APARATOS OPTO-ELECTRÓNICOS

INEL 5205 - Instrumentación

CIRCUITOS OPTO-ELECTRÓNICOS

- Señal óptica en la entrada o salida
- Aplicaciones
  - Medición de luz
    - Medir posición
    - Imágenes
  - Comunicaciones
    - "Optically-coupled isolators"
    - Controles remotos
    - comunicaciones a través de fibra óptica

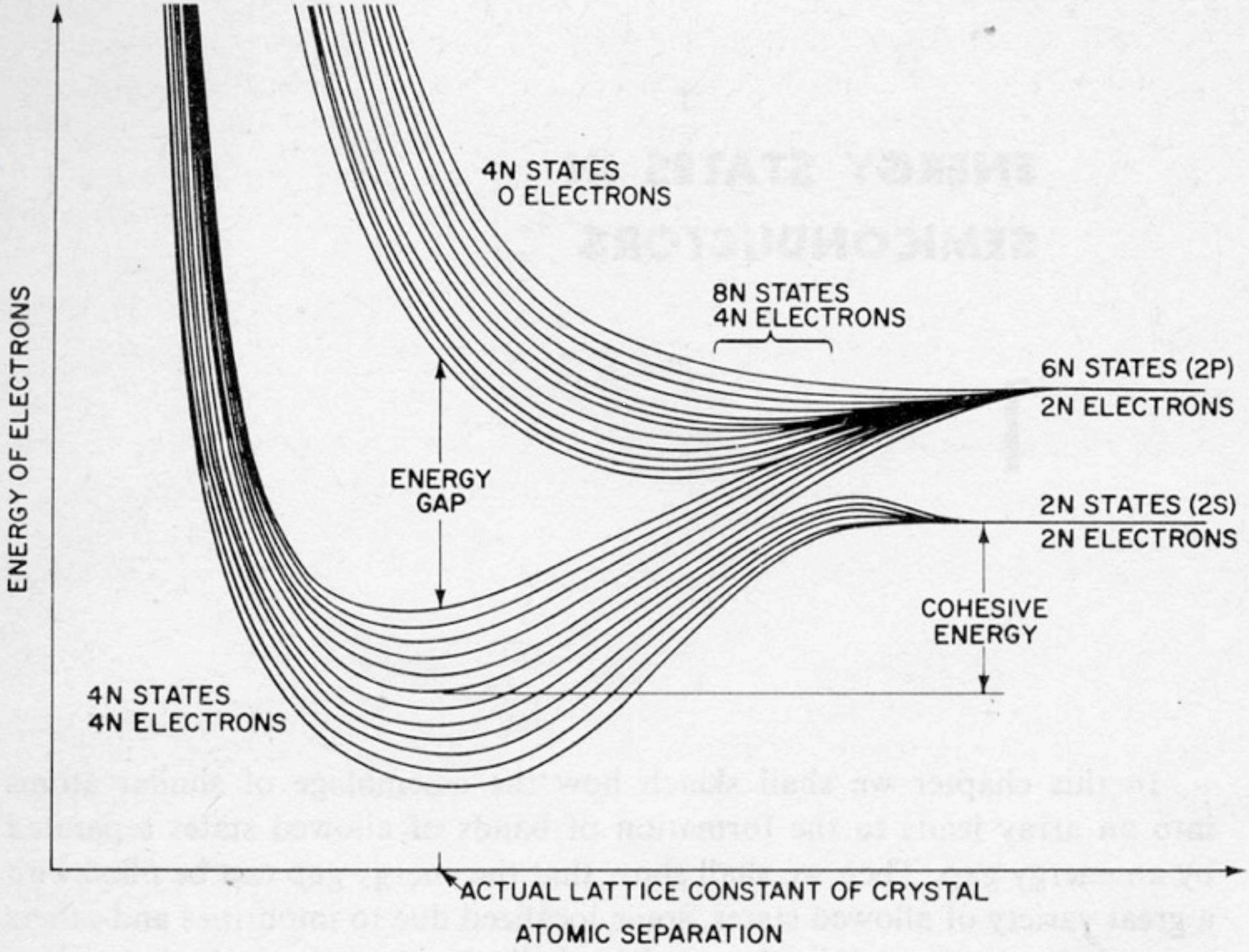
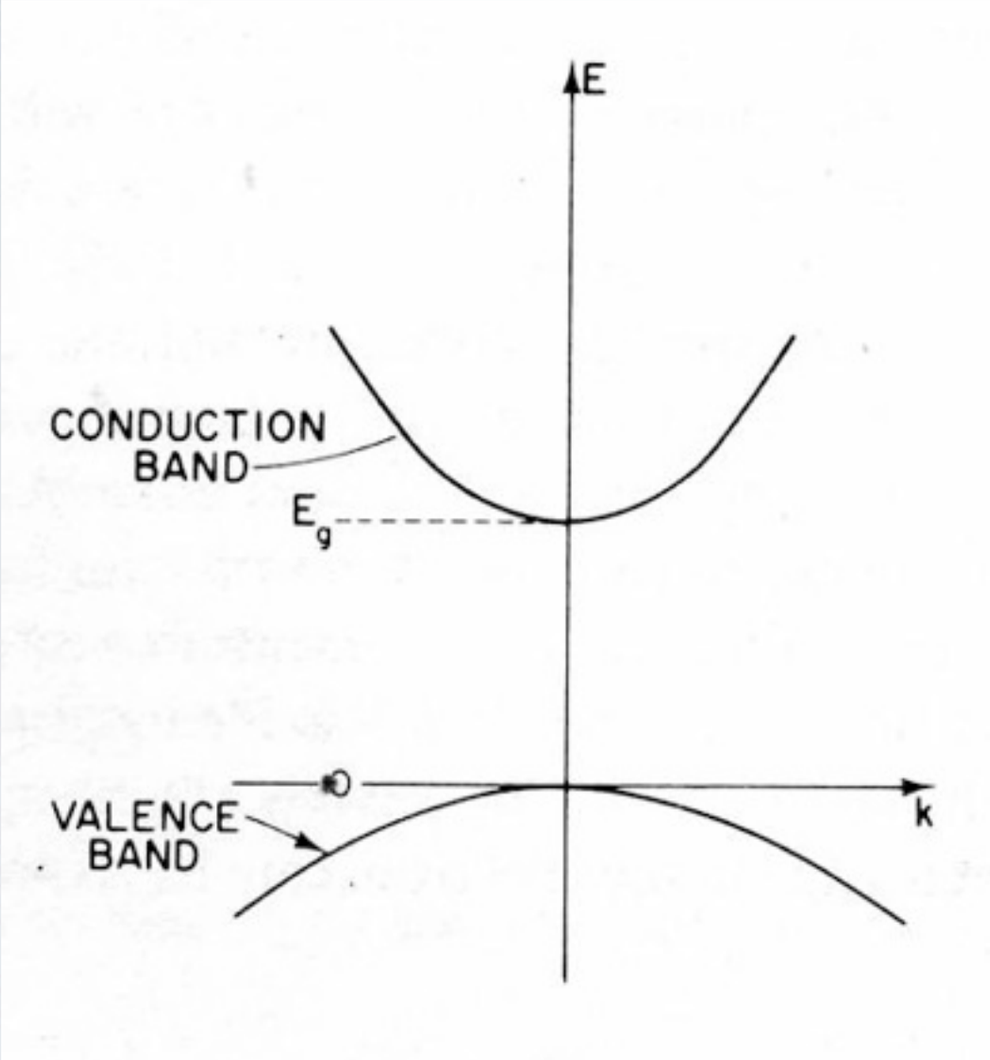
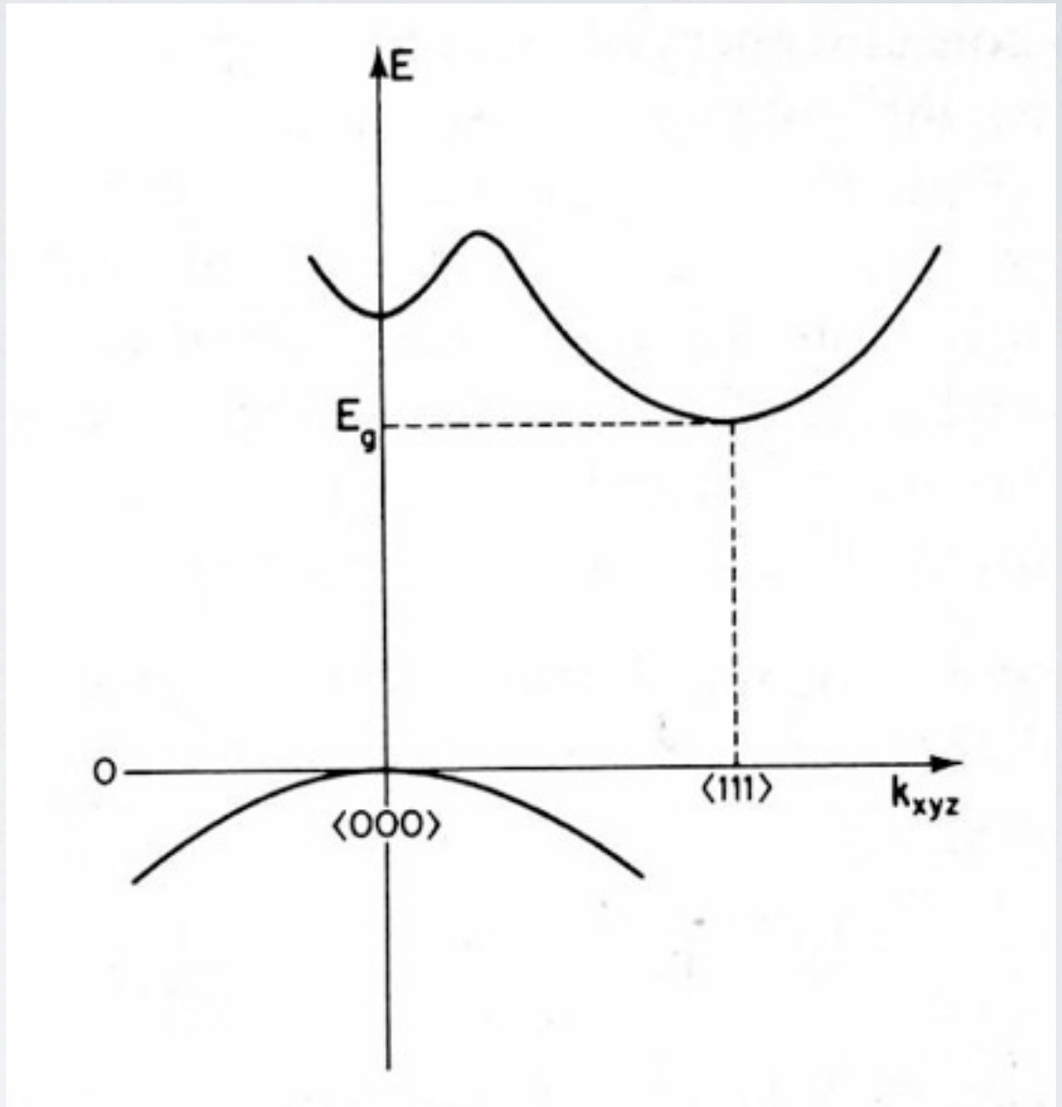


