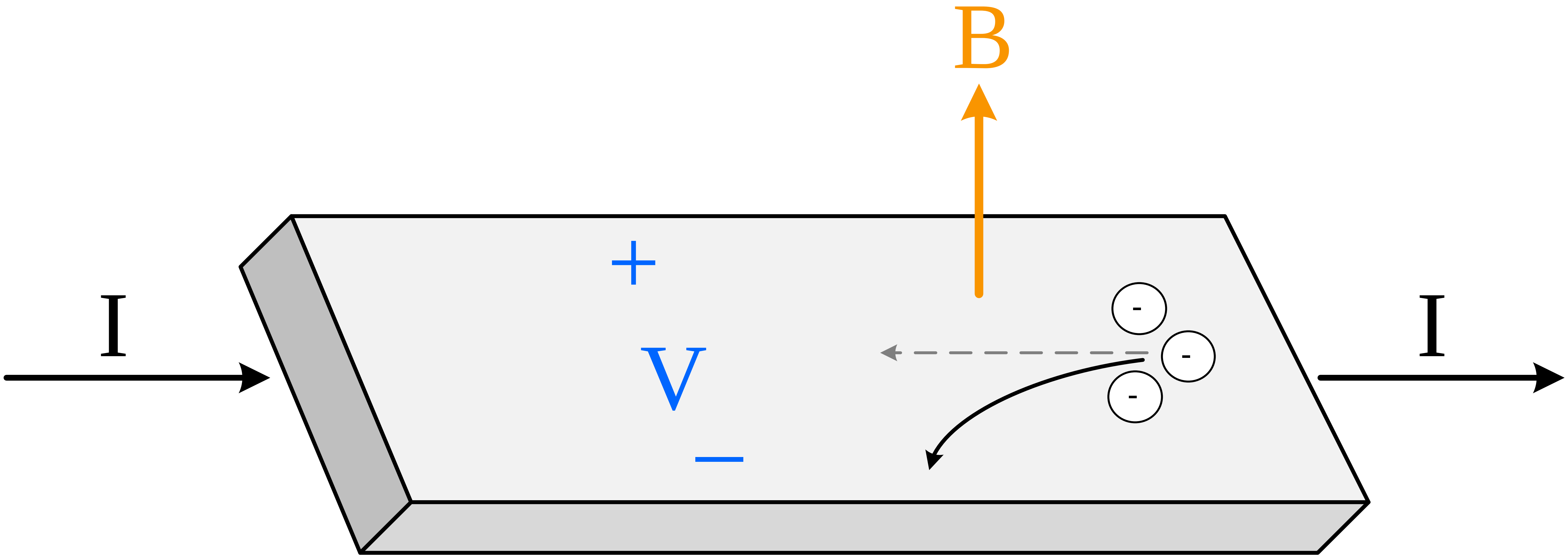
Introduction to Hall Effect Sensing

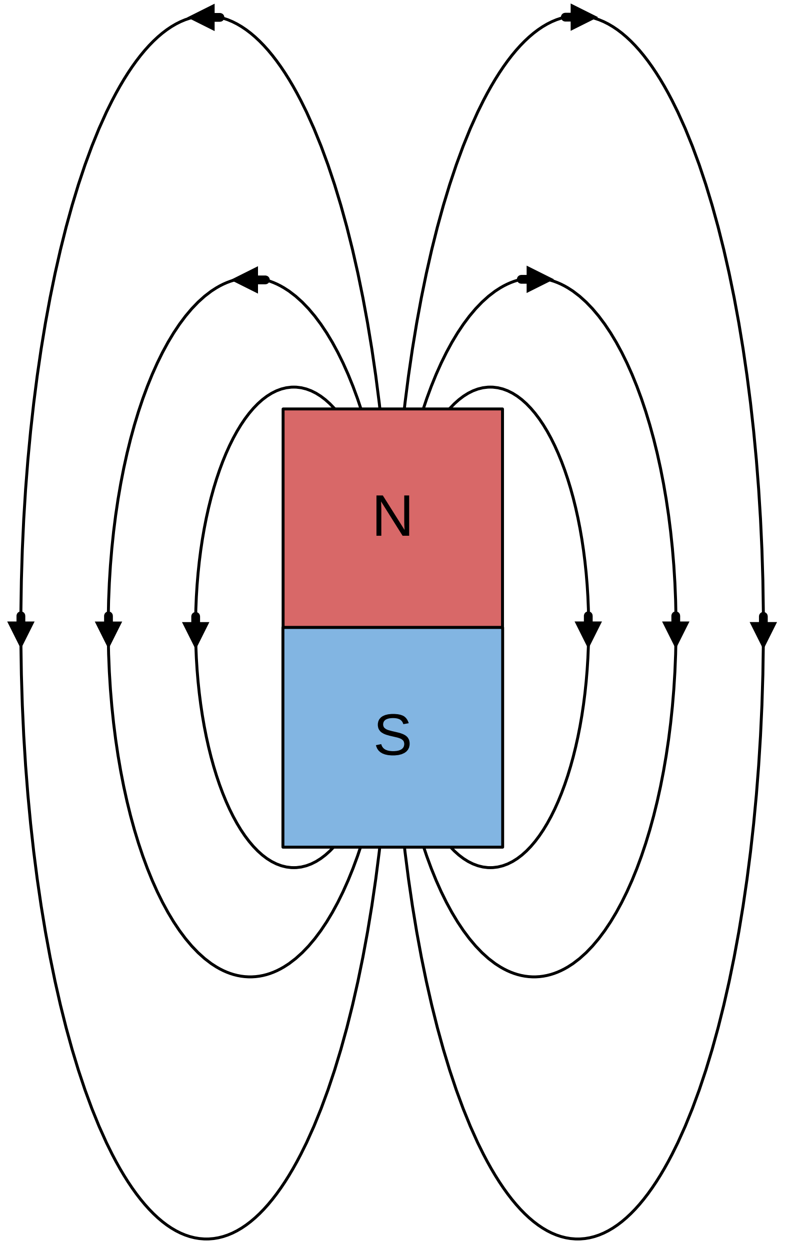
TI Precision Labs – Magnetic Position Sensing

