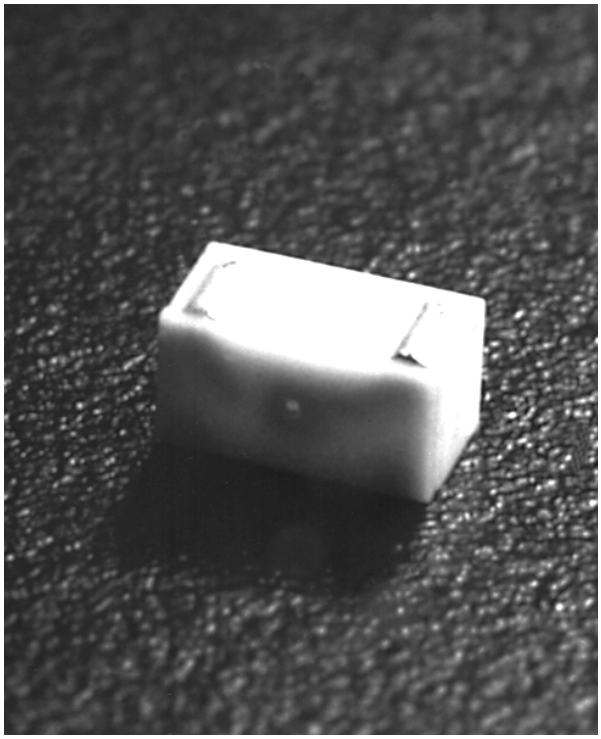
Data Sheet
September 1998

microelectronics group

Lucent Technologies
Bell Labs Innovations

126A/B/C InGaAs Avalanche Photodetectors



The 126A/B/C APDs are compatible with industry-standard ceramic carriers.

Features

- High performance at both 1.3 µm and 1.5 µm
- Suitable for use in harsh environments
- Higher sensitivity and longer wavelength response than germanium APDs
- Reliable planar structure with InGaAsP layer and dual guard ring for high-speed performance
- High responsivity from 1.0 µm to 1.6 µm
- Wide bandwidth:
  >1.0 GHz (126A)
  >1.8 GHz (126B)
  >2.5 GHz (126C)
- Compatible with industry-standard packaging
- Applications for high data rates: up to 1.5 Gbits/s (126A) or 2.5 Gbits/s (126B/C)
- Low capacitance
- Hermetic package
- Integral lens for easier coupling

Applications

- Telecommunications
  —High-speed, long-haul communication systems
  —High-speed metropolitan area networks
  —Submarine cable communication systems
  —High-frequency analog transmission
- Military
  —Very low-noise receivers
  —Satellite transmission
  —Optical radar
  —Free-space optical communication systems

Description

The Lucent Technologies Microelectronics Group 126A/B/C InGaAs Avalanche Photodetectors (APDs) are high-performance optical devices that are sensitive at both 1.3 μm and 1.5 μm. The APDs feature high sensitivity and wide bandwidths and are capable of data rates up to 2.5 Gbits/s. The APD chip is fabricated by vapor-phase epitaxy and has a planar structure for high reliability. Common applications include long-distance lightwave telecommunication systems and extremely sensitive optical measurement systems.

The 126A/B/C APDs are compatible with industry-standard ceramic carriers. The devices are back illuminated through an opening in the hermetically sealed package, permitting optical input directly from an externally mounted fiber.

All 126 APDs contain an integral lens to give a magnified junction diameter large enough for coupling to a 50 μm diameter case multimode fiber. The 126C has modified crystalline layers to give an increased bandwidth.

Absolute Maximum Ratings

Stresses in excess of the Absolute Maximum Ratings can cause permanent damage to the device. These are absolute stress ratings only. Functional operation of the device is not implied at these or any other conditions in excess of those given in the operations sections of the data sheet. Exposure to Absolute Maximum Ratings for extended periods can adversely affect device reliability.