Fig. 1-1 Energy banding of allowed levels in diamond as a function of spacing between atoms.[1]



directo



indirecto

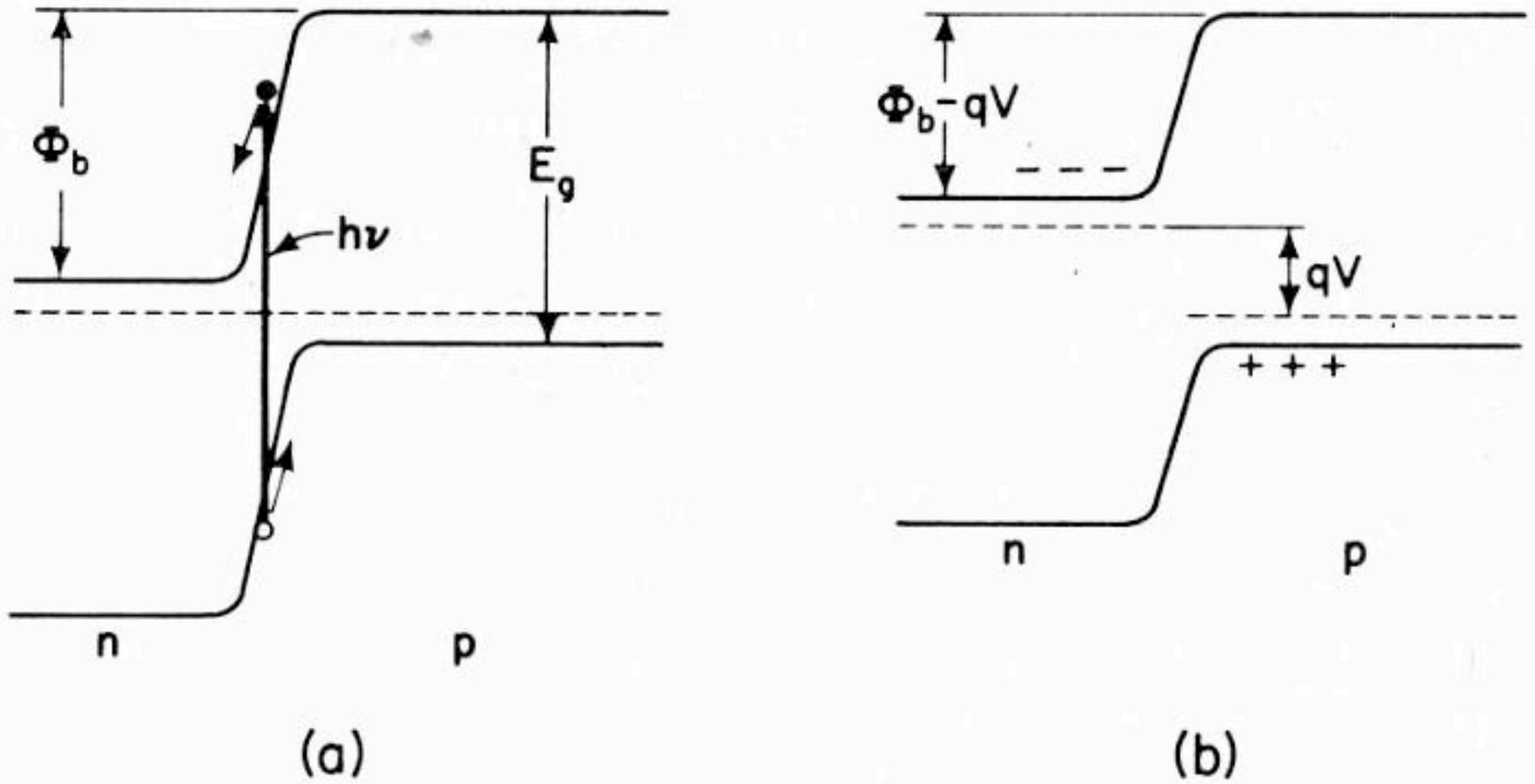


Fig. 14-1 Generation of a photovoltage V at a p–n junction.