Presented and prepared by Gloria Kim

What is Hall effect?



Permanent magnet



- Neodymium-Iron-Boron (NdFeB)
  - Highest B_r
  - -11% per +100°C

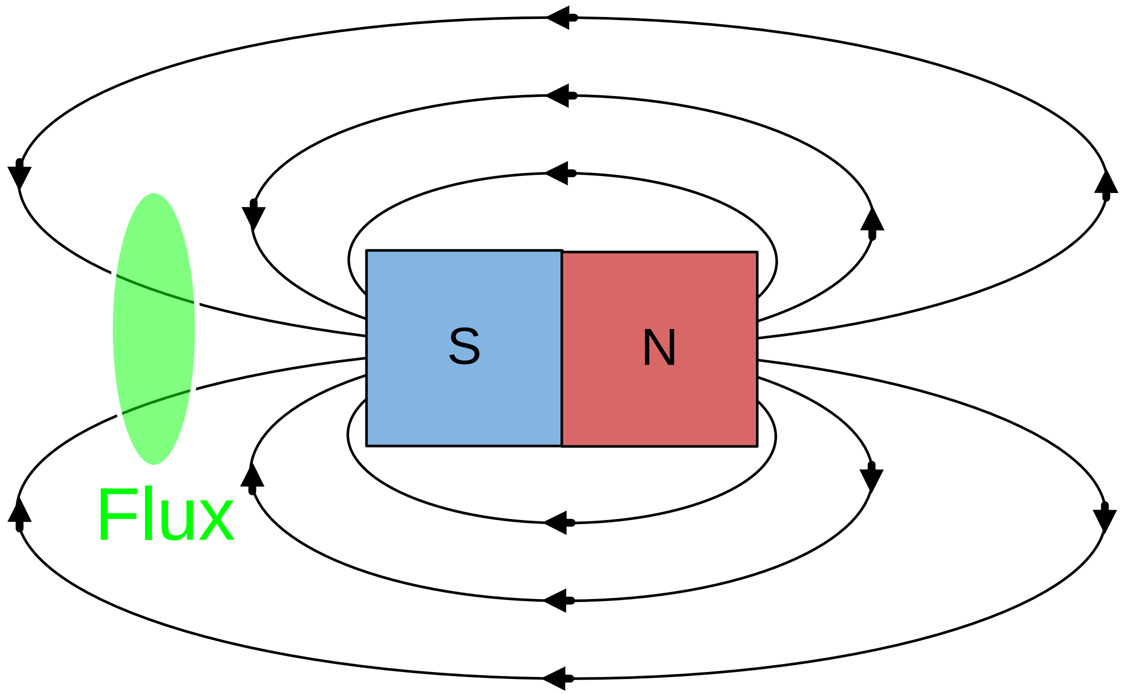
- Ferrite (iron-oxide ceramic)
  - Low-cost, but 30% B_r of NdFeB
  - -20% per +100°C

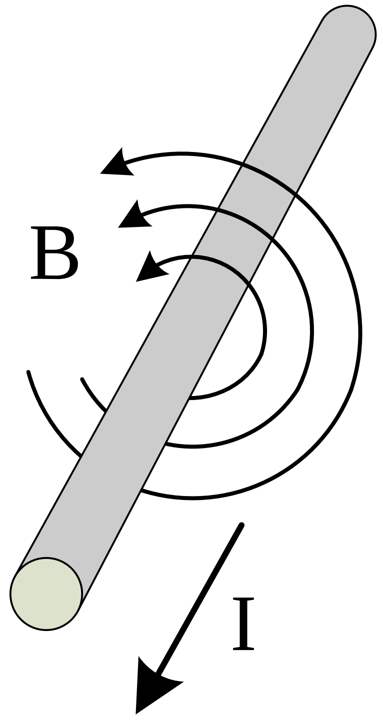
- Aluminum-Nickel-Cobalt (AlNiCo)
  - Temperature consistency
  - -2% per +100°C

