Understanding Two Dimensional (2D) Latches

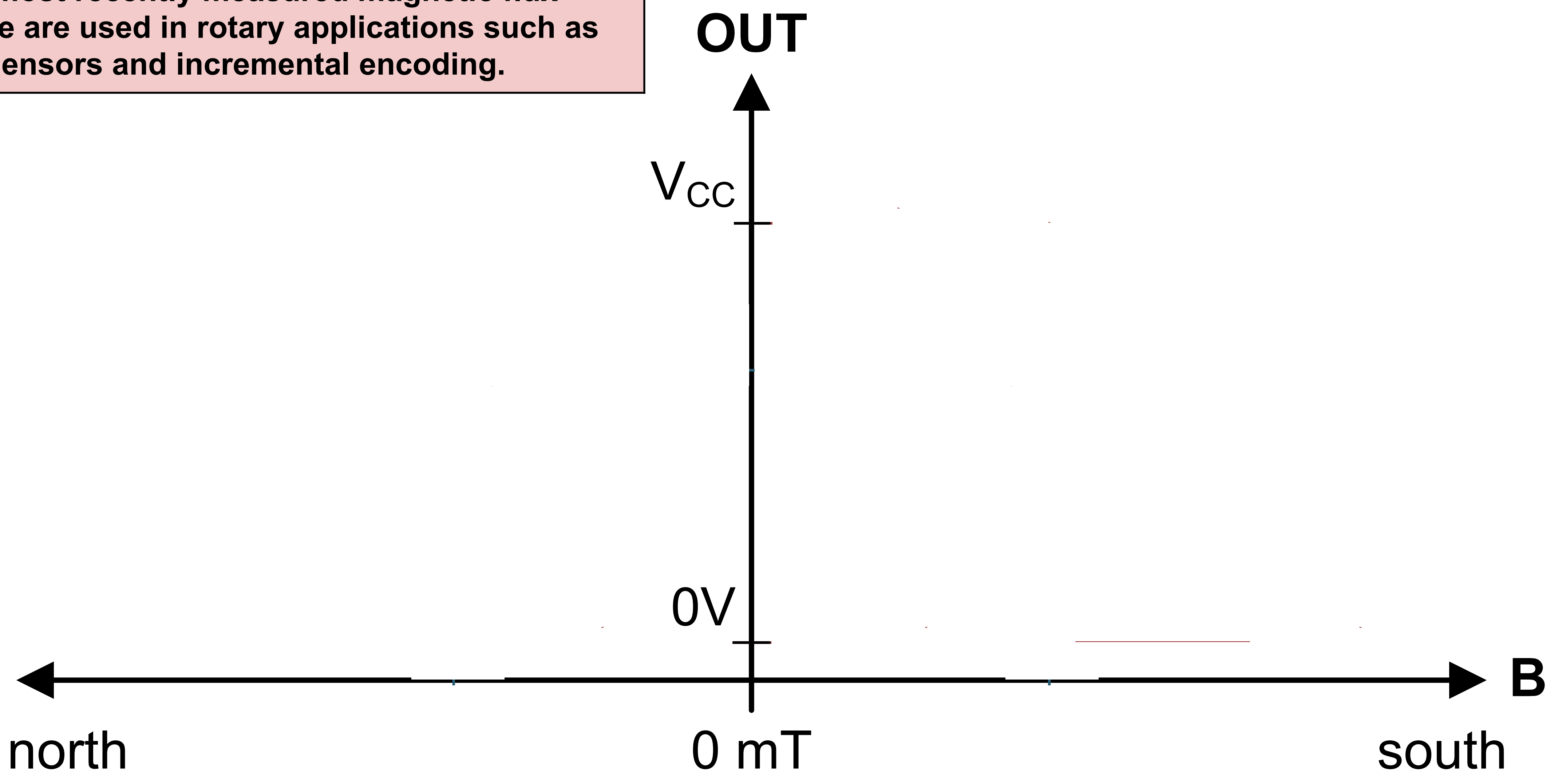
TI Precision Labs – Magnetic Position Sensing

