Specifications of Hall-Effect Latches for Rotary Encoding

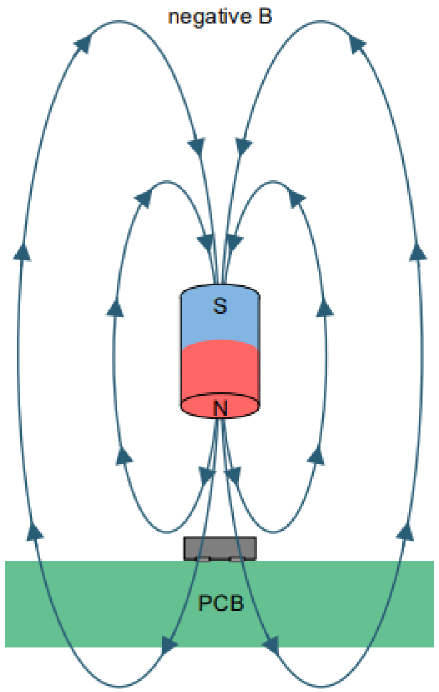
TI Precision Labs – Magnetic sensors

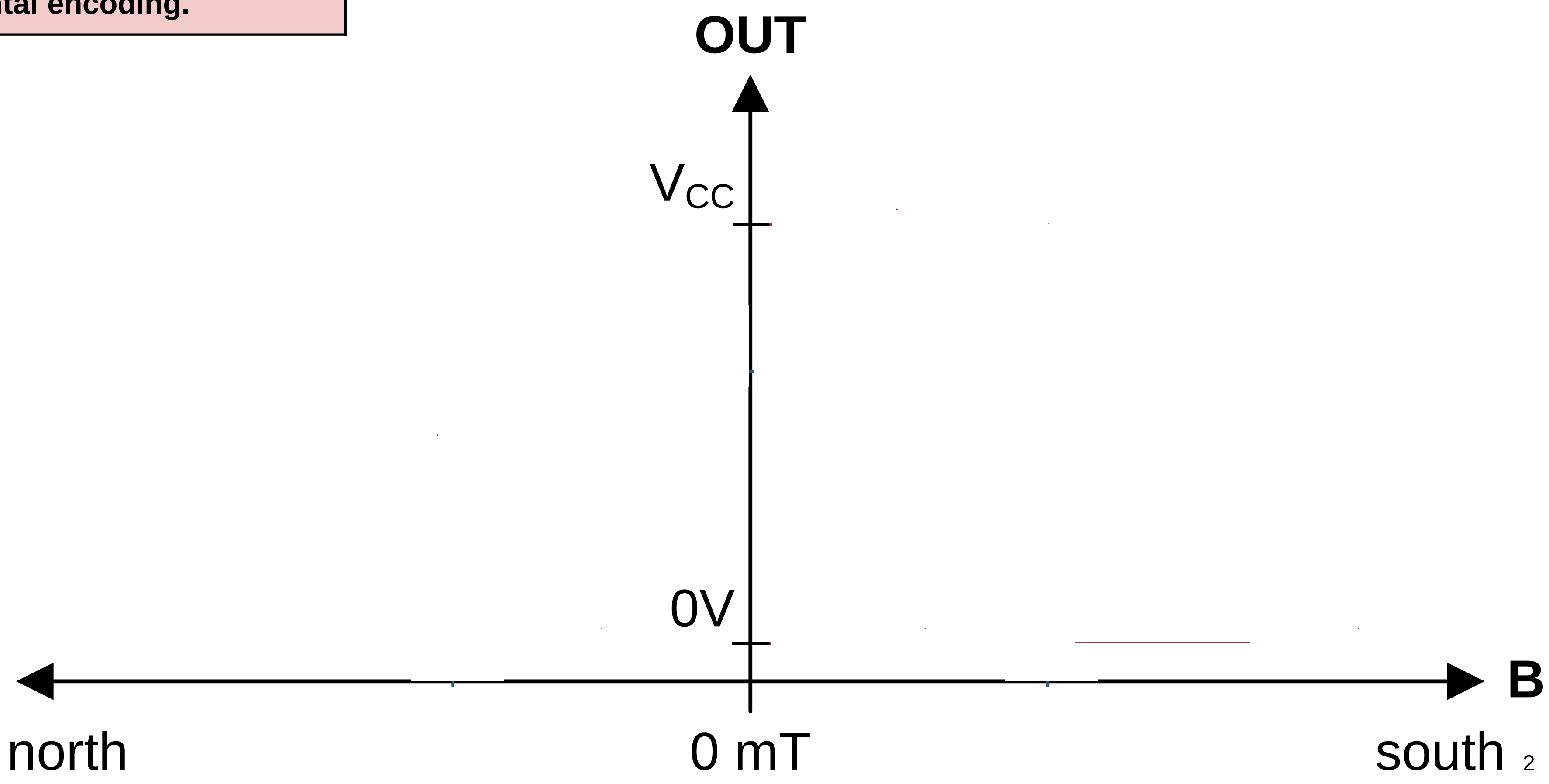
Presented and prepared by Isaac Lara

Sensitivity

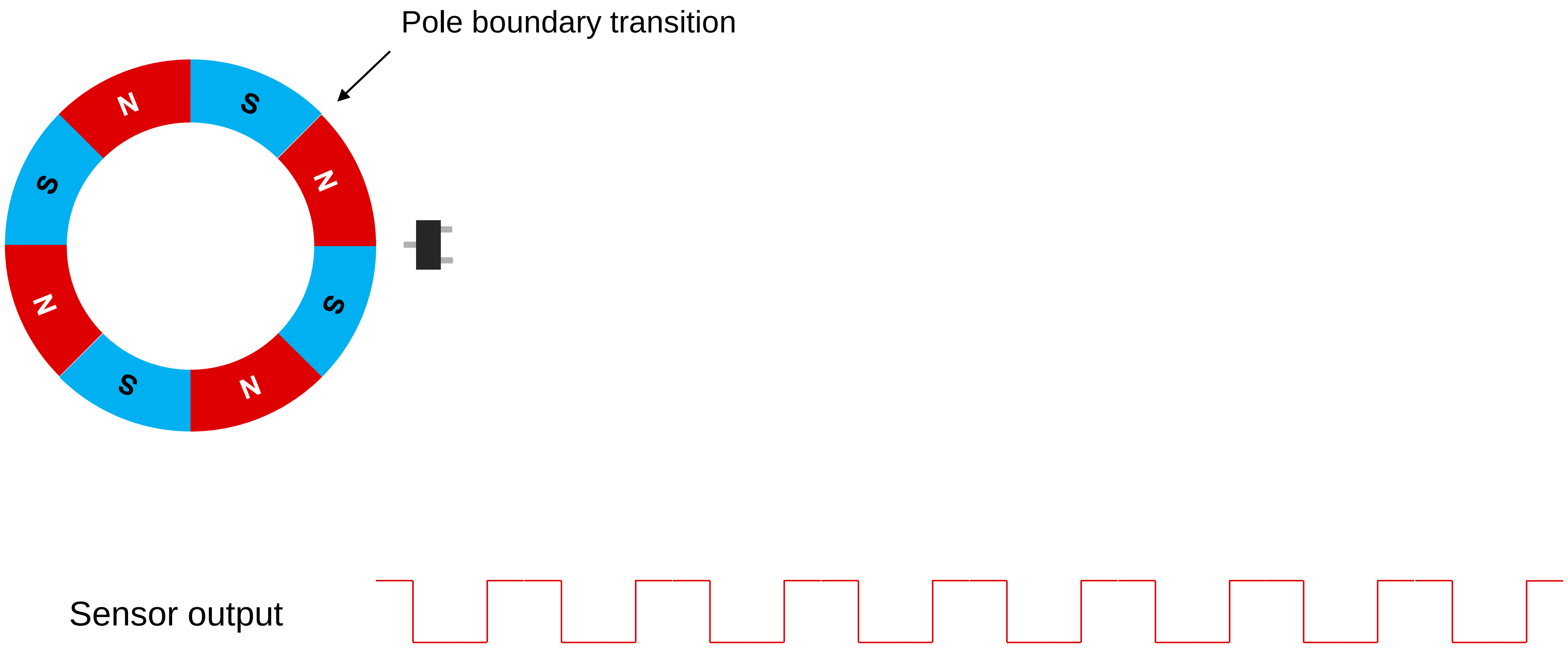
Hall-effect latch