Parameter	Symbol	Min	Max	Unit
Operating Case Temperature	T_c	–40	80	°C
Storage Case Temperature*	T_{stg}	–55	100	°C
Reverse Current	I_r	—	1	mA
Lead Soldering Temperature/Time	—	—	275/20	°C/s

Electrical Characteristics

All measurements are 25 °C, 1.3 µm light

Parameter	Device	Symbol	Conditions	Min	Typ	Max	Unit
Breakdown Voltage	126A	V_{br}	I_d = 10 µA	55	65	95	V
	126B	V_{br}	I_d = 10 µA	55	65	95	V
	126C	V_{br}	I_d = 10 µA	45	60	90	V
Vbr Temperature Coefficient	126A	γ	—	0.15	0.20	0.30	%/°C
	126B	γ	—	0.15	0.20	0.30	%/°C
	126C	γ	—	0.12	0.15	0.20	%/°C
Maximum Gain	126A	M_{max}	—	30	—	—	—
	126B	M_{max}	—	30	—	—	—
	126C	M_{max}	—	30	—	—	—
Primary Dark Current	126A	I_{dp}	—	—	5	10	nA
	126B	I_{dp}	—	—	5	10	nA
	126C	I_{dp}	—	—	10	15	nA
Total Dark Current	126A	I_{dm}	M = 12	—	50	100	nA
	126B	I_{dm}	M = 12	—	50	100	nA
	126C	I_{dm}	M = 12	—	100	150	nA
Bandwidth	126A	f_c	4 < M < 12	1.3	1.5	—	GHz
	126B	f_c	4 < M < 12	1.8	2.0	—	GHz
	126C	f_c	4 < M < 12	2.5	3.0	—	GHz
Excess Noise Factor	126A	F	M = 12	—	5	6	—
	126B	F	M = 12	—	5	6	—
	126C	F	M = 12	—	5	6	—
Capacitance	126A	C	M = 12	—	0.3	0.40	pF
	126B	C	M = 12	—	0.3	0.40	pF
	126C	C	M = 12	—	0.4	0.50	pF
Gain Coefficient*	126A	A	M > 3	50	60	70	V
	126B	A	M > 3	50	60	70	V
	126C	A	M > 3	30	40	60	V
Responsivity†	126A	R	M = 12	10.0	10.7	—	A/W
	126B	R	M = 12	10.0	10.7	—	A/W
	126C	R	M = 12	10.0	10.7	—	A/W
Apparent Junction Diameter	126A	—	—	60	65	—	µm
	126B	—	—	60	65	—	µm
	126C	—	—	60	65	—	µm

* The A coefficient and the breakdown voltage are given for each APD. The gain at any voltage (for M > 3) can be calculated from these parameters per M = A/(Vbr - V).
† Responsivity = (quantum efficiency) x gain x (l/1.24).

