ADVANCES IN LASER DIODES FOR PYROTECHNIC APPLICATIONS

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OUTLINE

BACKGROUND ON LASER DIODES
- DAMAGE LIMITS
- TEMPERATURE STABILITY
- FIBER COUPLING ISSUES

SMALL FIBER RESULTS (100 MICRON)
- PACKAGE GEOMETRY
- ELECTRO-OPTICAL PROPERTIES
- TEMPERATURE STABILITY

LARGE FIBER RESULTS (400 MICRON)
- LASER BAR PERFORMANCE
- PACKAGE GEOMETRY
- ELECTRO-OPTICAL PROPERTIES

POWER LIMITS FOR LASER DIODES

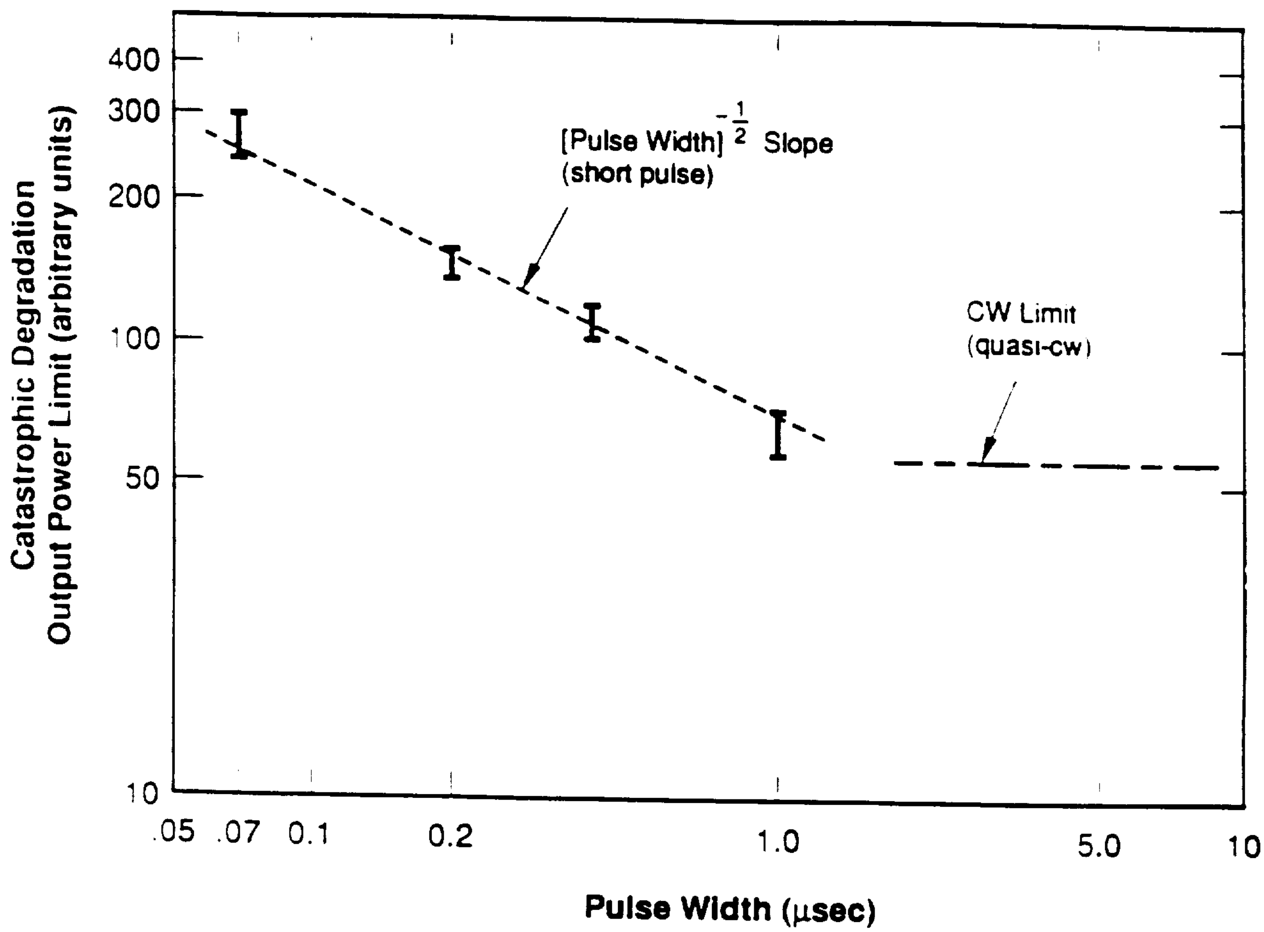
FOR OPTICAL PULSES LONGER THAN 1 MICROSECOND FACET DAMAGE DEPENDS ON OPTICAL POWER NOT OPTICAL ENERGY.

FOR WELL "PASSIVATED" LASERS DAMAGE LIMIT APPROXIMATELY 10 MW/cm .

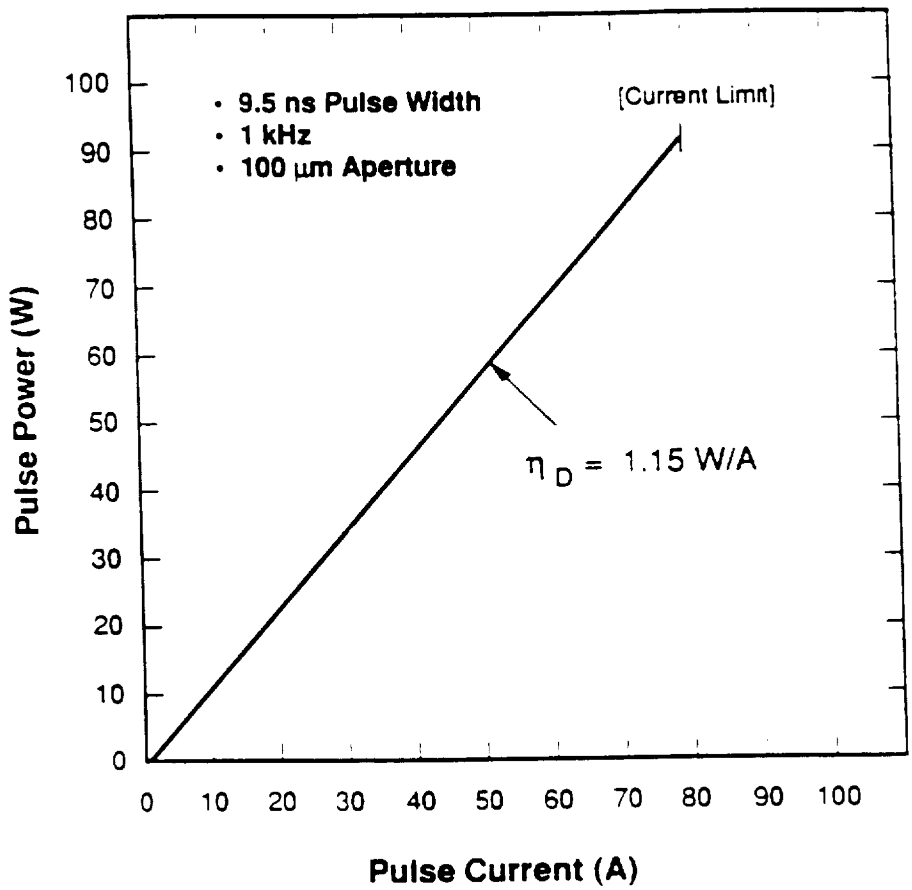
WELL "PASSIVATED" AlGaAs LASERS HAVE SAME DAMAGE LIMIT AS InGaAs LASERS.

LOW EFFICIENCY OR POOR HEATSINKING CAN CAUSE LASER TO "ROLL-OVER" BEFORE DAMAGE LIMIT IS REACHED.