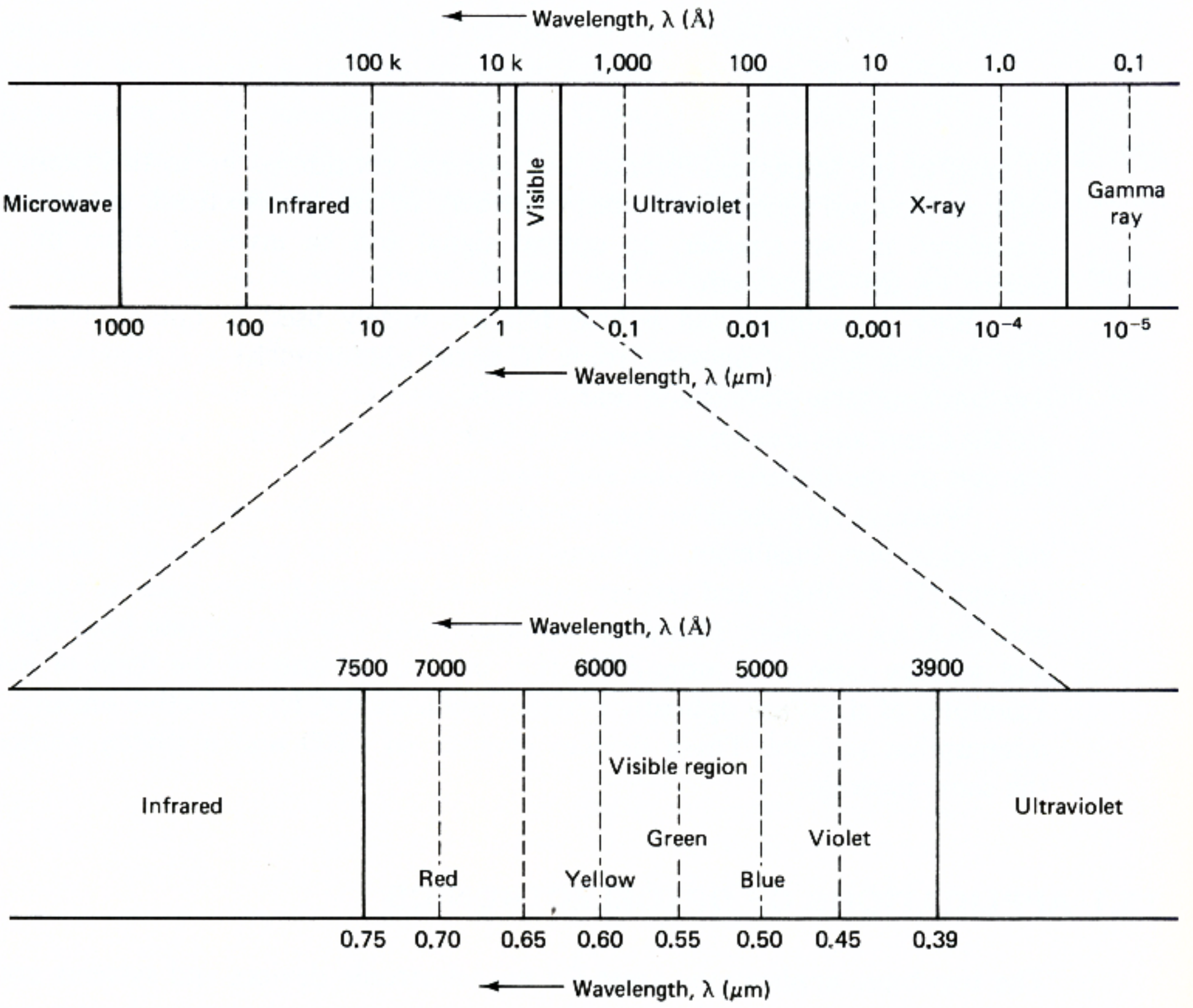
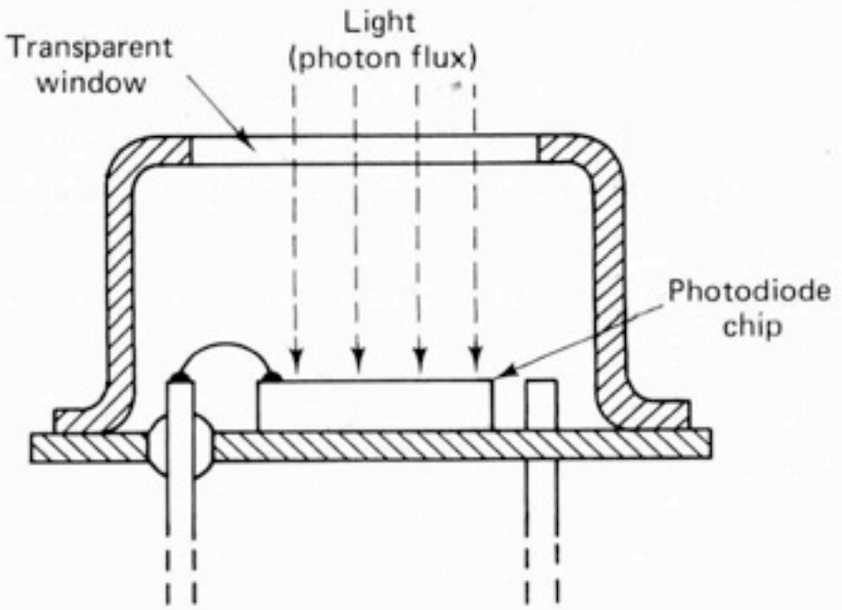
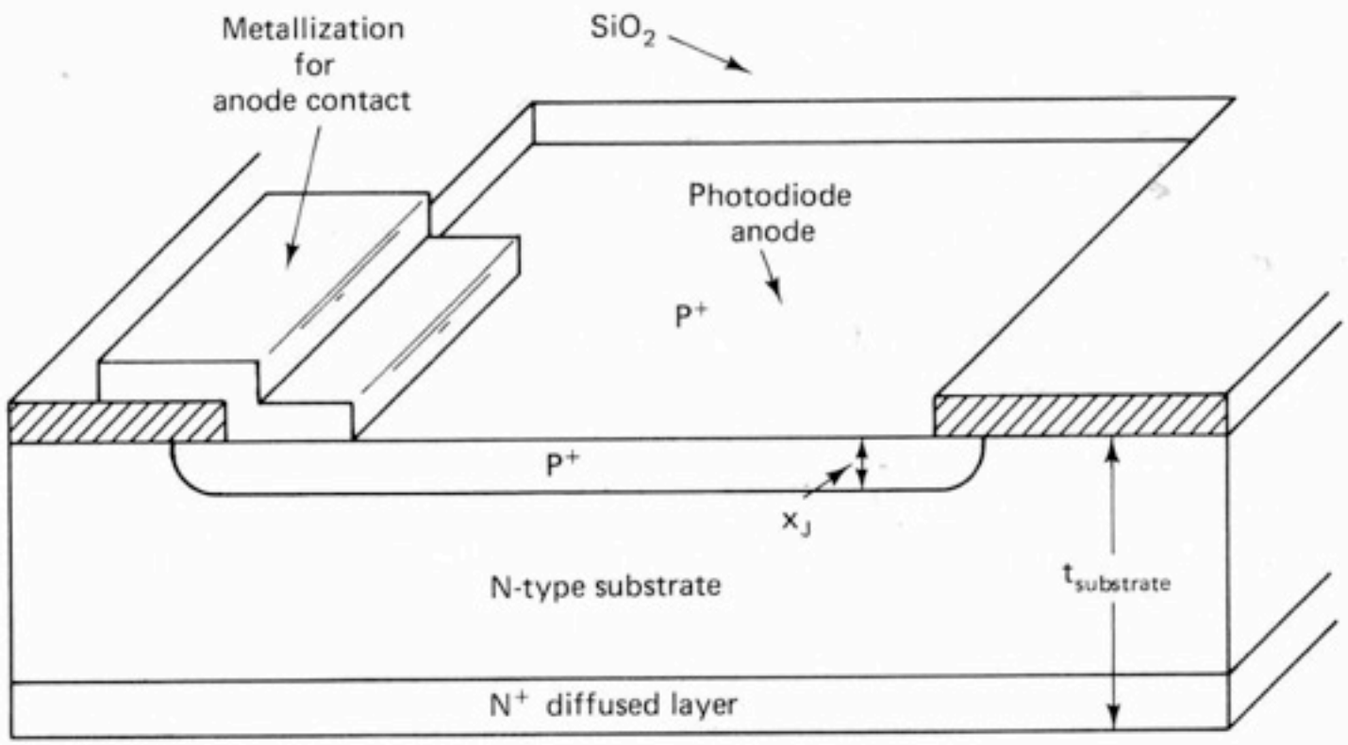


Figure 15.1 Electromagnetic spectrum.