Characteristic Curves

T_A= 25 °C

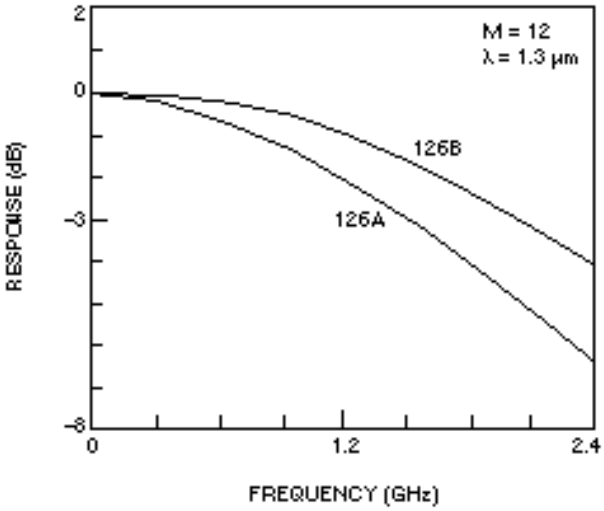


Figure 1. Frequency Response

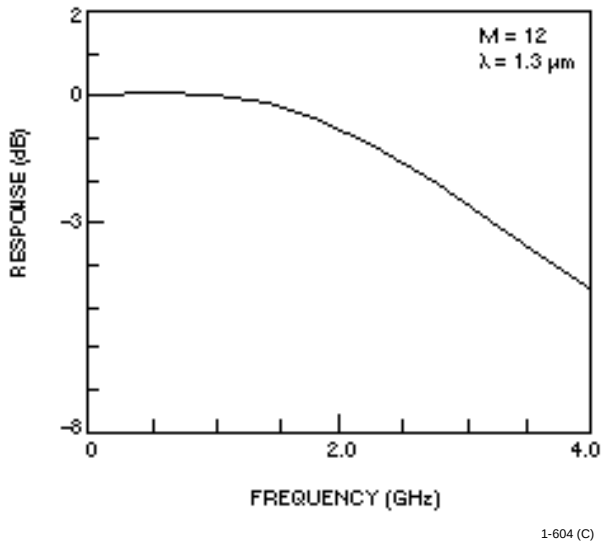
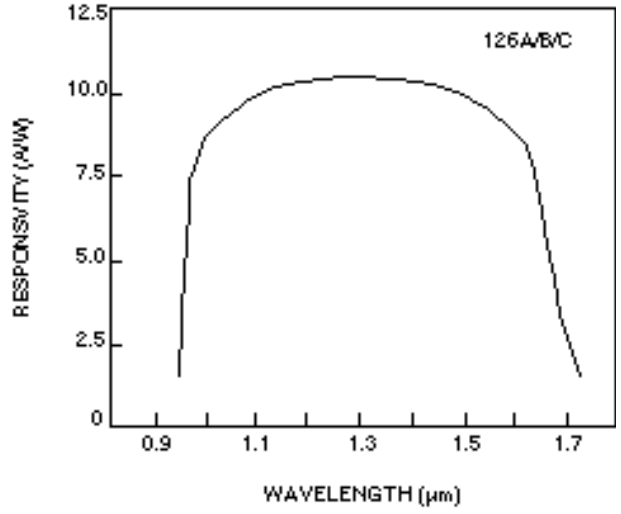


Figure 2. Frequency Response (126)



Note: Responsivity = (chip quantum efficiency) x gain x l (µm)/1.24. The minimum chip quantum efficiency is 80%, and the minimum pigtail coupling efficiency is 90%.

Figure 3. Responsivity vs. Wavelength for M = 12 and l = 1.3 µm

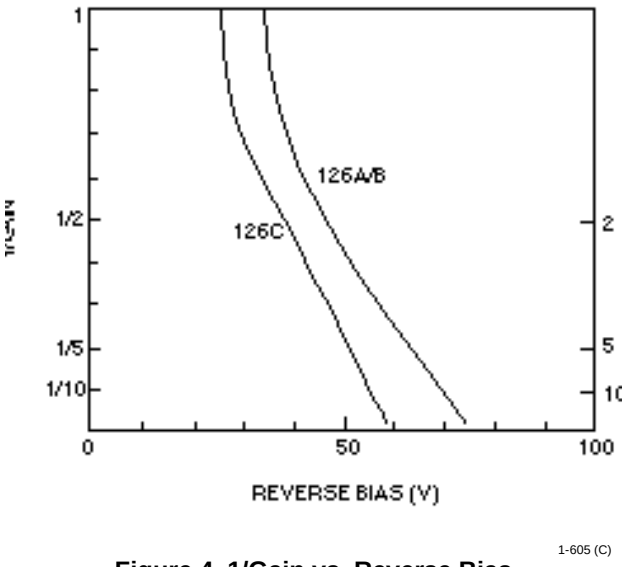
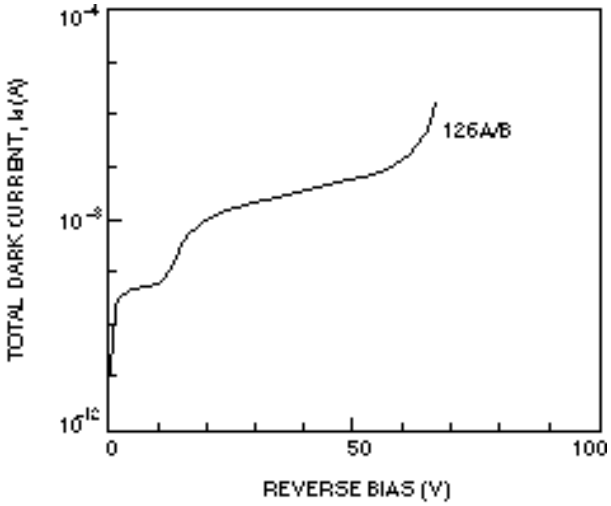