Pulsed Laser

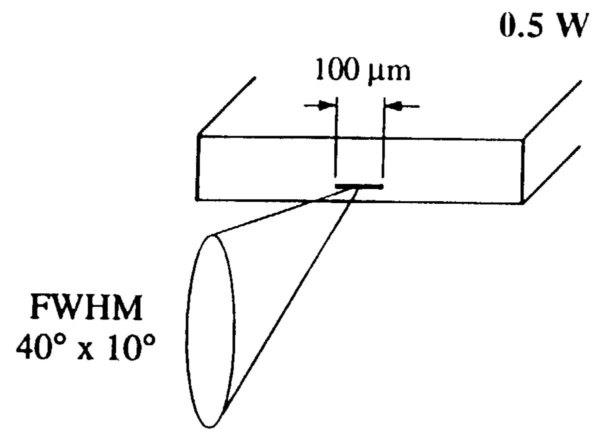


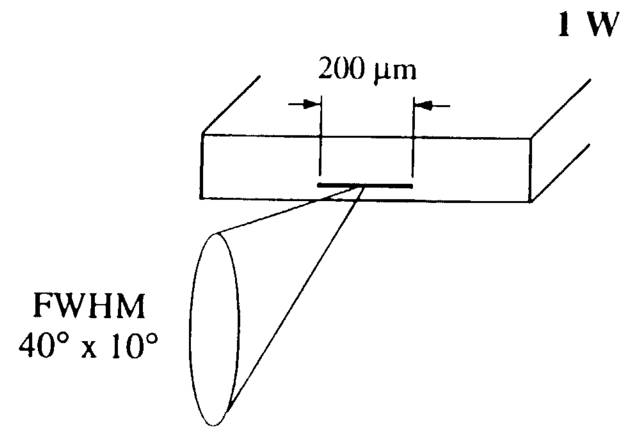
Short Pulse Power Curve



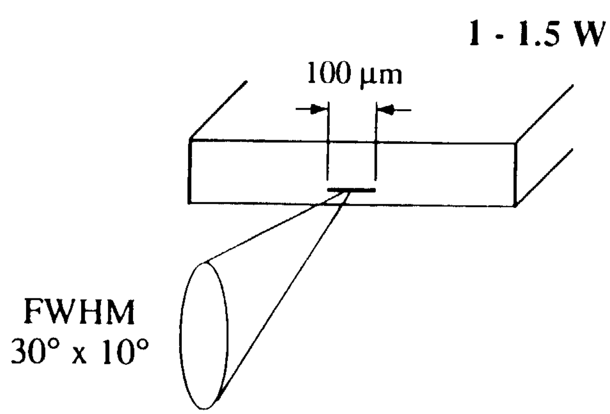
High Brightness Multimode Lasers

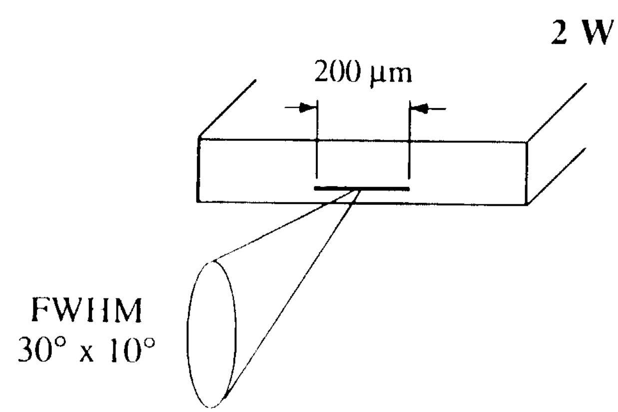
1987-1991 Commercial State-of-the-art



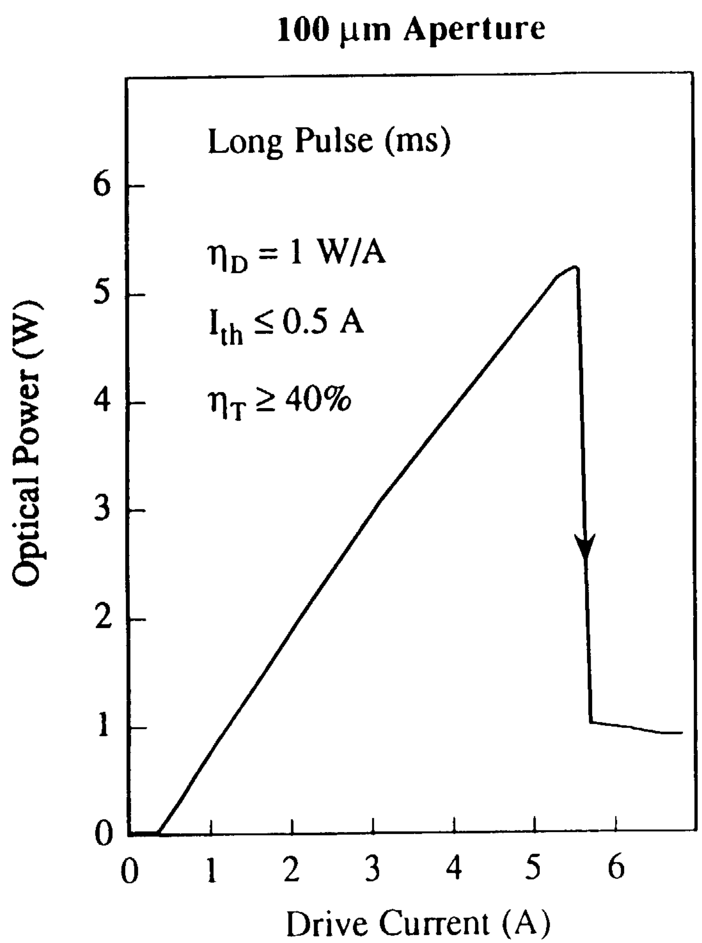


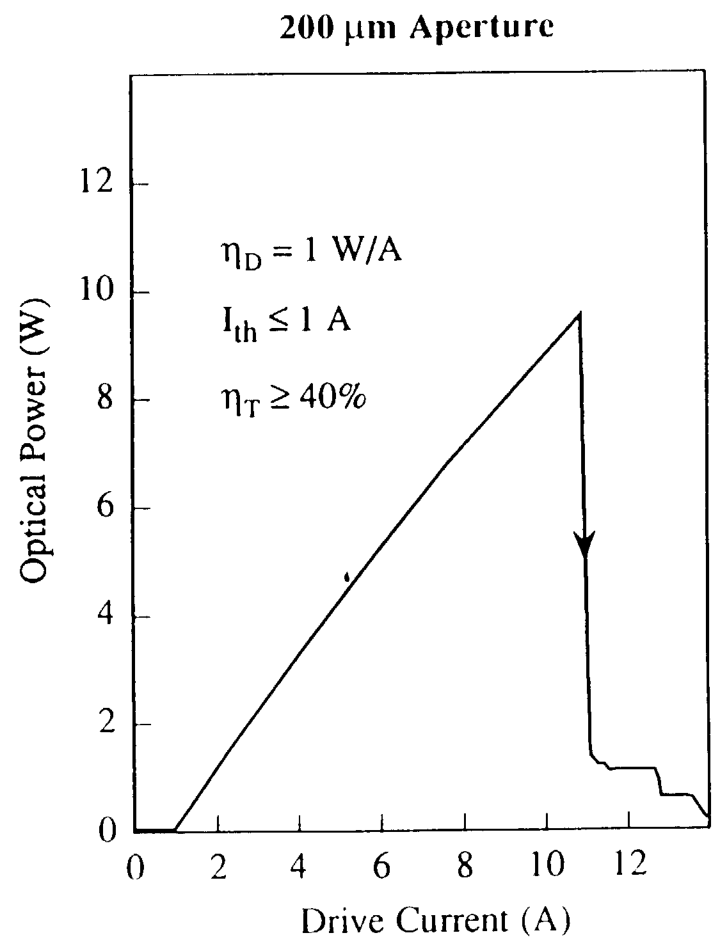
1991 New Technology





AlGaAs SQW Characteristics (795 - 860 nm)