Presented and prepared by Scott Bryson

Hall Effect Latch Operation

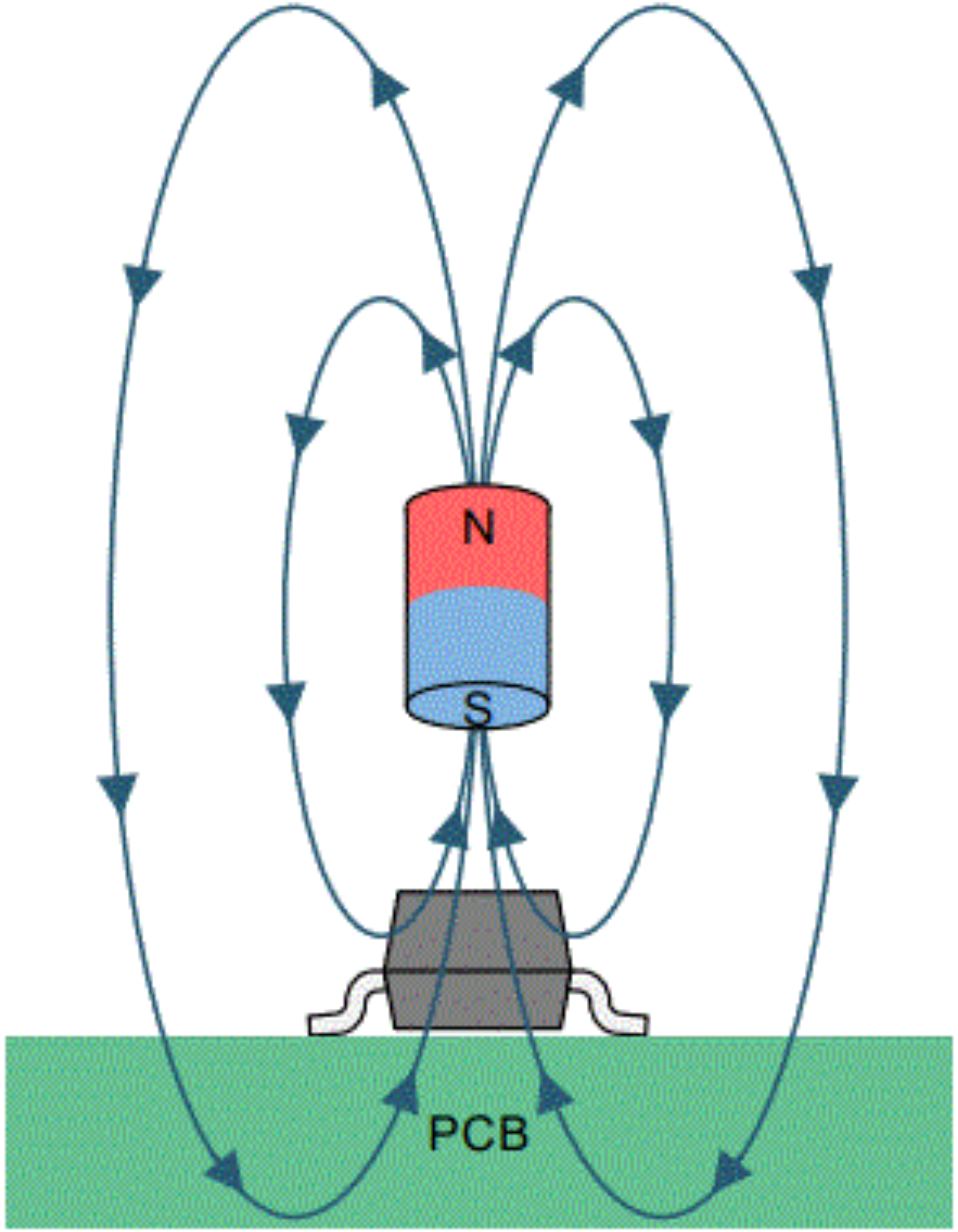
Hall effect latch

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

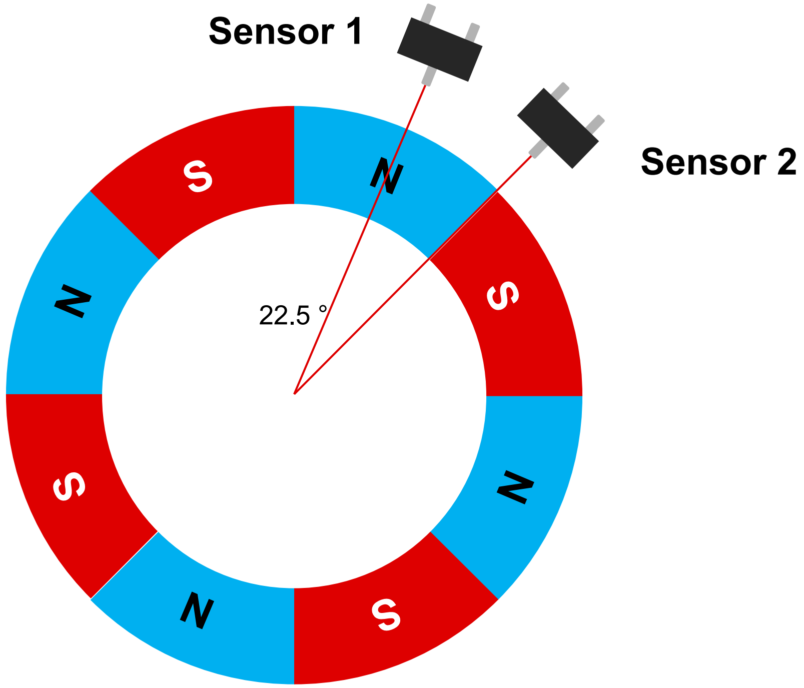


Magnetic Field Vectors

- Magnetic Field Vectors are never 1D
- 1D sensors require careful alignment and multiple sensors to enable
  - Quadrature tracking
  - Angular Measurement
  - Multi-Directional Motion



