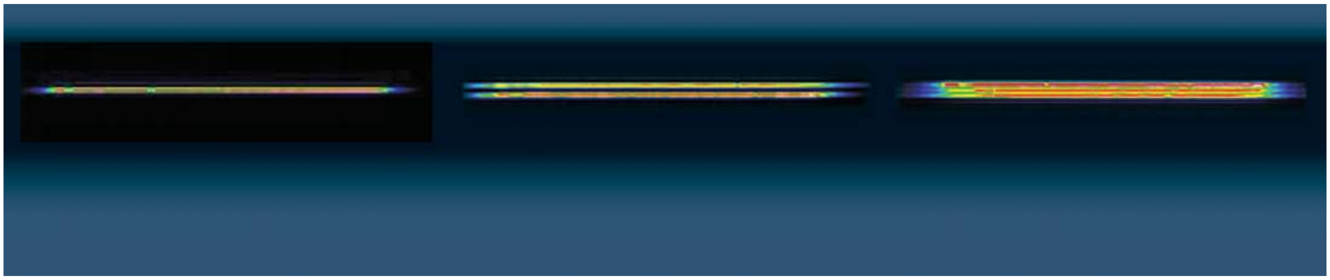
Multi EPI-Cavity Lasers, DPGA & TPGA Series

InGaAs Pulsed Epi-Cavity Laser Diodes

905 nm Multi Active Area (Epitaxially Stacked Multi Quantum Well Strained)



Overview

The double (DPGA) and triple (TPGA) EPI-cavity laser device families employ PerkinElmer's novel multi active area laser chips to deliver high output power in a small emitting area. The active areas are monolithically grown on the GaAs substrate and are separated by grown separation regions (tunnel junctions). With this approach, a doubling or tripling of the available optical output power from a single chip is achieved. This power enhancement comes with only a slight increase in the near-field transverse active area dimension. This "EPI-cavity" structure complements PerkinElmer's current PGA series of InGaAs Multi quantum well single active area product lines. Similar to the PGA series, chips of different stripe width from 75 to 225 µm are available, which in addition can be physically stacked to even increase output power further. A single triple cavity laser chip TPGA with 225 µm width has a typical peak power output of 80 W. By stacking 3 chips, the output power raises to 220 W.

The EPI-cavity structure possesses the same 25º beam divergence in the perpendicular direction as the PGA series product lines, as well as the same excellent stability of power output over the full MIL spec temperature range. Slightly higher forward voltage drops are experienced due to the additional active areas and tunnel junctions in the laser structure.
The structures are fabricated using metal organic chemical vapour deposition (MOCVD) in a similar fashion to the PGA series.

Recognizing that different applications require different packages, six standard package options are available, including the traditional stud designs as well as 5.6 and 9 mm CD packages and ceramic substrates. Since pulse widths have decreased and optical coupling has become important, the newer packages – boasting reduced inductance and thinner, flatter windows – have gained popularity. Additionally where fiber coupling applications are concerned, the transverse spacing of the EPI-cavity active areas concentrates more optical power into a smaller geometry allowing for increased optical power coupling into optical fibers.

For pulse widths below 5 ns, hybridization with integrated drive circuitry is also available with PerkinElmer's MGAD series.

Features and Benefits

- Doubling or tripling of the output power from a single EPI-cavity chip with a small active area: Peak power up to 80 W at 30 A drive current and 100 ns pulse width.
- Peak power >210 W at 30 A drive current and 100 ns pulse width for 3 physically stacked EPI-cavity chips.
- Extremely high reliability.
- Experience in EPI-cavity lasers for military applications since early 1990s.
- Range of single element and stacked devices.
- Choice of 6 standard packages.
- 80% power retention at 85°C ambient.
- Flexibility in customization for different applications.
- Small emitting areas allow ease of fiber coupling.

Applications

- Laser range finding.
- Laser safety curtains (laser scanning).
- Laser speed measurement (LIDAR).
- Automotive adaptive cruise control (ACC).
- Material excitation in medical and other analytical applications.
- Weapon simulation.