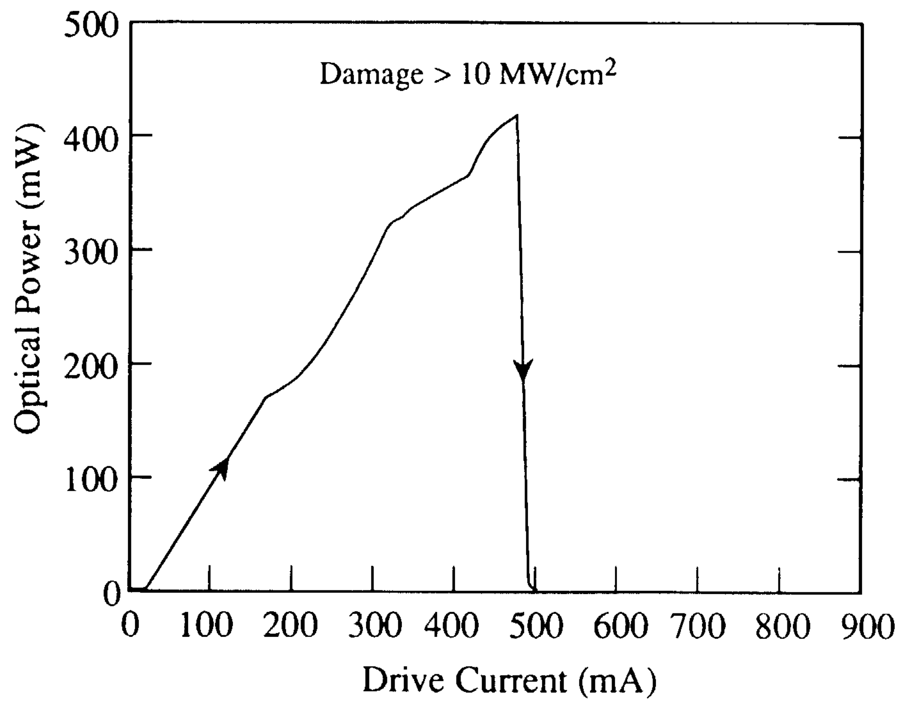


Damage Limits of Diode Lasers

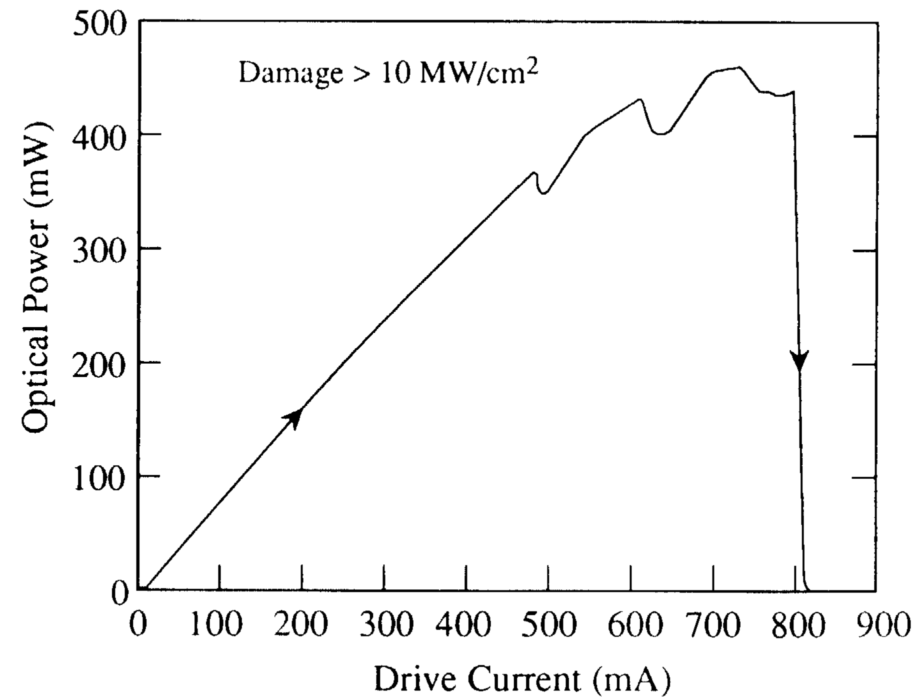
AlGaAs vs. InGaAs

(Both are single mode lasers of similar structure)

Aluminum-Gallium-Arsenide

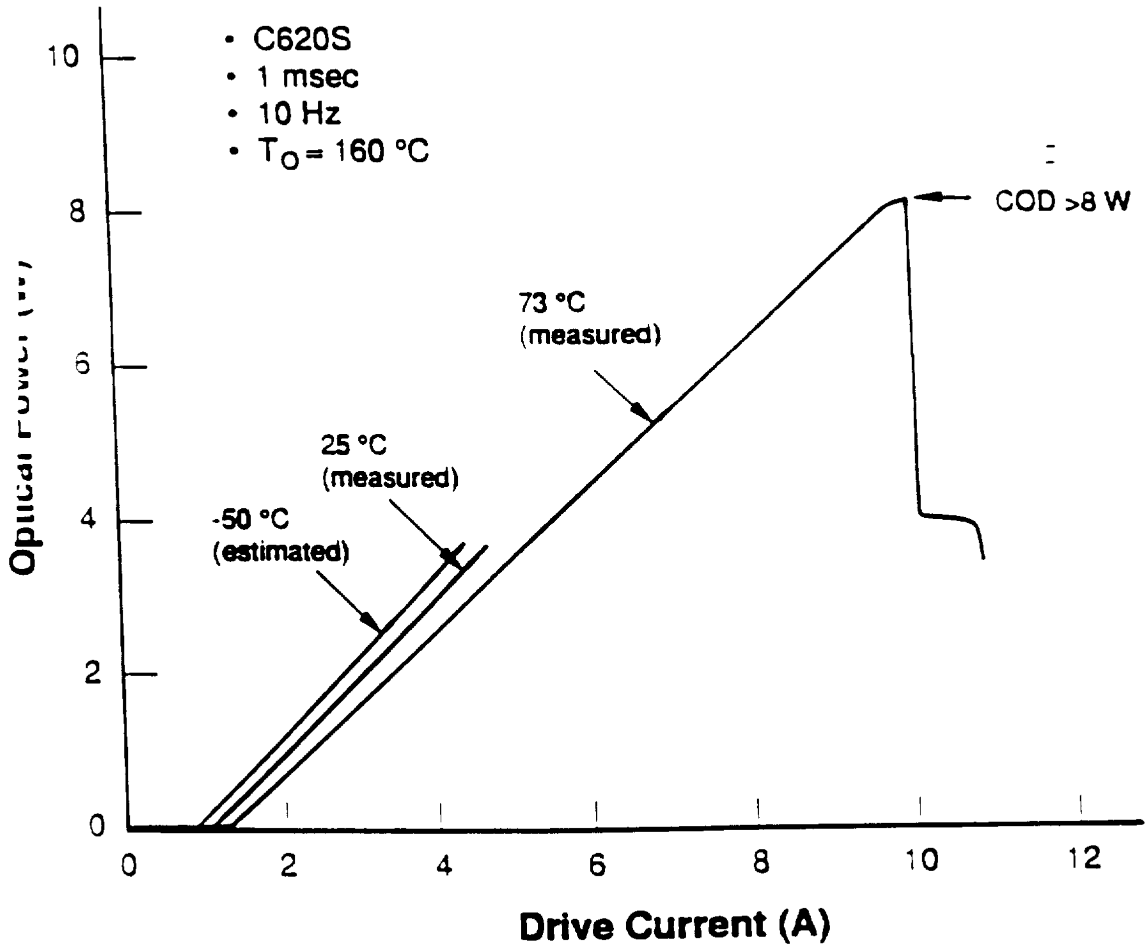


Indium-Gallium-Arsenide



DAMAGE LEVEL NOT SIGNIFICANTLY DIFFERENT

High T_O Quasi-cw 200 μm Aperture Laser

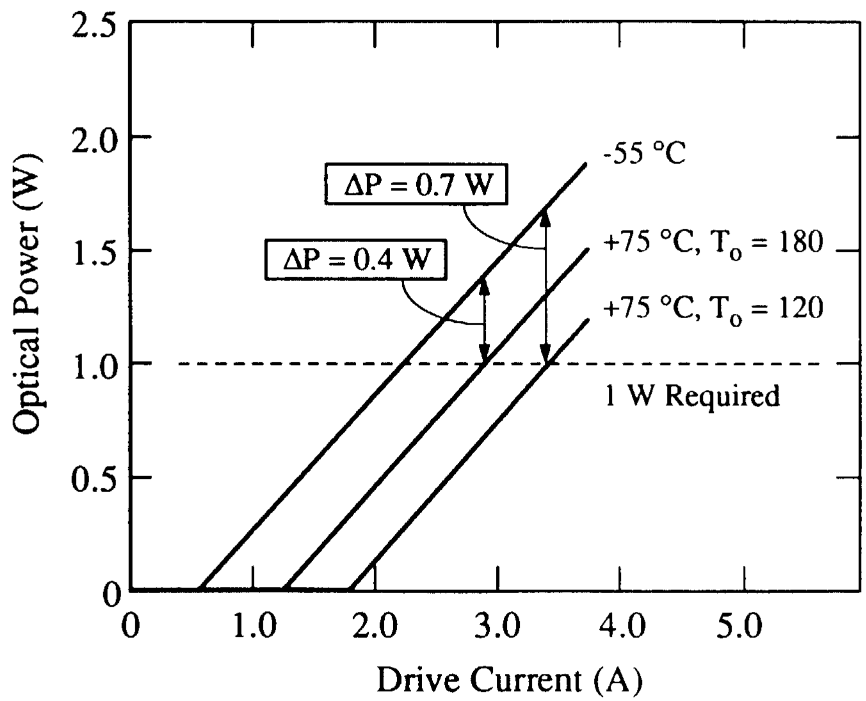


Temperature Dependence of Laser Threshold:

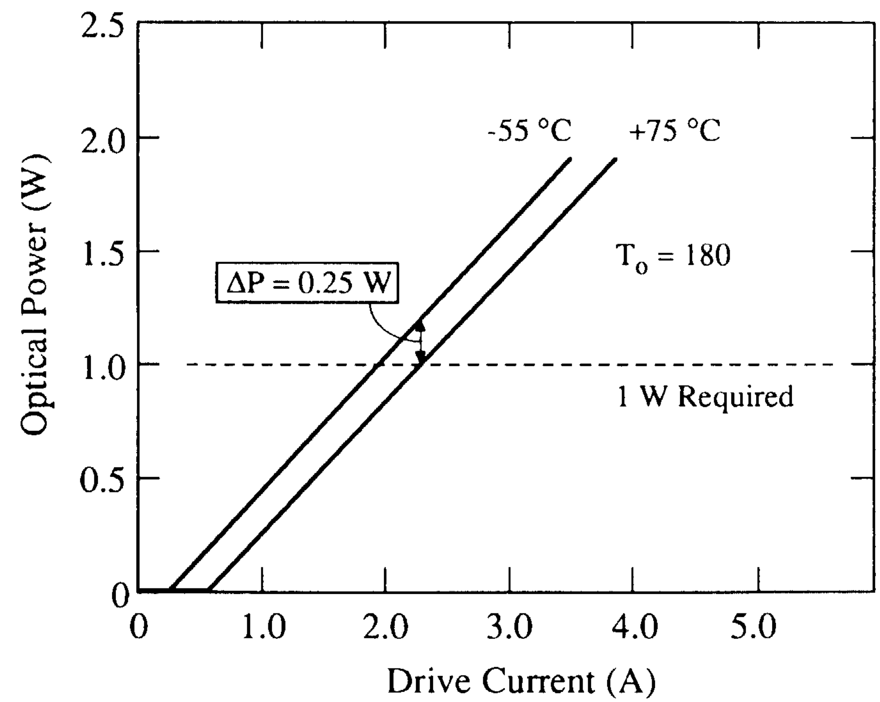
$$\frac{I_{TH_1}}{I_{TH_2}} = e^{(T_1 - T_2)/T_O}$$

Temperature Variations

Modeled 200 μm Aperture Laser



Modeled 100 μm Aperture Laser



FIBER COUPLING OF LASER DIODES

IN SIMPLE COUPLING SCHEMES THE LASER APERTURE IS SMALLER THAN THE FIBER DIAMETER.

TAPERED FIBERS OR OTHER LENS APPROACHES CAN ACHIEVE COUPLING OF LASERS WITH APERTURES GREATER THAN TWICE THE FIBER DIAMETER.

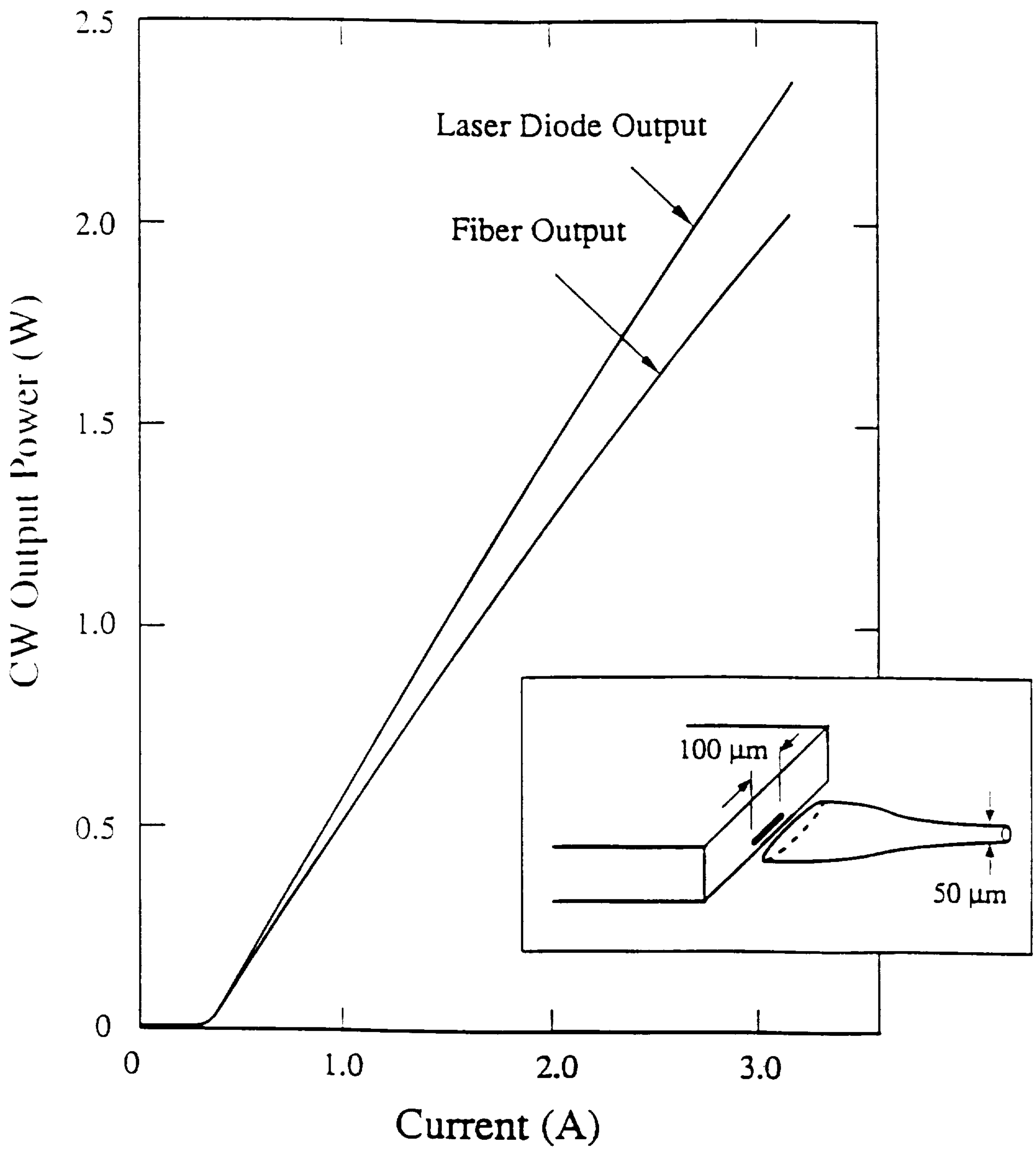
COMMON BASIS FOR COMPARISON OF LASER SYSTEM CAN BE BRIGHTNESS FROM THE FIBER

BRIGHTNESS = POWER/(AREA x SOLID ANGLE)

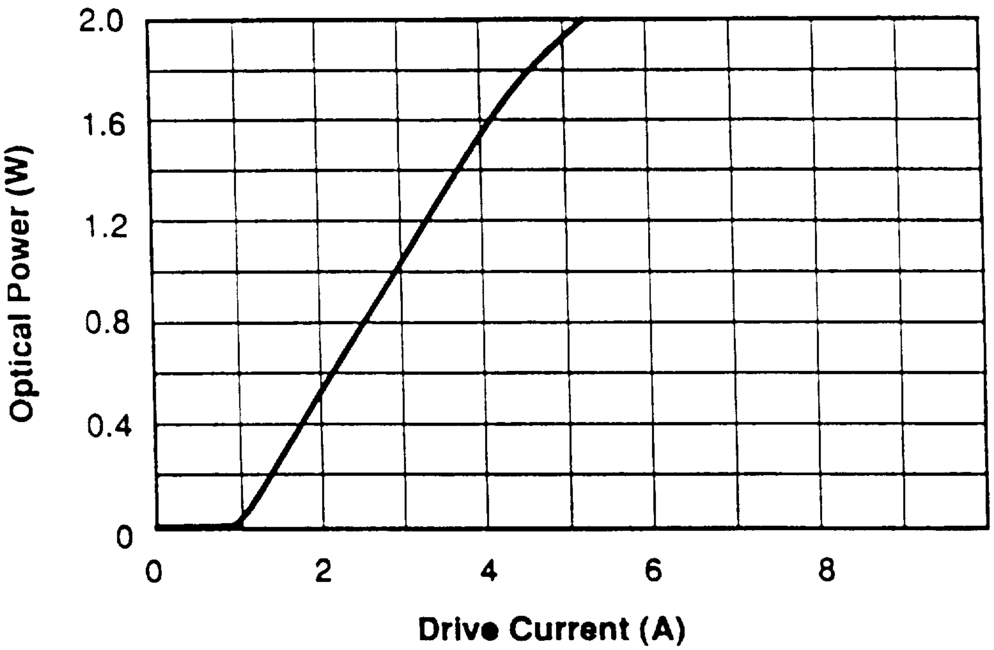
RELAXING BRIGHTNESS REQUIREMENT CAN REDUCE MANUFACTURING COSTS.