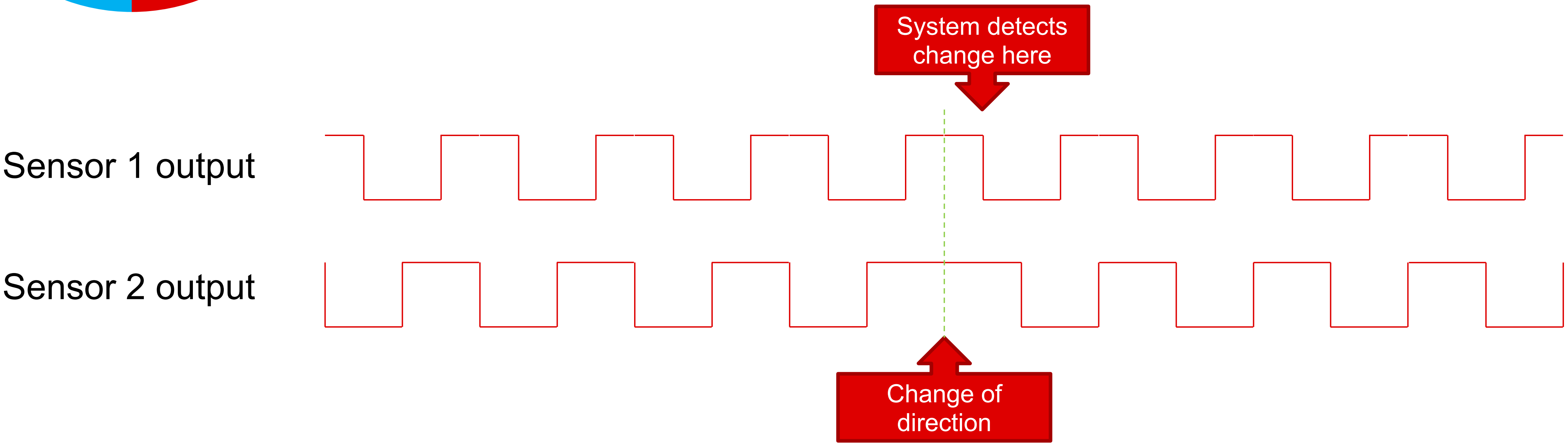
Rotary encoding using a 1D latches



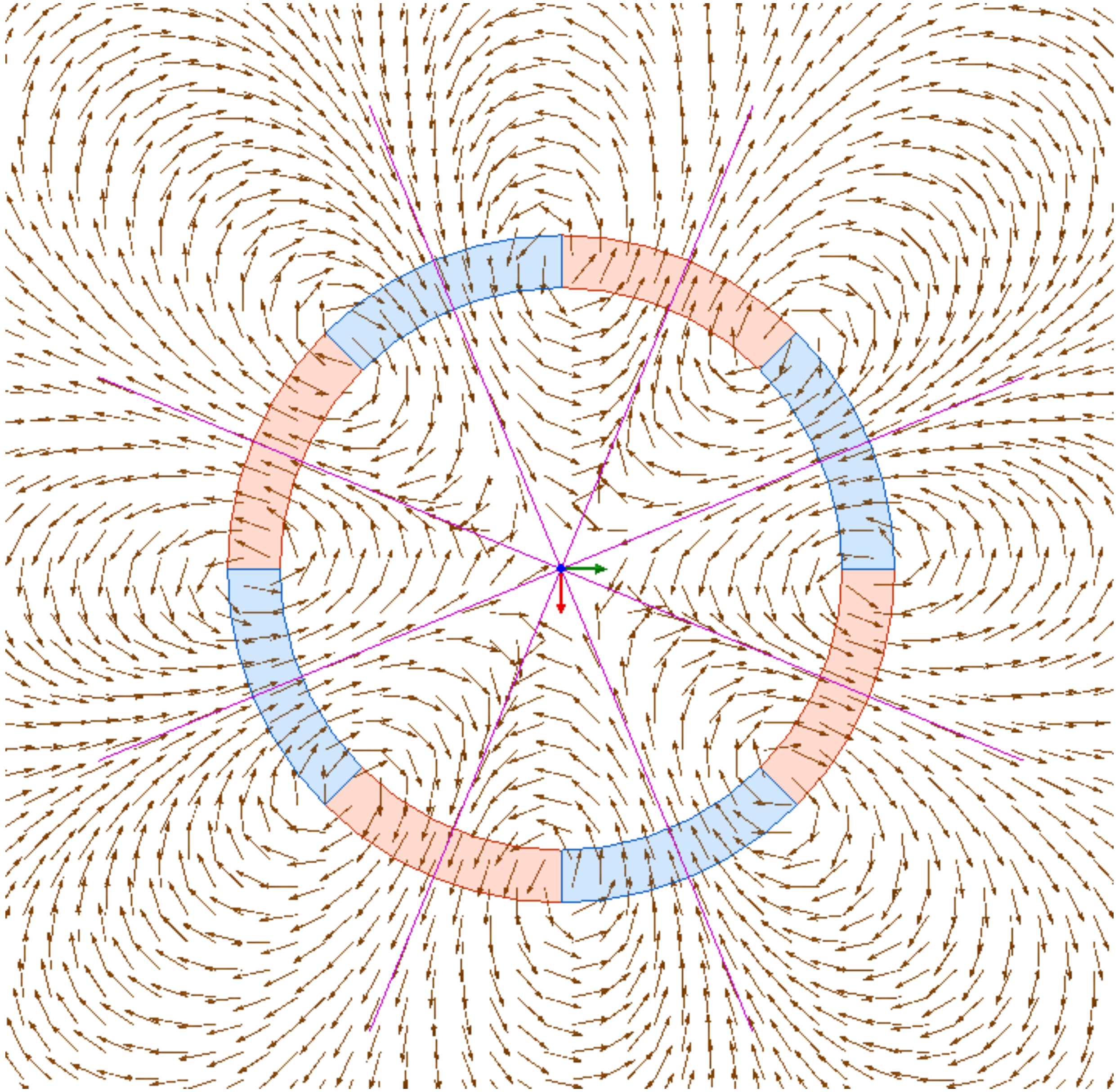
Latch spacing = ½ Pole Length + Integer # of Poles