PerkinElmer precisely.

Table 1 Maximum Ratings				
Parameter	**Symbol**	**Minimum**	**Maximum**	**Units**
Peak reverse voltage	V_{RM}		2	V
Pulse duration	t_W		100	ns
Duty factor	du		0.1	%
Storage temperature	T_S	-55	105	°C
Operating temperature	T_{op}	-55	85	°C
Soldering for 5 seconds (leads only)			+200	°C

Table 2 DPGA Generic Electro Optical Specifications at 23°C					
Parameter	**Symbol**	**Minimum**	**Typical**	**Maximum**	**Units**
Center wavelength of spectral envelope	λC	895	905	915	nm
Spectral bandwidth at 50% intensity points	$\Delta\lambda$		5		nm
Wavelength temperature coefficient	$\Delta\lambda/\Delta T$		0.25		nm/° C
Beam spread (50% peak intensity) parallel to junction plane	Θ_H		10		degrees
Beam spread (50% peak intensity) perpendicular to junction	Θ_H		25		degrees

Table 3 DPGA Single Chips – Typical Characteristics at top = 23 C, tw = 150 ns, du = 0.1%					
Parameter		**Symbol**	**DPGAS1S03H**	**DPGAS1S09H**	**Units**
Po at i_{FM}	min	Po_{min}	14	46	W
	typical	Po_{typ}	15	50	W
# of elements			1	1	
Emitting area	typical		75 X 10	225 X 10	µm
Maximum peak forward current		i_{FM}	10	30	A
Threshold current	typical	i_{th}	1.0	2.0	A
Forward voltage[1] @ i_{FM}	typical	V_f	7	8.5	V
Preferred packages			S, U	S, U	
Optional packages			C, F, R, Y	C, F, R, Y	

1) Excluding the voltage drop contribution due to the inductive element of the package.

Table 4 DPGA Stacked Arrays							
Parameter		**Symbol**	**DPGA S2S03H**	**DPGA S2S09H**	**DPGA S3S03H**	**DPGA S3S09H**	**Units**
Po at i_{FM}	min	Po_{min}	28	90	42	140	W
	typical	Po_{typ}	30	100	45	150	W
# of elements			2	2	3	3	
Emitting area	typical		75 X 125	225 X 125	75 X 225	225 X 225	µm
Maximum peak forward current		i_{FM}	10	30	10	30	A
Threshold current	typical	i_{th}	1.0	2.2	1.0	2.0	A
Forward voltage[1] @ i_{FM}	typical	V_f	13	16	20	23	V
Preferred packages			S, U	S, U	S, U	S,U	
Optional packages			C, F, R, Y	C, F, R, Y	C, F, R, Y	C, F, R, Y	

1) Excluding the voltage drop contribution due to the inductive element of the package.

1 Operating Conditions

The laser is operated by pulsing in the forward bias direction.

The PerkinElmer Optoelectronics warranty applies only to devices operated within the maximum rating, as specified. Exceeding these conditions is likely to cause permanent “burn off” damage to the laser facet and consequently a significant reduction in optical power. Operating the devices at increased duty cycles will ultimately and irreparably damage the crystal structure due to internal heating effects.

Diodes are static sensitive and suitable precautions should be taken when removing the units from their antistatic containers. Circuits should be designed to protect the diodes from high current and reverse voltage transients. Voltages exceeding the reverse breakdown of the semiconductor junction are particularly damaging and have been shown to cause degradation of power output.

Although the devices will continue to perform well at elevated temperatures for some thousands of hours, defect mechanisms are accelerated. Optimum long term reliability will be attained with the semiconductor at or below room temperature. Adequate heat sinking should be employed, particularly for the larger stacks and when operated at maximum duty factor.