- Samarium-Cobalt (SmCo)
  - Best for high temperatures
  - -4% per +100°C

Magnets and flux density

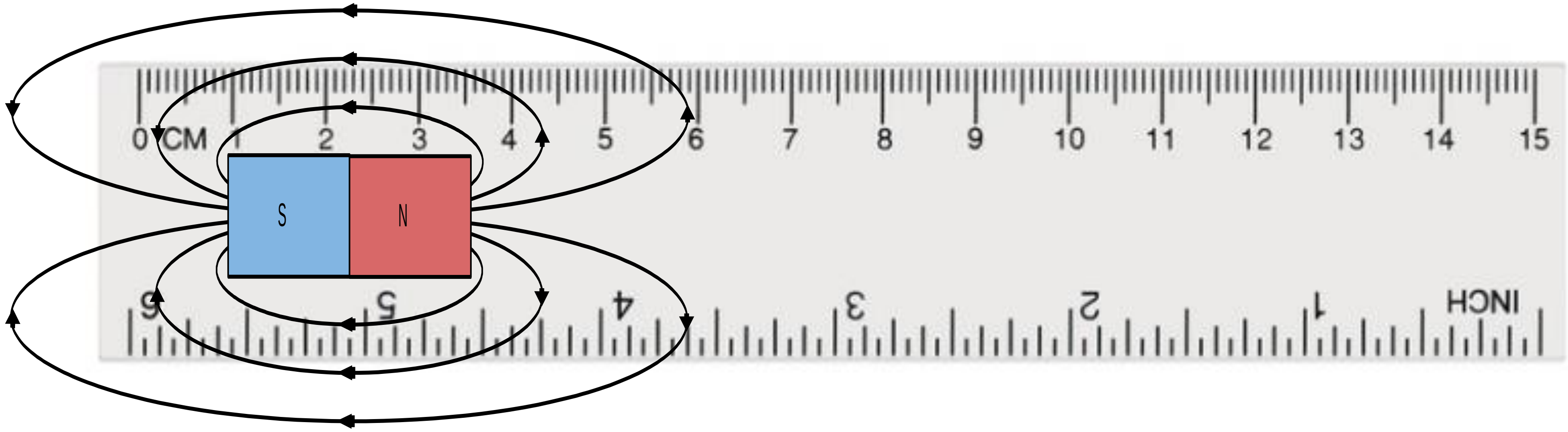
- Two main sources: magnets and current
- “Flux”: the sum of magnetic field lines passing through a specified area.
- “Flux density”: magnetic force
  - Flux per mm^2
  - Units: gauss (G) or tesla (T)
  - 10 G = 1 mT
  - Earth’s field ≈ 0.05 mT