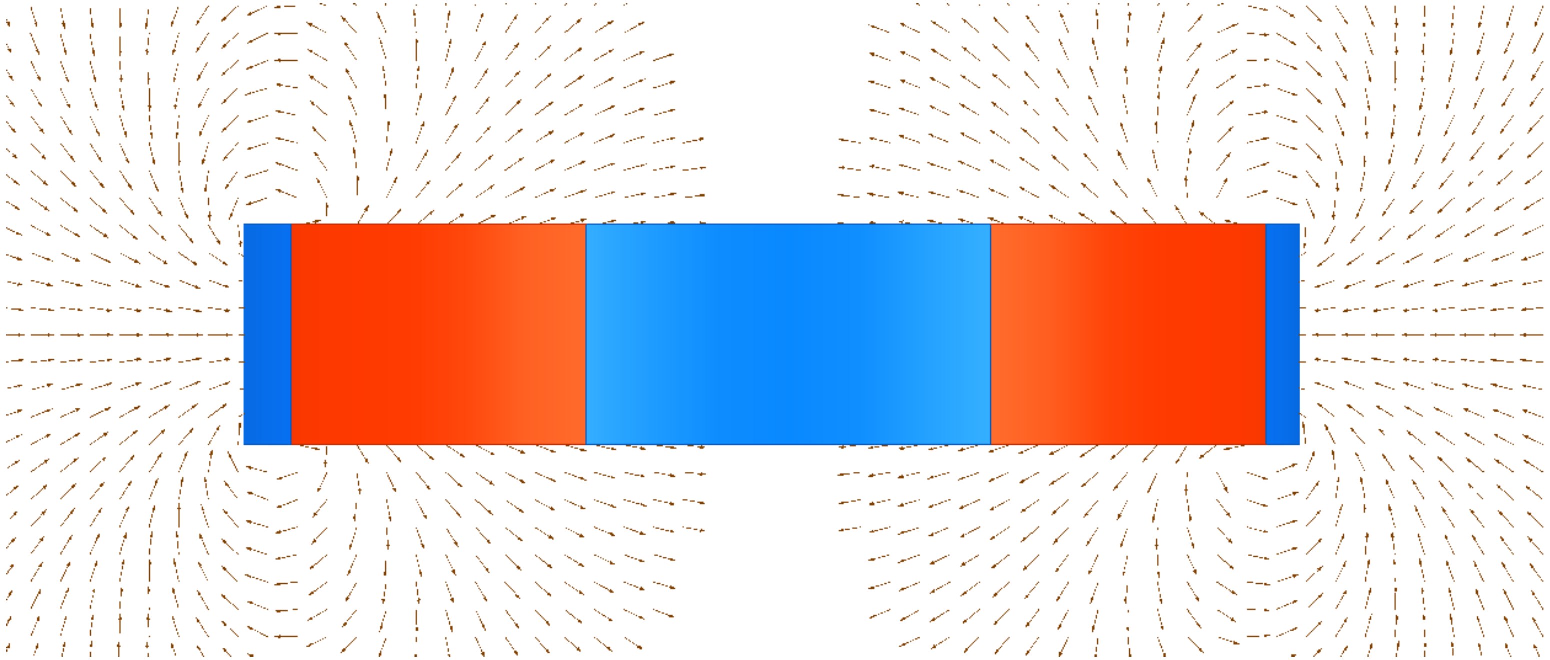
Output transitions = 360° / # poles / # sensors

For example, ½ Pole + 1 Integer Poles produces 90° phase shift for the 8 pole magnet shown. In one full rotation we will have 16 transitions over a full 360° rotation. Each transition will represent 22.5° motion.