(a)



(b)

Figure 15.2 Photodiode: (a) photodiode package with transparent window; (b) photodiode chip (cross-sectional perspective view).

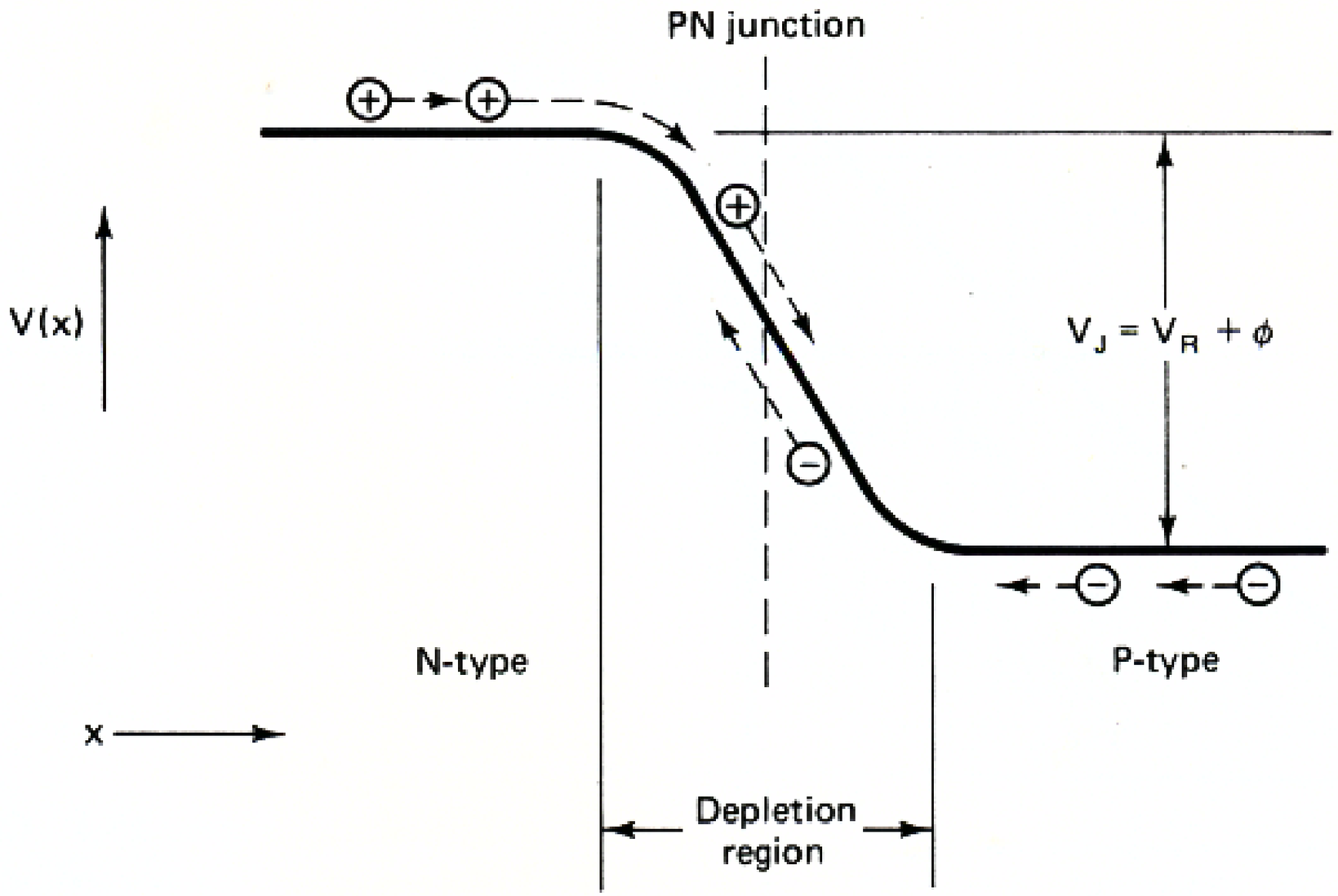


Figure 15.3 Flow of minority carriers across a reverse-biased PN junction.

$\underline{\text{Energía de un fotón}} = E = \frac{hc}{\lambda}$

Constante de Planck:
$h = 6.626 \times 10^{-34} J - s = 4.136 \times 10^{-15} eV - s$
$1eV = 1.602 \times 10^{-19} J$

$\underline{\text{Resposividad} =} \Re = I_L/P$

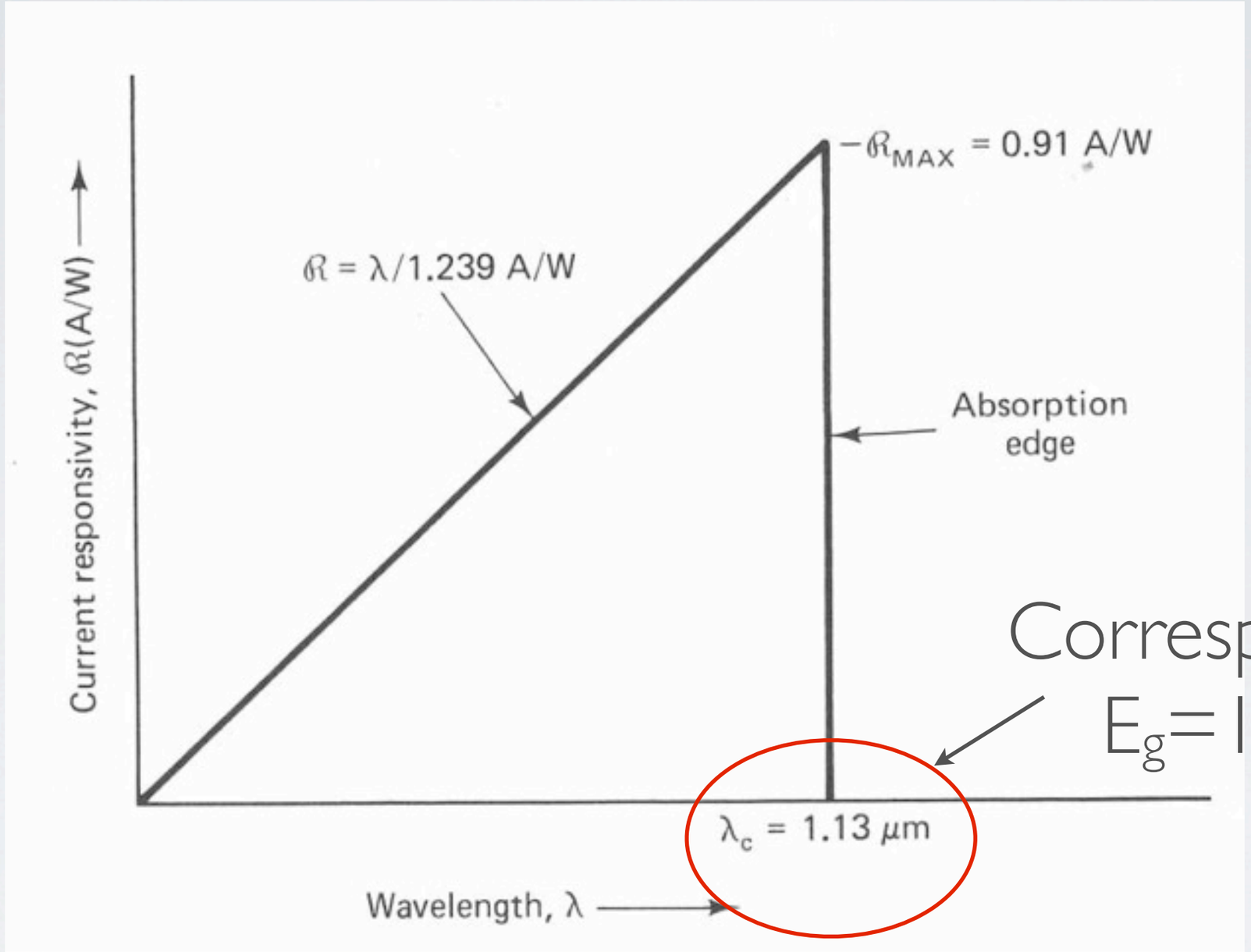
$P =$ potencia óptica (en Watts)

