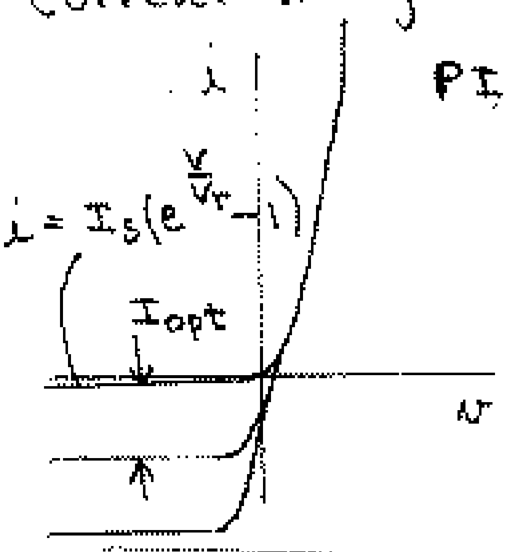
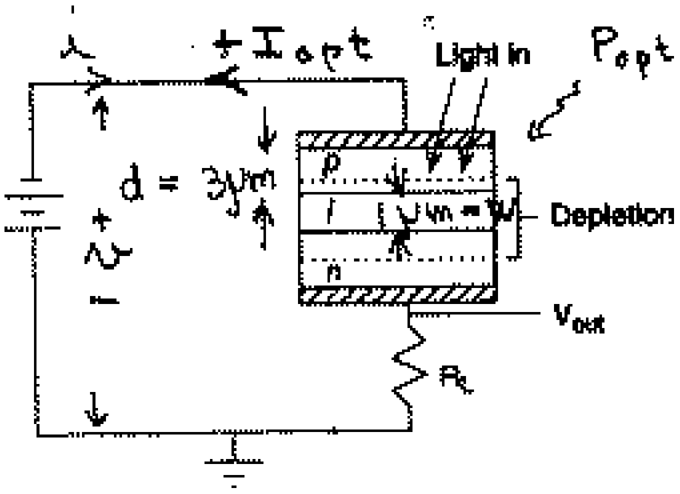
PIN Diode Detector