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

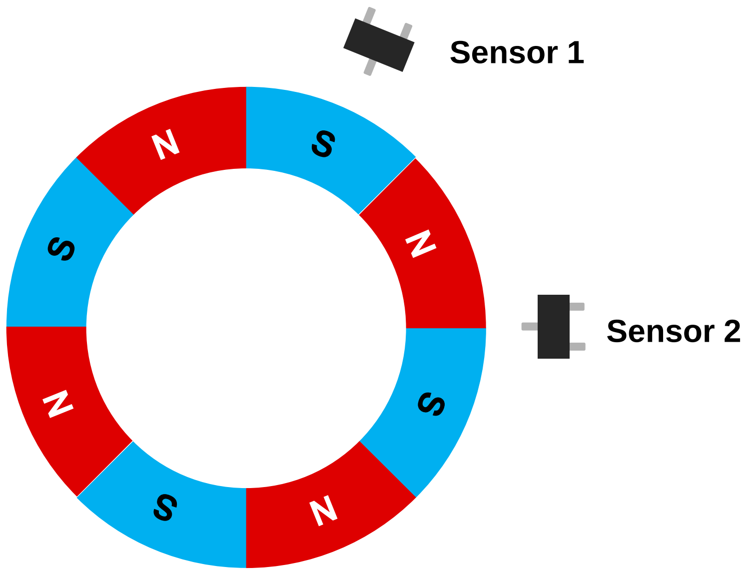


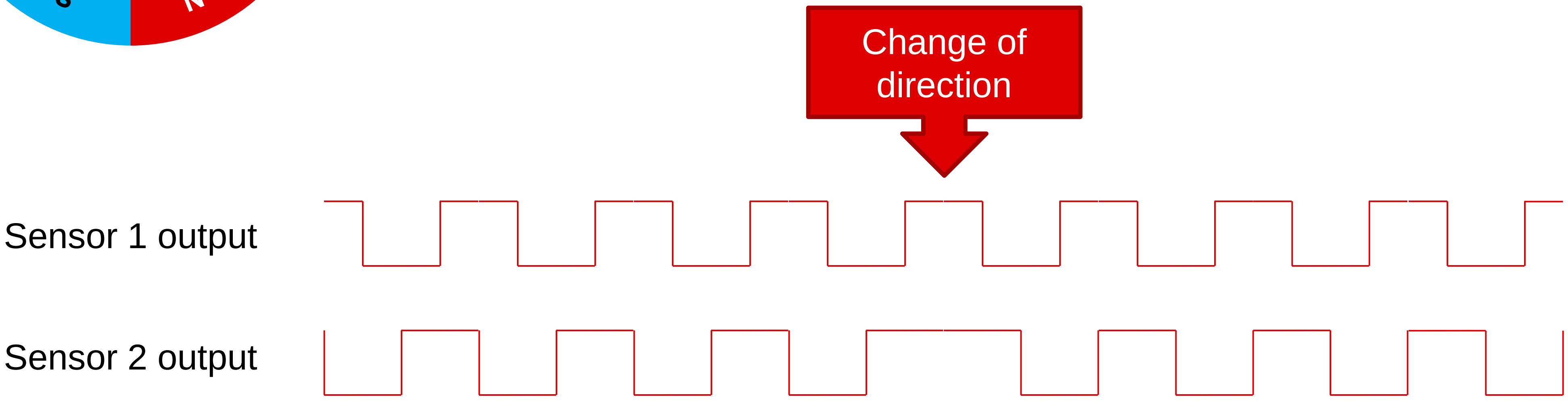


Rotary encoding review

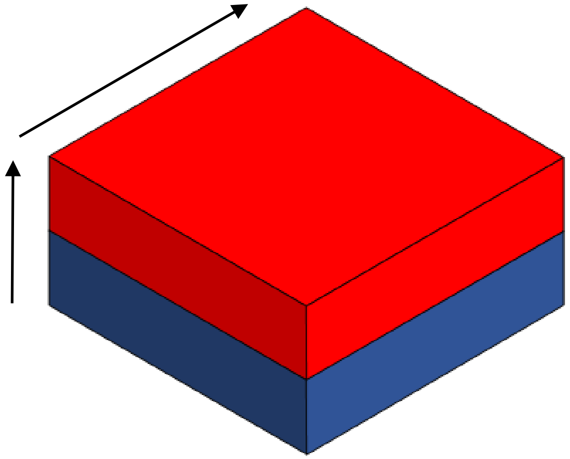


Rotary encoding review



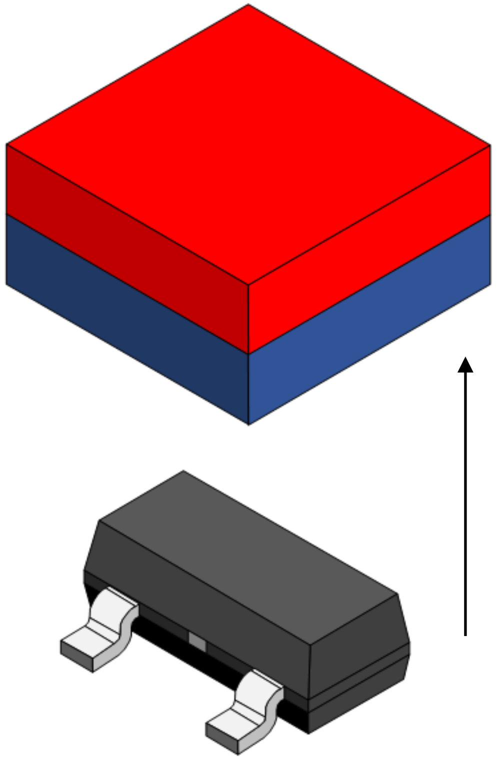


Sensitivity and resolution