2 Forward Voltage

The forward voltage of the device is a combination of: a static voltage drop resulting from band gaps and material characteristics; a dynamic series resistance resulting from the contact area dimensions, the resistivity of the contact layers, and the inductive voltage drop of the package. Voltages due to the inductive elements are additional and, therefore, are considered separately since they depend on the package inductance, the pulse rise time and the peak current.

3 Package Inductance

When narrow pulse widths are required, the system designer must take care that circuit inductance is kept to a minimum (note inductance on package list). Using the lower inductance packages will reduce the peak voltage required to obtain the desired drive current.

For example, to obtain approximate Gaussian pulse shapes for the "C" and "U" packages:

1. DPGAC1S12H:
t_w = 40 ns P_{rr} = 25 kHz, t_r = 20 ns, i_r = 60 A, L_{CPKG} = 12 nH
VL = L_{PKG} X di/dt
V_{CPKG} = 12 x 10_{-9} X 60/20 X 10_{-9} = 36 V
2. DPGAU1S12H:
t_w = 40 ns P_{rr} = 25 kHz, t_r = 20 ns, i_r = 60 A, L_{CPKG} = 5 nH
VL = L_{PKG} X di/dt
V_{CPKG} = 5 x 10_{-9} X 60/20 X 10_{-9} = 15 V

Note: These voltage drops are merely to overcome the inductance of the package and do not include the series package and chip static resistances. Other circuit elements typically increase voltage requirements to 3 X V_{PKG}, therefore the location of components to minimize lead length is critical.

Table 5 TPGA Generic Electro Optical Specifications at 23°C

Parameter	Symbol	Minimum	Typical	Maximum	Units
Center wavelength of spectral envelope	λC	895	905	915	nm
Spectral bandwidth at 50% intensity points	$\Delta\lambda$		6.5		nm
Wavelength temperature coefficient	$\Delta\lambda/\Delta T$		0.25		nm/° C
Beam spread (50% peak intensity) parallel to junction plane	Θ_H		8		degrees
Beam spread (50% peak intensity) perpendicular to junction	Θ_H		30		degrees

Table 6 TPGA Single Chips — Typical Characteristics at t_{op} = 23° C, t_w = 100 ns, p_{rr} = 1 KHz

Parameter		Symbol	TPGAS1S03H	TPGAS1S09H	Units
Po at i_{FM}	min	Po_{min}	22	70	W
	typical	Po_{typ}	23	75	W
# of elements			1	1	
Emitting area	typical		75 X 10	225 X 10	µm
Maximum peak forward current		i_{FM}	10	30	A
Threshold current	typical	i_{th}	1	1.5	A
Forward voltage[1] @ i_{FM}	typical	V_f	10	12.6	V
Preferred packages			S, U	S, U	
Optional packages			C, F, R, Y	C, F, R, Y	

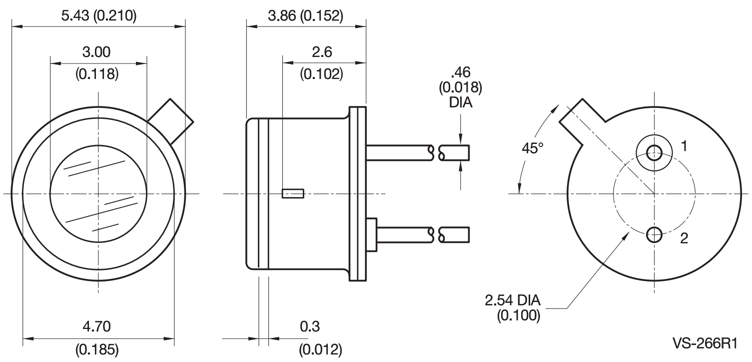
1) Excluding the voltage drop contribution due to the inductive element of the package.