Figure 4. 1/Gain vs. Reverse Bias

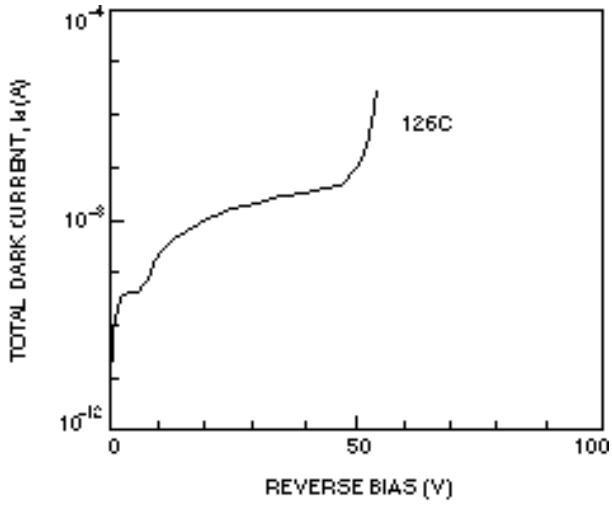
Characteristic Curves (continued)

T_A= 25 °C



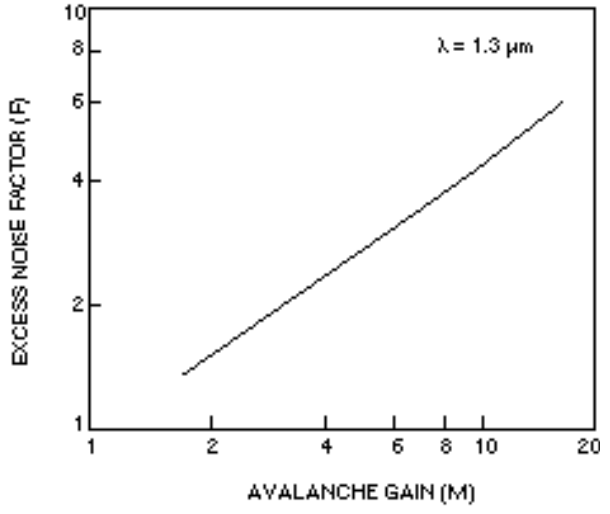
1-606 (C)

Figure 5. Dark Current vs. Reverse Bias (126A/B/C)



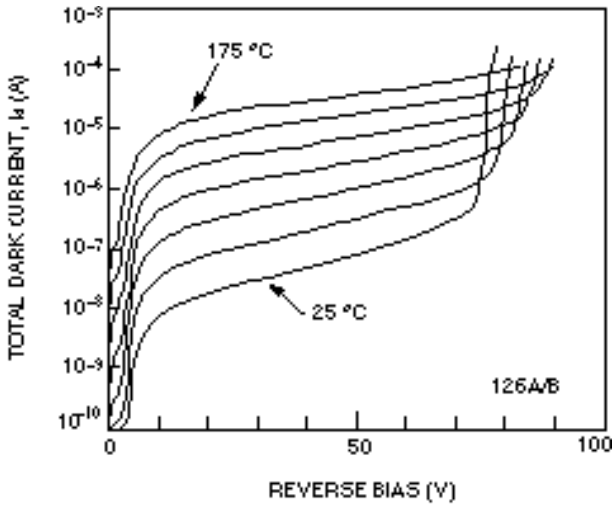
1-607 (C)

Figure 6. Dark Current vs. Reverse Bias (126C)



1-321 (C)