Current-voltage

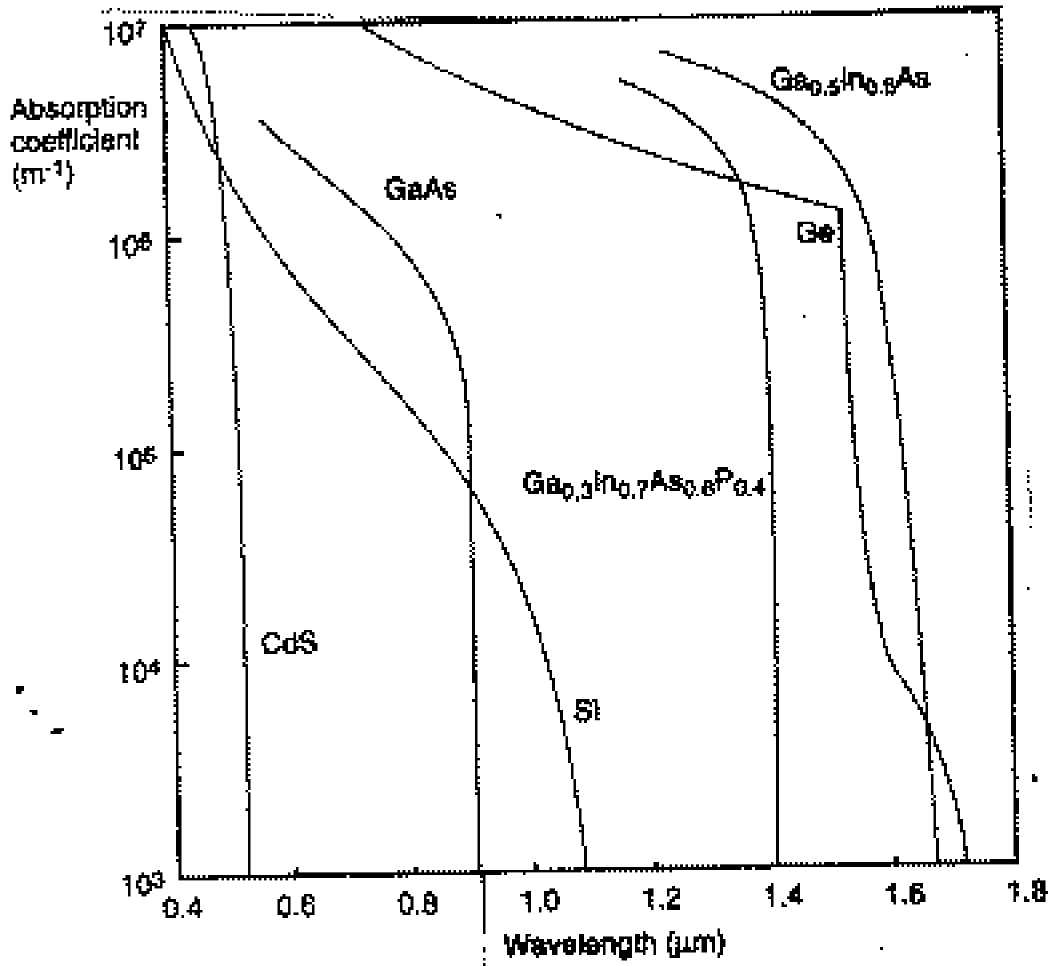


PIN

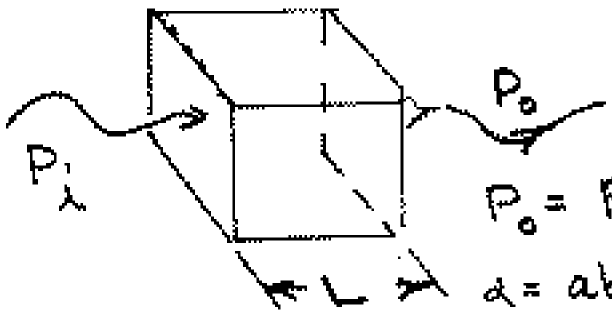


Typical Structure And Configuration

$$I_{opt} = \frac{P_{opt}\, e\, \eta}{hf} = \frac{[E(t)]^2}{(\mu/\epsilon)^{1/2}} \frac{e\eta}{hf}$$



Absorption of Various Materials



$P_o = P_i e^{-\alpha L}$

α = absorption coefficient

Power absorbed is converted to electron-hole pairs

→ Photons Do Not Have Sufficient Energy to Create electron-hole pairs in GaAs

η = quantum efficiency

Typical Numbers (above the band edge)

Si .9

Ge .5

InGaAs .5

Note Popt in an optical beam is

$$P_{opt} = \frac{E^2}{(\mu/\epsilon)^{1/2}} = \frac{E^2}{(377\,\Omega/m)}$$

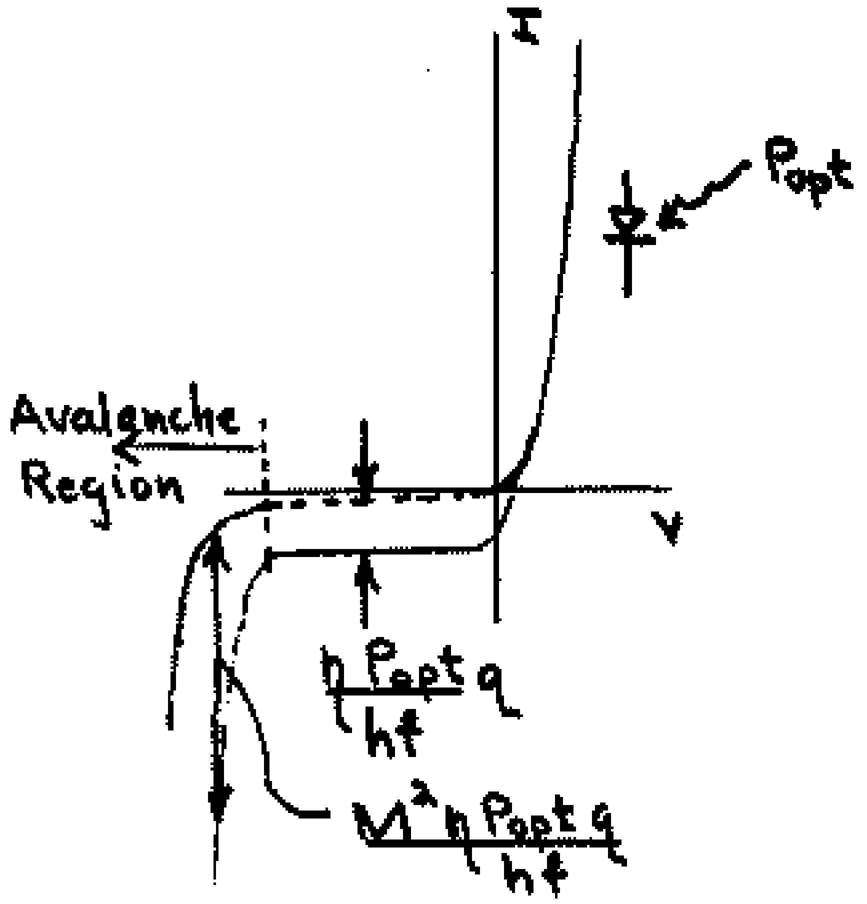
Only leave frequency components of E^2 which can respond