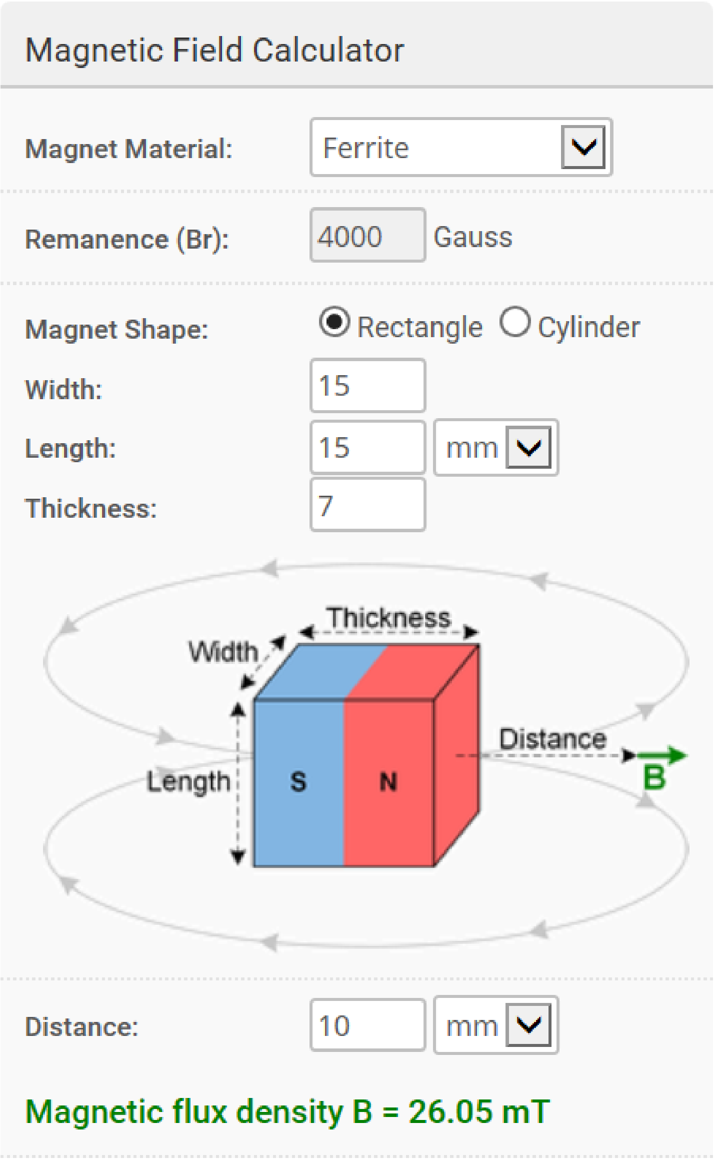




Determining a magnet's flux density vs. distance

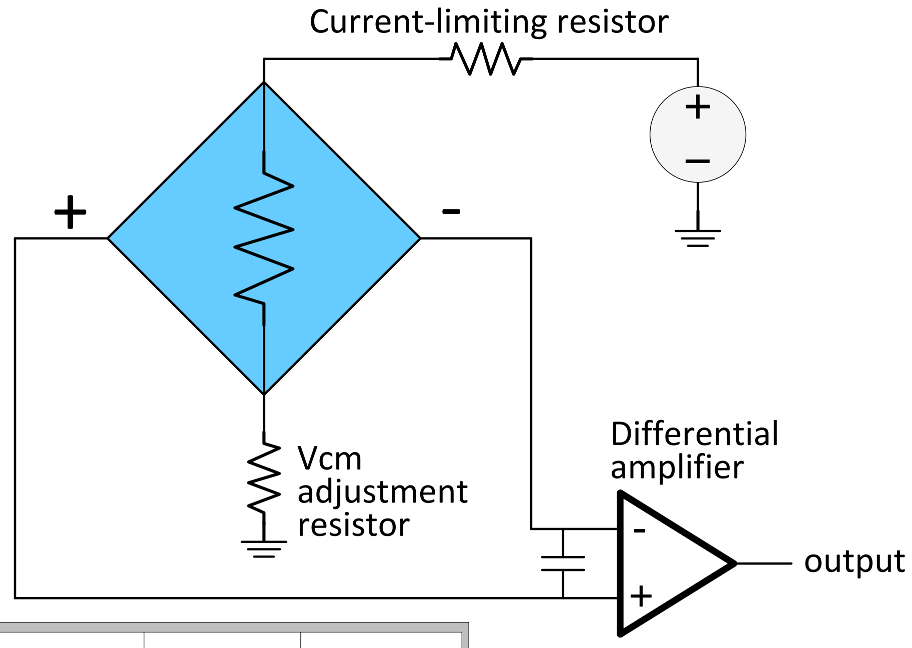
1. Magnet datasheet
2. Simulation (FEMM, COMSOL, ANSYS Maxwell)
3. Measurement (gaussmeter/teslameter, linear Hall)
4. TI magnetic field calculator

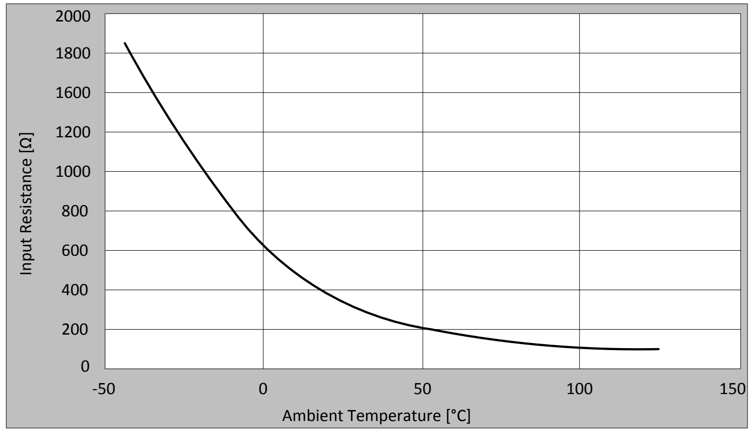




Industry devices: Hall elements and ICs

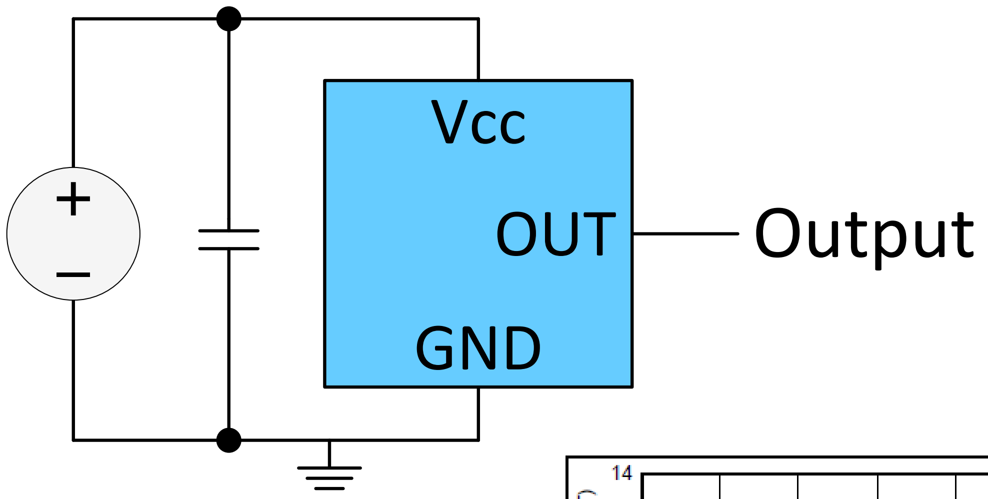
Element





- Passive component
- Requires signal conditioning
- Less robust
- Element resistance varies ten times across temperature

