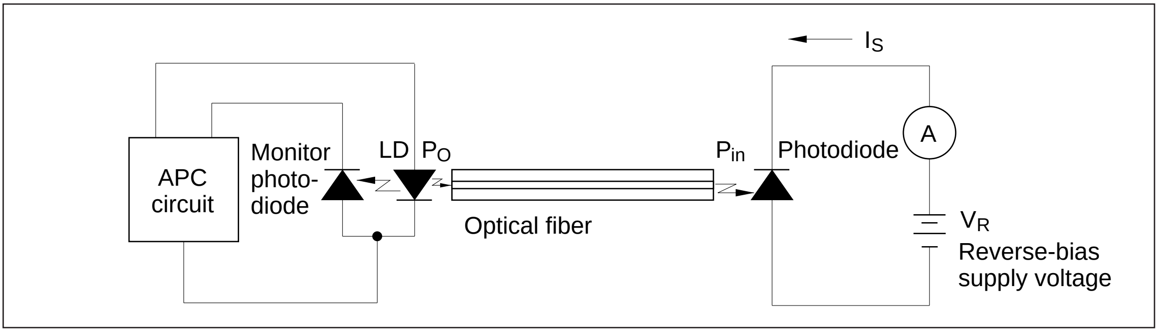


Figure 4-43 System for Measuring Photo-detecting Sensitivity

Figure 4-44 shows the relation between saturation current, I_S, and reverse voltage, V_R, for InGaAs/InP PIN photodiodes. Spectral sensitivity characteristics are listed in the individual product data sheets.

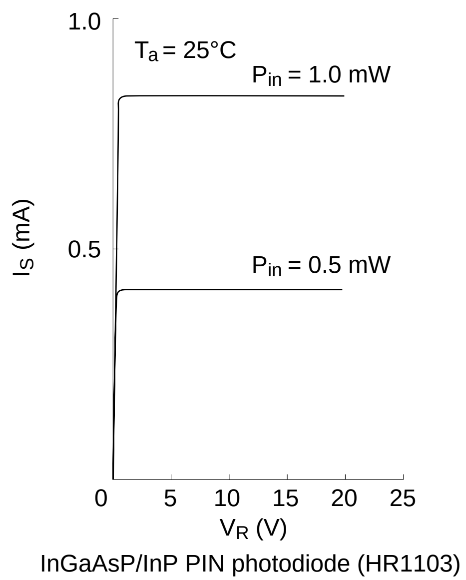


Figure 4-44   Relationship between Saturation Current and Voltage

4.3.2 Photo-detection Response Characteristics

Photo-detection response can be observed by measuring rise time, t_r, and fall time, t_f, for a photodiode output-current pulse when a pulse is input into the photodiode (figure 4-45). A measurement setup example is for presented in figure 4-46. A high-speed response capability is required for precise measurement of photodiode response when a monochromatic light source (LD) is employed. Optical power output from an LD focused using a lens, and the axis of the LD and the photodiode is adjusted so that the focused stop is within the photo-detection area of the photodiode. LD optical output power is then set by adjusting the pulse generator so that a specified volume of light is incident on the photodiode. A photo-detection response example is shown in figure 4-47.

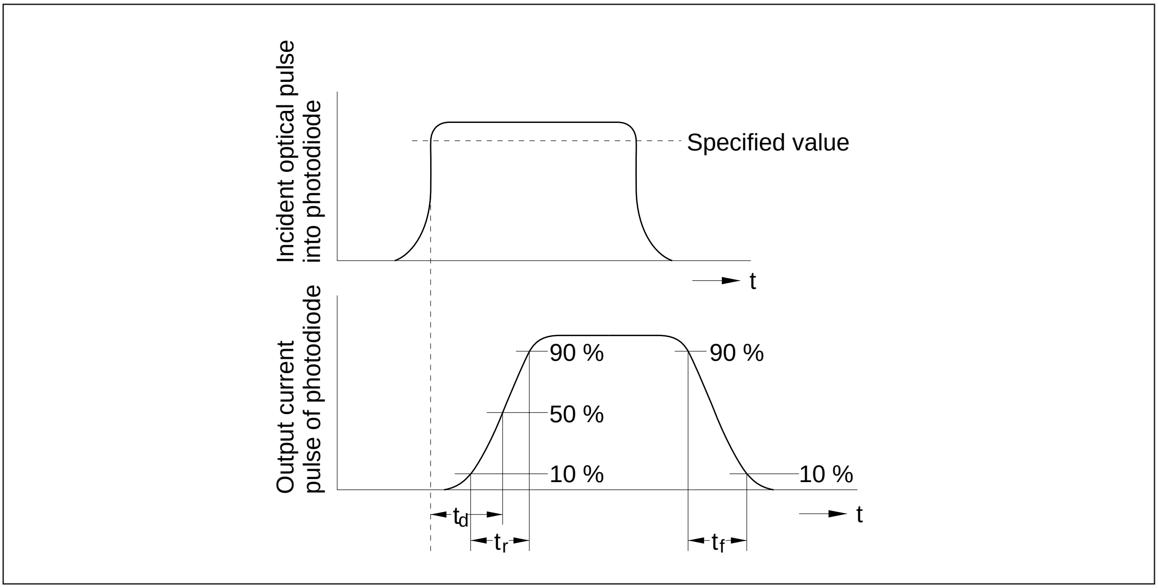


Figure 4-45 Definition of Photo-detection Response Time

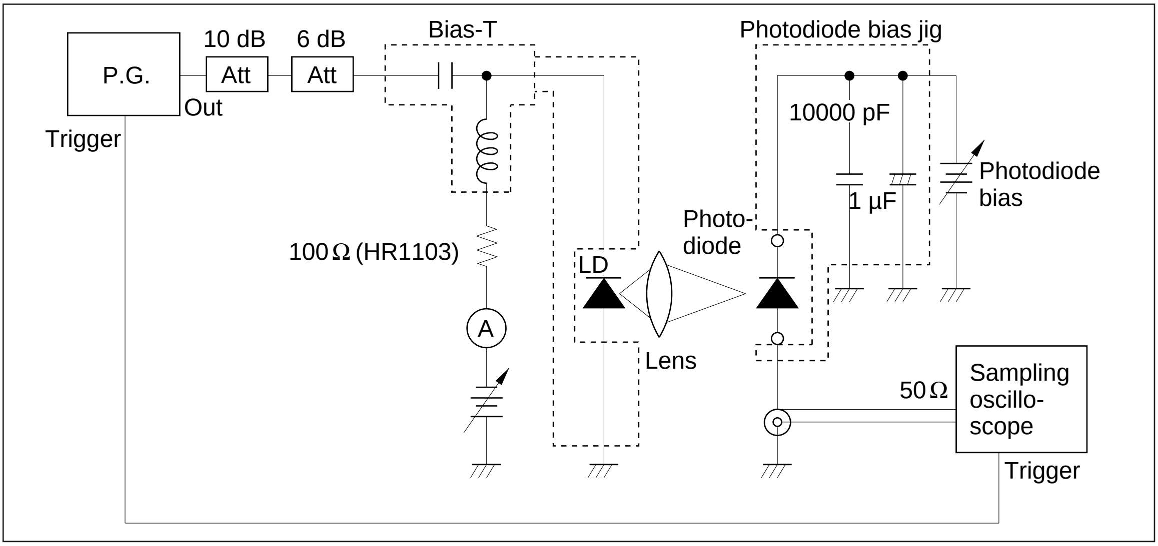


Figure 4-46 Measuring Setup for Photo-detection Response

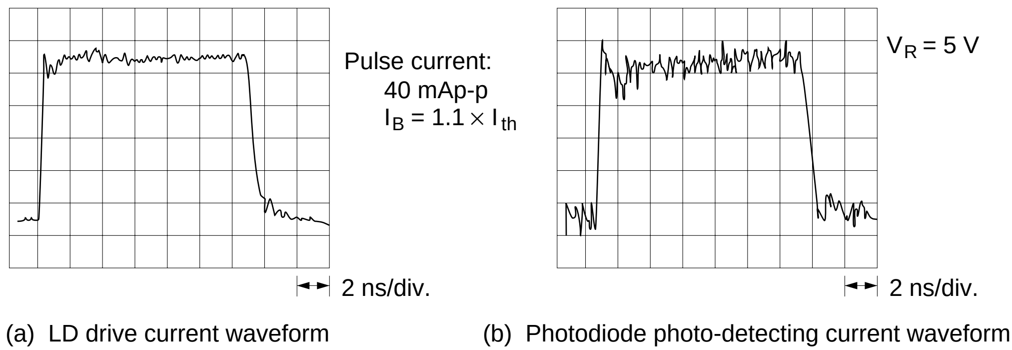


Figure 4-47 Photo-detecting Response Wave for InGaAs/InP PIN Photodiode (HR1103)

4.3.3 Frequency Response

The frequency response characteristic of InGaAs PD (HR1103) with multi-layer heterozygous structure, is shown in figure 4-48. As is clear from the figure, the frequency response is flat up to the GHz region, making it ideally suited for a signal detector in a high speed optical fiber transmission system.

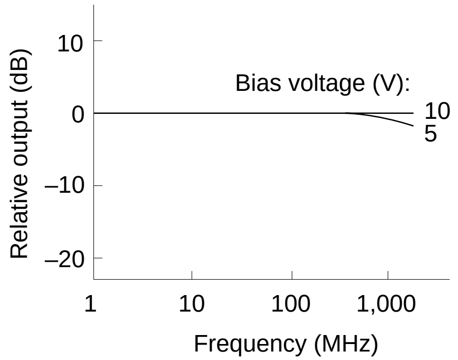


Figure 4-48 Frequency Response Characteristic of InGaAs /InP PIN PD

Section 5 Handling Instructions

Suitable handling precautions during device measurement and system design must be taken as described below for high performance of a device with high reliability.

5.1 The Absolute Maximum Ratings

Be careful never to exceed, even momentarily, the absolute maximum ratings specified in the data sheets herein.

Pay particular attention to the following points.

(1) It is possible for diodes to be damaged by spike current, generated when switching the power ON or OFF or when adjusting its output voltage. Before activating diodes, check the transient state of the power supply to assure that it does not exceed the maximum voltage rating.

(2) Operate the diodes below the maximum optical output power rating in order to prevent mirror facet damage and resultant loss in reliability.

5.2 Surge Energy

Electrostatic discharge and electric spike input which may damage the diodes should be prevented. The main causes of undesirable surge energy are static electricity on the human body, shipping containers made of unsuitable materials, abnormal pulses generated from test equipment, and voltage leakage from soldering irons.

Precautions below should be taken when using diodes.

(1) The human body should be grounded through a high resistance of 500 kΩ to 1 MΩ while handling diodes in order to prevent diode destruction due to static electricity contained in the body and clothes.

(2) Soldering irons should be grounded to prevent voltage leakage from transferring to the diodes.

(3) Suitable materials should be chosen for shipping containers and jigs so that they will not become charged with static electricity by rubbing during transportation. Use of electro-conductive materials or aluminum foil is effective.

5.3 Storage

(1) Store diodes in temperature of between 5 and 30°C and relative humidity of below 40%. Lower values of both are preferable. Avoid sharp drops in temperature in order to prevent condensation. It is recommended to store diodes in an atmosphere of dry nitrogen with a dew point of –40°C.

(2) Assure that the storage atmosphere is void of dust and gases harmful to diodes.

(3) Use a storage case which can not easily be charged with static electricity.

5.4 Safety Considerations

Even though barely visible to the human eye, laser beams can be harmful to the eye. Do not look at the beam through lenses when the diode is activated. When aligning the optical axis of a laser beam and an external optical system, use an ITV camera (e.g. a silicon-vidicon type) which can detect infrared rays to observe the laser beam.

5.5 LD-package Handling

5.5.1 A- and AC-types

A-type package is designed for experimental use and AC-type package for module assembly. A LD chip is mounted on a submount which is mounted on a heat sink; the mirror facets are exposed to the air. Special care is required as follows:

(1) Never touch the bonding wire on the upper part of a device.

(2) Prevent mechanical contact to LD chip, because the stress peels off the chip from the heat sink or deteriorates the device properties such as beam divergence, far field pattern, or reliability.

(3) The cleanest atmosphere is strongly desired when handling a device to keep mirror facets free from dust and scratches, because the light emitting area is extremely small. This precaution prevents degradation of optical output power and far field patterns.

(4) Hold the copper heat sink when handling a device. Do not drop the device or give any other mechanical shock.

(5) Do not process or deform a heat sink.

(6) Use a good thermal radiator for the mounting of the device. The temperature of a LD chip rises highly owing to the high current density unless a good heat sinking is provided. This precaution prevents lower optical output power and device deterioration. Observe the following cautions when using a thermal radiator.

   (i) Never use silicone grease because it adheres to the mirror facets, resulting in a degradation of optical output performance.

   (ii) Use a copper or an aluminum plate as a thermal radiator. The radiator should be larger than $30 \times 40 \times 2$ mm^3.

   (iii) Polish the thermal radiator surface to provide good thermal conductivity with the device heat sink. Finish the radiator surface to keep bumps, twists, or bends below 0.05 mm.

   (iv) Chamfer all screw holes. The diameters of the chamfered holes should be smaller than that of a screw cap.

   (v) When mounting a device to a radiator, do not allow the device to be turned by the screwing action or allow the chip to contact the thermal radiator.

(7) Soldering

Notice the following precautions when soldering the electrode ribbon of a device to the circuit.

   (i) Do not exceed the heat sink temperature of 80°C and finish the process within 30 seconds, because a low melting point solder is used for chip mounting.

   (ii) Use a fine tipped soldering iron commercially available or a common soldering iron with copper coil around the tip. When soldering, earth the tip of the iron. A battery operated type is the best kind to use.

   (iii) Do not allow the solder to flow into the pad of the bonding wire.

   (iv) Do not allow the scattered flux to adhere to the mirror facets.

   (v) Do not wash out flux after soldering, because that would contaminates the mirror facets.

(8) Hermetic seal

Hermetically seal a device to extend its life time.

These packages should be hermetically sealed when mounting on systems.

5.5.2 CF, CN, PF and SN-types

These packages are designed for fiberoptic communications. The CF, CN, PF and SN-types contain a PD. Those are provided with a single mode fiber. The LD and PD are hermetically sealed. Pay attention to the following precautions in handling these devices.

(1) Excessive force applied to an optical fiber disconnects the fiber rapidly an or deforms it

partially. Do not pull, crook, or twist the fiber because it deteriorates fiber characteristics. Do not bend the optical fiber within a 30 mm radius.

(2) Do not apply excessive stress between the package and the optical fiber, to prevent a fiber from breaking or falling out and reducing optical output power. Lift both the package and the optical fiber at the same time to avoid bending the fiber bottom.

(3) Do not apply excessive stress by bending or pulling the pins, because it deteriorates hermeticity.

(4) Do not process or deform a package.

(5) Processing the optical fiber

Do not contaminate or damage the tip of an optical fiber to prevent the loss of optical output power or of coupling efficiency. Follow the instructions below in processing the fiber tip.

(i) Remove an appropriate length of the nylon jacket from the fiber tip with a proper stripper.

(ii) Remove the fiber coating remedy from the peeled fiber with aceton.

(iii) Scratch the cutting point of the fiber with a diamond cutter.

(iv) Hold the fiber tip with a pair of tweezers and bend to snap, then expose the clean surface. When the surface of the fiber cannot be snapped flatly, try again (figure 5-1). Be careful when processing a fiber; the extremely thin core of the fiber may easily pierce human skin.

(6) Mounting a device on a thermal radiator

Use a LD with a thermal radiator.

(i) When screw mounting a device on a radiator, torque should be 1 to 2 kg·cm. Too small a torque may result in excessive thermal resistance and too excessive torque may damage the diode.

(ii) Use a screw of 2 mm diameter

Use a spring washer and apply lock paint to tapping holes or nuts to prevent turning or relaxation of the screw.

(iii) For other considerations, follow the instructions described in the previous section 5.5.1 (6).

(7) Soldering

Follow the instructions described in the previous section 5.5.1 (7).

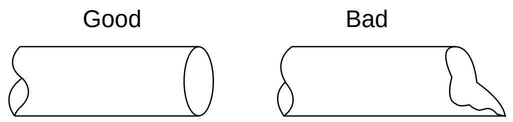


Figure 5-1 Processed Fiber-tip Examples

5.5.3 G-, MF- and MG-types

(1) Take care not to touch the window glass directly. Contamination and scratches on the window surface will result in decreased optical power output and distorted far field patterns. Contamination can usually be wiped off using a cotton swab with ethanol.

(2) Do not squeeze the cap tightly, as it will cause the window glass to crack and package hermeticity to deteriorate.

(3) Do not bend the bottom of the lead wire, as it will cause the glass area to crack and the hermeticity to deteriorate.

(4) Do not cut or process packages.

(5) Mounting a diode on a thermal radiator

Laser diodes must be mounted on thermal radiators. For higher reliability, it is necessary to minimize mechanical stress to the packages and achieve sufficient heat sinking. Attention should be paid to the following items when mounting diodes on thermal radiators.

(i) Use a copper or aluminum plate for the thermal radiator. The plate should be larger than $30 \times 40 \times 2$ mm^3.

(ii) To provide good thermal conductivity, polish the thermal radiator surface so it will lie flat with the diode heat sink. Finish the radiator surface to keep bumps, twists, or bends below 0.05 mm.

(iii) Do not solder packages to thermal radiators, as this may result in excessive temperature to the assemblies inside the packages or loss of package hermeticity.

(iv) When mounting the diodes, do not touch or hit them against the caps, to prevent the window glass from becoming contaminated or cracked.

(v) Do not use heat sink grease, as it may contaminate the window glass.

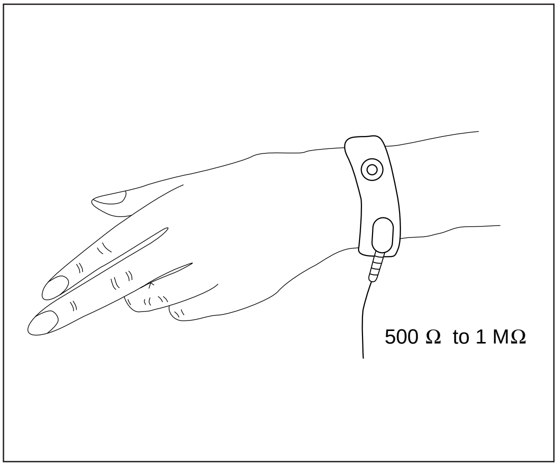
5.6 Advice for Beginners

(1) Avoiding surge energy

Laser diodes are easily destroyed by static electricity. To prevent electrostatic discharge, pay attention to the following precautions as well as table 5-1 when handling diodes and designing application circuits.

(i) Set the electric potential of the work bench to the same as that of the power supply ground line.

(ii) Ground the operator's body by wearing a wrist band, and connect it to the same potential as the power supply ground line.



(iii) Do not operate equipment which may generate high frequency surge energy near diodes. The lead wires of drive circuits pick up surge electricity which may destroy diodes in the induced electric field.

(2) Operating laser diodes

(i) Mount a diode on a thermal radiator. The radiator size depends on operating time and output power. When there is no condition set, use a relatively large radiator ($50\times50\times2$ mm^3) of copper or aluminum.

(ii) The drive circuits preferred are ones with APC (automatic power control) function. However, a simple constant current source is recommended when merely testing performance, because adjustment miscalculation can result when circuits are too complex, leading to destruction of the diodes.

(iii) Before connecting a laser diode to the power supply in the ON-state as shown in figure 5-2, set the output level to the minimum. Also, before disconnecting a laser diode from the power supply, set the output voltage to the minimum. After disconnecting, turn off the main switch.

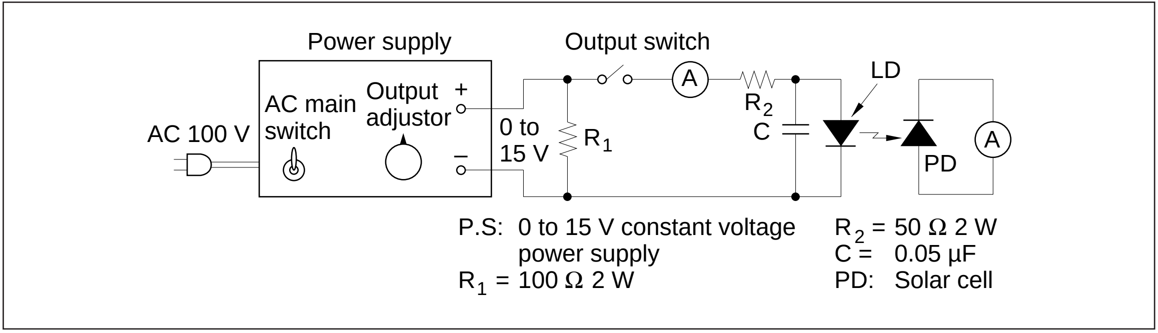


Figure 5-2 Simple Drive Circuit

(3) LD drive circuit

The optical output power from an LD is affected easily by the fluctuations in ambient temperature. A APC (automatic power control) function is generally recommended for a drive circuit to achieve stable operation. A function which monitors the beam and feeds it back to the drive current is useful to achieve constant optical output power against temperature change.

Table 5-1 Ways to Prevent Surge Destruction of LDs (Examples)

Items	Check Points	Specification Examples
Human body	Ground operator's body.	Place a non-metallic, carbon band with a resistance of 500 Ω to 1M Ω on his wrist.
	Commonly ground the measuring and inspecting equipment and the work bench.	Should be carried out in shielded rooms as well.
	Control the ground level.	Under 10 Ω
Power supply	Distribute power from main power supply through noise filter to each measuring and testing unit.	
	Insert noise filter in each power supply unit.	Organize with capacitors and resistors.
	Keep the main power supply in the on-state, and switch the power on and off using an external switch.	
	Set up sequence control for turning the power supply off during electric outages.	
	Eliminate relay chattering.	
	To prevent chattering, avoid turning the APC circuit or relay switch on and off as much as possible.	
Working conditions	Temporarily stop work when the power supply for lights or other equipment connected to the same power line is turned on or off.	
	Conduct diode packing and measuring while performing ion blowing or in a weak minus ion atmosphere.	
	Select the right soldering iron.	Battery operated soldering iron.
Jigs and other considerations	Make carrier jigs and packing cases conductive.	Particularly the cases.
	Place conductive mats on the working floor.	Under 300 Ω
	Control room temperature and humidity.	Humidity should be 50 ± 10%.
	Make short circuits between diode leads.	
	Do not use sticky volume knobs.	Periodically replace with new ones.
	Eliminate ripples from power supply.	Battery operated power supply.

5.7 IRED-package Handling

5.7.1 SG-, VG-, CL- and FL-types (Hermetically sealed)

These packages are moisture-proof and easy to handle because of the hermetic seal. Pay attention to the following precautions in handling these device.

(1) Keep the glass surface of a device clean to have uniform optical output available.

(2) Do not process or deform a package. Especially do not nip the cap hard or bend the bottom of a lead wire forcibly, as this will crack the glass area and deteriorate the hermeticity.

(3) Mounting a device on a thermal radiator.

Use of a thermal radiator is recommended for higher reliability. Do not apply silicone grease to the contact area of the thermal radiator even for effective heat sinking, because it adheres to the window glass as temperature increase, resulting in a degradation of optical properties and output power. For further details, see the previous section 7.1 (4).

(4) Soldering

(i) Soldering point must be away by 1.5 mm or more from the bottom of lead wires.

(ii) Use a low melting point (below 200°C) solder.

(iii) Soldering should be done in 10 seconds and at below 260°C.

5.8 Photodiode Package Handling

5.8.1 CR-type (Hermetically sealed)

These hermetically sealed packages are moisture-proof and easy to handle. Nevertheless, be careful to observe the following conditions when handling the packages.

(1) Do not process the packages or change their shape. Be especially careful not to apply heavy stress to the body, bend the bottom of the lead wires or fiber forcibly, or apply stress to the bottom of the stem since this may degrade the hermetic integrity of the package.

(2) Soldering

See item 5.7.1 (4).

5.8.2 CX-type (Chip-carrier)

This package has been designed for use in optical module assemblies. A photodiode chip is attached to a ceramic carrier stem, where it is left exposed to the air. With this package type, particular care must be taken in the following areas.

(1) Storage

(i) Store the photodiode in a dry, particle-free box, or in a nitrogen atmosphere between + 20 and + 30°C, where the dew point is below –30°C. Maintain these same conditions when storing the package unsealed during processing. The storage period recommendations in table 5-2 are meant to assure maximum product quality.

(ii) Use storage containers which are not subject to the buildup of static electricity.

(2) Handling and assembly conditions

(i) Never touch the chip bonding wire.

(ii) Keep the chip photodetector area clean.

(iii) Be careful not to scratch the chip surface, or crack or break the device when implementing the CX type in your system. The soldering conditions given in table 5-3 should be maintained if optical and electrical characteristics and reliability are not to degrade.

(iv) This device should be hermetically sealed when it is in its final mounting. The sealing process should be carried out within an atmosphere composed of an inactive gas such as nitrogen. Results of hermetic-seal helium leak tests should be below 10^{-8} atm.cc/sec.

(v) Be sure to ground the worker's body and equipment when he or she handles the device.

Table 5-2 Recommended Storage Period

Conditions	Storage Period
Unopened, in Hitachi's packing case	Less than three months
Stored under the above conditions after opening the packing case	Less than one month

Table 5-3 Recommended Soldering Conditions

Temperature	Time	Atmosphere
230°C	Within 30 sec.	Inactive gas such as nitrogen

Section 6 Reliability

This section covers points which particularly affect the operating life light emitting devices, and provides some examples which should be studied before proceeding with your system design.

6.1 Characteristic Drift

When optical emission devices such as the LD or IRED are operated in the forward mode, crystal defects (point defects and dislocations) propagate in the active region of the crystal.

These crystal defects cause optical emission characteristics (optical output power, threshold current, etc.) to drift, and ultimately lead to the end of the device's useful operating life. Figure 6-1 shows an example of drift in the optical output power vs current characteristic of a LD. From t_1 to t_4, the threshold current increases and the slope efficiency declines. The end of useful operating life is defined as the point where the operating current becomes 1.5 times of its initial value.

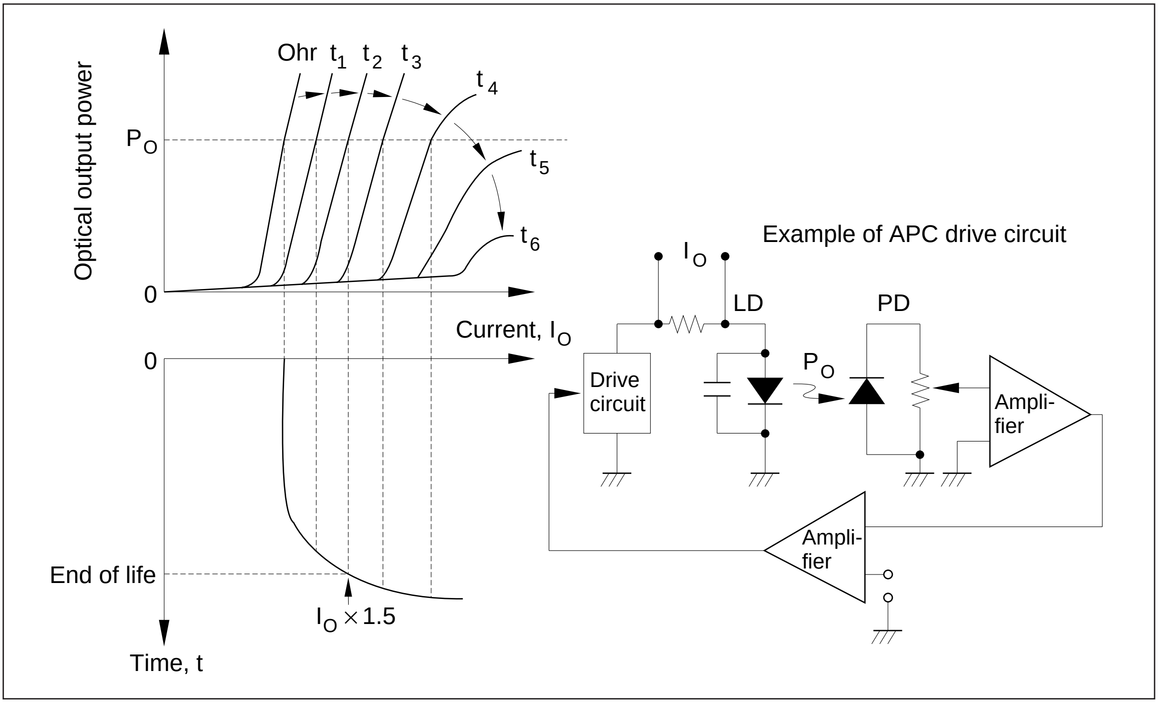


Figure 6-1 Example of Drift in LD Optical Output Power vs. Current Characteristic

6.2 Derating

LDs and IREDs have a strong temperature dependence of lifetime. Thus, the expected operating life shows an exponential decrease with operating temperature. Derating should be employed to keep the rise of junction temperature as small as possible. (See figure 6-2, and 6-3).

Figure 6-4 shows the dependence of operating life on optical output power. Please note that this decrease in operating life occurs even at threshold current bias.

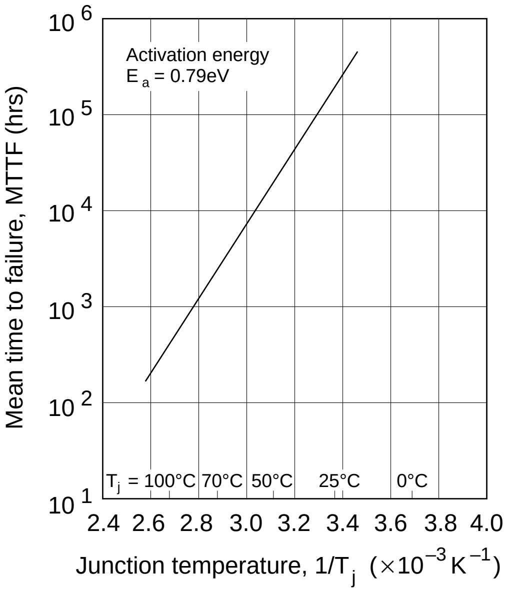


Figure 6-2 LD Mean Time to Failure vs. Junction Temperature (Example)

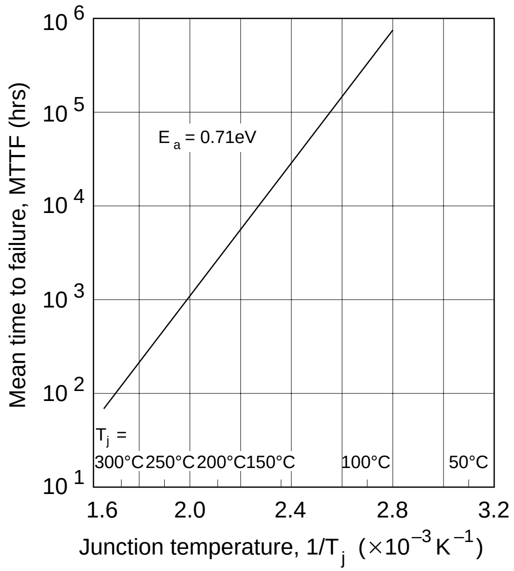


Figure 6-3 IRED Mean Time to Failure vs. Junction Temperature (Example)

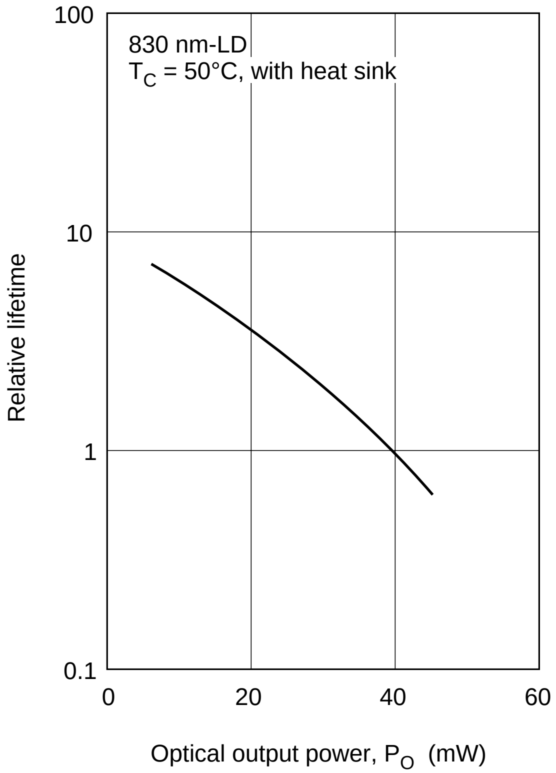


Figure 6-4 LD Operating Life vs. Optical Output Power (Example)

Figure 6-5 shows operating current dependence of IRED lifetime. In particular, when operated in open air at high current, the operating life is drastically affected by the rise in junction temperature due to heat generated by the device. Careful attention must be paid to carrying away excess heat.

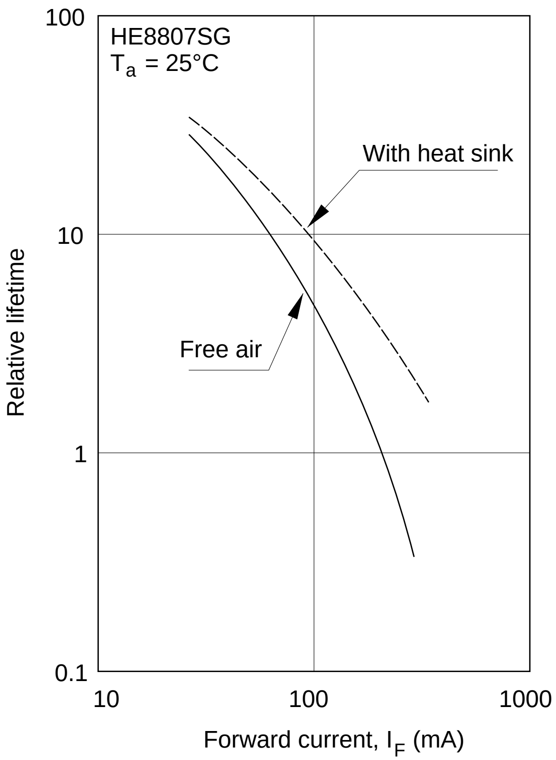


Figure 6-5 IRED Operating Life vs. Forward Current (Example)

6.3 Estimation for Useful Operating Life

The operating life of light emitting devices exhibits the typical wear failure distribution, and thus is generally approximated by the lognormal distribution. Figure 6-6 shows an example distribution for LD operating life. When the temperature derating and optical output power derating discussed in the previous section are also considered, the actual expected operating life under given operating conditions can be estimated.

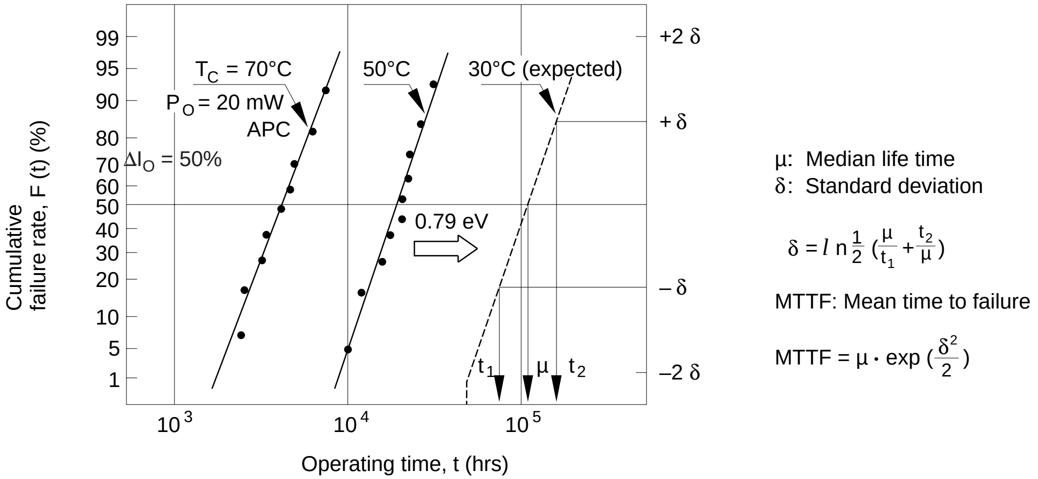


Figure 6-6 Distribution of Expected LD Life (Example)

6.4 Standard Devices Graded by Expected Life

Hitachi classifies IREDs of standard-specifications by life levels and applications as shown in table 6-1. For special requests or further details, please see your Hitachi representative.

Table 6-1 Lifetime and Application for Standard-specification IREDs

Applications	Expected Life Time	Operating Conditions	Criteria	Applicable Products
Auto-focusing still camera	10 hrs.	I_F = 200 mA	F(t) = 0.1%, $\Delta P_O \leq 30\%$	HE8813VG
Measurement or general use	1000 hrs.	$T_j \leq P_O$ 100°C	F(t) = 0.1%, $\Delta P_O \leq 30\%$	HE8811, HE8812SG, HE8404SG, HE7601SG
Industrial use	10000 hrs.	$T_j \leq$ 100°C	F(t) = 1%, $\Delta P_O \leq 50\%$	HE8807 series

Section 7 Purchasing Hitachi

7.1 Price and Delivery

For information on price and delivery, please check with your Hitachi representative.

HL6312/13G

AlGaInP Laser Diodes

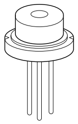
Description

The HL6312/13G are 0.63 µm band AlGalnP laser diodes with a multi-quantum well (MQW) structure. Wavelength is equal to He-Ne Gas laser. They are suitable as light sources in bar code readers , laser levelers and various other types of optical equipment. Hermetic sealing of the package achieves high reliability.

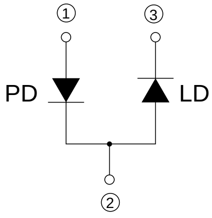
Features

- Visible light output: λ_p = 635 nm Typ. (nearly equal to He-Ne Gas Laser)
- Optical output power: 5 mW CW
- Low Operating voltage: 2.7 V Max.
- Single longitudinal mode.
- Built-in photodiode for monitoring laser output.

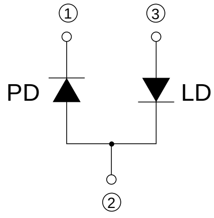
Package Type
- HL6312/13G: G2



Internal Circuit
- HL6312G



Internal Circuit
- HL6313G



Absolute Maximum Ratings (T_C = 25°C)

Item	Symbol	Rated Value	Unit
Optical output power	P_O	5	mW
Pulse optical output power	$P_{O\ (pulse)}$	6*1	mW
LD reverse voltage	$V_{R\ (LD)}$	2	V
PD reverse voltage	$V_{R\ (PD)}$	30	V
Operating temperature	T_{opr}	–10 to +50	°C
Storage temperature	T_{stg}	–40 to +85	°C

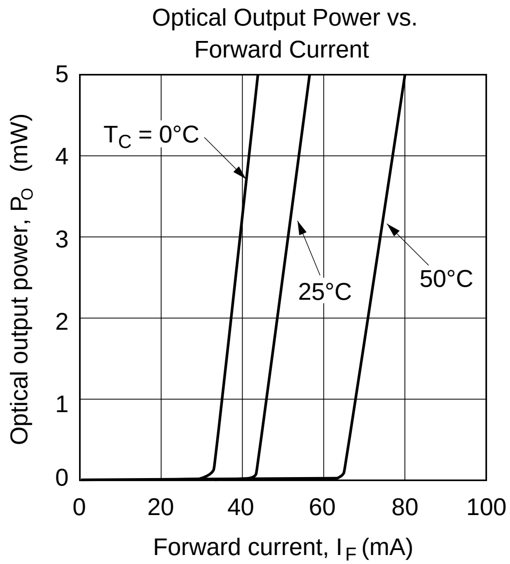
Note: 1. Pulse condition: Pulse width ≤1µs, duty ≤50%

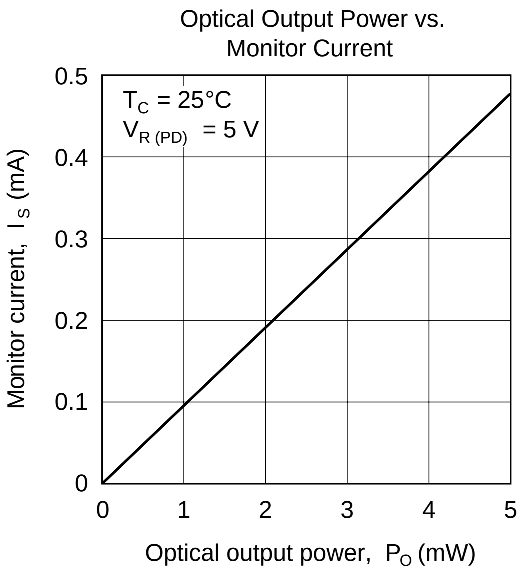
HL6312/13G

Optical and Electrical Characteristics (T_C = 25°C)

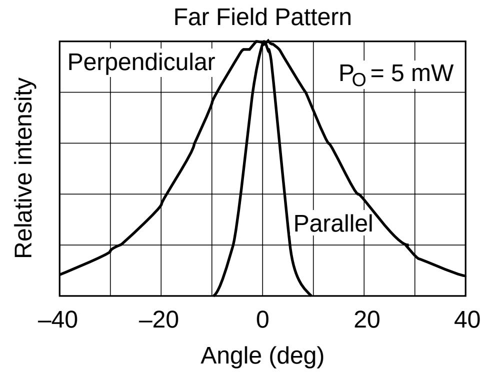
Item	Symbol	Min	Typ	Max	Unit	Test Conditions
Optical output power	P_O	5	—	—	mW	Kink free
Threshold current	I_{th}	20	45	70	mA	
Operating current	I_{op}	—	55	85	mA	P_O = 5 mW
Operating voltage	V_{op}	—	—	2.7	V	P_O = 5 mW
Lasing wavelength	λ_p	625	635	640	nm	P_O = 5 mW
Beam divergence (parallel)	$\theta_{//}$	5	8	11	deg.	P_O = 5 mW
Beam divergence (perpendicular)	$\theta_{\perp}$	25	31	37	deg.	P_O = 5 mW
Monitor current	I_S	0.2	0.4	0.8	mA	P_O = 5 mW, V_R = 5 V

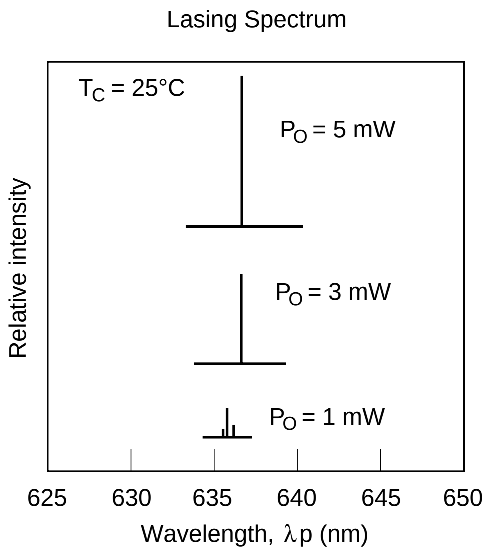
Typical Characteristic Curves

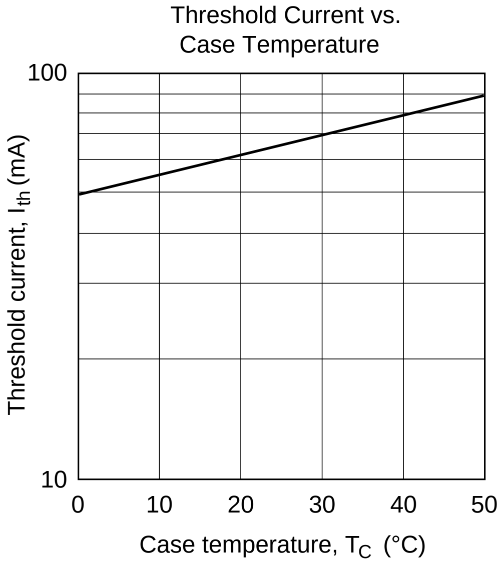


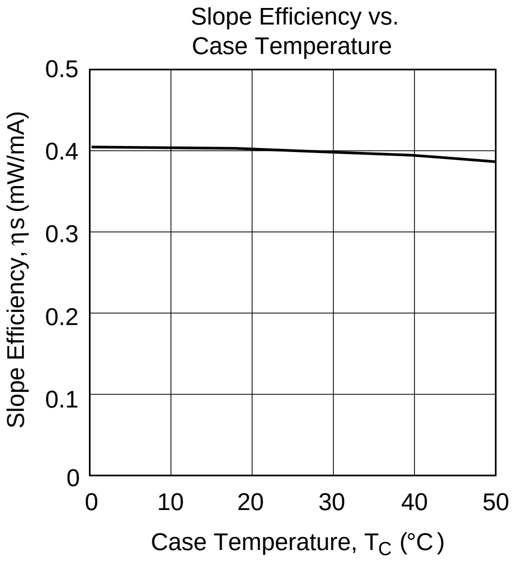


Typical Characteristic Curves (cont)

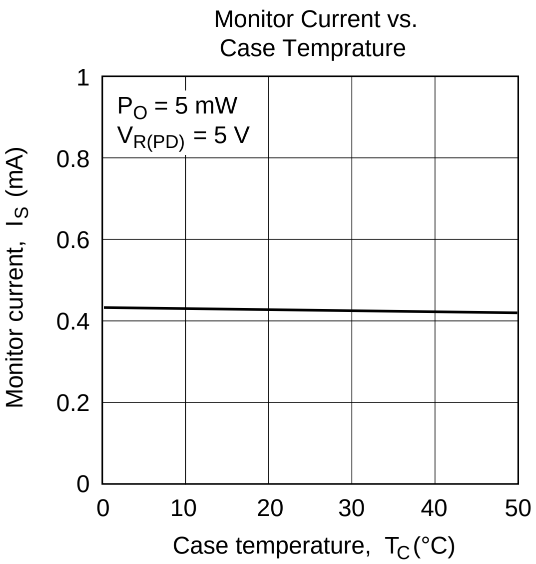


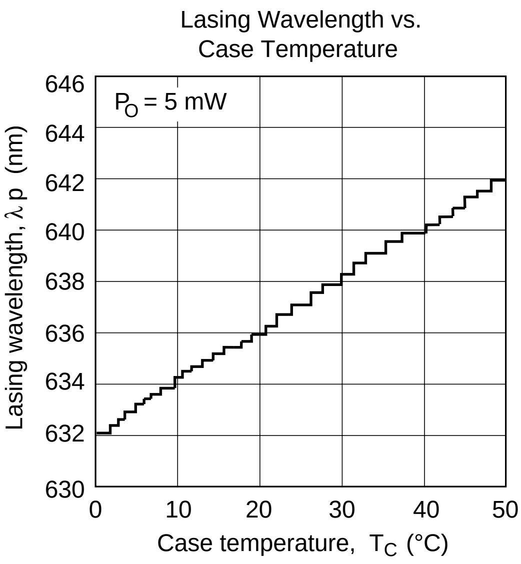


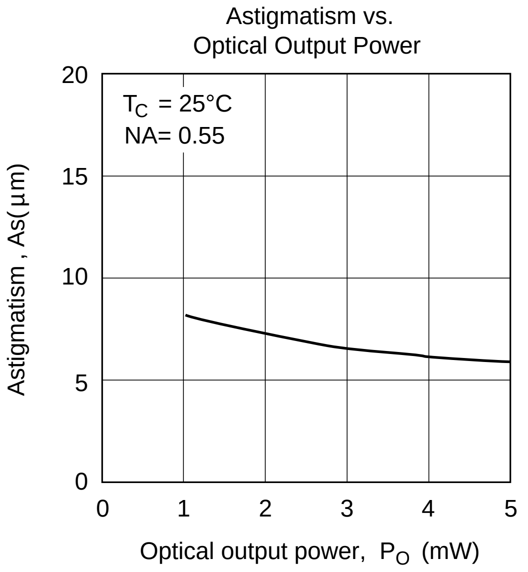


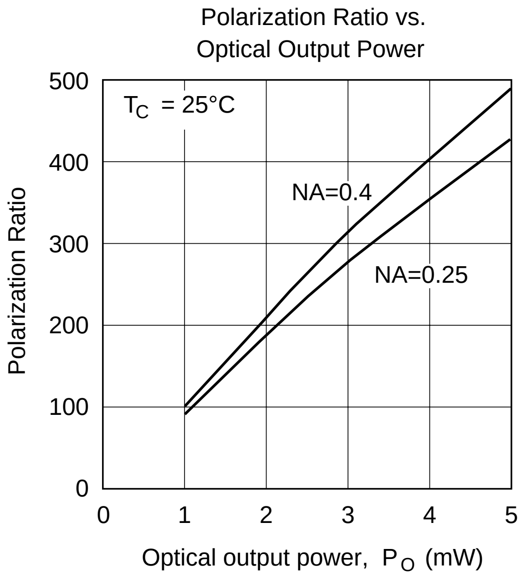


Typical Characteristic Curves (cont)



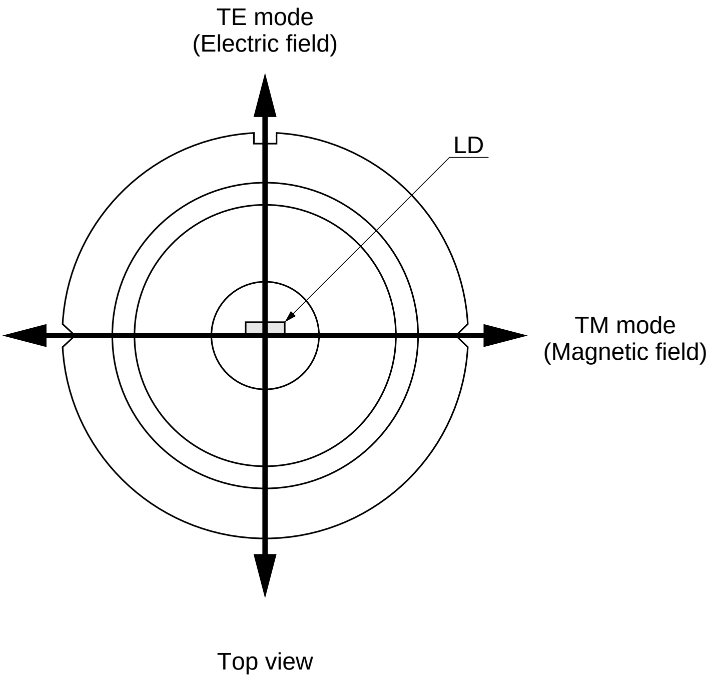






Polarization direction

The polarization direction of 0.63 µm LD’s is different from that of 0.83/0.78/0.67 µm LD’s.
The polarization direction of 0.63 µm LD’s is illustrated in the figure below.



HL6314MG

AlGaInP Laser Diode

Description

The HL6314MG is a 0.63 µm band AlGalnP laser diode with a multi-quantum well (MQW) structure. It is suitable as a light source for laser poiters and optical equipment for amusement.

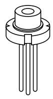
Application

- Laser pointer

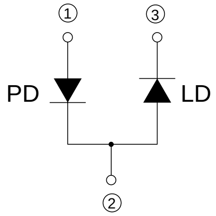
Features

- Visible light output: 635nm typ.
  (nearly equal to He-Ne gas laser)
- Optical output power: 3 mW CW
- Low operating current: 30 mA typ.
- Low operating voltage: 2.7 V max.,

Package Type
- HL6314MG: MG



Internal Circuit
- HL6314MG



Absolute Maximum Ratings (T_C = 25°C)

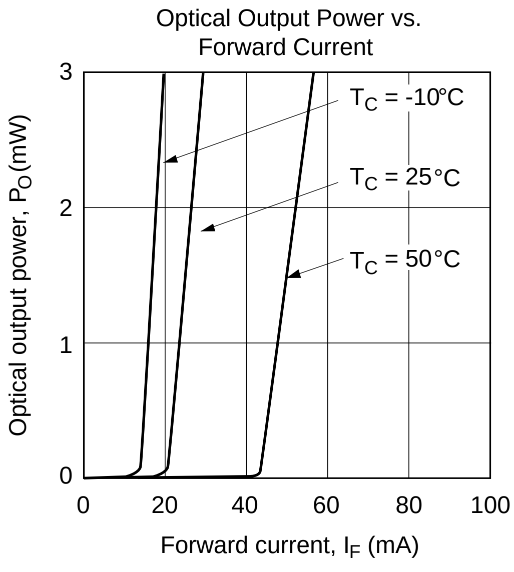
Item	Symbol	Rated Value	Unit
Optical output power	P_O	3	mW
Pulse optical output power	$P_{O\ (pulse)}$	5^{*1}	mW
LD reverse voltage	$V_{R\ (LD)}$	2	V
PD reverse voltage	$V_{R\ (PD)}$	30	V
Operating temperature	T_{opr}	–10 to +50	°C
Storage temperature	T_{stg}	–40 to +85	°C

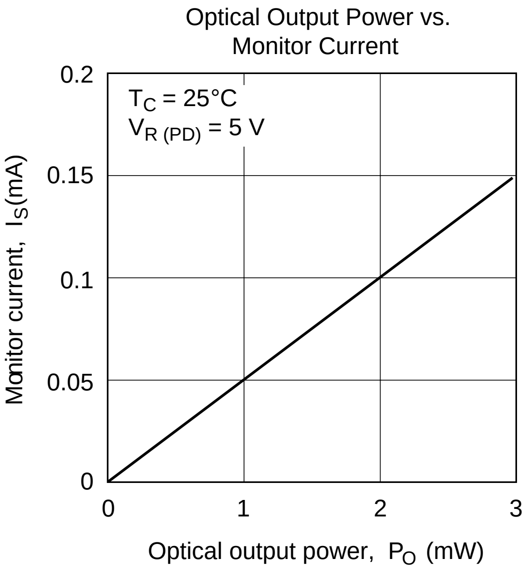
Note: 1. Pulse condition: Pulse width ≤1µs, duty ≤50%

Optical and Electrical Characteristics (T_C = 25°C)

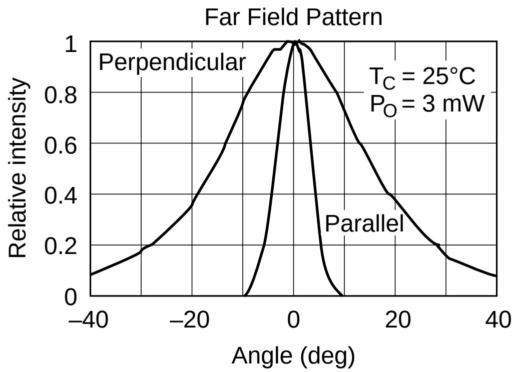
Item	Symbol	Min	Typ	Max	Unit	Test Conditions
Optical output power	P_O	3	—	—	mW	Kink free
Threshold current	I_{th}	—	25	—	mA	
Operating current	I_{op}	—	30	—	mA	P_O = 3 mW
Operating voltage	V_{op}	—	—	2.7	V	P_O = 3 mW
Lasing wavelength	λ_p	630	635	640	nm	P_O = 3 mW
Beam divergence (parallel)	$\theta_{//}$	6	8	10	deg.	P_O = 3 mW
Beam divergence (perpendicular)	$\theta_{\perp}$	23	30	39	deg.	P_O = 3 mW
Monitor current	I_S	—	0.15	—	mA	P_O = 3 mW, $V_{R(PD)}$ = 5 V

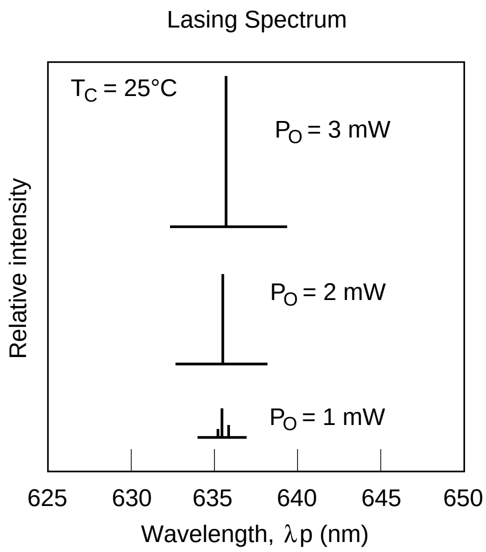
Typical Characteristic Curves

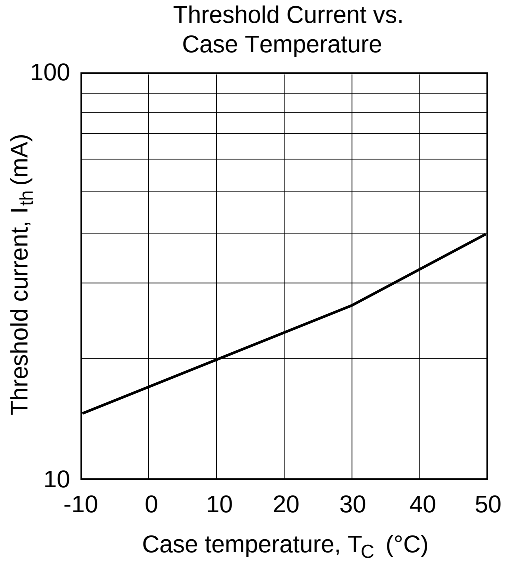


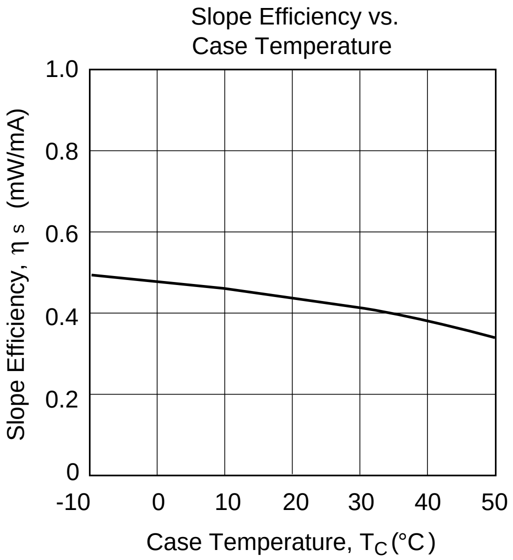


Typical Characteristic Curves (cont)



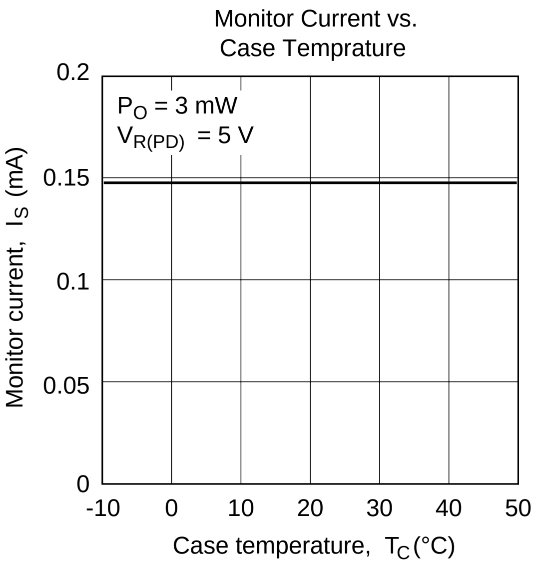


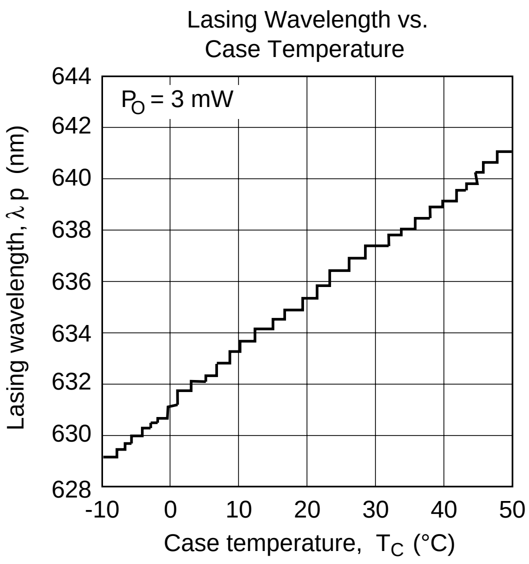


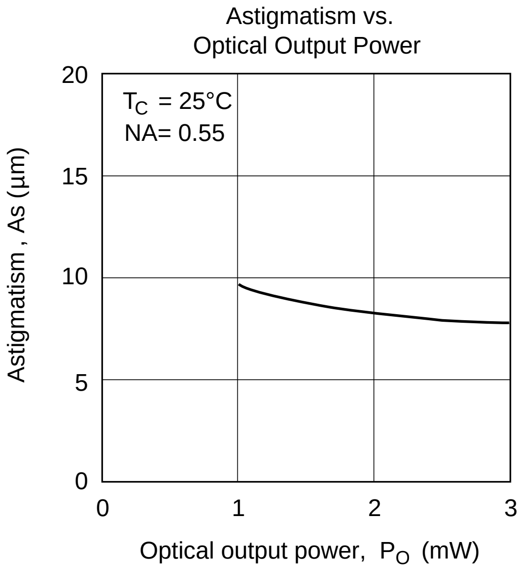


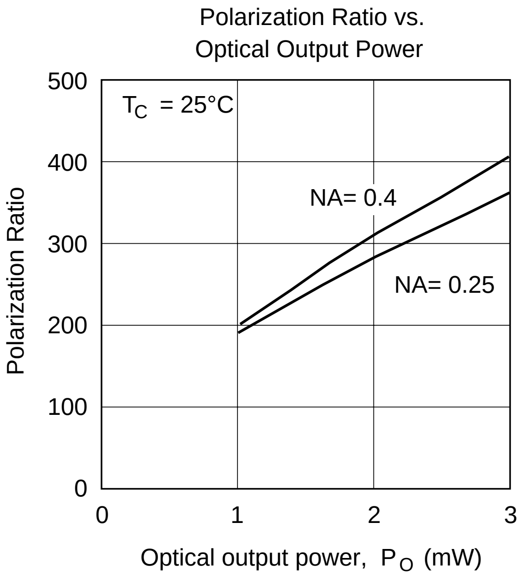
 HL6314MG

Typical Characteristic Curves (cont)









Polarization direction

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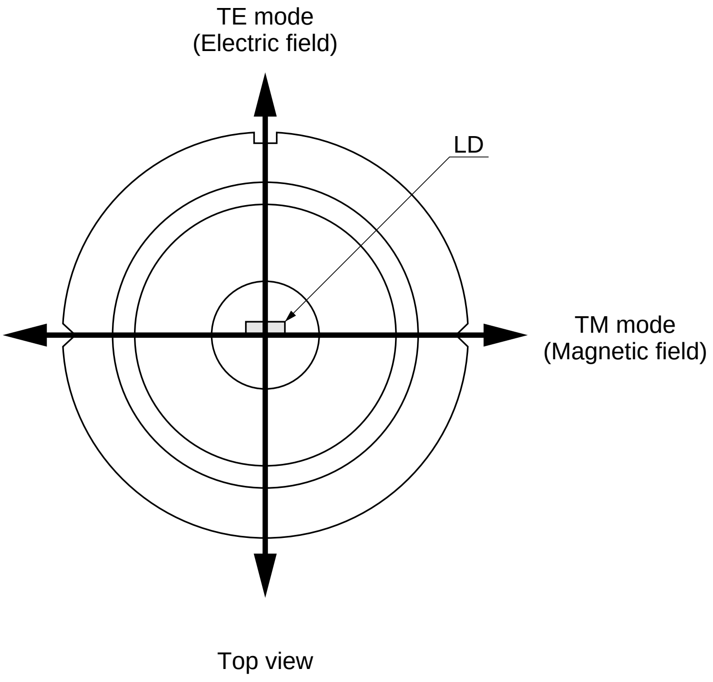
The polarization direction of 0.63 µm LD’s is illustrated in the figure below.



HL6315/16G

AlGaInP Laser Diodes

Description

The HL6315/16G are 0.63 µm band AlGaInP laser diodes with a multi-quantum well (MQW) structure. They are suitable as light sources for laser pointers and optical equipment.

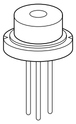
Application

- Laser pointer

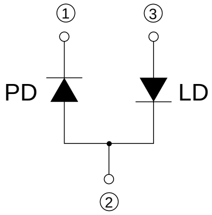
Features

- Visible light output: 635 nm Typ.
  (nearly equal to He-Ne Gas Laser)
- Optical output power: 3 mW CW
- Low Operating current: 30mA typ.
- Low Operating voltage: 2.7 V Max.