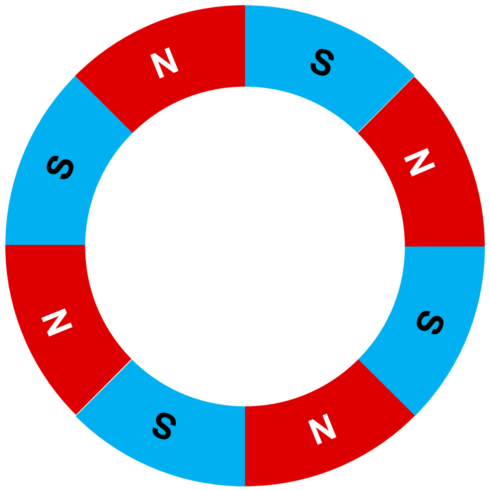
Size and # of poles

Magnet material



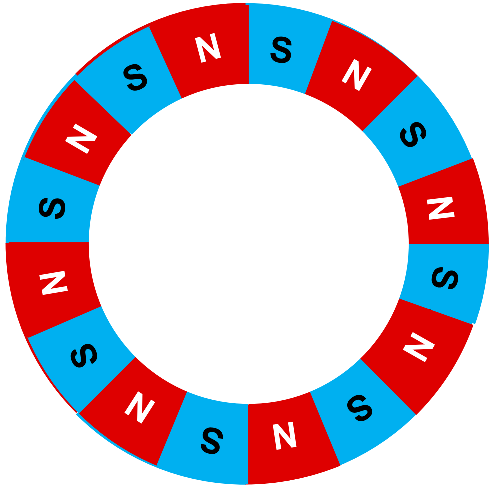
Distance from sensor

Sensitivity and resolution



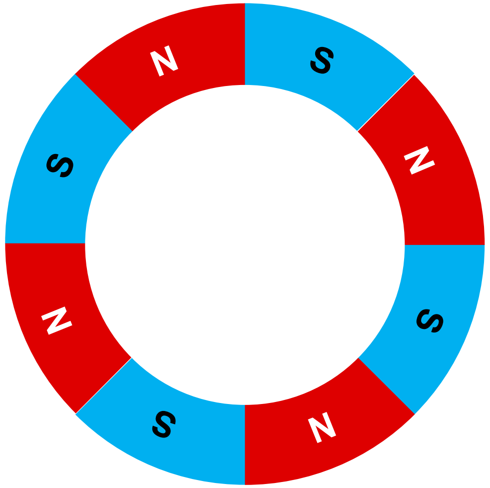
$$Resolution^\circ = \frac{360^\circ}{8\,poles} = 45^\circ$$