Example: $E = E_1 \cos\omega_1 t + E_2 \cos\omega_2 t = E_1 e^{i\omega_1 t} + c.c. + E_2 e^{+i\omega_2 t} + c.c.$

$$(E)^2 = \tfrac{1}{2}E_1E_1^* + \tfrac{1}{2}E_2E_2^* + \left(\tfrac{1}{4}E_1E_2^* e^{i(\omega_1-\omega_2)t} + c.c.\right) + \cdots \text{the rest}$$

can forget

Avalanche Photodiode



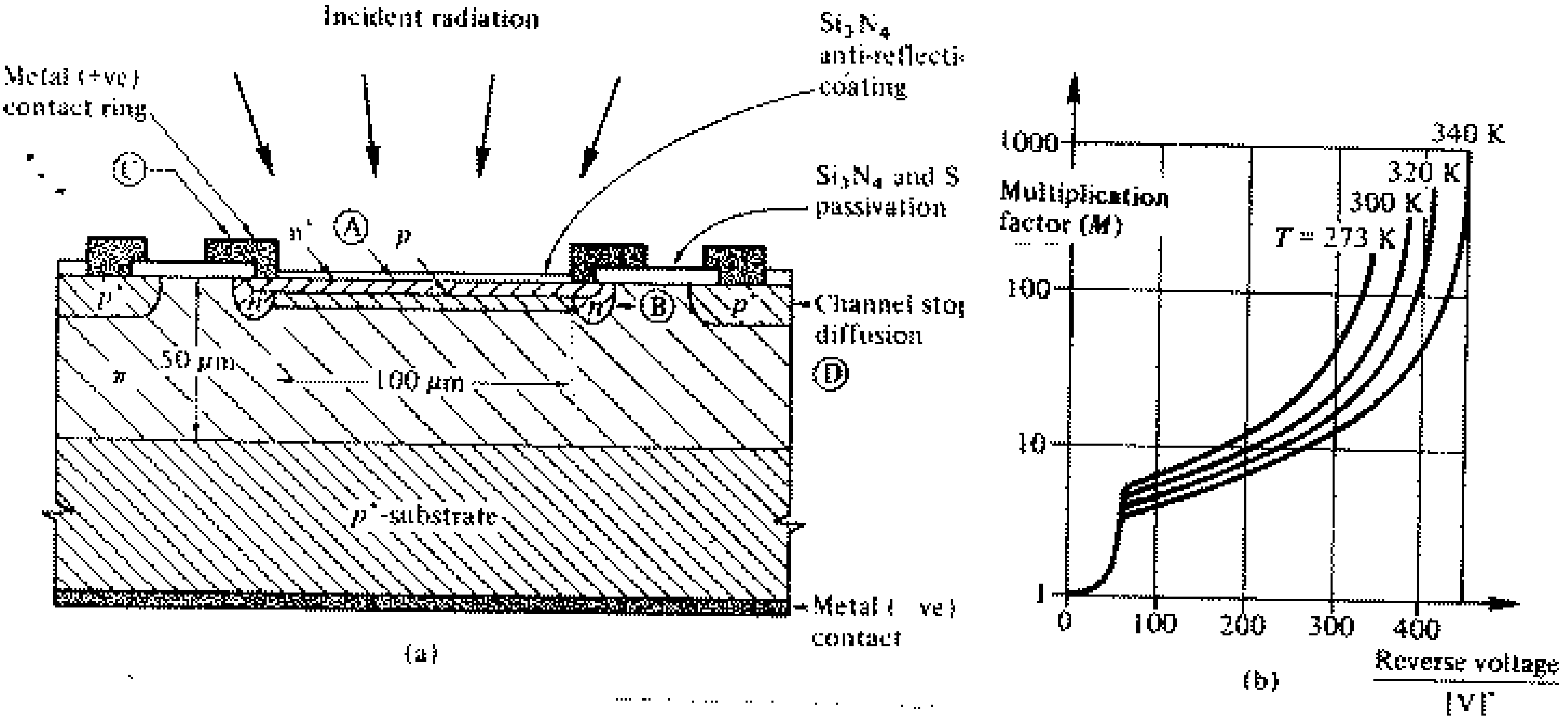
Important Points

1) Signal amplified (current by a factor M)
2) Noise also amplified but at the price of an enhanced noise

$$(\text{Shot Noise Current})^2 = M^2 F_e 2q\Delta f$$

$$F_e = M_e\{1 - (1-k)(M_e-1)^2/M_e^2\}$$

$k \leq .1$ for Silicon and electrons dominate



$$(SNR) = K^2 = \frac{M^2 I^2}{2eIF_e M^2 \Delta f + \frac{4kT}{R_A} F_n \Delta f + \frac{4kT}{R}\Delta f}$$

excluding Amp

Amp input R (R_A)

Amplifier Noise Facto

$\Delta f \ll \frac{1}{RC}$

Amplifier Gain = Const