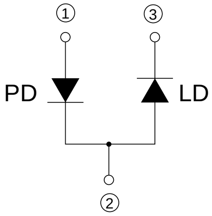
Package Type
- HL6315/16G: G2



Internal Circuit
- HL6315G



InternalCircuit
- HL6316G



Absolute Maximum Ratings (T_C = 25°C)

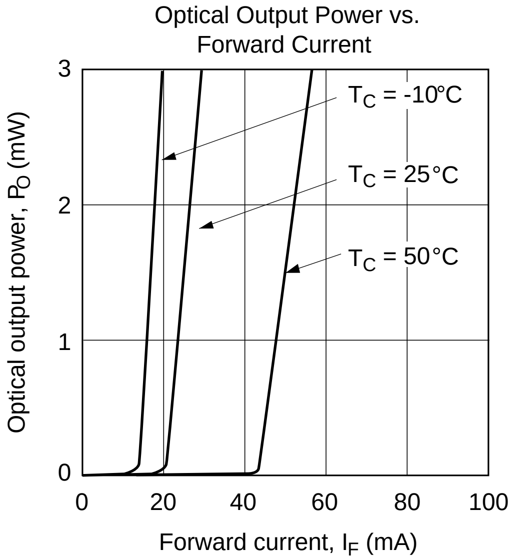
Item	Symbol	Rated Value	Unit
Optical output power	P_O	3	mW
Pulse optical output power	$P_{O\ (pulse)}$	5*1	mW
LD reverse voltage	$V_{R\ (LD)}$	2	V
PD reverse voltage	$V_{R\ (PD)}$	30	V
Operating temperature	T_{opr}	–10 to +50	°C
Storage temperature	T_{stg}	–40 to +85	°C

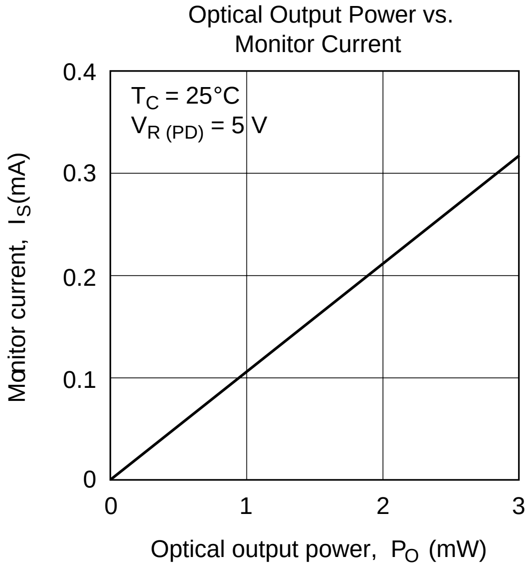
Note: 1. Pulse condition: Pulse width ≤1µs, duty ≤50%

Optical and Electrical Characteristics (T_C = 25°C)

Item	Symbol	Min	Typ	Max	Unit	Test Conditions
Optical output power	P_O	3	—	—	mW	Kink free
Threshold current	I_{th}	—	25	—	mA	
Operating current	I_{op}	—	30	—	mA	P_O = 3 mW
Operating voltage	V_{op}	—	—	2.7	V	P_O = 3 mW
Lasing wavelength	λ_p	630	635	640	nm	P_O = 3 mW
Beam divergence (parallel)	$\theta_{//}$	6	8	10	deg.	P_O = 3 mW
Beam divergence (perpendicular)	$\theta_{\perp}$	23	30	39	deg.	P_O = 3 mW
Monitor current	I_S	—	0.3	—	mA	P_O = 3 mW, V_R = 5 V

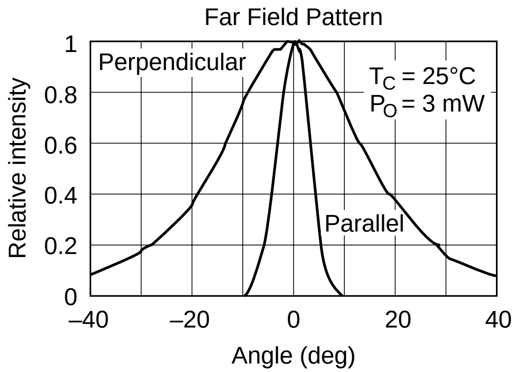
Typical Characteristic Curves

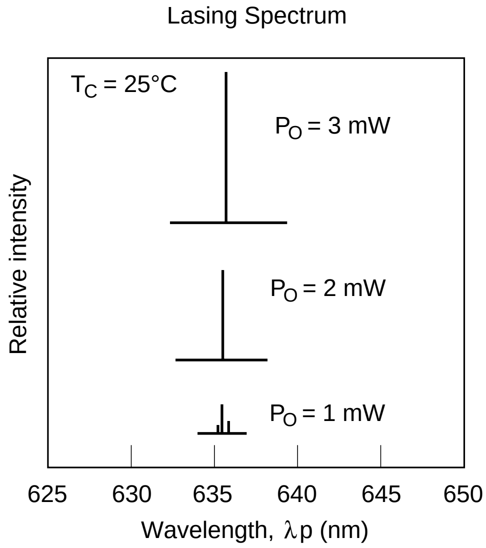


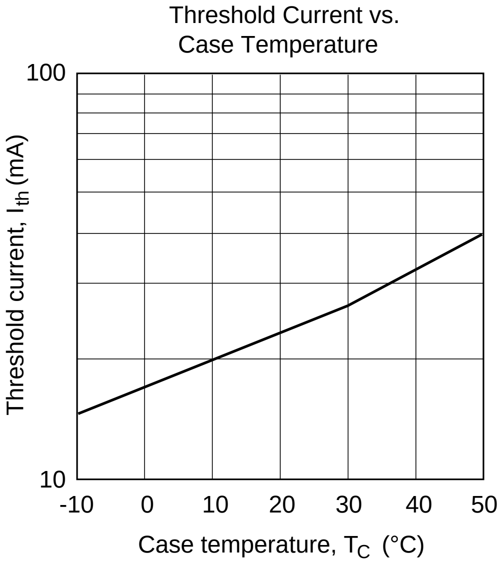


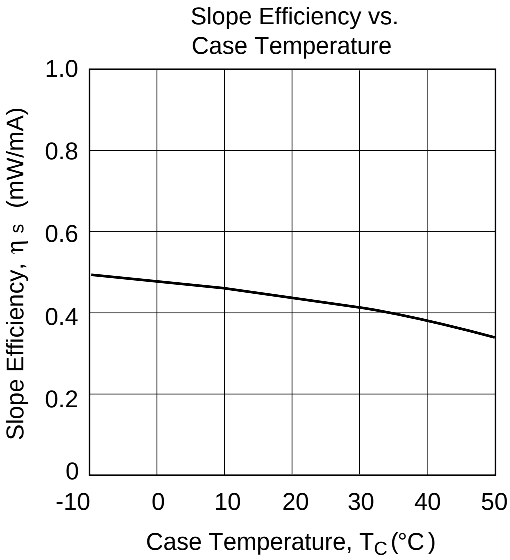
HL6315/16G

Typical Characteristic Curves (cont)



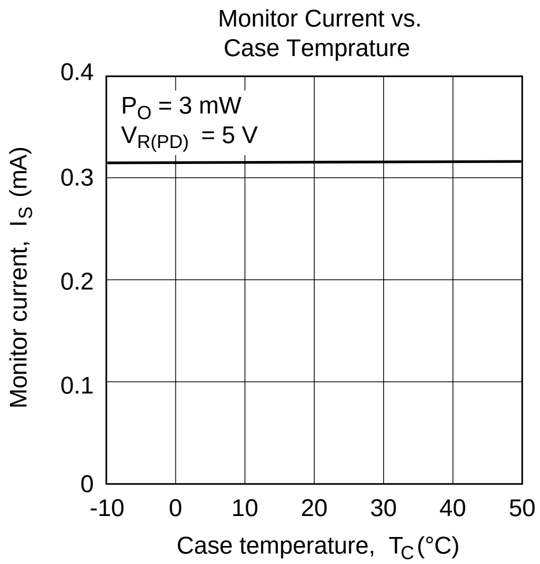


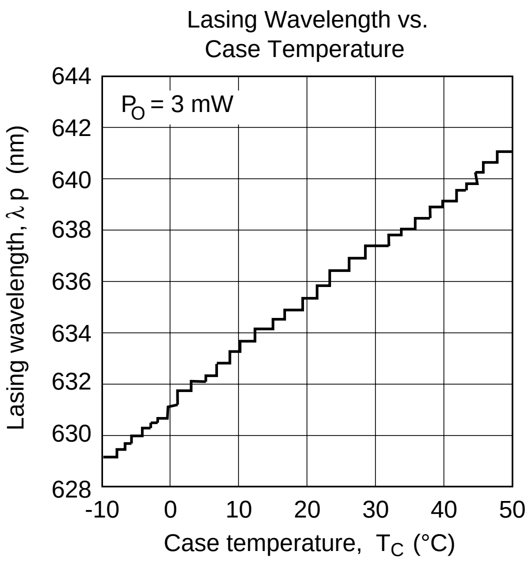


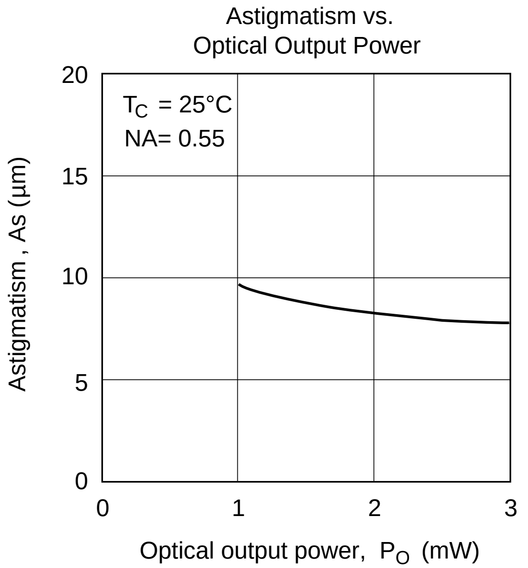


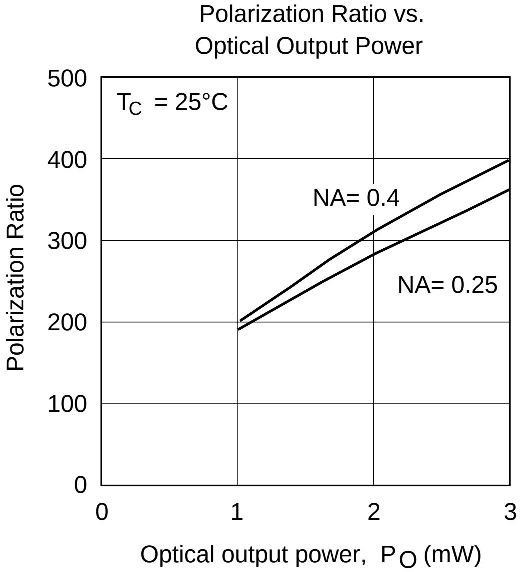
 HL6315/16G

Typical Characteristic Curves (cont)



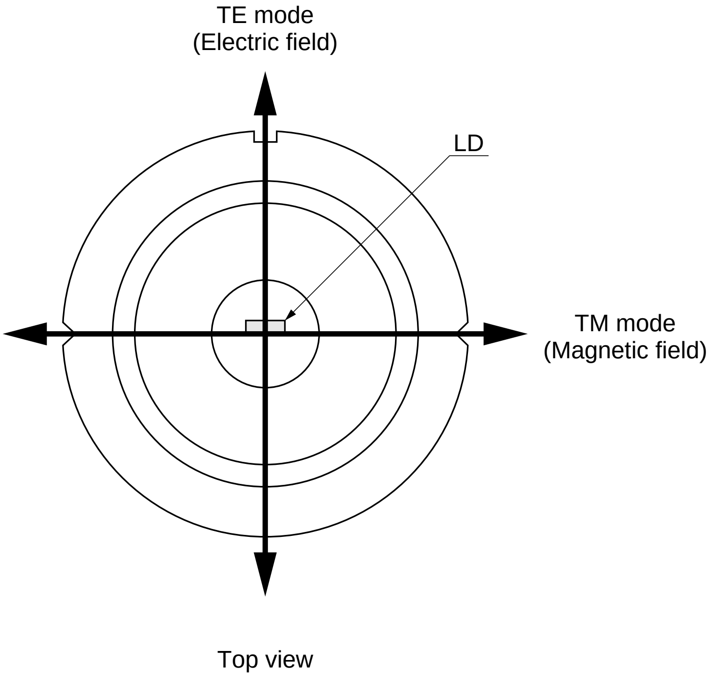






Polarization direction

The polarization of 0.63 µm LD’s is different from that of 0.83/0.78/0.67 µm LD’s.
The polarization direction of 0.63 µm LD’s is illustrated in the figure below.



HL6319G

InGaAsP Laser Diodes

HITACHI

ADE-208-479C (Z)
4th. Edition
August 1997

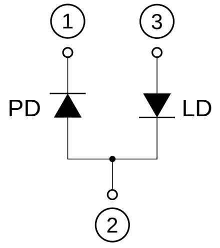
Application

- Laser levelers
- Measurement

Features

- Optical power : 10mW CW
- Visible wavelength : λp=635nm Typ

Internal Circuit



Hitachi semiconductor

Absolute Maximum Ratings (T_C = 25°C)

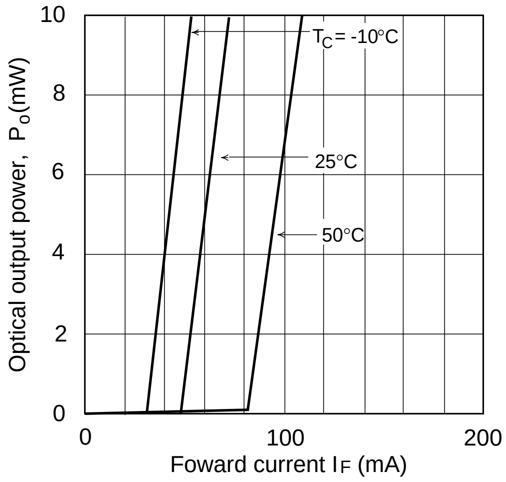
Item	Symbol	Value	Unit
Optical output power	P_O	10	mW
LD reverse voltage	$V_{R(LD)}$	2	V
PD reverse voltage	$V_{R(PD)}$	30	V
Operating temperature	Topr	–10 to +50	°C
Storage temperature	Tstg	–40 to +85	°C

Optical and Electrical Characteristics (T_C = 25°C)

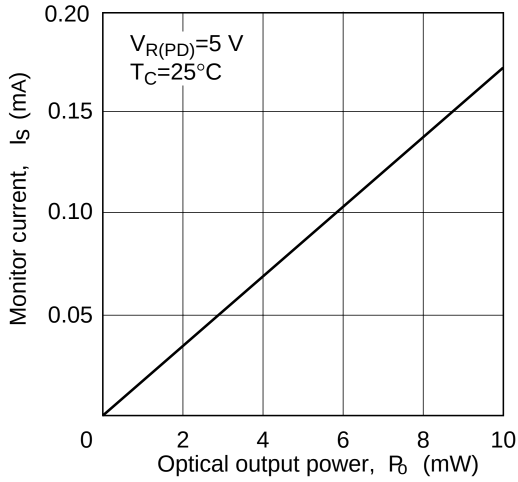
Item	Symbol	Min	Typ	Max	Unit	Test Conditions
Optical output power	P_O	10	—	—	mW	Kink free
Threshold current	Ith	20	—	75	mA	
Operating current	I_{OP}	—	—	95	mA	P_O = 10 mW
Operating voltage	V_{OP}	—	—	2.7	V	P_O = 10 mW
Slope efficiency	ηs	0.3	—	0.7	mW/mA	6(mW)/(I(8mW)–I(2mW))
Lasing wavelength	λp	625	635	640	nm	P_O = 10 mW
Beam divergence (parallel)	θ//	5	8	11	deg.	P_O = 10mW
Beam divergence (perpendicular)	θ⊥	25	31	37	deg.	P_O = 10 mW
Monitor current	Is	0.05	0.17	0.30	mA	P_O = 10mW, $V_{R(PD)}$=5V

Typical Characteristics Curves

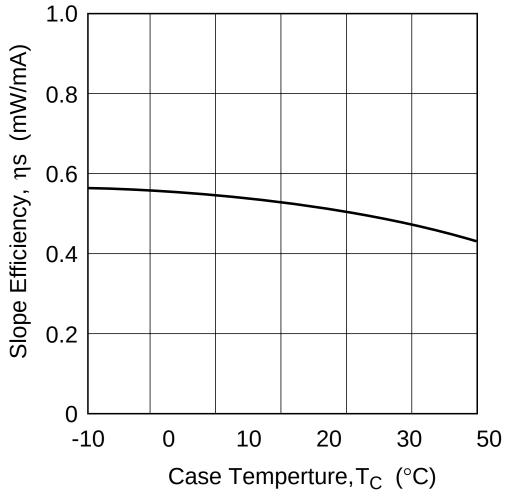
Optical Output Power vs.Foward Current



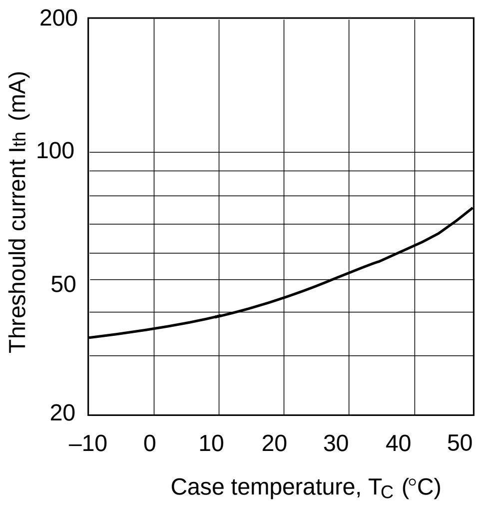
Optical Output Power vs.Monitor Current



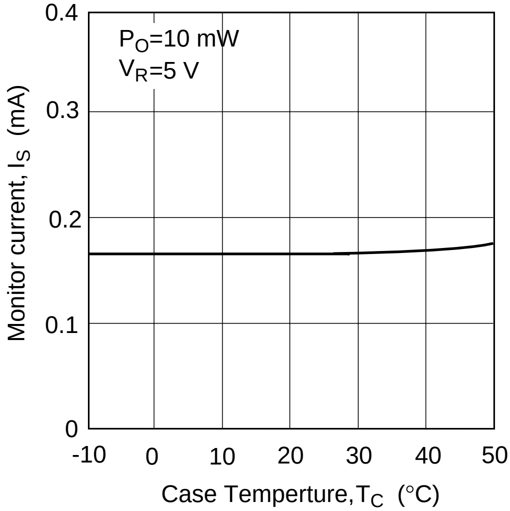
Slope Efficiency vs.Case Temperature



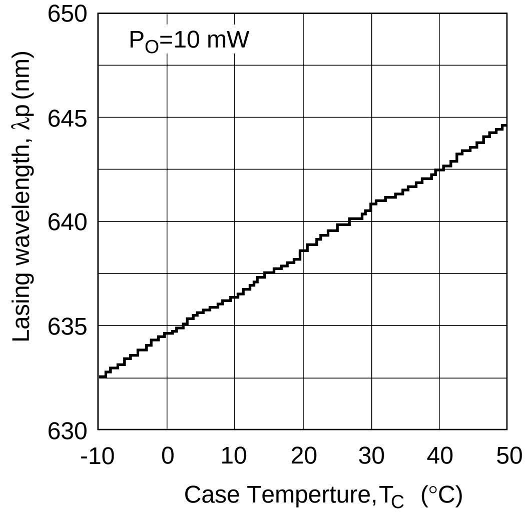
Threshold Current vs.Case Temperature



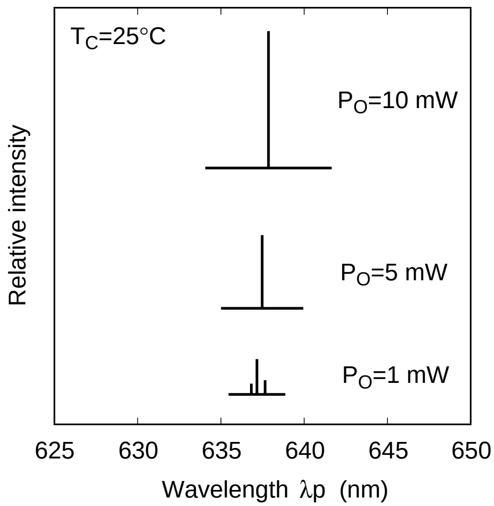
Monitor Current vs. Case Temprature



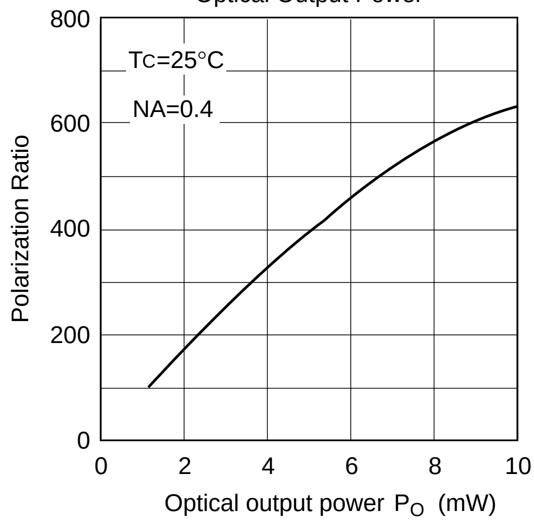
Lasing Wavelength vs. Case Temperature

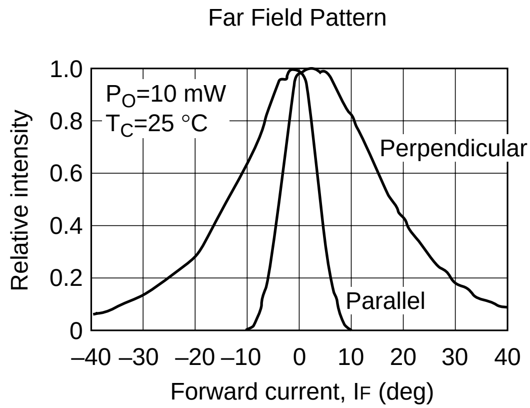


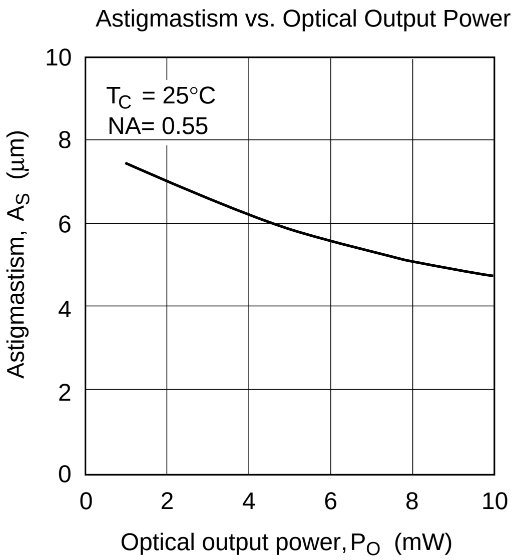
Lasing Spectrum

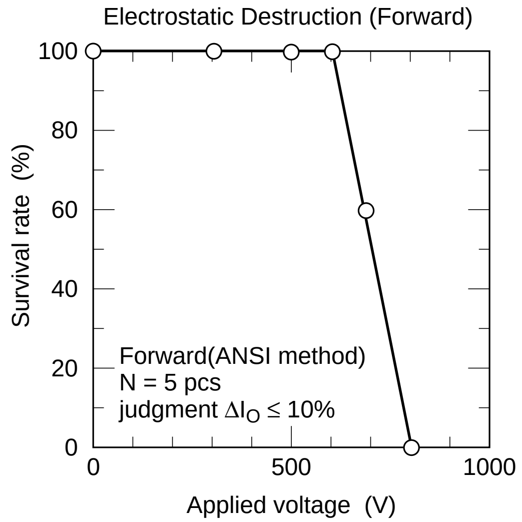


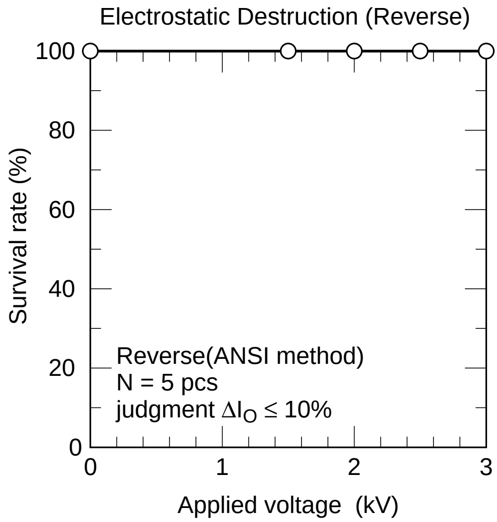
Polarization Ratio vs.
Optical Output Power




Far Field Pattern
PO=10 mW
TC=25 °C
Perpendicular
Parallel
Relative intensity
1.0
0.8
0.6
0.4
0.2
0
–40 –30 –20 –10 0 10 20 30 40
Forward current, IF (deg)

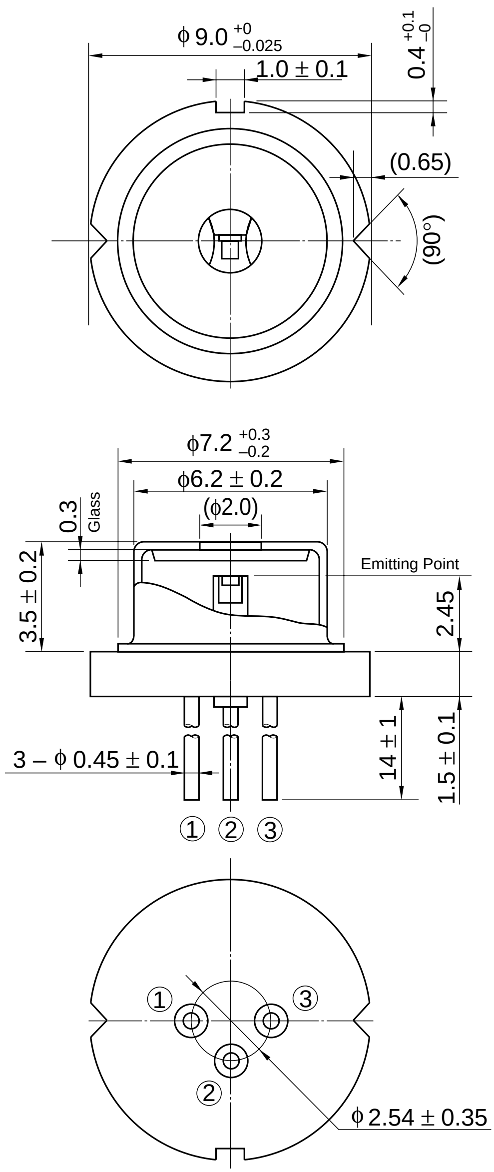

Astigmastism vs. Optical Output Power
TC = 25°C
NA= 0.55
Astigmastism, AS (µm)
10
8
6
4
2
0
0 2 4 6 8 10
Optical output power, PO (mW)

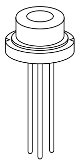

Electrostatic Destruction (Forward)
Survival rate (%)
100
80
60
40
20
0
Forward(ANSI method)
N = 5 pcs
judgment ΔIO ≤ 10%
0 500 1000
Applied voltage (V)


Electrostatic Destruction (Reverse)
Survival rate (%)
100
80
60
40
20
0
Reverse(ANSI method)
N = 5 pcs
judgment ΔIO ≤ 10%
0 1 2 3
Applied voltage (kV)

Package Dimensions

Unit: mm





Hitachi Code	LD/G1
JEDEC Code	—
EIAJ Code	—
Weight	1.1 g

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Harbour City, Canton Road
Tsim Sha Tsui, Kowloon
Hong Kong
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Fax: 27306071

HL6320G

InGaAsP Laser Diodes

HITACHI

ADE-208-502B (Z)
3rd.Edition
August 1997

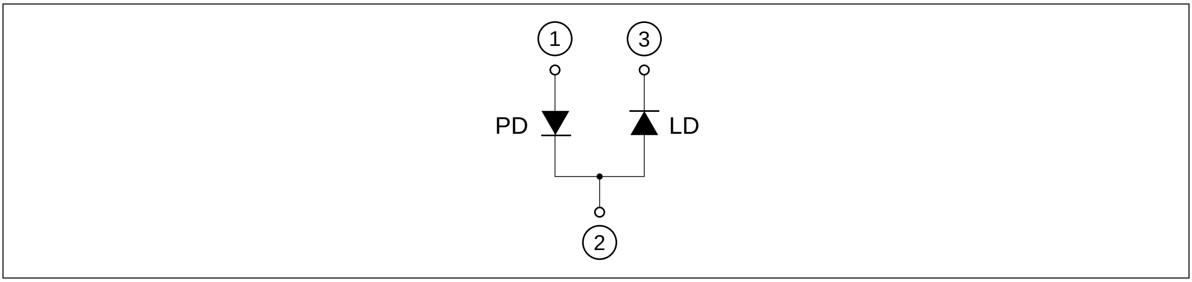
Application

- Laser levelers
- Measurement

Features

- Optical power : 10mW CW
- Visible wavelength : λp=635nm Typ

Internal Circuit



Hitachi semiconductor

Absolute Maximum Ratings (T_C = 25°C)

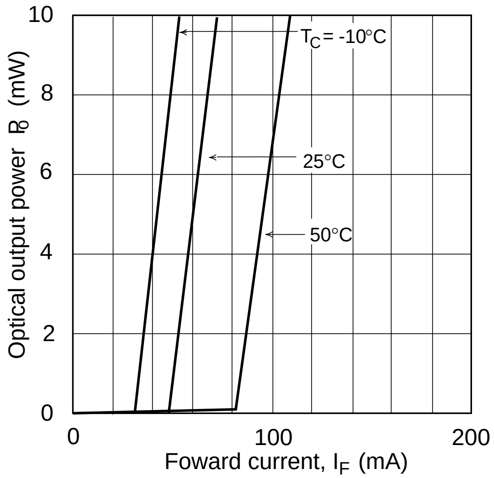
Item	Symbol	Value	Unit
Optical output power	P_O	10	mW
LD reverse voltage	$V_{R(LD)}$	2	V
PD reverse voltage	$V_{R(PD)}$	30	V
Operating temperature	Topr	–10 to +50	°C
Storage temperature	Tstg	–40 to +85	°C

Optical and Electrical Characteristics (T_C = 25°C)

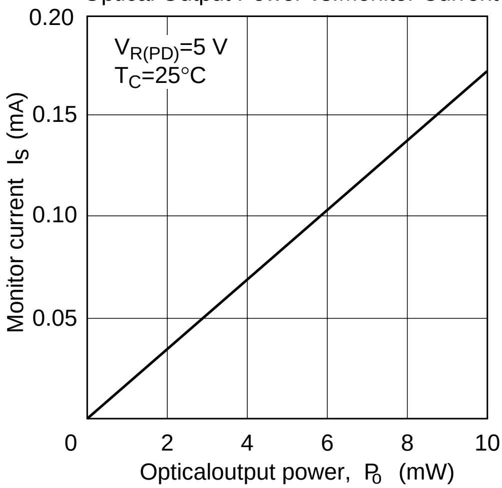
Item	Symbol	Min	Typ	Max	Unit	Test Conditions
Optical output power	P_O	10	—	—	mW	Kink free
Threshold current	Ith	20	—	75	mA	
Operating current	I_{OP}	—	—	95	mA	P_O = 10 mW
Operating voltage	V_{OP}	—	—	2.7	V	P_O = 10 mW
Slope efficiency	ηs	0.3	—	0.7	mW/mA	6(mW)/(I(8mW)–I(2mW))
Lasing wavelength	λp	625	635	640	nm	P_O = 10 mW
Beam divergence (parallel)	θ//	5	8	11	deg.	P_O = 10mW
Beam divergence (perpendicular)	θ⊥	25	31	37	deg.	P_O = 10 mW
Monitor current	Is	0.05	0.17	0.30	mA	P_O = 10mW, $V_{R(PD)}$=5V

Typical Characteristics Curves

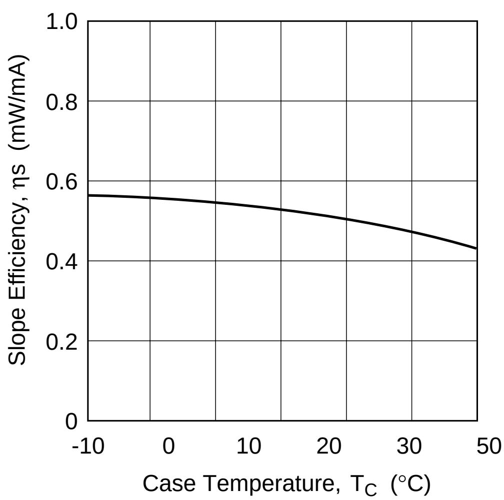
Optical Output Power vs. Forward Current



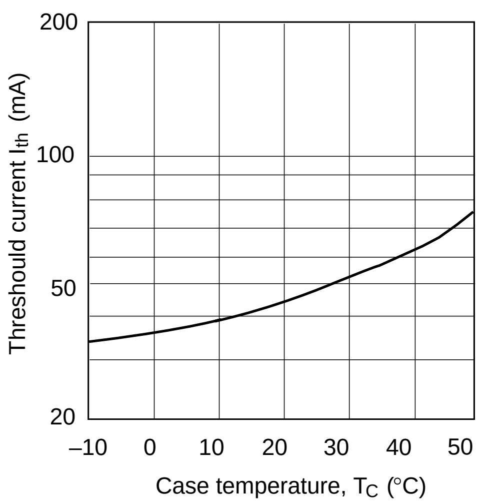
Optical Output Power vs.Monitor Current



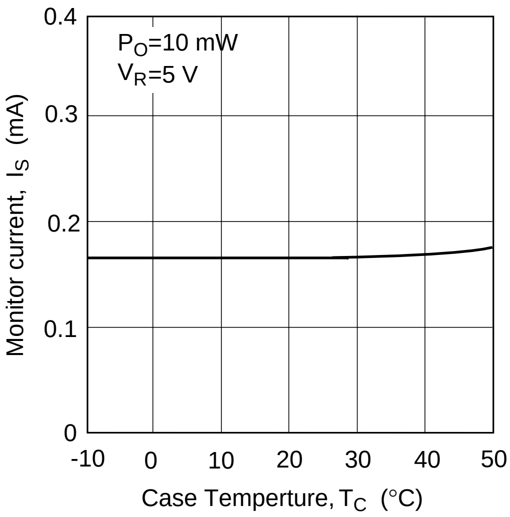
Slope Efficiency vs. Case Temperature



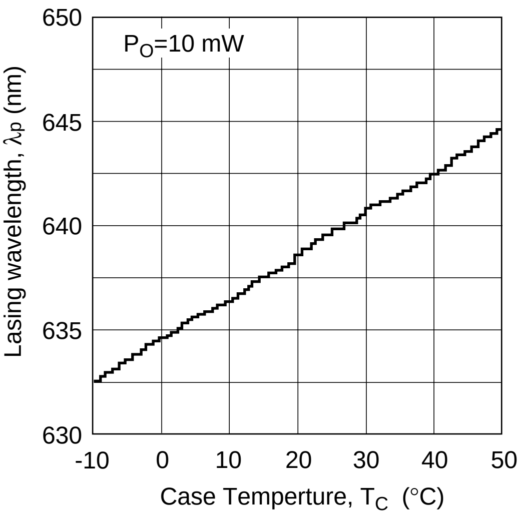
Threshold Current vs. Case Temperature



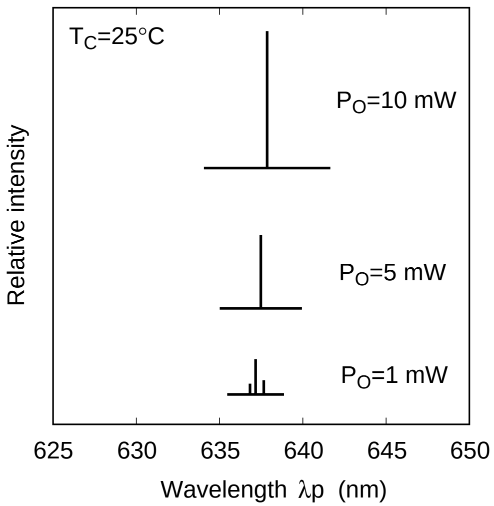
Monitor Current vs.Case Temprature



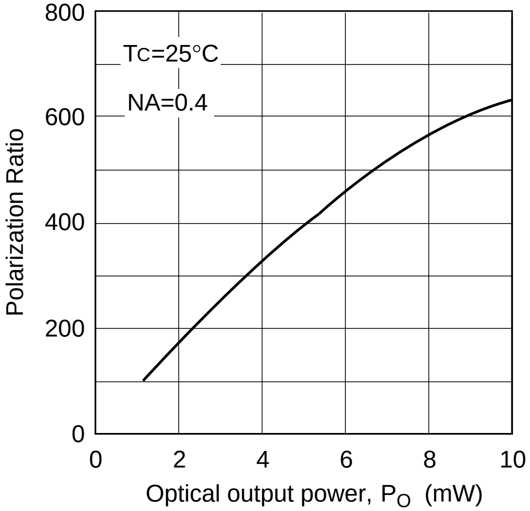
Lasing Wavelength vs.Case Temperature

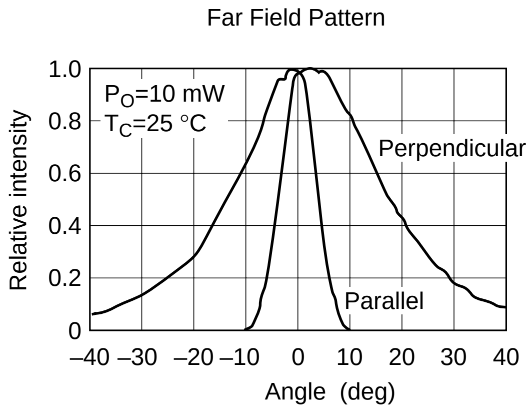


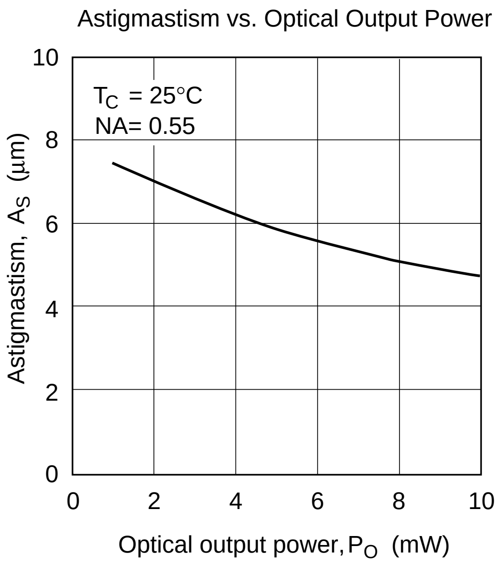
Lasing Spectrum

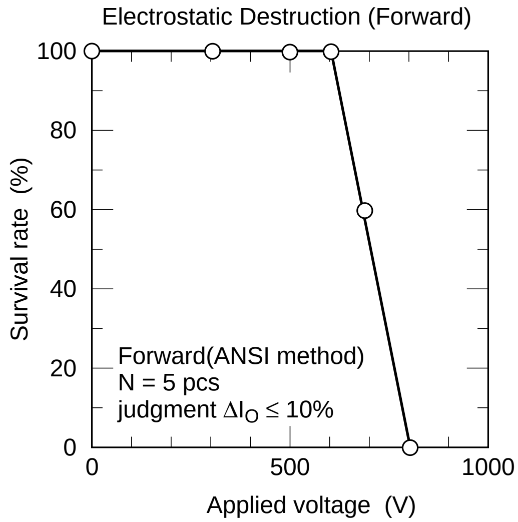


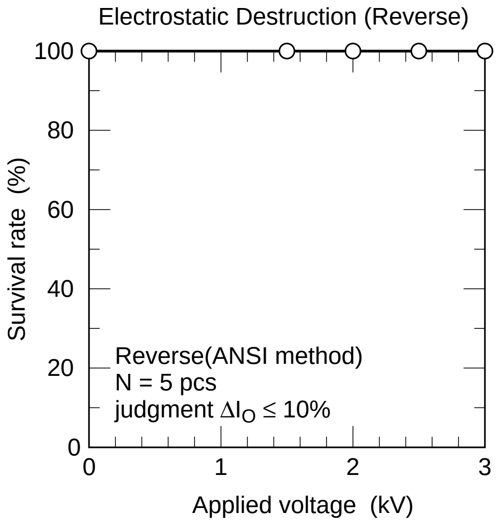
Polarization Ratio vs.
Optical Output power




Far Field Pattern
Relative intensity
1.0
0.8
0.6
0.4
0.2
0
PO=10 mW
TC=25 °C
Perpendicular
Parallel
–40 –30 –20 –10 0 10 20 30 40
Angle (deg)

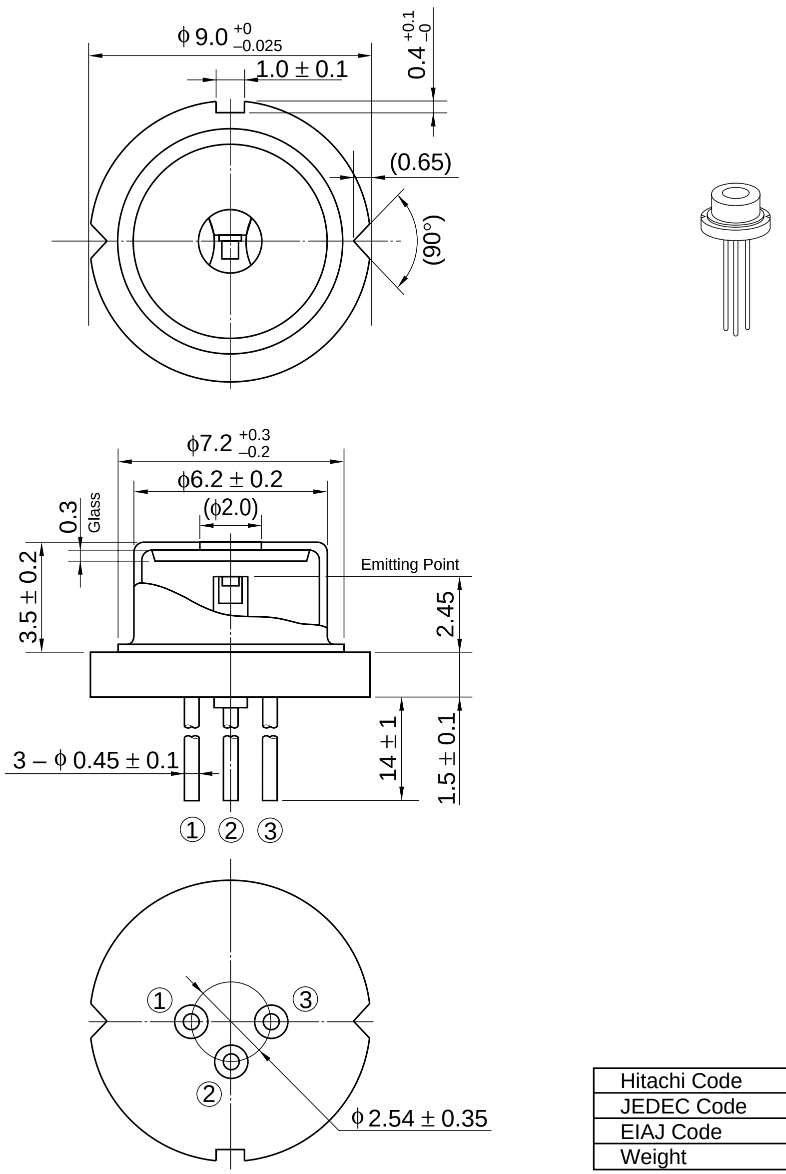

Astigmastism vs. Optical Output Power
TC = 25°C
NA= 0.55
Astigmastism, AS (µm)
10
8
6
4
2
0
0 2 4 6 8 10
Optical output power, PO (mW)


Electrostatic Destruction (Forward)
Survival rate (%)
100
80
60
40
20
0
Forward(ANSI method)
N = 5 pcs
judgment ΔIO ≤ 10%
0 500 1000
Applied voltage (V)


Electrostatic Destruction (Reverse)
Survival rate (%)
100
80
60
40
20
0
Reverse(ANSI method)
N = 5 pcs
judgment ΔIO ≤ 10%
0 1 2 3
Applied voltage (kV)

Package Dimensions

Unit: mm



Hitachi Code	LD/G1
JEDEC Code	—
EIAJ Code	—
Weight	1.1 g

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Harbour City, Canton Road
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Hong Kong
Tel: 27359218
Fax: 27306071

HL6321G

AlGaInP Laser Diodes

HITACHI

ADE-208-598 (Z)
Preliminary
1st Edition
Jan. 1998

Description

The HL6321G are 0.63 µm band AlGaInP laser diodes with a multi-quantum well (MQW) structure.They are suitable as light sources for laser levelers and optical equipment for measurement.

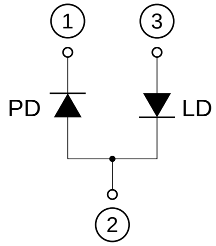
Application

- Laser levelers
- Measurement

Features

- Visible light output : 635 nm Typ (nearly equal to He-Ne gas laser)
- Optical output power : 15 mW CW
- Low operating current : 105 mA Max
- Low operating voltage : 2.7 V Max

Internal Circuit



Hitachi semiconductor

Absolute Maximum Ratings (T_C = 25°C)

Item	Symbol	Value	Unit
Optical output power	P_O	15	mW
LD reverse voltage	$V_{R(LD)}$	2	V
PD reverse voltage	$V_{R(PD)}$	30	V
Operating temperature	Topr	–10 to +50	°C
Storage temperature	Tstg	–40 to +85	°C

Optical and Electrical Characteristics (T_C = 25°C)

Items	Symbols	Min	Typ	Max	Units	Test Conditions
Optical output power	P_O	15	—	—	mW	Kink free *
Threshold current	Ith	20	—	75	mA	
Operating current	I_{Op}	—	—	105	mA	P_O = 15 mW
Operating voltage	V_{OP}	—	—	2.7	V	P_O = 15 mW
Slope efficiency	ηs	0.3	—	0.7	mW/mA	$9(mW)/(I_{(12mW)} - I_{(3mW)})$
Lasing wavelength	λp	625	635	642	nm	P_O = 15 mW
Beam divergence parallel to the junction	θ//	5	8	11	deg.	P_O = 15 mW
Beam divergence parpendicular to the junction	θ⊥	24	30	36	deg.	P_O = 15 mW
Monitor current	I_S	0.07	0.26	0.45	mA	P_O = 15 mW, $V_{R(PD)}$ = 5V

Note: Kink free is confirmed at the temperature of 25°C.

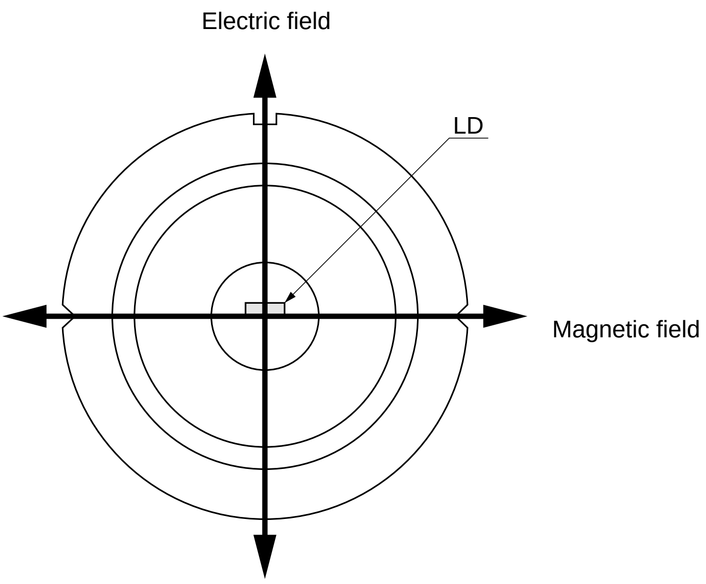
Polarization direction

The polarization direction is TM mode.

The polarization direction of 0.63 μm LD’s is different from that 0.83/0.78/0.67 μm LD’s.

The polarization direction of 0.63 μm LD’s is illustrated in the figure below.

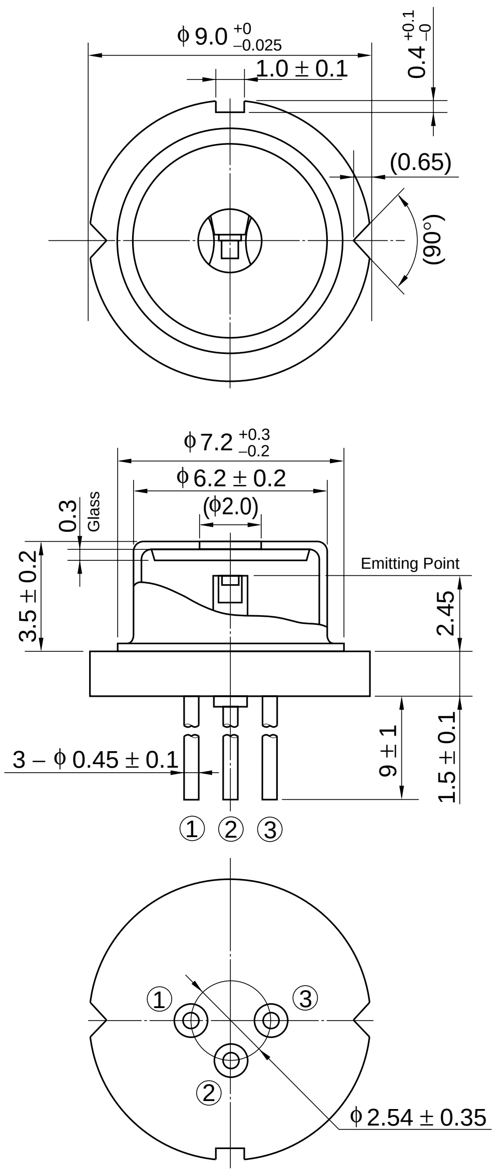
• TM mode

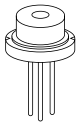


Top view

Package Dimensions

Unit: mm





Hitachi Code	LD/G2
JEDEC	—
EIAJ	—
Weight (reference value)	1.1 g

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HL6322G

AlGaInP Laser Diodes

HITACHI

ADE-208-599 (Z)
Preliminary
1st Edition
Jan. 1998

Description

The HL6322G are 0.63 µm band AlGaInP laser diodes with a multi-quantum well (MQW) structure.They are suitable as light sources for laser levelers and optical equipment for measurement.

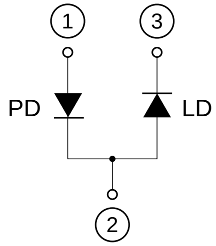
Application

- Laser levelers
- Measurement

Features

- Visible light output : 635 nm Typ (nearly equal to He-Ne gas laser)
- Optical output power : 15 mW CW
- Low operating current : 105 mA Max
- Low operating voltage : 2.7 V Max

Internal Circuit



Hitachi semiconductor

Absolute Maximum Ratings (T_C = 25°C)

Item	Symbol	Value	Unit
Optical output power	P_O	15	mW
LD reverse voltage	$V_{R(LD)}$	2	V
PD reverse voltage	$V_{R(PD)}$	30	V
Operating temperature	Topr	–10 to +50	°C
Storage temperature	Tstg	–40 to +85	°C

Optical and Electrical Characteristics (T_C = 25°C)

Items	Symbols	Min	Typ	Max	Units	Test Conditions
Optical output power	P_O	15	—	—	mW	Kink free *
Threshold current	Ith	20	—	75	mA	
Operating current	I_{Op}	—	—	105	mA	P_O = 15 mW
Operating voltage	V_{OP}	—	—	2.7	V	P_O = 15 mW
Slope efficiency	ηs	0.3	—	0.7	mW/mA	$9(mW)/(I_{(12mW)} - I_{(3mW)})$
Lasing wavelength	λp	625	635	642	nm	P_O = 15 mW
Beam divergence parallel to the junction	θ//	5	8	11	deg.	P_O = 15 mW
Beam divergence parpendicular to the junction	θ⊥	24	30	36	deg.	P_O = 15 mW
Monitor current	I_S	0.07	0.26	0.45	mA	P_O = 15 mW, $V_{R(PD)}$ = 5V

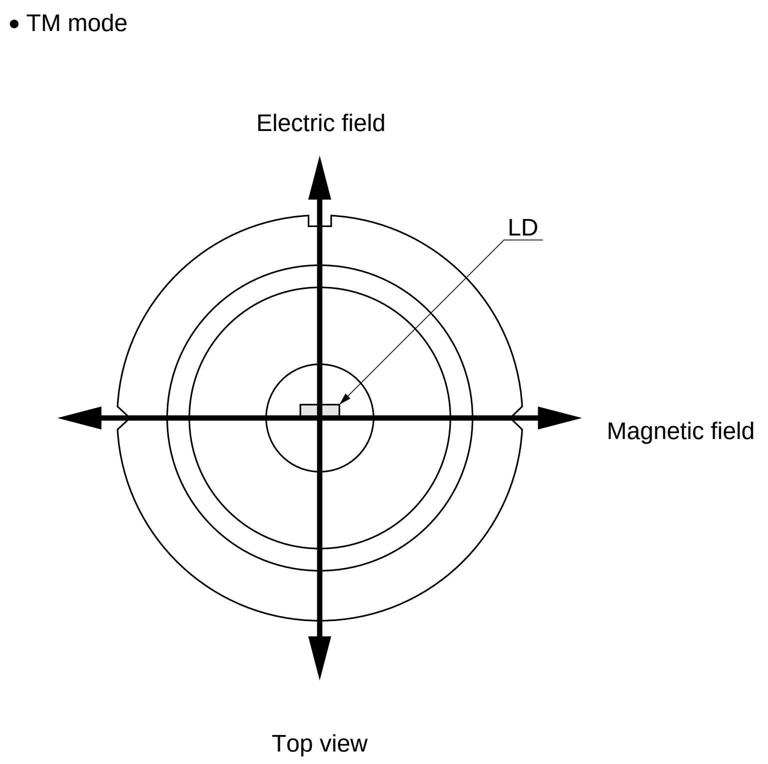
Note: Kink free is confirmed at the temperature of 25°C.

Polarization direction

The polarization direction is TM mode.

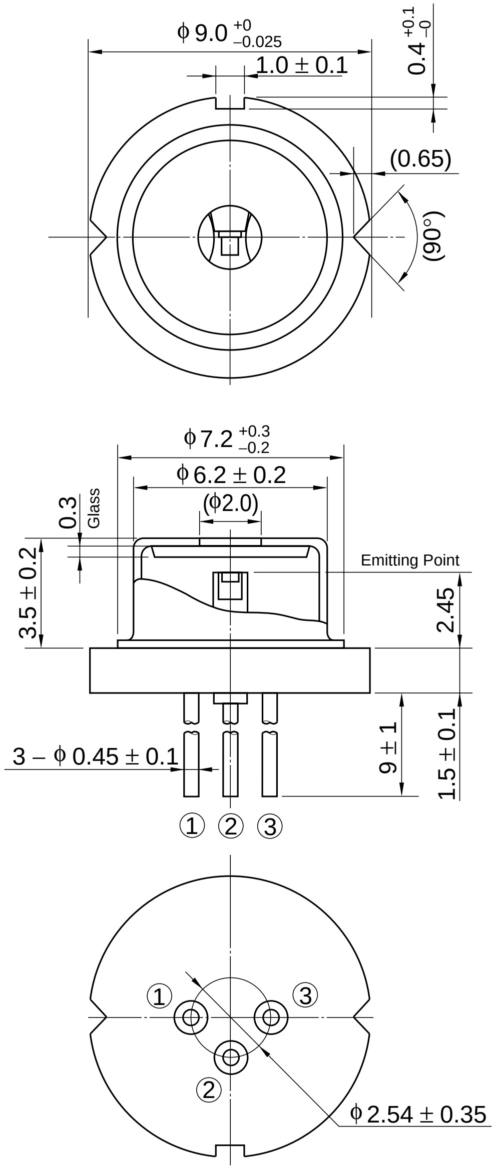
The polarization direction of 0.63 μm LD's is different from that 0.83/0.78/0.67 μm LD's.

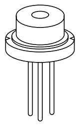
The polarization direction of 0.63 μm LD's is illustrated in the figure below.



Package Dimensions

Unit: mm





Hitachi Code	LD/G2
JEDEC	—
EIAJ	—
Weight (reference value)	1.1 g

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HL6501MG

Visible High Power Laser Diode for DVD-RAM

HITACHI

ADE-208-515F (Z)
Preliminary
7th Edition
February 1998

Description

The HL6501MG is a 0.65 µm band AlGalnP laser diode(LD) with a multi-quantum well (MQW) structure. It is suitable as a light source for large capacity optical disc memories, such as DVD-RAM, and various other types of optical equipment.

Hermetic sealing of the small package (ϕ5.6 mm) assures high reliability.

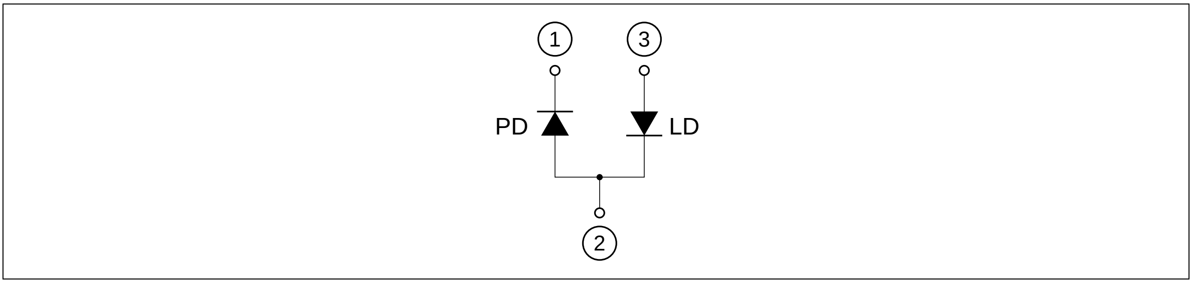
Application

- Optical disc memories
- Optical equipment

Features

- High output power : 35 mW (CW)
- Visible light output : λp = 658 nm Typ
- Small package : ϕ 5.6 mm
- Low astigmatism : 6 µm Typ (P_O = 5 mW)

Internal Circuit



Hitachi semiconductor

Absolute Maximum Ratings (T_C = 25°C)

Item	Symbol	Value	Unit
Optical output power	P_O	35	mW
Pulse optical output power	P_O (pulse)	50 *	mW
Laser diode reverse voltage	$V_{R(LD)}$	2	V
Photo diode reverse voltage	$V_{R(PD)}$	30	V
Operating temperature	Topr	–10 to +60	°C
Storage temperature	Tstg	–40 to +85	°C

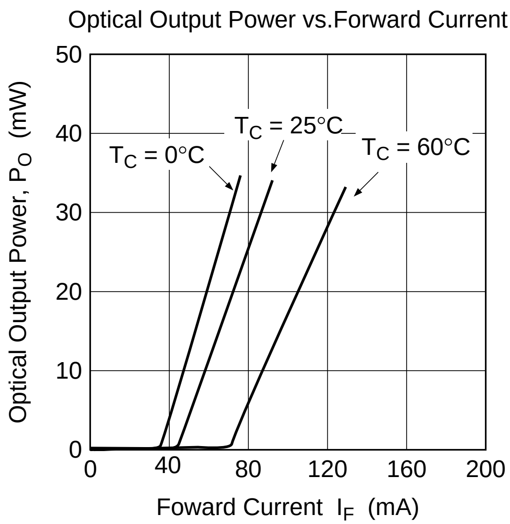
Note: Pulse condition : Pulse width = 100 ns, duty = 50%

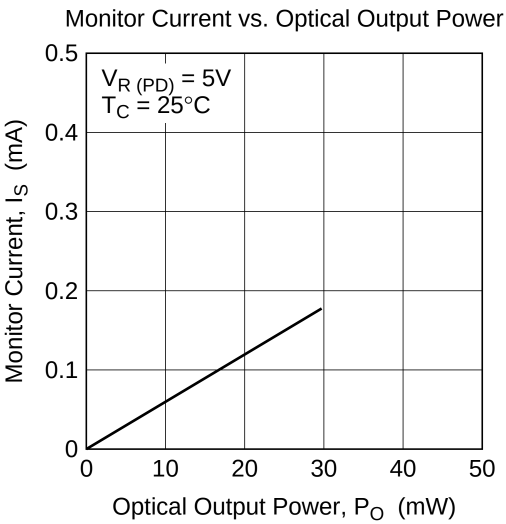
Optical and Electrical Characteristics (T_C = 25°C)

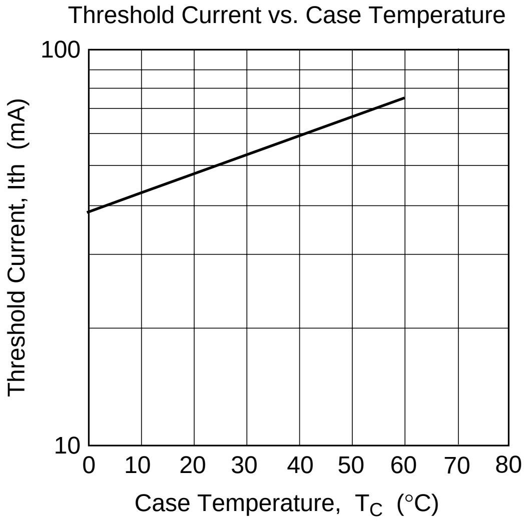
Items	Symbols	Min	Typ	Max	Units	Test Conditions
Optical output power	P_O	35	—	—	mW	Kink free *
Pulse optical output power	$P_{O(pulse)}$	50	—	—	mW	Kink free *
Threshold current	Ith	30	45	70	mA	—
Operating voltage	V_{OP}	2.1	2.6	3.0	V	P_O = 30 mW
Slope efficiency	ηs	0.5	0.75	1.0	mW/mA	18(mW)/($I_{(24mW)} - I_{(6mW)}$)
Lasing wavelength	λp	645	658	665	nm	P_O = 30 mW
Beam divergence parallel to the junction	θ//	7	8.5	10.5	deg.	P_O = 30 mW
Beam divergence parpendicular to the junction	θ⊥	18	22	26	deg.	P_O = 30 mW
Monitor current	I_S	0.05	0.3	1.5	mA	P_O = 30 mW, $V_{R(PD)}$ = 5 V
Asitgmatism	A_S	—	6	—	µm	P_O = 5 mW, NA = 0.55

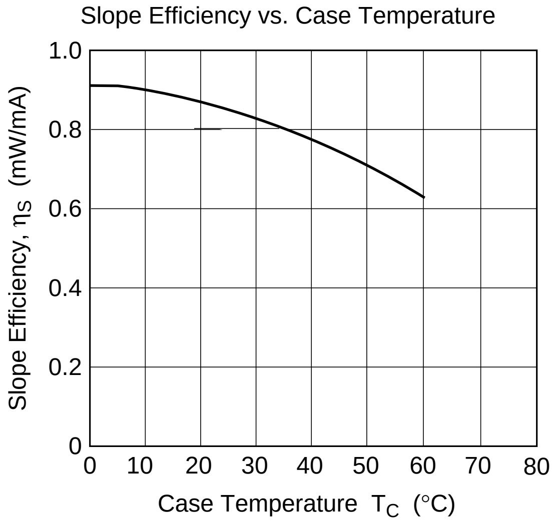
Note: Kink free is confirmed at the temperature of 25°C.