Sensitivity and resolution

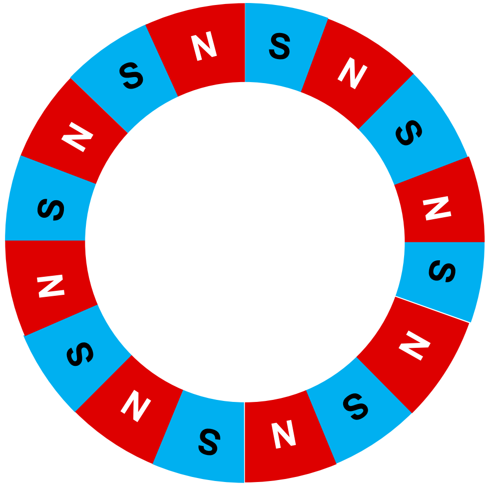


$$Resolution° = \frac{360°}{16\,poles} = 22.5°$$

Sensitivity and resolution



B field strength: ↑ Resolution: ↓

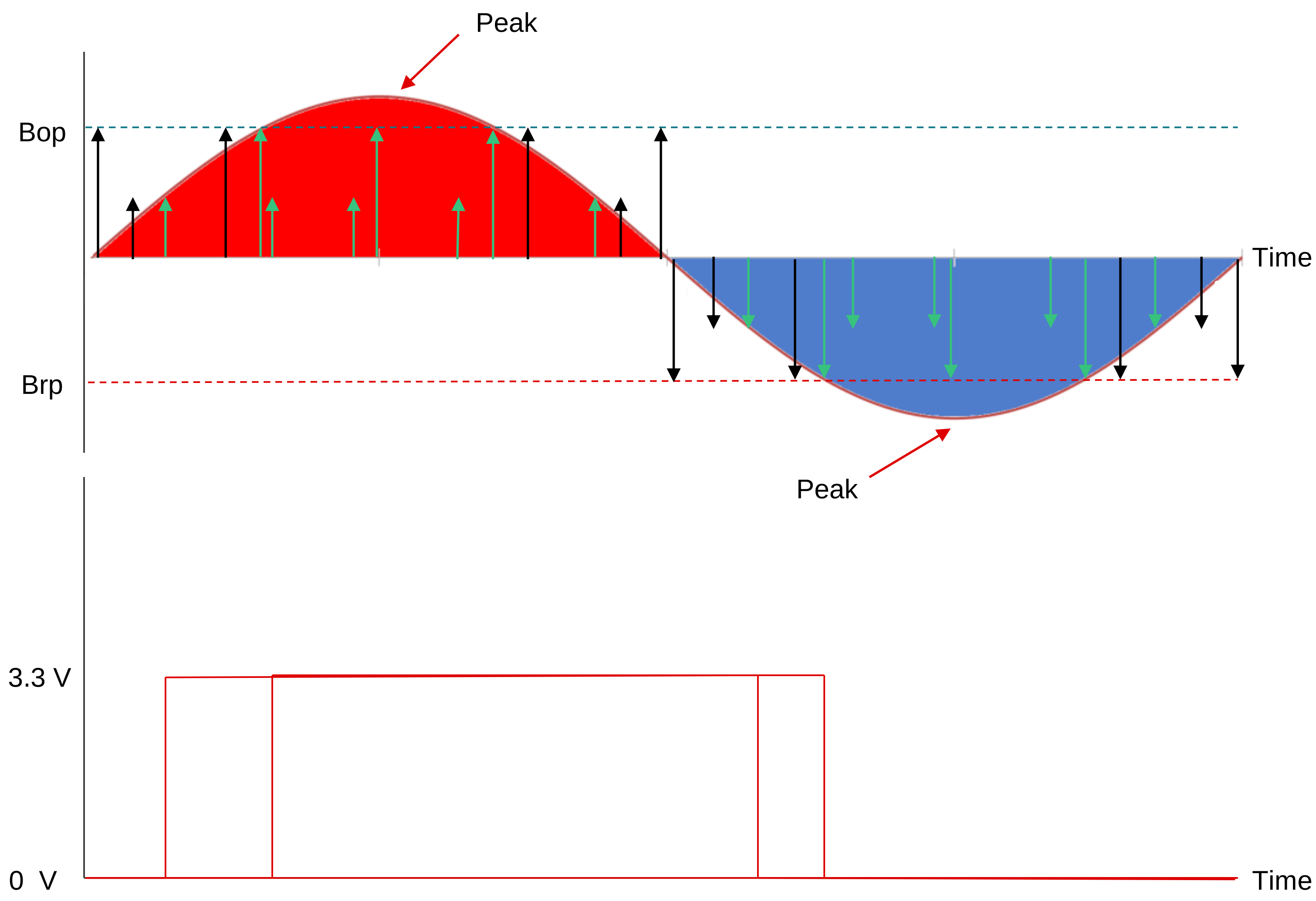


B field strength: ↓ Resolution: ↑

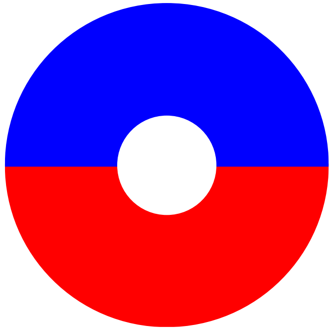
Frequency bandwidth

- Frequency bandwidth dictates the fastest changing magnetic field that can be detected and translated to the output.

- Frequency bandwidth should be greater than two times the number of poles per second and ideally should be three times higher.



Pole count vs. pulses



$$\frac{2\,poles}{1\,rotation} \times \frac{1\,pulse}{2\,poles} = 1 \text{ pulse per rotation}$$

$$\frac{4\,poles}{rotation} \times \frac{1\,pulse}{2\,poles} = 2 \text{ pulses per rotation}$$

$$\frac{3\,poles}{rotation} \times \frac{1\,pulse}{2\,poles} = 4 \text{ pulses per rotation}$$