Tapered Fiber Couple

50 μm Diameter, 0.4 NA



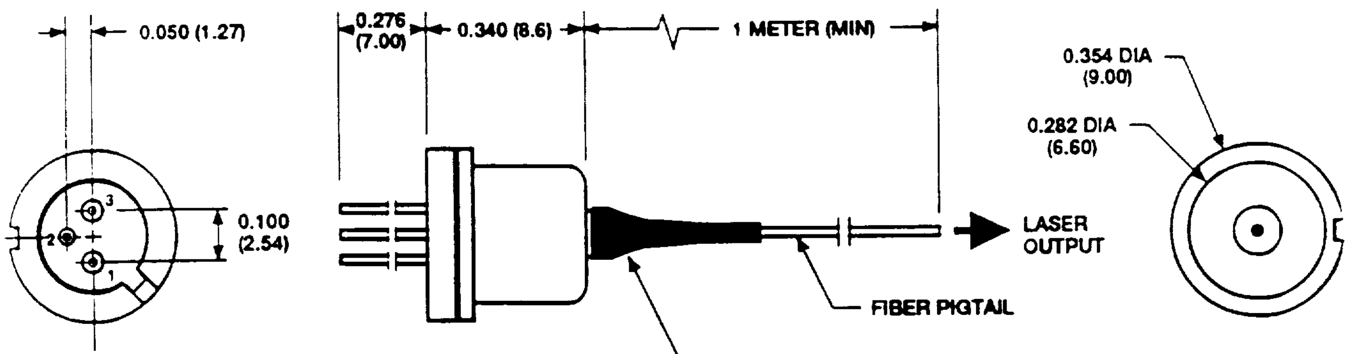
2 Watt Quasi-cw (10 msec) Fiber Coupled to 100 μm Fiber



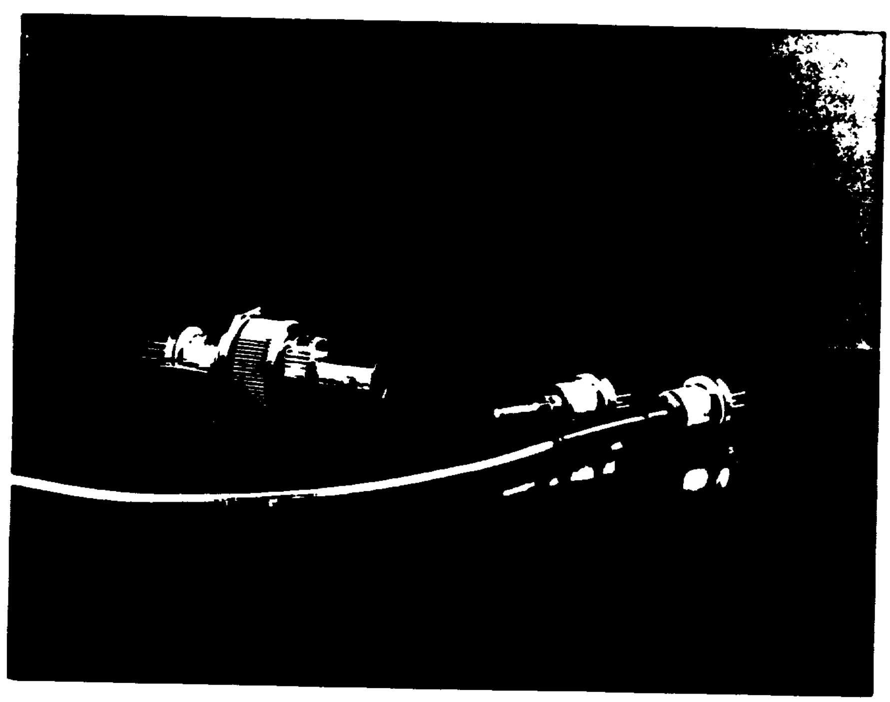
1 Watt Quasi-cw from 100 μm Fiber
Meets Present Sandia Detonator Requirements

Package Specifications [Dimensions in inches (mm)]

S9140 SOT-148 Fiber Pigtail Package



Pin 1: Laser Cathode (-)
Pin 2: Laser Anode, MPD Cathode & Case Ground
Pin 3: Monitor Photodiode Anode (+)



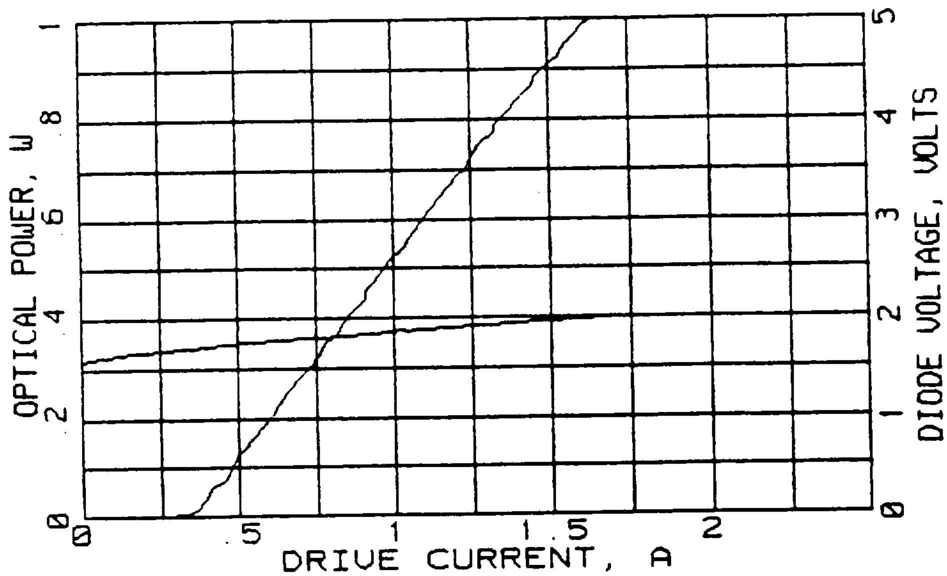
100 μm Fiber Results

SPECTRA DIODE LABS, INC.