Curve Characteristics

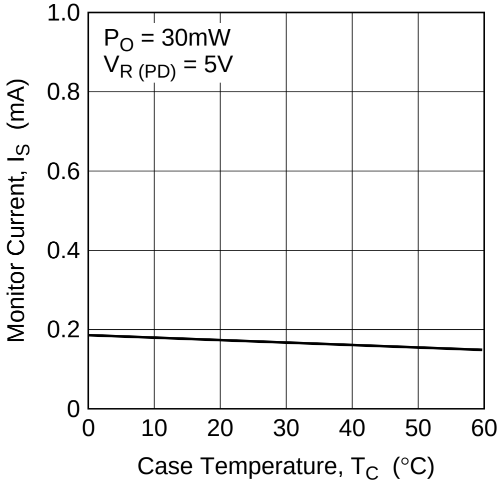




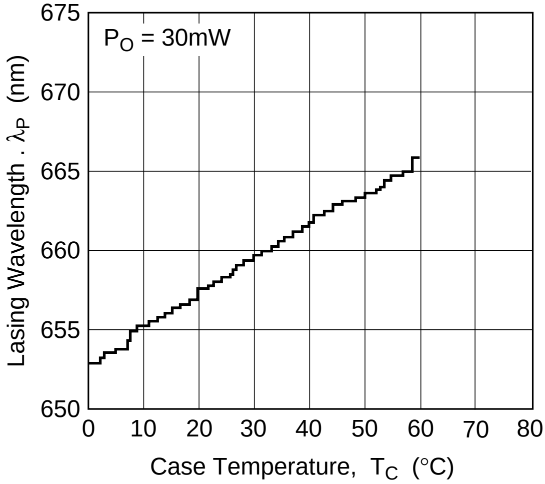




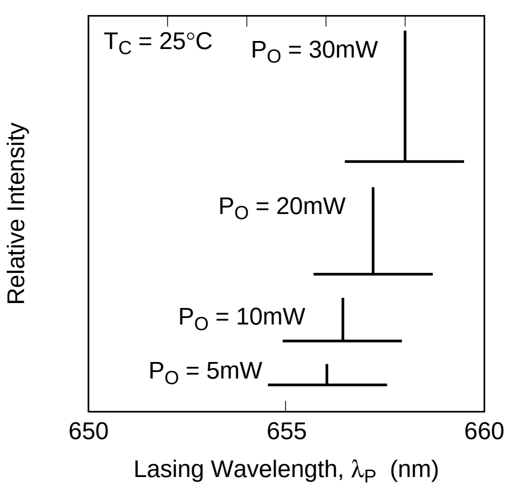
Monitor Current vs. Case Temperature



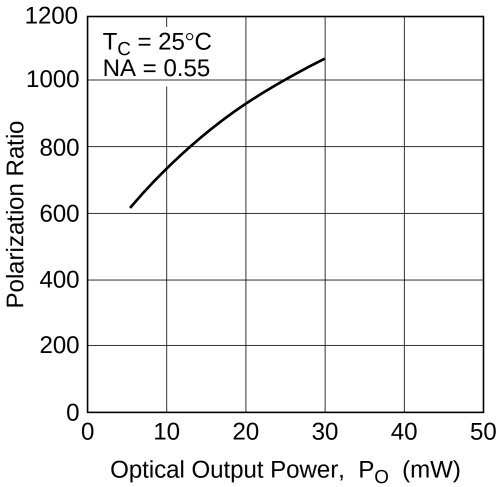
Lasing Wavelength vs. Case Temperature

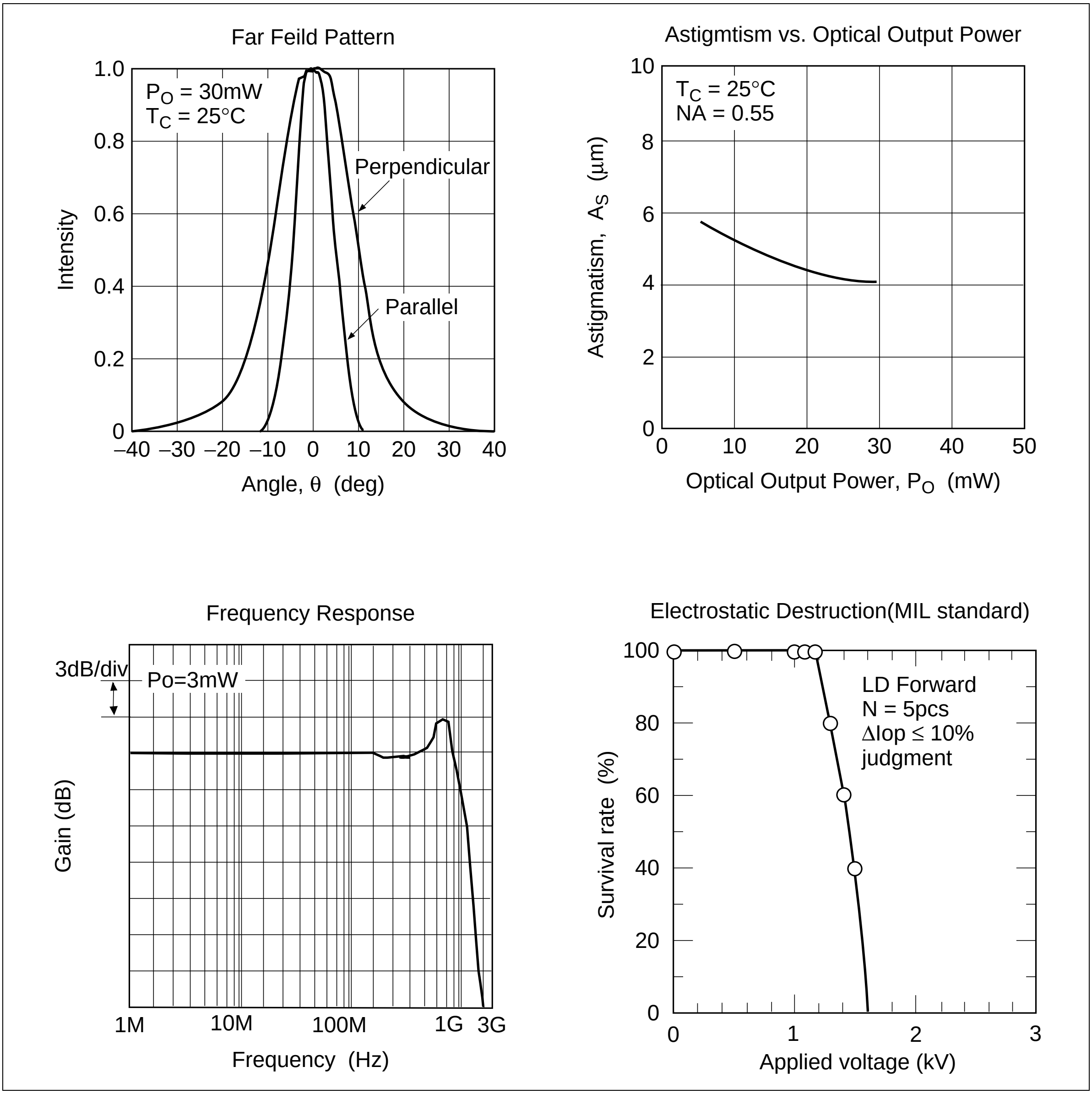


Lasing Spectrum

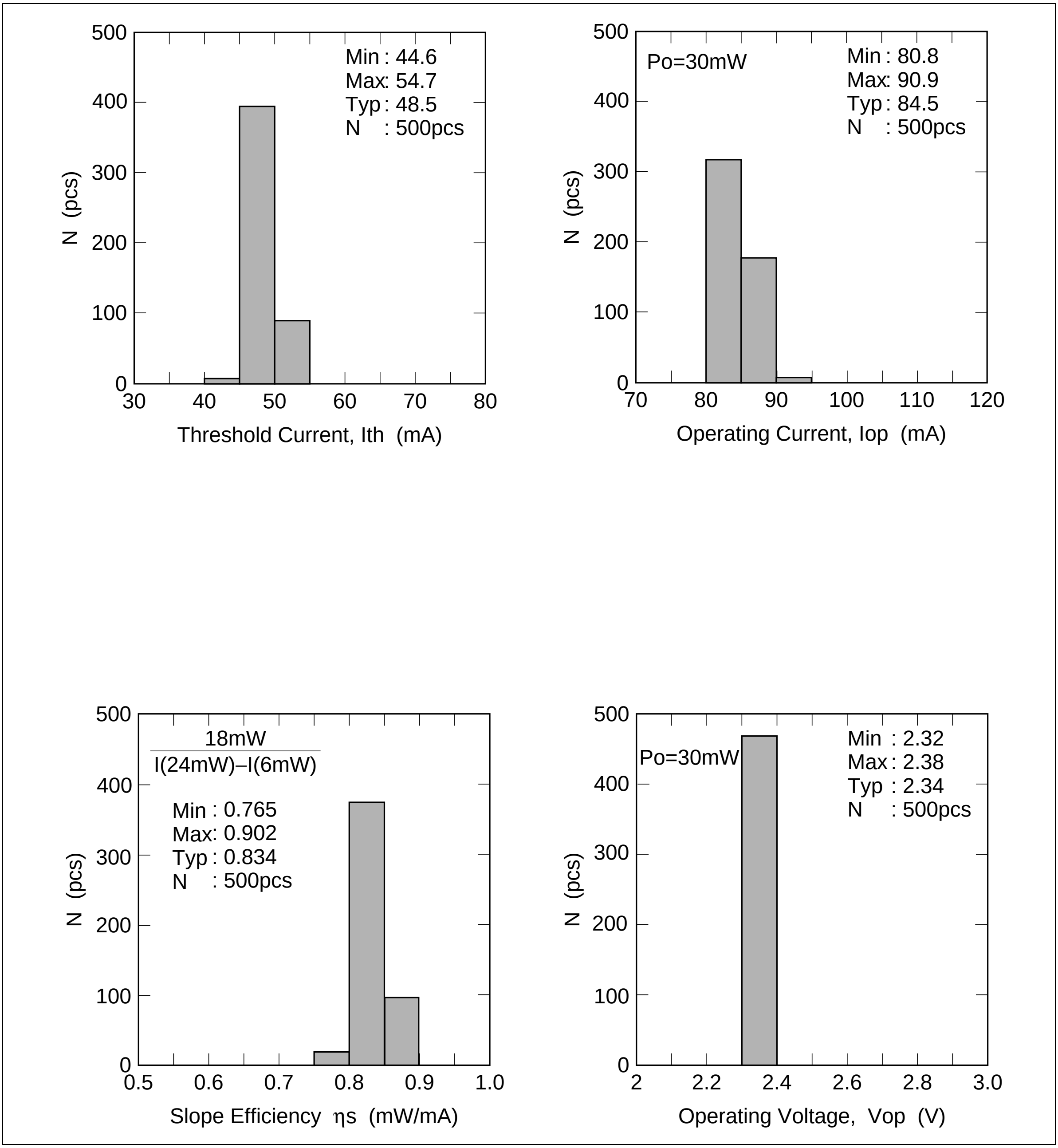


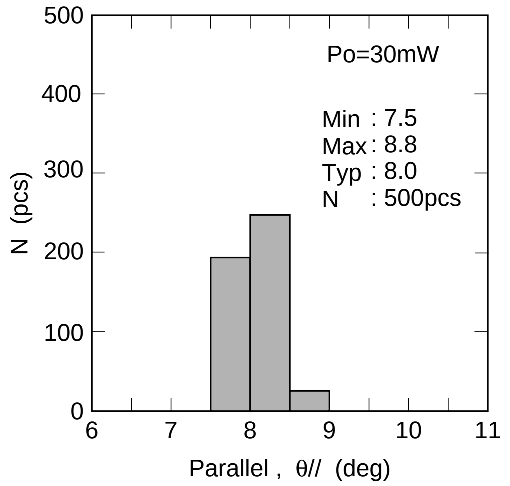
Polarization Ratio vs. Optical Output Power

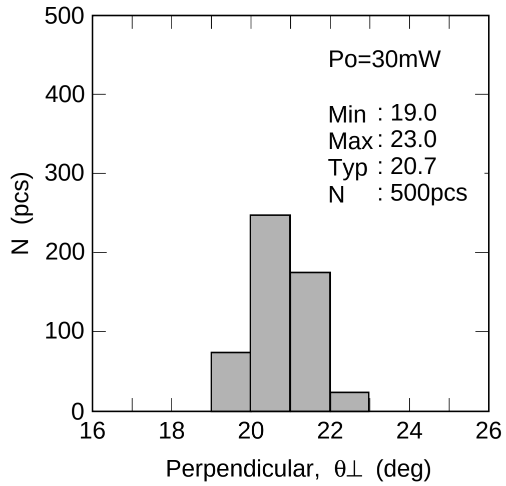


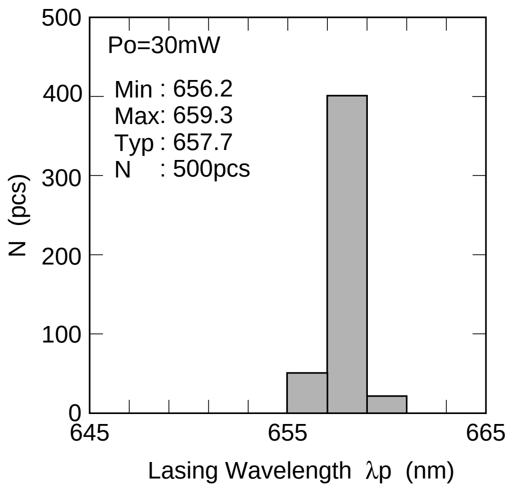

Far Feild Pattern
P_O = 30mW
T_C = 25°C
Perpendicular
Parallel
Intensity
1.0
0.8
0.6
0.4
0.2
0
–40 –30 –20 –10 0 10 20 30 40
Angle, θ (deg)
Astigmtism vs. Optical Output Power
T_C = 25°C
NA = 0.55
Astigmatism, A_S (µm)
10
8
6
4
2
0
0 10 20 30 40 50
Optical Output Power, P_O (mW)
Frequency Response
3dB/div
Po=3mW
Gain (dB)
1M 10M 100M 1G 3G
Frequency (Hz)
Electrostatic Destruction(MIL standard)
LD Forward
N = 5pcs
ΔIop ≤ 10%
judgment
Survival rate (%)
100
80
60
40
20
0
0 1 2 3
Applied voltage (kV)

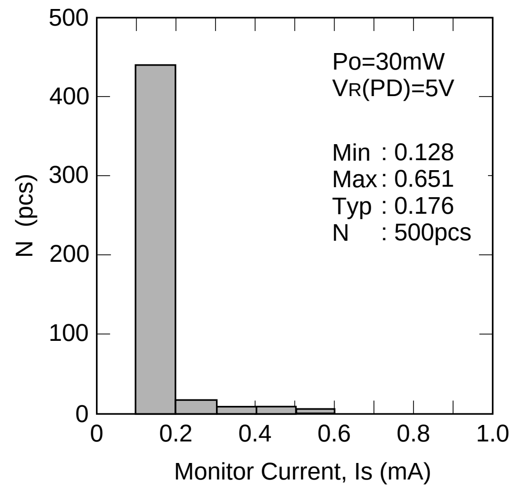
Characteristics Distribution




Po=30mW
Min : 7.5
Max : 8.8
Typ : 8.0
N : 500pcs
N (pcs)
500
400
300
200
100
0
6
7
8
9
10
11
Parallel , θ// (deg)

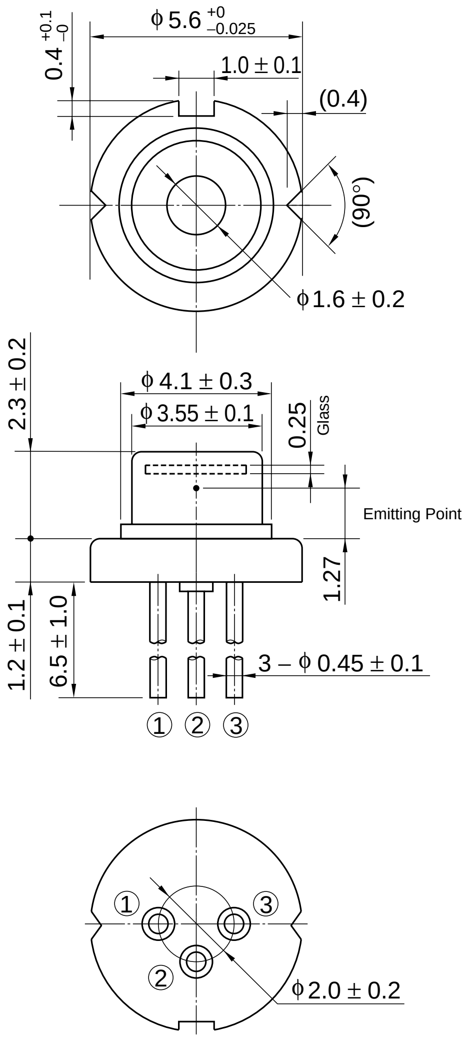

Po=30mW
Min : 19.0
Max : 23.0
Typ : 20.7
N : 500pcs
N (pcs)
500
400
300
200
100
0
16
18
20
22
24
26
Perpendicular, θ⊥ (deg)

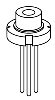

Po=30mW
Min : 656.2
Max: 659.3
Typ : 657.7
N : 500pcs
N (pcs)
500
400
300
200
100
0
645
655
665
Lasing Wavelength λp (nm)


Po=30mW
VR(PD)=5V
Min : 0.128
Max : 0.651
Typ : 0.176
N : 500pcs
N (pcs)
500
400
300
200
100
0
0
0.2
0.4
0.6
0.8
1.0
Monitor Current, Is (mA)

Package Dimensions

Unit: mm





Hitachi Code	LD/MG
JEDEC	—
EIAJ	—
Weight (reference value)	0.3 g

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HL6712G/MG

AlGaInP Laser Diodes

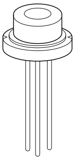
Description

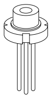
The HL6712G/MG are 0.67 µm band AlGaInP index-guided laser diodes with a double heterostructure. They are suitable as light sources for barcode readers, levelers, laser printers, and various other types of optical equipment. Hermetic sealing of the packages assure high reliability.

Features

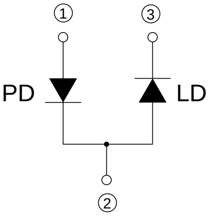
- Visible light output at wavelengths up to 680 nm
- Single longitudinal mode
- Low threshold current: 40 mA Typ.
- Low astigmatism: 10 µm Typ.
- Operates at temperatures up to 50°C
- Built-in monitor photodiode

Package Type
- HL6712G: G1
- HL6712MG: MG





Internal Circuit



Absolute Maximum Ratings (T_C = 25°C)

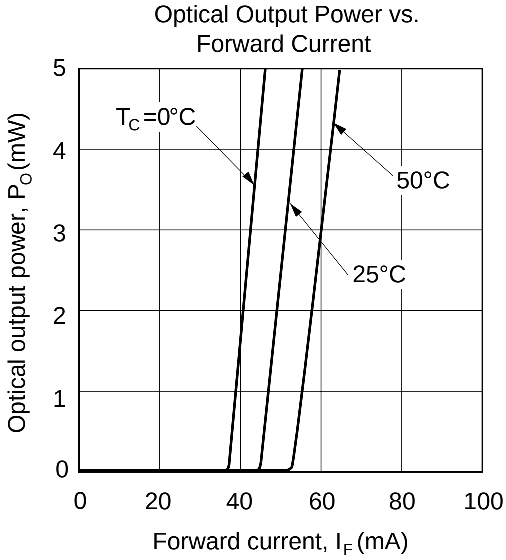
Item	Symbol	Rated Value	Unit
Optical output power	P_O	5	mW
Pulsed optical output power	$P_{O\ (pulse)}$	6*1	mW
LD reverse voltage	$V_{R\ (LD)}$	2	V
PD reverse voltage	$V_{R\ (PD)}$	30	V
Operating temperature	T_{opr}	–10 to +50	°C
Storage temperature	T_{stg}	–40 to +85	°C

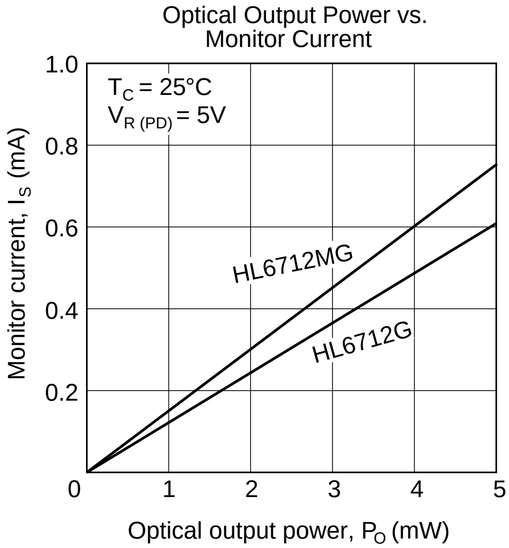
Note: 1. Maximum 50% duty cycle, maximum 1 µs pulse width

Optical and Electrical Characteristics (T_C = 25°C)

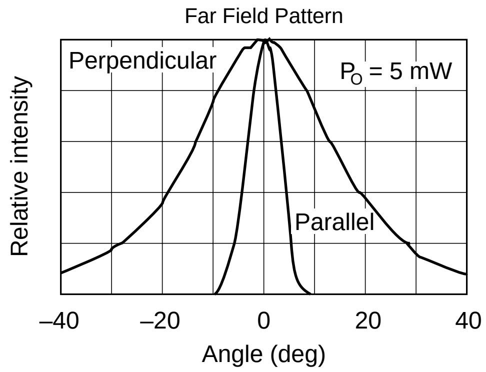
Item		Symbol	Min	Typ	Max	Unit	Test Conditions
Optical output power		P_O	5	—	—	mW	Kink free
Threshold current		I_{th}	—	40	65	mA	
Slope efficiency		η	0.3	0.55	0.7	mW/mA	3 mW/$I_{(4\ mW)}$–$I_{(1\ mW)}$
Lasing wavelength		λ_p	660	670	680	nm	P_O = 5 mW
Beam divergence (parallel)		$\theta_{//}$	5	8	11	deg.	P_O = 5 mW, FWHM
Beam divergence (perpendicular)		$\theta_{\perp}$	22	27	37	deg.	P_O = 5 mW, FWHM
Monitor current	HL6712G	I_S	0.25	0.6	1.25	mA	P_O = 5 mW, $V_{R\ (PD)}$ = 5 V
	HL6712MG		0.2	0.75	1.3		
Astigmatism		A_S	—	10	—	µm	P_O = 5 mW, NA = 0.4

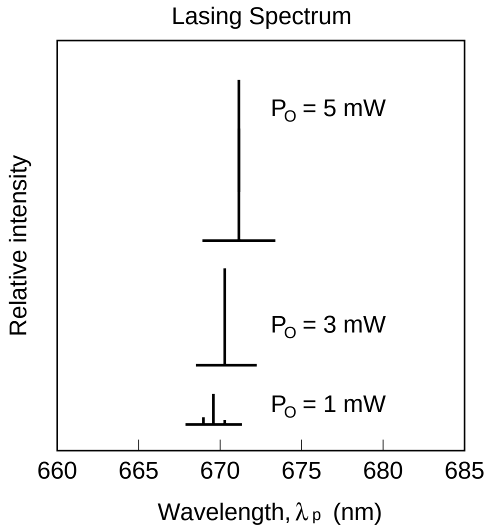
Typical Characteristic Curves

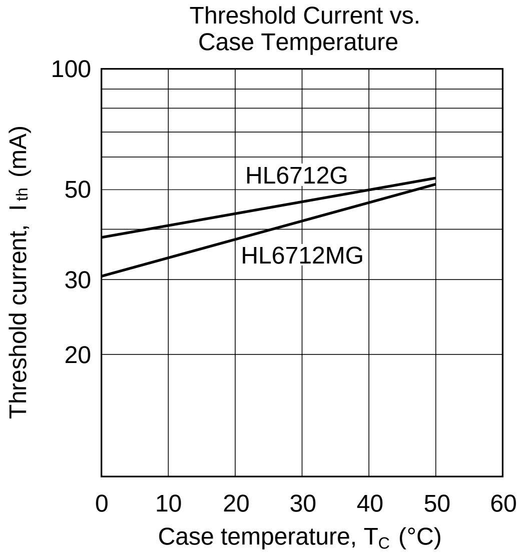


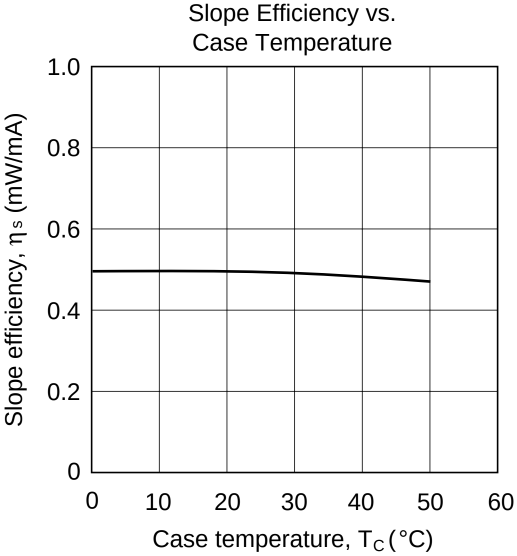


Typical Characteristic Curves (cont)



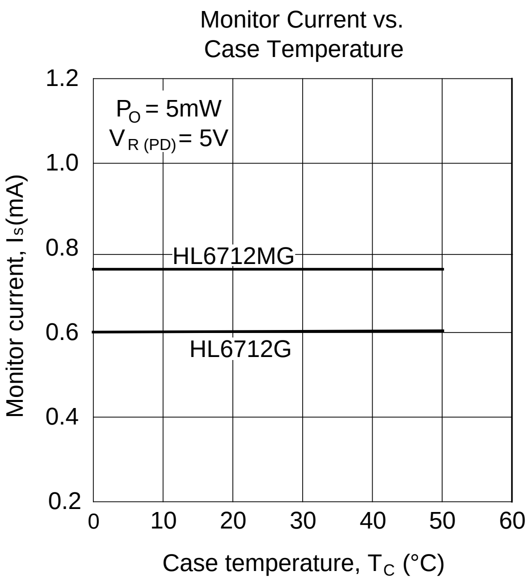


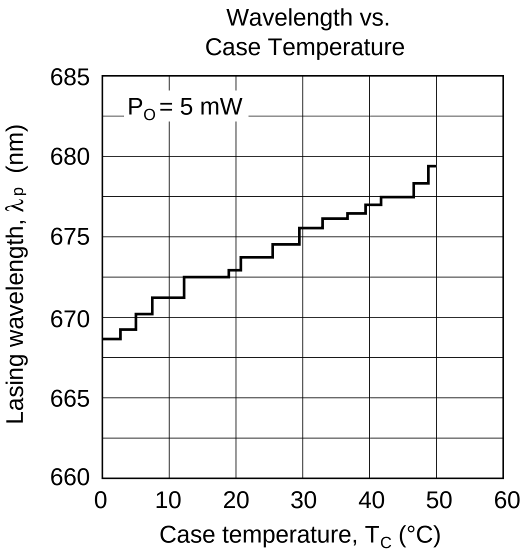


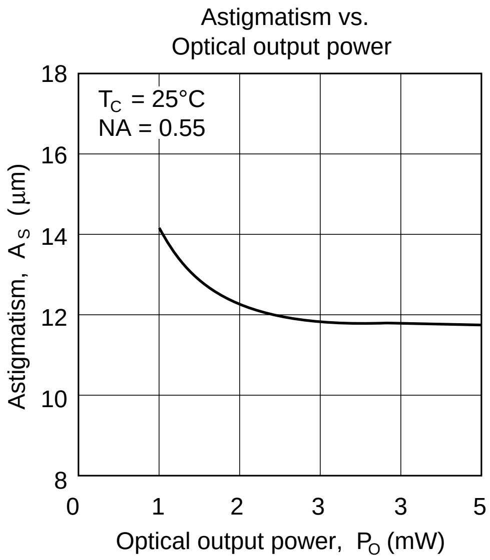


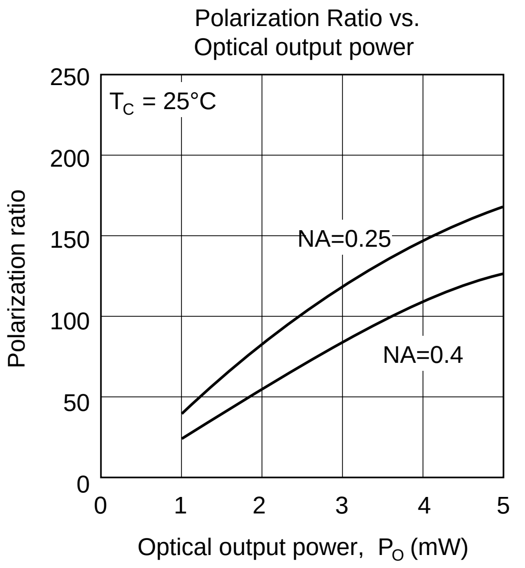
HL6712G/MG

Typical Characteristic Curves (cont)









HL6713G

AlGaInP Laser Diode

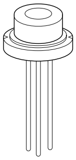
Description

The HL6713G is a 0.67 µm band AlGaInP index-guided laser diode with a double heterostructure. It is suitable as a light source for laser beam printers, levelers and various other types of optical equipment. Hermetic sealing of the package assures high reliability.

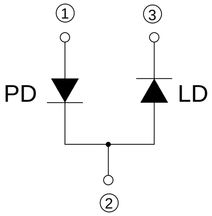
Features

- Visible light output at wavelengths up to 680 nm.
- Single longitudinal mode
- Low astigmatism: 10 µm Typ.
- Small droop under pulse operation: 10% max
- Built-in monitor photodiode

Package Type
- HL6713G: G1



Internal Circuit



Absolute Maximum Ratings (T_C = 25°C)

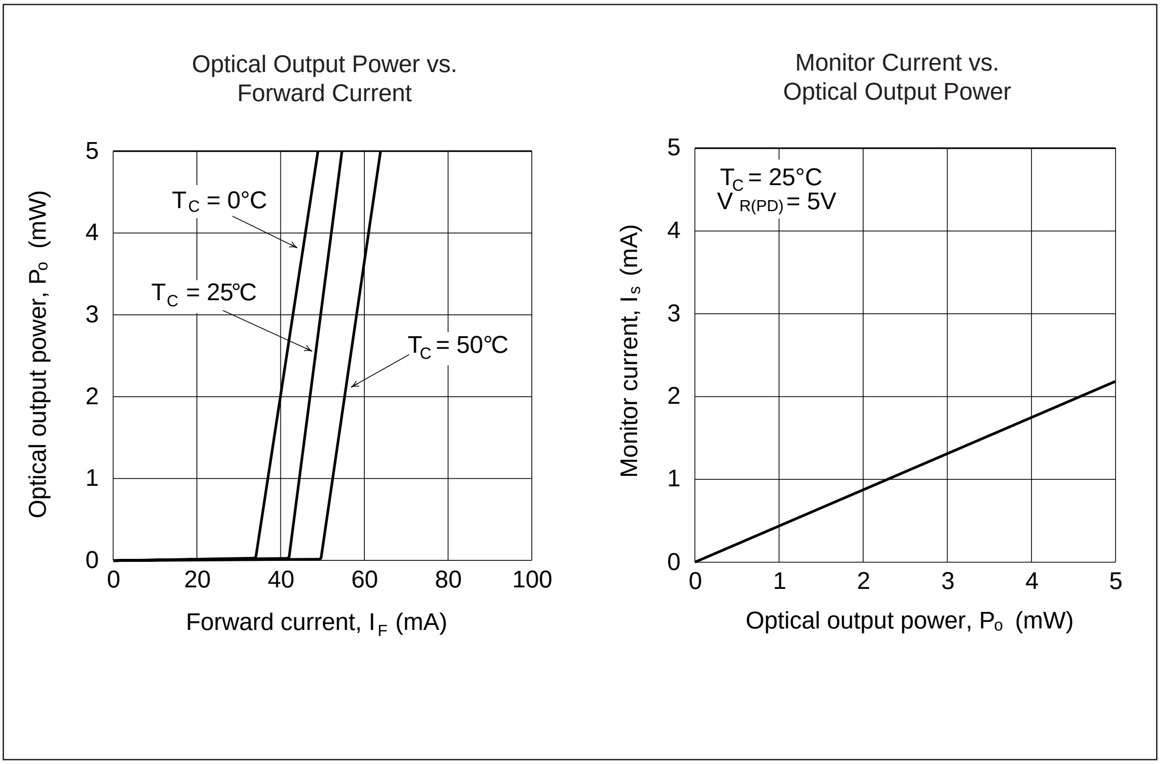
Item	Symbol	Rated Value	Units
Optical output power	P_O	5	mW
Pulse optical output power	$P_{O\ (pulse)}$	6*1	mW
LD reverse voltage	$V_{R\ (LD)}$	2	V
PD reverse voltage	$V_{R\ (PD)}$	30	V
Operating temperature	T_{opr}	–10 to +50	°C
Storage temperature	T_{stg}	–40 to +85	°C

Note: 1. Maximum 50% duty cycle, maximum 1 µs pulse width

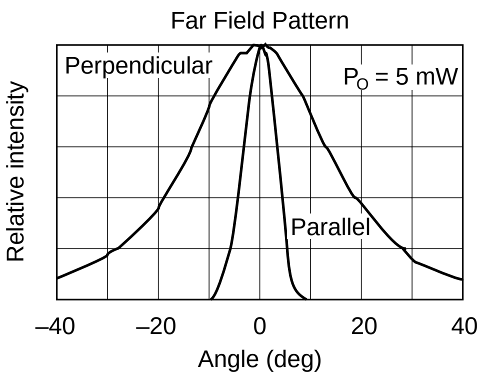
Optical and Electrical Characteristics (T_C = 25°C)

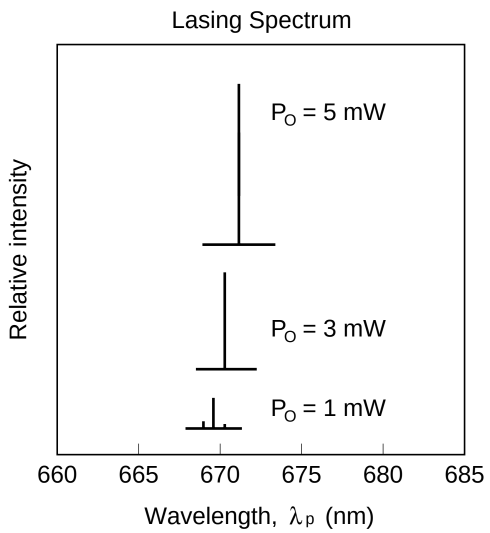
Item	Symbol	Min	Typ	Max	Units	Test Conditions
Optical output power	P_O	5	—	—	mW	Kink free
Threshold current	I_{th}	20	—	50	mA	
Slope efficiency	η	0.16	—	0.45	mW/mA	3 (mW) / $I_{(4\ mW)} - I_{(1\ mW)}$
LD Operating Voltage	V_{op}	—	2.3	2.7	V	P_O = 5 mW
Lasing wavelength	λ_P	660	670	680	nm	P_O = 5 mW
Beam divergence (parallel)	$\theta_{//}$	7	9	11	deg.	P_O = 5 mW, FWHM
Beam divergence (perpendicular)	$\theta_{\perp}$	25	30	38	deg.	P_O = 5 mW, FWHM
Monitor current	I_S	1.0	2.0	3.0	mA	P_O = 5 mW, $V_{R\ (PD)}$ = 5 V
Astigmatism	A_S	—	10	—	µm	P_O = 3 mW, NA = 0.55
Droop	$-R_{th}$	—	—	10	%	P_O = 3 mW, f = 600 Hz

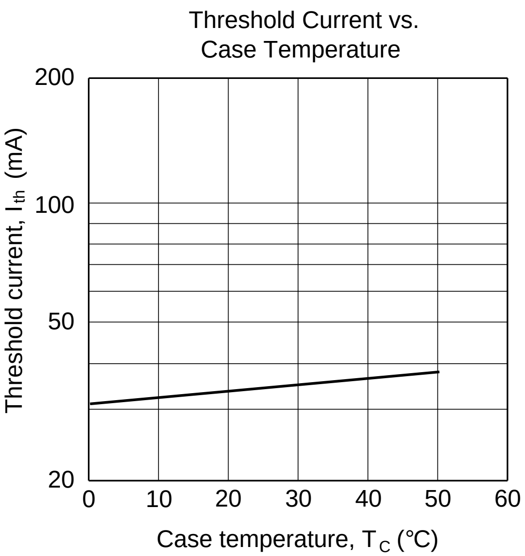
Typical Characteristic Curves

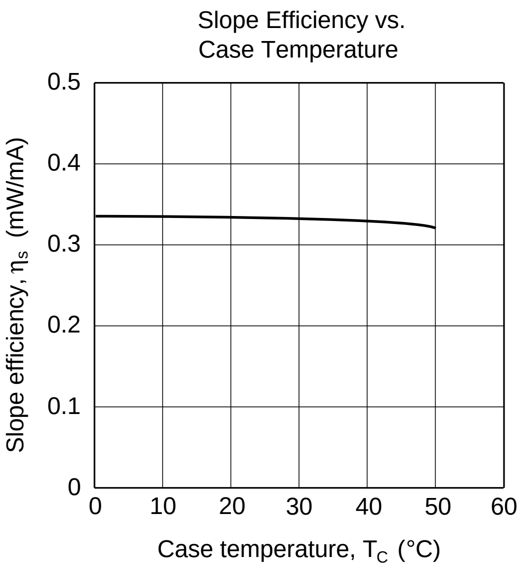


Typical Characteristic Curves (cont)



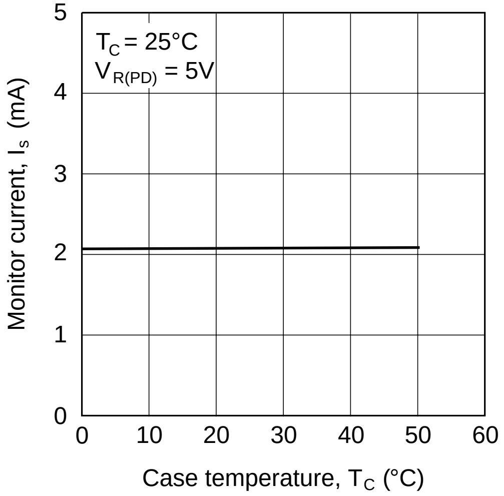




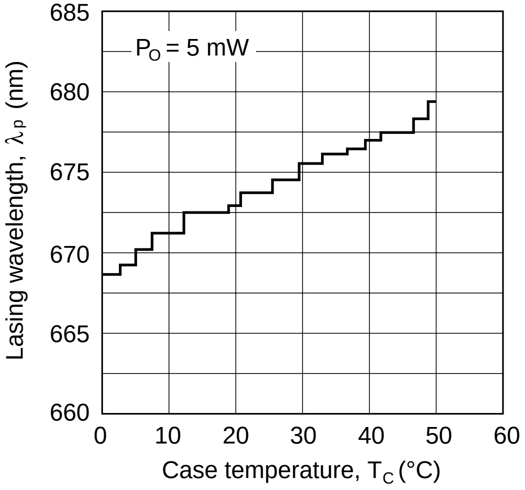


Typical Characteristic Curves (cont)

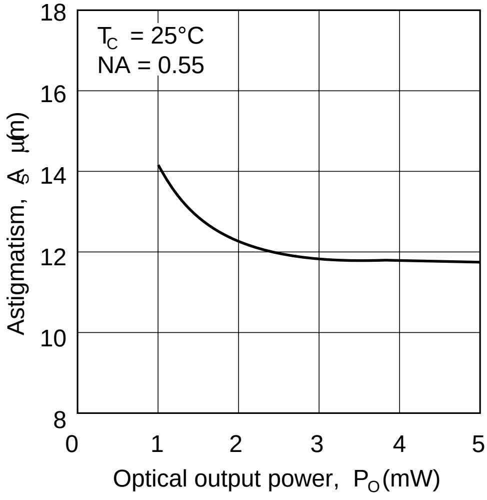
Monitor Current vs.
Case Temperature



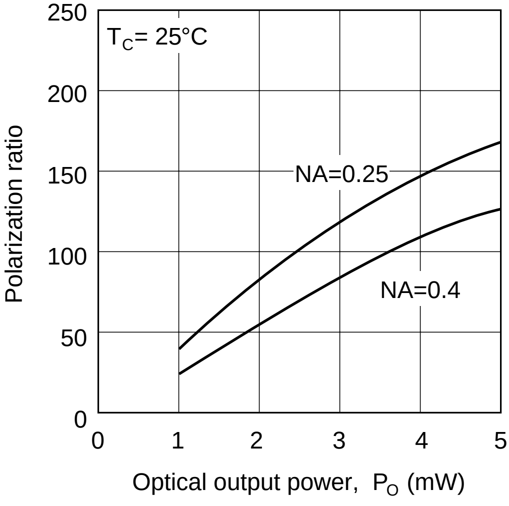
Wavelength vs.
Case Temperature



Astigmatism vs.
Optical output power



Polarization Ratio vs.
Optical output power



HL6714G

AlGaInP Laser Diode

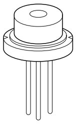
Description

The HL6714G is a 0.67 µm band AlGaInP index-guided laser diode with a multi-quantum well(MQW)structure. It is suitable as a light source for laser beam printers, levelers and various other types of optical equipment. Hermetic sealing of the package assures high reliability.

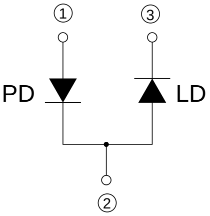
Features

- Visible light output at wavelengths up to 680 nm.
- Single longitudinal mode
- Low astigmatism: 10 µm Typ.
- High output power: 10 mW (CW)
- Built-in monitor photodiode

Package Type
- HL6714G: G2



Internal Circuit



Absolute Maximum Ratings (T_C = 25°C)

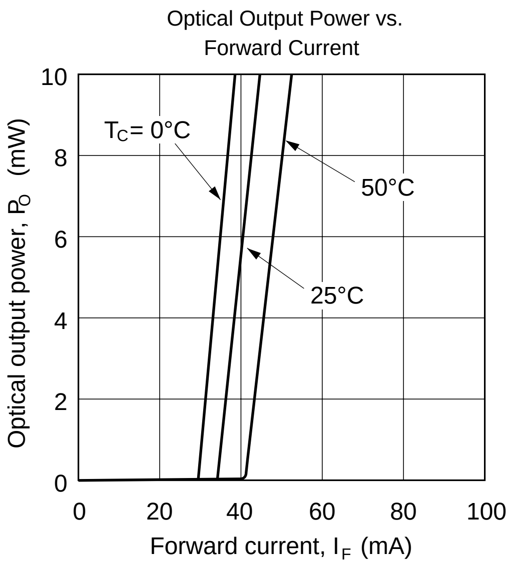
Item	Symbol	Rated Value	Units
Optical output power	P_O	10	mW
Pulse optical output power	$P_{O\ (pulse)}$	12[*1]	mW
LD reverse voltage	$V_{R\ (LD)}$	2	V
PD reverse voltage	$V_{R\ (PD)}$	30	V
Operating temperature	T_{opr}	–10 to +50	°C
Storage temperature	T_{stg}	–40 to +85	°C

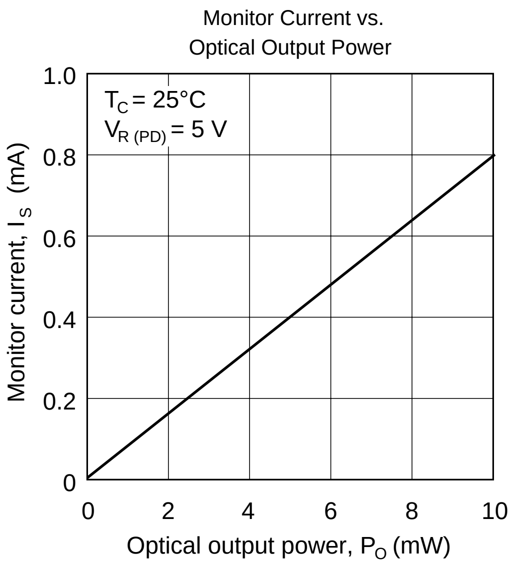
Note: 1. Maximum 50% duty cycle, maximum 1 µs pulse width

Optical and Electrical Characteristics (T_C = 25°C)

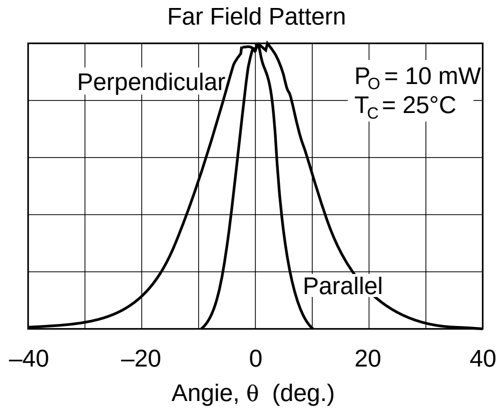
Item	Symbol	Min	Typ	Max	Units	Test Conditions
Optical output power	P_O	10	—	—	mW	Kink free
Threshold current	I_{th}	20	35	60	mA	
Slope efficiency	η	0.3	0.5	0.8	mW/mA	6 (mW)/ $I_{(8\ mW)} - I_{(2\ mW)}$
LD Operating Voltage	V_{op}	—	—	2.7	V	P_O = 10 mW
Lasing wavelength	λ_P	660	670	680	nm	P_O = 10 mW
Beam divergence (parallel)	$\theta_{//}$	5	8	11	deg.	P_O = 10 mW, FWHM
Beam divergence (perpendicular)	$\theta_{\perp}$	18	22	30	deg.	P_O = 10 mW, FWHM
Monitor current	I_S	0.3	0.8	1.5	mA	P_O = 10 mW, $V_{R\ (PD)}$ = 5 V
Astigmatism	A_S	—	10	—	µm	P_O = 10 mW, NA = 0.55

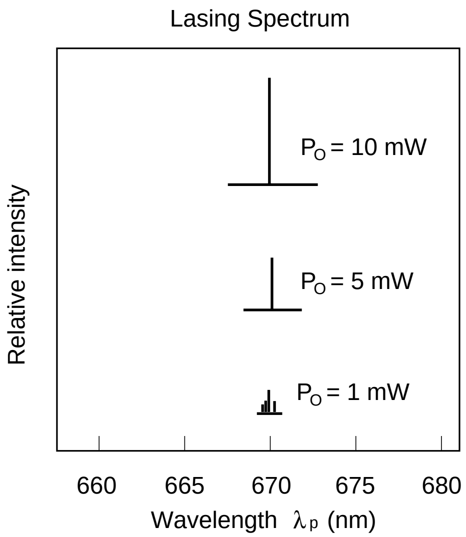
Typical Characteristics Curves

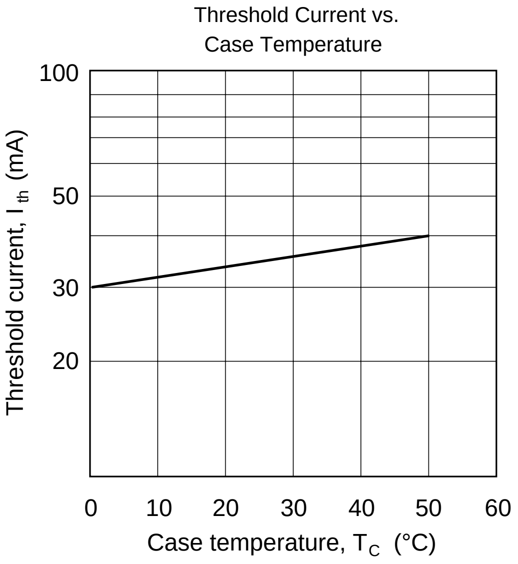


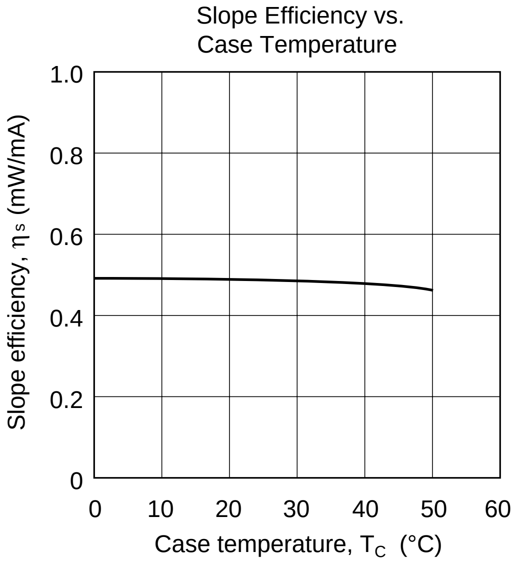


Typical Characteristics Curves (cont)



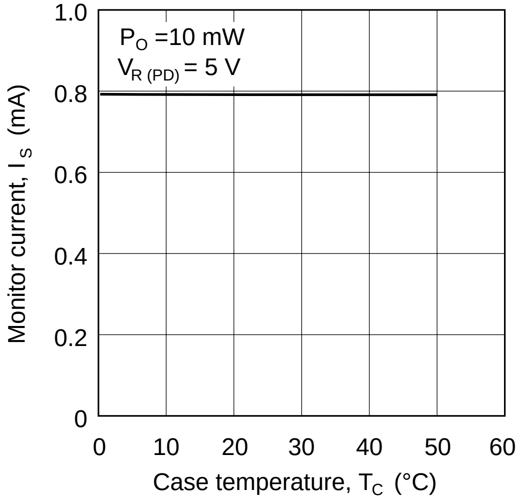




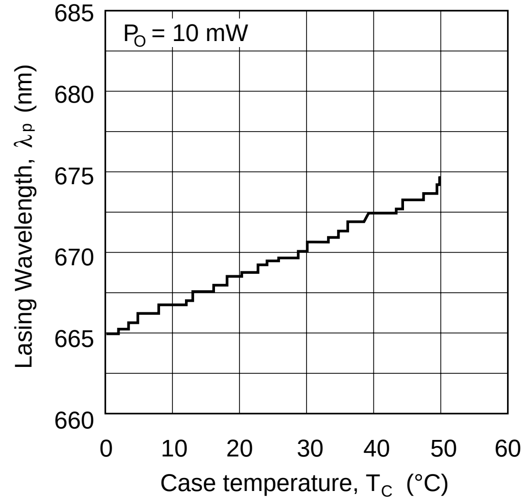


Typical Characteristics Curves (cont)

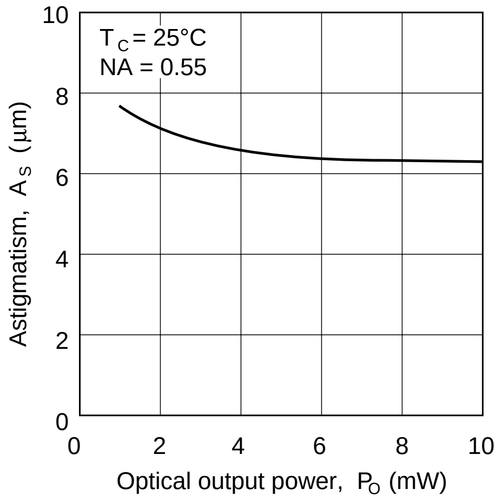
Monitor Current vs.
Case Temperature



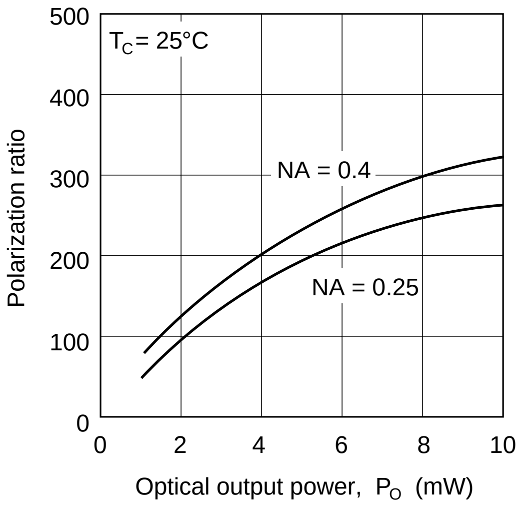
Wavelength vs.
Case Temperature



Astigmatism vs.
Optical output power



Polarization Ratio vs.
Optical output power



HL6720G

AlGaInP Laser Diode

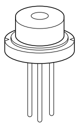
Description

The HL6720G is a 0.67 µm band AlGaInP index-guided laser diode with a double heterostructure.
It is suitable as a light source for pointers, and various other types of optical equipment. Hermetic sealing of the package assures high reliability.

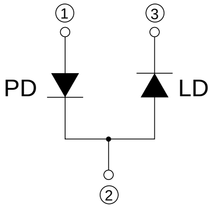
Features

- Visible light output at wavelengths up to 680 nm
- Continuous operating output: 5 mW CW
- Low voltage operation: 2.7 V Max
- Single longitudinal mode
- Built-in monitor photodiode

Package Type
- HL6720G: G2



Internal Circuit



Absolute Maximum Ratings (T_C = 25°C)

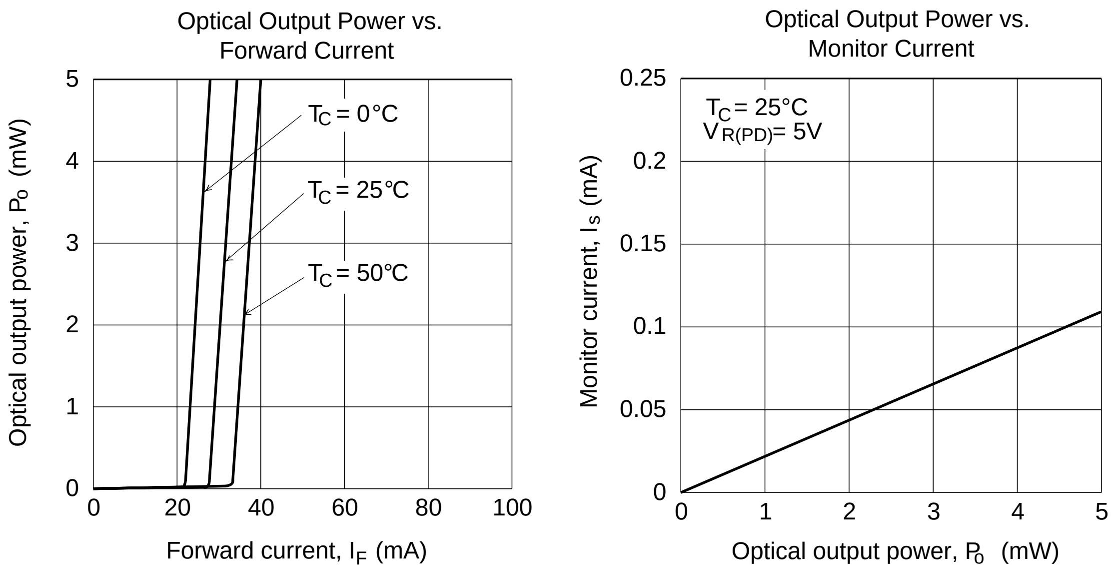
Item	Symbol	Rated Value	Unit
Optical output power	P_O	5	mW
Pulse optical output power	$P_{O\ (pulse)}$	6*1	mW
LD reverse voltage	$V_{R\ (LD)}$	2	V
PD reverse voltage	$V_{R\ (PD)}$	30	V
Operating temperature	T_{opr}	–10 to +50	°C
Storage temperature	T_{stg}	–40 to +85	°C

Note: 1. Maximum 50% duty cycle, maximum 1 µs pulse width

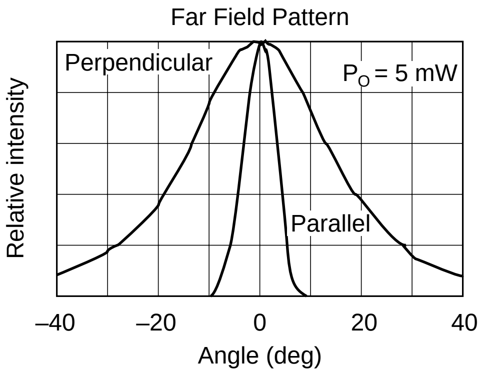
Optical and Electrical Characteristics (T_C = 25°C)

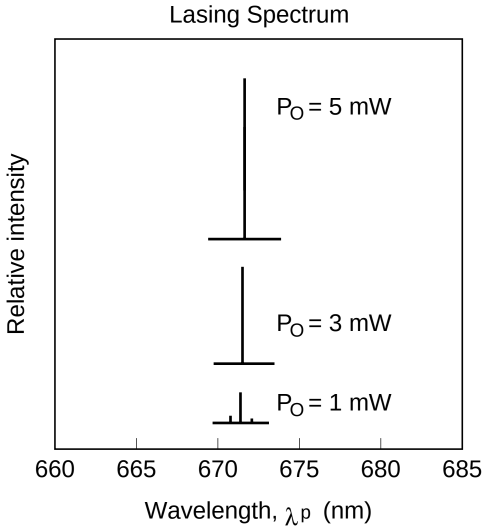
Item	Symbol	Min	Typ	Max	Unit	Test Conditions
Optical output power	P_O	5	—	—	mW	Kink free
Threshold current	I_{th}	—	30	60	mA	
Slope efficiency	η	0.4	—	1.0	mW/mA	3 mW/$I_{(4\ mW)} - I_{(1\ mW)}$
LD operating current	I_{op}	—	35	70	mA	P_O = 5 mW
LD operating voltage	V_{op}	—	—	2.7	V	P_O = 5 mW
Lasing wavelength	λ_p	660	670	680	nm	P_O = 5 mW
Beam divergence (parallel)	$\theta_{//}$	6	9	12	deg.	P_O = 5 mW
Beam divergence (perpendicular)	$\theta_{\perp}$	20	30	40	deg.	P_O = 5 mW
Monitor current	I_S	0.03	—	0.2	mA	P_O = 5 mW, V_R = 5 V

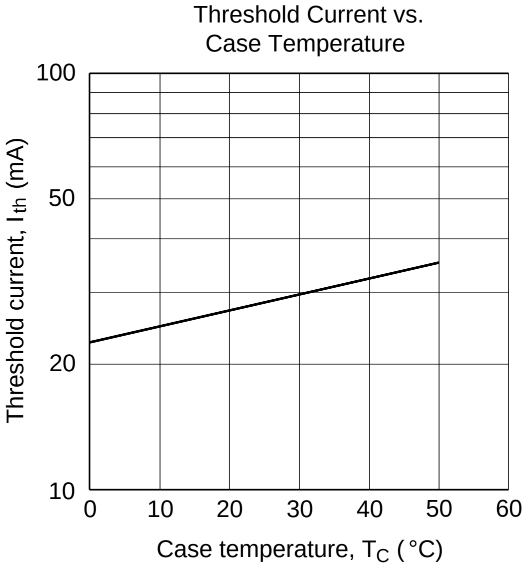
Typical Characteristic Curves.

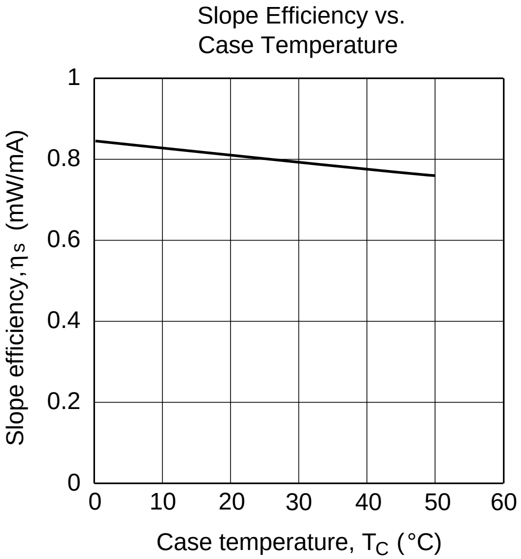


Typical Characteristics Curves (cont)

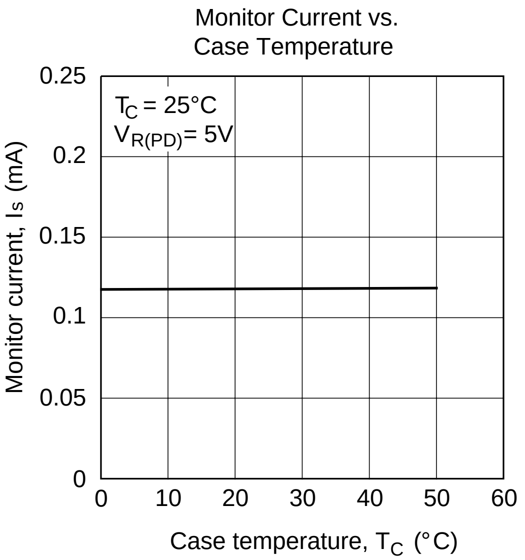


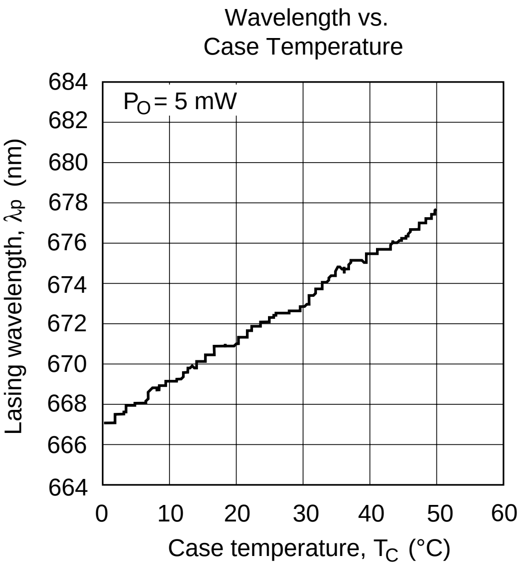


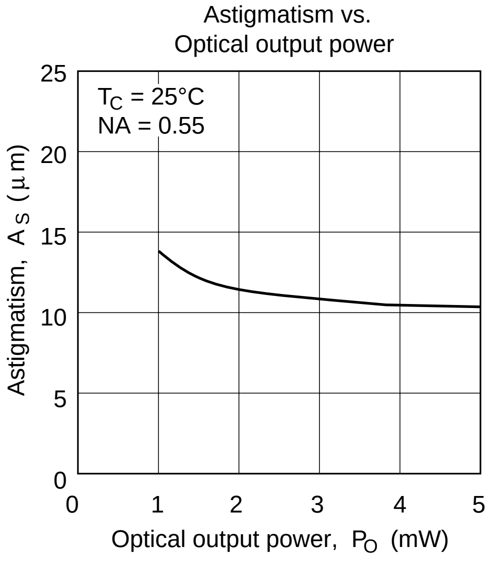


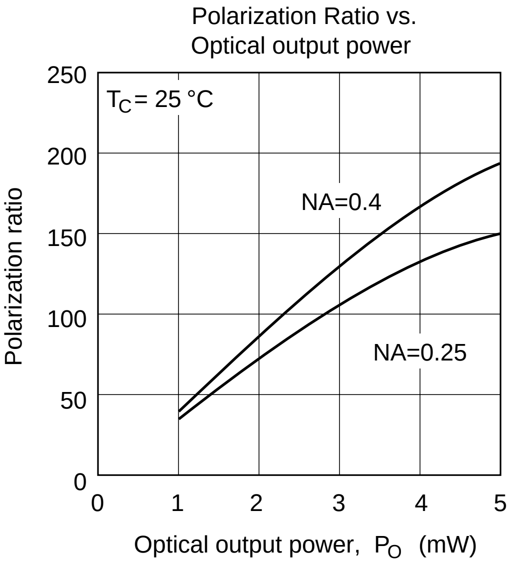


Typical Characteristics Curves (cont)









HL6722G

AlGaInP Laser Diode

Description

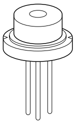
The HL6722G is a 0.67 µm band AlGaInP index-guided laser diode with a multi-quantum well(MQW) structure. It is suitable as a light source for bercode scanner, and various other types of optical equipment. Hermetic sealing of the package assures high reliability.

Features

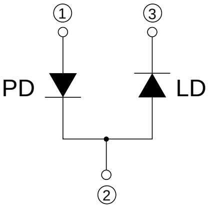
- Visible light output at wavelengths up to 680 nm
- Continuous operating output: 5 mW CW
- Low voltage operation: 2.7 V Max
- Low current operation: 32 mA Typ
- Single longitudinal mode
- Built-in monitor photodiode

Package Type

- HL6722G: G2



Internal Circuit



Absolute Maximum Ratings (T_C = 25°C)

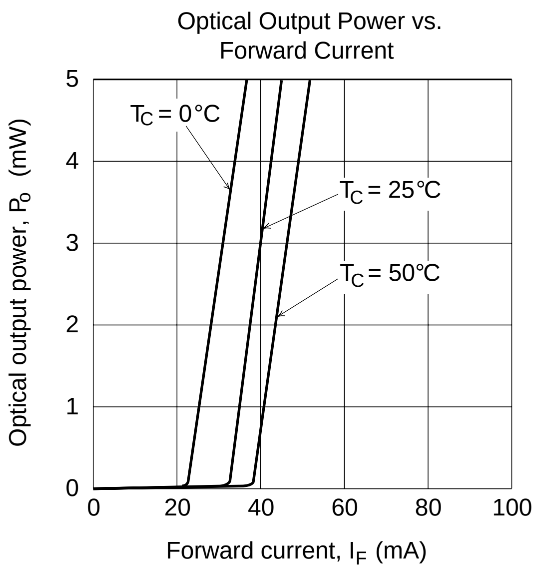
Item	Symbol	Rated Value	Unit
Optical output power	P_O	5	mW
Pulse optical output power	$P_{O\ (pulse)}$	6*1	mW
LD reverse voltage	$V_{R\ (LD)}$	2	V
PD reverse voltage	$V_{R\ (PD)}$	30	V
Operating temperature	T_{opr}	–10 to +50	°C
Storage temperature	T_{stg}	–40 to +85	°C

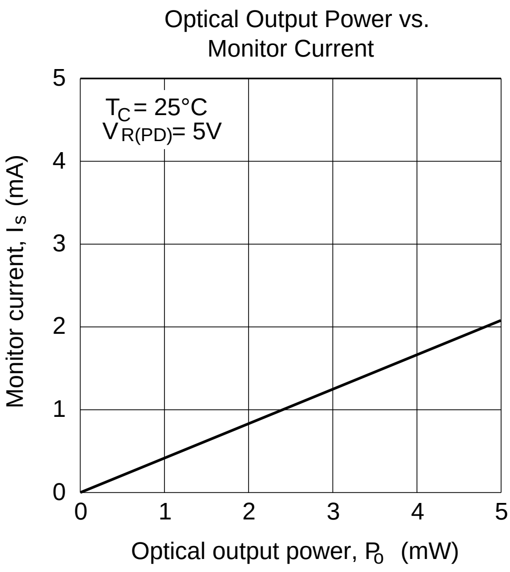
Note: 1. Maximum 50% duty cycle, maximum 1 µs pulse width

Optical and Electrical Characteristics (T_C = 25°C)

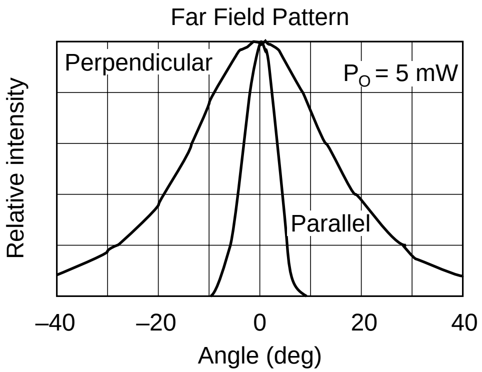
Item	Symbol	Min	Typ	Max	Unit	Test Conditions
Optical output power	P_O	5	—	—	mW	Kink free
Threshold current	I_{th}	20	32	55	mA	
Slope efficiency	η	0.3	0.5	0.7	mW/mA	3 mW/$I_{(4\ mW)} - I_{(1\ mW)}$
LD operating current	I_{op}	—	42	70	mA	P_O = 5 mW
LD operating voltage	V_{op}	—	—	2.7	V	P_O = 5 mW
Lasing wavelength	λ_p	660	670	680	nm	P_O = 5 mW
Beam divergence (parallel)	$\theta_{//}$	5	8	11	deg.	P_O = 5 mW
Beam divergence (perpendicular)	$\theta_{\perp}$	22	30	38	deg.	P_O = 5 mW
Monitor current	I_S	1	—	3	mA	P_O = 5 mW, V_R = 5 V

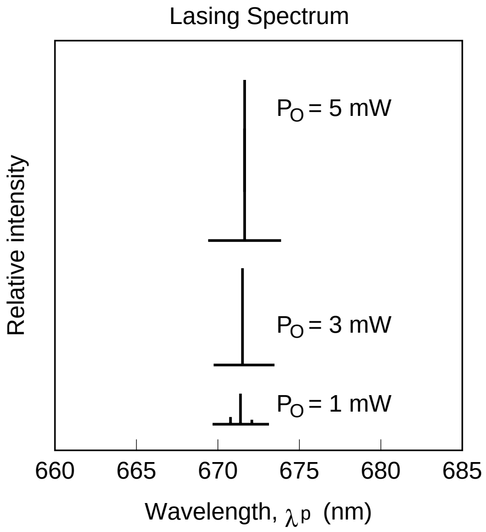
Typical Characteristic Curves.