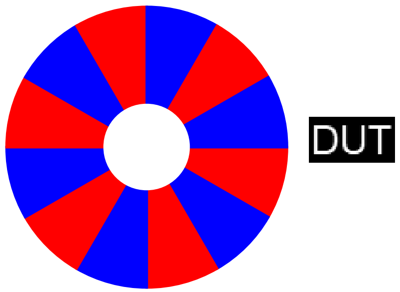
- The number of pulses seen by single hall latch is equivalent to the number of pole pairs in a magnet.

Calculating electrical frequency and RPM

$$\frac{\#\ poles\ pairs}{1\ rotations} \times \frac{\#\ rotations}{minute} \times \frac{1\ minute}{60\ s} = \frac{\#\ pulses}{s} = Electrical\ frequency\ (Hz)$$

Example: In your application you plan to have a 6 pole pair ring magnet around a motor shaft and the motor will have a max speed of 6000 RPM. Is DRV5013's frequency bandwidth of 30kHz suitable for your application?

$$600\ Hz = \frac{6000 RPM * 6\ pole\ pairs}{60 s}$$



$$1800\ Hz = 600\ Hz * 3$$

Calculating electrical frequency and RPM

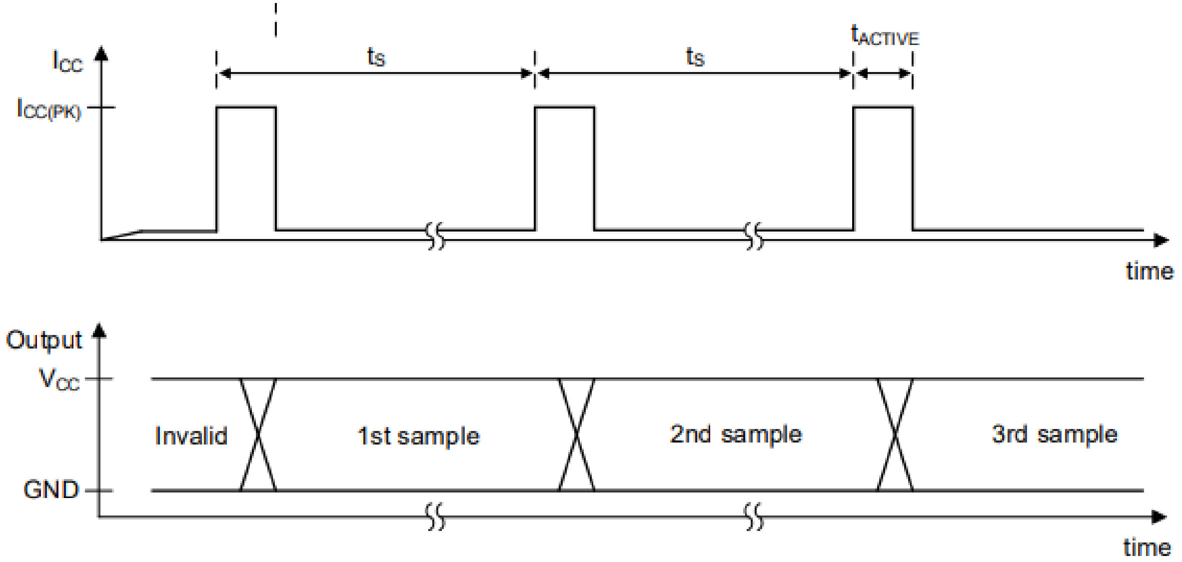
$$Electrical\ frequency\ (Hz) = \frac{RPM * \#\ of\ pole\ pairs}{60s}$$