Table 7 TPGA Stacked Arrays

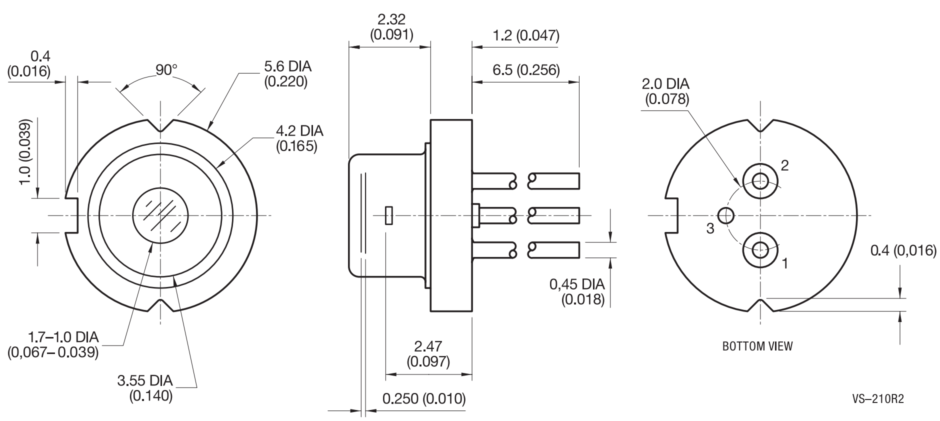
Parameter		Symbol	TPGA S2S03H	TPGA S2S09H	TPGA S3S03H	TPGA S3S09H	Units
Po at i_{FM}	min	Po_{min}	43	140	65	210	W
	typical	Po_{typ}	45	148	68	224	W
# of elements			2	2	3	3	
Emitting area	typical		75 X 175	225 X 175	75 X 350	225 X 350	µm
Maximum peak forward current		i_{FM}	10	30	10	30	A
Threshold current	typical	i_{th}	1	1.5	1	1.5	A
Forward voltage[1] @ i_{FM}	typical	V_f	18	22	28	32	V
Preferred packages			S, U	S, U	S, U	S,U	
Optional packages			C, F, R, Y	C, F, R, Y	C, F, R, Y	C, F, R, Y	

1) Excluding the voltage drop contribution due to the inductive element of the package.

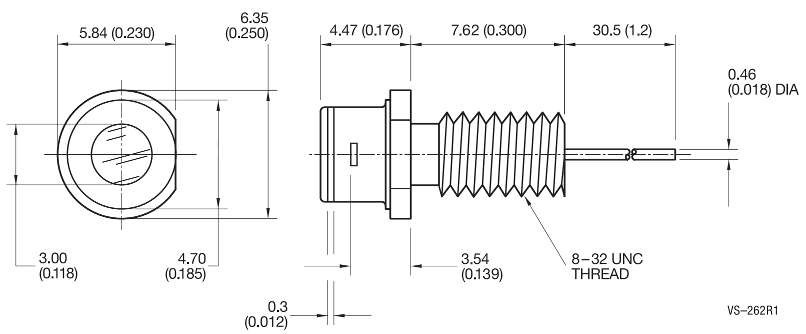
4 Package Drawings



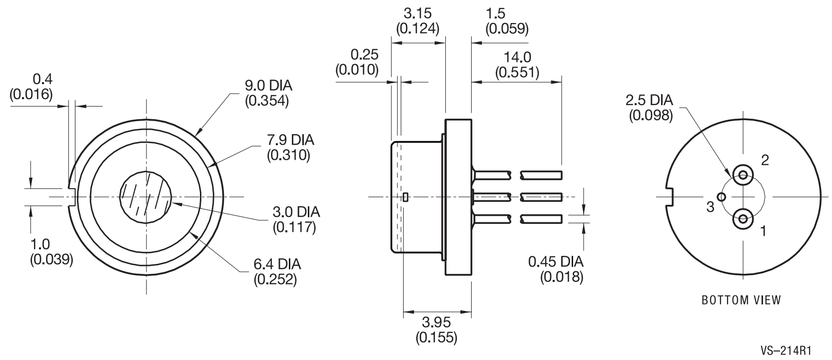
Package S: Pin out 1. LD Anode (+), 2. LD Cathode (-) Case, Inductance 5.2 nH