$I_L =$ foto-corriente (idealmente igual al flujo de fotones $\times q$)

Solo fotones con energía mayor a la del *energy gap* pueden ser absorbidos.

$$
\begin{aligned}
\Re &= \frac{I_L}{P} = \frac{q/\Delta t}{E/\Delta t} \\
&= \frac{q}{hc/\lambda} = \frac{\lambda}{hc/q} \\
\frac{hc}{q} &= \frac{6.626 \times 10^{-34} J - s \times 300 \times 10^{6} m/s}{1.602 \times 10^{-19} C} \\
&= 1.24 \times 10^{-6} \frac{J/s - m}{C/s} \\
&= 1.24 W - \mu m/A = 1.24 V - \mu m \\
\Re &= \frac{\lambda(\mu m)}{1.24 V - \mu m}
\end{aligned}
$$

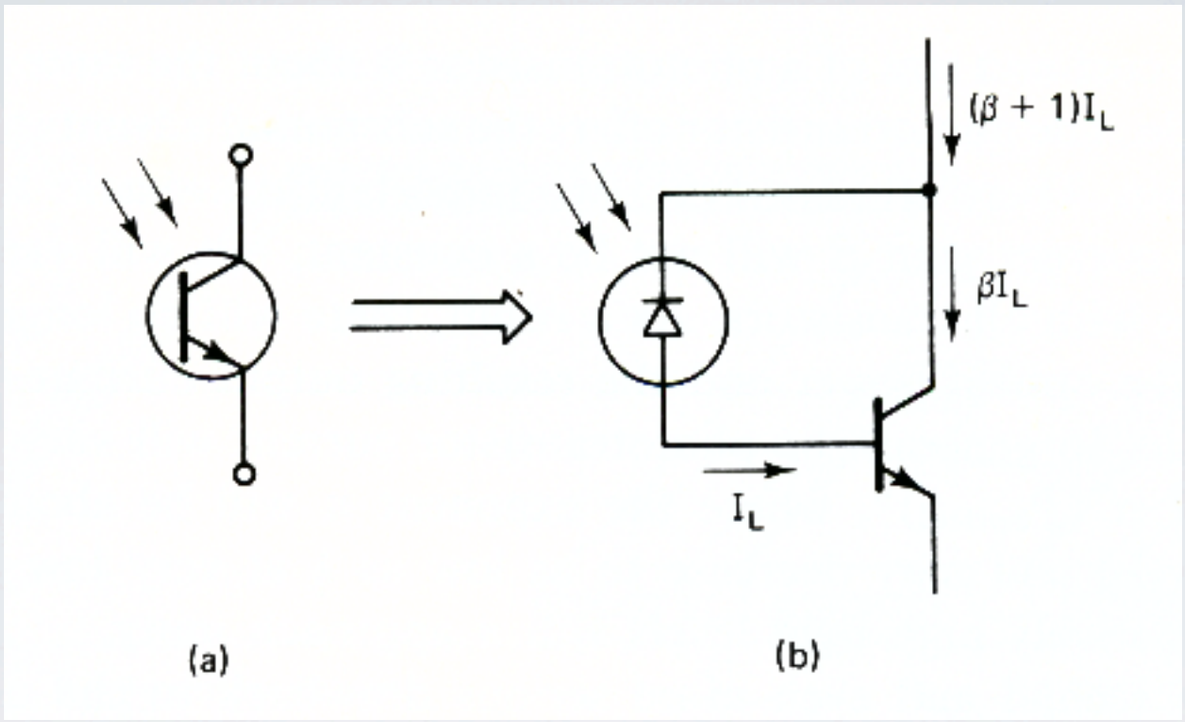
$$
\begin{aligned}
E_{gap} &= \frac{hc}{\lambda} = 1.1eV \\
\lambda_{corner} &= \frac{hc}{1.1eV} \\
&= \frac{\left((6.626 \times 10^{-34} J/s)/(1.6 \times 10^{-19} J/eV)\right) 300 \times 10^{6} m/s}{1.1eV} \\
&= \frac{1.24eV - \mu m}{1.1eV} = 1.13\mu m
\end{aligned}
$$



Corresponde a
E_g=1.1eV

Una fuente produce 1W de energía radiante con una longitud de onda igual a $1000nm$.

1. ¿Cual es la energía de un fotón?
2. ¿Cual es el flujo de fotones?
3. Si la fuente es isotrópica, ¿cual es flujo de electrones a 2m de distancia?
4. Un foto-diodo de silicio con un área activa de $1.0mm^2$ se encuentra a $200cm$ de la fuente. Cual es la foto-corriente resultante si el foto-diodo tiene una responsitividad de $0.45A/W$ a la longitud de onda indicada?