Integrated Circuit



- Protection, robustness
- Fully integrated analog design
- Temperature compensation
- Many different device classes

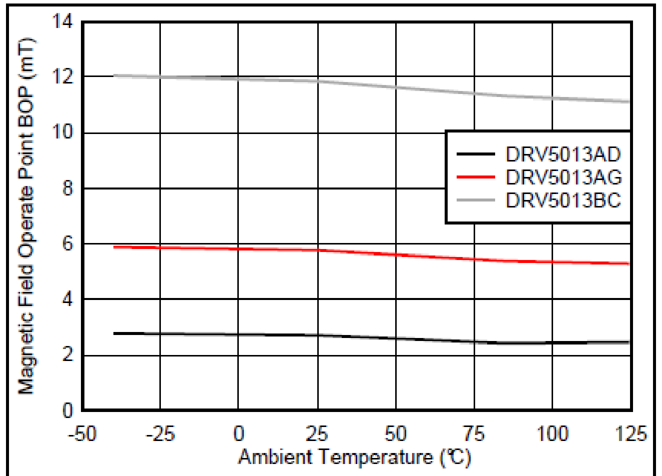
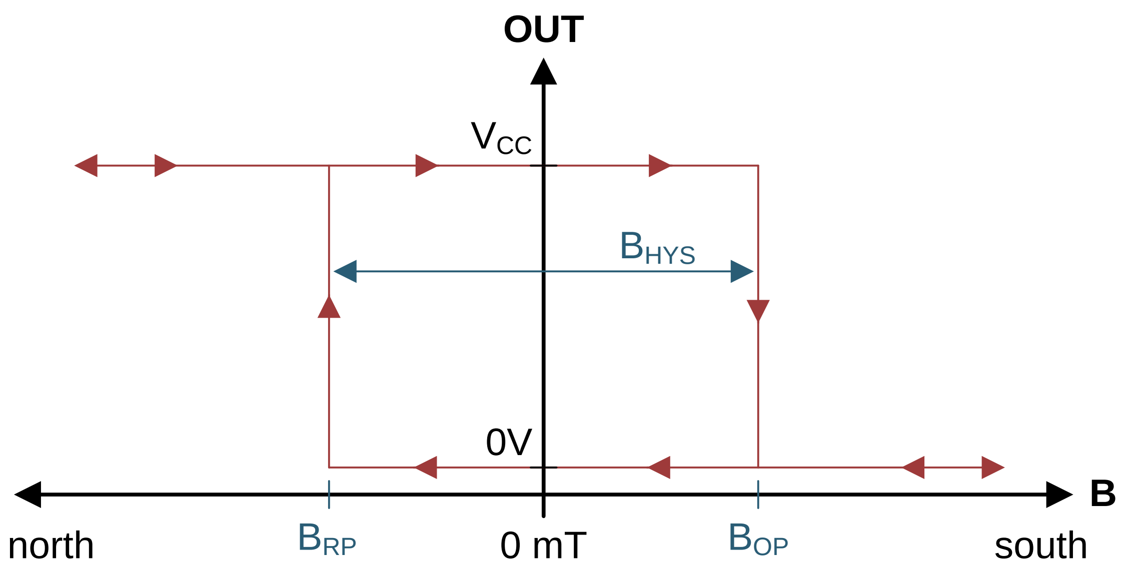


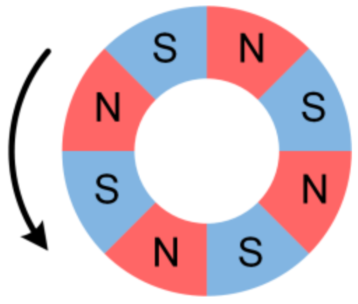
Figure 4. B_{OP} **vs Temperature**

Hall effect latches

Hall effect latch

Indicates the most recently measured magnetic flux density. These are used in rotary applications such as BLDC motor sensors and incremental encoding.