DEVICE TYPE: SDL-5-9141-G2 SERIAL NUMBER: RL499
DATE: 1 APRIL 92 TIME: 13:56

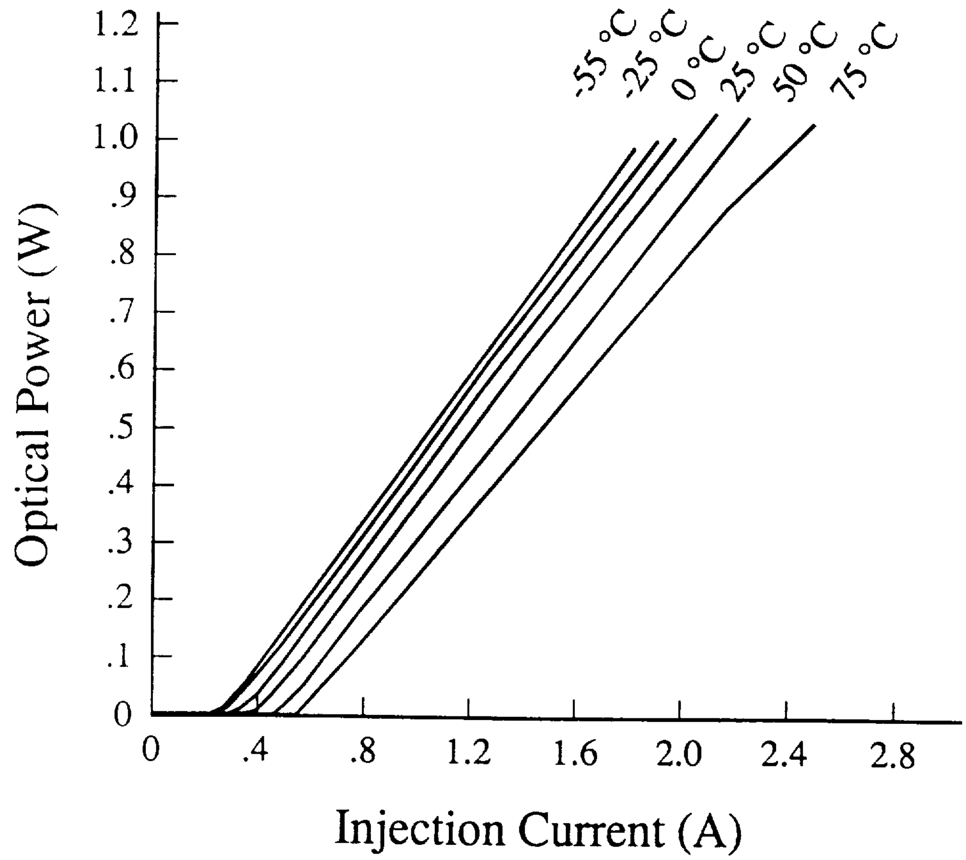
PARAMETER	PULSED	UNITS
THRESHOLD	.34	A
DIFF. Q. E.	51	%
SLOPE EFF.	.78	W/A
V AT 1 A	1.9	VOLTS
RESISTANCE	.216	OHMS
I AT 1.0 W	1.63	A
V AT 1.0 W	1.99	V

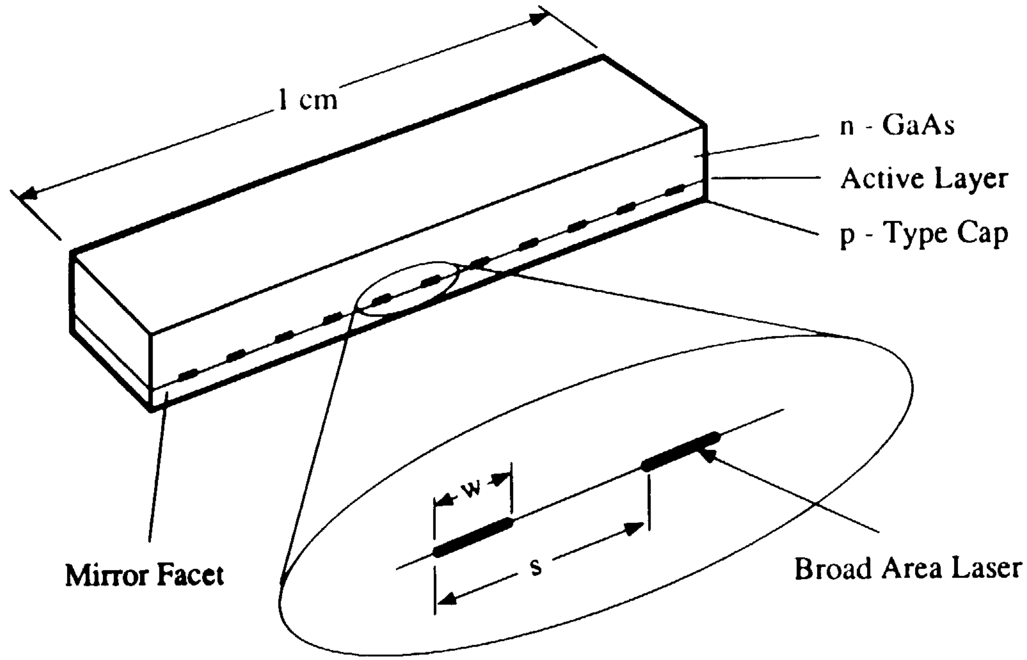
PULSE: WIDTH = 10000 usec, RATE = 10 Hz, TEST TEMP = 25 C
MONITOR GAIN: .6 mA/W



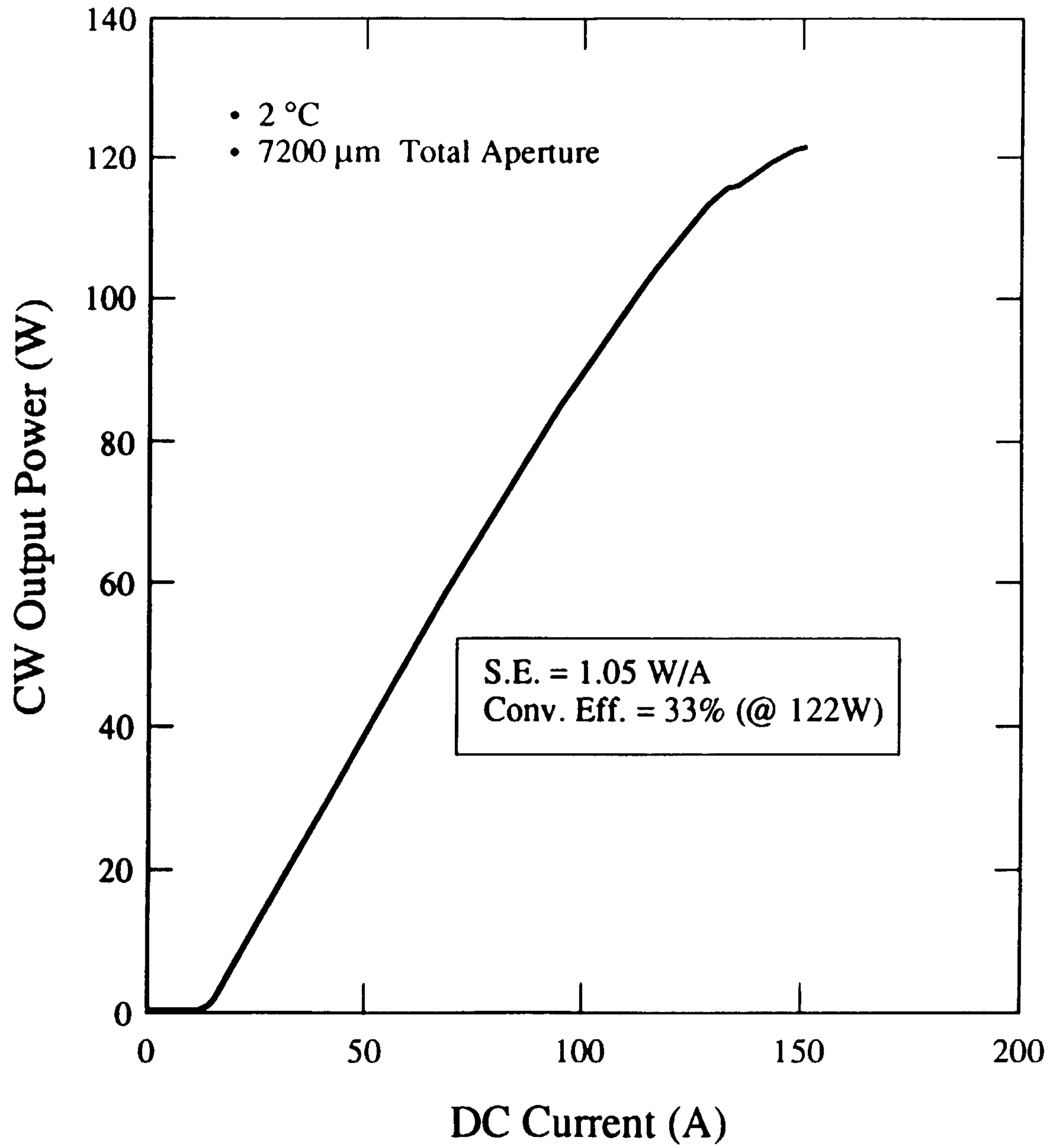
********** SHIPMENT CHECKLIST CHECKED BY SDL A 4 QA
LABELS: SDL, S/N ✓ # -???? (??) 3069. # -3138
SERIAL NUMBERS MATCH ✓ WAVELENGTH MATCHES ORDER N/A
OPERATOR'S MANUAL ✓