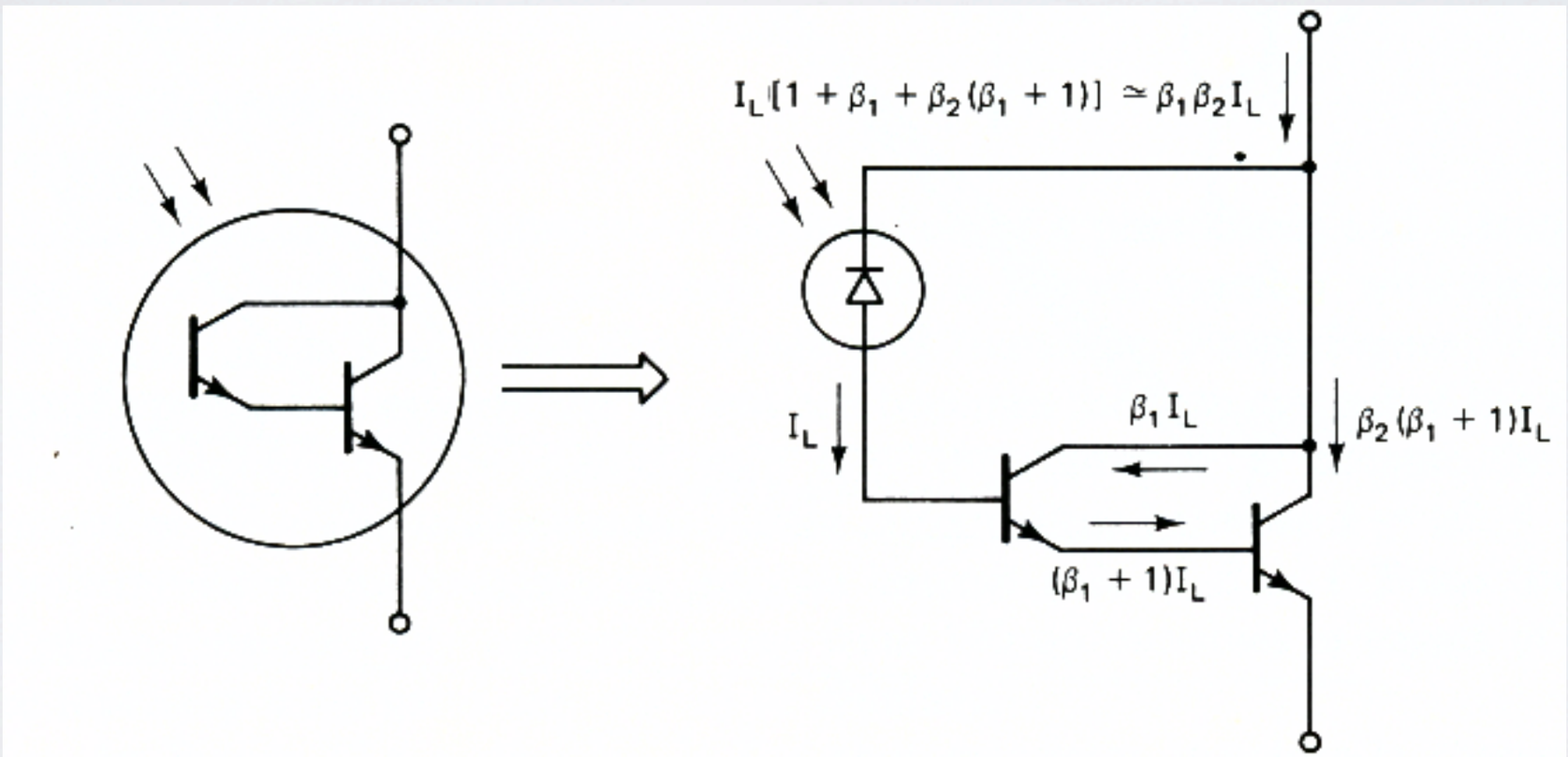


Figure 15.7 Photodarlington transistor.

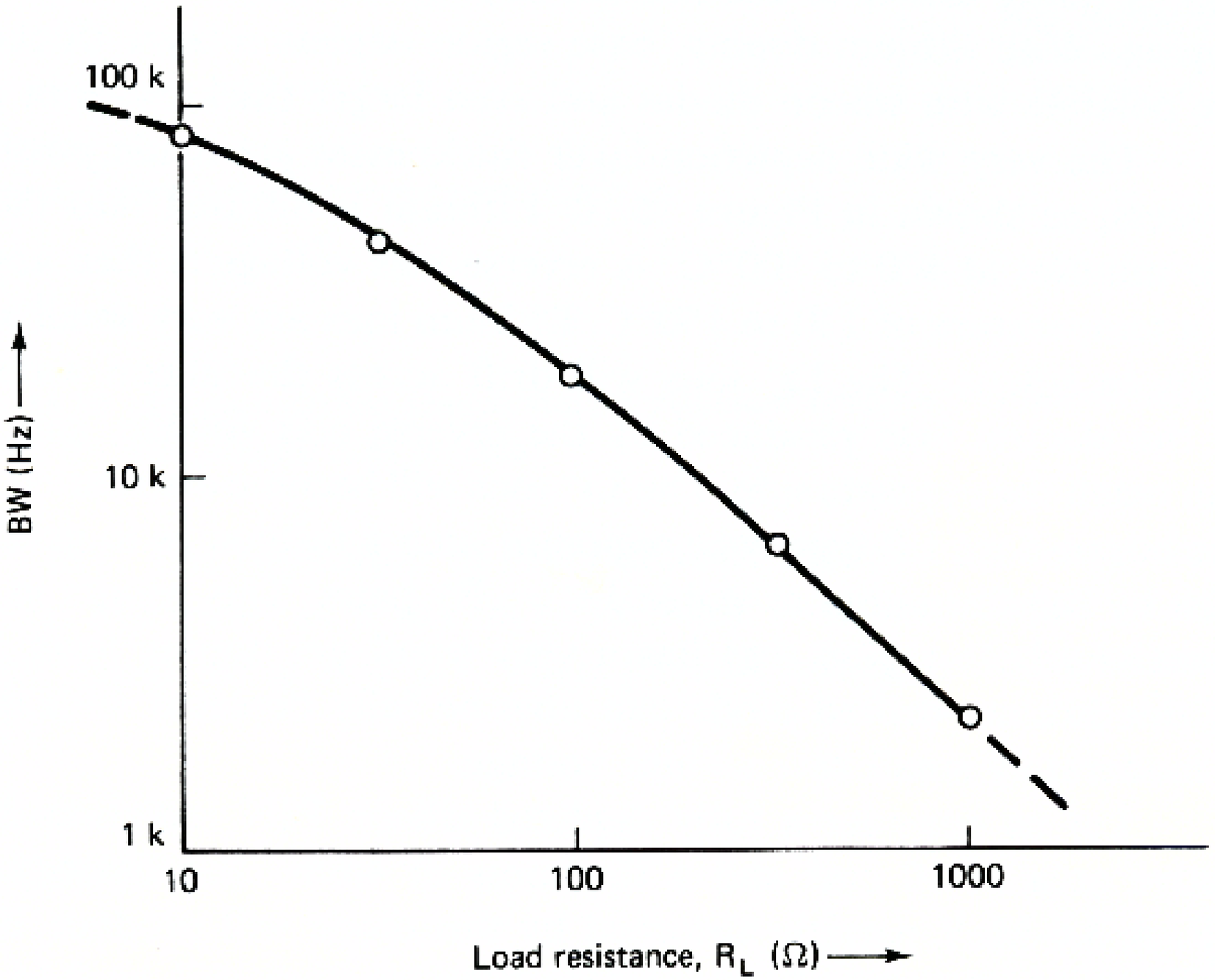
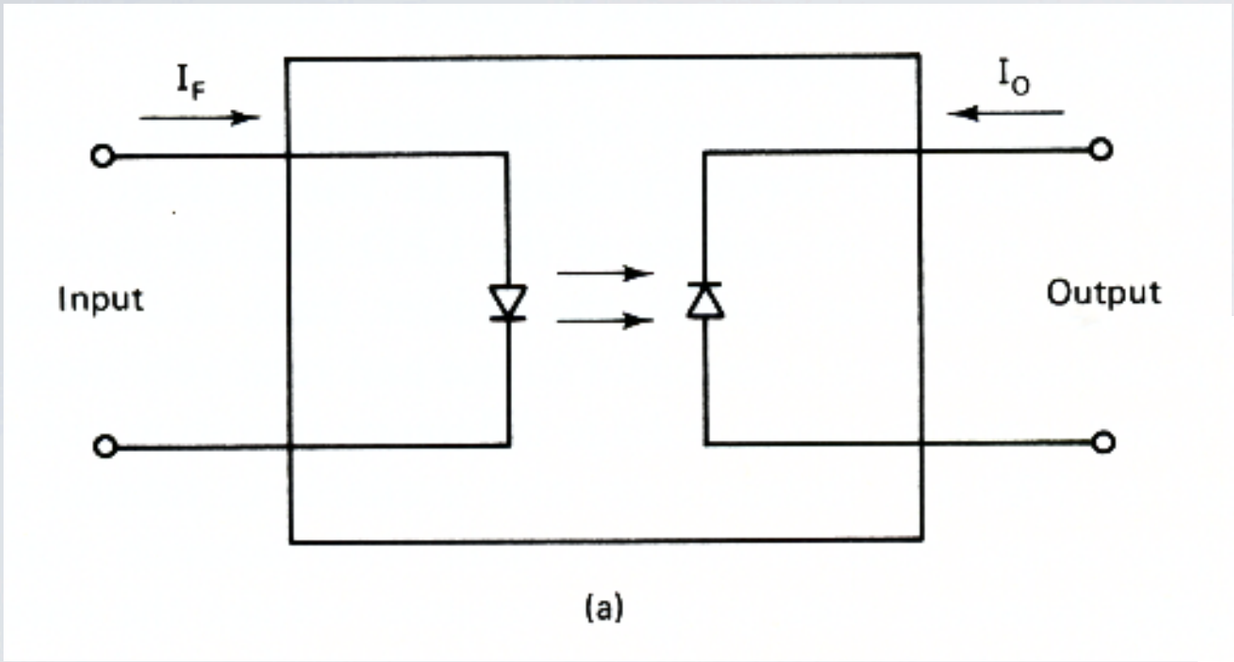
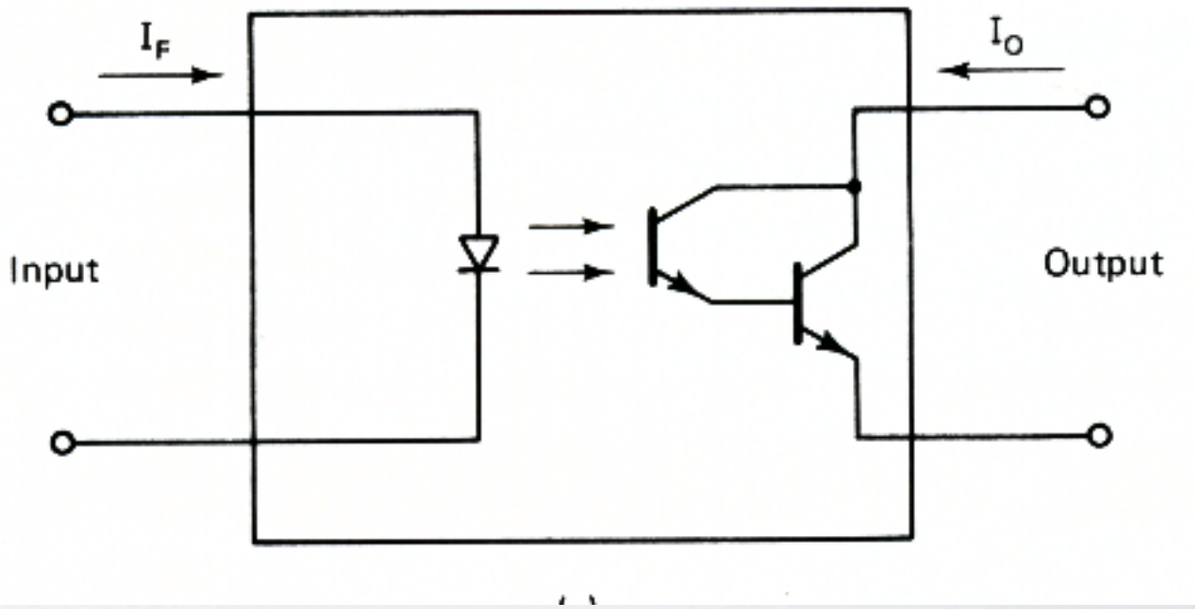