- Motors
- Incremental encoders

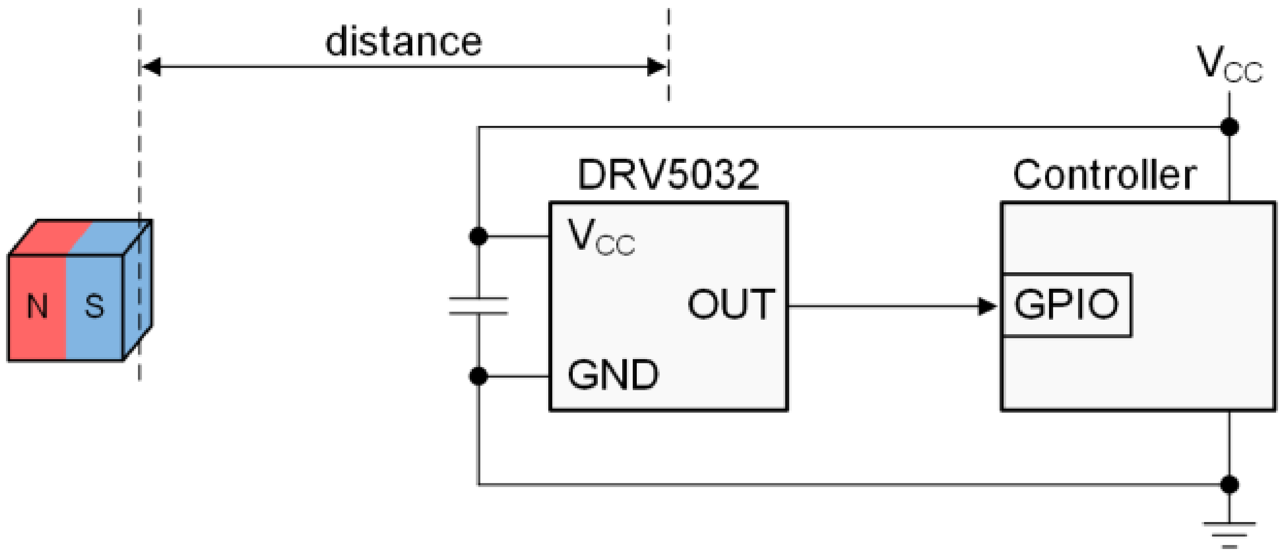
Incremental Rotary Encoder Design Considerations
http://www.ti.com/lit/pdf/sboa200

Hall effect switch

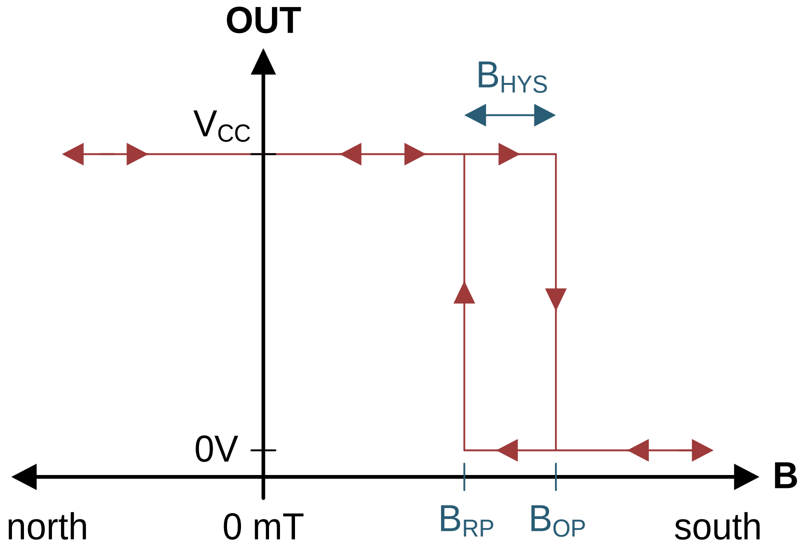
Hall effect switch

Indicates the presence or absence of magnetic flux density compared to a defined threshold.

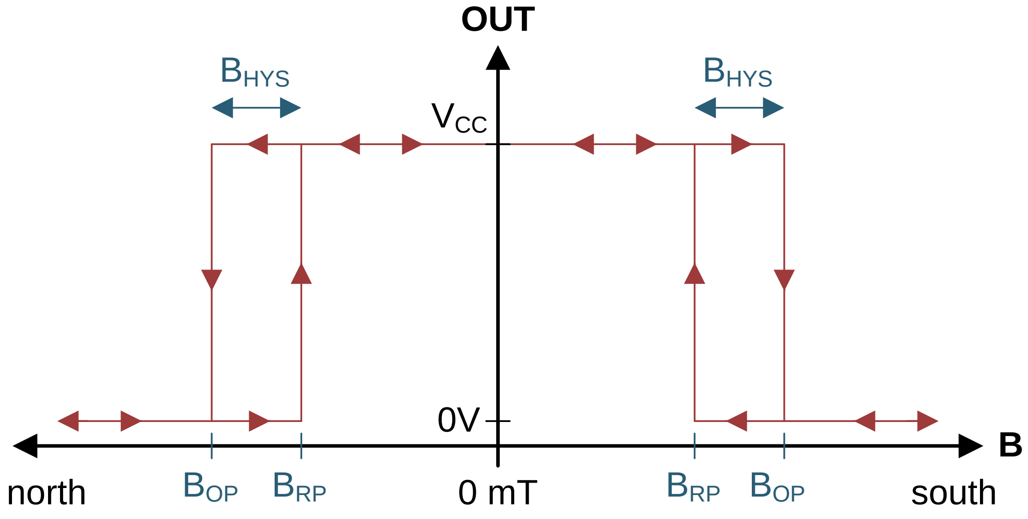
- Unipolar switch – responds only to south magnetic poles
- Omnipolar switch – responds to both south and north magnetic poles