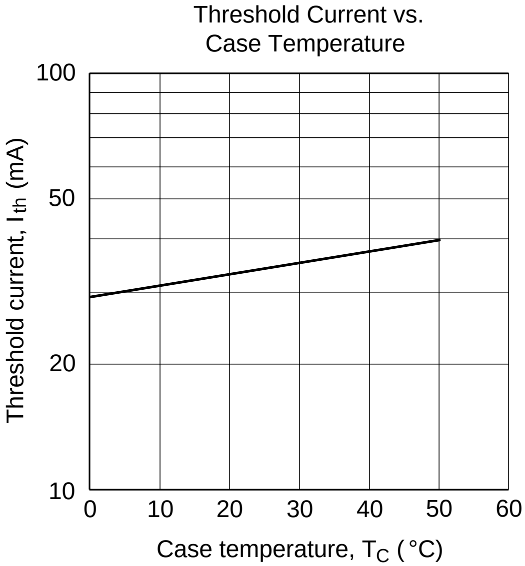


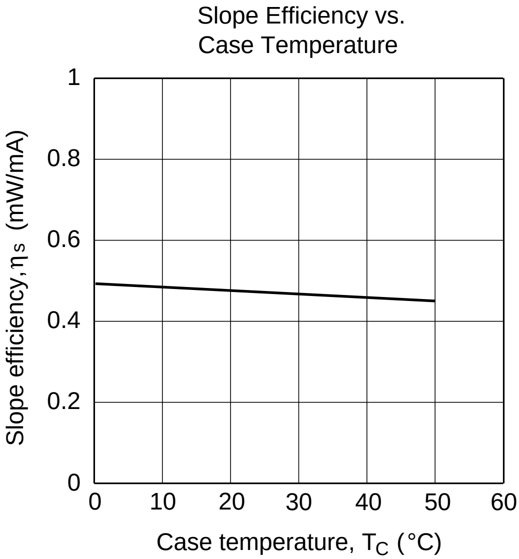


Typical Characteristics Curves (cont)



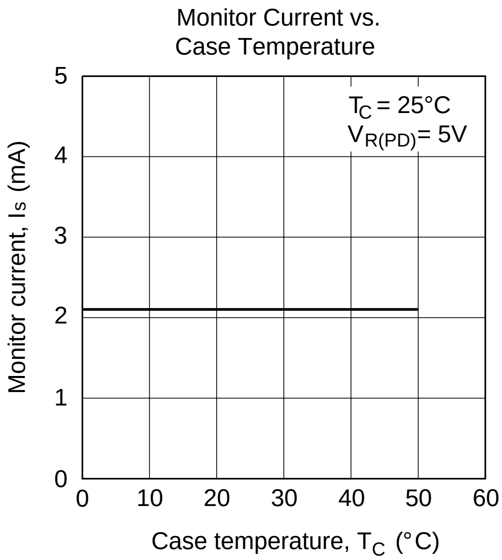


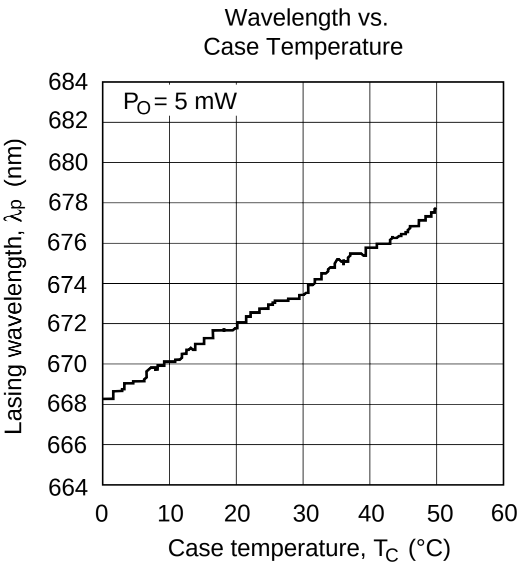


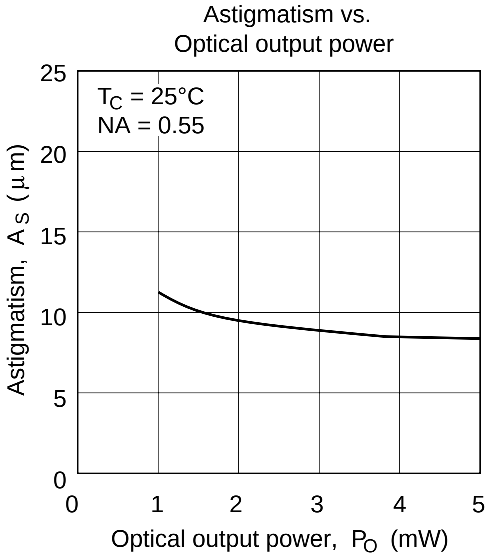


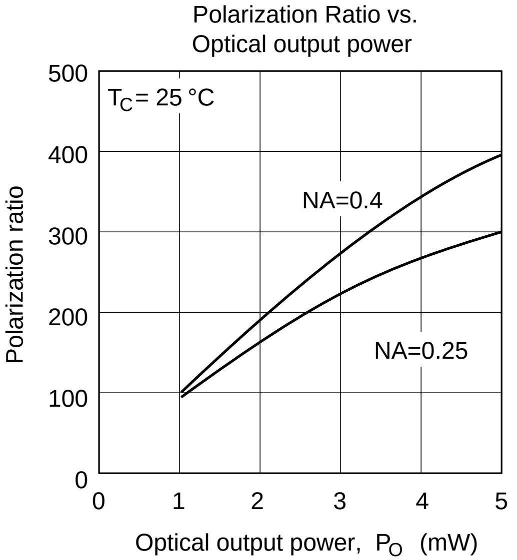
HL6722G

Typical Characteristics Curves (cont)









HL6724MG

AlGaInP Laser Diode

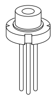
Description

The HL6724MG is a 0.67 µm band AlGalnP laser diode with a multi-quantum well (MQW) structure. It is suitable as a light source for laser pointers and optical equipments for amusement.

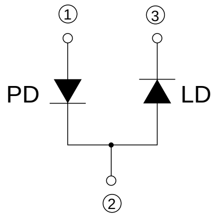
Features

- Visible light output: 670nm typ.
- Optical output power: 5 mW CW
- Low operating current: 35 mA typ.
- Low operating voltage: 2.7 V max.,

Package Type
- HL6724MG: MG



Internal Circuit
- HL6724MG



Absolute Maximum Ratings (T_C = 25°C)

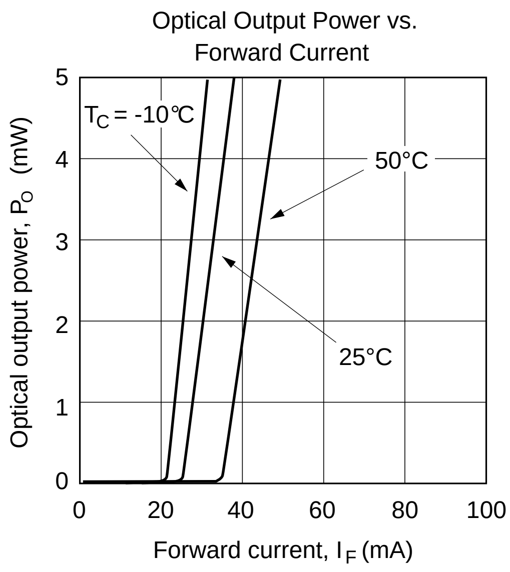
Item	Symbol	Rated Value	Unit
Optical output power	P_O	5	mW
Pulse optical output power	$P_{O\ (pulse)}$	6*1	mW
LD reverse voltage	$V_{R\ (LD)}$	2	V
PD reverse voltage	$V_{R\ (PD)}$	30	V
Operating temperature	T_{opr}	–10 to +50	°C
Storage temperature	T_{stg}	–40 to +85	°C

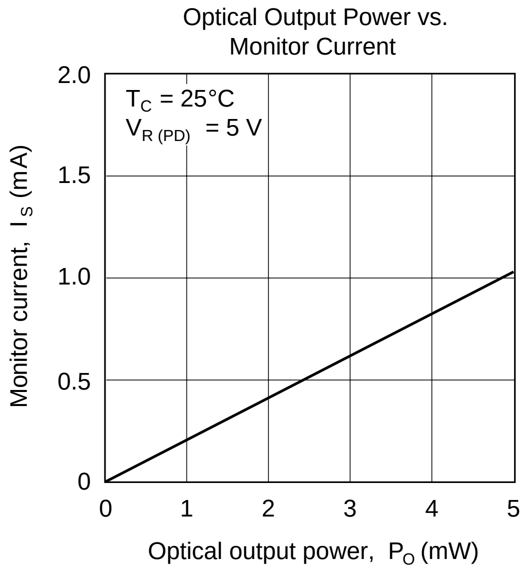
Note: 1. Pulse condition: Pulse width ≤1µs, duty ≤50%

Optical and Electrical Characteristics (T_C = 25°C)

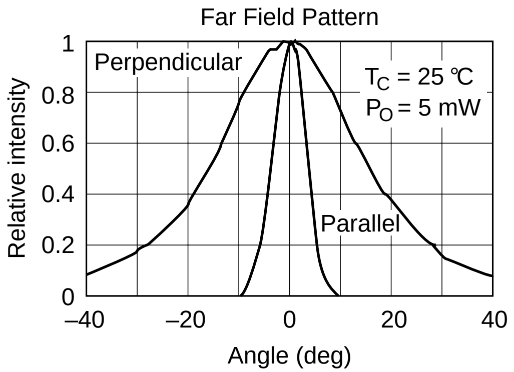
Item	Symbol	Min	Typ	Max	Unit	Test Conditions
Optical output power	P_O	5	—	—	mW	Kink free
Threshold current	I_{th}	—	25	—	mA	
Operating current	I_{op}	—	35	—	mA	P_O = 5 mW
Operating voltage	V_{op}	—	—	2.7	V	P_O = 5 mW
Lasing wavelength	λ_p	660	670	680	nm	P_O = 5 mW
Beam divergence (parallel)	$\theta_{//}$	5	8	11	deg.	P_O = 5 mW
Beam divergence (perpendicular)	$\theta_{\perp}$	22	30	40	deg.	P_O = 5 mW
Monitor current	I_S	—	0.9	—	mA	P_O = 5 mW, $V_{R(PD)}$ = 5 V

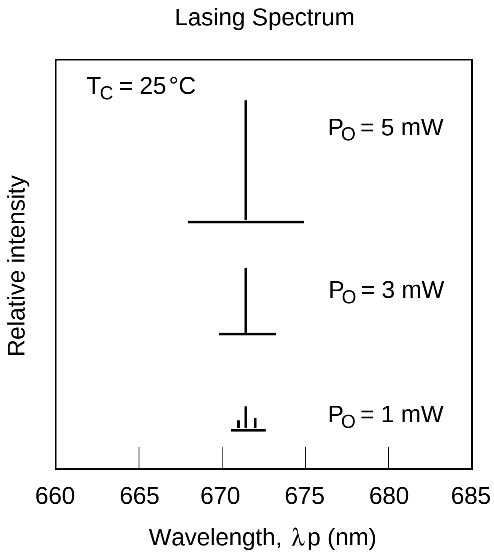
Typical Characteristic Curves

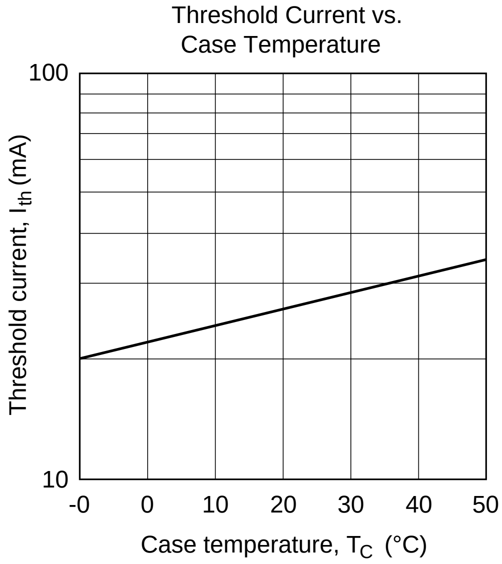


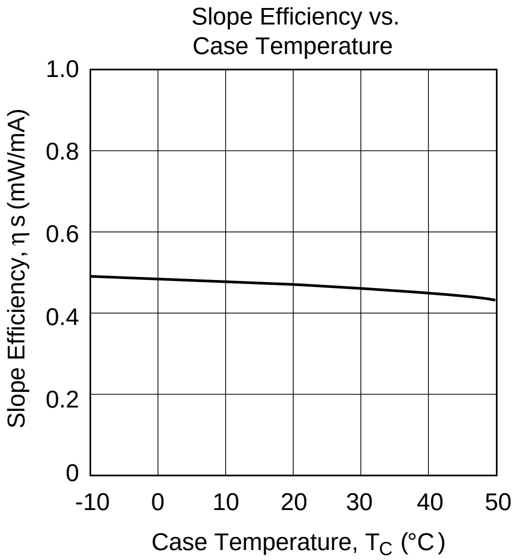


Typical Characteristic Curves (cont)

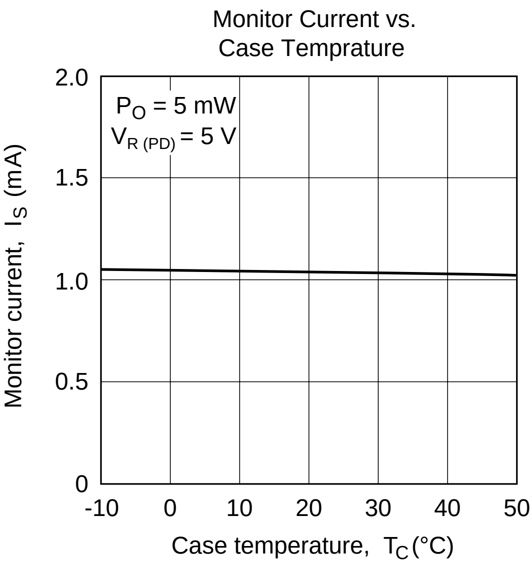


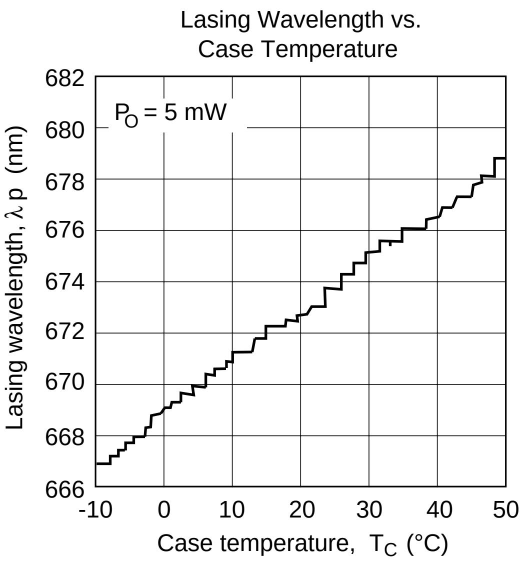


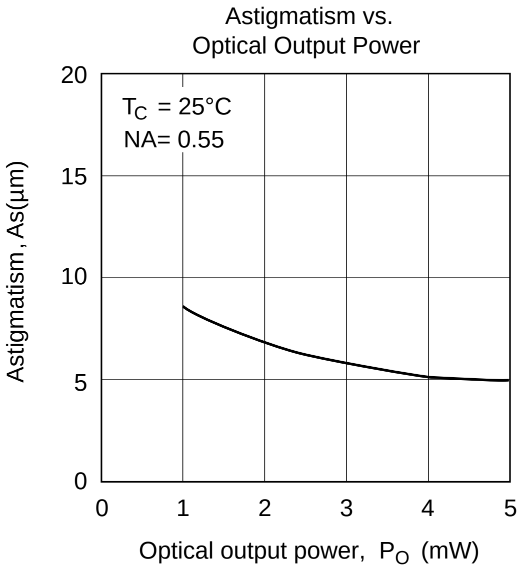


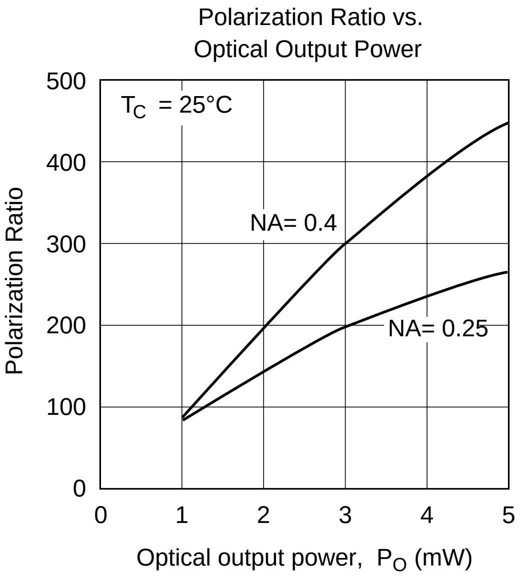


Typical Characteristic Curves (cont)









HL6726MG

Visible High Power Laser Diode

HITACHI

Description

The HL6726MG is a 0.68μm band AlGaInP laser diode (LD) with a multi-quantum well (MQW) structure. It is suitable as a light source for large capacity optical disc memories and various other types of optical equipment.

Hermetic sealing of the small package (φ5.6mm) assures high reliability.

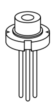
Application

- Optical disc memories

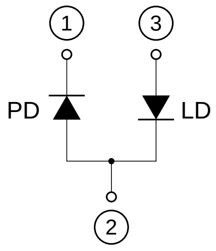
Features

- High output power: 30mW (CW)
- Visible light output: λ_P = 675 to 695nm
- Small packege: φ5.6mm dia.
- Low astigmatism: 5μm Typ (P_O = 5mW)

Package Type
- HL6726MG: MG



Internal Circuit



Absolute Maximum Ratings (T_C = 25°C)

Item	Symbol	Value	Unit
Optical output power	P_O	30	mW
Pulse optical output power	$P_{O(pulse)}$	45*[1]	mW
Laser diode reverse voltage	$V_{R(LD)}$	2	V
Photo diode reverse voltage	$V_{R(PD)}$	30	V
Operating Temperature	Topr	–10 to +60*[2]	°C
Storage temperature	Tstg	–40 to +85	°C

Note: 1. Pulse condition: Pulse width ≤ 1µs, duty ≤ 50%
2. It is recommended that this product is used within the hatched area, as shown in figure 1.

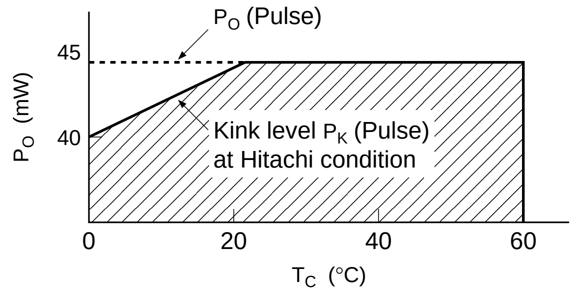
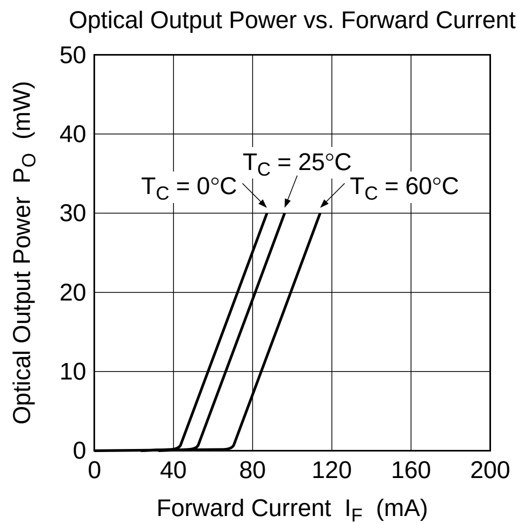


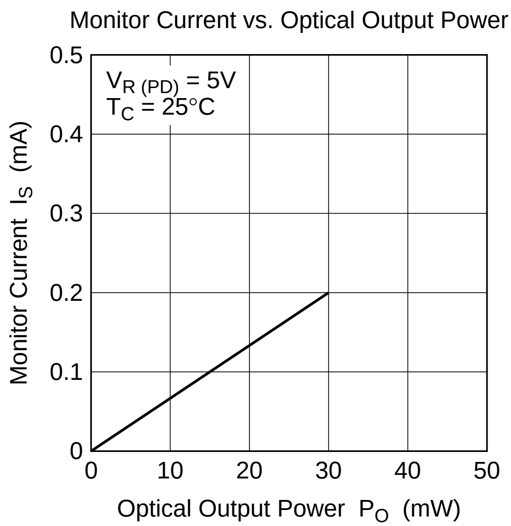
Figure 1 $P_{O(pulse)}$ vs. T_C Recommendatory Condition

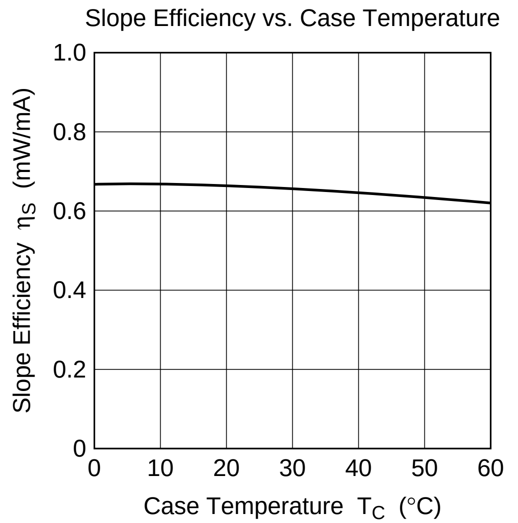
Optical and Electrical Characteristics (T_C = 25°C)

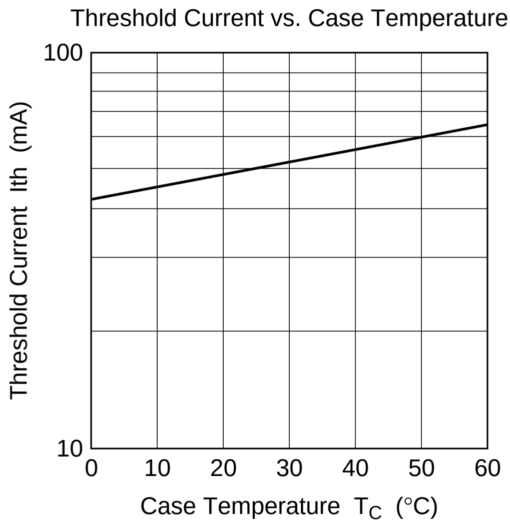
Item	Symbol	Min	Typ	Max	Unit	Test Conditions
Optical output power	P_O	30	—	—	mW	Kink free
Threshold current	Ith	30	50	70	mA	
Operating voltage	V_{OP}	2.0	2.6	2.8	V	P_O = 30mW
Slope efficiency	η_S	0.5	0.7	0.9	mW/mA	18(mW) / ($I_{(24mW)} - I_{(6mW)}$)
Lasing wavelength	λ_P	675	685	695	nm	P_O = 30mW
Beam divergence parallel to the junction	θ//	7	9	11	deg	P_O = 30mW
Beam divergence perpendicular to the junction	θ⊥	17	19	24	deg	P_O = 30mW
Monitor current	Is	0.02	0.2	0.45	mA	P_O = 30mW, $V_{R(PD)}$ = 5V
Asitgmatism	A_S	—	6	—	µm	P_O = 5mW, NA = 0.55

Typical Characteristics Curves

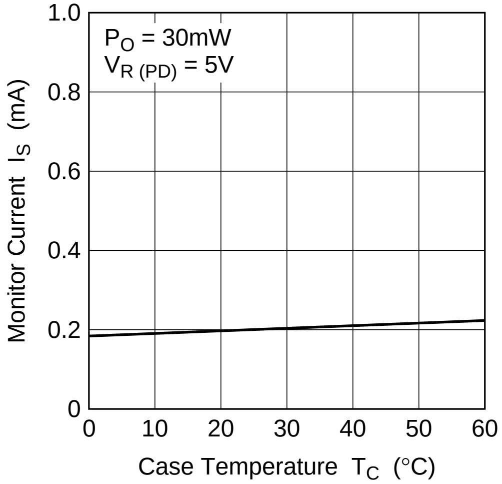




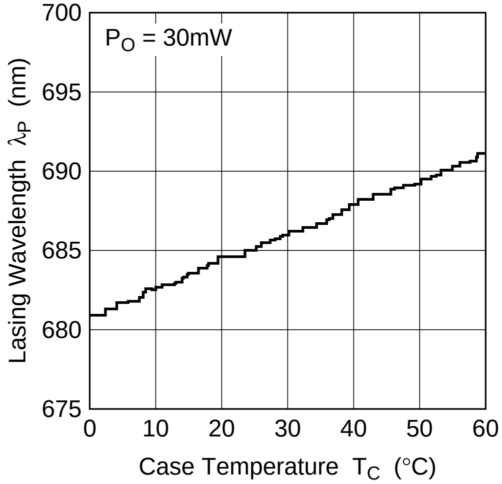




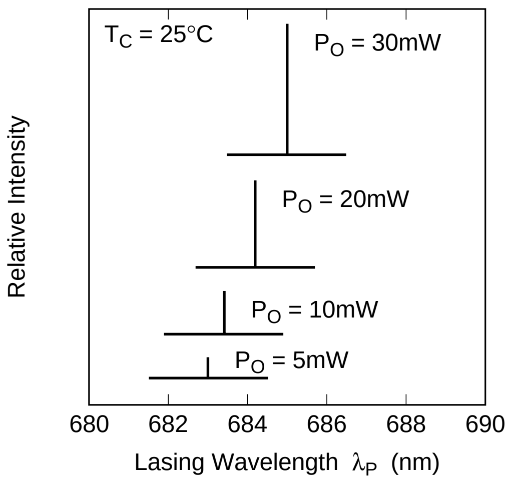
Monitor Current vs. Case Temperature



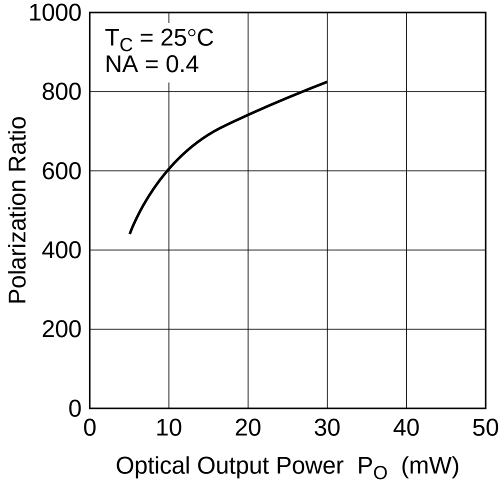
Lasing Wavelength vs. Case Temperature

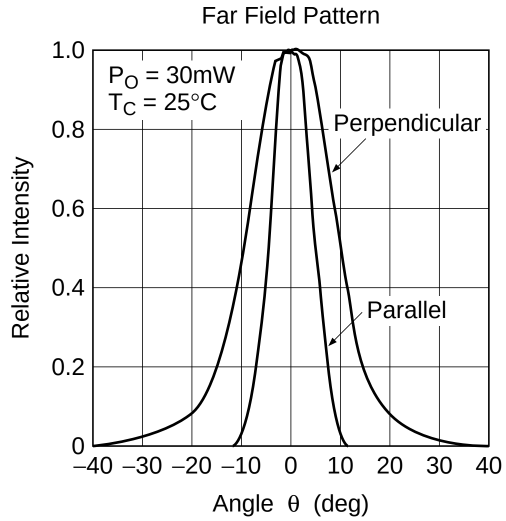


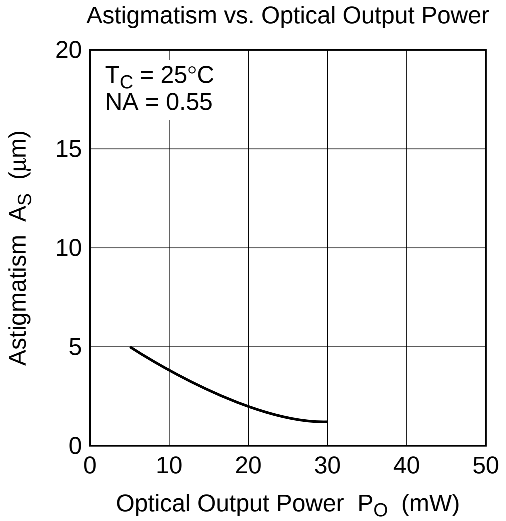
Lasing Spectrum

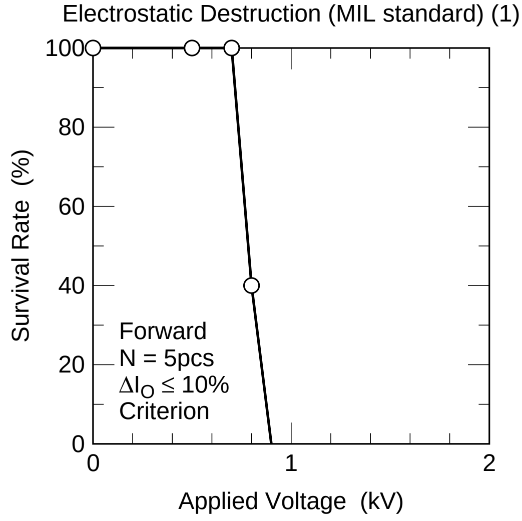


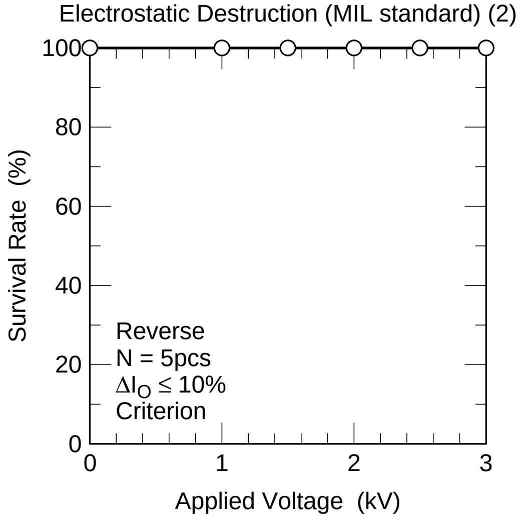
Polarization Ratio vs. Optical Output Power




Far Field Pattern
P_O = 30mW
T_C = 25°C
Perpendicular
Parallel
Relative Intensity
1.0
0.8
0.6
0.4
0.2
0
–40 –30 –20 –10 0 10 20 30 40
Angle θ (deg)


Astigmatism vs. Optical Output Power
T_C = 25°C
NA = 0.55
Astigmatism A_S (μm)
20
15
10
5
0
0 10 20 30 40 50
Optical Output Power P_O (mW)


Electrostatic Destruction (MIL standard) (1)
Survival Rate (%)
100
80
60
40
20
0
Forward
N = 5pcs
$\Delta I_O \leq$ 10%
Criterion
0 1 2
Applied Voltage (kV)


Electrostatic Destruction (MIL standard) (2)
Survival Rate (%)
100
80
60
40
20
0
Reverse
N = 5pcs
$\Delta I_O \leq$ 10%
Criterion
0 1 2 3
Applied Voltage (kV)

HL6727MG

AlGaInP Laser Diode

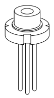
Description

The HL6727MG is a 0.68 µm band AlGalnP laser diode with a multi-quantum well (MQW) structure. It is suitable as a light source for maesurement/Alignment systems , senser, optical disk and various other types of optical equipment.

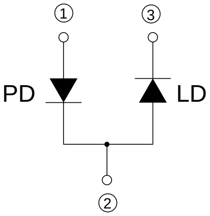
Features

- Visible light output: 690nm typ.
- Optical output power: 5 mW CW
- Low noise: S/N≥70dB
- High Temperature operation: Tc = 60°C, MTTF = 3,000h

Package Type
- HL6727MG: MG



Internal Circuit
- HL6727MG



Absolute Maximum Ratings (T_C = 25°C)

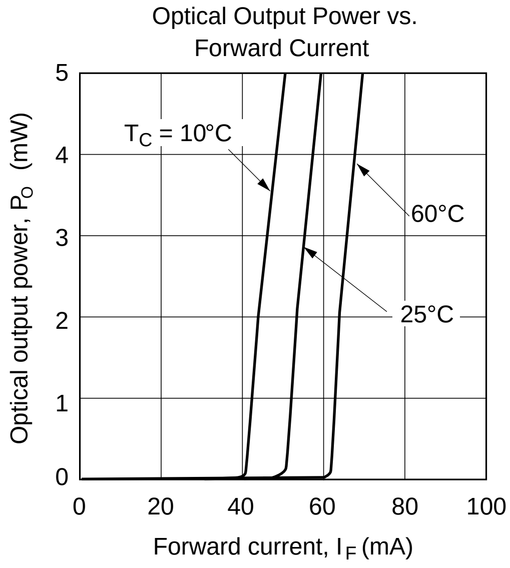
Item	Symbol	Rated Value	Unit
Optical output power	P_O	5	mW
Pulse optical output power	$P_{O\ (pulse)}$	6*1	mW
LD reverse voltage	$V_{R\ (LD)}$	2	V
PD reverse voltage	$V_{R\ (PD)}$	30	V
Operating temperature	T_{opr}	–10 to +60	°C
Storage temperature	T_{stg}	–40 to +85	°C

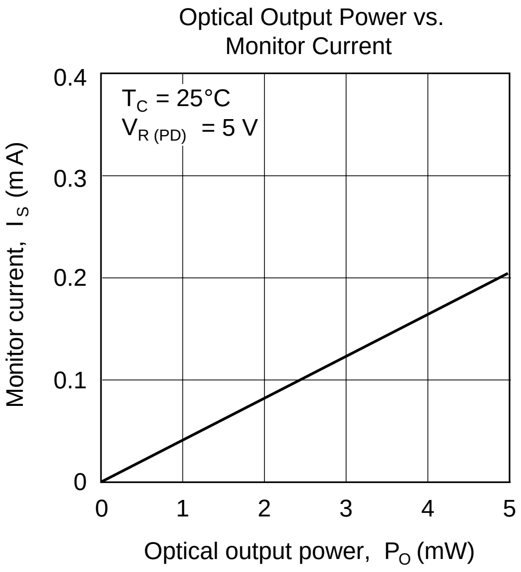
Note: 1. Pulse condition: Pulse width ≤1µs, duty ≤50%

Optical and Electrical Characteristics (T_C = 25°C)

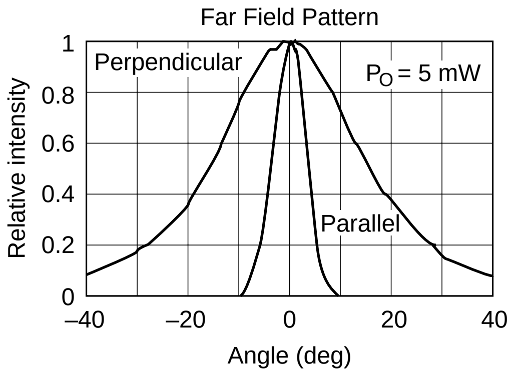
Item	Symbol	Min	Typ	Max	Unit	Test Conditions
Optical output power	P_O	5	—	—	mW	Kink free
Threshold current	I_{th}	—	55	75	mA	
Operating current	I_{op}	—	60	85	mA	P_O = 5 mW
Operating voltage	V_{op}	—	—	3.0	V	P_O = 5 mW
Lasing wavelength	λ_p	680	690	695	nm	P_O = 5 mW
Beam divergence (parallel)	$\theta_{//}$	5	8	11	deg.	P_O = 5 mW
Beam divergence (perpendicular)	$\theta_{\perp}$	24	33	40	deg.	P_O = 5 mW
Monitor current	I_S	0.1	—	—	mA	P_O = 5 mW, $V_{R(PD)}$ = 5 V
Noise characteristic	S/N	70	—	—	dB	P_O = 5 mW, f = 8MHz Δf = 30kHz, F.B = 0.5%

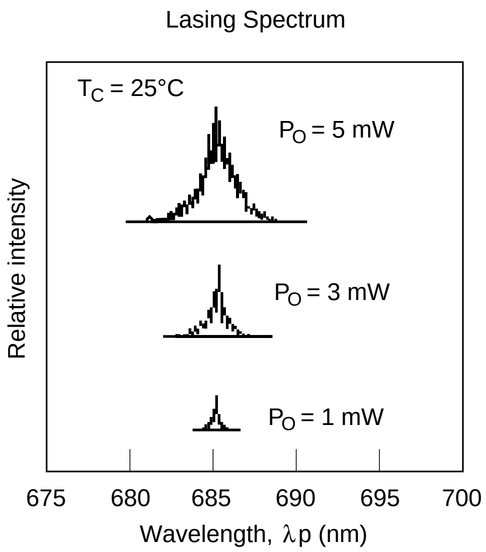
Typical Characteristic Curves

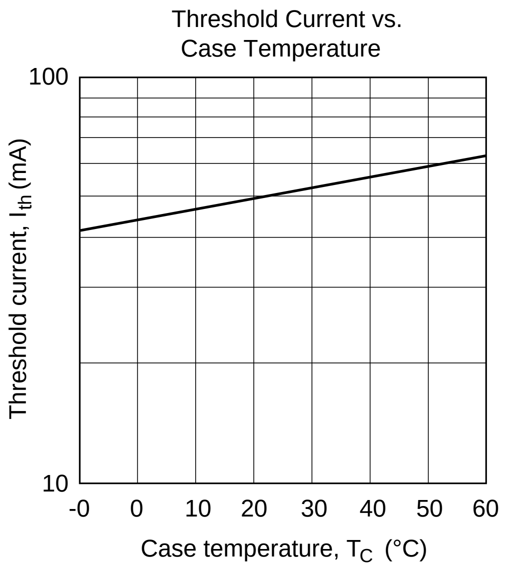


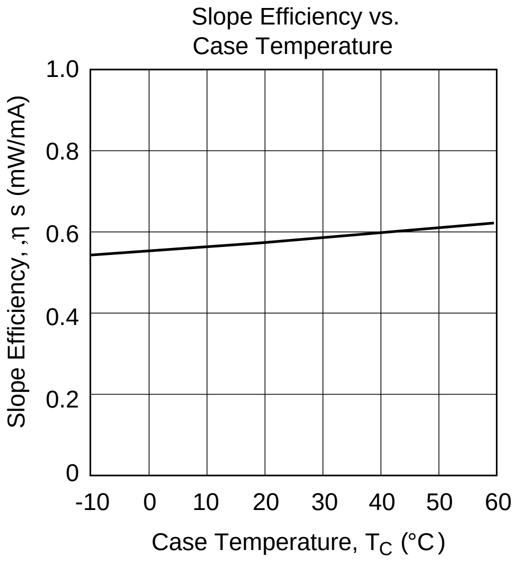


Typical Characteristic Curves (cont)



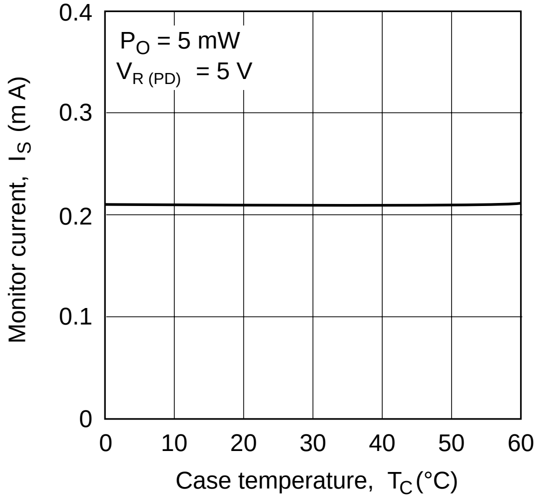




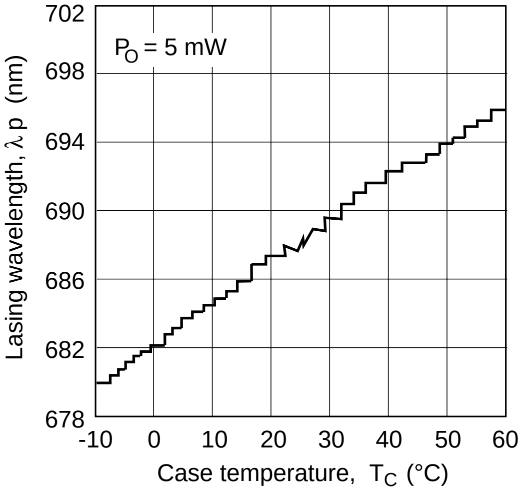


Typical Characteristic Curves (cont)

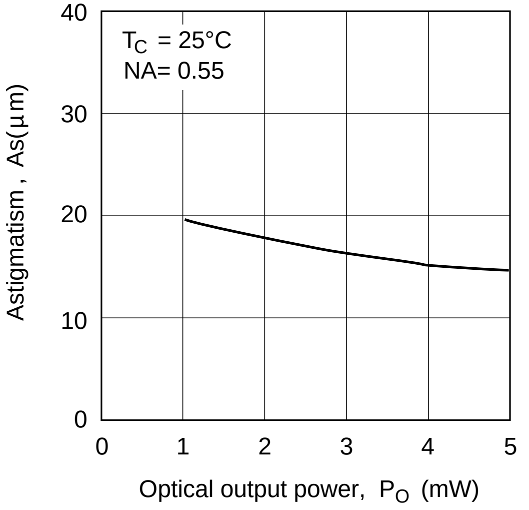
Monitor Current vs.
Case Temprature



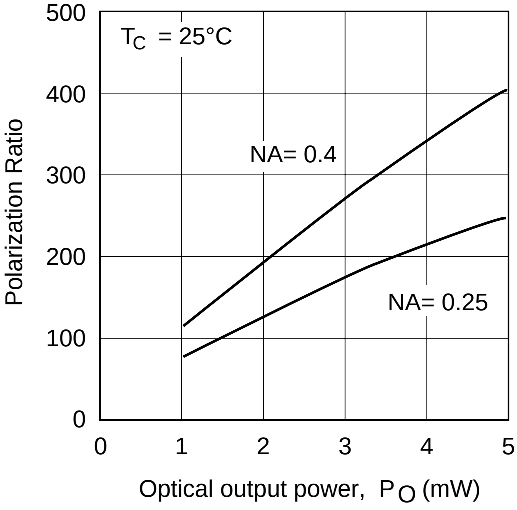
Lasing Wavelength vs.
Case Temperature



Astigmatism vs.
Optical Output Power



Polarization Ratio vs.
Optical Output Power



HL6733FM

Visible High Power Laser Diode

HITACHI

ADE-208-516A (Z)
2nd Edition
Dec. 1997

Description

The HL6733FM is a 0.68 µm band AlGaInP laser diode (LD) with a multi-quantum well (MQW) structure. It is suitable as a light source for large capacity optical disc memories and various other types of optical equipment.

It does not have a photodiode, and the GND pin is not connected with the LD chip.The outline is the same as MG-type (5.6 mmϕ).

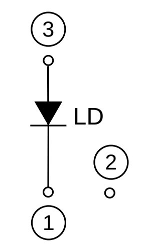
Application

- Optical disc memories.
- Optical equipment

Features

- High output power : 35 mW (CW)
- Visible light output : λp = 675 to 695 nm
- Small package : ϕ 5.6 mm
- Low astigmatism : 6 µm Typ (P_O = 5 mW)

Internal Circuit



Hitachi semiconductor

Absolute Maximum Ratings (T_C = 25°C)

Item	Symbol	Value	Unit
Optical output power	P_O	35	mW
Pulse optical output power	P_O (pulse)	50 *	mW
Laser diode reverse voltage	$V_{R(LD)}$	2	V
Operating temperature	Topr	–10 to +70	°C
Storage temperature	Tstg	–40 to +85	°C

Note: Pulse condition : Pulse width = 100 ns, duty = 50%

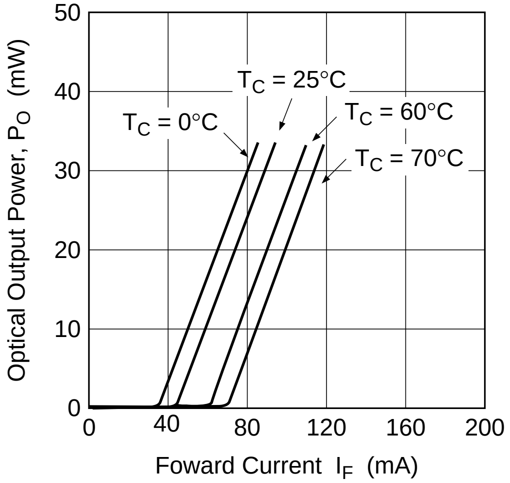
Optical and Electrical Characteristics (T_C = 25°C)

Items	Symbols	Min	Typ	Max	Units	Test Conditions
Optical output power	P_O	35	—	—	mW	Kink free *
Pluse optical output power	$P_{O(pulse)}$	50	—	—	mW	Kink free *
Threshold current	Ith	30	45	70	mA	—
Operating voltage	V_{OP}	2.1	2.5	2.8	V	P_O = 30 mW
Slope efficiency	ηs	0.5	0.7	0.9	mW/mA	18(mW)/($I_{(24mW)}$–$I_{(6mW)}$)
Lasing wavelength	λp	675	690	695	nm	P_O = 30 mW
Beam divergence parallel to the junction	θ//	7	8.5	11	deg.	P_O = 30 mW
Beam divergence parpendicular to the junction	θ⊥	17	19	23	deg.	P_O = 30 mW
Asitgmatism	A_S	—	6	—	µm	P_O = 5 mW, NA = 0.55

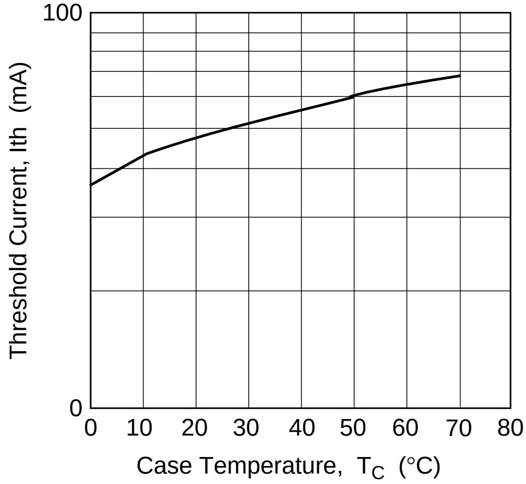
Note: Kink free is confirmed at the temperature of 25°C.

Curve Characteristics

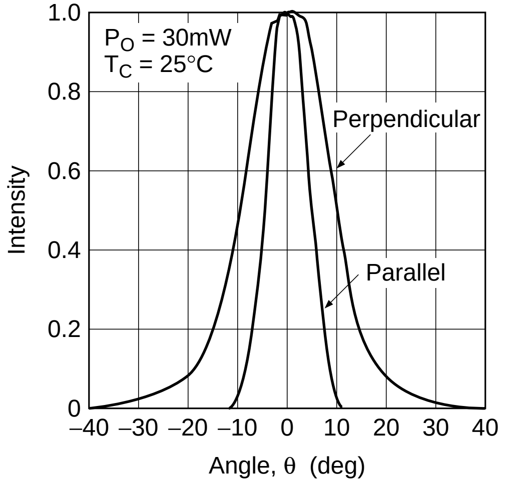
Optical Output Powervs.Forward Current



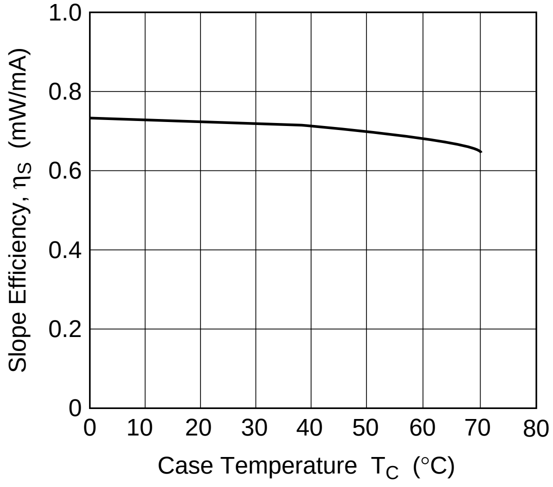
Threshold Current vs. Case Temperature

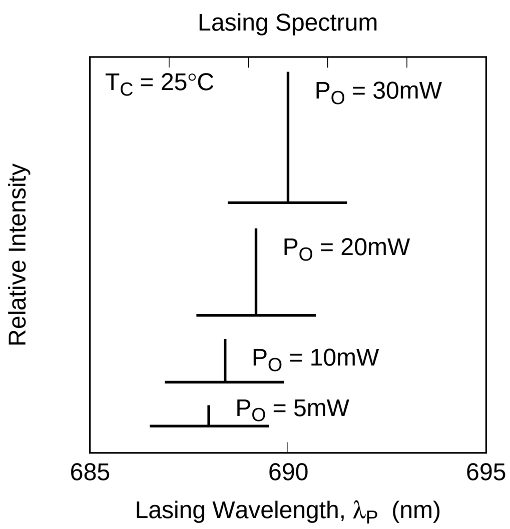


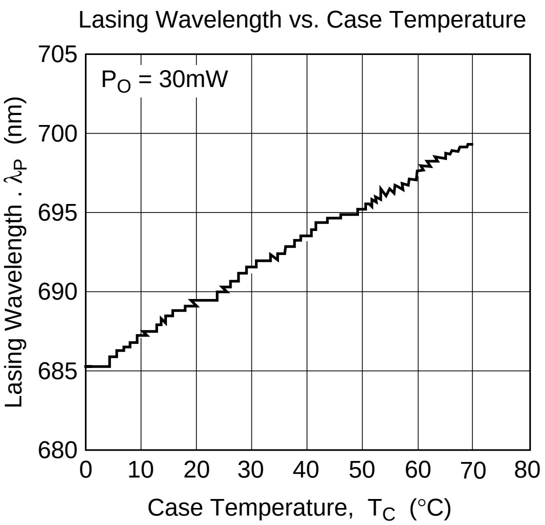
Far Feild Pattern

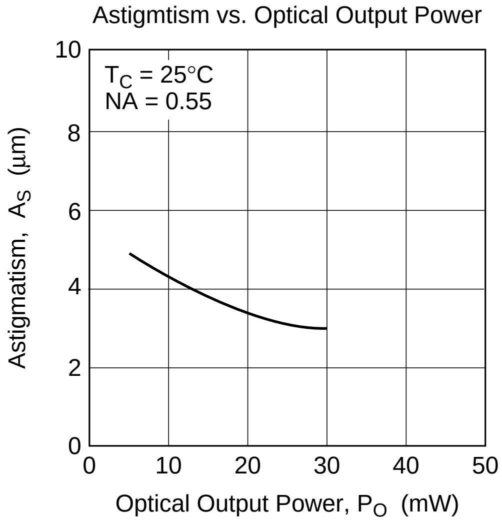


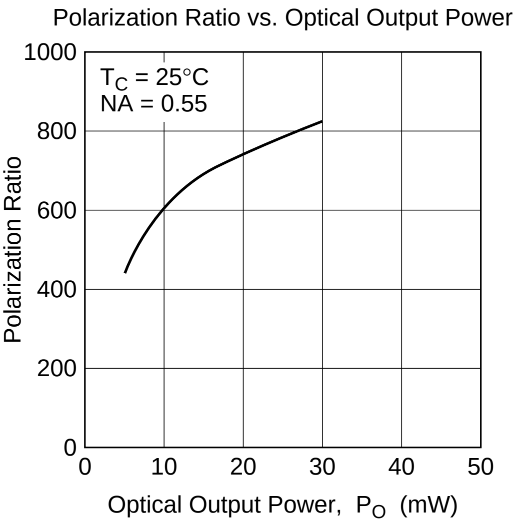
Slope Efficiency vs. Case Temperature

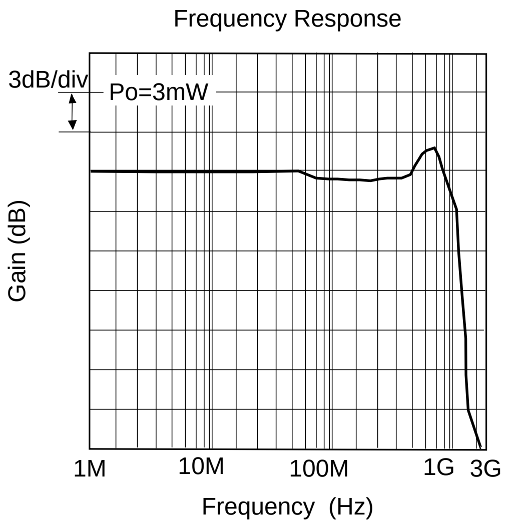


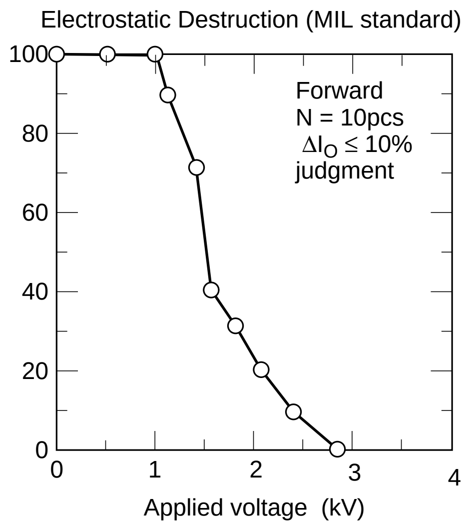

Lasing Spectrum
T_C = 25°C
P_O = 30mW
P_O = 20mW
P_O = 10mW
P_O = 5mW
Relative Intensity
685
690
695
Lasing Wavelength, λ_P (nm)


Lasing Wavelength vs. Case Temperature
P_O = 30mW
Lasing Wavelength . λ_P (nm)
705
700
695
690
685
680
0
10
20
30
40
50
60
70
80
Case Temperature, T_C (°C)

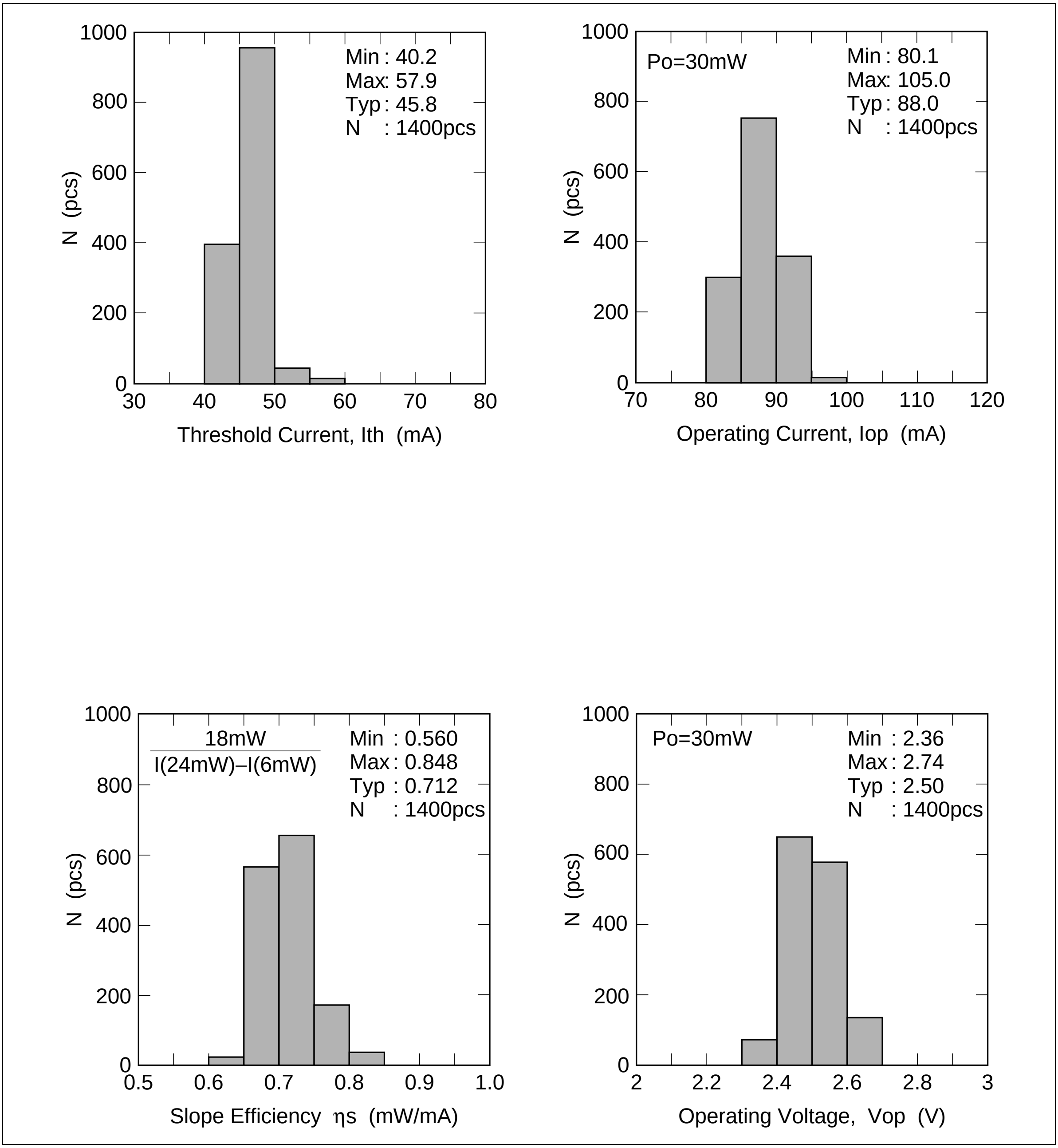

Astigmtism vs. Optical Output Power
T_C = 25°C
NA = 0.55
Astigmatism, A_S (µm)
10
8
6
4
2
0
0
10
20
30
40
50
Optical Output Power, P_O (mW)

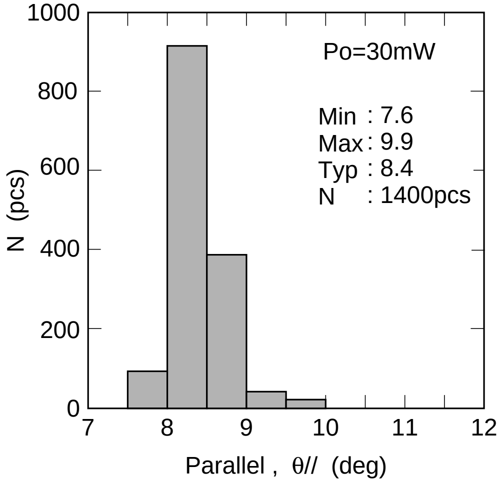

Polarization Ratio vs. Optical Output Power
T_C = 25°C
NA = 0.55
Polarization Ratio
1000
800
600
400
200
0
0
10
20
30
40
50
Optical Output Power, P_O (mW)

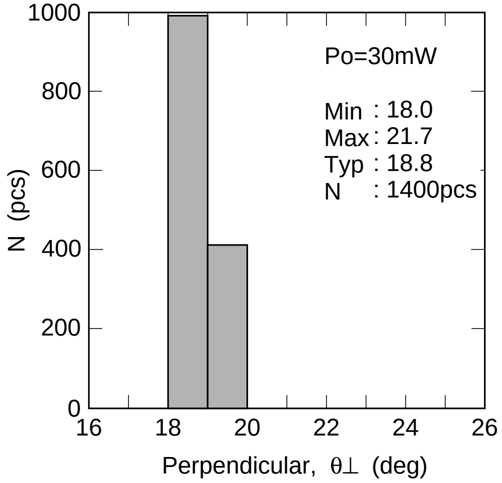

Frequency Response
3dB/div
Po=3mW
Gain (dB)
1M
10M
100M
1G
3G
Frequency (Hz)

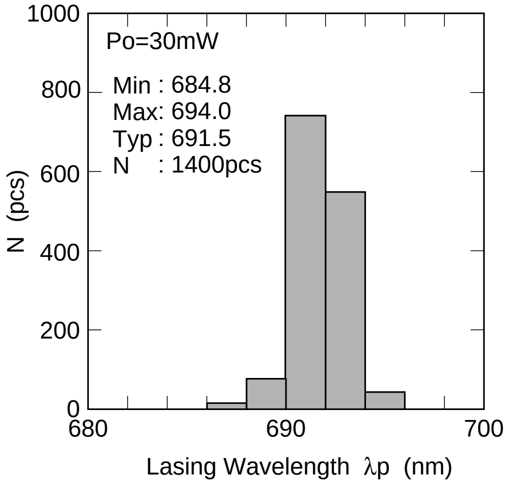

Electrostatic Destruction (MIL standard)
Forward
N = 10pcs
ΔIO ≤ 10%
judgment
100
80
60
40
20
0
0
1
2
3
4
Applied voltage (kV)

Characteristics Distribution



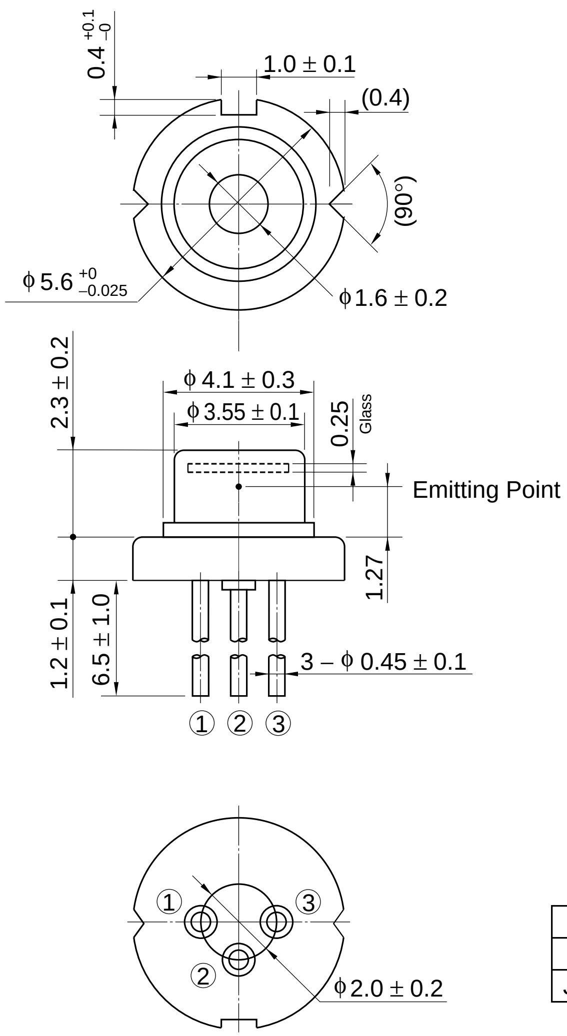

Po=30mW
Min : 7.6
Max : 9.9
Typ : 8.4
N : 1400pcs
N (pcs)
Parallel , θ// (deg)

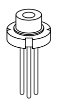

Po=30mW
Min : 18.0
Max : 21.7
Typ : 18.8
N : 1400pcs
N (pcs)
Perpendicular, θ⊥ (deg)


Po=30mW
Min : 684.8
Max: 694.0
Typ : 691.5
N : 1400pcs
N (pcs)
Lasing Wavelength λp (nm)

Package Dimensions

Unit: mm





Hitachi code	LD/FM
EIAJ code	—
JEDEC code	—

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HL7836MG

GaAlAs Laser Diode

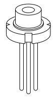
Description

The HL7836MG is a 0.78 µm band GaAlAs laser diode with a double heterojunction structure. It is designed to be used with a unitary positive voltage power supply, and is appropriate as a light source for various optical application devices, including laser beam printers and laser levellers.