Figure 7. Excess Noise Factor vs. Gain



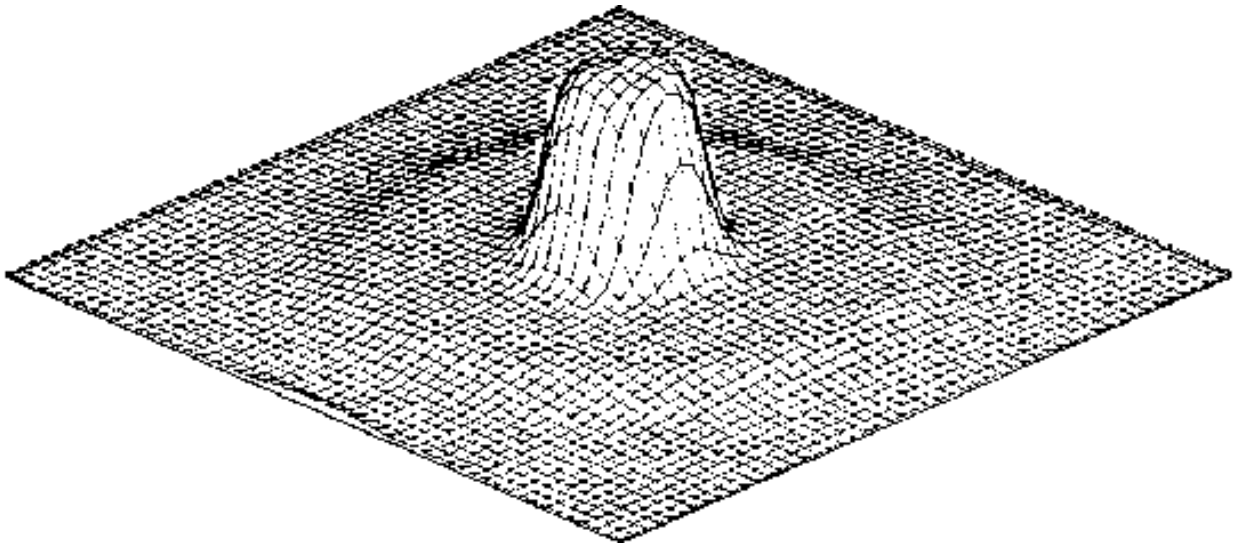
Note: The temperature dependence of the 126C dark current is the same as the 126A/B.

1-608 (C)

Figure 8. Dark Current vs. Voltage as a Function of Temperature at 25 °C Increments

Characteristic Curves (continued)

T_A= 25 °C



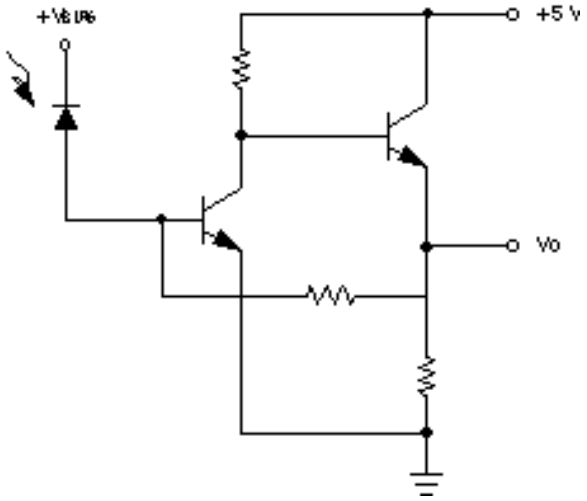
Notes:M = 12; total scanned area = 200 µm x 200 µm; active area diameter = 40 µm.

1-601 (S)

Figure 9. Photo-Response Scan

Applications

Transimpedance Front-End Configuration*



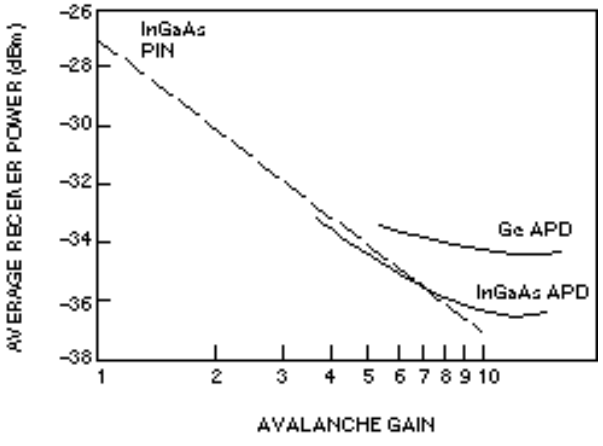
* Reference: Optical Fiber Communications, John M. Senior, © 1985, Prentice-Hall; ISBN-0-13-638248-7.

1-487 (C)

Figure 10. Bipolar Transistor Design

APD Receiver Sensitivity

The following figure illustrates typical receiver sensitivity at a receiver rate of 1.7 Gbits/s and l = 1.3 µm for an InGaAs PIN, Ge APD, and InGaAs APD.