Unipolar



Omnipolar

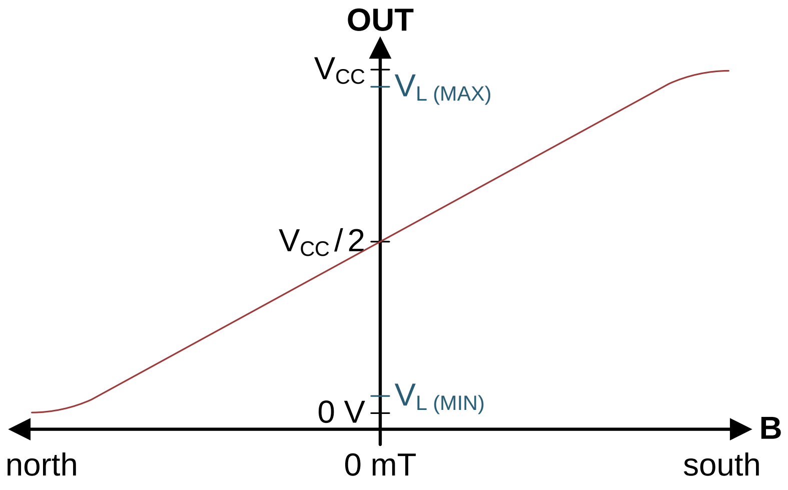


Single-axis linear Hall effect sensor

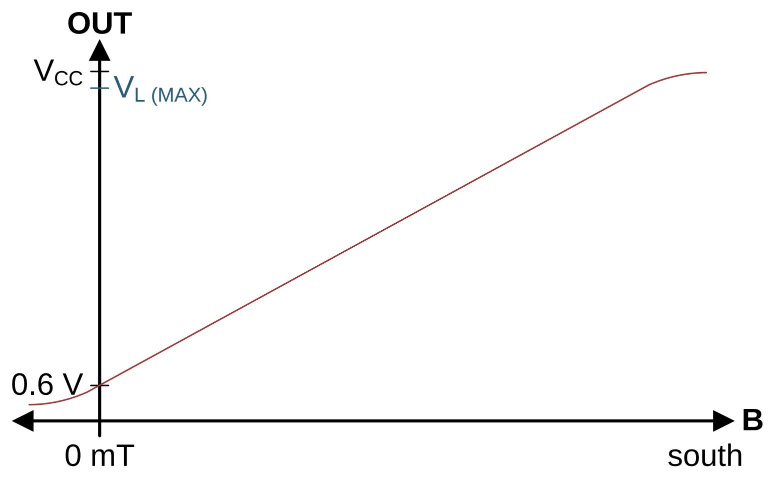
Linear Hall effect sensors

Outputs a signal that is proportional to magnetic flux density in order to measure precise movement.