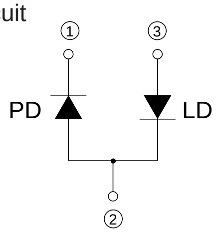
Features

- Visible light output: λ_p = 770 to 795 nm
- Built-in monitor photodiode
- Astigmatism: A_S = 3 µm Typ.
- Single longitudinal mode lasing

Package Type
- HL7836MG: MG



- Internal Circuit



Absolute Maximum Ratings (T_C = 25°C)

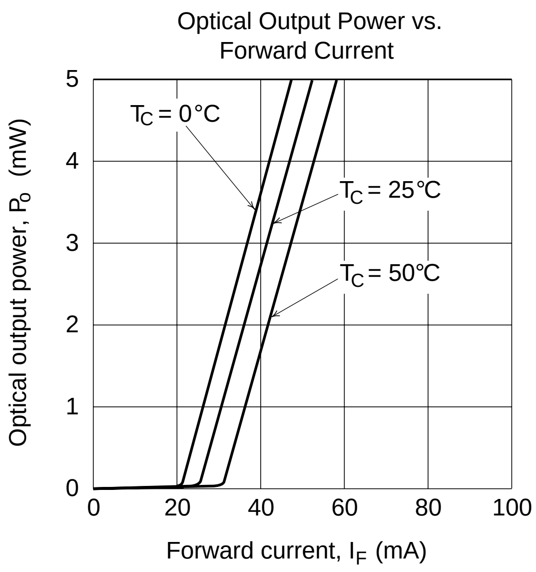
Item	Symbol	Rated Value	Unit
Optical output power	P_O	5	mW
Pulsed optical output power	$P_{O\ (pulse)}$	6*1	mW
LD reverse voltage	$V_{R\ (LD)}$	2	V
PD reverse voltage	$V_{R\ (PD)}$	30	V
Operating temperature	T_{opr}	–10 to +60	°C
Storage temperature	T_{stg}	–40 to +85	°C

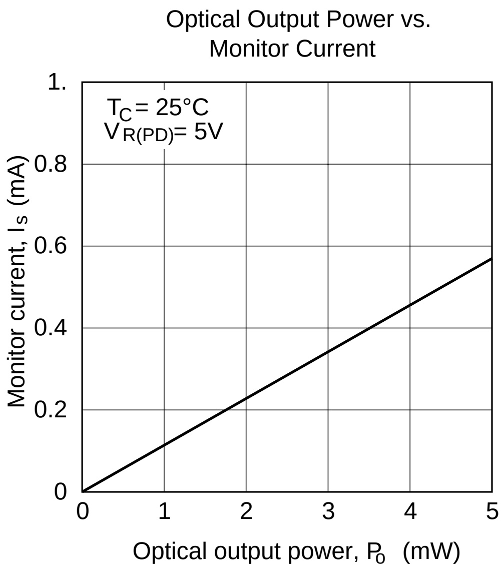
Note: 1. At a duty cycle under 50% and pulse widths under 1µs

Optical and Electrical Characteristics (T_C = 25°C)

Item	Symbol	Min	Typ	Max	Unit	Test Conditions
Optical output power	P_O	5	—	—	mW	Kink free
Threshold current	I_{th}	—	—	70	mA	
Slope efficiency	η	0.1	0.25	0.45	mW/mA	3 mW/$I_{(4\ mW)} - I_{(1\ mW)}$
LD operating voltage	V_{op}	—	—	2.7	V	P_O = 5 mW
Lasing wavelength	λ_p	770	785	795	nm	P_O = 5 mW
Beam divergence (parallel)	$\theta_{//}$	8	11	16	deg.	P_O = 5 mW
Beam divergence (perpendicular)	$\theta_{\perp}$	20	27	35	deg.	P_O = 5 mW
Monitor current	I_S	0.25	0.6	1.0	P_O = 5 mW, $V_{R\ (PD)}$ = 5 V	

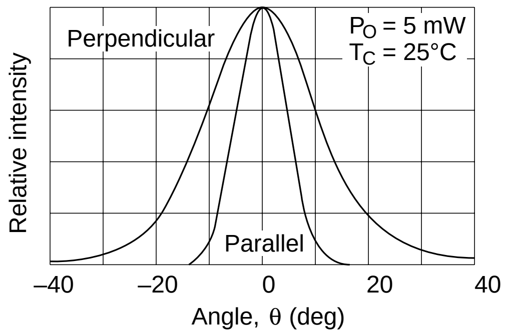
Typical Characteristic Curves.



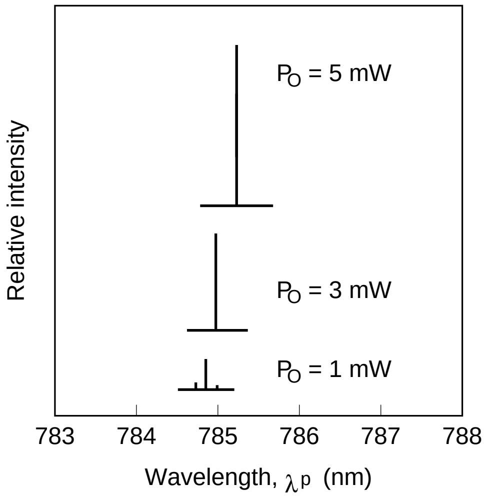


Typical Characteristics Curves (cont)

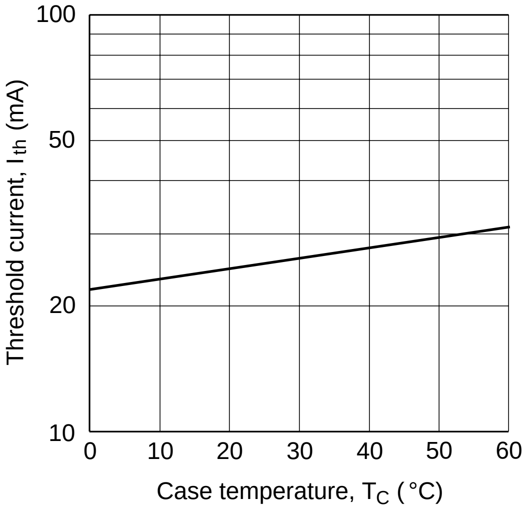
Far Field Pattern



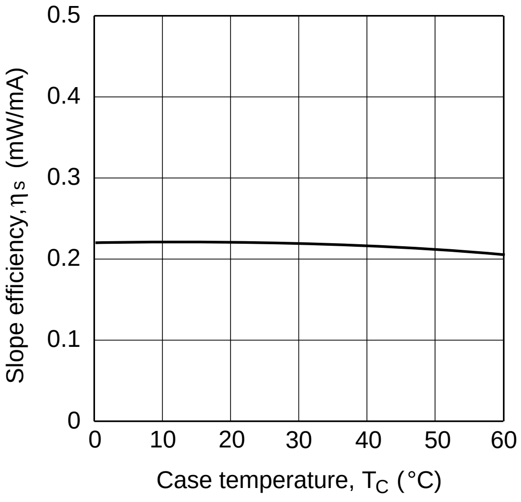
Lasing Spectrum



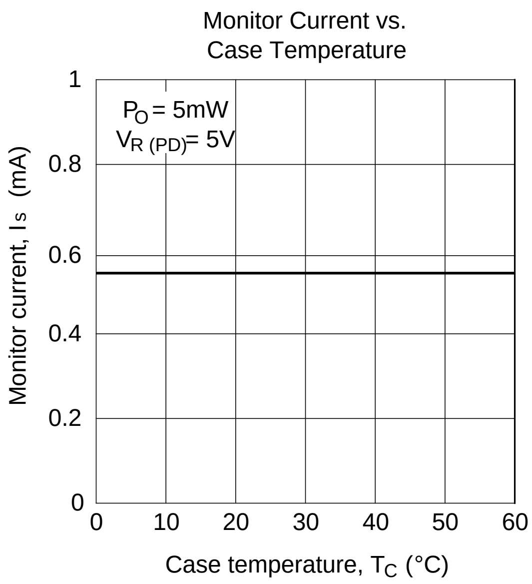
Threshold Current vs.
Case Temperature

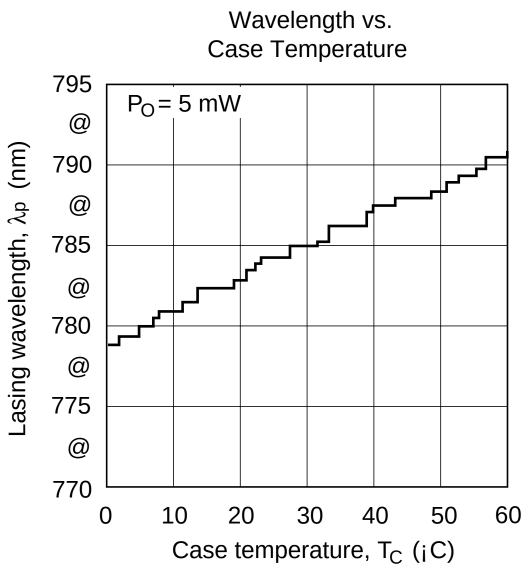


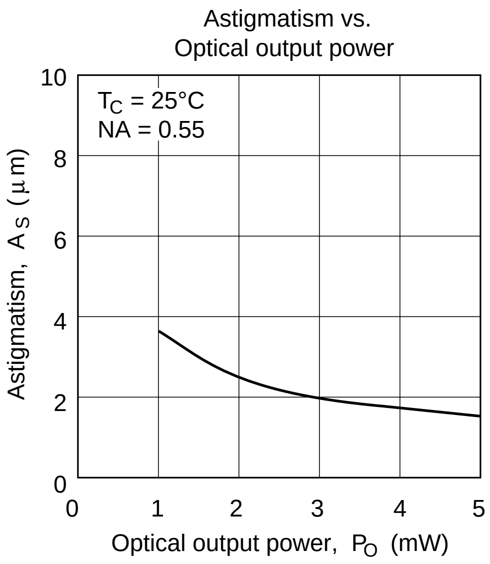
Slope Efficiency vs.
Case Temperature

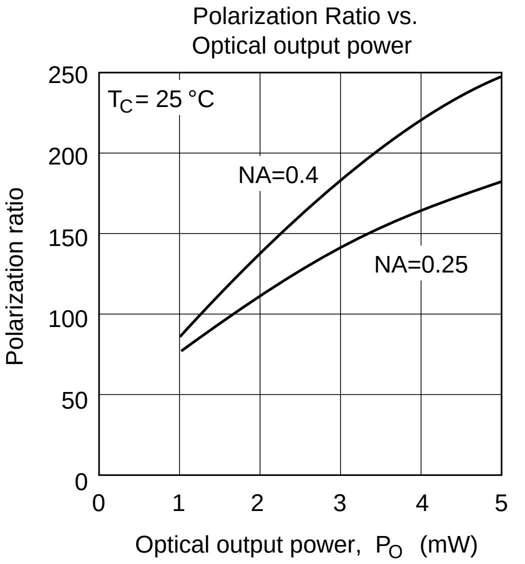


Typical Characteristics Curves (cont)









HL7843MG

GaAlAs Laser Diode

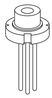
Description

The HL7843MG is a 0.78 µm band GaAlAs laser diode with a multi-quantum well (MQW) structure. It is especially suitable as a light source for laser beam printers with its low threshold current and low slope efficiency. Hermetic sealing of the package assures high reliability.

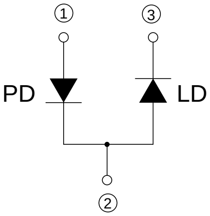
Features

- Visible light output: λ_p =775 to 795 nm
- Low slope efficiency: 0.2 mW/mA Typ.
- Low threshold current: 15 mA Typ.
- Low astigmatism: 5 µm Typ.
- Built-in monitor photodiode

Package Type
- HL7843MG: MG



Internal Circuit



Absolute Maximum Ratings (T_C = 25°C)

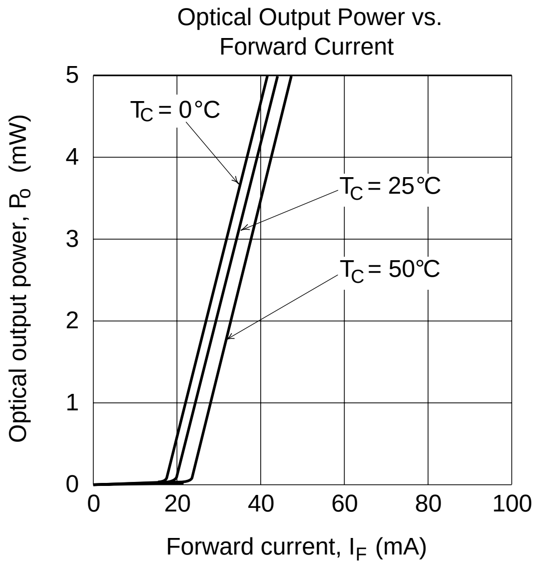
Item	Symbol	Rated Value	Unit
Optical output power	P_O	5	mW
Pulsed optical output power	$P_{O\ (pulse)}$	6*1	mW
LD reverse voltage	$V_{R\ (LD)}$	2	V
PD reverse voltage	$V_{R\ (PD)}$	30	V
Operating temperature	T_{opr}	–10 to +60	°C
Storage temperature	T_{stg}	–40 to +85	°C

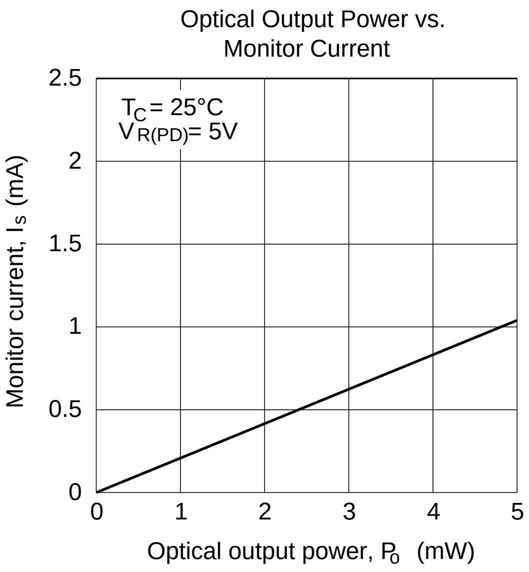
Note: 1. Maximum 50% duty cycle, maximum 1 µs pulse width

Optical and Electrical Characteristics (T_C = 25°C)

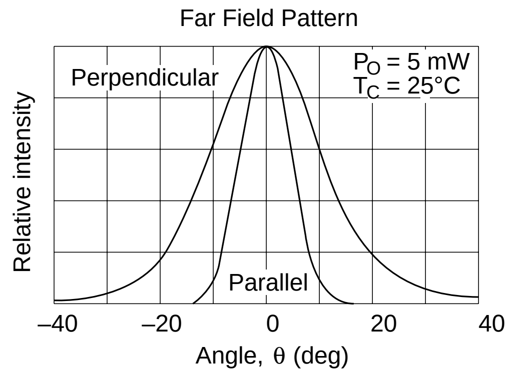
Item	Symbol	Min	Typ	Max	Unit	Test Conditions
Optical output power	P_O	5	—	—	mW	Kink free
Threshold current	I_{th}	10	15	30	mA	
Slope efficiency	η	0.1	0.2	0.35	mW/mA	3 mW/$I_{(4\ mW)} - I_{(1\ mW)}$
LD operating voltage	V_{op}	—	—	2.3	V	P_O = 5 mW
Lasing wavelength	λ_p	775	785	795	nm	P_O = 5 mW
Beam divergence (parallel)	$\theta_{//}$	8	10	13	deg.	P_O = 5 mW
Beam divergence (perpendicular)	$\theta_{\perp}$	20	24	30	deg.	P_O = 5 mW
Monitor current	I_S	0.5	1.0	1.5	mA	P_O = 5 mW, V_R = 5 V
Astigmatism	A_S	—	5	—	µm	P_O = 5 mW, NA = 0.55
Droop	$-R_{th}$	—	—	10	%	P_O = 5 mW, f = 600 Hz

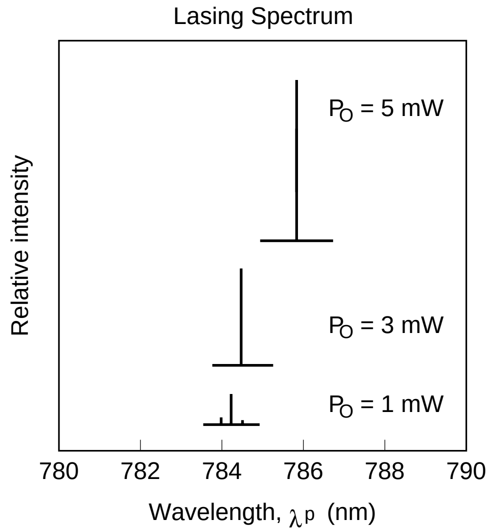
Typical Characteristic Curves.

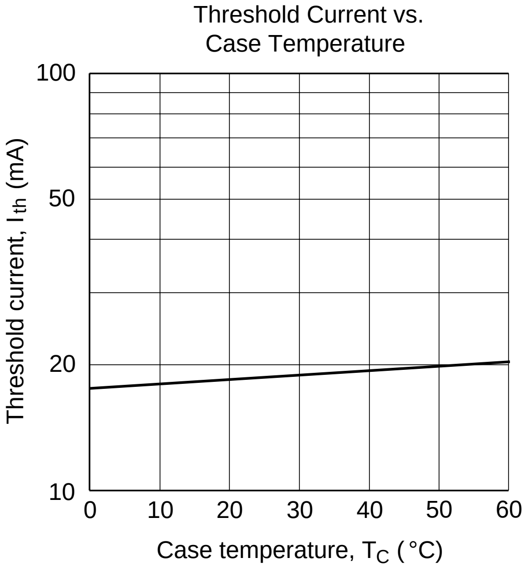


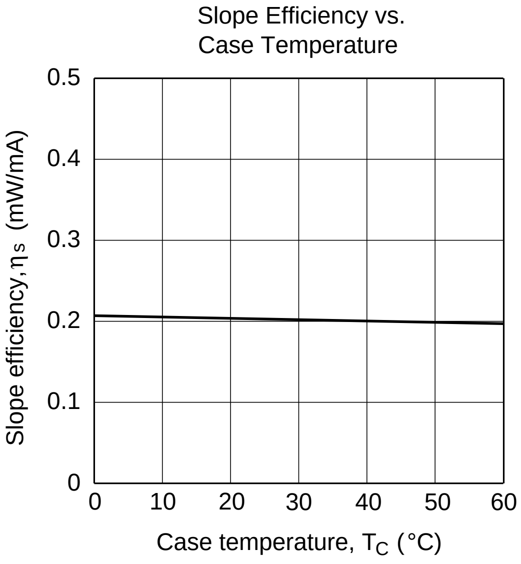


Typical Characteristics Curves (cont)



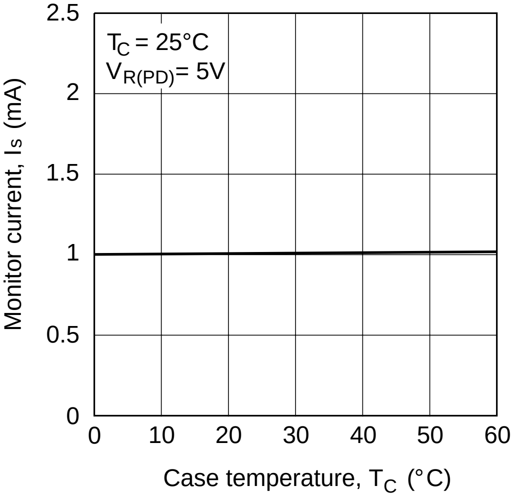




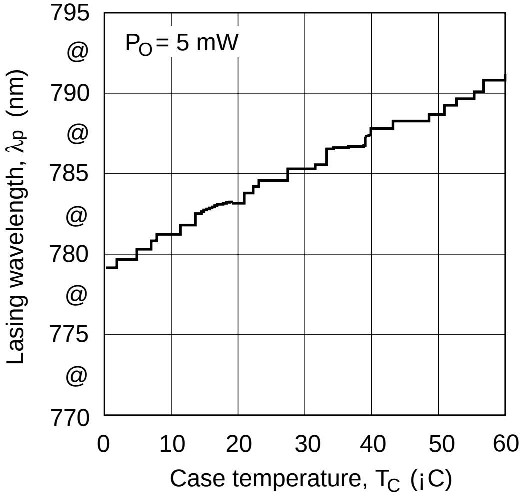


Typical Characteristics Curves (cont)

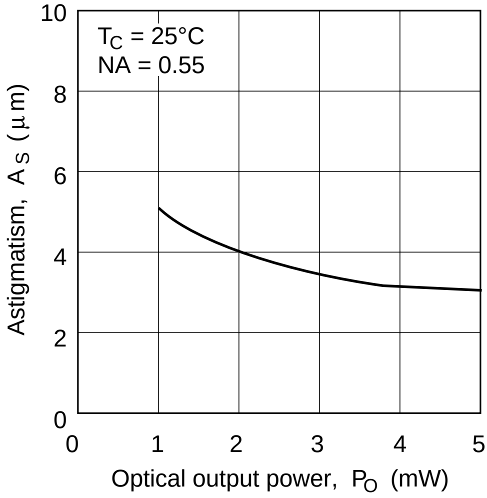
Monitor Current vs.
Case Temperature



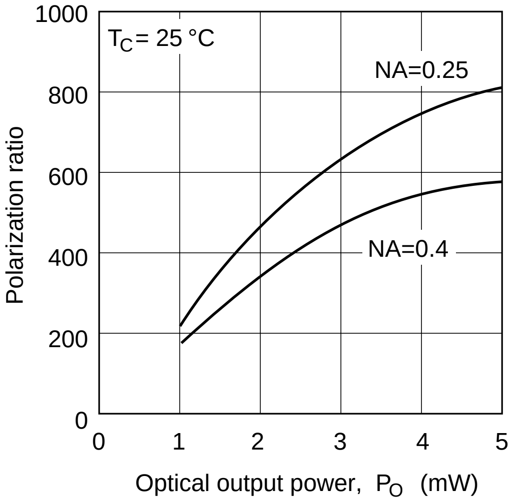
Wavelength vs.
Case Temperature



Astigmatism vs.
Optical output power



Polarization Ratio vs.
Optical output power



HL7851G

GaAlAs Laser Diode

Description

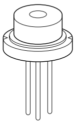
The HL7851G is a high power 0.78 µm band GaAlAs laser diode with a multi-quantum well (MQW) structure. It is suitable as a light source for optical disk memories, levelers and various other types of optical equipment. Hermetic sealing of the package assures high reliability.

Features

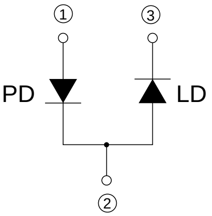
- Visible light output: λ_p = 785 nm Typ.
- Small beam ellipticity: 9.5:23
- High output power: 50 mW (CW)
- Built-in monitor photodiode

Package Type

- HL7851G: G2



Internal Circuit



Absolute Maximum Ratings (T_C = 25°C)

Item	Symbol	Rated Value	Unit
Optical output power	P_O	50	mW
Pulsed optical output power	$P_{O\ (pulse)}$	60[*1]	mW
LD reverse voltage	$V_{R\ (LD)}$	2	V
PD reverse voltage	$V_{R\ (PD)}$	30	V
Operating temperature	T_{opr}	–10 to +60	°C
Storage temperature	T_{stg}	–40 to +85	°C

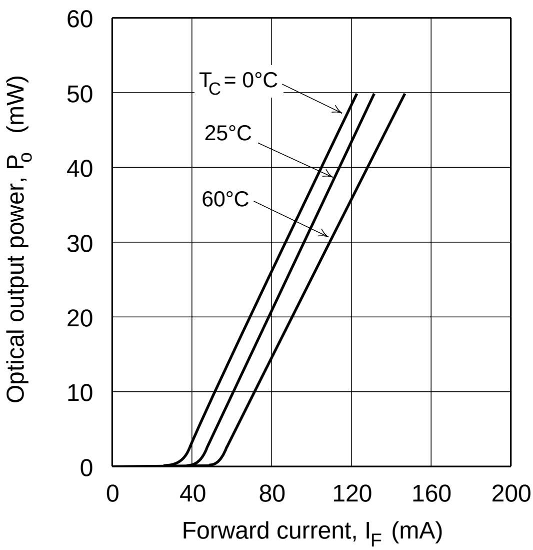
Note: 1. Maximum 50% duty cycle, maximum 1 µs pulse width

Optical and Electrical Characteristics (T_C = 25 ±3°C)

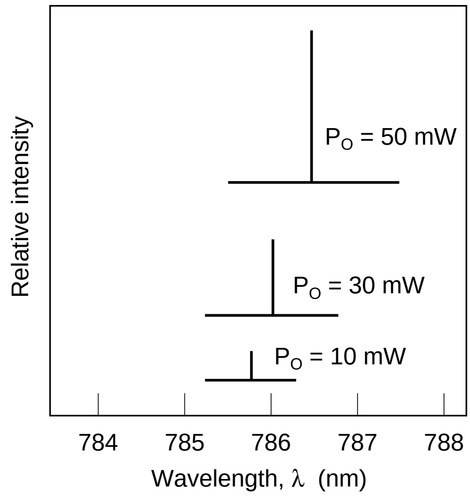
Item	Symbol	Min	Typ	Max	Unit	Test Conditions
Optical output power	P_O	50	—	—	mW	Kink free
Threshold current	I_{th}	—	45	70	mA	
Slope efficiency	η	0.35	0.55	0.7	mW/mA	$\frac{40\ (mW)}{I_{(45\ mW)} - I_{(5\ mW)}}$
Operating current	I_{op}	—	140	170	mA	P_O = 50 mW
LD Operating voltage	V_{op}	—	2.3	2.7	V	P_O = 50 mW
Lasing wavelength	λ_p	775	785	795	nm	P_O = 50 mW
Beam divergence (parallel)	$\theta_{//}$	8	9.5	12	deg.	P_O = 50 mW, FWHM
Beam divergence (perpendicular)	$\theta_{\perp}$	18	23	28	deg.	P_O = 50 mW, FWHM
Monitor current	I_S	25	—	150	µA	P_O = 5 mW, $V_{R\ (PD)}$ = 5 V
Astigmatism	A_S	—	5	—	µm	P_O = 5 mW, NA = 0.4

Typical Characteristic Curves

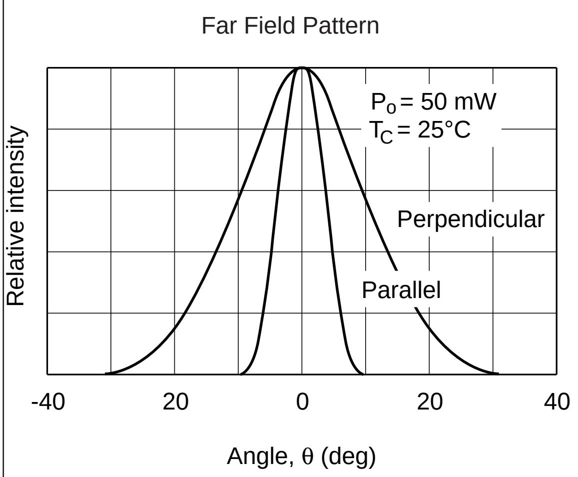
Optical Output Power vs. Forward Current

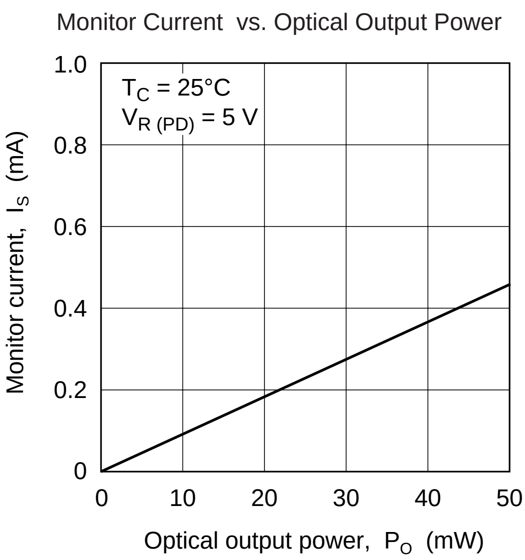


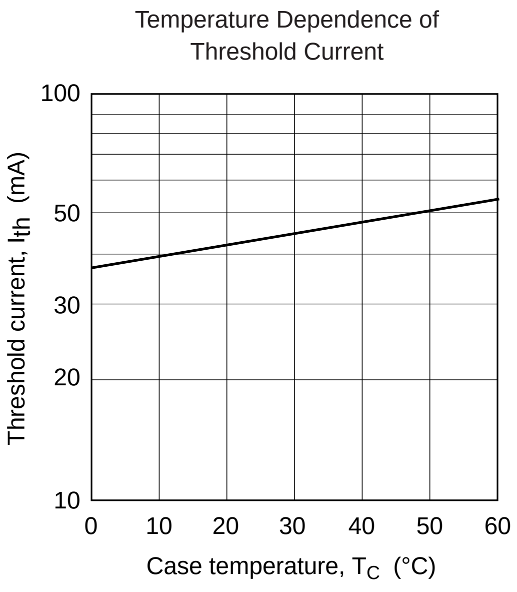
Lasing Spectrum

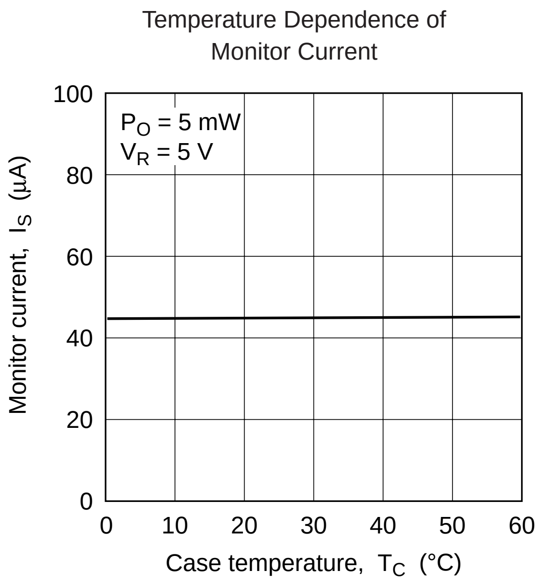


Typical Characteristic Curves (cont)



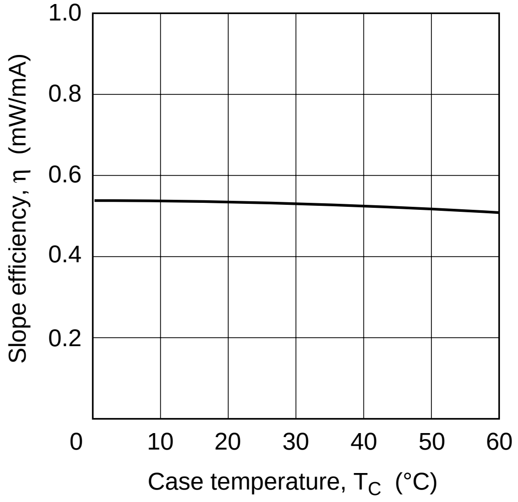




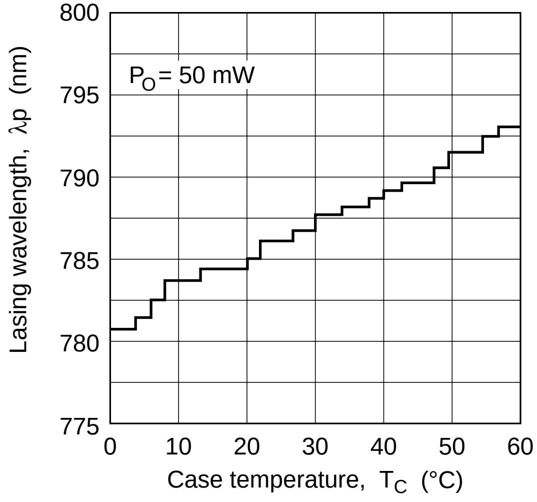


Typical Characteristic Curves (cont)

Temperature Dependence of Slope Efficiency



Temperature Dependence of Lasing Wavelength



HL7852G

GaAlAs Laser Diode

Description

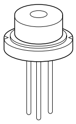
The HL7852G is a high power 0.78 µm band GaAlAs laser diode with a multi-quantum well (MQW) structure. It is suitable as a light source for optical disk memories, levelers and various other types of optical equipment. Hermetic sealing of the package assures high reliability.

Features

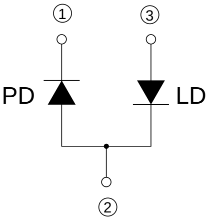
- Visible light output: λ_p = 785 nm Typ.
- Small beam ellipticity: 9.5:23
- High output power: 50 mW (CW)
- Built-in monitor photodiode

Package Type

- HL7852G: G2



Internal Circuit



Absolute Maximum Ratings (T_C = 25°C)

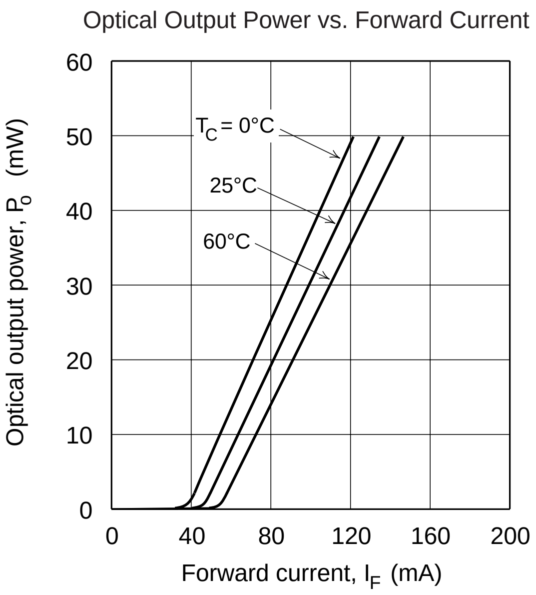
Item	Symbol	Rated Value	Unit
Optical output power	P_O	50	mW
Pulsed optical output power	$P_{O\ (pulse)}$	60*1	mW
LD reverse voltage	$V_{R\ (LD)}$	2	V
PD reverse voltage	$V_{R\ (PD)}$	30	V
Operating temperature	T_{opr}	–10 to +60	°C
Storage temperature	T_{stg}	–40 to +85	°C

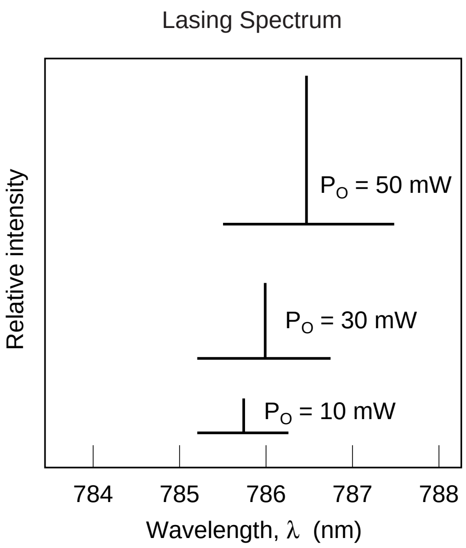
Note: 1. Maximum 50% duty cycle, maximum 1 µs pulse width

Optical and Electrical Characteristics (T_C = 25 ±3°C)

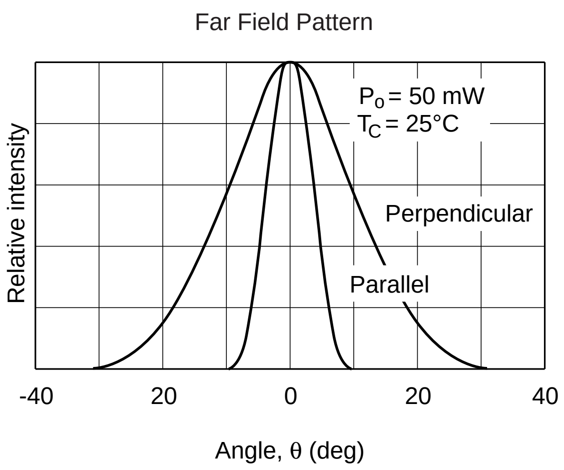
Item	Symbol	Min	Typ	Max	Unit	Test Conditions
Optical output power	P_O	50	—	—	mW	Kink free
Threshold current	I_{th}	—	45	70	mA	
Slope efficiency	η	0.35	0.55	0.7	mW/mA	$\frac{40\ (\text{mW})}{I_{(45\ \text{mW})} - I_{(5\ \text{mW})}}$
Operating current	I_{op}	—	140	170	mA	P_O = 50 mW
LD Operating voltage	V_{op}	—	2.3	2.7	V	P_O = 50 mW
Lasing wavelength	λ_P	775	785	795	nm	P_O = 50 mW
Beam divergence (parallel)	$\theta_{//}$	8	9.5	12	deg.	P_O = 50 mW, FWHM
Beam divergence (perpendicular)	$\theta_{\perp}$	18	23	28	deg.	P_O = 50 mW, FWHM
Monitor current	I_S	25	—	150	µA	P_O = 5 mW, $V_{R\ (PD)}$ = 5 V
Astigmatism	A_S	—	5	—	µm	P_O = 5 mW, NA = 0.4

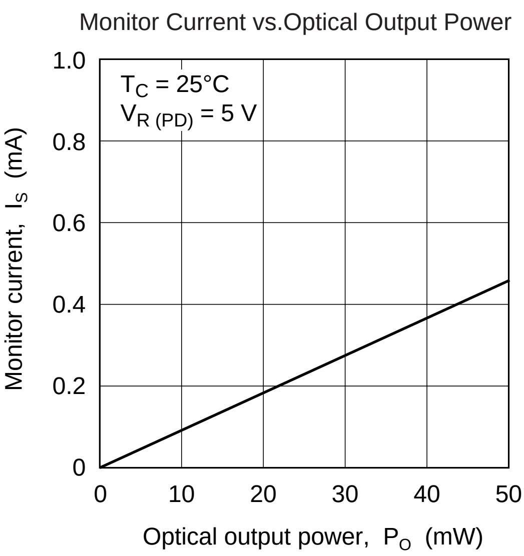
Typical Characteristic Curves

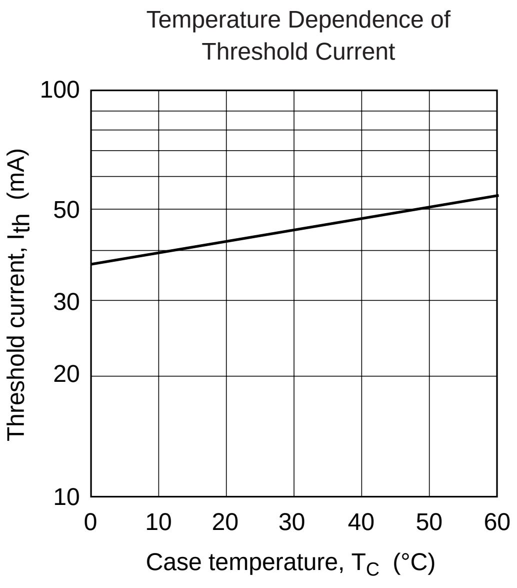


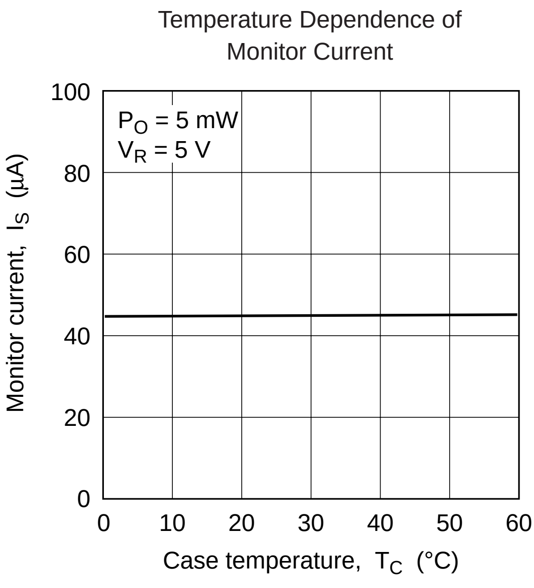


Typical Characteristic Curves (cont)

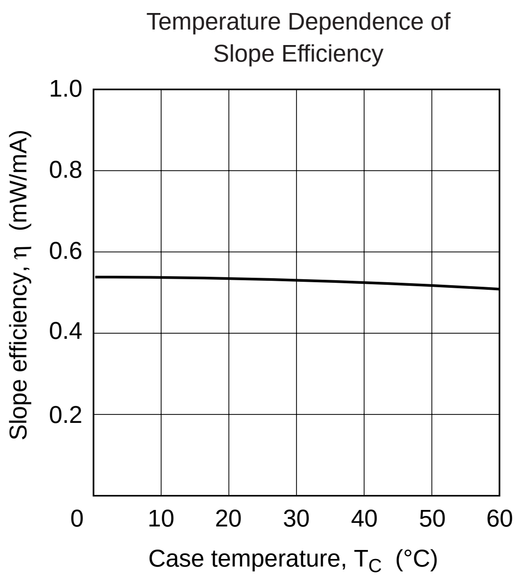


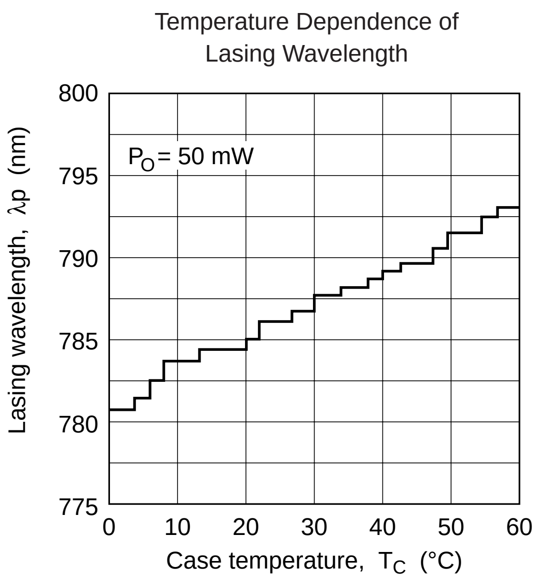






Typical Characteristic Curves (cont)





HL7853MG

GaAlAs Laser Diode

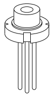
Description

The HL7853MG is a high power 0.78 µm band GaAlAs laser diode with a multi-quantum well (MQW) structure. It is suitable as a light source for optical disk memories, and various other types of optical equipment.

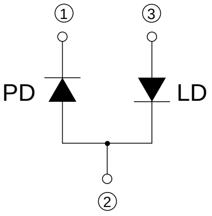
Features

- High output power: 40 mW CW
- Visible light output: λ_p = 785 mm Typ.
- Small beam ellipticity: 9.5 : 23
- Built-in monitor photodiode
- Compact package (ϕ5.6 mm)

Package Type
- HL7853MG: MG



Internal Circuit



Absolute Maximum Ratings (T_C = 25°C)

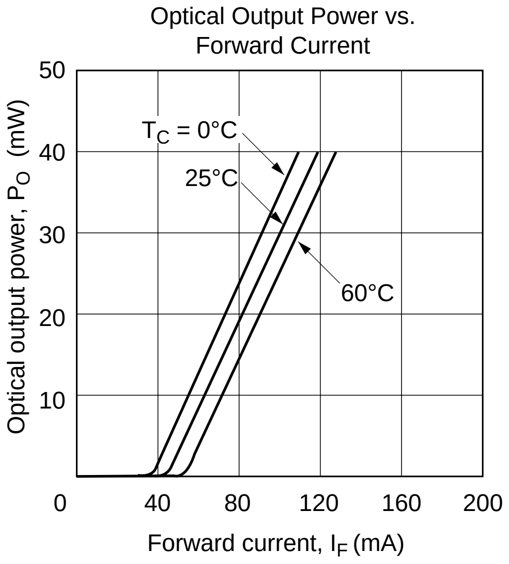
Item	Symbol	Rated Value	Unit
Optical output power	P_O	40	mW
Pulsed optical output power	$P_{O\ (pulse)}$	50*1	mW
LD reverse voltage	$V_{R\ (LD)}$	2	V
PD reverse voltage	$V_{R\ (PD)}$	30	V
Operating temperature	T_{opr}	–10 to +60	°C
Storage temperature	T_{stg}	–40 to +85	°C

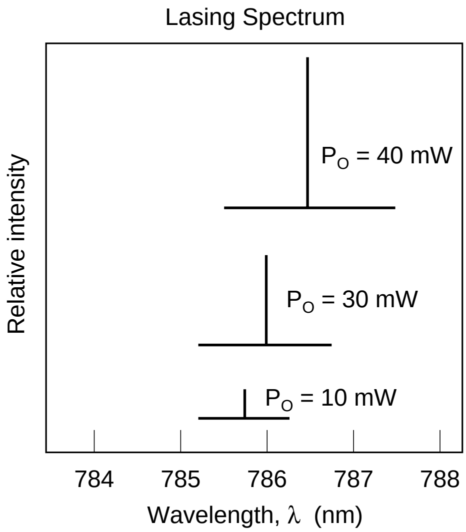
Note: 1. Maximum 50% duty cycle, maximum 1 µs pulse width

Optical and Electrical Characteristics (T_C = 25 ±3°C)

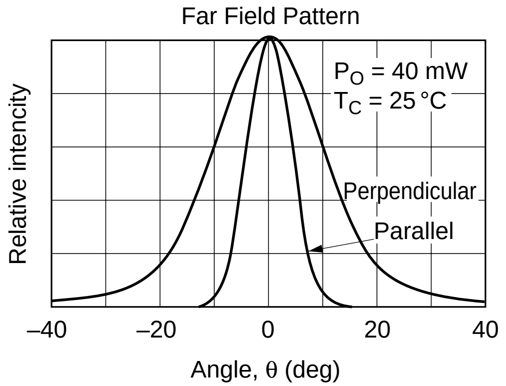
Item	Symbol	Min	Typ	Max	Unit	Test Conditions
Optical ouput power	P_O	40	—	—	mW	Kink free
Threshold current	I_{th}	—	45	70	mA	
Slope efficiency	η	0.35	0.55	0.7	mW/mA	24 mW/ { $I_{(32\ mW)}$–$I_{(8\ mW)}$}
LD operating voltage	V_{op}	—	2.3	2.7	V	P_O = 40 mW
Lasing wavelength	λ_p	775	785	795	nm	P_O = 40 mW
Beam divergence (parallel)	$\theta_{//}$	8	9.5	12	deg.	P_O = 40 mW, FWHM
Beam divergence (perpendicular)	$\theta_{\perp}$	18	23	28	deg.	P_O = 40 mW, FWHM
Monitor current	I_S	20	—	—	µA	P_O = 4 mW, $V_{R(PD)}$ = 5 V
Astigmatism	A_S	—	5	—	µm	P_O = 5 mW, NA = 0.4

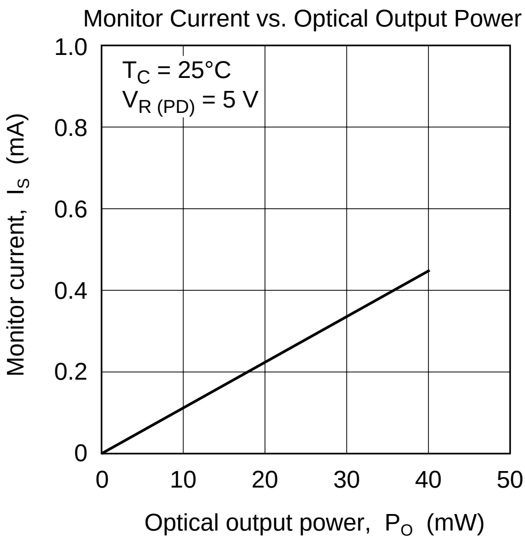
Typical Characteristic Curves

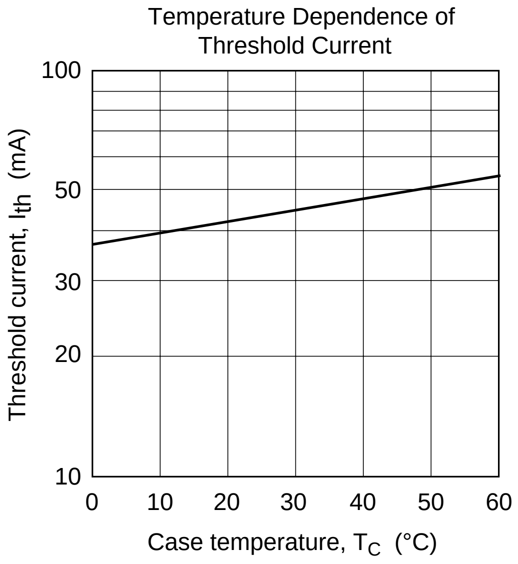


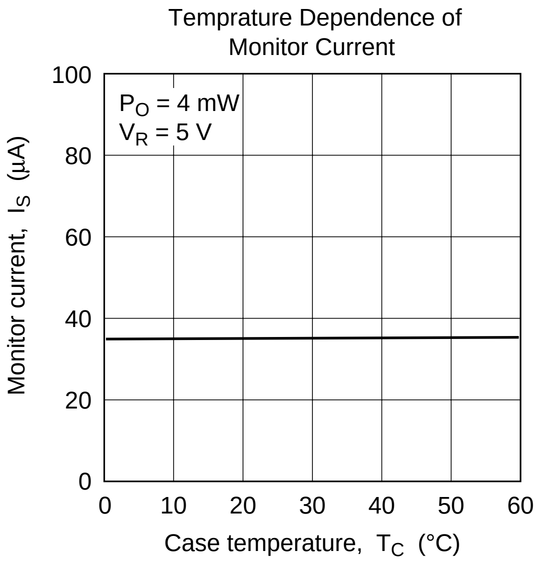


Typical Characteristic Curves (cont)

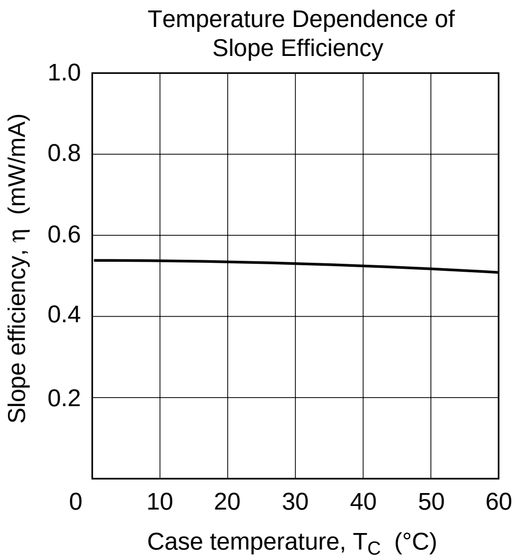


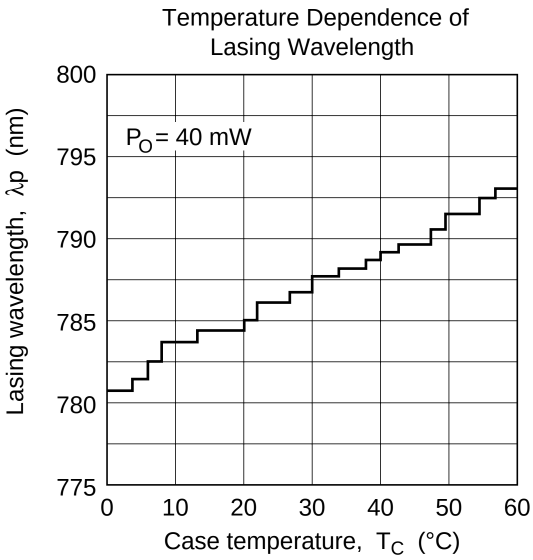






Typical Characteristic Curves (cont)





HL7859MG

Visible High Power Laser Diode

HITACHI

Description

The HL7859MG is a 0.78 µm band GaAlAs laser diode with a multi-quantum well (MQW)structure. It is suitable as a light source for optical disc memories and various other types of optical equipment. Hermetic sealing of the small package (ϕ5.6 mm) assures high reliability.

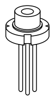
Application

- Optical disc memories.

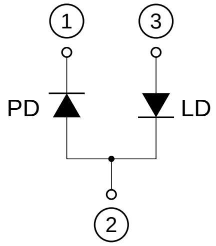
Features

- High output power : 35 mW (CW)
- Visible light output : λp = 775 to 795 nm
- Small package : ϕ 5.6 mm dia.
- Low astigmatism : 5 µm Typ (P_O = 5 mW)

Package Type
• HL7859MG: MG



Internal Circuit



Absolute Maximum Ratings (T_C = 25°C)

Item	Symbol	Value	Unit
Optical output power	P_O	35	mW
Pulse optical output power	P_O (pulse)	42 *	mW
Laser diode reverse voltage	$V_{R(LD)}$	2	V
Photo diode reverse voltage	$V_{R(PD)}$	30	V
Operating temperature	Topr	–10 to +60	°C
Storage temperature	Tstg	–40 to +85	°C

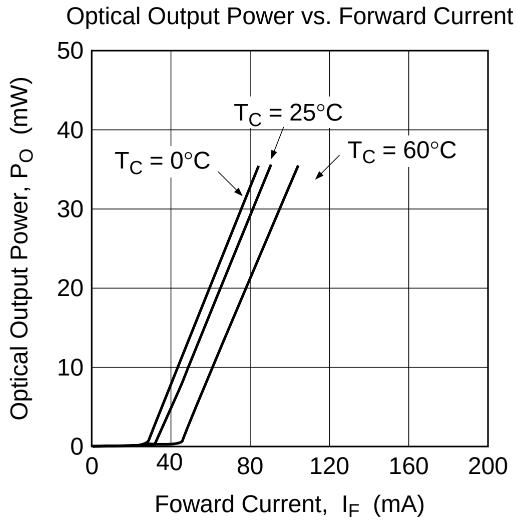
Note: Pulse condition : Pulse width = 1 µs, duty = 50%

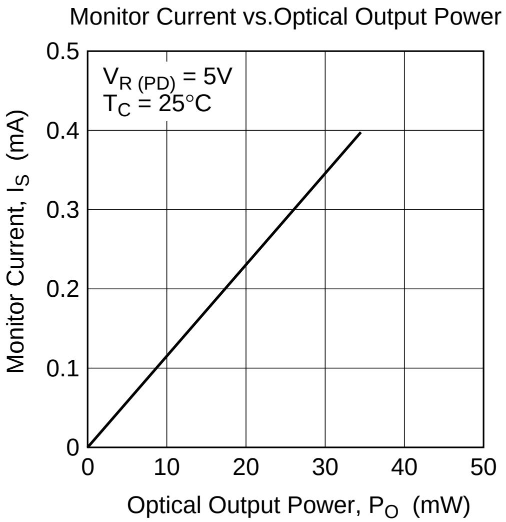
Optical and Electrical Characteristics (T_C = 25°C)

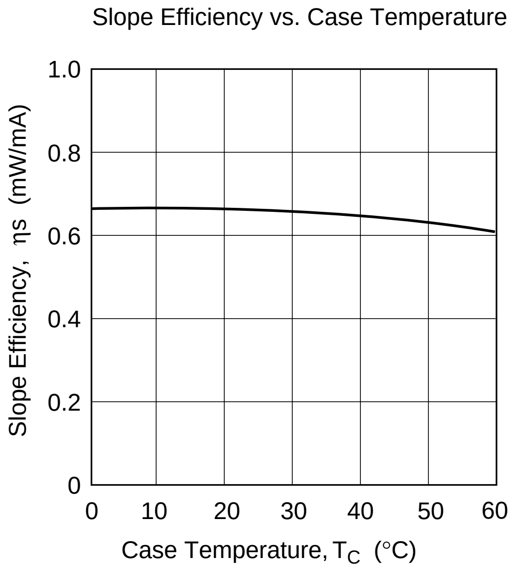
Items	Symbols	Min	Typ	Max	Units	Test Conditions
Optical output power	P_O	35	—	—	mW	Kink free *
Threshold current	Ith	—	35	60	mA	—
Operating voltage	V_{OP}	—	2.1	2.5	V	P_O = 35 mW
Slope efficiency	ηs	0.35	0.65	0.80	mW/mA	21 (mW) / ($I_{(28\ mW)} - I_{(7\ mW)}$)
Lasing wavelength	λp	775	785	795	nm	P_O = 35 mW
Beam divergence parallel to the junction	θ//	8	9.5	12	deg.	P_O = 35 mW
Beam divergence parpendicular to the junction	θ⊥	18	23	28	deg.	P_O = 35 mW
Monitor current	Is	0.2	—	2	mA	P_O = 35 mW, $V_{R(PD)}$ = 5 V
Asitgmatism	A_S	—	5	—	µm	P_O = 5 mW, NA = 0.4

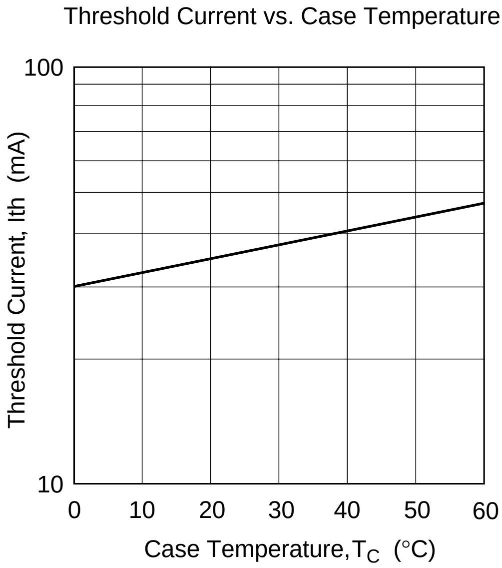
Note: Kink free is confirmed at the temperature of 25°C.

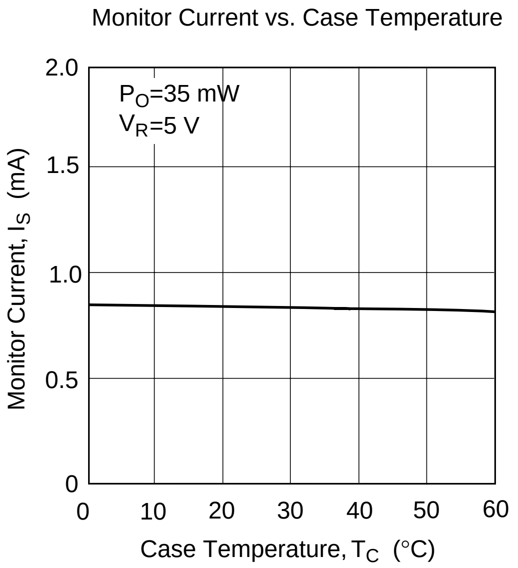
Curve Characteristics

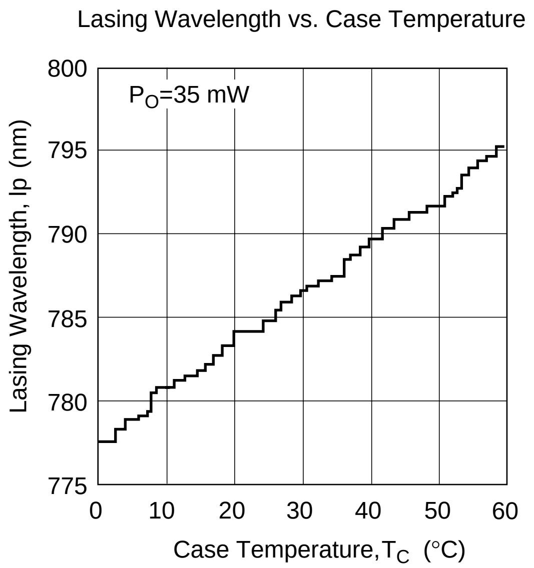


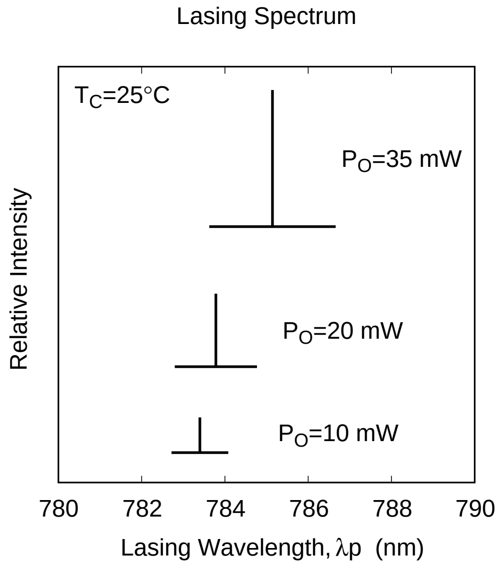


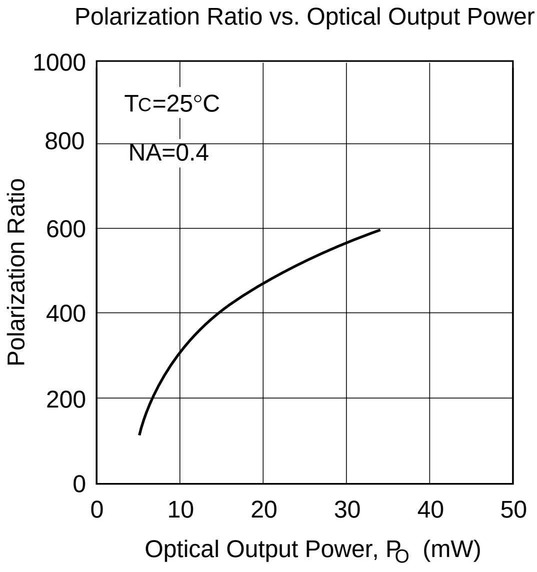




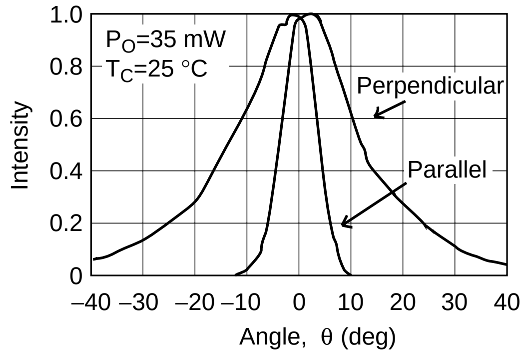

Monitor Current vs. Case Temperature
PO=35 mW
VR=5 V
Monitor Current, IS (mA)
2.0
1.5
1.0
0.5
0
0
10
20
30
40
50
60
Case Temperature, TC (°C)


Lasing Wavelength vs. Case Temperature
PO=35 mW
Lasing Wavelength, lp (nm)
800
795
790
785
780
775
0
10
20
30
40
50
60
Case Temperature, TC (°C)

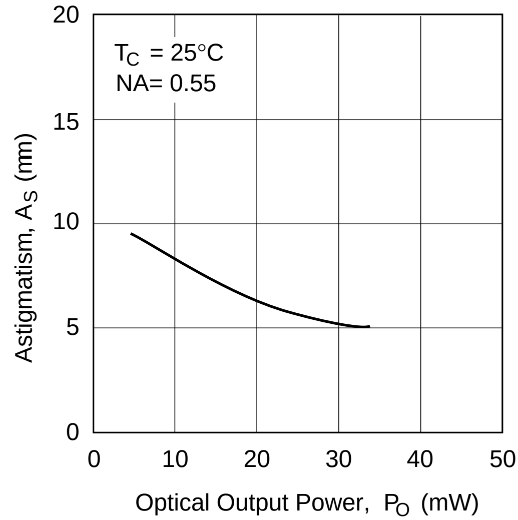

Lasing Spectrum
TC=25°C
PO=35 mW
PO=20 mW
PO=10 mW
Relative Intensity
780
782
784
786
788
790
Lasing Wavelength, λp (nm)


Polarization Ratio vs. Optical Output Power
TC=25°C
NA=0.4
Polarization Ratio
1000
800
600
400
200
0
0
10
20
30
40
50
Optical Output Power, PO (mW)

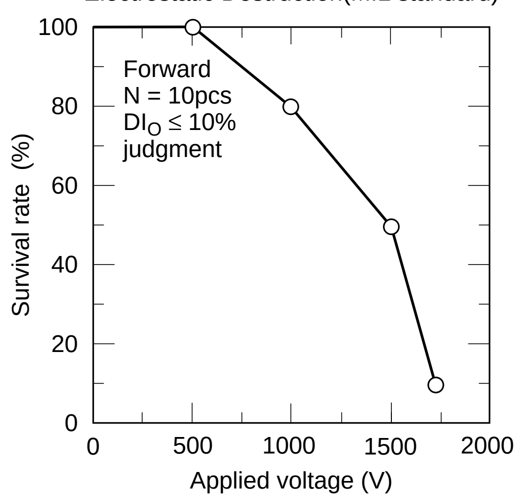
Far Feild Pattem



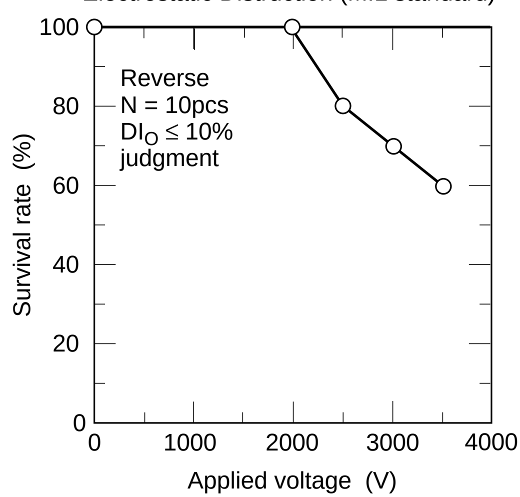
Astigmatism vs. Optical Output Power



Electrostatic Destruction(MIL standard)



Electrostatic Distruction (MIL standard)



HL8325G

GaAlAs Laser Diode

Description

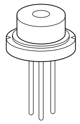
The HL8325G is a high-power 0.8 µm band GaAlAs laser diode with a TQW (triple quantum well) structure. Its internal circuit configuration is suited for operation on a single positive supply voltage. It is suitable as a light source for optical disk memories, card readers and various other types of optical equipment.