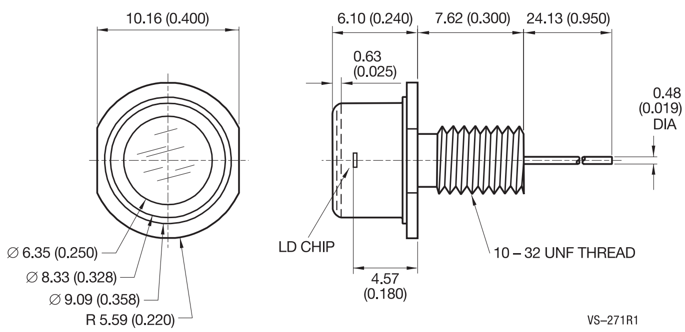
Package U: Pin out 1. LD Anode (+), 2. NC, 3. LD Cathode (-) Case, Inductance 5.0 nH



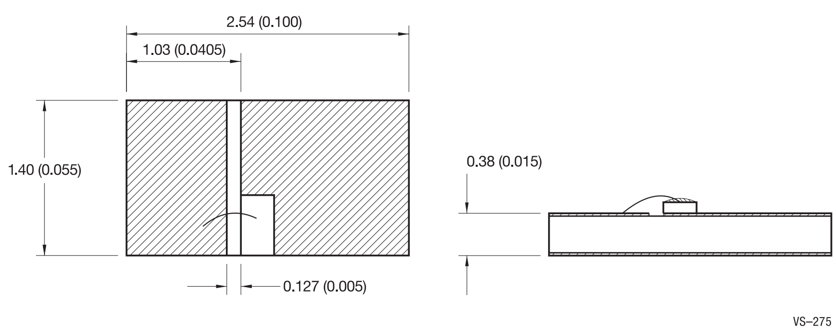
Package C: Pin out: Case (-), Pin (+), Inductance 12 nH



Package R: Pin out 1. LD Anode (+), 2. NC, 3. LD Cathode (-) Case, Inductance 6.8 nH

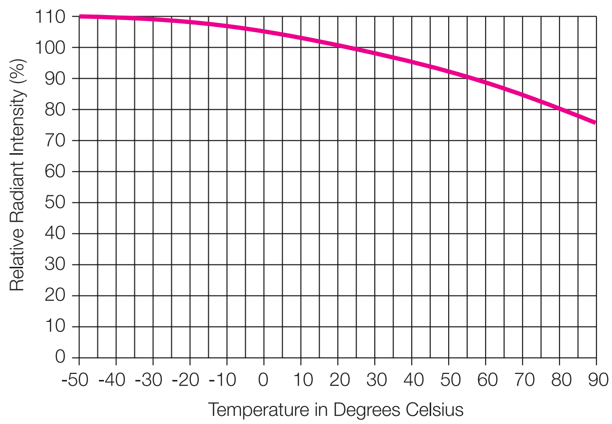


Package F: Pin out: Case (-), Pin (+), Inductance 11 nH



Package Y: Pin out 1. ID Cathode (-), 2. LD Anode (+), Inductance 1.6 nH

Figure 1 Peak Radiant Intensity vs. Temperature / Total Peak Radiant Intensity vs. Peak Drive Current