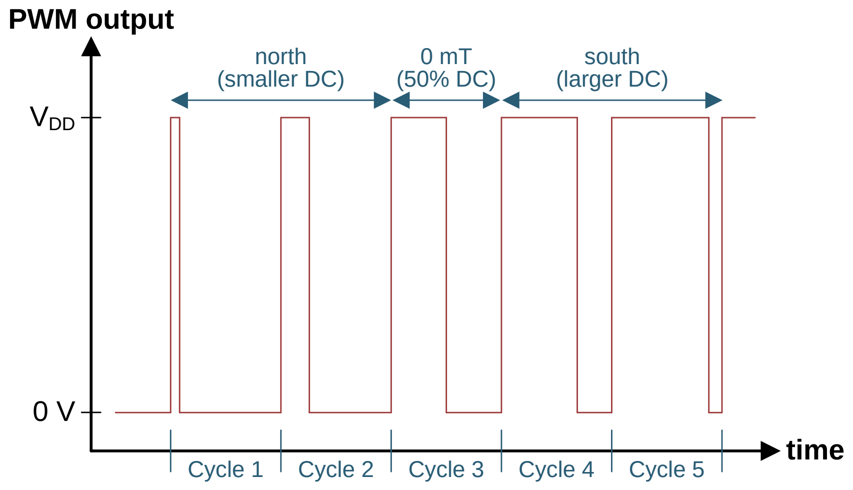
Bipolar measurement with analog output



Unipolar measurement with analog output

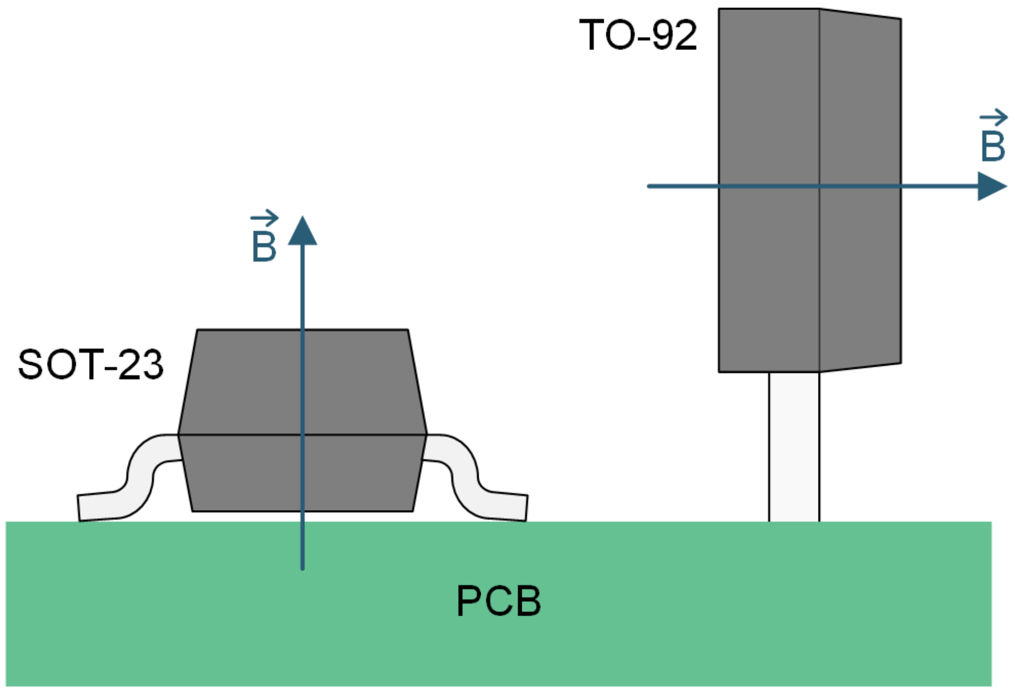


Bipolar measurement with PWM output

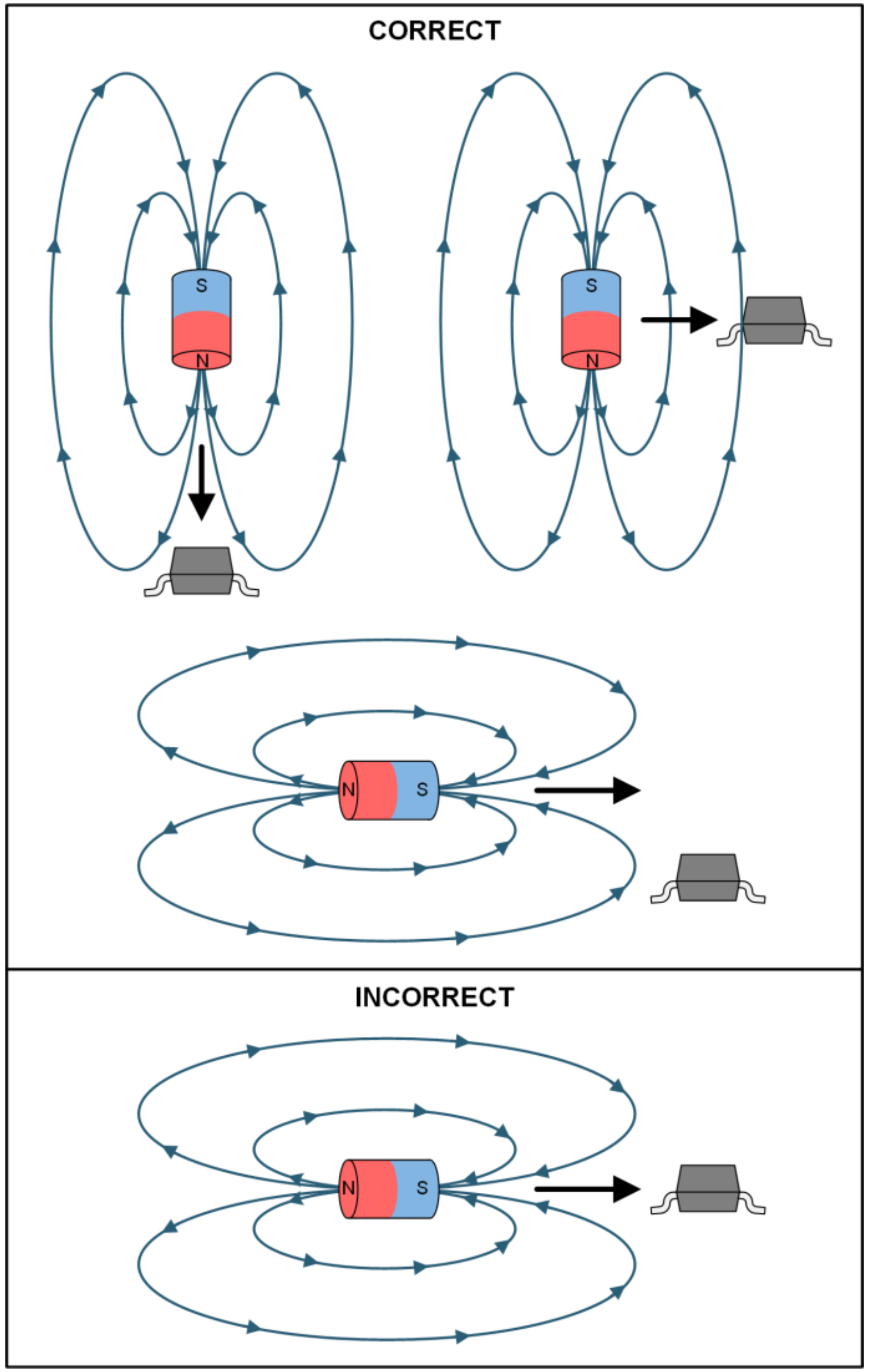


Common package types

2 packages, 2 sensing directions



SOT-23 **TO-92 or "SIP"**



To find more magnetic position sensing technical resources and search products, visit ti.com/halleffect