Features

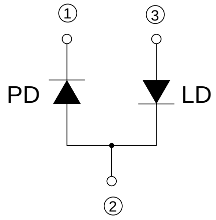
- Infrared light output: λ_p = 820 to 840 nm
- High power: standard continuous operation at 40 mW (CW), pulsed operation at 50 mW
- Built-in monitor photodiode
- Single longitudinal mode

Package Type

- HL8325G: G2



Internal Circuit



Absolute Maximum Ratings (T_C = 25°C)

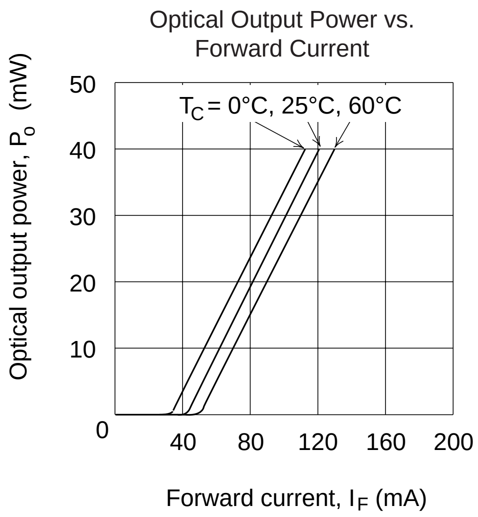
Item	Symbol	Rated Value	Units
Optical output power	P_O	40	mW
Pulse optical output power	$P_{O\ (pulse)}$	50*1	mW
LD reverse voltage	$V_{R\ (LD)}$	2	V
PD reverse voltage	$V_{R\ (PD)}$	30	V
Operating temperature	T_{opr}	–10 to +60	°C
Storage temperature	T_{stg}	–40 to +85	°C

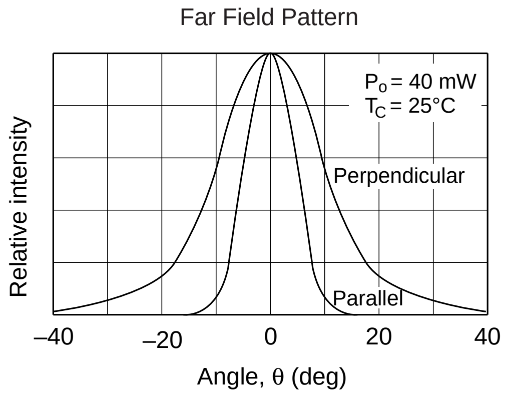
Note: 1. Maximum 50% duty cycle, maximum 1 µs pulse width

Optical and Electrical Characteristics (T_C = 25 ±3°C)

Item	Symbol	Min	Typ	Max	Unit	Test Conditions
Optical output power	P_O	40	—	—	mW	Kink free
Threshold current	I_{th}	—	40	70	mA	
Slope efficiency	η	0.4	0.5	0.9	mW/mA	$\frac{24\ (mW)}{I_{(32\ mW)} - I_{(8\ mW)}}$
Lasing wavelength	λ_p	820	830	840	nm	P_O = 40 mW
Beam divergence (parallel)	$\theta_{//}$	7	10	14	deg.	P_O = 40 mW, FWHM
Beam divergence (perpendicular)	$\theta_{\perp}$	18	22	32	deg.	P_O = 40 mW, FWHM
Monitor current	I_S	20	40	130	µA	$V_{R\ (PD)}$ = 5 V, P_O = 4 mW
Astigmatism	A_S	—	5	—	µm	P_O = 4 mW, NA = 0.4

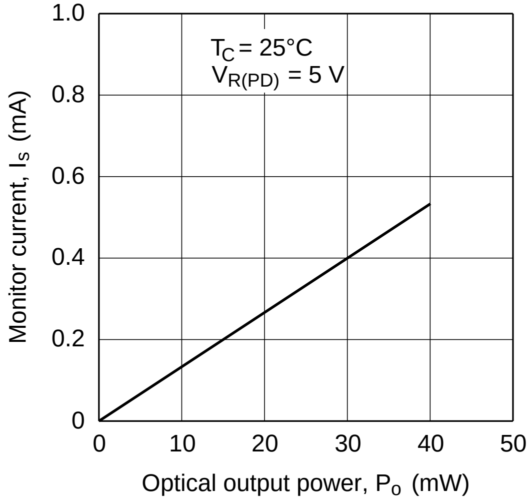
Typical Characteristic Curves



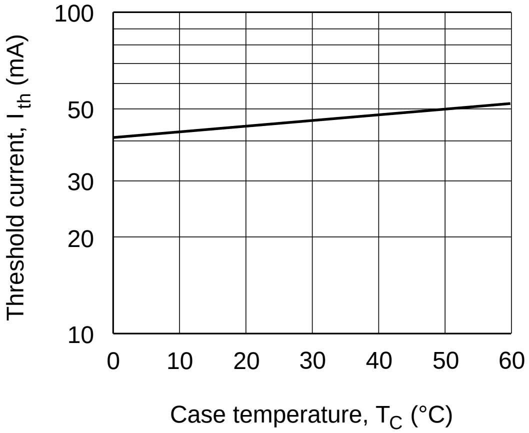


Typical Characteristic Curves (cont)

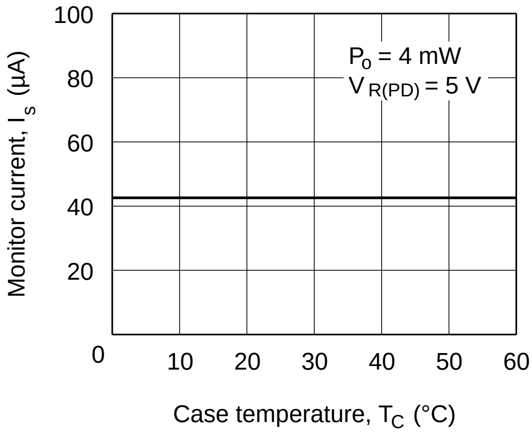
Monitor Current vs. Optical Output Power



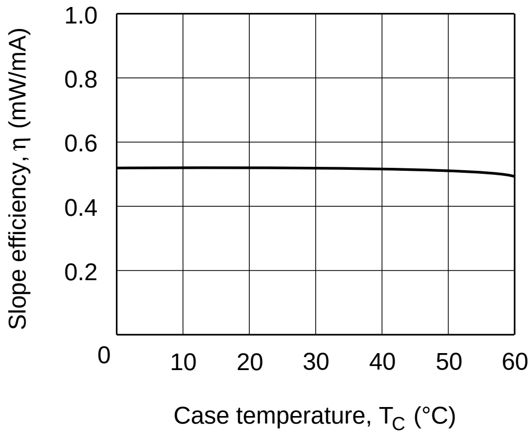
Temperature Dependence of Threshold Current



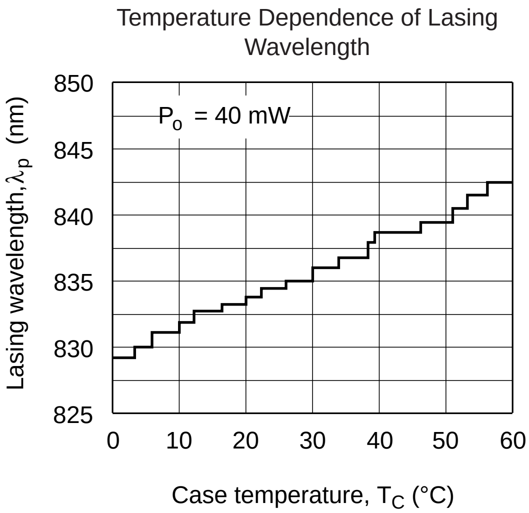
Temperature Dependence of Monitor Current

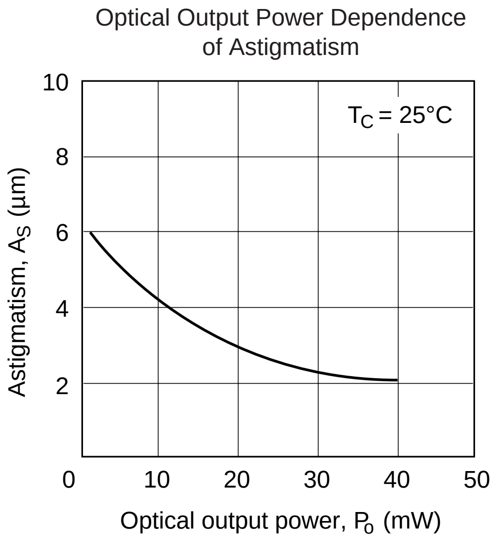


Temperature Dependence of Slope Efficiency



Typical Characteristic Curves (cont)





HL1326CF/CN/SN/PF

InGaAsP Laser Diodes

Description

The HL1326CF/CN/SN/PF are 1.3 µm InGaAsP Fabry-Perot laser diodes with a multi-quantum well (MQW) structure. They are suitable as light sources in short and medium range fiberoptic communication systems. Laser output is delivered from the coaxial package through an attached single mode fiber. A built-in photodiode provides monitor current output.

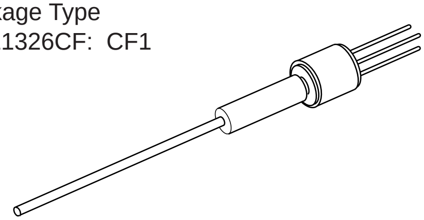
Features

- Wide operating temperature range:
  T_{opr} = –40 to +85°C
- High output power: 3 mW (Pulse)
  2 mW (CW)
- Low operating current:
  I_{op} (P_f = 2.0 mW) = 18 mA (Typ. @T_C = 25°C)
  I_{op} (P_f = 2.0 mW) = 38 mA (Typ. @T_C = 85°C)

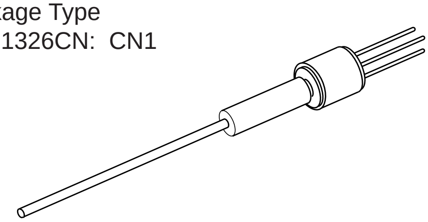
Fiber Specifications

Mode field diameter: 9.5 ±1.0 µm
Cutoff wavelength: 1.10 to 1.27 µm
Outer diameter: 125 µm
Jacket diameter: 900 µm
Fiber minimum Bend Radius: 25mm
Fiber length: More than 1000 mm

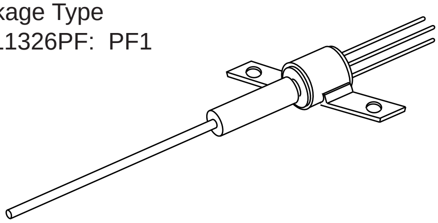
Package Type
- HL1326CF: CF1



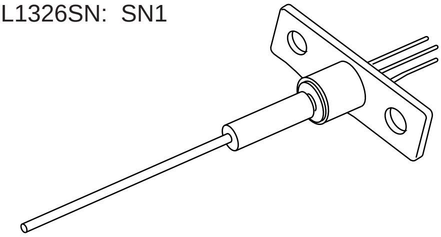
Package Type
- HL1326CN: CN1



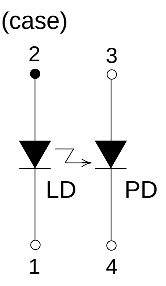
Package Type
- HL1326PF: PF1



Package Type
- HL1326SN: SN1



Internal Circuit



Absolute Maximum Ratings (T_C = 25°C)

Item	Symbol	Rated Value	Unit
Fiber optical output power	P_f (Pulse)	3 *1	mW
	P_f (CW)	2	mW
LD reverse voltage	$V_{R\ (LD)}$	2	V
PD reverse voltage	$V_{R\ (PD)}$	15	V
PD forward current	$I_{F\ (PD)}$	1	mA
Operating temperature	T_{opr}	–40 to +85	°C
Storage temperature	T_{stg}	–40 to +85	°C

Note: 1. Maximum 50 % duty cycle, maximum 1µs pulse width.

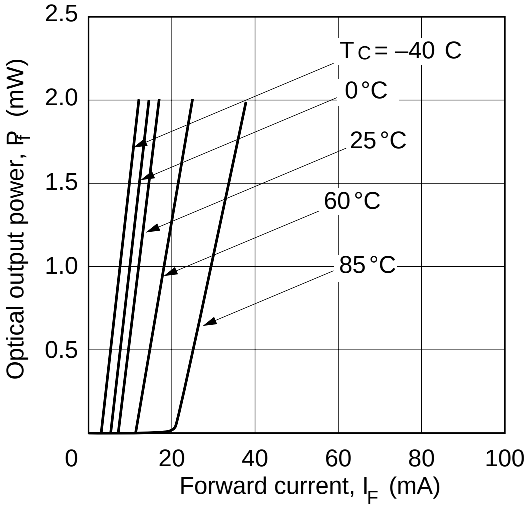
Optical and Electrical Characteristics (T_C = 25°C)

Item	Symbol	Min	Typ	Max	Unit	Test Conditions
Threshold current	I_{th}	—	8	20	mA	
Fiber optical output power	P_f	2	—	—	mW	Kink free
Slope efficiency	η_s	0.08	0.20	—	mW/mA	T_C = 25°C
		0.04	0.12	—		T_C = 85°C
Lasing wavelength	λ_c	1280	1310	1340	nm	P_f = 1.5 mW, RMS
Spectral width	σ	—	2	—	nm	P_f = 1.5 mW, RMS
Rise time	t_r	—	—	0.5	ns	10 to 90%
Fall time	t_f	—	—	0.5	ns	90 to 10%
Monitor current	I_S	100	—	—	µA	P_f = 1.5 mW, $V_{R(PD)}$ = 5 V
PD dark current	$I_{(DARK)}$	—	—	350	nA	$V_{R(PD)}$ = 5 V
PD capacitance	C_t	—	15	20	pF	$V_{R(PD)}$ = 5 V, f = 1 MHz
Photosensitivity saturation voltage	$V_{R(S)}$	—	—	2	V	

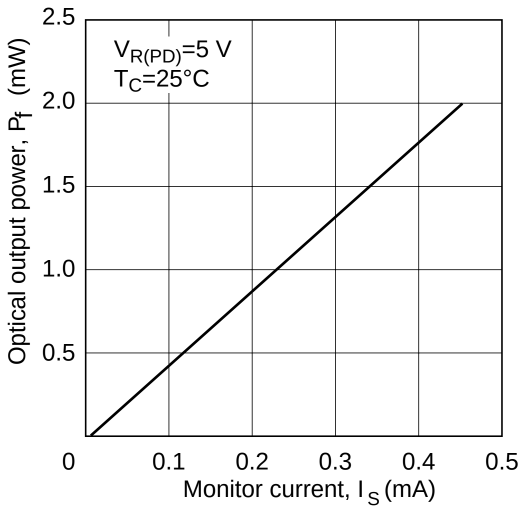
 HL1326CF/CN/SN/PF

Typical Characteristic Curves

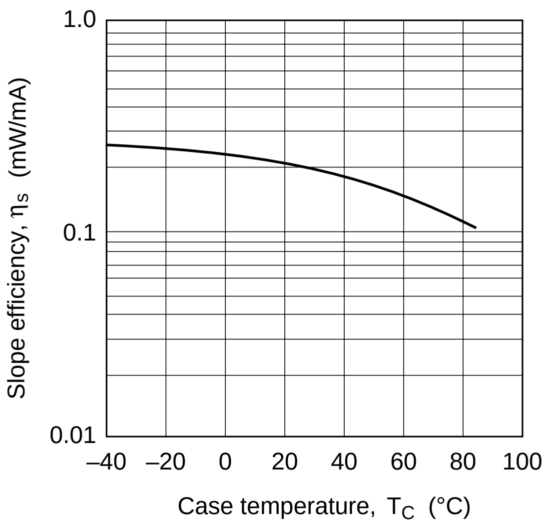
Optical Output Power vs. Forward Current



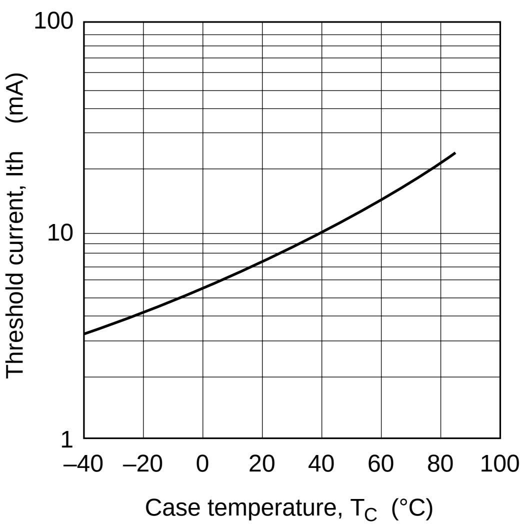
Optical Output Power vs. Monitor Current



Slope efficiency vs.Case Temperature



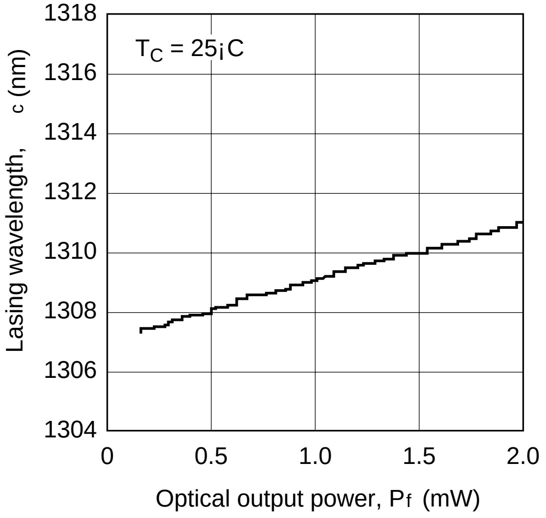
Threshold current vs. Case Temperature



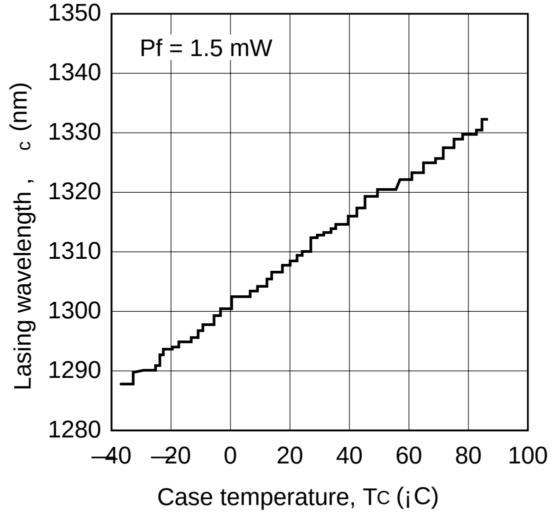
 HL1326CF/CN/SN/PF

Typical Characteristic Curves (cont)

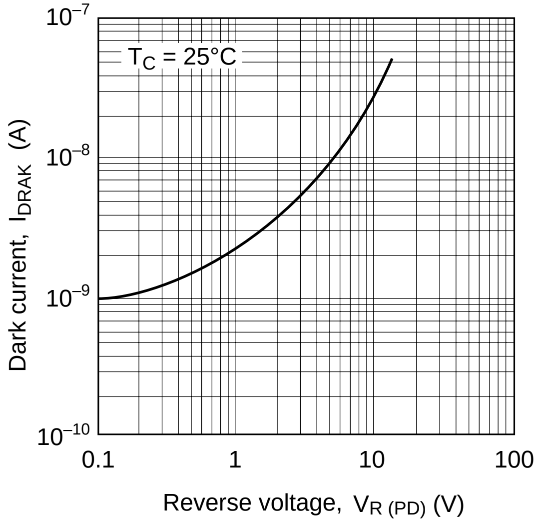
Lasing Spectrum vs. Optical Output Power



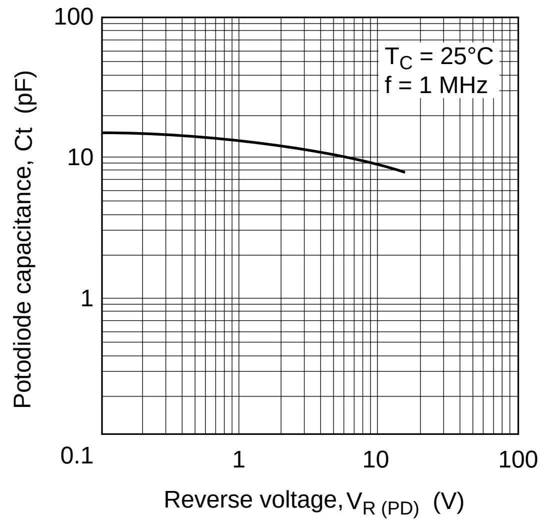
Lasing Spectrum vs.Case Temperature



PD Dark Current vs. Reverse Voltage

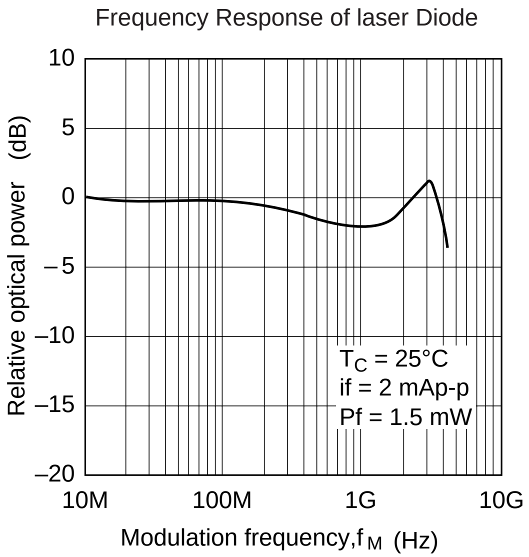


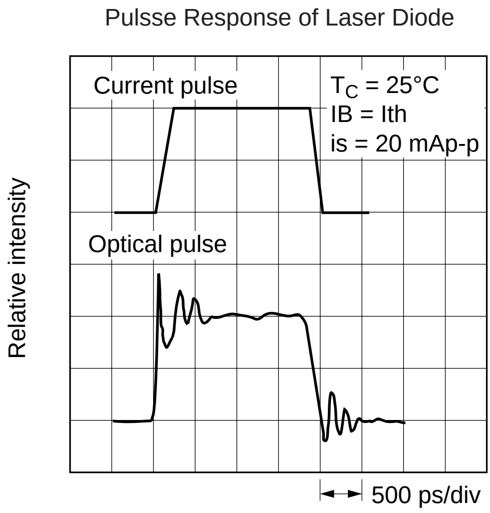
PD Capacitance vs. Reverse Voltage



HL1326CF/CN/SN/PF

Typical Characteristic Curves (cont)





HL1326MF

InGaAsP Laser Diode

Description

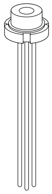
The HL1326MF is a 1.3 µm InGaAsP Fabry Perot laser diode with a multi-quantum well (MQW) structure. It is suitable as a light source in short and medium range fiberoptic communication systems and other applied optical equipment. It has high optical power with low drive current and wide operating temperature range (–40 to +85°C). The compact package is suitable for module assembly.

Features

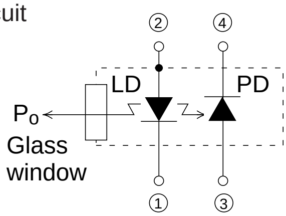
- Wide operating temperature range:
  T_{opr} = –40 to +85°C
- High output power: 10 mW (Pulse)
  5 mW (CW)
- Low operating current:
  I_{op} (P_O = 5 mW) = 20 mA (Typ. @T_C = 25°C)
  I_{op} (P_O = 5 mW) = 40 mA (Typ. @T_C = 85°C)

Package Type

- HL1326MF: MF



Internal Circuit



Absolute Maximum Ratings (T_C = 25°C)

Item	Symbol	Rated Value	Unit
Optical output power	P_O	10 (Pulse)	mW
		5 (CW)	mW
LD reverse voltage	$V_{R(LD)}$	2	V
PD reverse voltage	$V_{R(PD)}$	15	V
PD forward current	$I_{F(PD)}$	1	mA
Operating temperature	T_{opr}	–40 to +85	°C
Storage temperature	T_{stg}	–40 to +100	°C

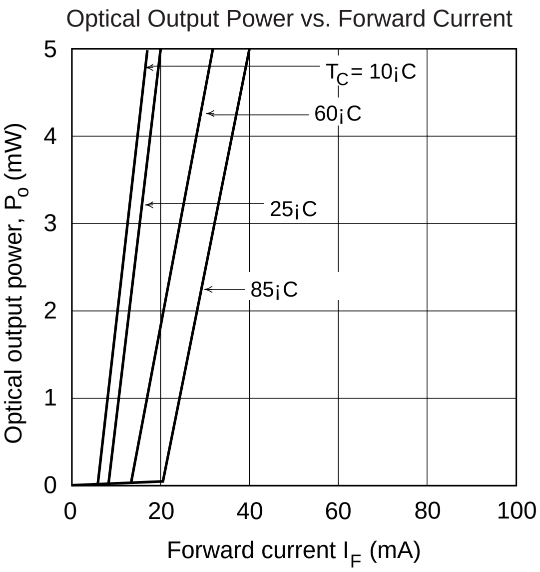
Note: Maximum 50% duty cycle, maximum 1µs pulse width.

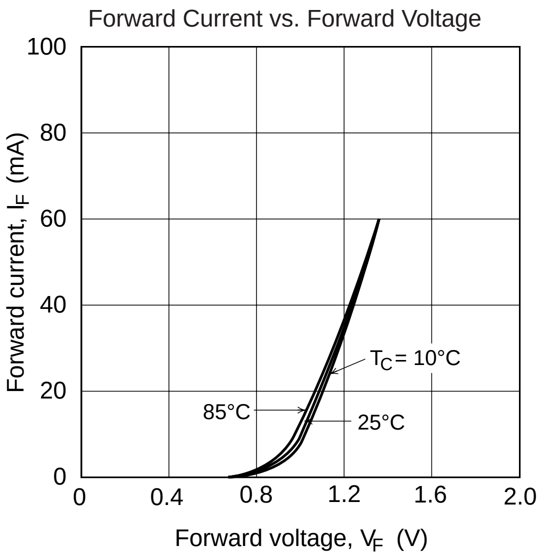
Optical and Electrical Characteristics (T_C = 25°C)

Item	Symbol	Min	Typ	Max	Unit	Test Conditions
Threshold current	I_{th}	—	8	20	mA	
Optical output power	P_O	5	—	—	mW	Kink free*1
Slope efficiency	η_s	0.3	0.4	—	mW/mA	T_C = 25°C
		0.15	0.25	—		T_C = 85°C
Lasing wavelength	λ_c	1280	1310	1340	nm	P_O = 5 mW, RMS
Spectral width	σ	—	2	—	nm	P_O = 5 mW, RMS
Beam divergence (parallel)	$\theta_{//}$	—	30	—	deg.	P_O = 5 mW, FWHM
Beam divergence (perpendicular)	$\theta_{\perp}$	—	40	—	deg.	P_O = 5 mW, FWHM
Rise time	t_r	—	—	0.5	ns	10 to 90%
Fall time	t_f	—	—	0.5	ns	90 to 10%
Monitor current	I_S	100	—	—	µA	P_O = 5 mW, $V_{R(PD)}$ = 5 V
PD dark current	$I_{(DARK)}$	—	—	350	nA	$V_{R(PD)}$ = 5 V
PD capacitance	C_t	—	15	20	pF	$V_{R(PD)}$ = 5 V, f = 1 MHz
Photosensitivity saturation voltage	$V_{R(S)}$	—	—	2	V	

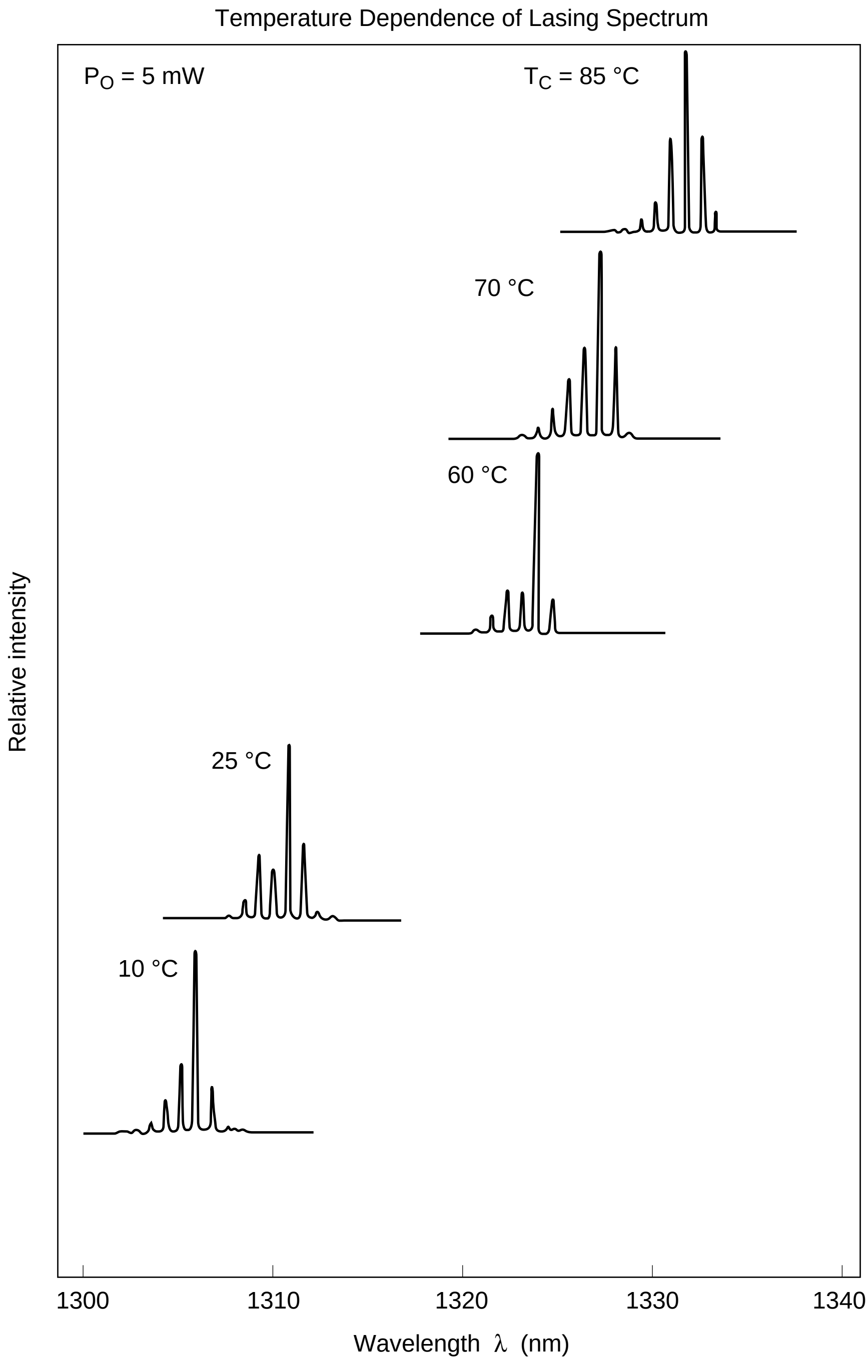
Note: 1. Kink free up to 5mW is confirmed at the temprature of 10°C, 25°C and 85°C.

Typical Characteristic Curves

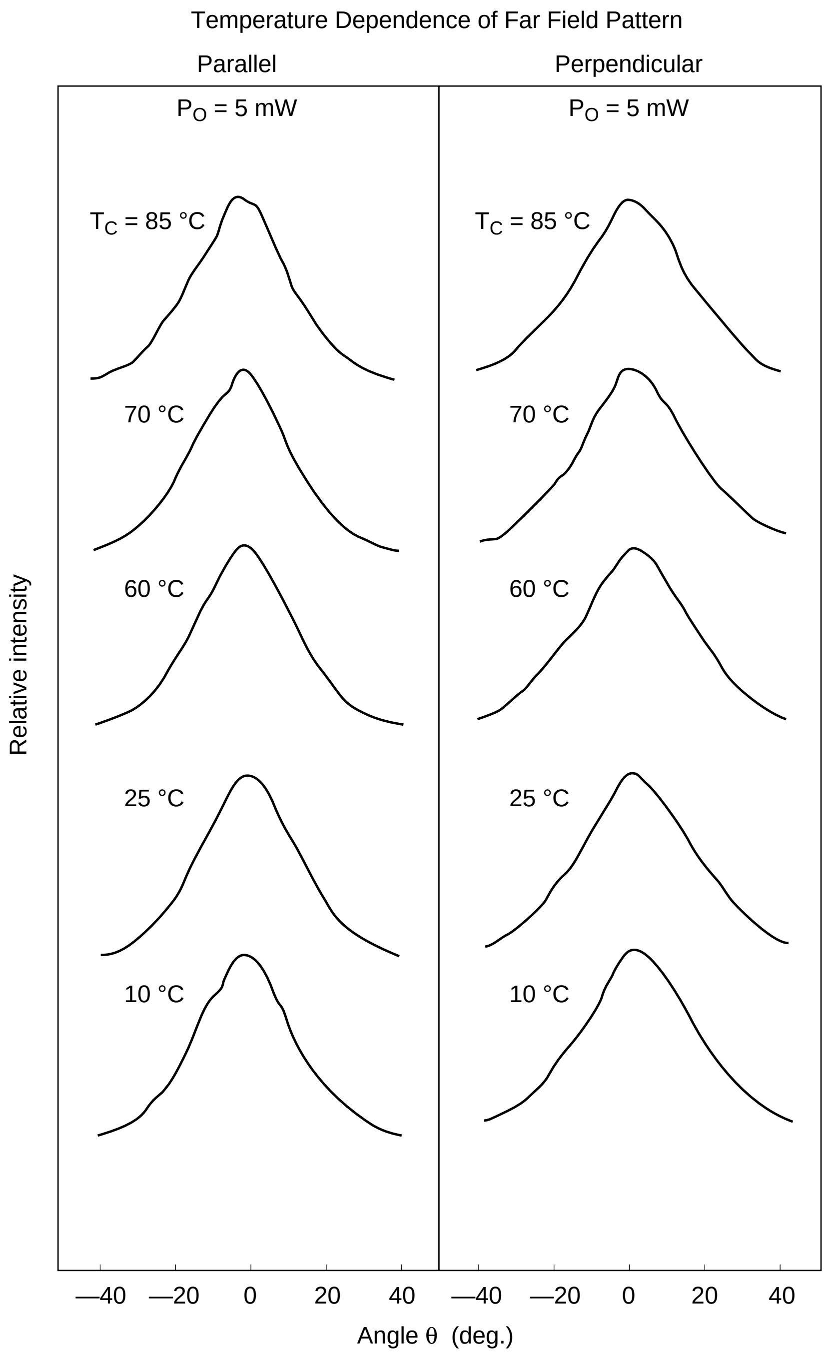




Typical Characteristic Curves (cont)

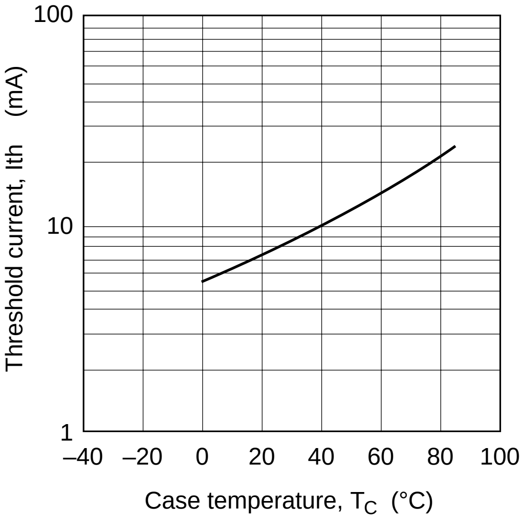


Typical Characteristic Curves (cont)

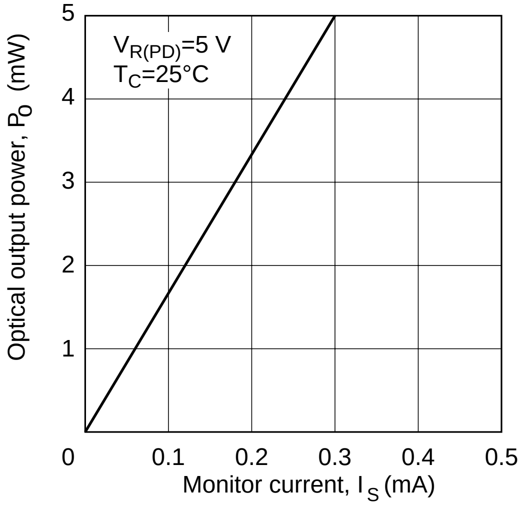


Typical Characteristic Curves (cont)

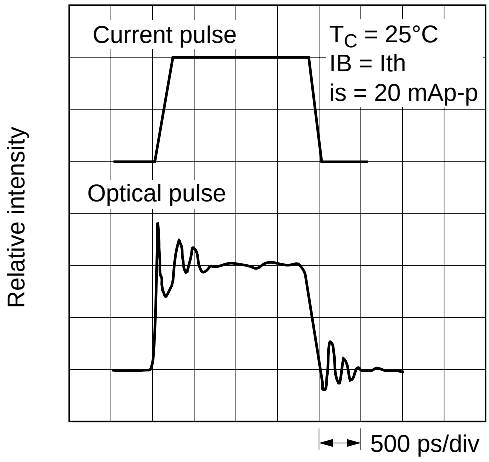
Threshold Current vs. Case Temperature



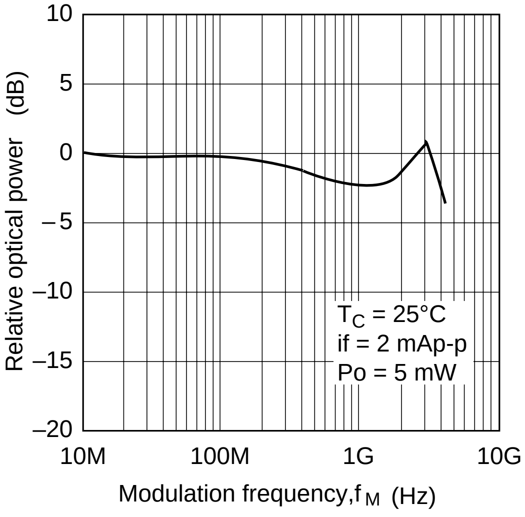
Optical Output Power vs. Monitor Current



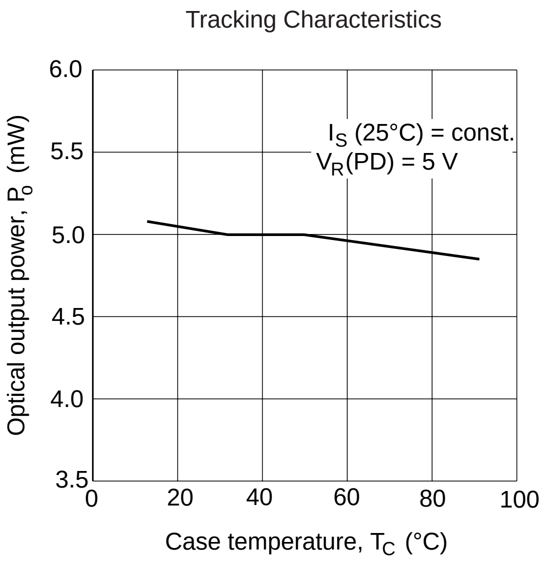
Pulse Response of Laser Diode

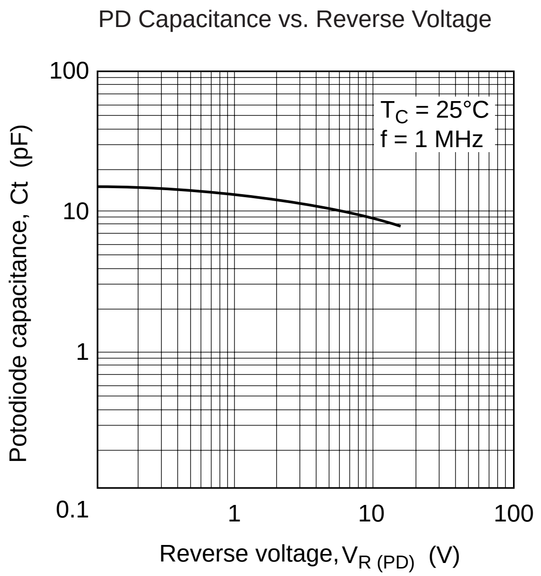


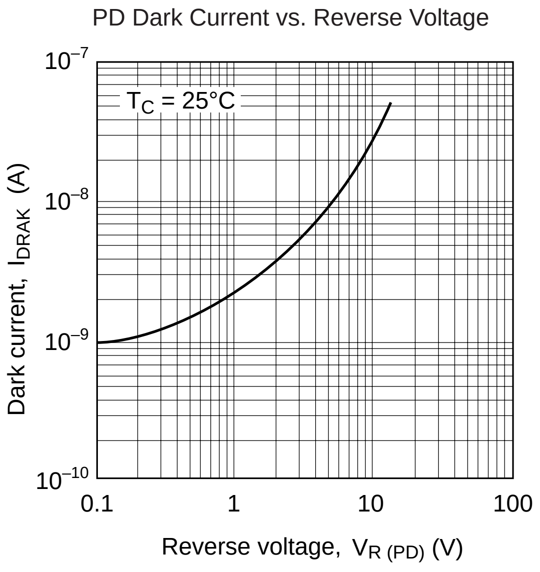
Frequency Response of Laser Diode



Typical Characteristic Curves (cont)







HL1327CF/CN/SN/PF

InGaAsP Laser Diodes

Description

The HL1327CF/CN/SN/PF are 1.3 µm InGaAsP Fabry-Perot laser diodes with a multi-quantum well (MQW) structure. They are suitable as light sources in short and medium range fiberoptic communication systems. Laser output is delivered from the coaxial package through an attached single mode fiber. A built-in photodiode provides monitor current output.

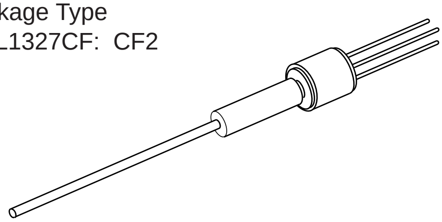
Features

- Wide operating temperature range:
  T_{opr} = –40 to +85°C
- High output power: 0.6 mW (Pulse)
  0.4 mW (CW)
- Low operating current:
  I_{op} (P_f = 0.4 mW) = 18 mA (Typ. @T_C = 25°C)
  I_{op} (P_f = 0.4 mW) = 38 mA (Typ. @T_C = 85°C)

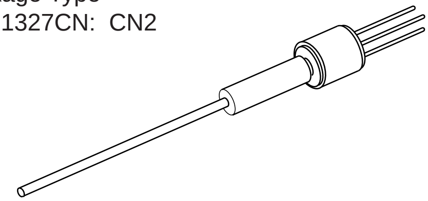
Fiber Specifications

Mode field diameter: 9.5 ±1.0 µm
Cutoff wavelength: 1.10 to 1.27 µm
Outer diameter: 125 µm
Jacket diameter: 900 µm
Fiber minimum Bend Radius: 25mm
Fiber length: More than 1000 mm

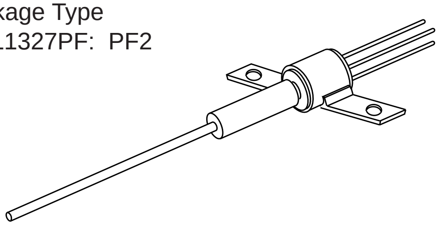
Package Type
- HL1327CF: CF2



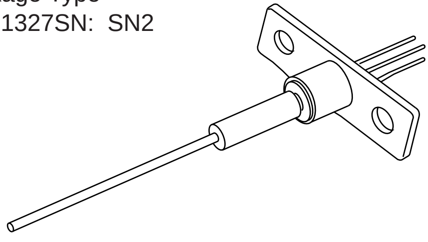
Package Type
- HL1327CN: CN2



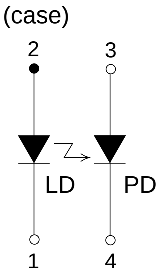
Package Type
- HL1327PF: PF2



Package Type
- HL1327SN: SN2



Internal Circuit



HL1327CF/CN/SN/PF

Absolute Maximum Ratings (T_C = 25°C)

Item	Symbol	Rated Value	Unit
Fiber optical output power	P_f (Pulse)	0.6 *1	mW
	P_f (CW)	0.4	mW
LD reverse voltage	$V_{R\ (LD)}$	2	V
PD reverse voltage	$V_{R\ (PD)}$	15	V
PD forward current	$I_{F\ (PD)}$	1	mA
Operating temperature	T_{opr}	–40 to +85	°C
Storage temperature	T_{stg}	–40 to +85	°C

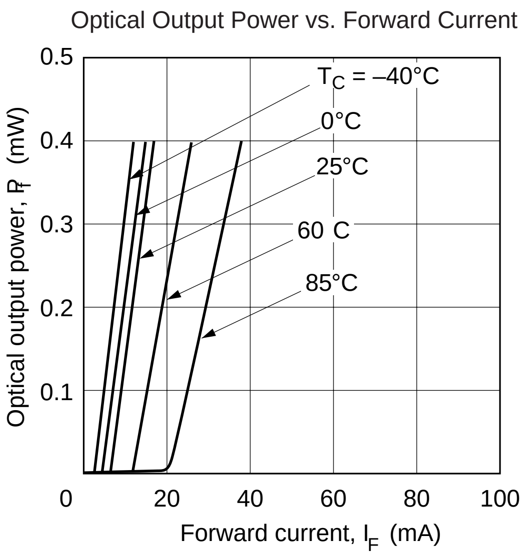
Note: 1. Maximum 50 % duty cycle, maximum 1µs pulse width.

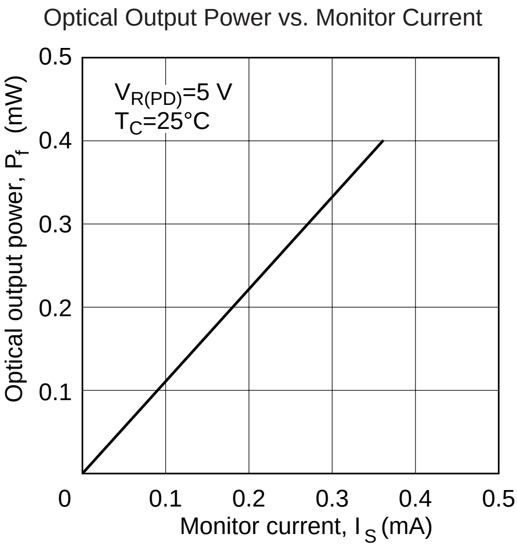
Optical and Electrical Characteristics (T_C = 25°C)

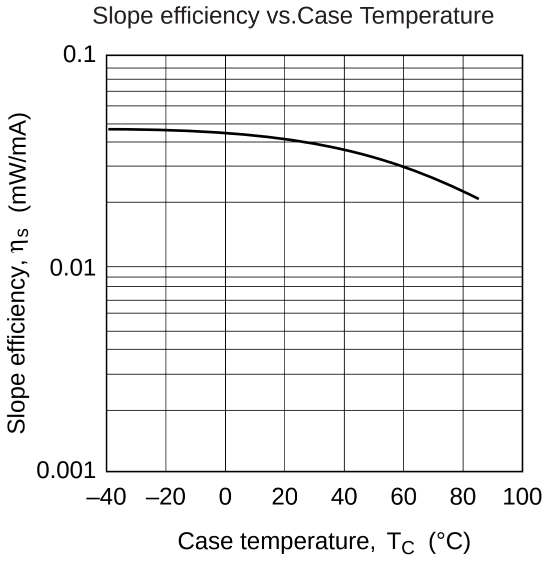
Item	Symbol	Min	Typ	Max	Unit	Test Conditions
Threshold current	I_{th}	—	8	20	mA	
Fiber optical output power	P_f	0.4	—	—	mW	Kink free
Slope efficiency	η_s	0.008	0.040	—	mW/mA	T_C = 25°C
		0.004	0.020	—		T_C = 85°C
Lasing wavelength	λ_c	1280	1310	1340	nm	P_f = 0.3 mW, RMS
Spectral width	σ	—	2	—	nm	P_f = 0.3 mW, RMS
Rise time	t_r	—	—	0.5	ns	10 to 90%
Fall time	t_f	—	—	0.5	ns	90 to 10%
Monitor current	I_S	100	—	—	µA	P_f = 0.3 mW, $V_{R(PD)}$ = 5 V
PD dark current	$I_{(DARK)}$	—	—	350	nA	$V_{R(PD)}$ = 5 V
PD capacitance	C_t	—	15	20	pF	$V_{R(PD)}$ = 5 V, f = 1 MHz
Photosensitivity saturation voltage	$V_{R(S)}$	—	—	2	V	

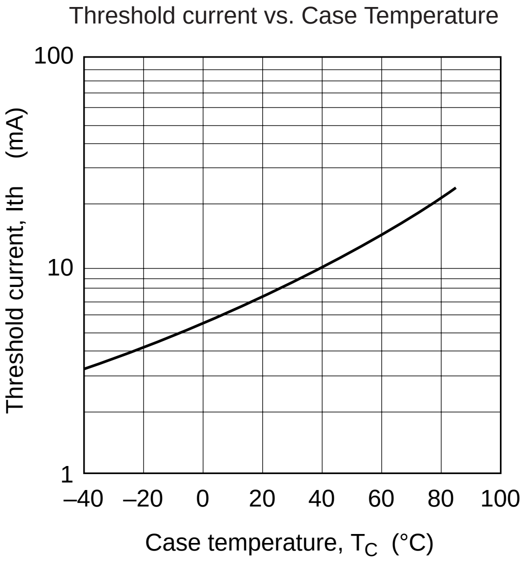
HL1327CF/CN/SN/PF

Typical Characteristic Curves

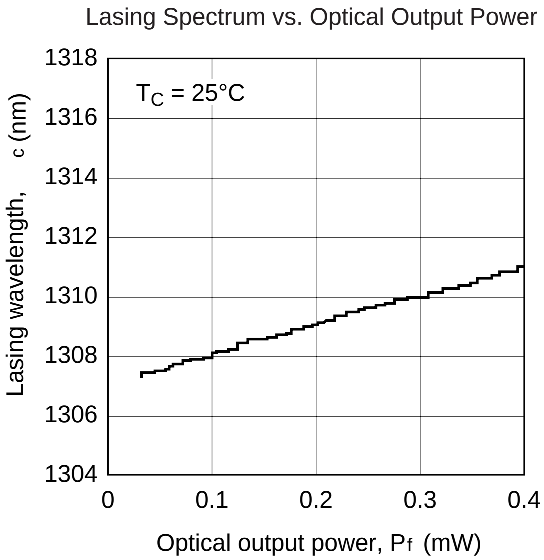


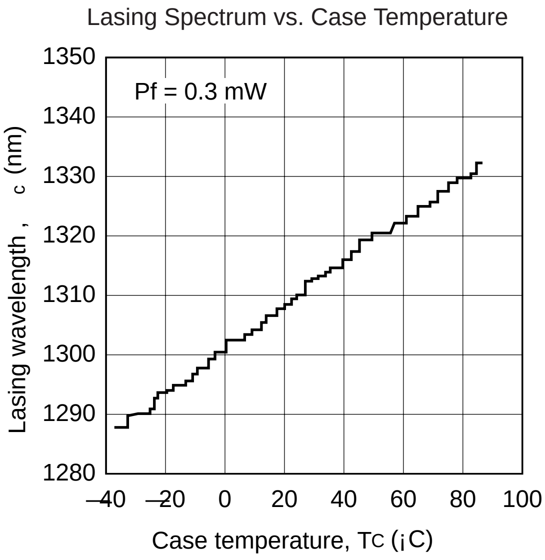


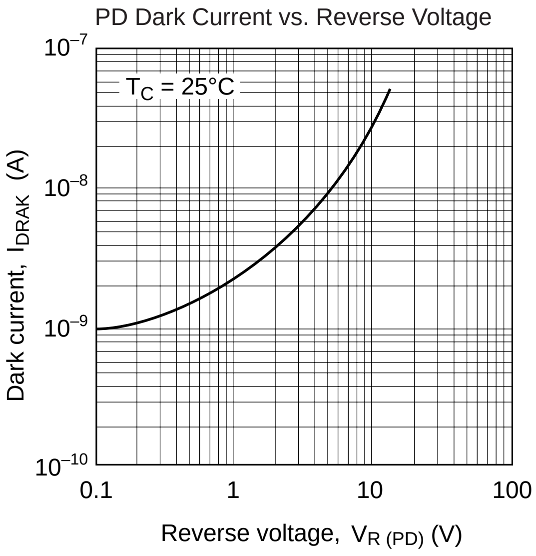


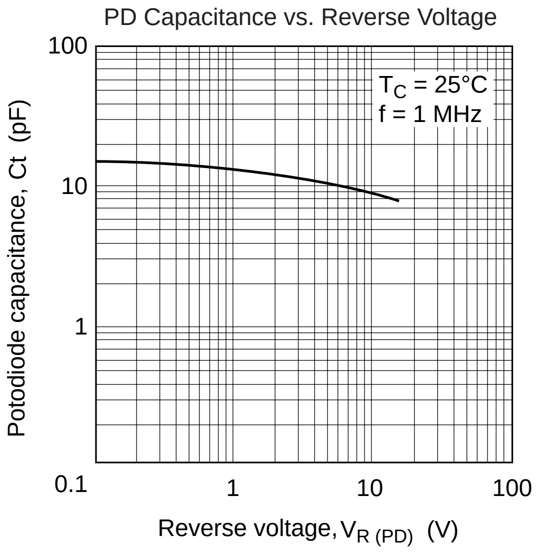


Typical Characteristic Curves (cont)



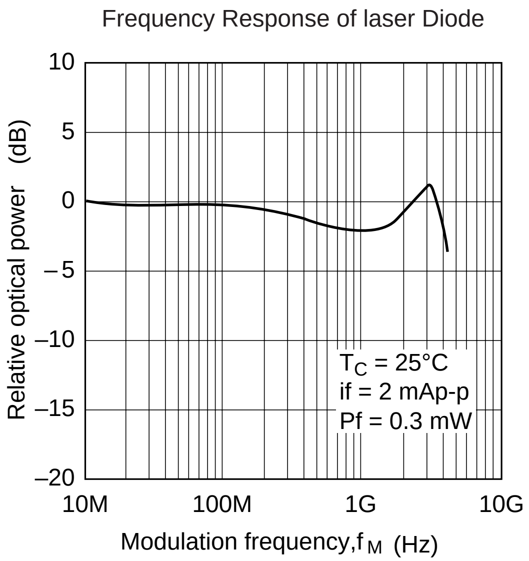


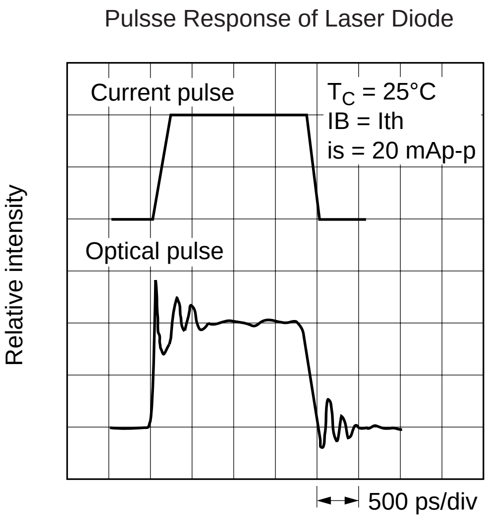




HL1327CF/CN/SN/PF

Typical Characteristic Curves (cont)





HL1352CN/SN

InGaAsP Laser Diodes

Description

The HL1352CN/SN are 1.3 µm InGaAsP DFB laser diodes with a multi-quantum well (MQW) structure. They are suitable as light sources in short and medium range fiberoptic communincation systems. Laser output is delivered from the coaxial package through an attached single mode fiber. A built-in photodiode provides monitor current output.

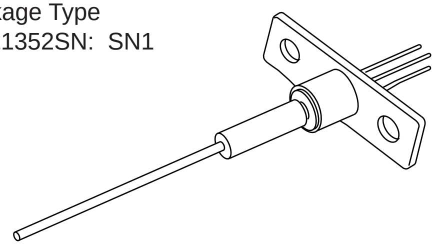
Features

- Wide operating temperature range: T_{opr} = –20 to +85°C
- High output power: 3 mW (Pulse)
  2 mW (CW)
- Low operating current:
  I_{op} (P_f =2.0 mW) = 20 mA (Typ. @T_C = 25°C)
  I_{op} (P_f =2.0 mW) = 50mA (Typ. @T_C = 85°C)

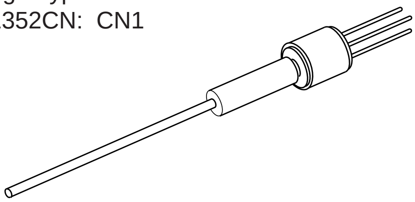
Fiber Specifications

Mode field diameter: 9.5 ±1.0 µm
Cutoff wavelength: 1.10 to 1.27 µm
Outer diameter: 125 µm
Jacket diameter: 900 µm
Fiber minimum Bend Radius: 25mm
Fiber length: More than 1000 mm

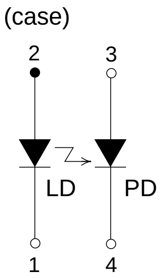
Package Type
- HL1352SN: SN1



Package Type
- HL1352CN: CN1



Internal Circuit



HL1352CN/SN

Absolute Maximum Ratings (T_C = 25°C)

Item	Symbol	Rated Value	Unit
Fiber optical output power	$P_{f\ (Pulse)}$	3 *1	mW
	$P_{f\ (CW)}$	2	mW
LD reverse voltage	$V_{R\ (LD)}$	2	V
PD reverse voltage	$V_{R\ (PD)}$	15	V
PD forward current	$I_{F\ (PD)}$	1	mA
Operating temperature	T_{opr}	–20 to +85	°C
Storage temperature	T_{stg}	–40 to +85	°C

Note: 1. Maximum 50 % duty cycle, maximum 1µs pulse width.

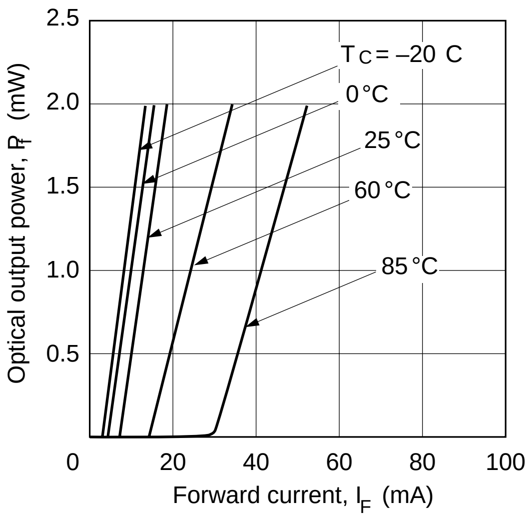
Optical and Electrical Characteristics (T_C = 25°C)

Item	Symbol	Min	Typ	Max	Unit	Test Conditions
Threshold current	I_{th}	—	8	20	mA	
Fiber optical output power	P_f	2	—	—	mW	Kink free
Slope efficiency	η_s	0.08	0.17	—	mW/mA	T_C = 25°C
		0.04	0.07	—		T_C = 85°C
Lasing wavelength	λ_p	1290	1310	1330	nm	P_f = 1.5 mW
Side-mode suppression ratio	S_r	30	—	—	dB	P_f = 1.5 mW
Rise time	t_r	—	—	0.5	ns	10 to 90%
Fall time	t_f	—	—	0.5	ns	90 to 10%
Monitor current	I_s	100	—	—	µA	P_f = 1.5 mW, $V_{R(PD)}$ = 5 V
PD dark current	$I_{(DARK)}$	—	—	350	nA	$V_{R(PD)}$ = 5 V
PD capacitance	C_t	—	15	20	pF	$V_{R(PD)}$ = 5 V, f = 1 MHz
Photosensitivity saturation voltage	$V_{R(S)}$	—	—	2	V	

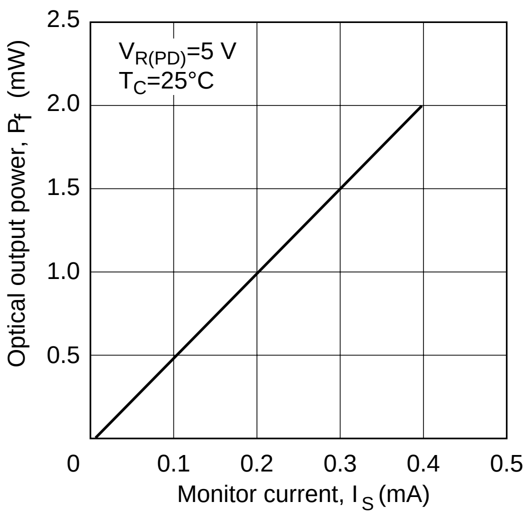
HL1352CN/SN

Typical Characteristic Curves (cont)

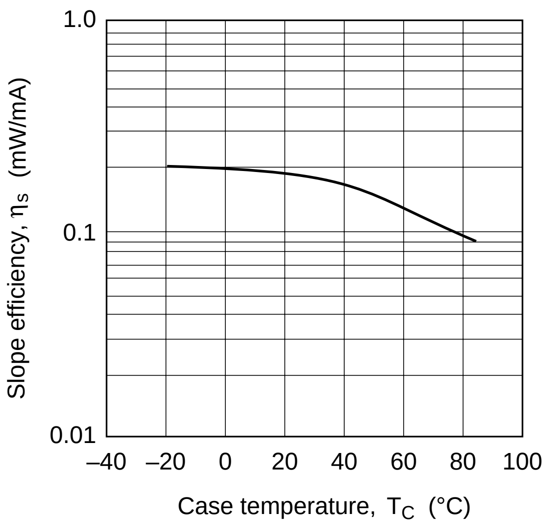
Optical Output Power vs. Forward Current



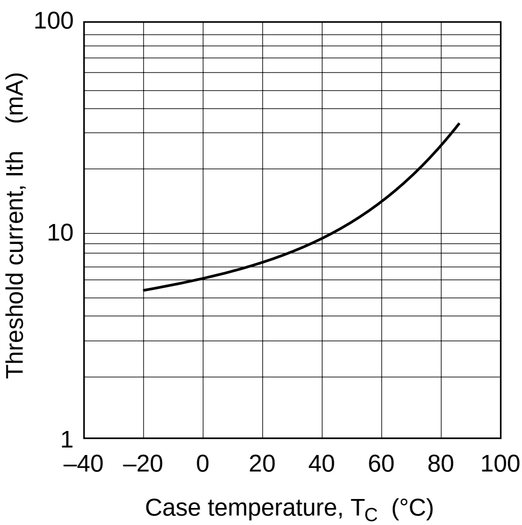
Optical Output Power vs. Monitor Current



Slope efficiency vs.Case Temperature

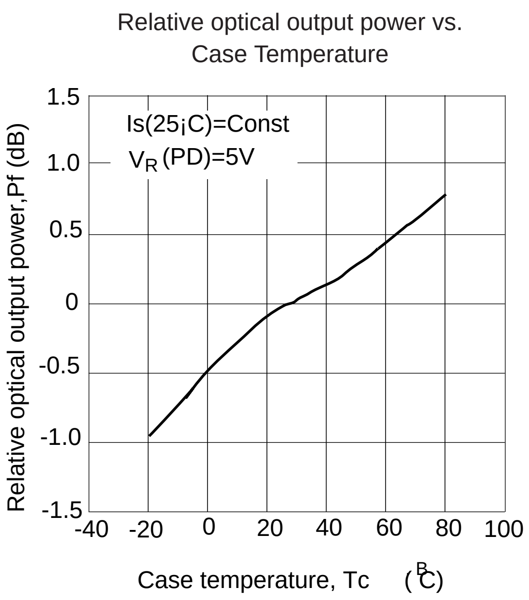


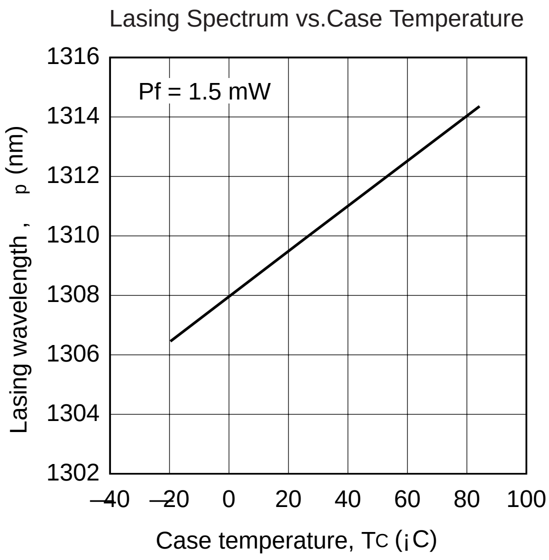
Threshold current vs. Case Temperature

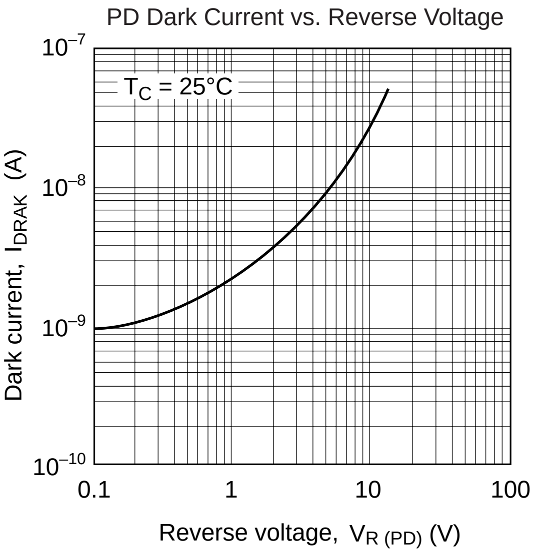


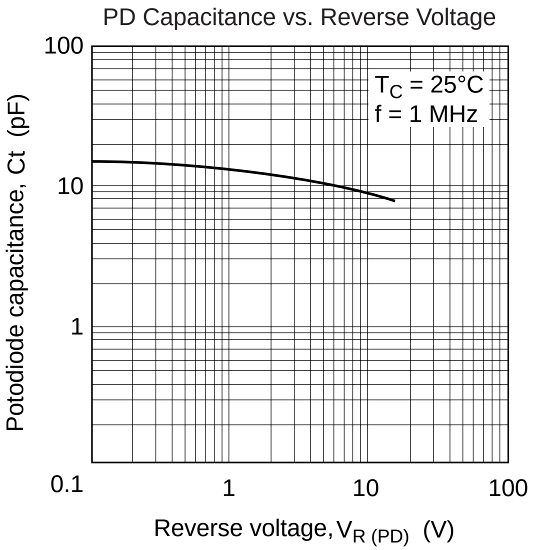
HL1352CN/SN

Typical Characteristic Curves (cont)



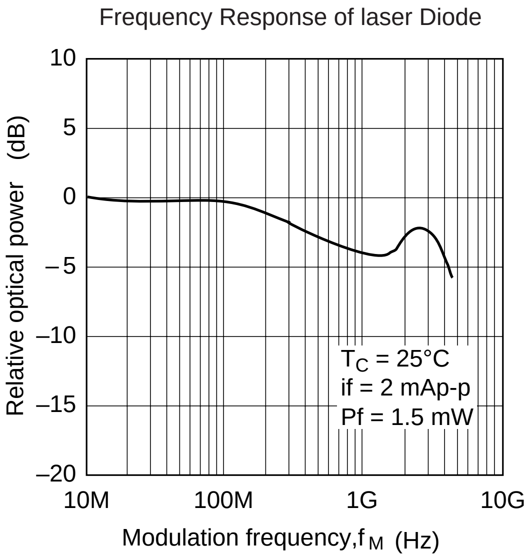


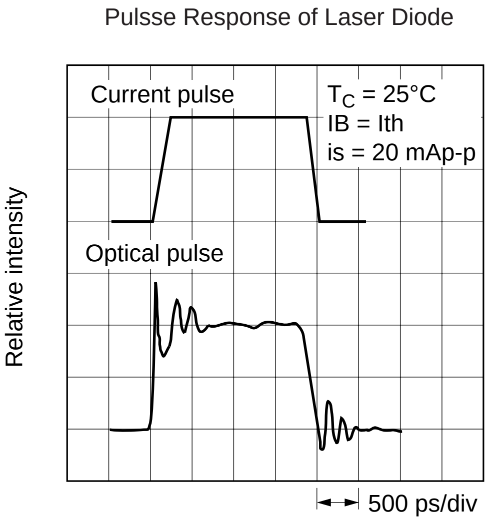




 HL1352CN/SN

Typical Characteristic Curves (cont)





HL1362A/AC

InGaAsP Laser Diodes

Description

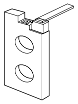
The HL1362A/AC are 1.3 µm InGaAsP λ/4 phase-shifted distributed-feedback laser diodes (DFB-LDs). They are suitable as light sources for high-bit-rate, long-haul fiberoptic communication systems and other applied optical equipment. The compact packages are suitable for module assembly.