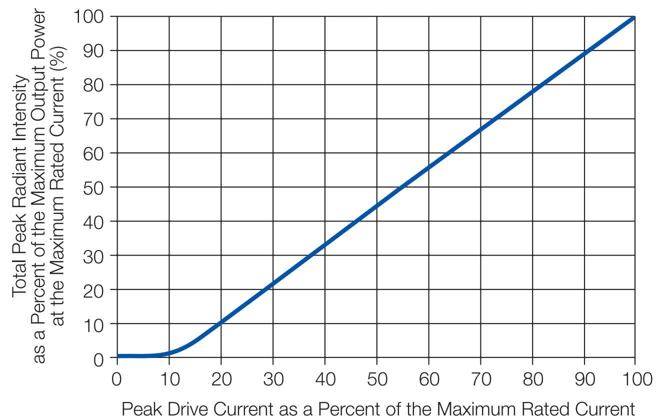
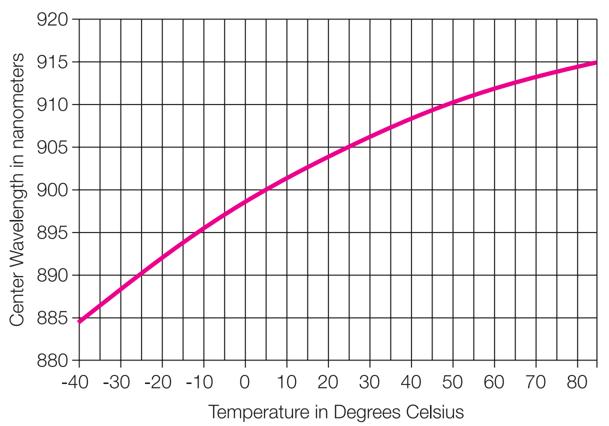


Figure 2 Center Wavelength vs. Temperature / Radiant Intensity vs. F Number



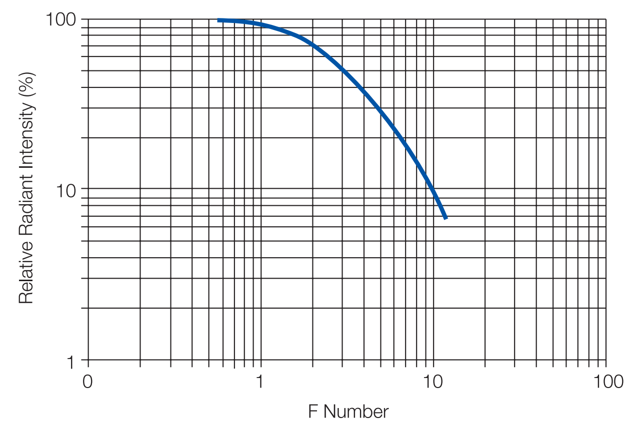
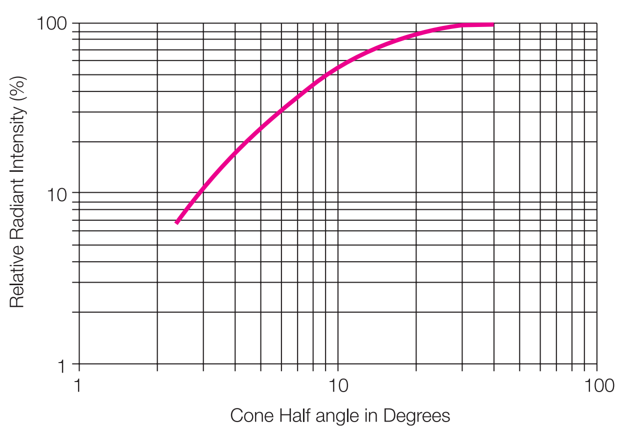


Figure 3 Radiant Intensity vs. Half Angle / Spectral Plot Distribution



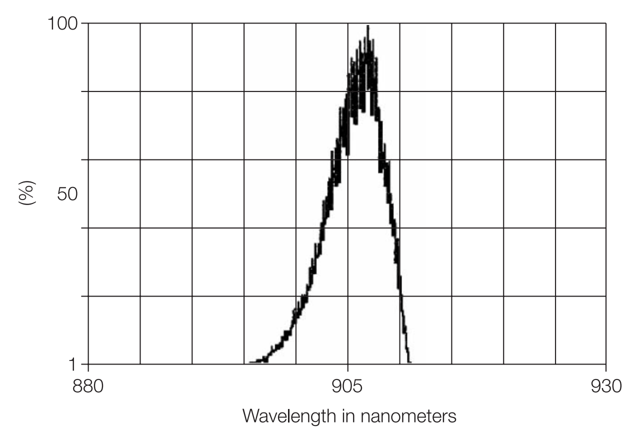


Figure 4 DPGA Far Field Pattern Parallel to Junction Plane / DPGA Far Field Pattern Perpendicular to Junction Plane