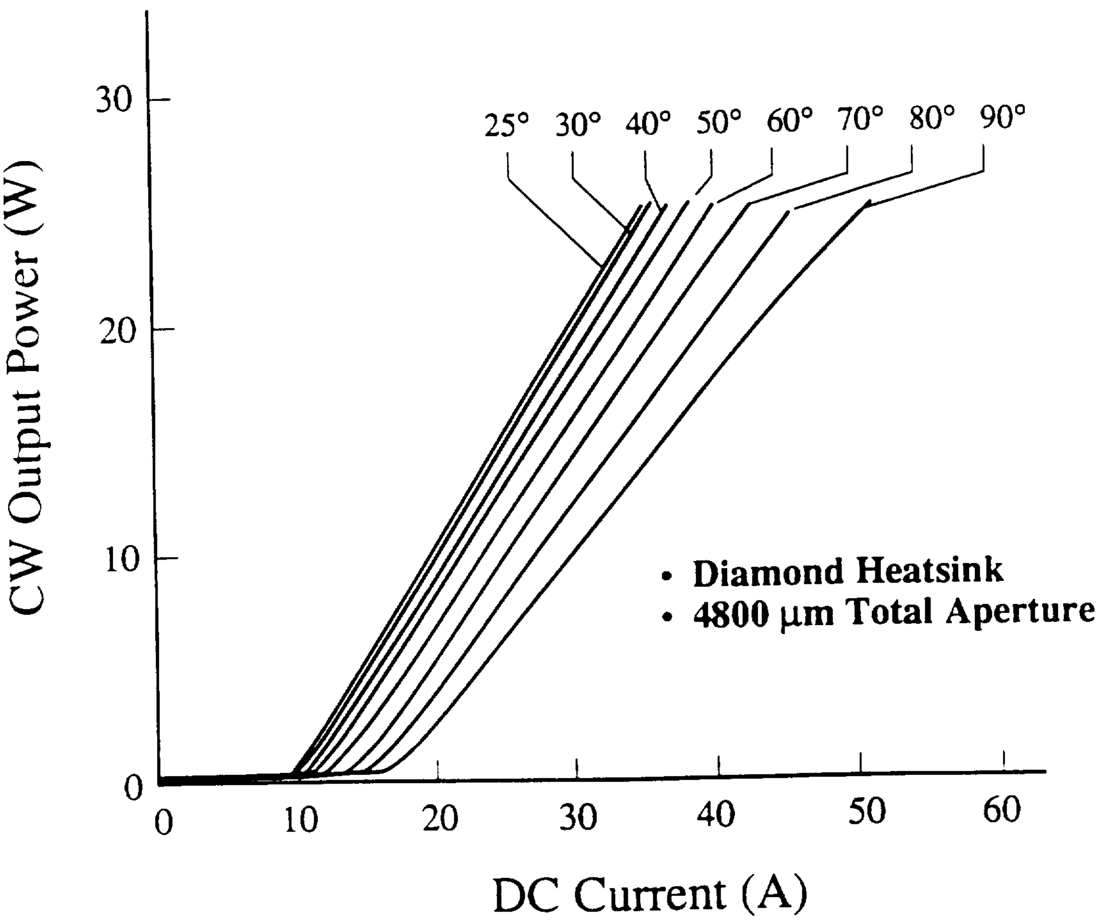
Power Characteristics of S9140





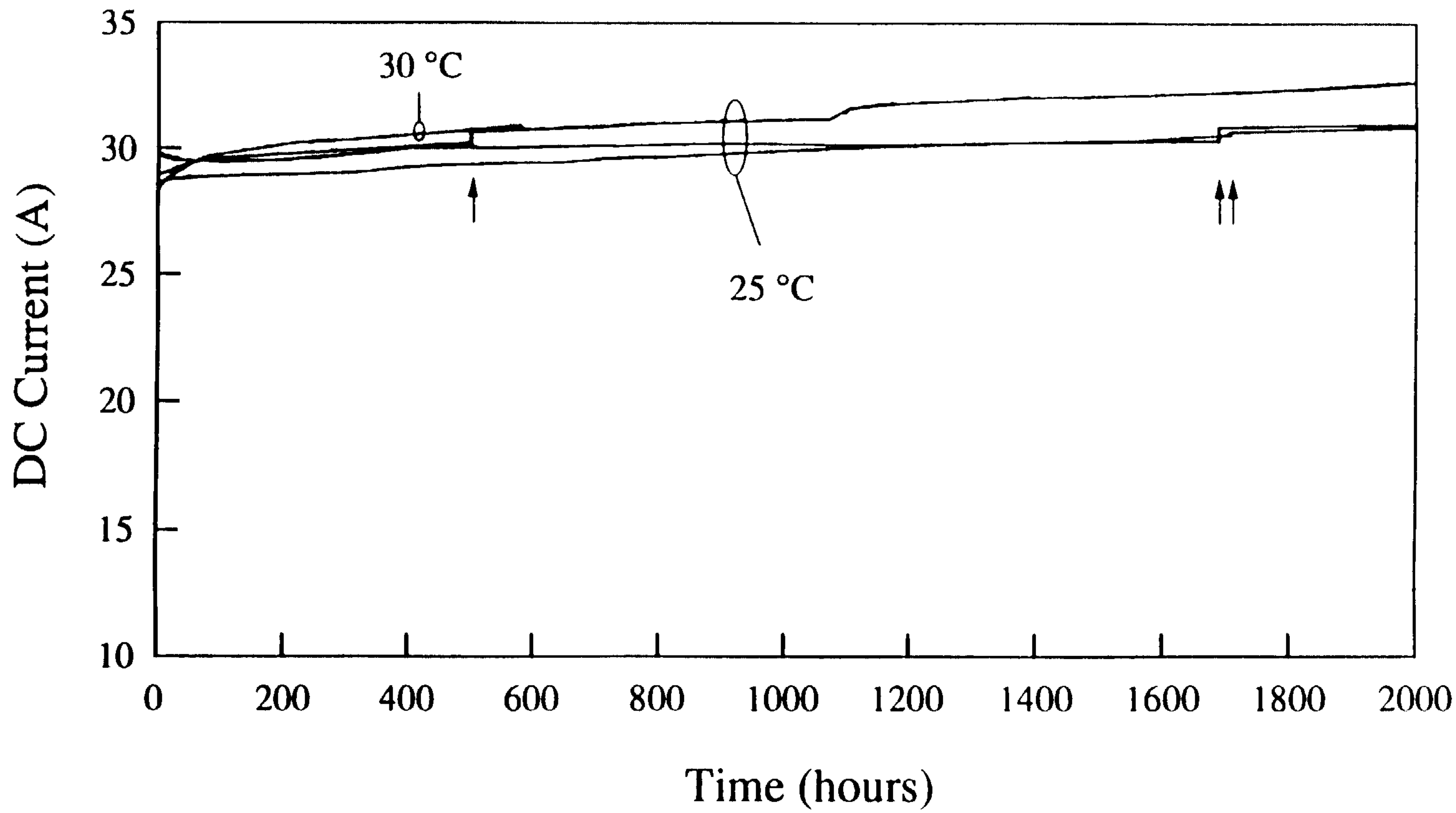
Total Width	w	s
2400 μm	170 μm	700 μm
4800 μm	100 μm	200 μm
6000 μm	80 μm	125 μm
7200 μm	96 μm	125 μm


• 2 °C
• 7200 μm Total Aperture
S.E. = 1.05 W/A
Conv. Eff. = 33% (@ 122W)
CW Output Power (W)
DC Current (A)
0
20
40
60
80
100
120
140
0
50
100
150
200