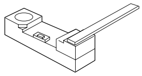
Features

- Long wavelength output: 1290 to 1330 nm
- High-power output: 12 mW
- High quantum efficiency: $\eta_s \geq 0.2$ mW/mA
- Fast pulse response: t_r and t_f ≤ 0.2 ns
- Dynamic single longitudinal mode: $S_r = 40$ dB Typ.
- High frequency response: $f_r = 10$ GHz Typ.

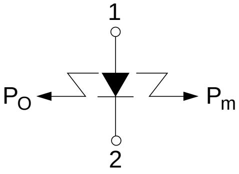
Package Type

- HL1362A: A1
- HL1362AC: AC





Internal Circuit



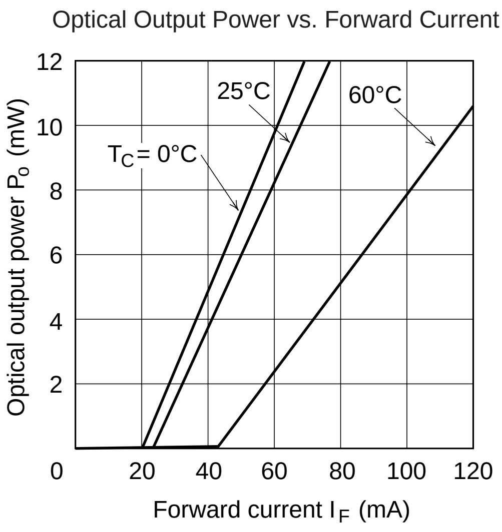
Absolute Maximum Ratings ($T_C = 25°C$)

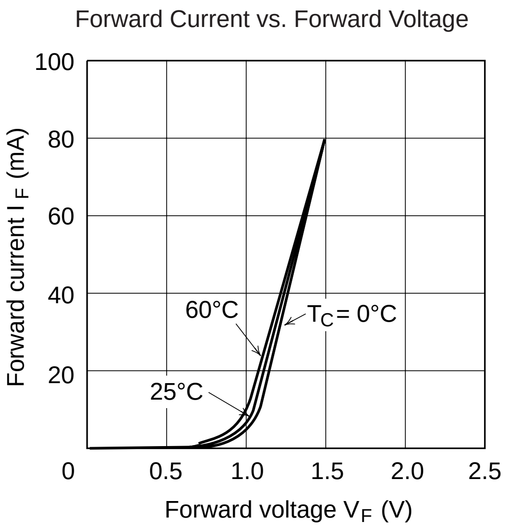
Item	Symbol	Value	Unit
Optical output power	P_O	12	mW
Reverse voltage	V_R	2	V
Operating temperature	T_{opr}	0 to +60	°C
Storage temperature	T_{stg}	0 to +80	°C

Optical and Electrical Characteristics (T_C = 25°C)

Item	Symbol	Min	Typ	Max	Unit	Test Conditions
Threshold current	I_{th}	—	25	50	mA	
Optical output power	P_O	12	—	—	mW	Kink free
Monitor optical output power	P_m	2	—	—	mW	P_O = 8 mW
Slope efficiency	η_s	0.2	—	—	mW/mA	
Lasing wavelength	λ_p	1290	1310	1330	nm	P_O = 8 mW
Side-mode suppression ratio	S_r	30	40	—	dB	2.5 Gbps (NRZ)
Beam divergence (parallel)	$\theta_{//}$	—	30	—	deg.	P_O = 8 mW, FWHM
Beam divergence (perpendicular)	$\theta_{\perp}$	—	40	—	deg.	P_O = 8 mW, FWHM
Rise time	t_r	—	0.1	—	ns	P_O = 3 mW, I_b = I_{th}, 10 to 90%
Fall time	t_f	—	0.15	—	ns	P_O = 3 mW, I_b = I_{th}, 90 to 10%

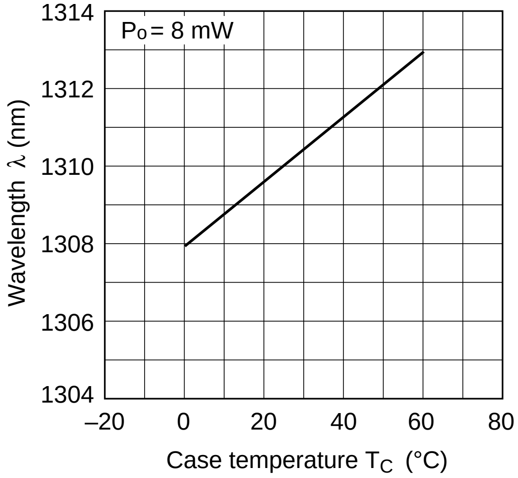
Typical Characteristic Curves



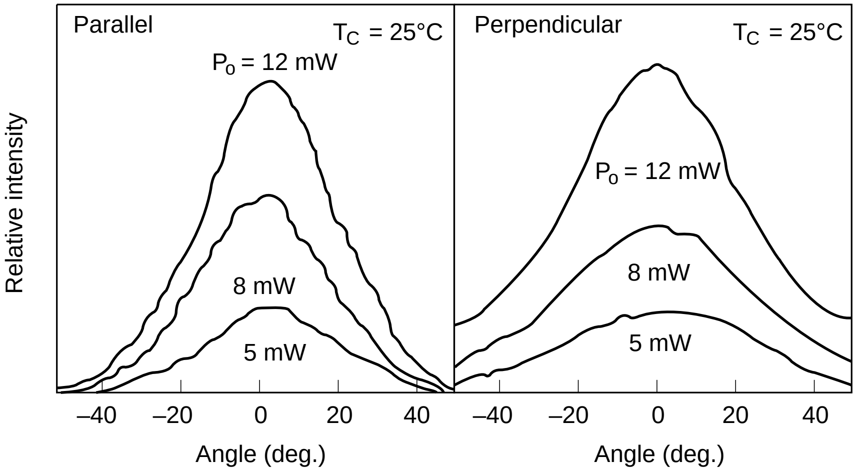


Typical Characteristic Curves (cont)

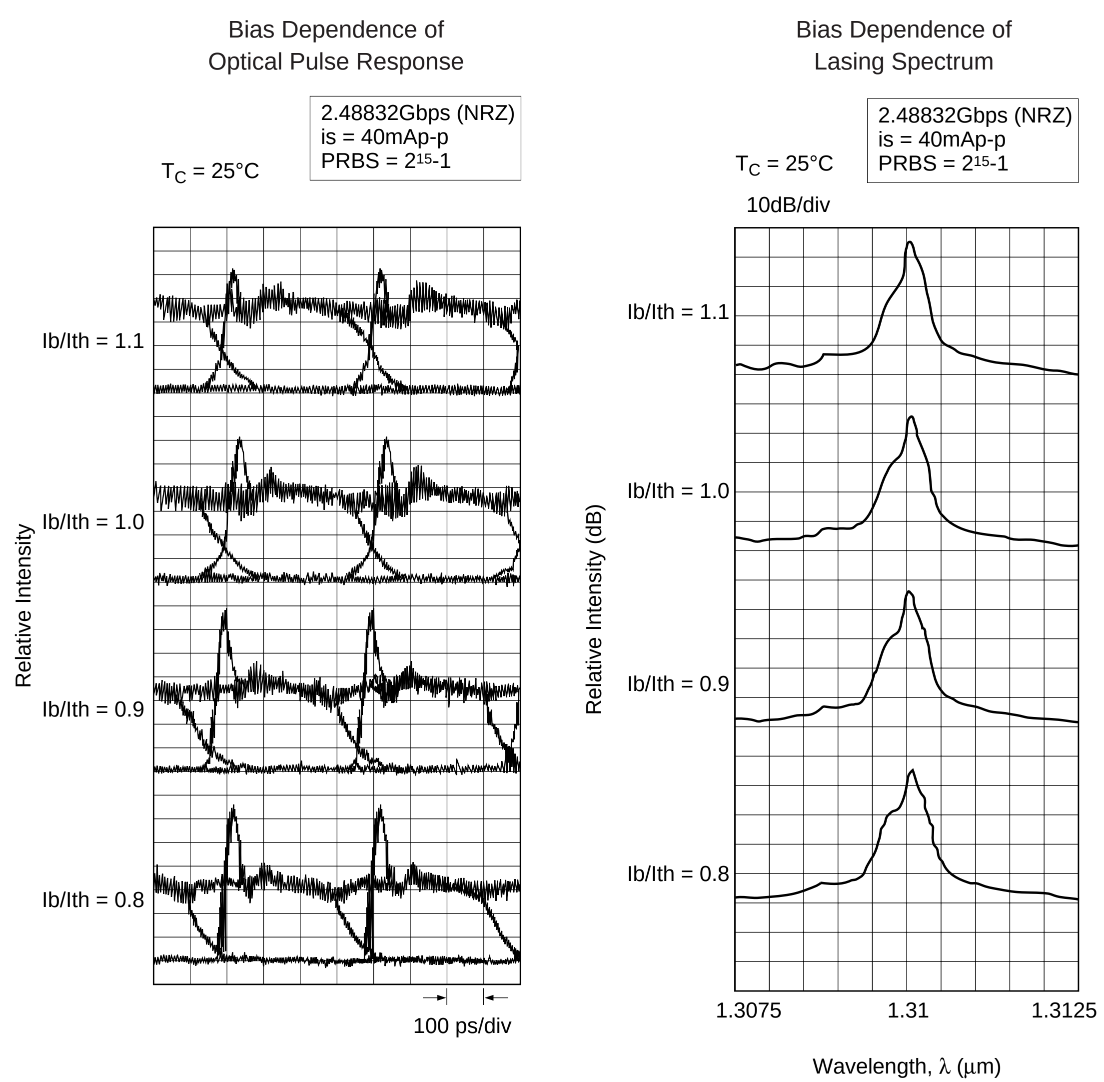
Lasing Wavelength Temperature Dependence



Far Field Pattern

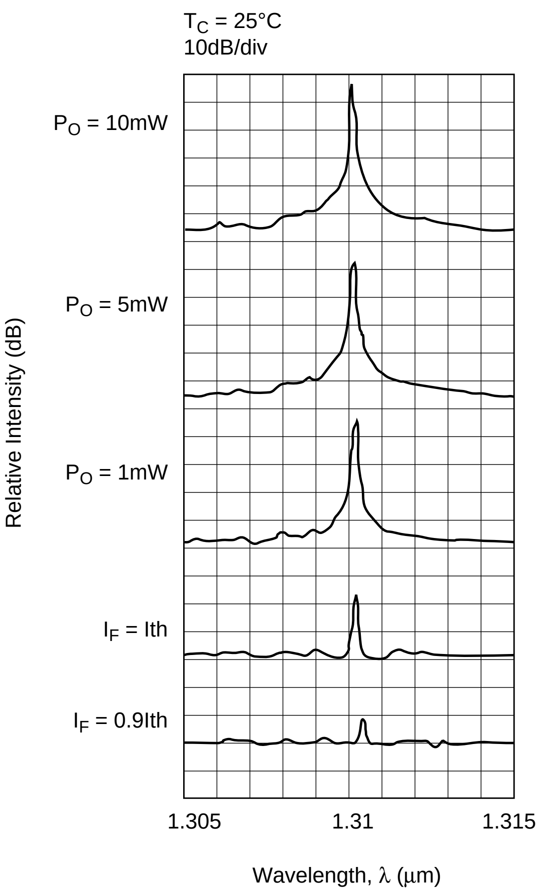


Typical Characteristic Curves (cont)

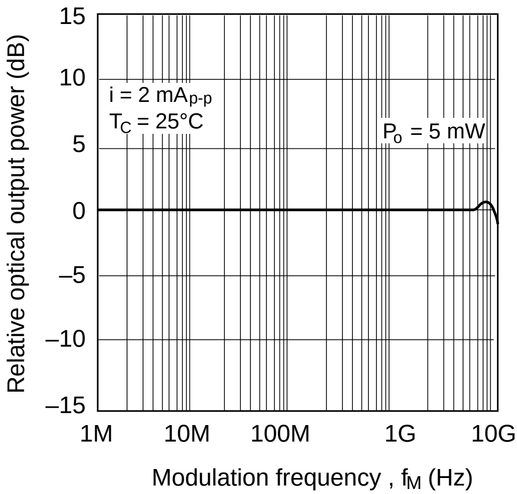


Typical Characteristic Curves (cont)

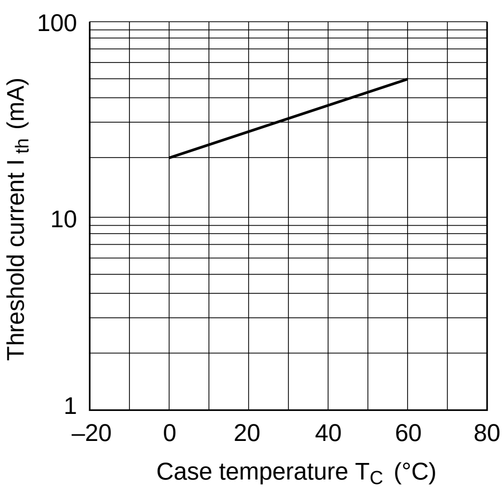
Optical Output Power Dependence of Lasing Spectrum



Frequency Response of Laser Diode



Threshold Current vs. Case Temperature



HL1541BF/DL

InGaAsP Laser Diodes

Description

The HL1541BF/DL are 1.55 µm band InGaAsP distributed feedback (DFB) laser diodes with a buried hetero structure. They are suitable as light sources in fiber optic communications and various other types of optical equipment.

Features

- The HL1541BF is packaged in a butterfly-type package with attached fiber optics cable and has a Peltier cooler, and the HL1541DL is packaged in a DIP package with attached fiber optics cable and also has a Peltier cooler. Thus these models provide stable operation.
- Wavelength output: λp = 1530 to 1570 nm
- Side mode suppression ration: S_r:= 35 dB (Typ.)
- Fast pulse response: t_r = 0.2 ns, t_f = 0.3 ns (Typ.)

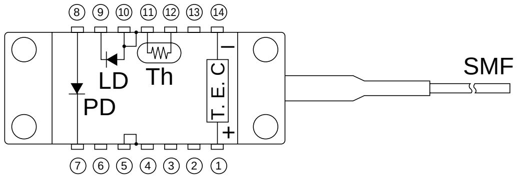
Fiber Specifications

Mode field diameter: 10.0 ± 1.0 µm
Cutoff wavelength: 1.10 to 1.20 µm
Core diameter: 10 µm
Outer diameter: 125 µm
Jacket diameter: 900 µm
Fiber length: over 500 mm

HL1541BF/DL

Pin Connections (Bottom view)

- HL1541BF

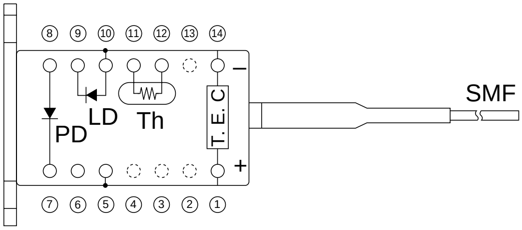


LD: Laser diode
PD: Photodiode
Th: Thermistor
T. E. C.: T. E. cooler
SMF: Single-mode fiber

1. T.E.C. anode
2. N. C.
3. N. C.
4. N. C.
5. Case
6. N. C.
7. PD cathode
8. PD anode
9. LD cathode
10. LD anode (case)
11. Thermistor
12. Thermistor
13. N. C.
14. T. E. C. cathode

Package Type
- HL1541BF: BF

- HL1541DL



LD: Laser diode
PD: Photodiode
Th: Thermistor
T. E. C.: T. E. cooler
SMF: Single-mode fiber

1. T.E.C. anode
2. —
3. —
4. —
5. Case
6. N. C.
7. PD cathode
8. PD anode
9. LD cathode
10. LD anode (case)
11. Thermistor
12. Thermistor
13. —
14. T. E. C. cathode

Package Type
- HL1541DL: DL

Absolute Maximum Ratings (T_C = 25°C)

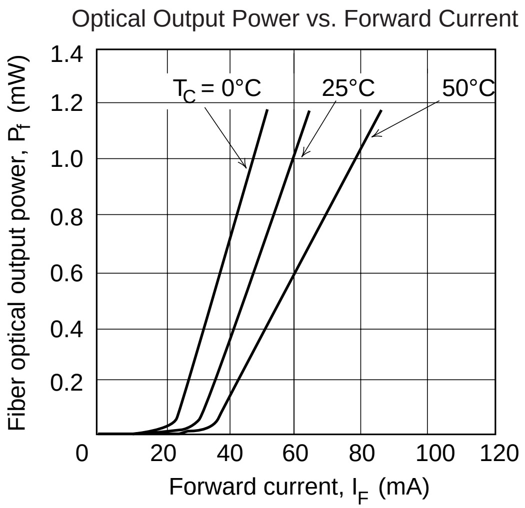
Item	Symbol	Rated Value	Unit
Fiber optical output power	P_f	1.0	mW
LD reverse voltage	$V_{R (LD)}$	2	V
PD reverse voltage	$V_{R (PD)}$	15	V
PD forward current	$I_{F (PD)}$	1	mA
Cooler current	I_C	1.4	A
Operating temperature	T_{opr}	0 to + 60	°C
Storage temperature	T_{stg}	– 40 to + 70	°C

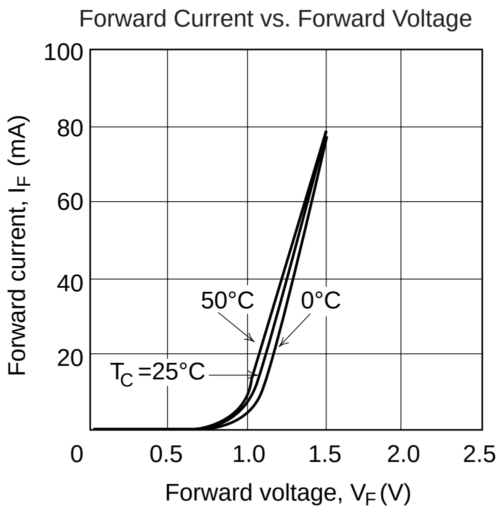
Optical and Electrical Characteristics (T_C = 25°C)

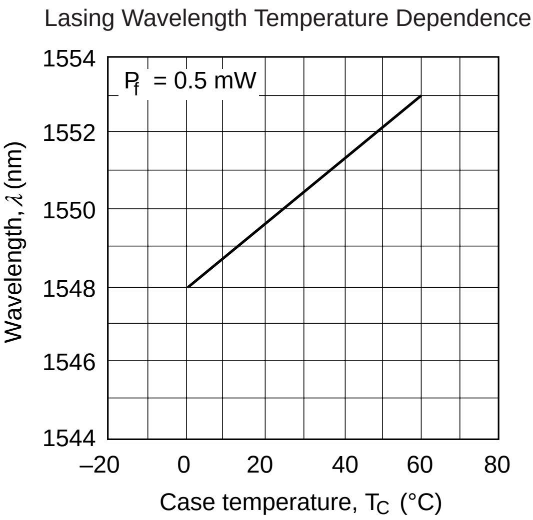
Item	Symbol	Min	Typ	Max	Units	Test Conditions
Threshold current	I_{th}	—	25	50	mA	
Fiber optical output power	P_f	1.0	—	—	mW	Kink free
		0.3	—	—		$I_F = I_{th}$ + 20 mA
Lasing wave-length	λ_p	1530	1550	1570	nm	P_f = 0.5 mW
Side mode suppression ratio	S_r	30	35	—	dB	P_f = 0.5 mW
Rise time	t_r	—	—	0.5	ns	$I_{bias} = I_{th}$, 10 to 90 %
Fall time	t_f	—	—	0.5	ns	$I_{bias} = I_{th}$, 90 to 10 %
PD dark current	I_{DARK}	—	—	350	nA	$V_{R (PD)}$ = 5 V
Monitor current	I_S	50	—	—	µA	$V_{R (PD)}$ = 5 V, P_f = 0.5 mW
PD capacitance	C_t	—	10	20	pF	$V_{R (PD)}$ = 5 V, f = 1 MHz
Photosensitivity saturation bias current	$V_{R (S)}$	—	—	2	V	
Cooling capacity	ΔT	40	—	—	°C	P_f = 0.5 mW, T_C = 60 °C
Cooler current	I_C	—	—	1.4	A	ΔT = 40 °C
Cooler voltage	V_C	—	—	1.8	V	ΔT = 40 °C
Thermistor resistance	R_{TM}	—	10	—	kΩ	

HL1541BF/DL

Typical Characteristic Curves

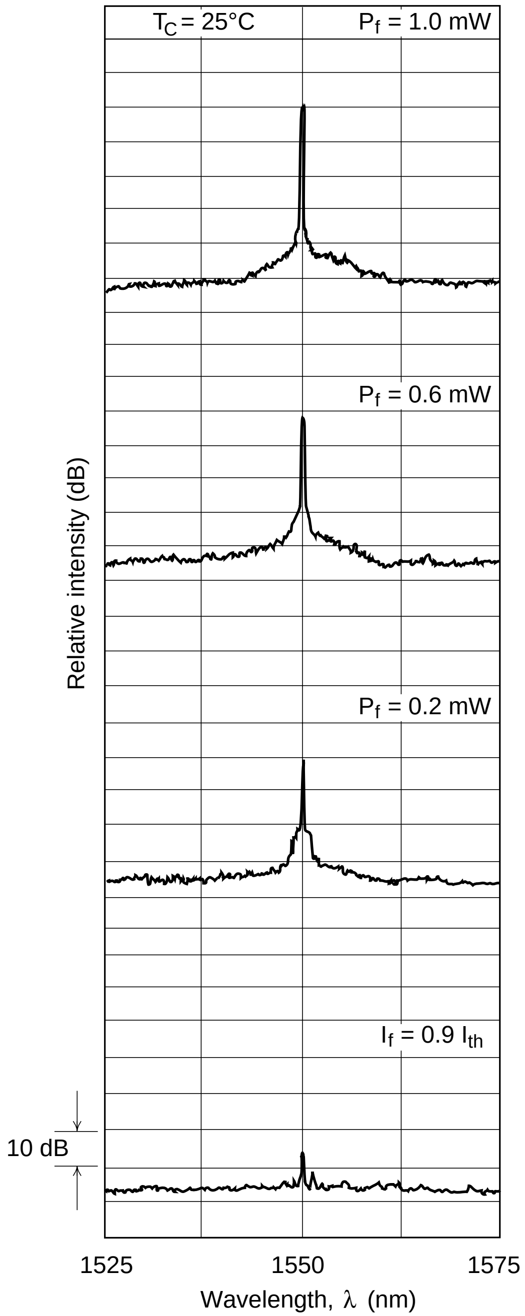




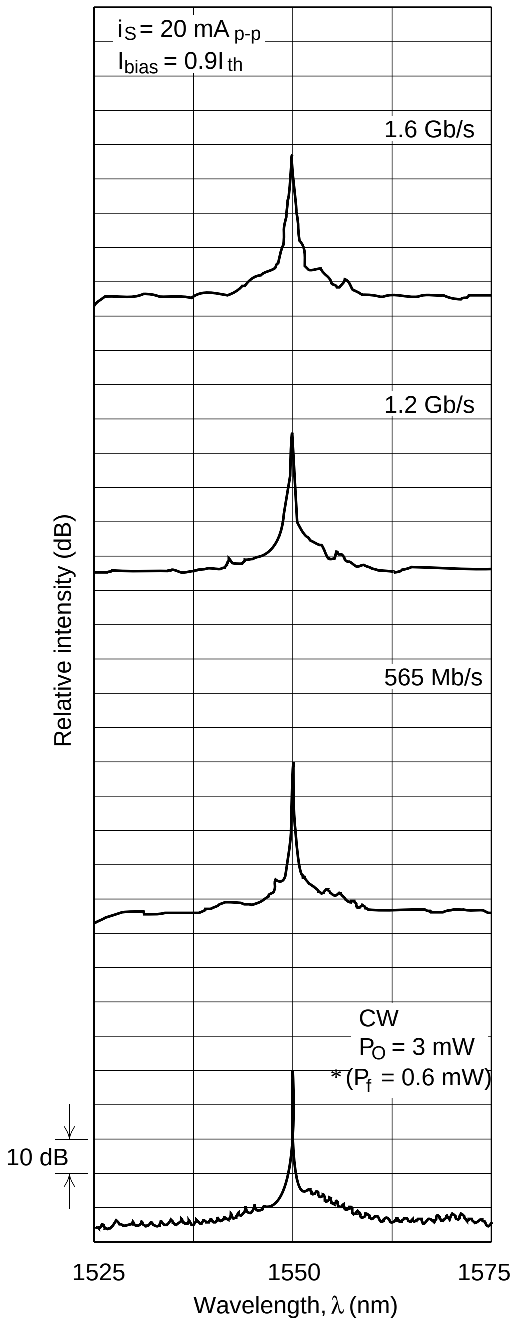


Typical Characteristic Curves (cont)

Output Power Dependence ofLasing Spectrum

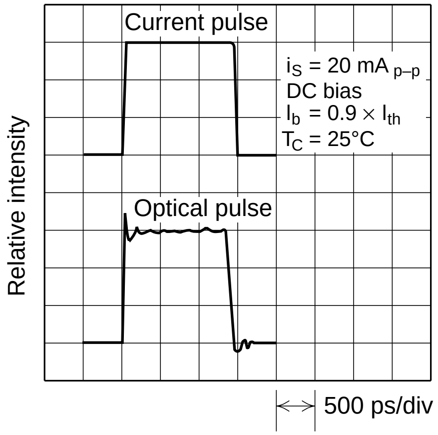


Frequency Dependence ofLasing Spectral

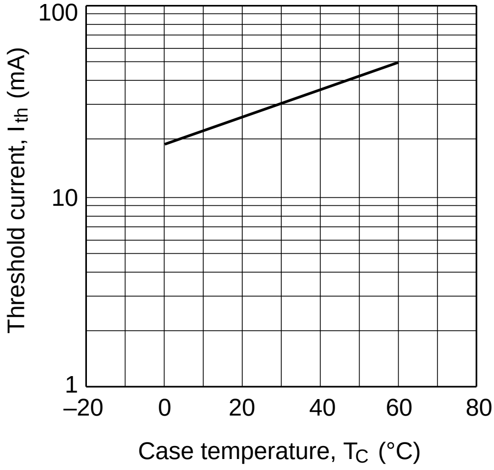


Typical Characteristic Curves (cont)

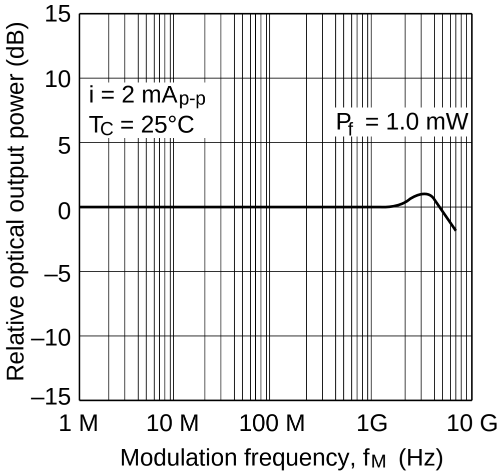
Pulse Response Characteristics



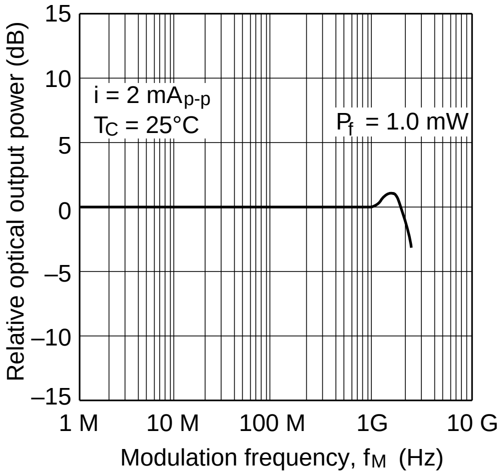
Threshold Current vs.Case Temperature



Frequency Response Characteristics
(HL1541BF)

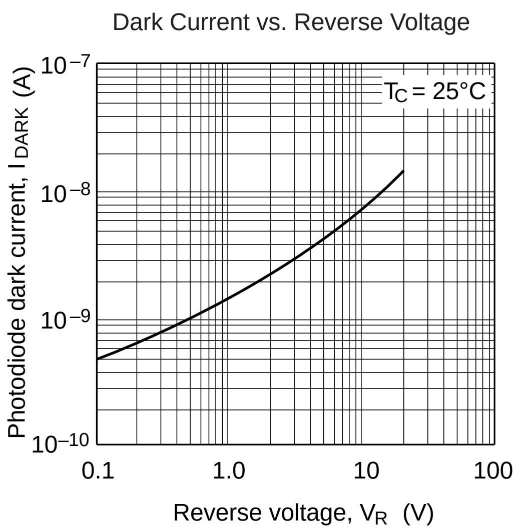


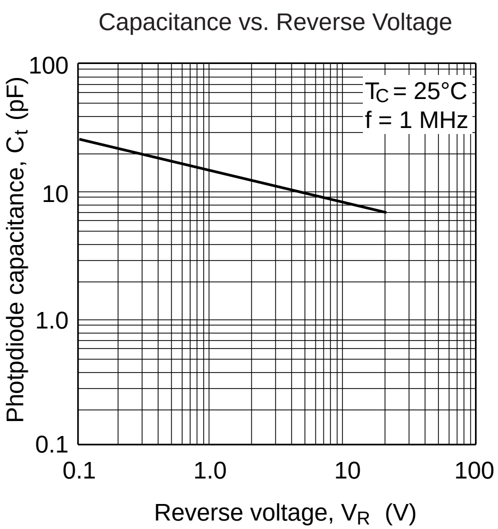
Frequency Response Characteristics
(HL1541DL)

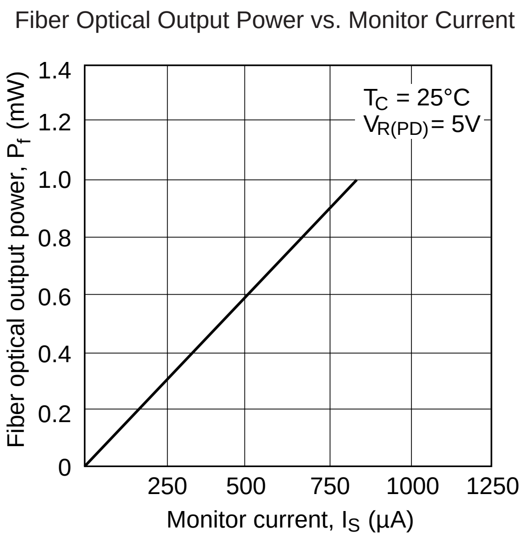


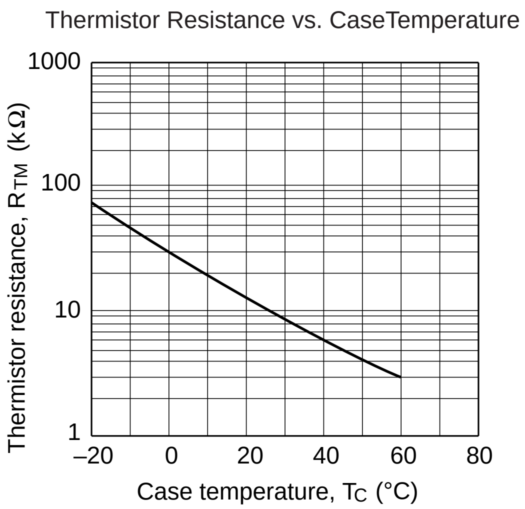
HL1541BF/DL

Typical Characteristic Curves (cont)

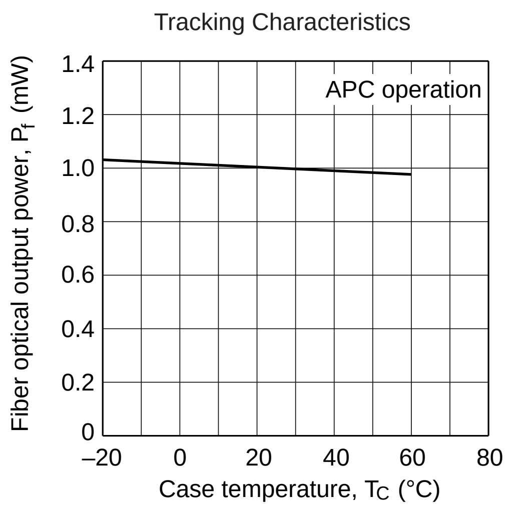








Typical Characteristic Curves (cont)



HL1551A/AC

InGaAsP Laser Diodes

Description

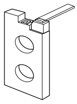
The HL1551A/AC are 1.55 µm InGaAsP λ/4 phase-shifted distributed-feedback laser diodes (DFB-LD) with a multi-quantum well (MQW) structure. They are suitable as light sources for high-bit-rate, long-haul fiberoptic communication systems and other applied optical equipment. The compact package is suitable for module assembly.

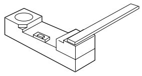
Features

- Long wavelength output: 1530 to 1570 nm
- High-power output: 12 mW
- High quantum efficiency: $\eta_s \geq 0.125$ mW/mA
- Fast pulse response: t_r, t_f: ≤ 0.2 ns
- Dynamic single longitudinal mode: $S_r = 40$ dB Typ.
- Narrow spectral width (2.5 Gbps): $\Delta\lambda = 0.5$ nm Typ.

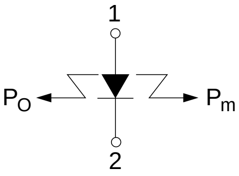
Package Type

- HL1551A: A1
- HL1551AC: AC





Internal Circuit



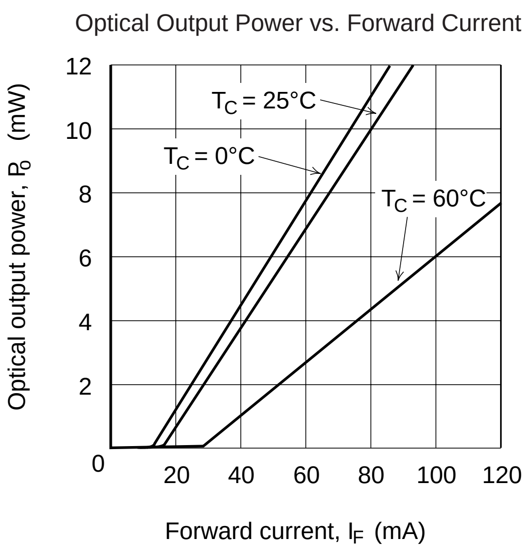
Absolute Maximum Ratings (T_C = 25°C)

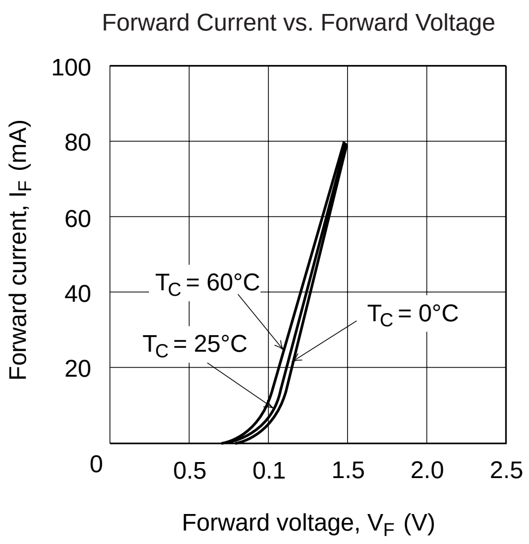
Item	Symbol	Value	Unit
Optical output power	P_O	12	mW
Reverse voltage	V_R	2	V
Operating temperature	T_{opr}	0 to +60	°C
Storage temperature	T_{stg}	0 to +80	°C

Optical and Electrical Characteristics (T_C = 25°C)

Item	Symbol	Min	Typ	Max	Unit	Test Conditions
Threshold current	I_{th}	—	15	50	mA	
Optical output power	P_O	12	—	—	mW	Kink free
Monitor optical output power	P_m	2	—	—	mW	P_O = 8 mW
Slope efficiency	η_s	0.125	0.15	—	mW/mA	
Spectral width	$\Delta\lambda$	—	0.5	—	nm	–27 dB, 2.5 Gbps (NRZ)
Lasing wavelength	λ_p	1530	1550	1570	nm	P_O = 8 mW
Side-mode suppression ratio	S_r	30	40	—	dB	2.5 Gbps (NRZ)
Beam divergence (parallel)	$\theta_{//}$	—	30	—	deg.	P_O = 8 mW, FWHM
Beam divergence (perpendicular)	$\theta_{\perp}$	—	40	—	deg.	P_O = 8 mW, FWHM
Rise time	t_r	—	0.1	—	ns	P_O = 3 mW, $I_b = I_{th}$, 10 to 90%
Fall time	t_f	—	0.15	—	ns	P_O = 3 mW, $I_b = I_{th}$, 90 to 10%

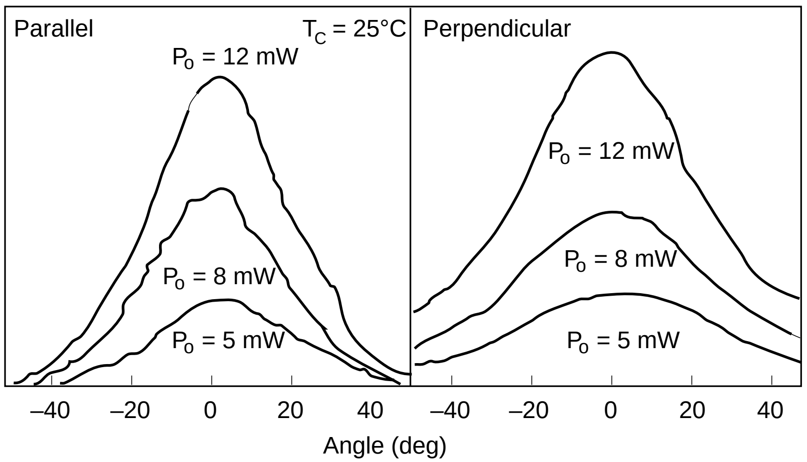
Typical Characteristic Curves



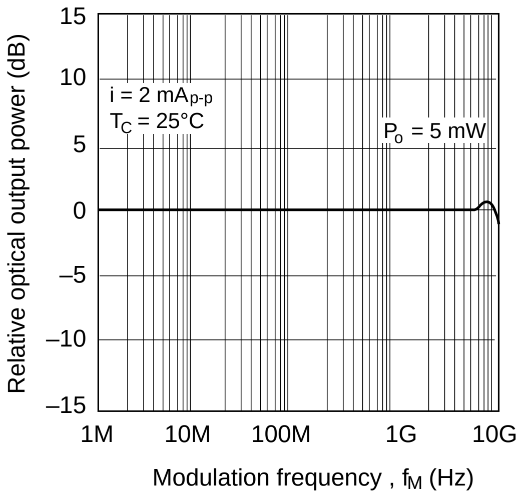


Typical Characteristic Curves (cont)

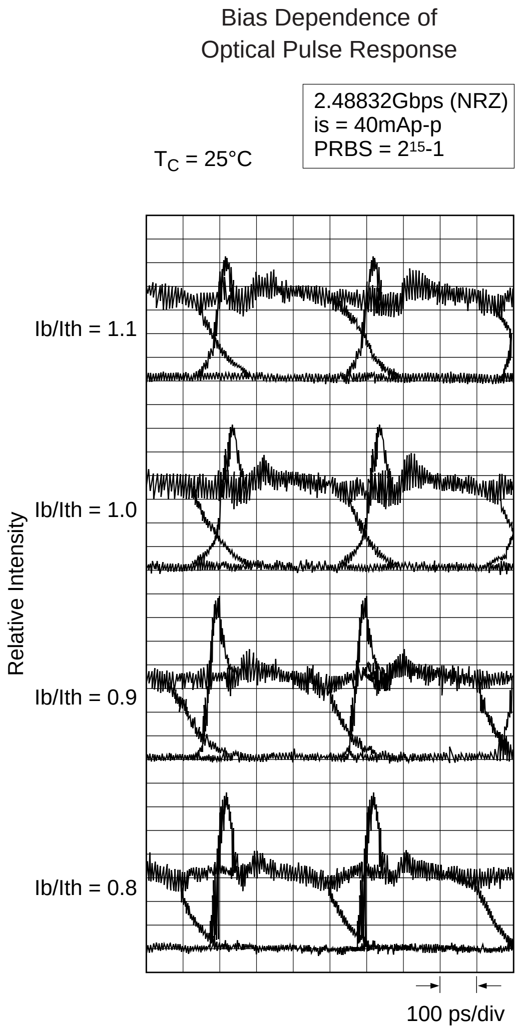
Far Field Pattern

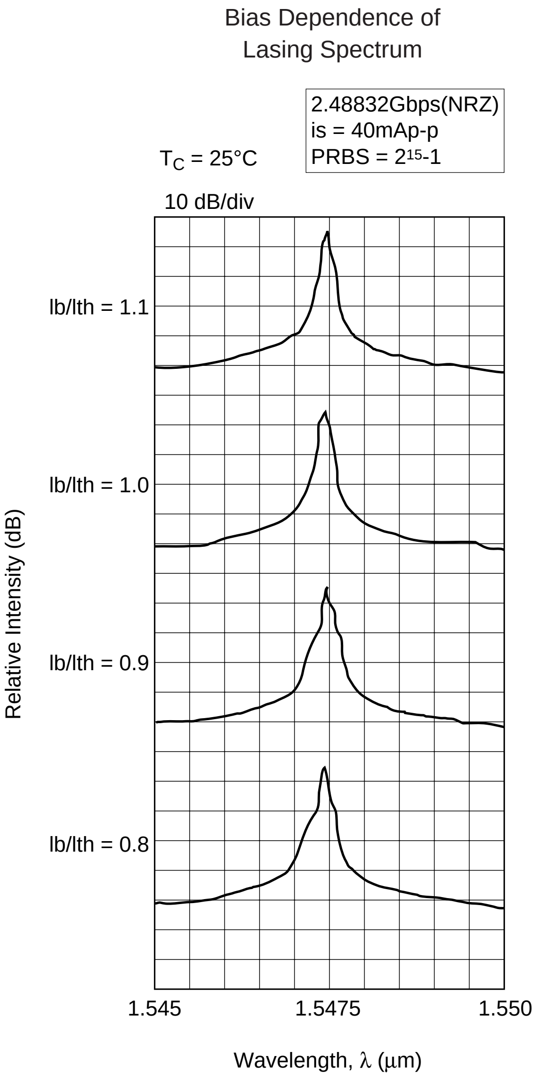


Frequency Response of Laser Diode



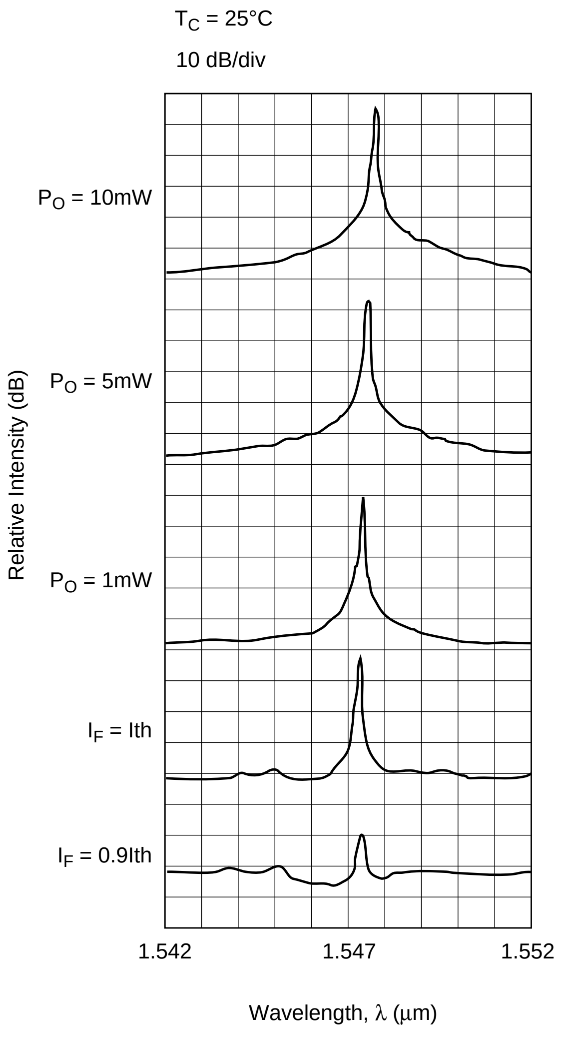
Typical Characteristic Curves (cont)



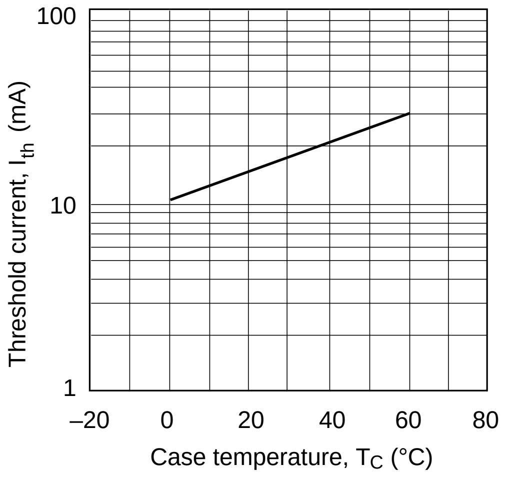


Typical Characteristic Curves (cont)

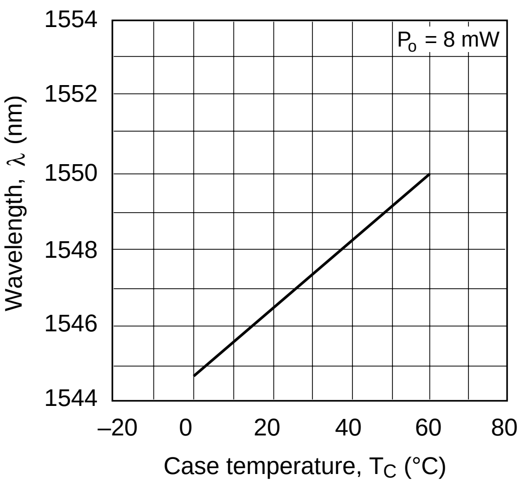
Optical Output Power Dependence
of Lasing Spectrum



Threshold Current vs. Case Temperature



Temperature Dependence of
Lasing Wavelength



HL1553

1.55 μm Laser Diode with EA Modulator

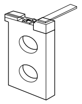
Description

The HL1553 is a 1.55 μm InGaAsP distributed-feedback laser diode (DFB-LD) with a multi-quantum well (MQW) structure. An electroabsorption (EA) modulator is integrated with the laser diode. It is suitable as a light source for high-bit-rate, longhaul fiberoptic communication systems, such as 2.5 Gbps external modulation systems.

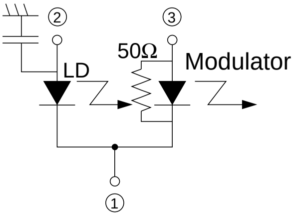
Features

- Long wavelength output: λp = 1557 nm Typ.
- High extinction ratio: 13 dB Min. at V_R (EA) = –2 V
- Fast pulse response: tr / tf: ≤ 125 ps
- Dynamic single longitudinal mode: Sr = 40 dB Typ.

Package Type
- HL1553: AF



Internal Circuit



Absolute Maximum Ratings (T_C = 25°C)

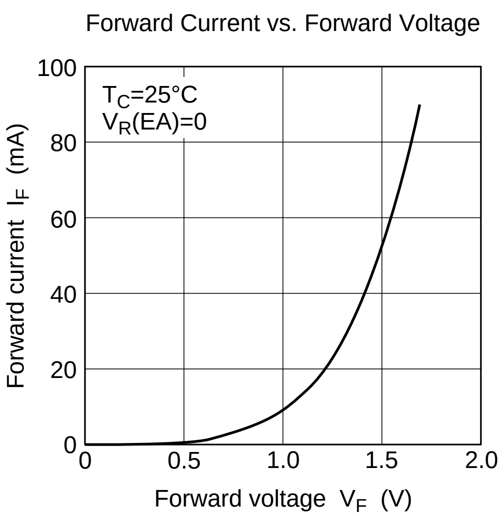
Item	Symbol	Value	Unit
LD forward current	I_F	100	mA
Optical output power*1	P_O	1.5	mW
Laser diode reverse voltage	V_R(LD)	2	V
Modulator reverse voltage	V_R(EA)	–3	V
Operating temperature	Topr	10 to 40	°C
Storage temperature	Tstg	0 to 60	°C

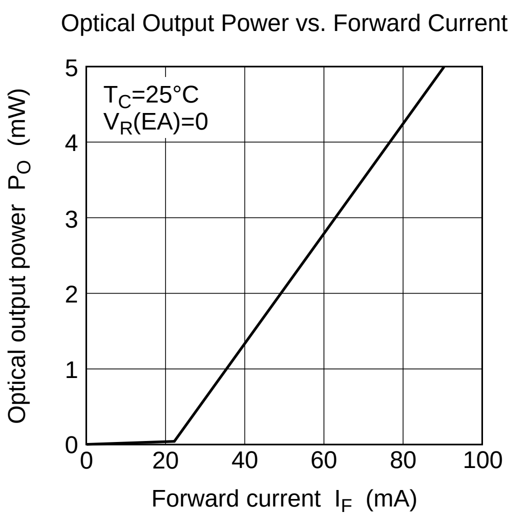
Note: 1. T_C = 40°C; Life time of the HL1553 is determined under the conditions at T_C = 40°C, P_O = 1.5 mW (V_R (EA) = 0).

Optical and Electrical Characteristics (T_C = 25°C)

Item	Symbol	Min	Typ	Max	Unit	Test Conditions
Optical output power	P_O	3.0	—	—	mW	Kink free, V_R(EA) = 0
Threshold current	Ith	—	25	40	mA	
Slope efficiency	ηs	0.04	—	—	mW/mA	I_F(LD) ≤ 70 mA, V_R(EA) = 0
Monitor output power	Pm	0.1	—	—	mW	P_O = 3 mW, V_R(EA) = 0
Extinction ratio	ER	13	—	—	dB	I_F(LD) = 70 mA, V_R(EA) = –2 V
Lasing wavelength	λp	1530	1557	1570	nm	2.5 Gbps(NRZ)
Beam divergence (parallel)	θ//	—	30	—	deg.	P_O = 3 mW, V_R(EA) = 0
Beam divergence (perpendicular)	θ⊥	—	40	—	deg.	P_O = 3 mW, V_R(EA) = 0
Side-mode suppression ratio	Sr	30	40	—	dB	2.5 Gbps(NRZ)
Rise / Fall time	tr / tf	—	—	125	ps	2.5 Gbps(NRZ)
Cutoff frequency	S_{21}	4	—	—	GHz	I_F(LD) = 70 mA, V_R(EA) = –1 V
RF return loss	S_{11}	10	—	—	dB	I_F(LD) = 70 mA, V_R(EA)=–1 V, f ≤ 3GHz

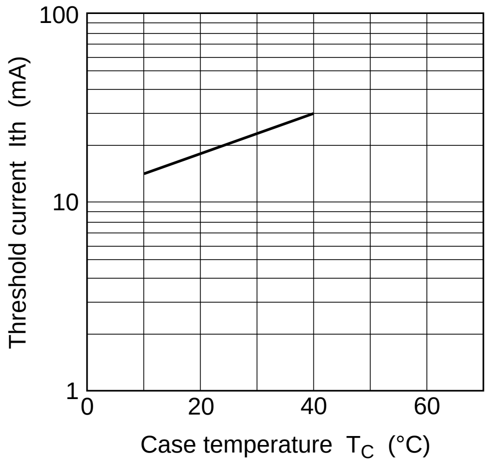
Typical Characteristic Curves



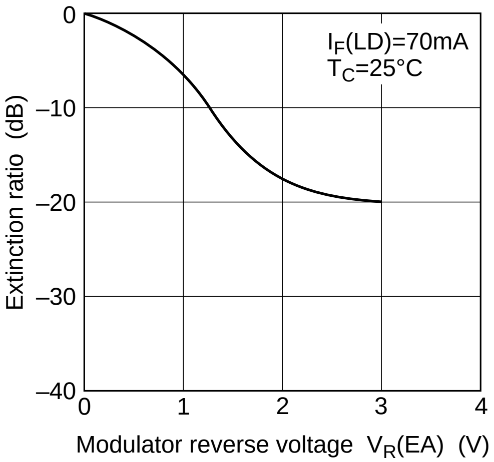


Typical Characteristic Curves (cont)

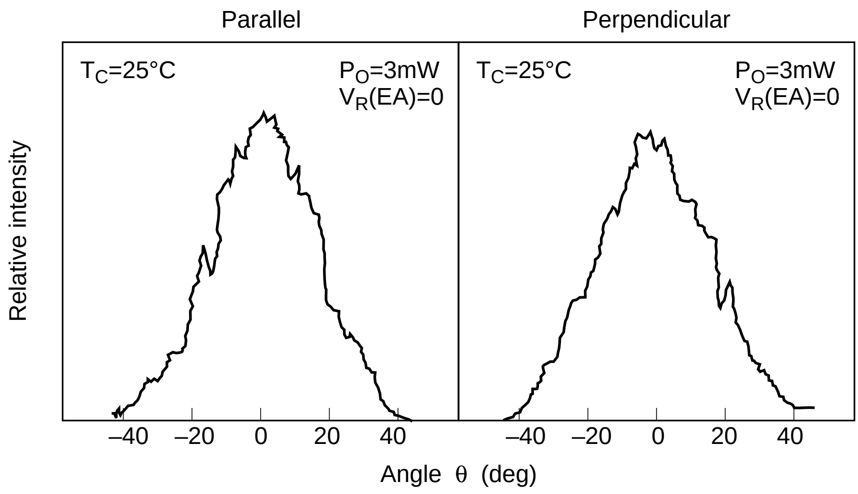
Threshold Current vs. Case Temperature



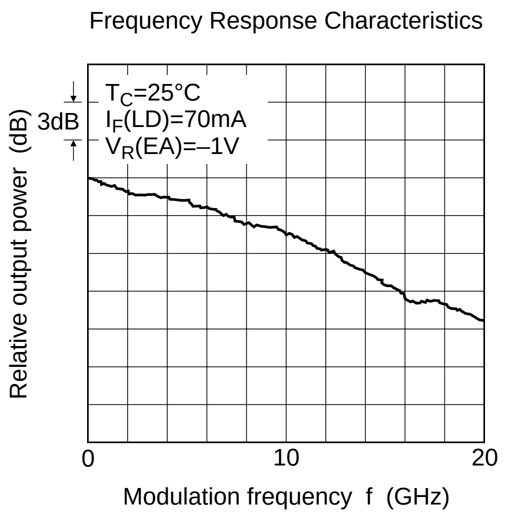
Extinction Ratio vs. Modulator Reverse Voltage

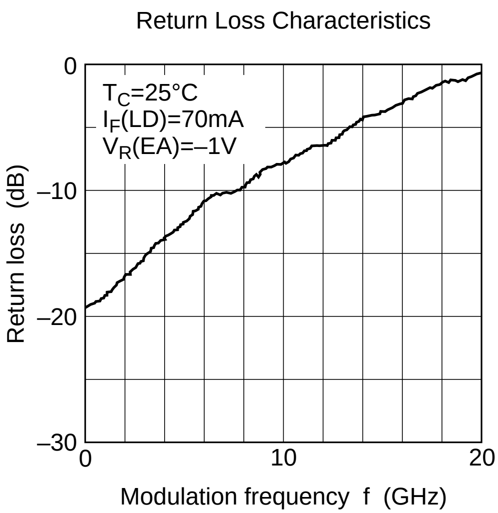


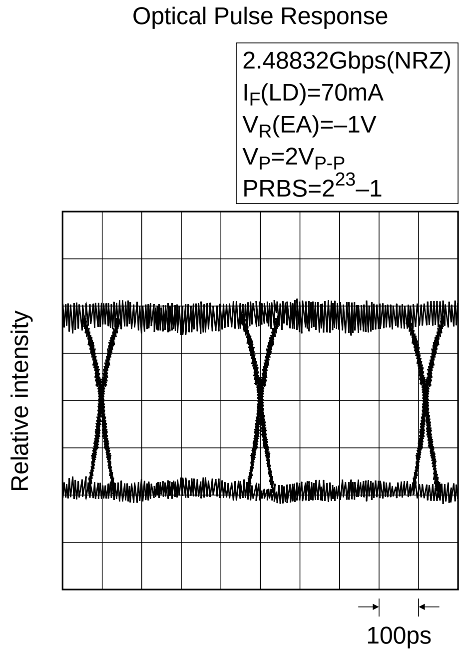
Far Field Pattern

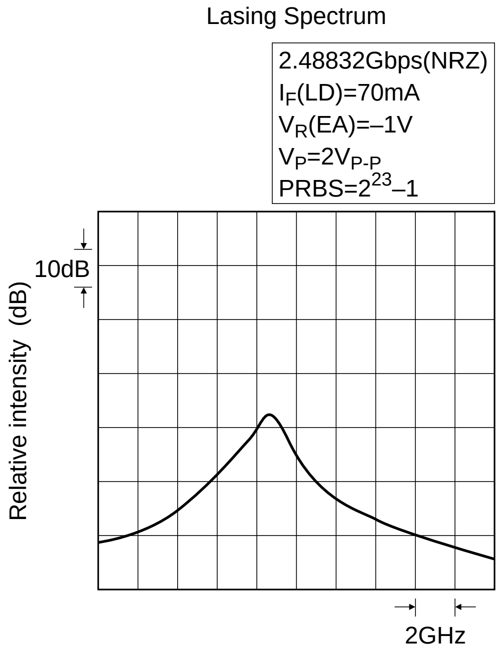


Typical Characteristic Curves (cont)









HE7601SG

GaAlAs Infrared Emitting Diode

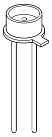
Description

The HE7601SG is a 770 nm band GaAlAs infrared emitting diode with a double heterojunction structure. It is suitable as a light source for optical control devices and sensors.