Multi-Pole Ring Magnet Field Vectors

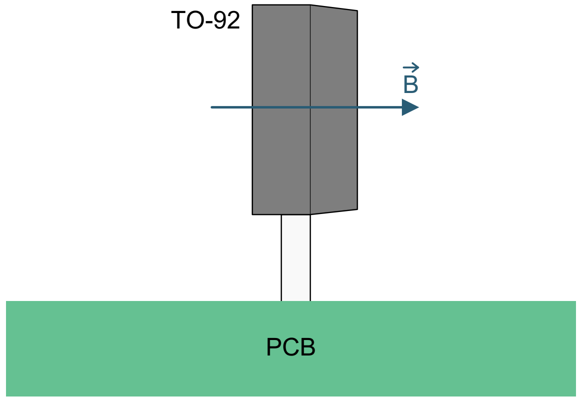




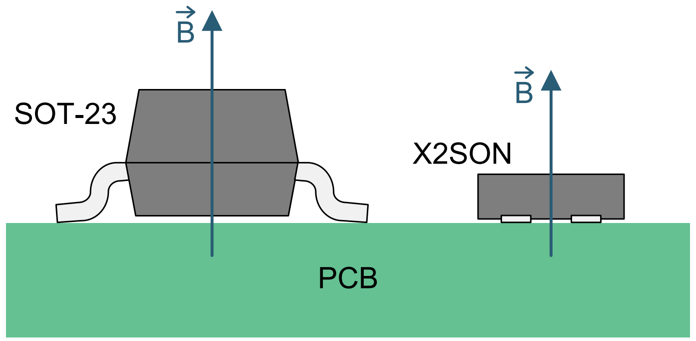
Hall Effect Latch: Sensing Directions

1D latch

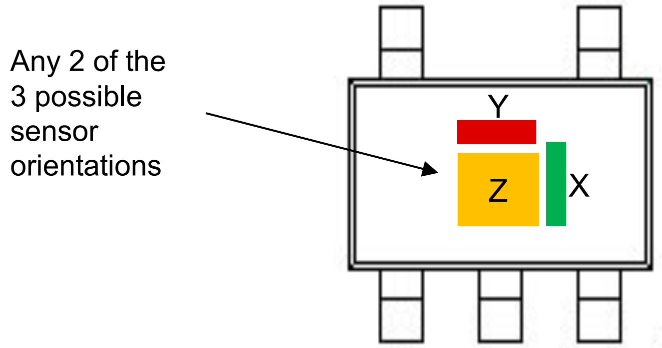
- Through-hole package:

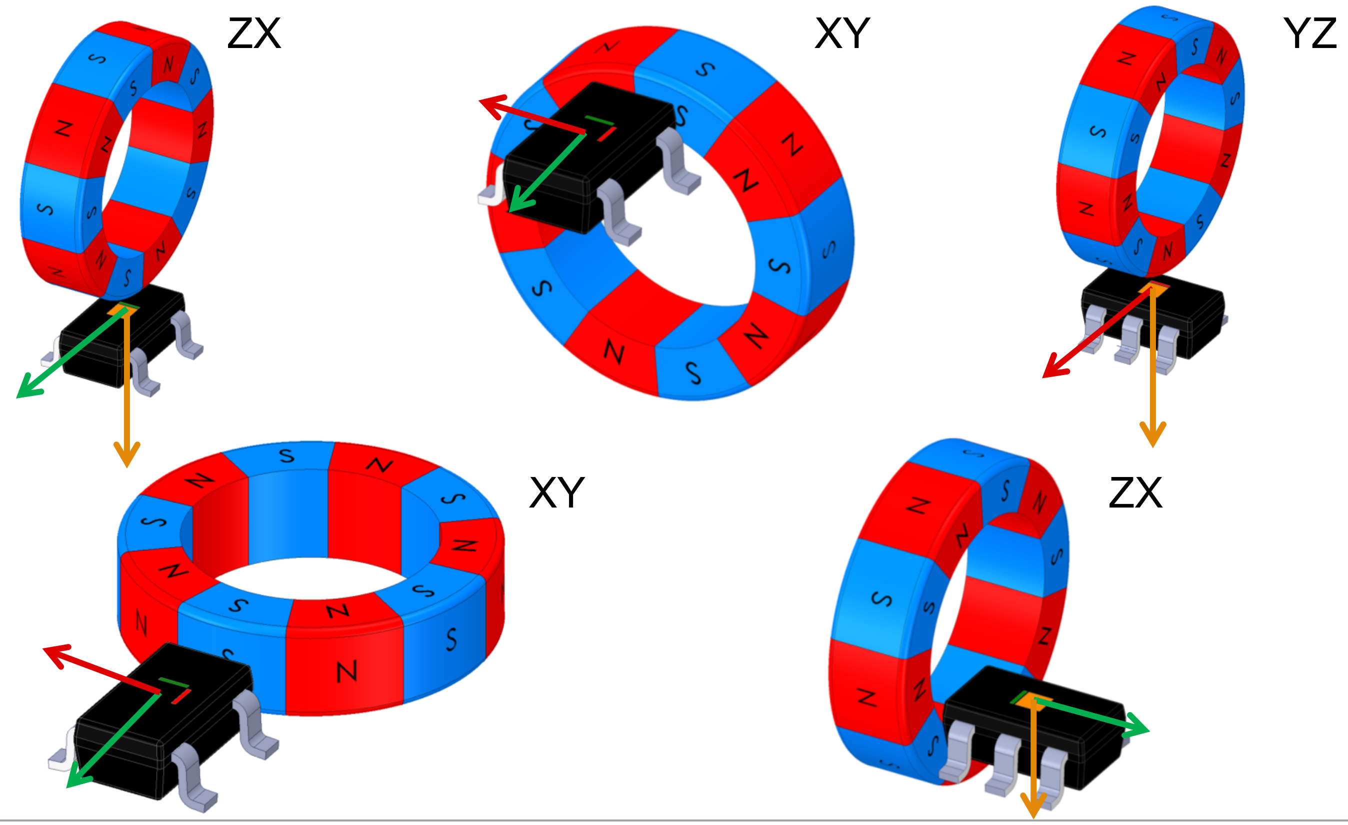


- Surface-mount package:

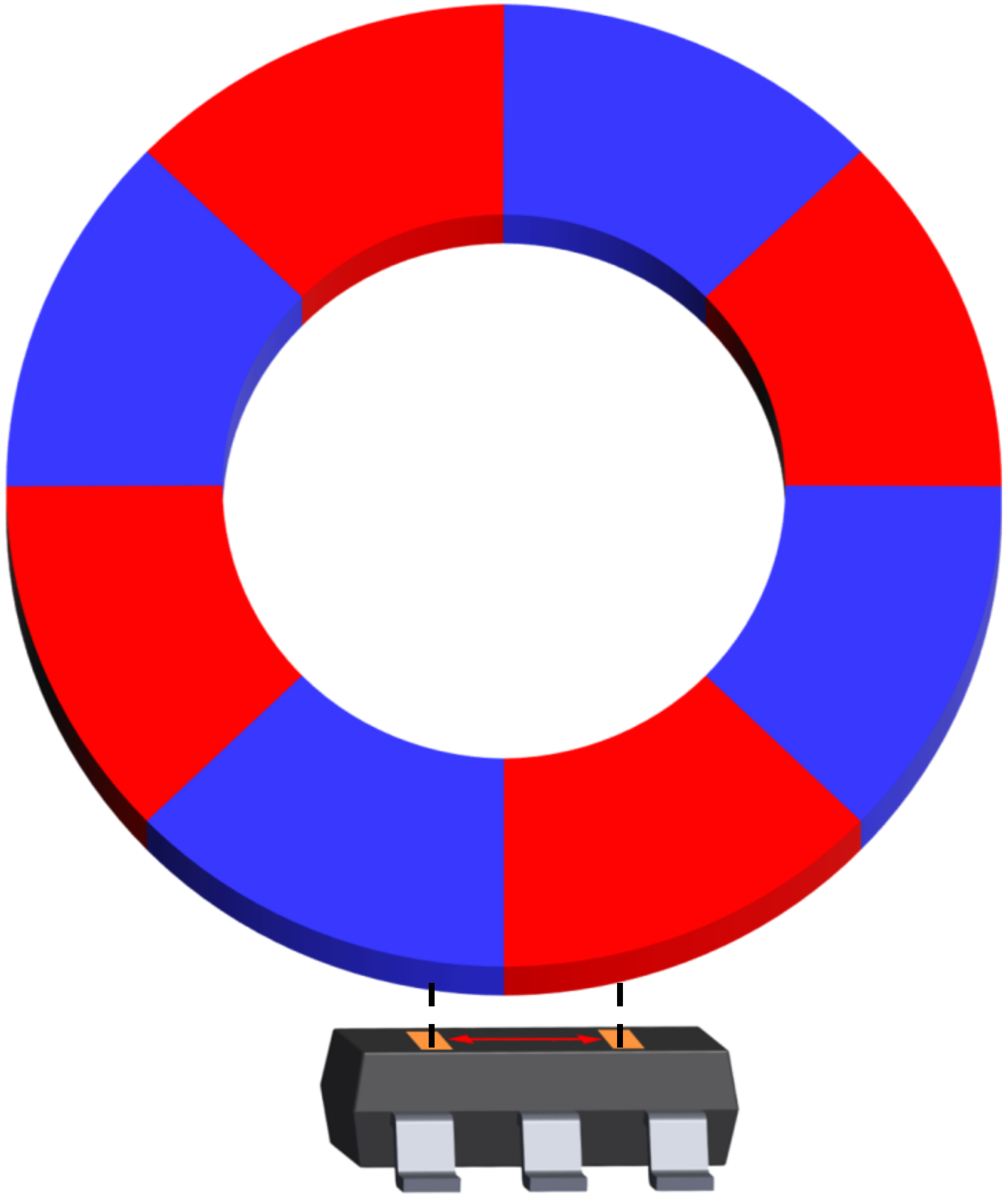