In order to convert electrical frequency to a revolutions per minute measurement we can use the following formula:

$$RPM = \frac{60 * Electrical\ frequency}{\#\ pole\ pairs}$$

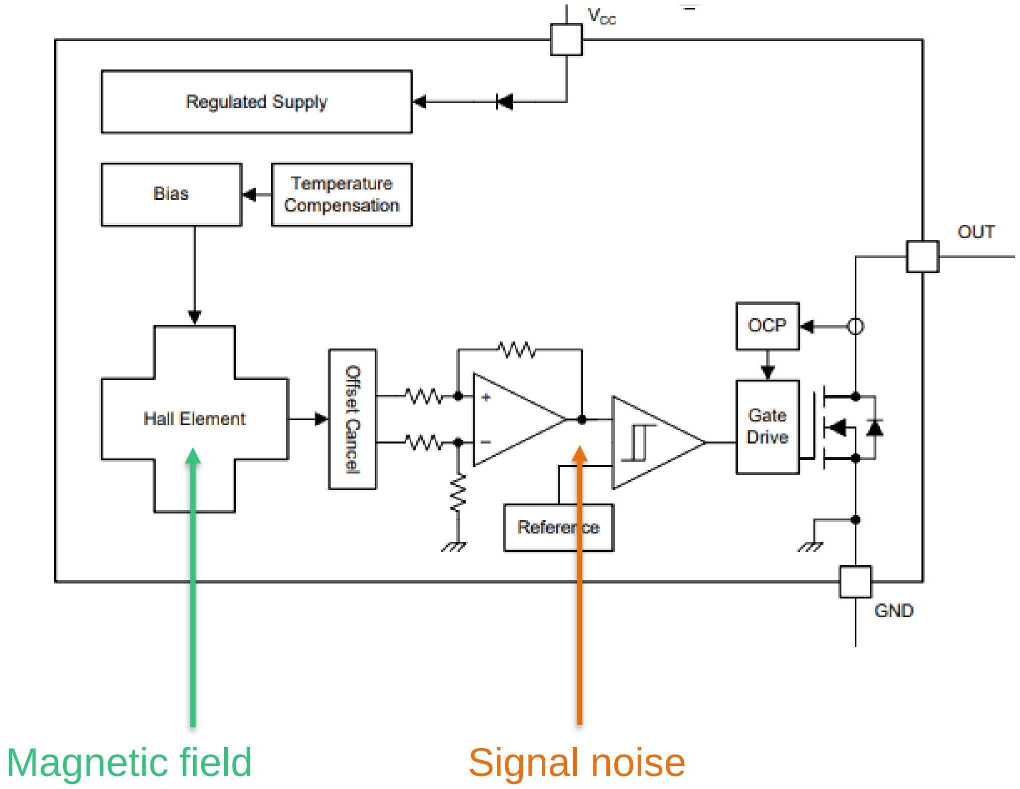
Current consumption

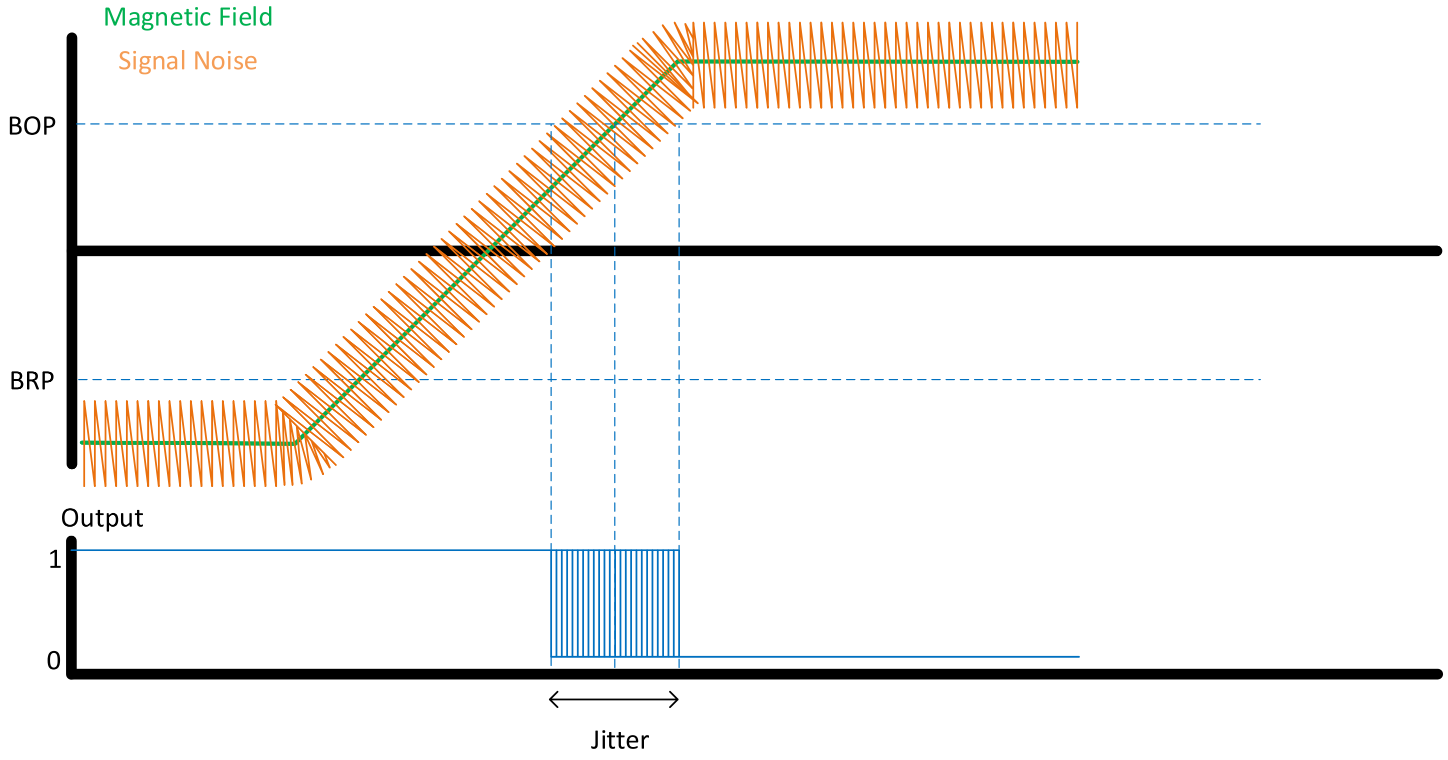
	High bandwidth	Low bandwidth
Sensing bandwidth	20 kHz- 40 kHz	20 Hz- 2.5 kHz
Current consumption	2.3 mA- 6 mA	0.0013 mA- 0.37 mA



