5.47 Germanium is doped with 5×10^{15} donor atoms per cm^3 at $T = 300$ K. The dimensions of the Hall device are $d = 5 \times 10^{-3}$ cm, $W = 2 \times 10^{-2}$ cm, and $L = 10^{-1}$ cm. The current is $I_x = 250\ \mu A$, the applied voltage is $V_x = 100$ mV, and the magnetic flux density is $B_z = 500$ gauss $= 5 \times 10^{-2}$ tesla. Calculate: (*a*) the Hall voltage, (*b*) the Hall field, and (*c*) the carrier mobility.

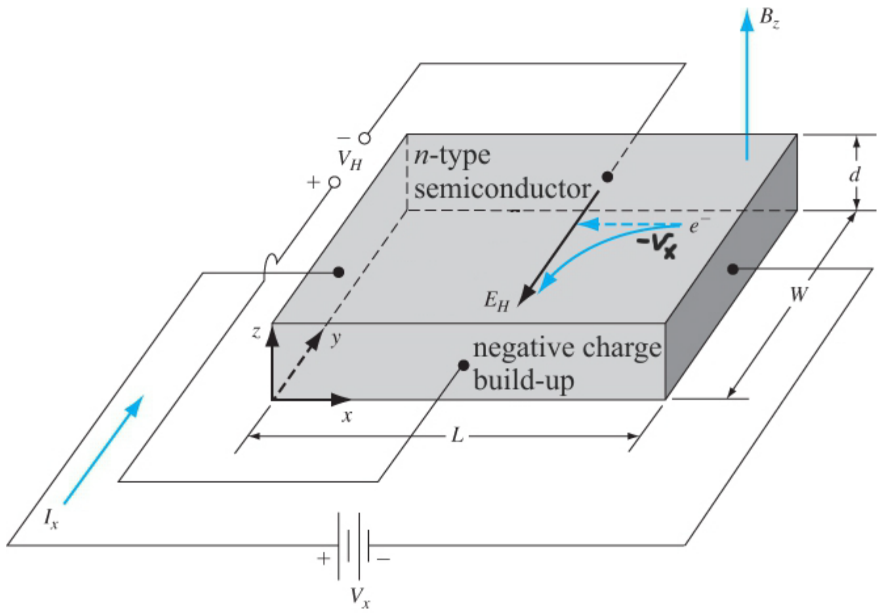

Figure 5.13 | Geometry for measuring the Hall effect.

a) Per (5.55), $V_H = \dfrac{-I_x B_z}{ned}$. Using all MKS units and assuming $n \cong N_d$,

$$V_H = \frac{-I_x B_z}{ned} = \frac{-250\times10^{-6}(5\times10^{-2})}{5\times10^{21}(1.602176634\times10^{-19})5\times10^{-5}} \Rightarrow \underline{V_H = -0.3121\ \text{mV}}.$$

b) Per (5.50), the Hall electric field is

$$E_H = V_H/W = -0.3121\times10^{-3}/2\times10^{-4} \Rightarrow \underline{E_H = -1.56\ \text{V/m} = -0.0156\ \text{V/cm}}.$$

c) Use (5.60), $\mu_n = \dfrac{I_x L}{enV_x Wd}$. Using all MKS units,

$$\mu_n = \frac{250\times10^{-6}(1\times10^{-3})}{(1.602176634\times10^{-19})(5\times10^{21})0.1(2\times10^{-4})(5\times10^{-5})}$$

$$\Rightarrow \underline{\mu_n = 0.312075\ \text{m}^2/\text{V-s} = 3120.75\ \text{cm}^2/\text{V-s}}$$