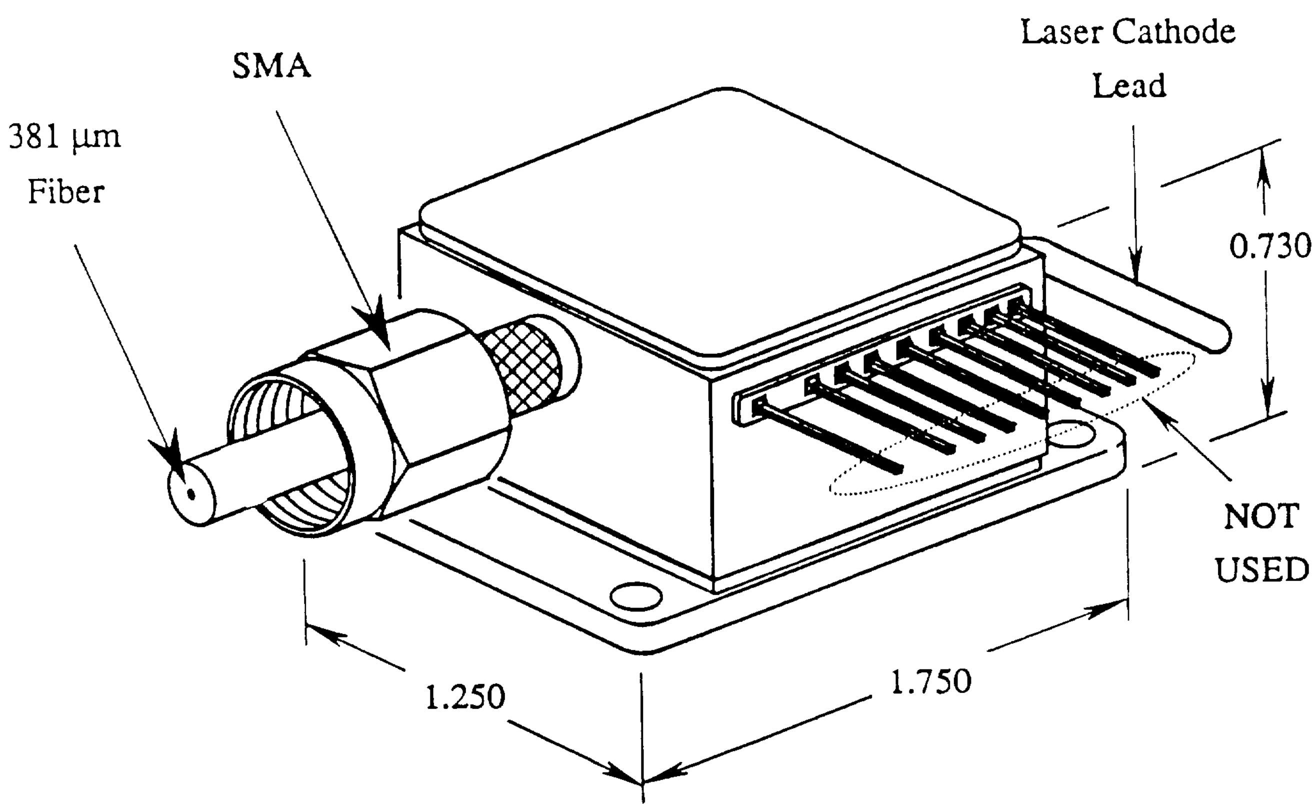
CW Output Power (W)
30
20
10
0
0
10
20
30
40
50
60
DC Current (A)
25°
30°
40°
50°
60°
70°
80°
90°
• Diamond Heatsink
• 4800 μm Total Aperture

20 W CW (4800 μm Total Aperture)



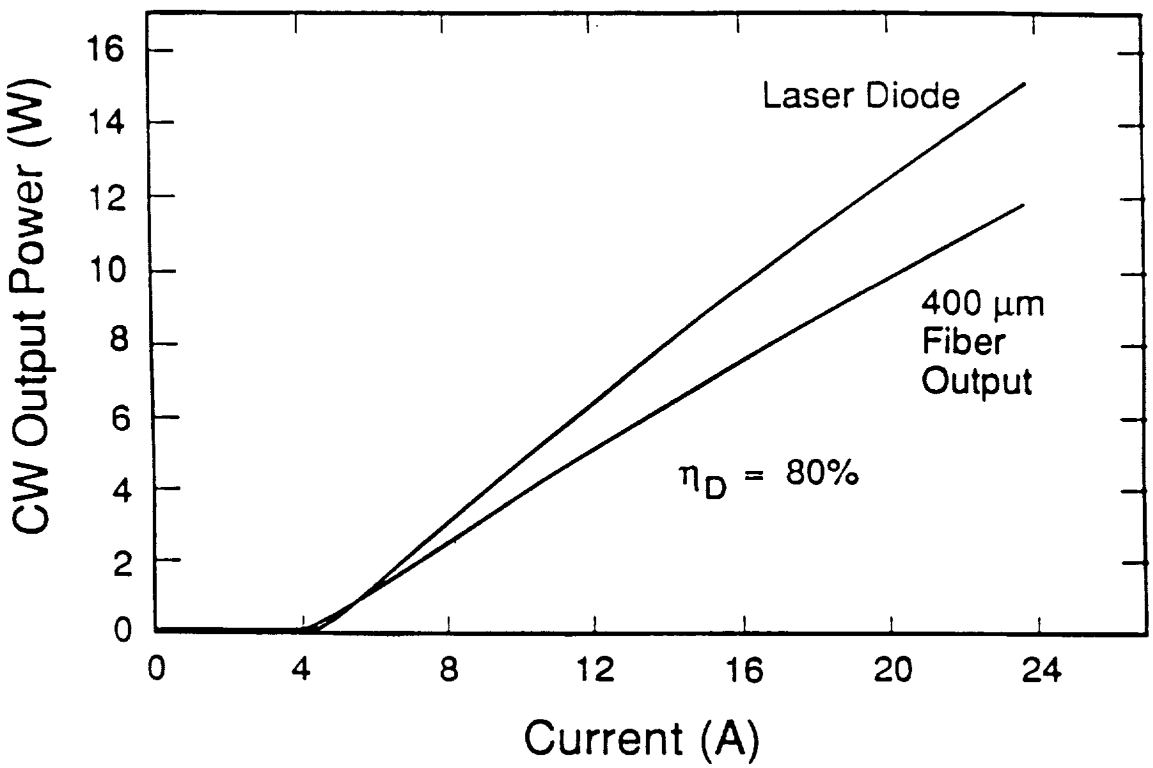
Projected Lives of 4,000, 7000, and 15,000 hours @ 25 °C
(3 bars, 20% increase in operating current)

High Heat Load Fiber Coupled Package (P5)



PACKAGE IS ANODE

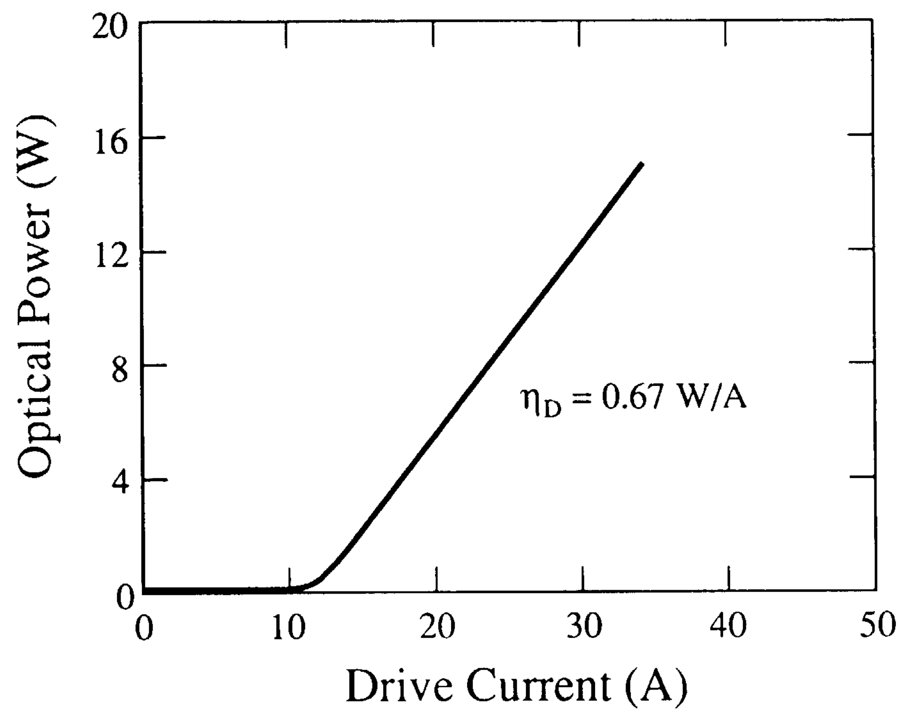
SDL-3450-P5
Light vs. Current



High Power Fiber Coupled Laser for Pyrotechnics

Test Conditions: 10 ms pulse, 10 Hz
20 °C

Fiber: 400 µm, 0.4 NA



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