Jitter

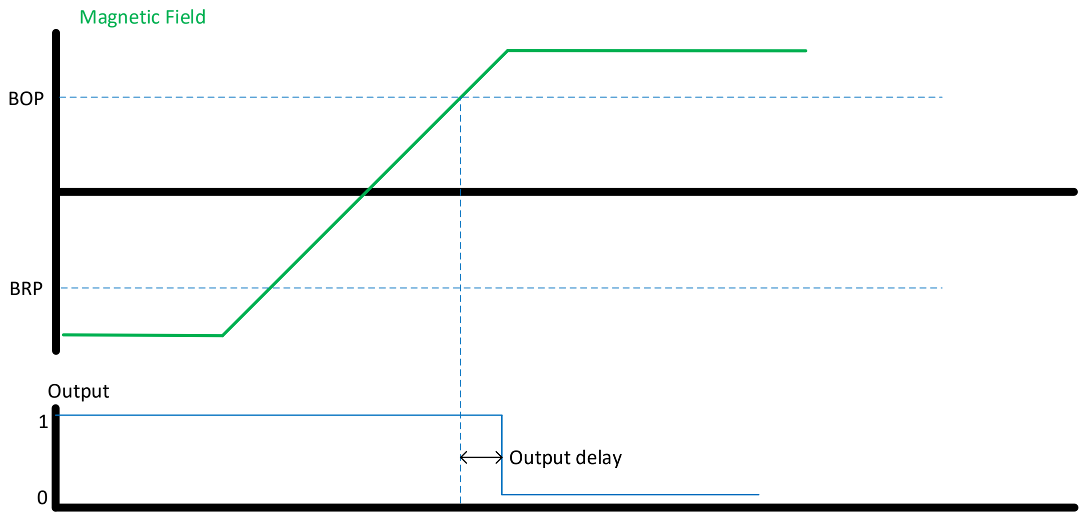
- Jitter is characterized as the variation seen in the output pulse width.
  - Typically caused by noise in the signal chain



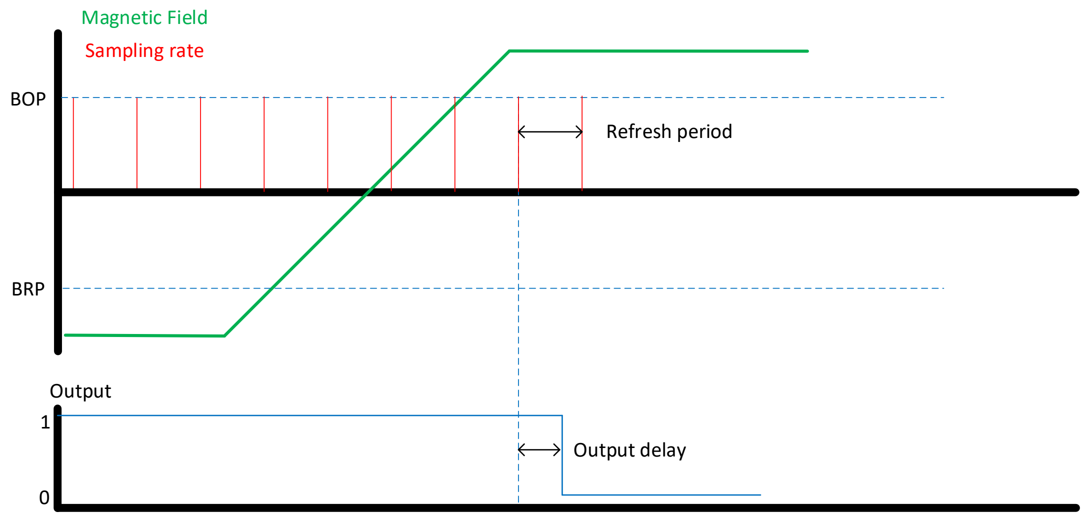


Output delay / Refresh period

- Output delay is the time between the B field crosses the Bop or Brp threshold and the time it takes for the output to reflect its new value
- Refresh period is the period of time the device takes before takes a new sample and updates the output as necessary
  - Also referred to as sample rate



