HEWLETT hp PACKARD
COMPONENTS

PIN PHOTODIODES

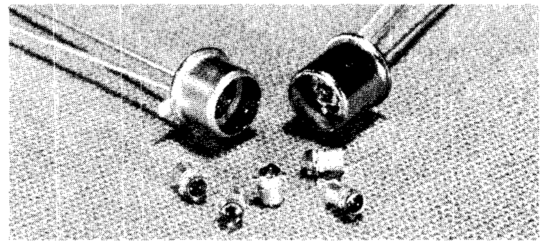
5082-4200 SERIES

TECHNICAL DATA APRIL 1976

Features

- HIGH SENSITIVITY (NEP <-108 dBm)
- WIDE DYNAMIC RANGE (1% LINEARITY OVER 100 dB)
- BROAD SPECTRAL RESPONSE
- HIGH SPEED (T_r, T_f<1ns)
- STABILITY SUITABLE FOR PHOTOMETRY/ RADIOMETRY
- HIGH RELIABILITY
- FLOATING, SHIELDED CONSTRUCTION
- LOW CAPACITANCE
- LOW NOISE

Active area		
1mm Diam	5082-4207	TALL SIZE (TO-18)
0.5mm Diam	5082-4203	TALL SIZE (TO-18)
0.5mm Diam	5082-4204	TALL SIZE (TO-18)
0.5mm Diam	5082-4220	Short (TO-46)
0.25mm Magnified 2.5x	5082-4205	Subminiature



Description

The HP silicon planar PIN photodiodes are ultra-fast light detectors for visible and near infrared radiation. Their response to blue and violet is unusually good for low dark current silicon photodiodes.

These devices are suitable for applications such as high speed tachometry, optical distance measurement, star tracking, densitometry, radiometry, and fiber-optic termination.

The speed of response of these detectors is less than one nanosecond. Laser pulses shorter than 0.1 nanosecond may be observed. The frequency response extends from dc to 1 GHz.

The low dark current of these planar diodes enables detection of very low light levels. The quantum detection efficiency is constant over ten decades of light intensity, providing a wide dynamic range.

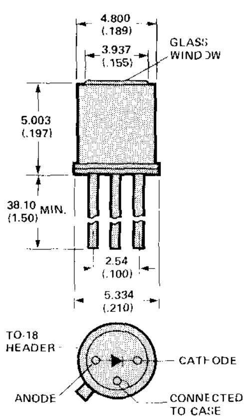
The 5082-4203, -4204, and -4207 are packaged on a standard TO-18 header with a flat glass window cap. For versatility of circuit connection, they are electrically insulated from the header. The light sensitve area of the 5082-4203 and -4204 is 0.508mm (0.020 inch) in diameter and is located 1.905mm (0.075 inch) behind the window. The light sensitive area of the 5082-4207 is 1.016mm (0.040 inch) in diameter and is also located 1.905mm (0.075 inch) behind the window.

The 5082-4205 is in a low capacitance Kovar and ceramic package of very small dimensions, with a hemispherical glass lens.

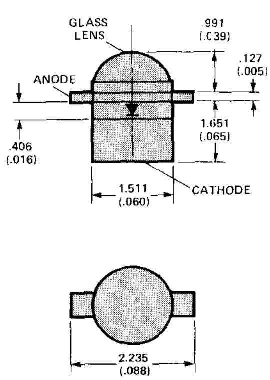
The 5082-4220 is packaged on a TO-46 header with the 0.508mm (0.020 inch) diameter sensitive area located 2.540mm (0.100 inch) behind a flat glass window.

Package Dimensions

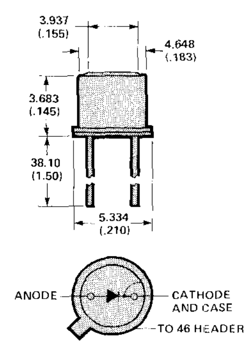
DIMENSIONS IN MILLIMETERS (INCHES).



-4203, -4204, -4207



-4205



-4220

Absolute Maximum Ratings

Parameter	-4203	-4204	-4205	-4207	-4220	Units
P_{MAX} Power Dissipation [1]	100	100	50	100	100	mW
Peak Reverse Voltage[2]	200	200	200	200	200	volts
Steady Reverse Voltage[3]	50	20	50	20	50	volts