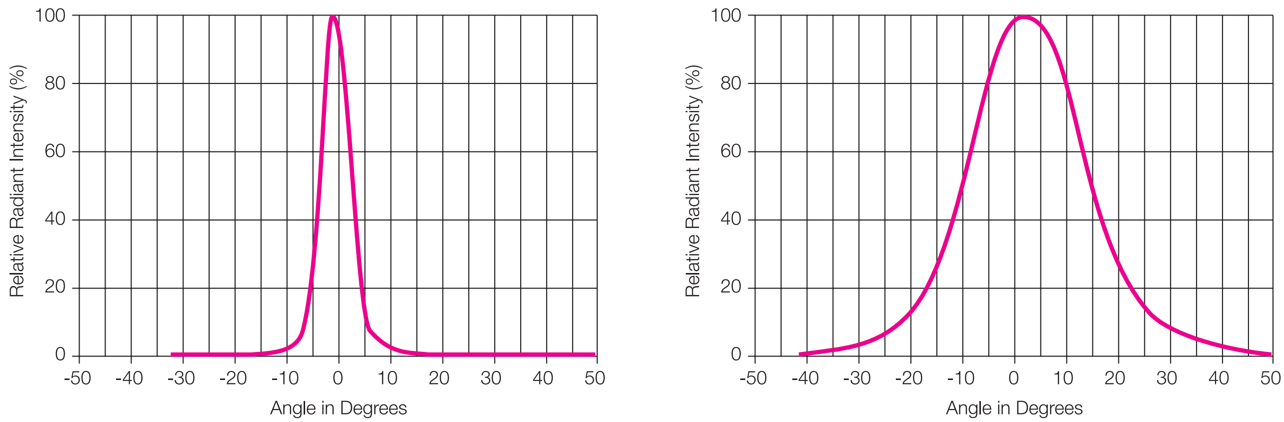


Figure 5 TPGA Far Field Pattern Parallel to Junction Plane / TPGA Far Field Pattern Perpendicular to Junction Plane

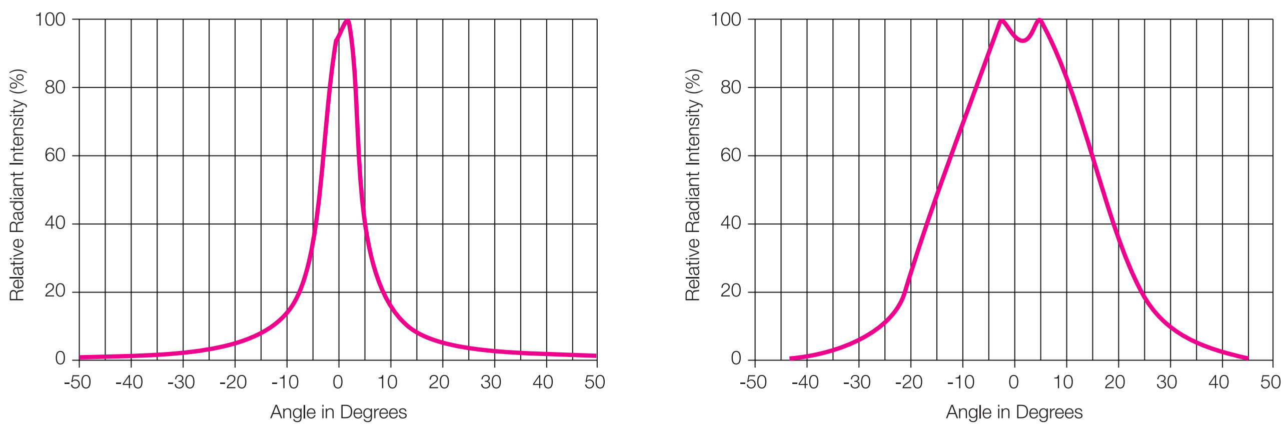
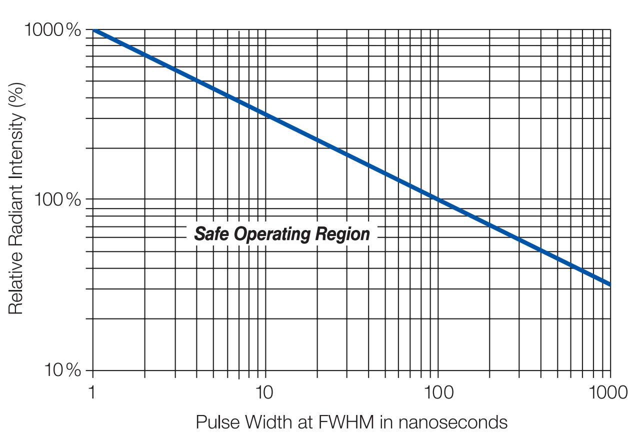


