From *Semiconductor Physics and Devices: Basic Principles* (4th Edition), Donald A. Neamen, McGraw Hill, 2012, ISBN 978-0-07-352958-5.

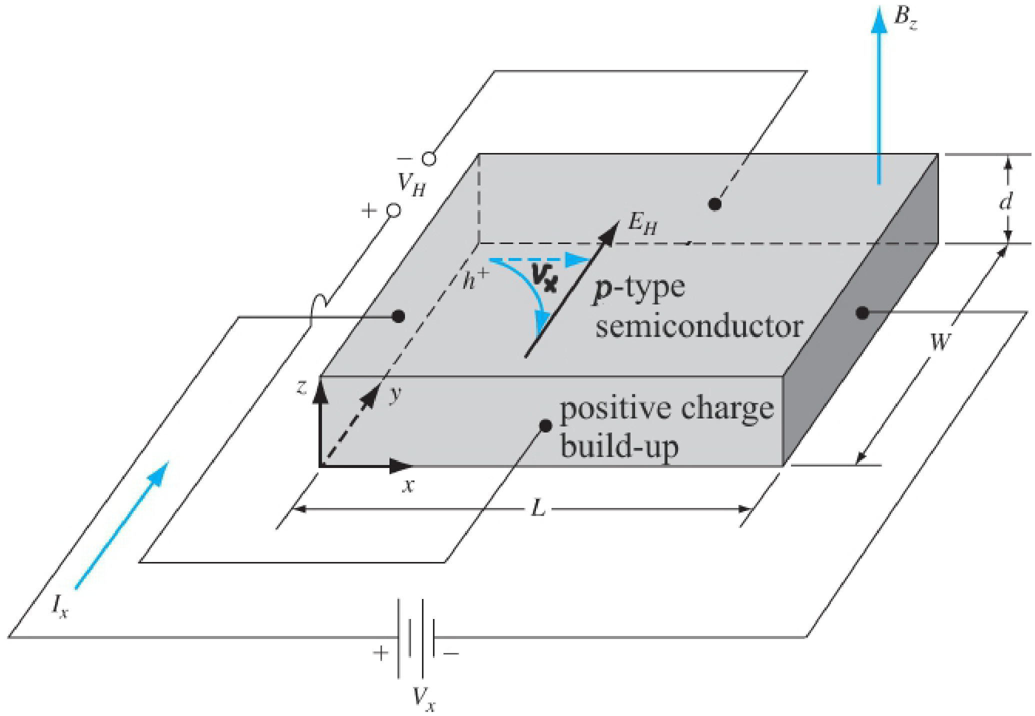

Figure 5.13 | Geometry for measuring the Hall effect.

p-type semiconductor

- In this case, the current flowing in the x-direction will be composed of holes (positive) inside the p-type semiconductor moving in the x-direction.
- Looking at the magnetic part of the Lorentz force equation $\bar{F}_m = q\bar{v} \times \bar{B}$, we get $\bar{F}_m = e\hat{a}_x v_x \times \hat{a}_z B_z = -\hat{a}_y e v_x B_z = -\hat{a}_y F_y$ which will push holes in -x-direction leading to positive charge build-up on the front face (y = 0) of the p-type semiconductor block (and corresponding negative charge at $y = w$).
- The charge build-up continues until the opposing <u>induced</u> electric field E_H exerts a Coulomb force, equal in magnitude, in the opposite direction (equilibrium).
- Since electric field lines go from positive to negative charges, the induced Hall effect electric field E_H will be in the +y-direction, i.e., $\bar{E}_H = \hat{a}_y E_y = \hat{a}_y E_H$.
- Therefore, $\boldsymbol{V_H > 0}$ (positive) for p-type semiconductors!

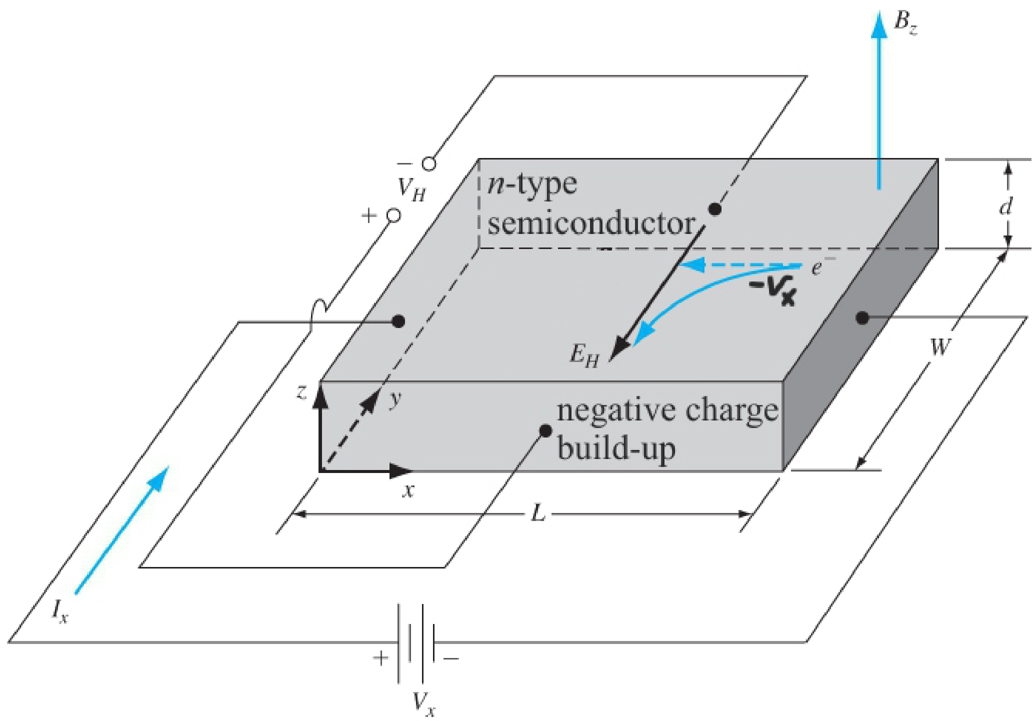

Figure 5.13 | Geometry for measuring the Hall effect.

***n*-type semiconductor**

- In this case, the current flowing in the *x*-direction will be electrons (negative) inside the *n*-type semiconductor moving in the -*x*-direction.
- Looking at the magnetic part of the Lorentz force equation $\overline{F}_m = q\overline{v} \times \overline{B}$, we get $\overline{F}_m = -e(-\hat{a}_x v_x) \times \hat{a}_z B_z = -\hat{a}_y e v_x B_z = -\hat{a}_y F_y$ which will push electrons in -*x*-direction leading to negative charge build-up on the front face ($y = 0$) of the *n*-type semiconductor block (and corresponding positive charge at $y = w$).
- The charge build-up continues until the opposing induced electric field E_H exerts a Coulomb force, equal in magnitude, in the opposite direction (equilibrium).
- Since electric field lines go from positive to negative charges, the induced Hall effect electric field E_H will be in the -*y*-direction, i.e., $\overline{E}_H = -\hat{a}_y E_y = -\hat{a}_y E_H$.
- Therefore, $\boldsymbol{V_H < 0}$ (negative) for *n*-type semiconductors!