Electrical/Optical Characteristics at $T_A = 25°C$

		-4203			-4204			-4205			-4207			-4220			
Symbol	Description	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	Units
RA	Axial Incidance Response at 770nm (4)		1.0			1.0			1.5*			4.0			1.0		$\frac{\mu A}{mW/cm^2}$
A	Active Area[4]		2×10^{-3}			2×10^{-3}			3×10^{-3}*			8×10^{-3}			2×10^{-3}		cm^2
R	Responsivity 770 nm[5] (Fig. 1, 3)		.5			.5			.5			.5			.5		$\frac{\mu A}{\mu W}$
I_D	Dark Current[6] (Fig. 4)			2.0			0.6			.15			2.5			5.0	nA
NEP	Noise Equivalent Power [7] (Fig. 8)			5.1×10^{-14}			2.8×10^{-14}			1.4×10^{-14}			5.7×10^{-14}			8.1×10^{-14}	$\frac{W}{\sqrt{Hz}}$
D*	Detectivity[8]	8.7×10^{11}			1.6×10^{12}			$4.0 \times$* 10^{12}			1.5×10^{12}			5.6×10^{11}			$\frac{cm\sqrt{Hz}}{W}$
C_j	Junction Capacitance[9] (Fig. 5)		1.5			2.0			0.7			5.5			2.0		pF
C_P	Package Capacitance [10]		2			2						2					pF
t_r, t_f	Zero Bias Speed (Rise, Fall Time) 11		300			300			300			300			300		ns
t_r, t_f	Rev.-Bias Speed (Rise, Fall Time) 12			1			1			1			1			1	ns
R_S	*Series Resistance*			50			50			50			50			50	Ω

*see Note 4.

NOTES:

1. Peak Pulse Power

   When exposing the diode to high level incidance the following photocurrent limits must be observed:

   $$I_{p\,(avg)} < \frac{P_{MAX} - P_{\phi}}{E_c}$$; and in addition:

   $$I_{p(PEAK)} < \frac{1000\ A}{t\ (\mu sec)} \text{ or } I_p < 500mA \text{ or } I_{p(PEAK)} < \frac{I_{p\,(avg)}}{f \times t}$$

   whichever of the above three conditions is least.

   I_p - photocurrent (A) f - pulse repetion rate (MHz)
   E_c - supply voltage (V) P_{ϕ} - power input via photon flux
   t - pulse duration (μs) P_{MAX} - max dissipation (W)

   Power dissipation limits apply to the sum of both the optical power input to the device and the electrical power input from flow of photocurrent when reverse voltage is applied.
2. Exceeding the *Peak Reverse Voltage will cause permanent damage to the diode. Forward current is harmless to the diode,* within the power dissipation limit. For optimum performance, the diode should be reversed biased with E_c between 5 and 20 volts.
3. Exceeding the Steady Reverse Voltage may impair the low-noise properties of the photodiodes, an effect which is noticeable only if operation is diode-noise limited (see Figure 8).
4. The 5082-4205 has a lens with approximately 2.5x magnification; the actual junction area is $0.5 \times 10^{-3}\ cm^2$, corresponding to a diameter of 0.25mm (.010"). Specification includes lens effect.
5. At any particular wavelength and for the flux in a small spot falling entirely within the active area, responsivity is the ratio of incremental photodiode current to the incremental flux producing it. It is related to quantum efficiency, η_q in electrons per photon by:

   $$R = \eta_q \left(\frac{\lambda}{1240}\right)$$

   where λ is the wavelength in nanometers. Thus, at 770nm, a responsivity of 0.5 A/W corresponds to a quantum efficiency of 0.81 (or 81%) electrons per photon.
6. At -10V for the 5082-4204, -4205, and -4207; at -25V for the 5082-4203 and -4220.
7. For (λ, f, Δf) = (770nm, 100Hz, 6Hz) where f is the frequency for a spot noise measurement and Δf is the noise bandwidth, NEP is the optical flux required for unity signal/noise ratio normalized for bandwidth. Thus:

   $$NEP = \frac{I_N/\sqrt{\Delta f}}{R}$$ where $I_N/\sqrt{\Delta f}$ *is the bandwidth — normalized noise current computed from the shot noise formula:*

   $$I_N/\sqrt{\Delta f} = \sqrt{2qI_D} = 17.9 \times 10^{-15}\sqrt{I_D}\ (A/\sqrt{Hz})$$ where I_D is in nA.
8. Detectivity, D* is the active-area-normalized signal to noise ratio. It is computed: $$D^* = \frac{\sqrt{A}}{NEP}\left(\frac{cm\sqrt{Hz}}{W}\right)$$ for A in cm^2, for (λ, f, Δf) = (770nm, 100Hz, 6Hz).
9. At -10V for 5082-4204, -4205, -4207, -4220; at -25V for 5082-4203.
10. Between diode cathode lead and case — does not apply to 5082-4205, -4220.
11. With 50Ω load.
12. With 50Ω load and -20V bias.