Figure 6 Radiant Intensity vs. Pulse Width for Safe Operation



5 For Your Safety

Laser Radiation:

Under operation, these devices produce invisible electromagnetic radiation that may be harmful to the human eye.

To ensure that these laser components meet the requirements of Class IIIb laser products, they must not be operated outside their maximum ratings. Power supplies used with these components must be such that the maximum peak forward current cannot be exceeded. It is feasible to operate the diodes within Class I laser operation, but it is the responsibility of the user incorporating a laser into a system to certify the Class of use and ensure that it meets the requirements of the DHHS or appropriate authority. Further details may be obtained in the publication FDA 88-8035:

US Department of Health and Human Services Food and Drug Administration Center for Devices and Radiological Health 1390 Picard Drive Rockville, MD 20850 U.S.A.

PerkinElmer Optoelectronics has used the data in the above document to calculate "Accessible Emission Limits" in terms of radiation power output and plotted them against pulse width for 850 nm and 1500 nm lasers. Ask for Technical Report "A Comparison of the Accessible Emission Limits (AEL's) for Laser Radiation at 850 nm and 1500 nm".

6 Ordering Information

The "preferred package" options on the list will normally be offered at lower cost and with shorter delivery times. To keep the costs down the standard devices are tested and burned-in under standard conditions. While the devices are warranted over the entire specification, for a quantity purchase, customers are advised to discuss their requirements in advance so that any special test needs can be accommodated and yields optimized.

PerkinElmer Optoelectronics has been routinely supplying multi active EPI-cavity lasers for military applications since the early 1990s. These diodes benefit from long years of experience from screened laser diodes to European and North American military specifications. Though the commercial products are not continuously screened, they are designed to meet demanding environmental conditions. Typical qualification of these parts would include:

- High Temperature Storage
- Hermetic Seal
- Thermal Shock
- Random Vibration
- Acceleration
- Mechanical Shock

PerkinElmer Optoelectronics is pleased to assist with advice and test procedures for your specific environmental needs.

7 RoHS Compliance

This series of laser diodes are designed and built to be fully compliant with the European Union Directive 2002/95EEC – Restriction of the use of certain Hazardous Substances in Electrical and Electronic equipment.

Table 8

	X	P	G	A	X	X	S	XX	H
Double active area	D								
Triple active area	T								
Pulsed		P							
905 nm wavelength			G						
+/-10 nm spectral width				A					
Preferred S package					S				
Preferred U package					U				
Optional C package					C				
Optional R package					R				
Optional F package					F				
Optional Y package					Y				
Single chip stack						1			
Double chip stack						2			
Triple chip stack						3			
Stackable chip							S		
0.003" wide laser stripe (75 µm)								03	
0.009" wide laser stripe (225 µm)								09	
RoHS Compliance									H

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