Output delay in a none sample device

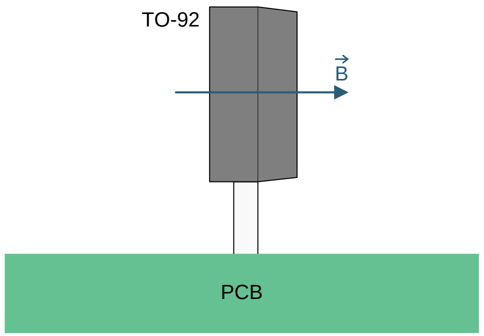


Refresh period and output delay in samples device

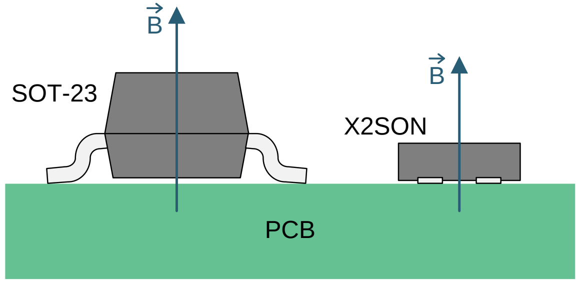
Size / Sensing directions

1D latch

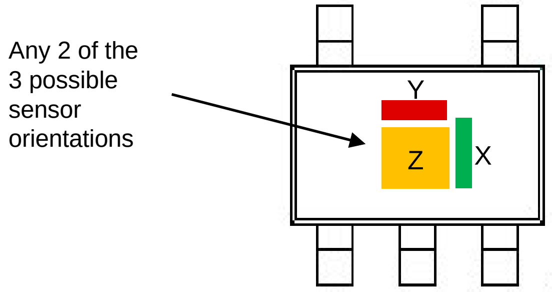
- Through-hole package:

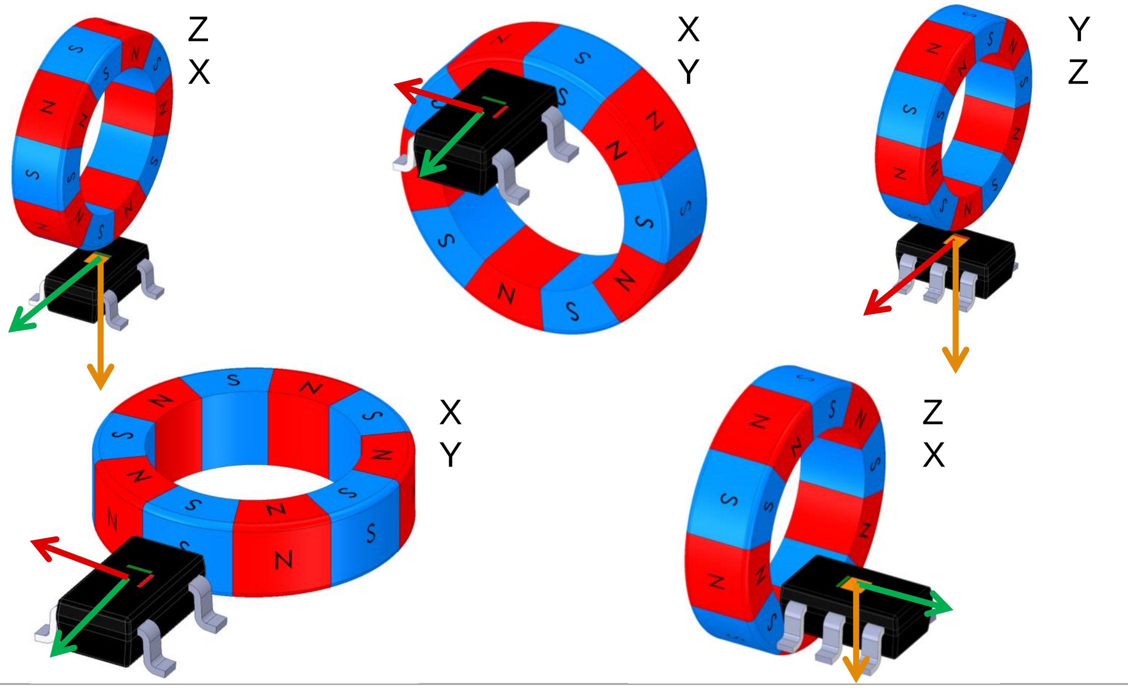


- Surface-mount package:



2D latch





Summary

Parameter	System effect
Sensitivity	Helps determine detection range and number of poles in a magnet
Frequency bandwidth	Establishes max detection speed
Current consumption	Low current will lead to longer battery life
Jitter	Influences precision which leads to angle error and speed miscalculations
Output delay/Refresh period	Affects reaction time in high speed applications
Size/Sensing direction	Facilitates mechanical flexibility

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