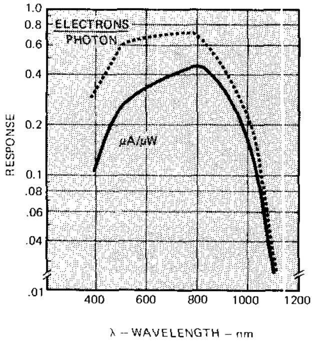


Figure 1. Spectral Response.

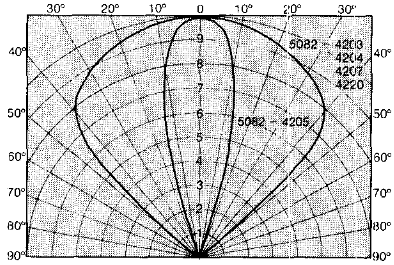


Figure 2. Relative Directional Sensitivity of the PIN Photodiodes.

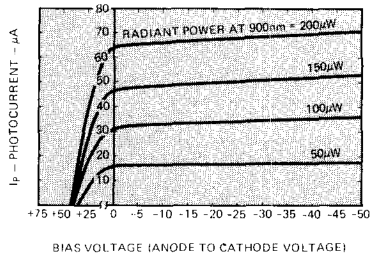


Figure 3. Typical Output Characteristics at λ = 900nm.

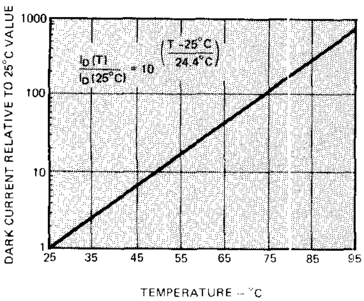


Figure 4. Dark Current at -10V Bias vs. Temperature.

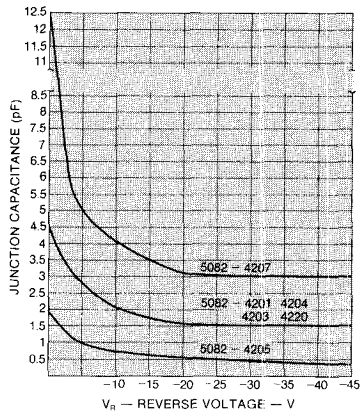


Figure 5. Typical Capacitance Variation With Applied Voltage.

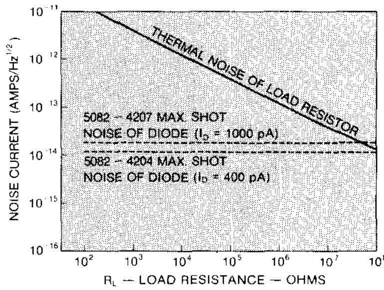


Figure 6. Noise vs. Load Resistance.

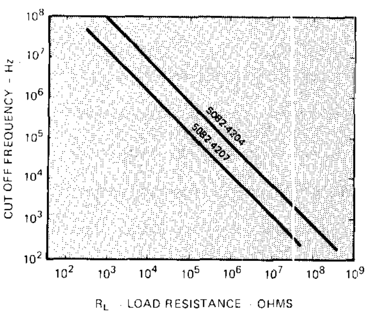


Figure 7. Photodiode Cut-Off Frequency vs. Load Resistance (C = 2pF).

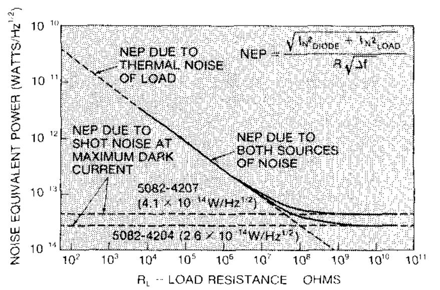


Figure 8. Noise Equivalent Power vs. Load Resistance.

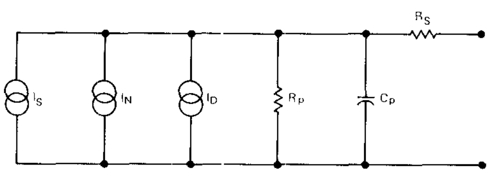


Figure 9. Photodiode Equivalent Circuit.

I_S = Signal current ≈ 0.5μA/μW x P input

I_N = Shot noise current

$< 1.2 \times 10^{-14}$ amps/Hz$^{1/2}$(5082-4204)

$< 4 \times 10^{-14}$ amps/Hz$^{1/2}$(5082-4207)

I_D = Dark current

$< 600 \times 10^{-12}$ amps at -10 V dc (5082-4204)

$< 2500 \times 10^{-12}$ amps at -10 V dc (5082-4207)

$R_P = 10^{11}\Omega$

$R_S = < 50\Omega$