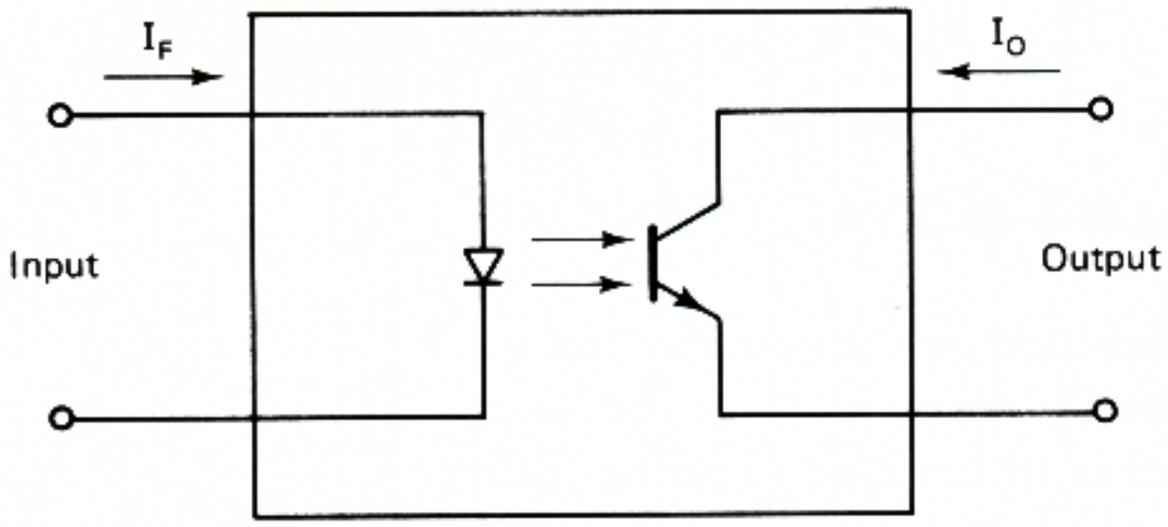
Figure 15.9 Photodarlington transistor (ZN5777) bandwidth versus load resistance ($I_C = 10$ mA, $V_{CE} = +10$ V, GaAs light-emitting-diode light source).

Optically Coupled Isolators



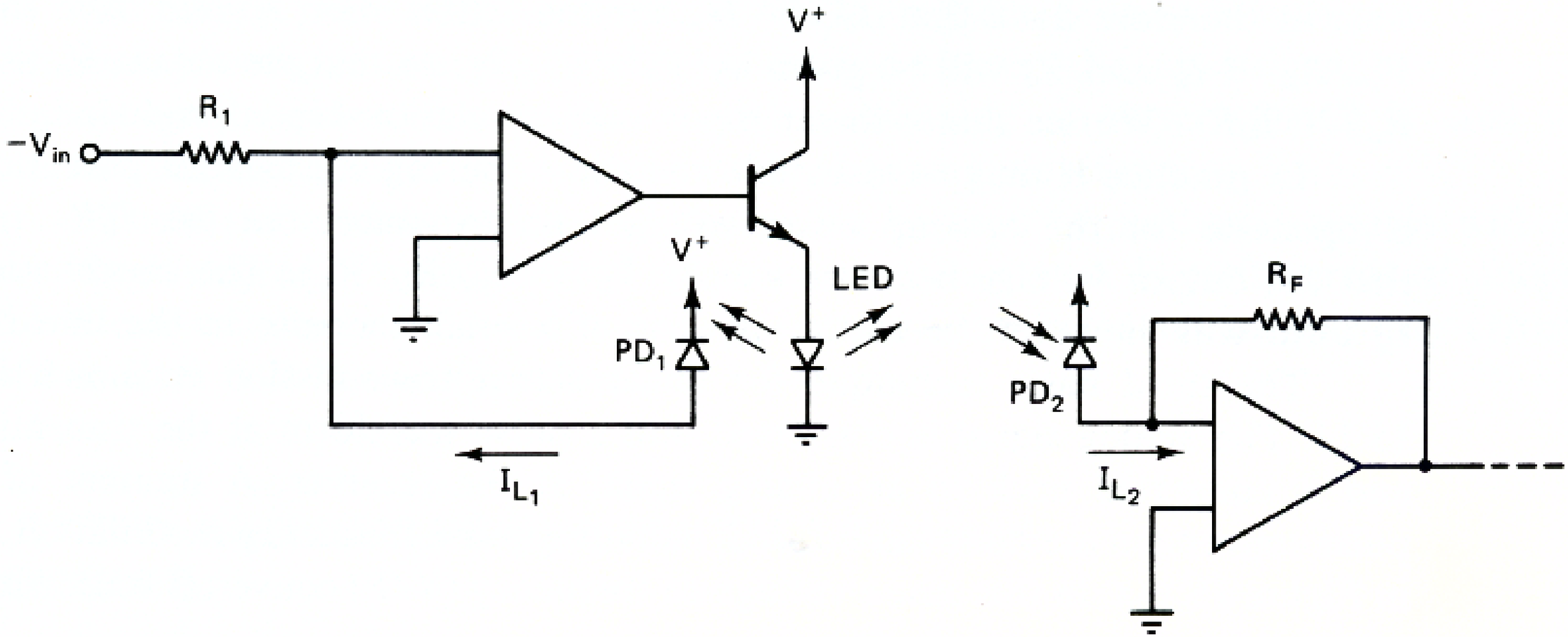
(a)





(b)