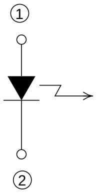
Features

- High efficiency and high output power

Package Type
- HE7601SG: SG1



Internal Circuit



Absolute Maximum Ratings (T_C = 25°C)

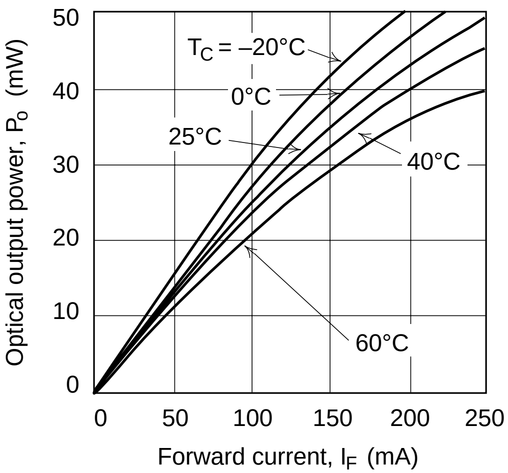
Item	Symbol	Rated Value	Units
Forward current	I_F	250	mA
Reverse voltage	V_R	3	V
Operating temperature	T_{opr}	–20 to +60	°C
Storage temperature	T_{stg}	–40 to +90	°C

Optical and Electrical Characteristics (T_C = 25°C)

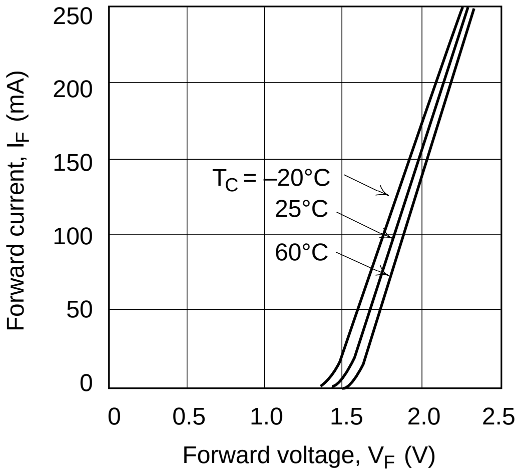
Item	Symbol	Min	Typ	Max	Units	Test Conditions
Optical output power	P_O	30	—	—	mW	I_F = 200 mA
Peak wavelength	λ_P	740	770	800	nm	I_F = 200 mA
Spectral width	$\Delta\lambda$	—	50	—	nm	I_F = 200 mA
Forward voltage	V_F	—	—	2.5	V	I_F = 200 mA
Reverse current	I_R	—	—	100	µA	V_R = 3 V
Capacitance	C_t	—	30	—	pF	V_R = 0 V, f = 1 MHz
Rise and fall time	t_r, t_f	—	10	—	ns	I_F = 50 mA

Typical Characteristic Curves

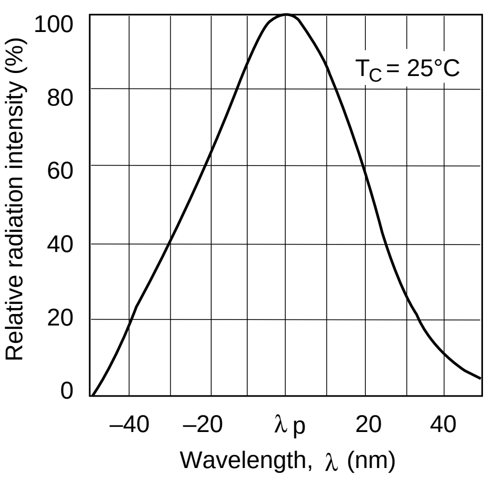
Optical Output Power vs. Forward Current



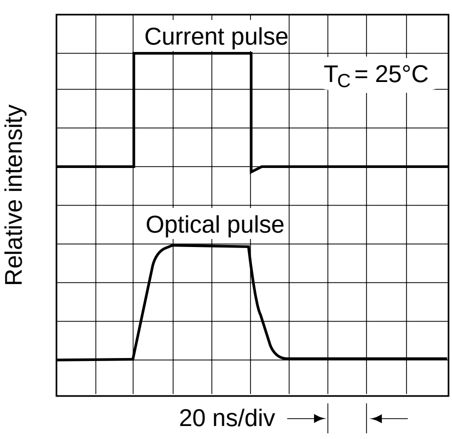
Forward Current vs. Forward Voltage



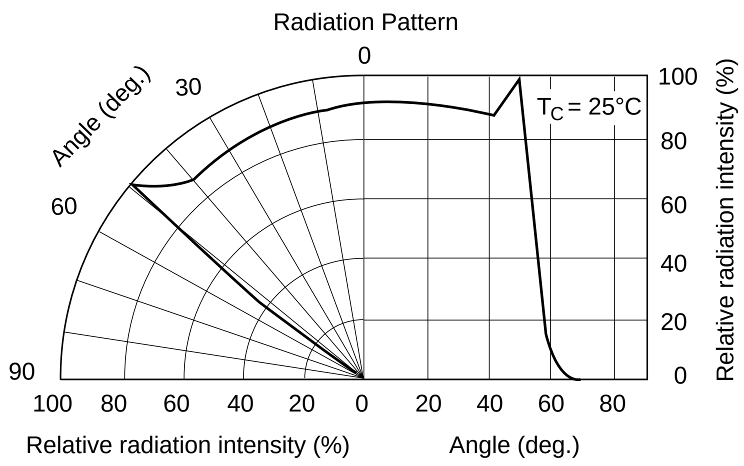
Spectral Distribution



Pulse Response



Typical Characteristic Curves (cont)



HE8404SG

GaAlAs Infrared Emitting Diode

Description

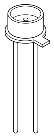
The HE8404SG is a GaAlAs double heterojunction structure 820 nm band light emitting diode. It is suitable for use as the light source in a wide range of optical control and sensing equipment.

Features

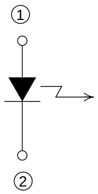
- High efficiency, high output

Package Type

- HE8404SG: SG1



Internal Circuit



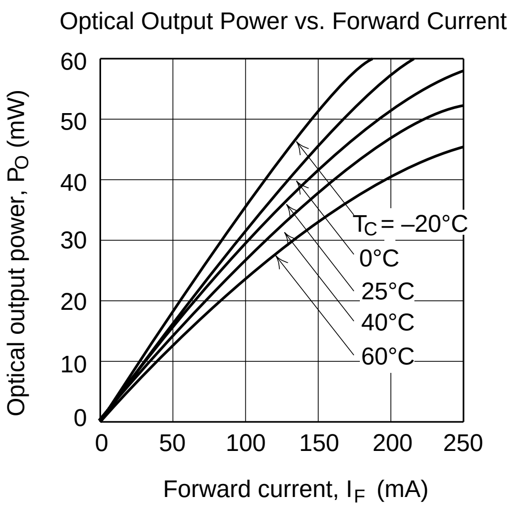
Absolute Maximum Ratings (T_C = 25°C)

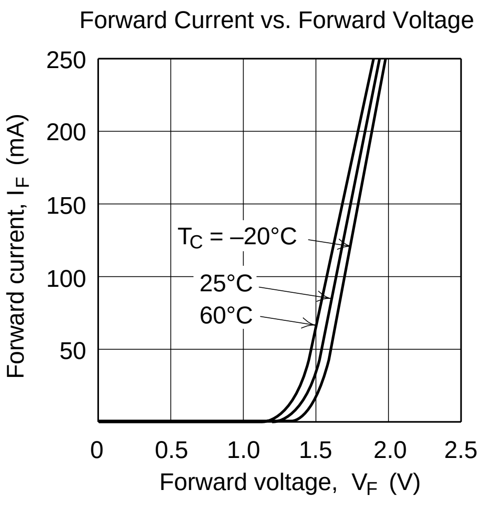
Item	Symbol	Rated Value	Units
Forward current	I_F	250	mA
Reverse voltage	V_R	3	V
Operating temperature	T_{opr}	–20 to +60	°C
Storage temperature	T_{stg}	–40 to +90	°C

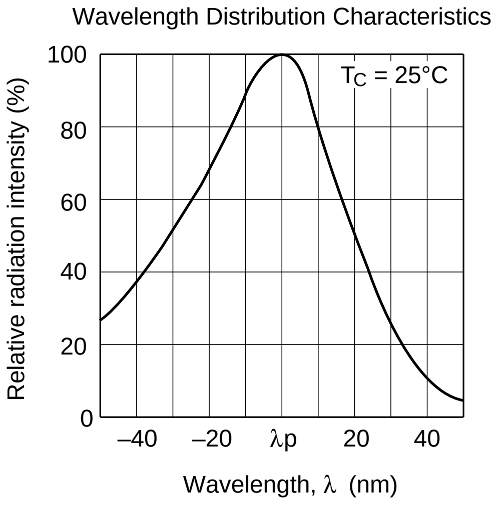
Optical and Electrical Characteristics (T_C = 25°C)

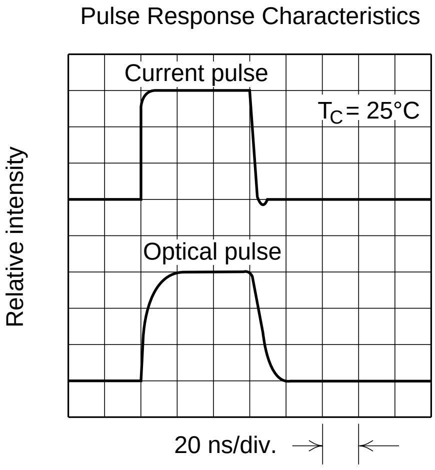
Item	Symbol	Min	Typ	Max	Units	Test Conditions
Optical output power	P_O	40	—	—	mW	I_F = 200 mA
Peak wavelength	λ_p	790	820	850	nm	I_F = 200 mA
Spectral width	$\Delta\lambda$	—	50	—	nm	I_F = 200 mA
Forward voltage	V_F	—	—	2.5	V	I_F = 200 mA
Reverse current	I_R	—	—	100	µA	V_R = 3 V
Capacitance	C_t	—	30	—	pF	V_R = 0 V, f = 1 MHz
Rise and fall times	t_r , t_f	—	10	—	ns	I_F = 50 mA

Typical Characteristic Curves

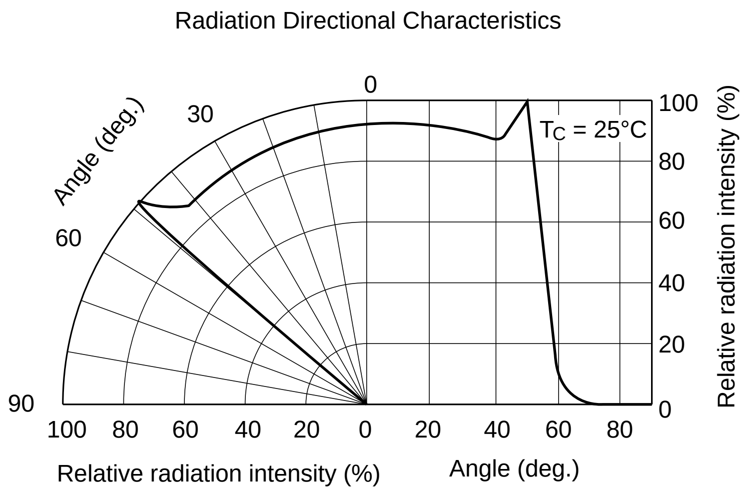








Typical Characteristic Curves (cont)



HE8807SG/CL/FL

GaAlAs Infrared Emitting Diodes

Description

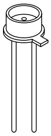
The HE8807SG/CL/FL are single heterojunction structure GaAlAs light emitting diodes with a wavelength of 880 nm.

Features

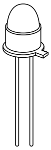
- High output, high efficiency
- Narrow spectral width
- Sharp radiation directivity (HE8807CL/FL)
- Wide radiation directivity (HE8807SG)
- High reliability

Package Type

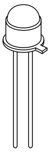
- HE8807SG: SG1



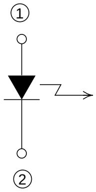
- HE8807CL: CL



- HE8807FL: FL



Internal Circuit



Absolute Maximum Ratings (T_C = 25°C)

Item	Symbol	Rated Value	Units
Forward current	I_F	200	mA
Reverse voltage	V_R	3	V
Operating temperature	T_{opr}	–20 to +85	°C
Storage temperature	T_{stg}	–40 to +100	°C

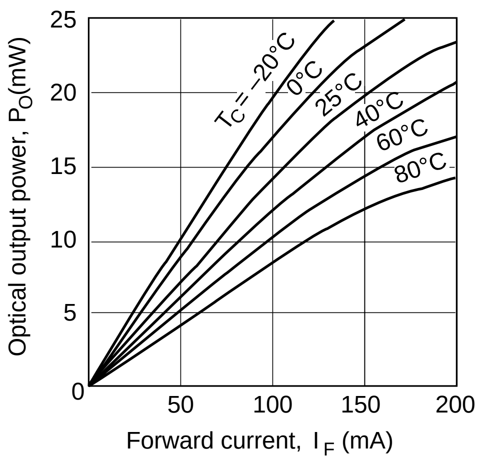
Optical and Electrical Characteristics (T_C = 25°C)

Item		Symbol	Min	Typ	Max	Units	Test Conditions
Optical output power	HE8807SG	P_O	10	20	—	mW	I_F = 150 mA
	HE8807CL		5	15	—		
	HE8807FL	P_F*1	0.5	1.0	—		I_F = 20 mA
Peak wavelength		λ_p	800	880	900	nm	I_F = 150 mA
Spectral width		$\Delta\lambda$	—	30	—	nm	I_F = 150 mA
Forward voltage		V_F	—	1.7	2.3	V	I_F = 150 mA
Reverse current		I_R	—	—	100	μA	V_R = 3V
Capacitance		C_t	—	10	—	pF	V_R = 0 V, f = 1 MHz
Rise time		t_r	—	20	—	ns	I_F = 50 mA
Fall time		t_f	—	20	—	ns	I_F = 50 mA

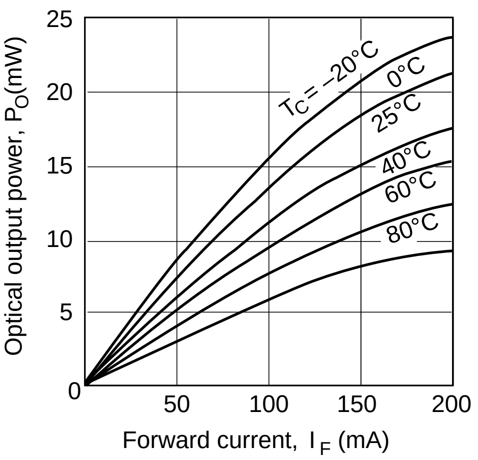
Note: 1. P_F specification: The optical output within 9 degrees of the acceptance angle.

Typical Characteristic Curves

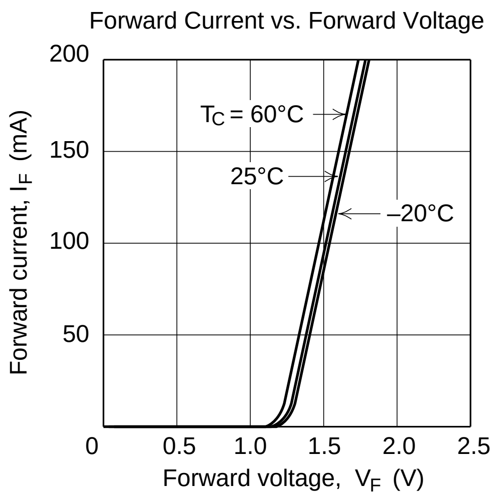
Optical Output Power vs. Forward Current (HE8807SG)

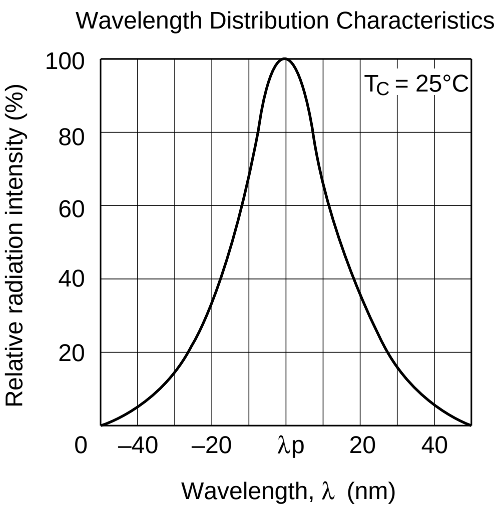


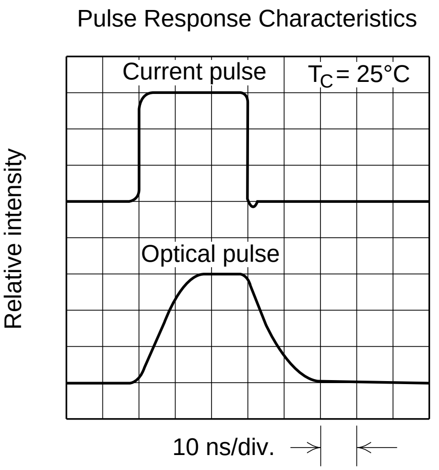
Optical Output Power vs. Forward Current (HE8807CL)



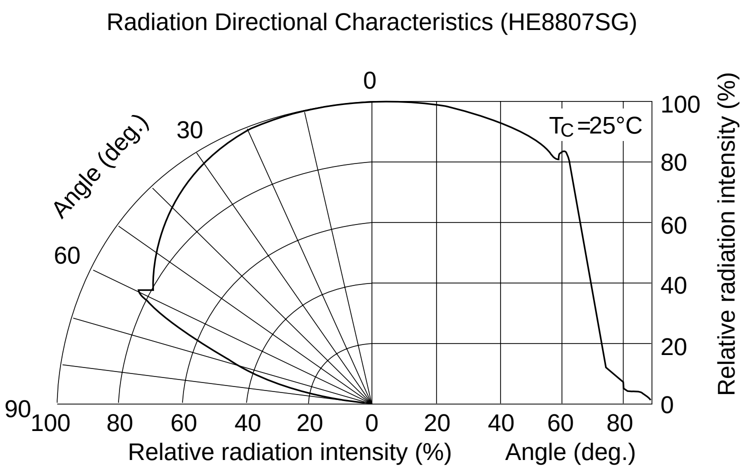
Typical Characteristic Curves (cont)

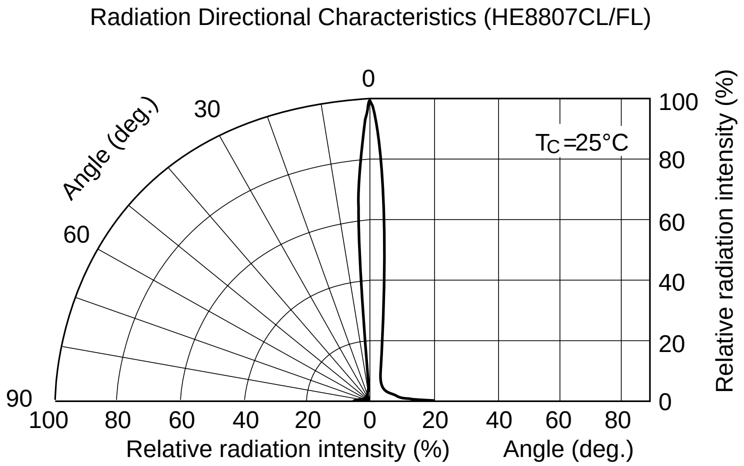




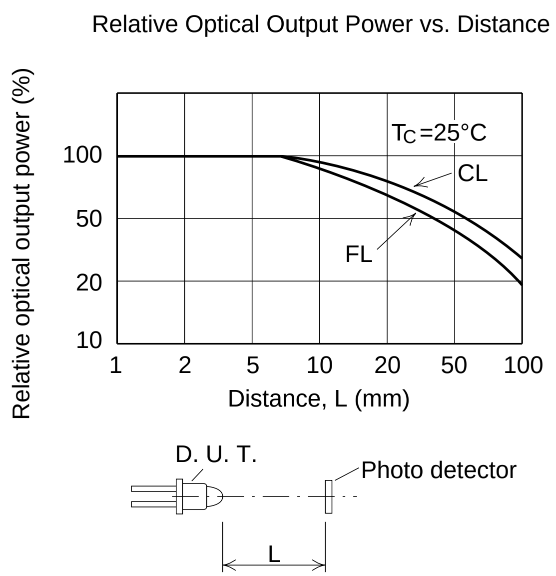


Typical Characteristic Curves (cont)





Typical Characteristic Curves (cont)



HE8811

GaAlAs Infrared Emitting Diode

Description

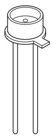
The HE8811 is a GaAlAs infrared emitting diode with a double heterojunction structure. It is high brightness, high output power and fast response make it suitable as a light source in measuring instruments and infrared-beam communication equipment.

Features

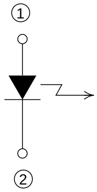
- High-frequency response
- High efficiency and high output power
- Broad radiation pattern

Package Type

- HE8811: SG1



Internal Circuit



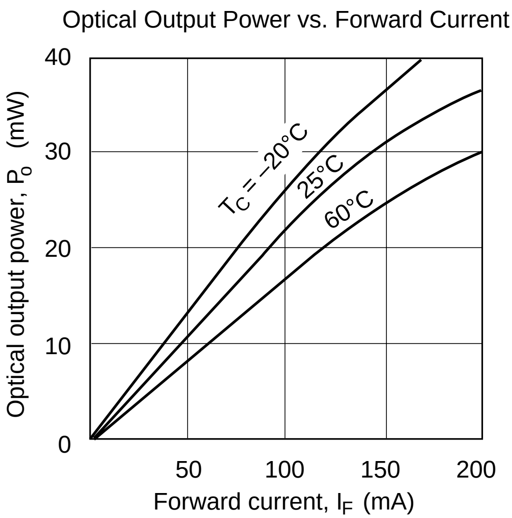
Absolute Maximum Ratings (T_C = 25°C)

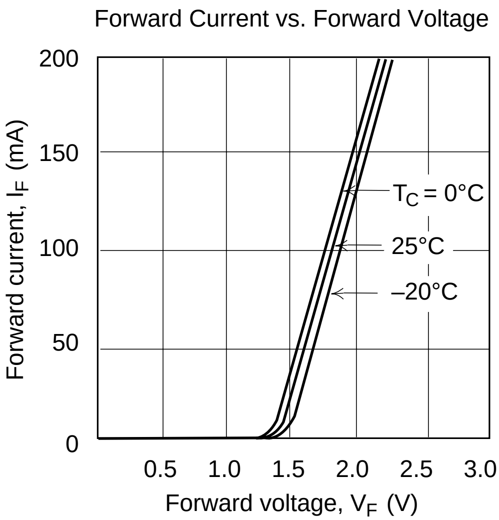
Item	Symbol	Rated Value	Units
Forward current	I_F	200	mA
Reverse voltage	V_R	3	V
Operating temperature	T_{opr}	–20 to +60	°C
Storage temperature	T_{stg}	–40 to +90	°C

Optical and Electrical Characteristics (T_C = 25°C)

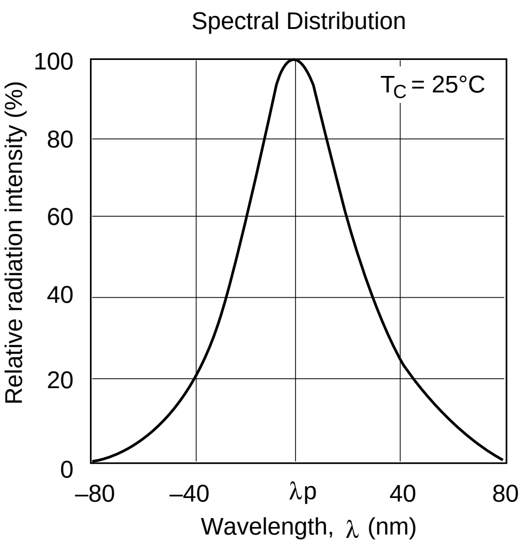
Item	Symbol	Min	Typ	Max	Units	Test Conditions
Optical output power	P_O	20	30	—	mW	I_F = 150 mA
Peak wavelength	λ_P	780	820	900	nm	I_F = 150 mA
Spectral width	$\Delta\lambda$	—	50	—	nm	I_F = 150 mA
Forward voltage	V_F	—	—	2.5	V	I_F = 150 mA
Reverse current	I_R	—	—	100	µA	V_R = 3 V
Capacitance	C_t	—	10	—	pF	V_R = 0 V, f = 1 MHz
Rise time	t_r	—	5	—	ns	I_F = 50 mA
Fall time	t_f	—	7	—	ns	I_F = 50 mA

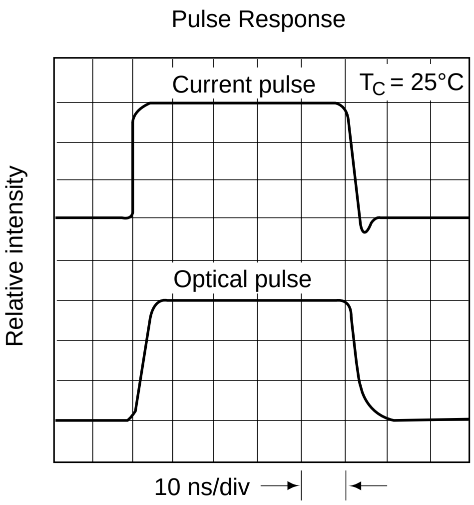
Typical Characteristic Curves

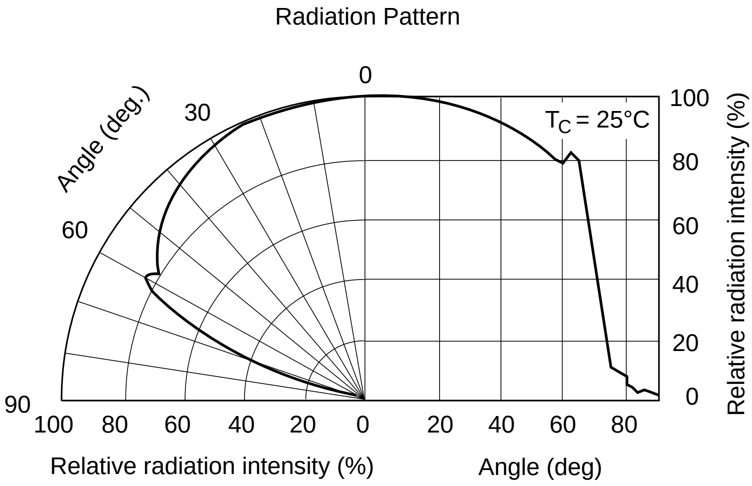




Typical Characteristic Curves (cont)







HE8812SG

GaAlAs Infrared Emitting Diode

Description

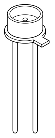
The HE8812SG is a GaAlAs double heterojunction structure 870 nm band light emitting diode. It is suitable for use as the light source in a wide range of optical control and sensing equipment.

Features

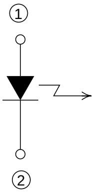
- High efficiency, high output

Package Type

- HE8812SG: SG1



Internal Circuit



Absolute Maximum Ratings (T_C = 25°C)

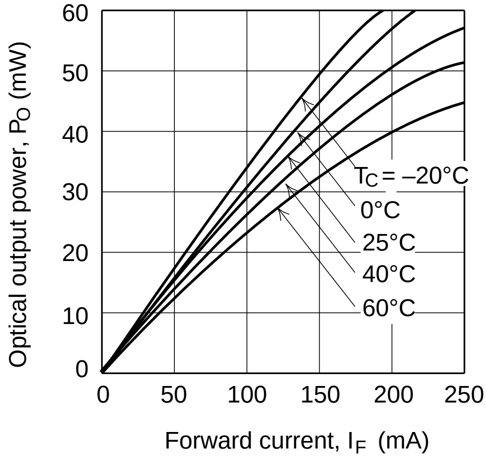
Item	Symbol	Rated Value	Units
Forward current	I_F	250	mA
Reverse voltage	V_R	3	V
Operating temperature	T_{opr}	–20 to +60	°C
Storage temperature	T_{stg}	–40 to +90	°C

Optical and Electrical Characteristics (T_C = 25°C)

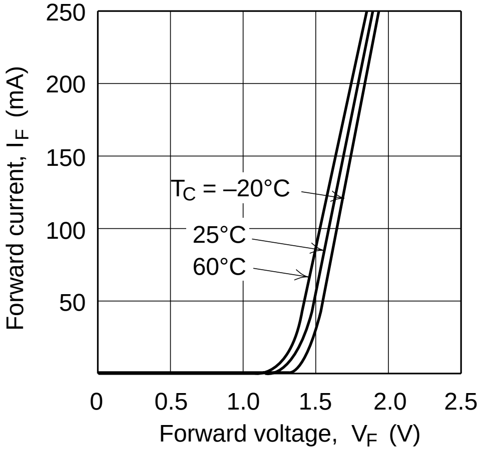
Item	Symbol	Min	Typ	Max	Units	Test Conditions
Optical output power	P_O	40	—	—	mW	I_F = 200 mA
Peak wavelength	λ_p	840	870	900	nm	I_F = 200 mA
Spectral width	$\Delta\lambda$	—	50	60	nm	I_F = 200 mA
Forward voltage	V_F	—	—	2.5	V	I_F = 200 mA
Reverse current	I_R	—	—	100	µA	V_R = 3 V
Capacitance	C_t	—	30	—	pF	V_R = 0 V, f = 1 MHz
Rise and fall times	t_r , t_f	—	10	—	ns	I_F = 50 mA

Typical Characteristic Curves

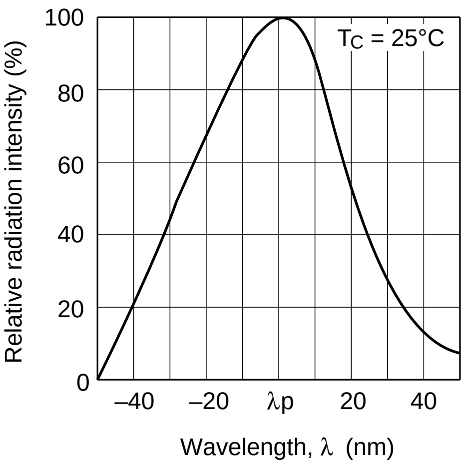
Optical Output Power vs. Forward Current



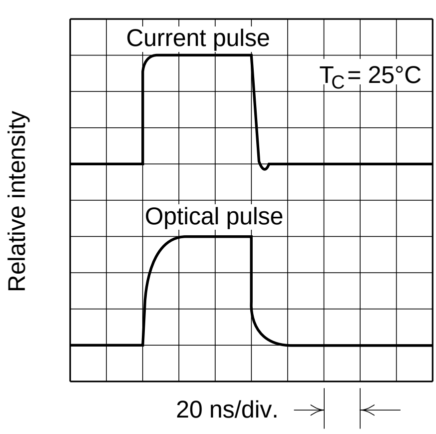
Forward Current vs. Forward Voltage



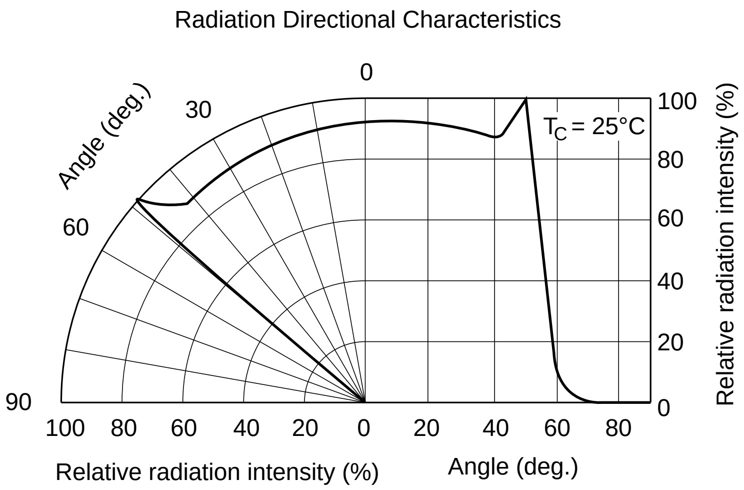
Wavelength Distribution Characteristics



Pulse Response Characteristics



Typical Characteristic Curves (cont)



HE8813VG

GaAlAs Infrared Emitting Diode

Description

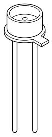
The HE8813VG is a GaAlAs double heterojunction structure 0.8 μm band light emitting diode. It is suitable for use as the light source in still camera autofocus mechanisms.

Features

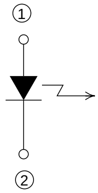
- High efficiency and high power output

Package Type

- HE8813VG: VG



Internal Circuit



Absolute Maximum Ratings (T_C = 25°C)

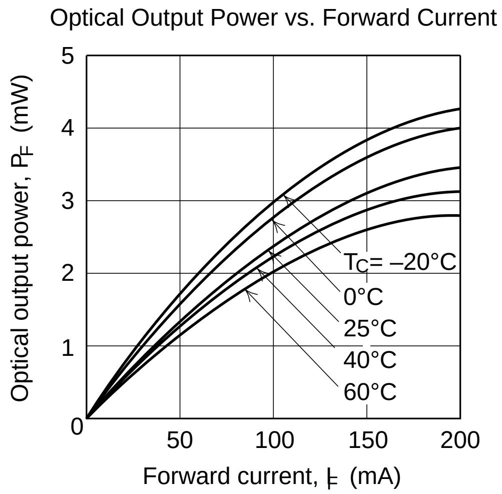
Item	Symbol	Rated Value	Units
Forward current	I_F	200	mA
Reverse voltage	V_R	3	V
Operating temperature	T_{opr}	–20 to +60	°C
Storage temperature	T_{stg}	–40 to +90	°C

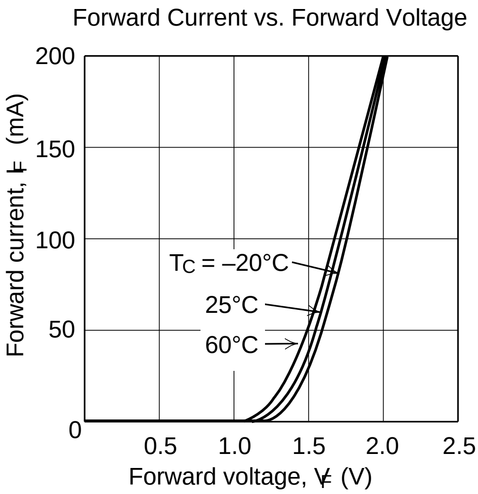
Optical and Electrical Characteristics (T_C = 25°C)

Item	Symbol	Min	Typ	Max	Units	Test Conditions
Optical output power	P_F*1	2.2	—	—	mW	I_F = 150 mA
Peak wavelength	λ_p	800	880	900	nm	I_F = 150 mA
Spectral width	$\Delta\lambda$	—	50	60	nm	I_F = 150 mA
Forward voltage	V_F	—	—	2.3	V	I_F = 150 mA
Reverse current	I_R	—	—	100	µA	V_R = 3 V
Capacitance	C_t	—	10	—	pF	V_R = 0 V, f = 1 MHz
Rise and fall times	t_r , t_f	—	10	—	ns	I_F = 50 mA

Note: 1. P_F specification: The optical output within 14 degrees of the acceptance angle.

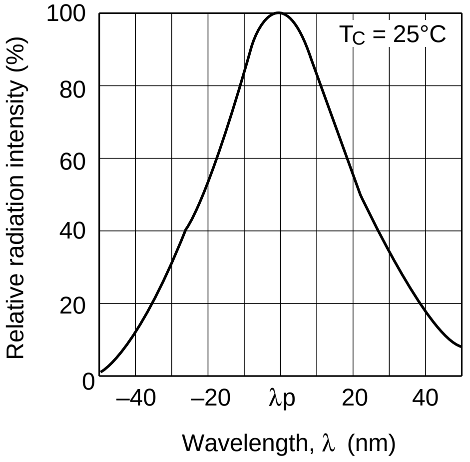
Typical Characteristic Curves



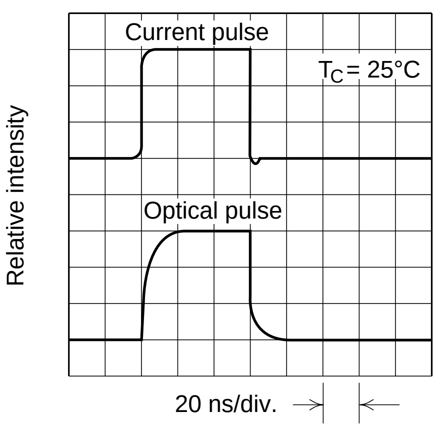


Typical Characteristic Curves (cont)

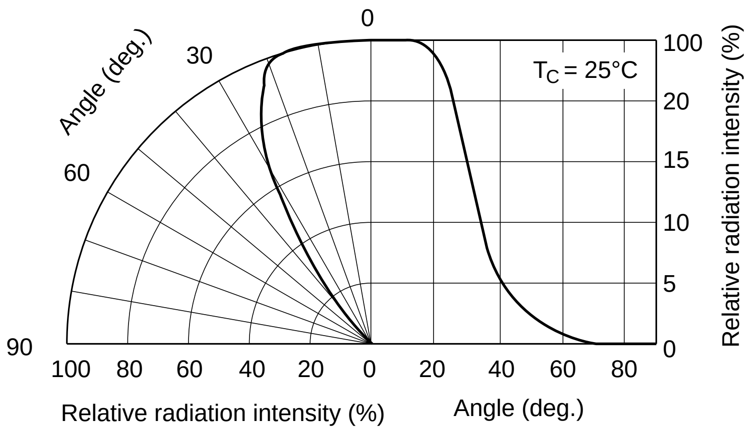
Wavelength Distribution Characteristics



Pulse Response Characteristics



Radiation Directional Characteristics



HR1103CX

InGaAs PIN Photodiode

Description

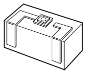
The HR1103CX is an InGaAs PIN photodiode which respond to the 1.0 to 1.65 µm band.
It has a fast pulse response, and is appropriate as an optical detector in high capacity optical fiber communications systems.

Features

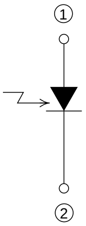
- Fast pulse response: t_r, t_f = 0.5 ns typ.
- High sensitivity: S = 0.9 mA/mW typ. (λ_p = 1550 nm)
- Low dark current: I_{DARK} = 1 nA typ.
- Effective reception area: 100 µm dia.
- Low capacitance: C_t = 1.2 pF typ.

Package Type

- HR1103CX: CX



Internal Circuit



Absolute Maximum Ratings (T_C = 25°C)

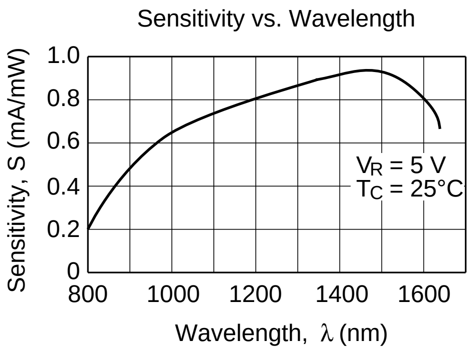
Item	Symbol	Rated Value	Units
Reverse voltage	V_R	20	V
Forward current	I_F	1.0	mA
Reverse current	I_R	500	µA
Operating temperature	T_{opr}	–40 to +85	°C
Storage temperature	T_{stg}	–45 to +100	°C

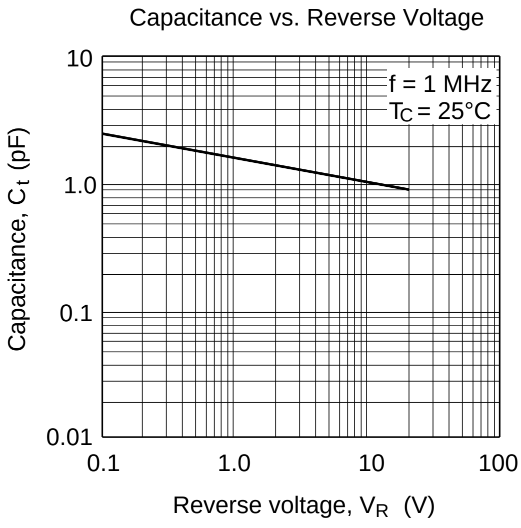
Note: The HR1103CX is designed to be built into optical modules. It is expected that it will be used in hermetically sealed packages. When using this product, be sure to read the "Usage Notes" section.

Optical and Electrical Characteristics (T_C = 25°C)

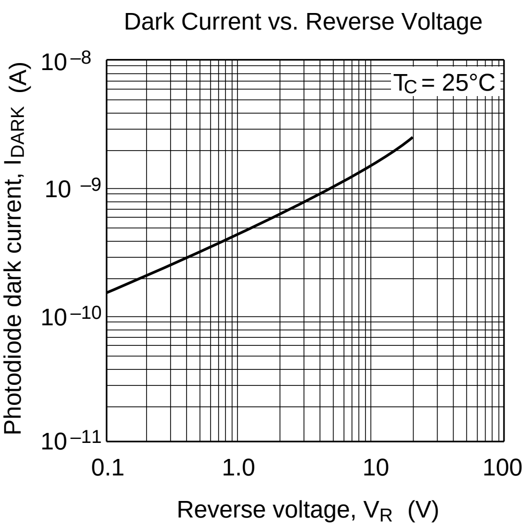
Item	Symbol	Min	Typ	Max	Units	Test Conditions
Dark current	I_{DARK}	—	1	50	nA	V_R = 5 V
Capacitance	C_t	—	1.2	2.0	pF	V_R = 5 V, f = 1 MHz
Sensitivity	S_1	0.73	0.85	—	mA/mW	V_R = 5 V, λ_p = 1300 nm
	S_2	—	0.9	—		V_R = 5 V, λ_p = 1550 nm
Sensitivity saturation bias voltage	$V_{R(S)]}$	—	—	2	V	—
Rise time	t_r	—	0.5	—	ns	V_R = 5 V, λ_p = 1300 nm R_L = 50 Ω
Fall time	t_f	—	0.5	—	ns	V_R = 5 V, λ_p = 1300 nm R_L = 50 Ω

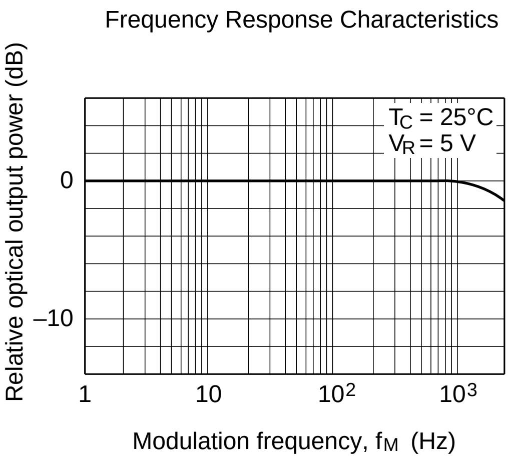
Typical Characteristic Curves

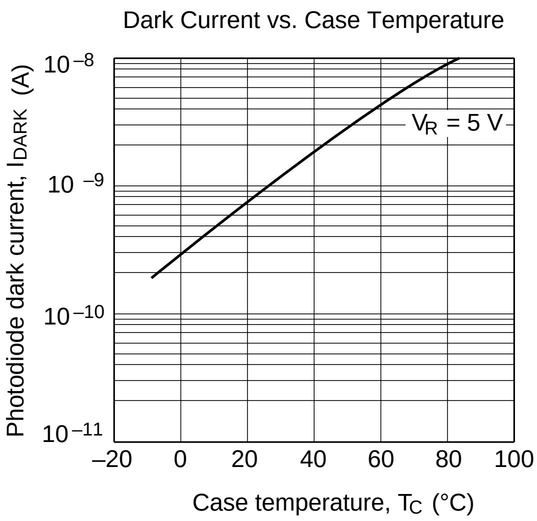




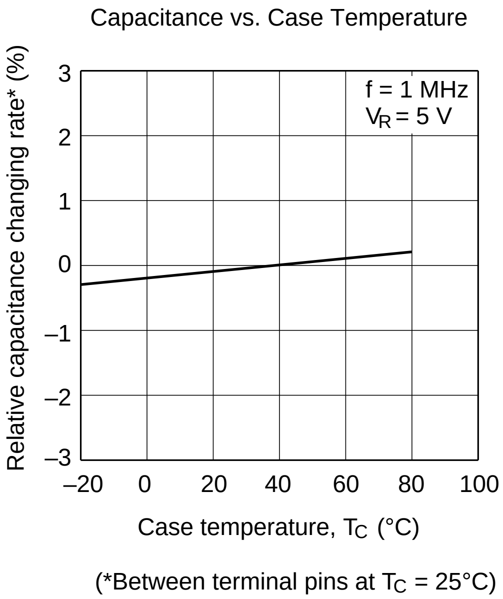
Typical Characteristic Curves (cont)

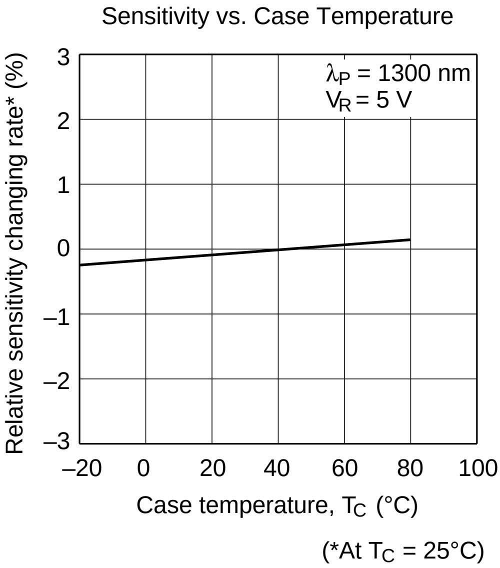






Typical Characteristic Curves (cont)





HR1104CX

InGaAs PIN Photodiode

Description

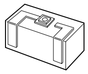
The HR1104CX is an InGaAs PIN photodiode which respond to the 1.0 to 1.65 µm band.
It is appropriate for use in high capacity optical fiber communications systems.

Features

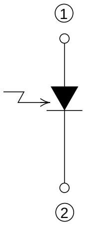
- Fast pulse response: t_r, t_f = 1.0 ns typ.
- High sensitivity: S = 0.9 mA/mW typ. (λ_p=1550 nm)
- Low dark current: I_{DARK} = 1 nA typ.
- Low capacitance: C_t = 5 pF typ.
- Effective reception area: 300 µm dia.

Package Type

- HR1104CX: CX



Internal Circuit



HR1104CX

Note: The HR1104CX is designed to be built into optical modules. It is expected that it will be used in hermetically sealed packages. When using this product, be sure to read the "Usage Notes" section.

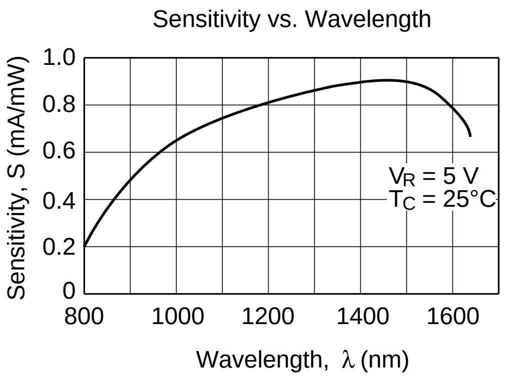
Absolute Maximum Ratings (T_C = 25°C)

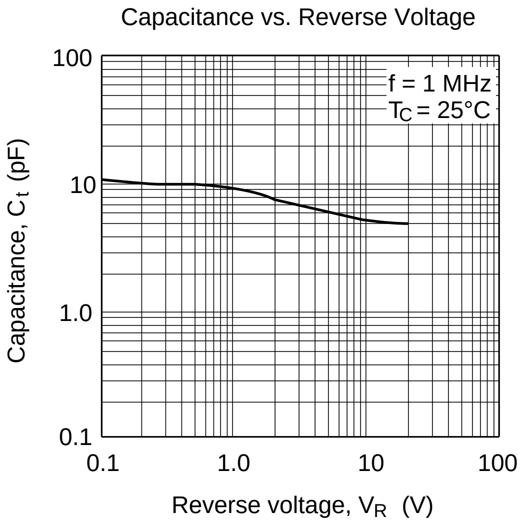
Item	Symbol	Rated Value	Units
Reverse voltage	V_R	20	V
Forward current	I_F	4	mA
Reverse current	I_R	2	mA
Operating temperature	T_{opr}	–40 to +85	°C
Storage temperature	T_{stg}	–45 to +100	°C

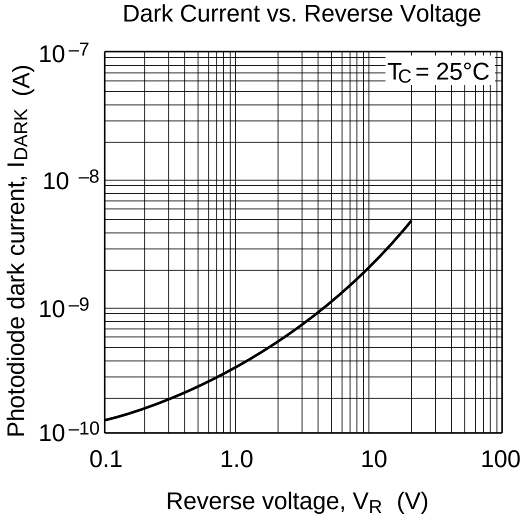
Optical and Electrical Characteristics (T_C = 25°C)

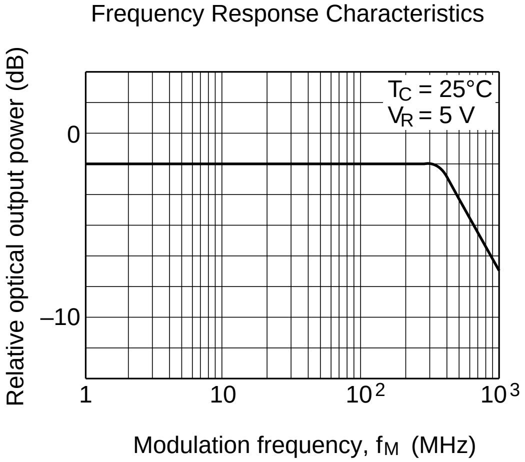
Item	Symbol	Min	Typ	Max	Units	Test Conditions
Dark current	I_{DARK}	—	1	30	nA	V_R = 5 V
Capacitance	C_t	—	5	10	pF	V_R = 5 V, f = 1 MHz
Sensitivity	S_1	0.73	0.85	—	mA/mW	V_R = 5 V, λ_p = 1300 nm
	S_2	—	0.9	—		V_R = 5 V, λ_p = 1550 nm
Sensitivity saturation bias voltage	$V_{R(S)}$	—	—	2	V	—
Rise time	t_r	—	1.0	—	ns	V_R = 5 V, λ_p = 1300 nm R_L = 50 Ω
Fall time	t_f	—	1.0	—	ns	V_R = 5 V, λ_p = 1300 nm R_L = 50 Ω

Typical Characteristic Curves

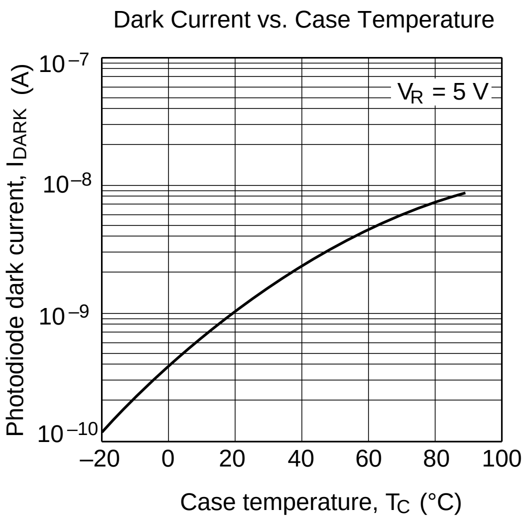


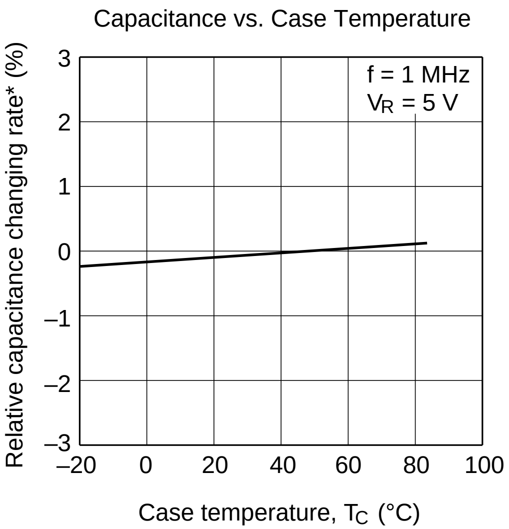




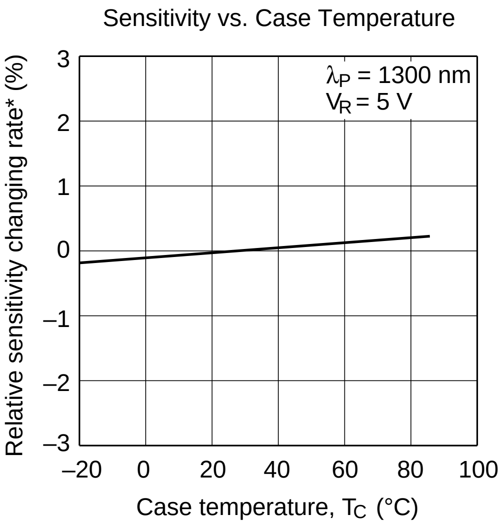


Typical Characteristic Curves (cont)





(*Between terminal pins at T_C = 25°C)



(*At T_C = 25°C)

HR1107CR

InGaAs PIN Photodiode

Description

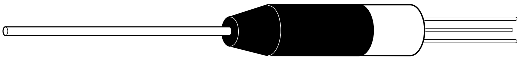
The HR1107CR is an InGaAs PIN photodiode for detecting light in the 1.0 µm to 1.65 µm band. Its fast pulse response makes it suitable as an optical signal detector in high-bit-rate fiberoptic communications equipment.

Features

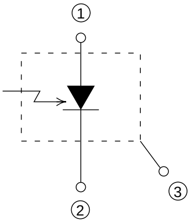
- Fast pulse response: t_r, t_f = 0.3 ns Typ.
- High sensitivity:
  S = 0.8 mA/mW Typ. (λ_p = 1550 nm)
- Low dark current: I_{DARK} = 1 nA Typ.
- Low capacitance:
  C_t = 0.9 pF Typ.
- Photodetectable area: 80 µm Dia.

Package Type

- HR1107CR: CR



Internal Circuit



Fiber Specifications

Numerical aperture: 0.2
Core diameter: 50 µm
Outer diameter: 125 µm
Jacket diameter: 900 µm
Refractive index profile: GI
Fiber length: More than 1000 mm

Absolute Maximum Ratings (T_C = 25°C)

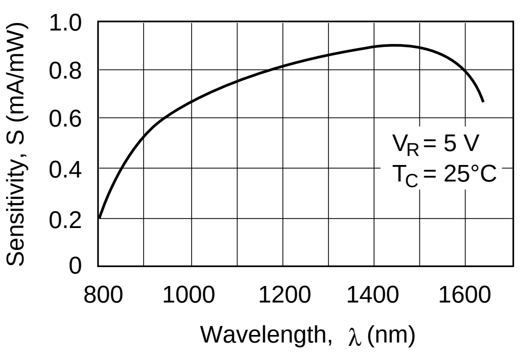
Item	Symbol	Rated Value	Unit
Reverse voltage	V_R	20	V
Forward current	I_F	5.0	mA
Reverse current	I_R	500	µA
Operating temperature	T_{opr}	–20 to +70	°C
Storage temperature	T_{stg}	–40 to +85	°C

Optical and Electrical Characteristics (T_C = 25°C)

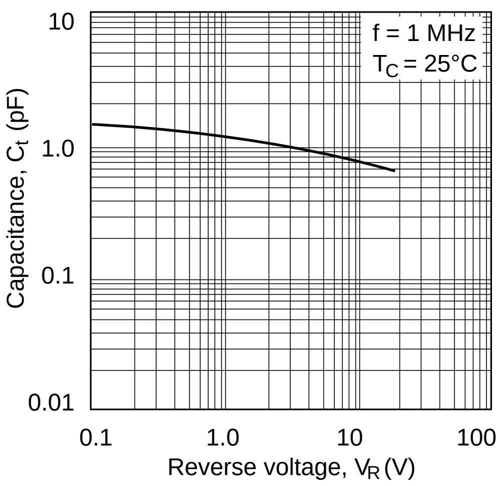
Item	Symbol	Min	Typ	Max	Unit	Test Conditions
Dark current	I_{DARK}	—	1	5	nA	V_R = 5 V
Capacitance	C_t	—	0.9	1.3		V_R = 5 V, f = 1 MHz
Sensitivity	S_1	0.70	0.78	—	mA/mW	V_R = 5 V, λ_p = 1300 nm
	S_2	—	0.8		mA/mW	V_R = 5 V, λ_p = 1550 nm
Photosensitivity saturation voltage	$V_{R\,(S)}$	—	—	2	V	
Rise time	t_r	—	0.3	—	ns	V_R = 5 V, λ_p = 1300 nm R_L = 50 Ω
Fall time	t_f	—	0.3	—	ns	V_R = 5 V, λ_p = 1300 nm R_L = 50 Ω

Typical Characteristic Curves

Sensitivity vs. Wavelength

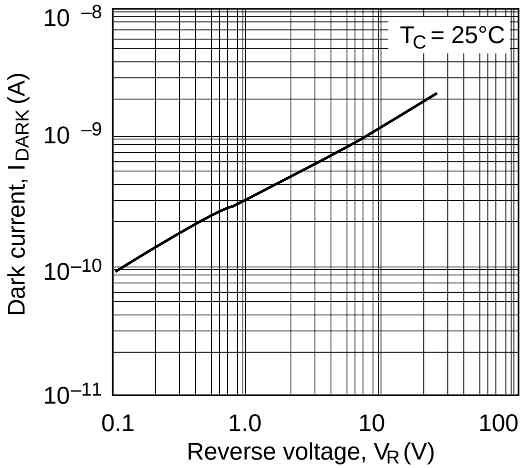


Capacitance vs. Reverse Voltage

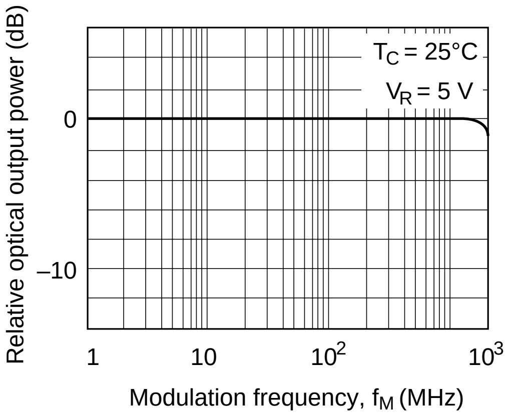


Typical Characteristic Curves (cont)

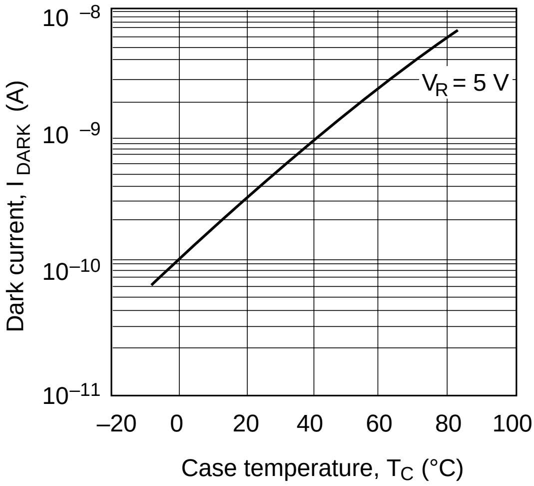
Dark Current vs. Reverse Voltage



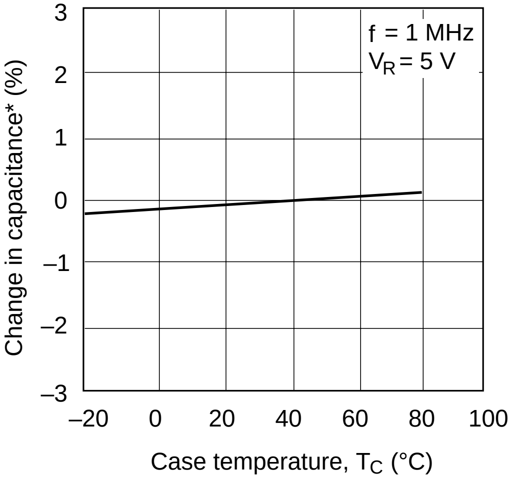
Frequency Response



Dark Current Temperature Dependence

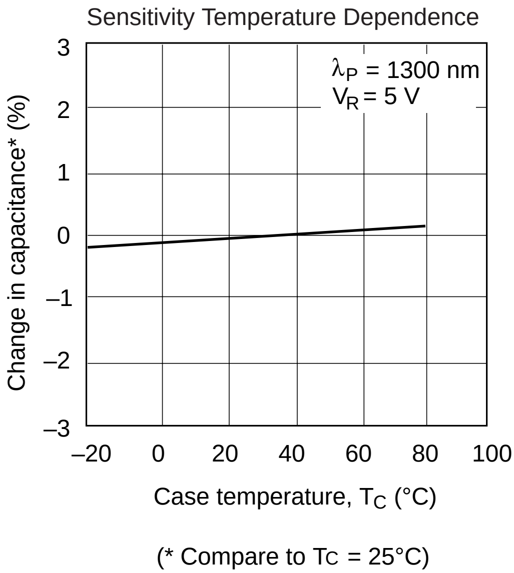


Capacitance Temperature Dependence



(* Compare to T_C = 25°C)

Typical Characteristic Curves (cont)



HR1201CX

InGaAs Avalanche Photodiode

Description

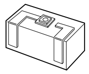
The HR1201CX is an InGaAs avalanche photodiode developed as a photodetector for fiberoptic communications in the 1.0 µm to 1.65 µm. Its fast pulse response makes it suitable for high-bit-rate fiberoptic communications.

Features

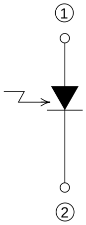
- High sensitivity:
  S = 0.9 mA/mW at λ_p = 1550 nm Typ.
- Low dark current: I_{DARK} = 2 nA Typ.
- Small capacitance:
  C_t = 0.7 pF
- Photodetectable area: 50 µm Dia.
- High multiplication ratio: M = 40 Typ.
- Excellent frequency characteristics:
  G.B. = 30

Package Type

- HR1201CX: CX



Internal Circuit



HR1201CX

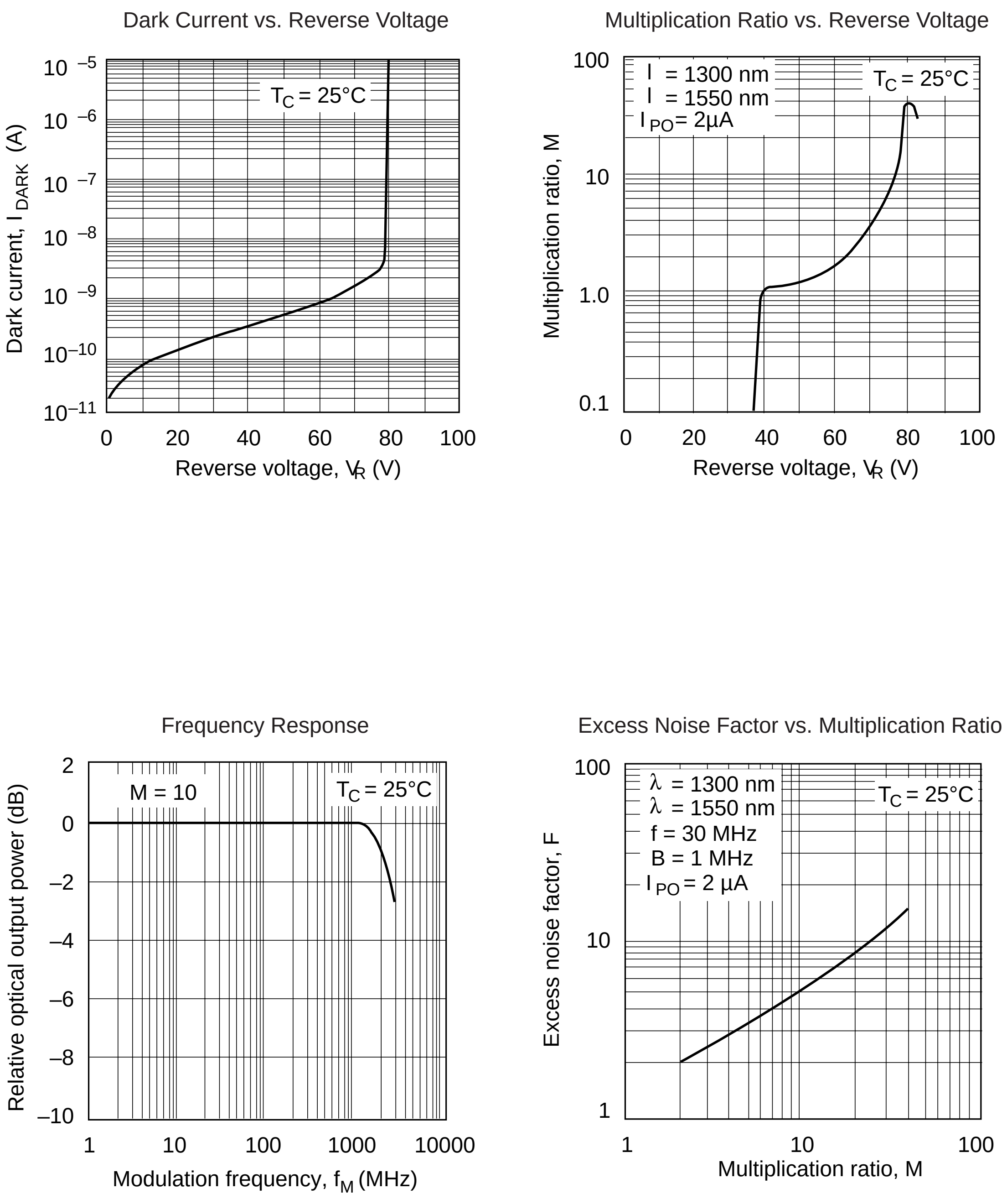
Absolute Maximum Ratings (T_C = 25°C)

Item	Symbol	Rated Value	Unit
Forward current	I_F	10	mA
Reverse current	I_R	500	µA
Operating temperature	T_{opr}	–40 to +80	°C
Storage temperature	T_{stg}	–45 to +100	°C

Optical and Electrical Characteristics (T_C = 25°C)

Item	Symbol	Min	Typ	Max	Unit	Test Conditions
Dark current	I_{DARK}	—	2	50	nA	V_R = 0.9 V_B
Multiplied dark current	I_{DM}	—	0.5	5	nA	M = 1
Capacitance	C_t	—	0.7	1.0	pF	f = 1 MHz, V_R = 0.9 V_B
Sensitivity	S_1	0.73	0.85	—	mA/mW	λ_p = 1300 nm
	S_2	—	0.9	—	mA/mW	λ_p = 1550 nm
Breakdown voltage	V_B	60	80	100	V	I_{DARK} = 100 µA
Cutoff frequency	f_C	1	—	—	GHz	M = 5; λ_p = 1300 nm, R_L = 50Ω, 500KHz to -3 dB
		1	—	—		M = 10
		—	1	—		M = 30
Excess noise factor	F	—	5	—	—	λ_p = 1300 nm, M = 10, f = 30 MHz, B = 1 MHz, I_{PO} = 2 µA
	X	—	0.7	—	—	
Maximum multiplication ratio	M	30	40	—	—	λ_p = 1300 nm, I_{PO} = 2 µA

Typical Characteristic Curves



Typical Characteristic Curves (cont)