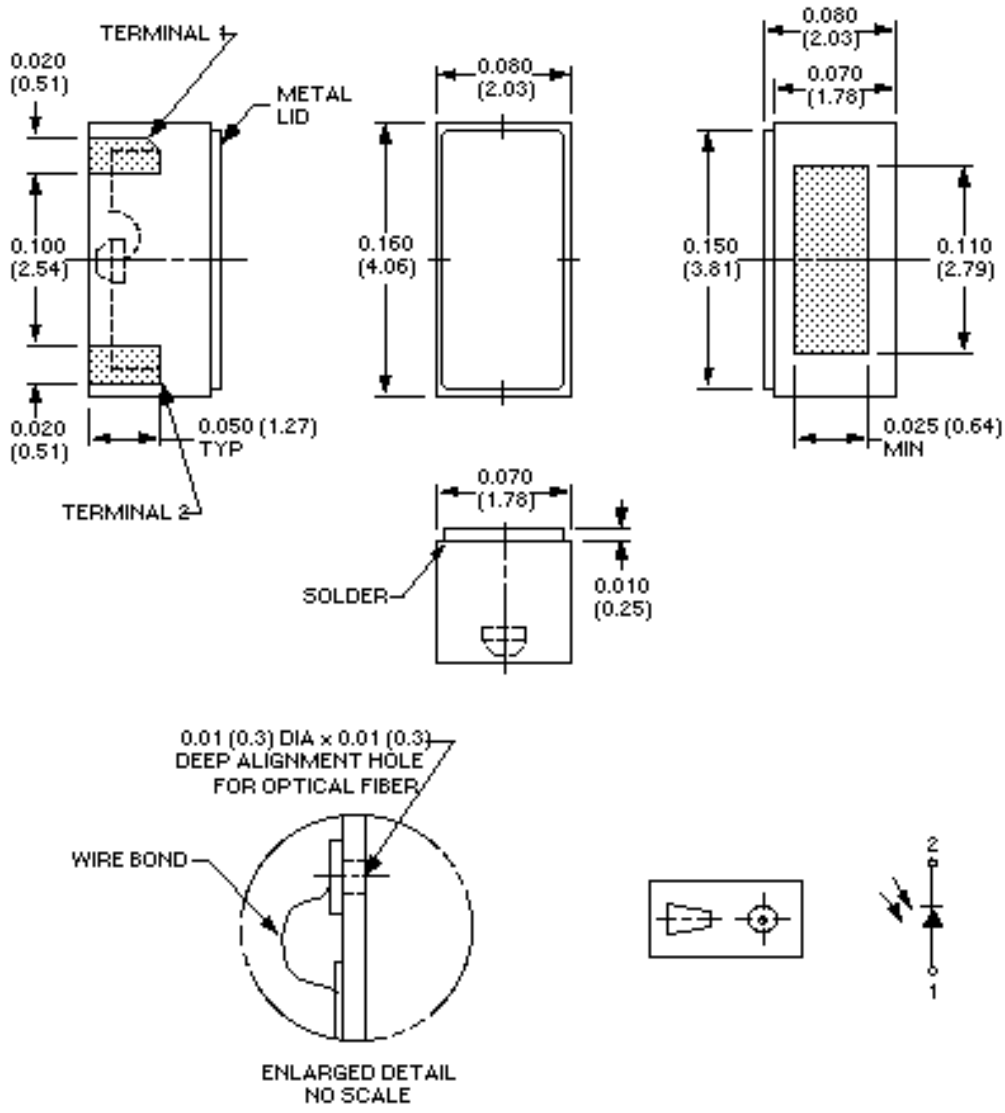


1-491 (C)

Figure 11. APD Receiver Sensitivity

Outline Diagram

Dimensions are in inches and (millimeters).



1-602 (C)

Terminal	Bias
1	Negative
2	Positive

Ordering Information

Description	Part Number	Comcode
InGaAs Avalanche Photodetector	126A	105742944
	126B	105742951
	126C	106395445

Related Documentation

Description	Document Number
Lithium Niobate High-Speed Modulator	DS98-110LWP
1712 Erbium-Doped Fiber Amplifier	DS96-086LWP
1713 Erbium-Doped Fiber Amplifier	DS96-134WP
127A/B/C InGaAs Avalanche Photodetectors	DS98-426LWP
1319-Type High-Speed Lightwave Receiver	DS97-106LWP

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