Optoelectronic Analog Signal Transmission



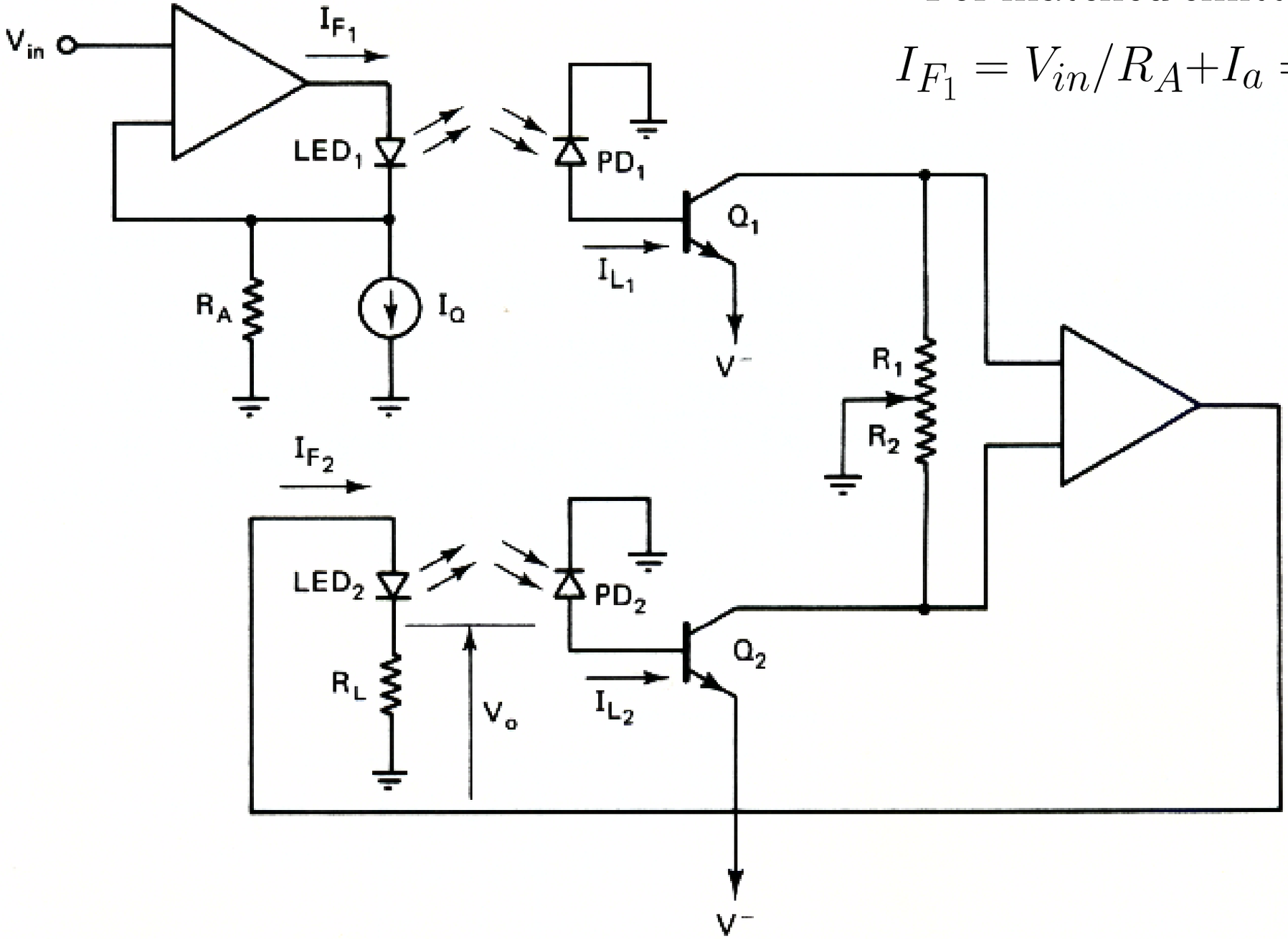
$$\beta_2 I_{L_2} R_2 = \beta_1 I_{L_1} R_1$$

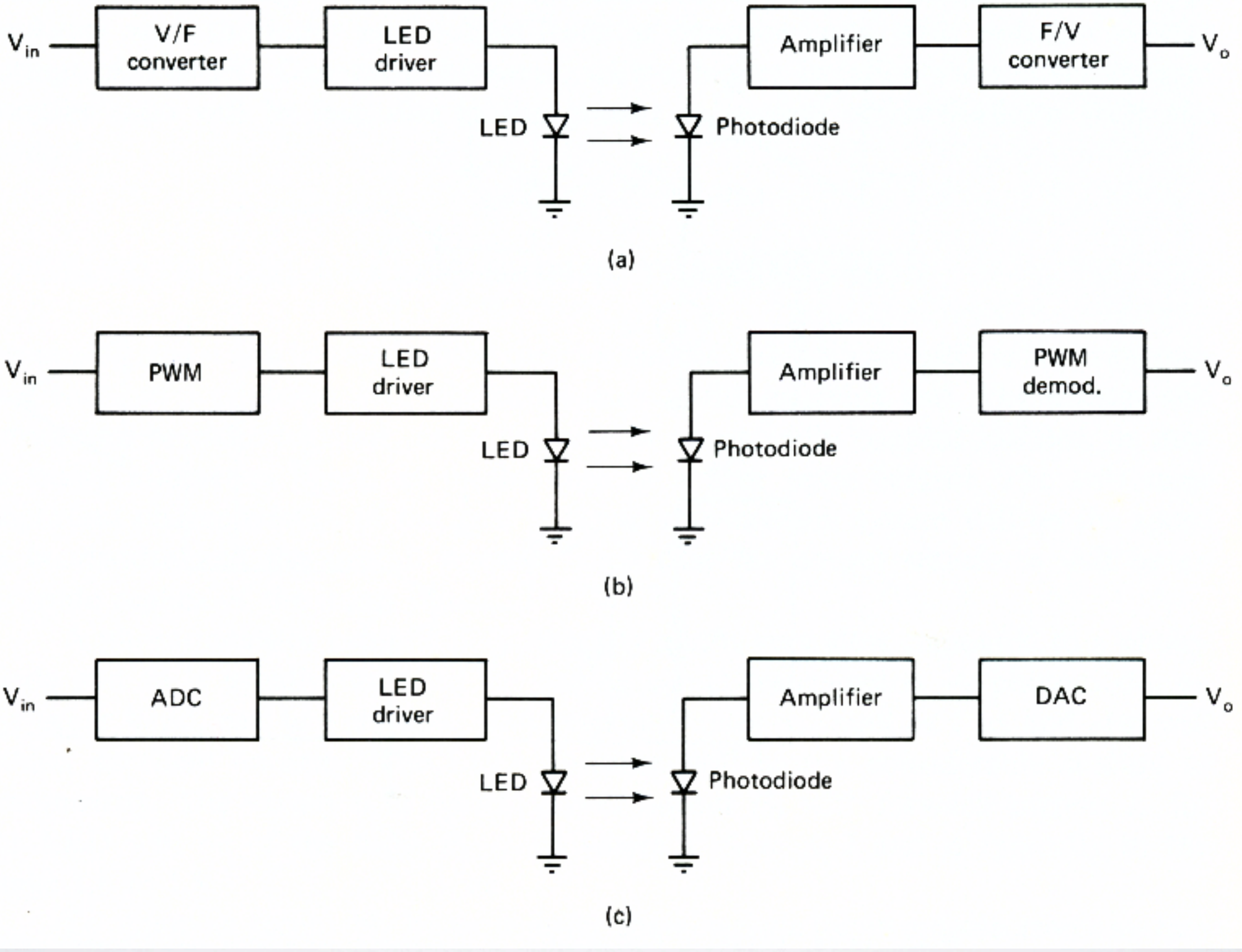
If

$$R_2 = R_1 \rightarrow I_{L_2} = I_{L_1}$$

For matched emitter-detector pairs,

$$I_{F_1} = V_{in}/R_A + I_a = I_{F_2} = V_O/R_L$$




V_{in}
V/F converter
LED driver
LED
Photodiode
Amplifier
F/V converter
V_o
(a)
V_{in}
PWM
LED driver
LED
Photodiode
Amplifier
PWM demod.
V_o
(b)
V_{in}
ADC
LED driver
LED
Photodiode
Amplifier
DAC
V_o
(c)