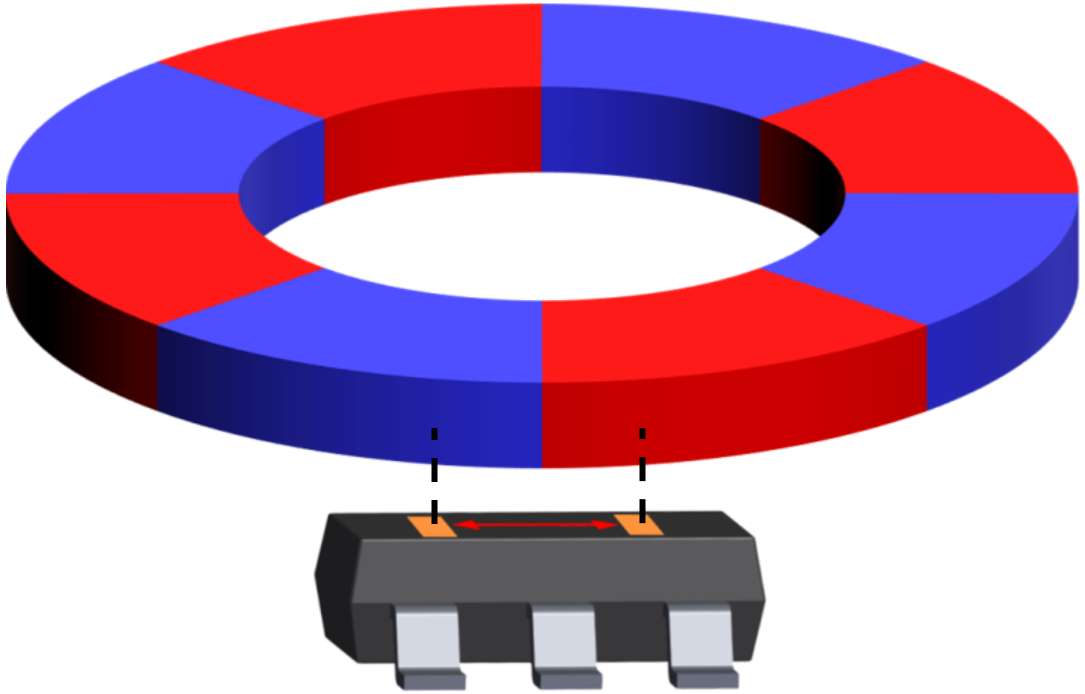
2D latch





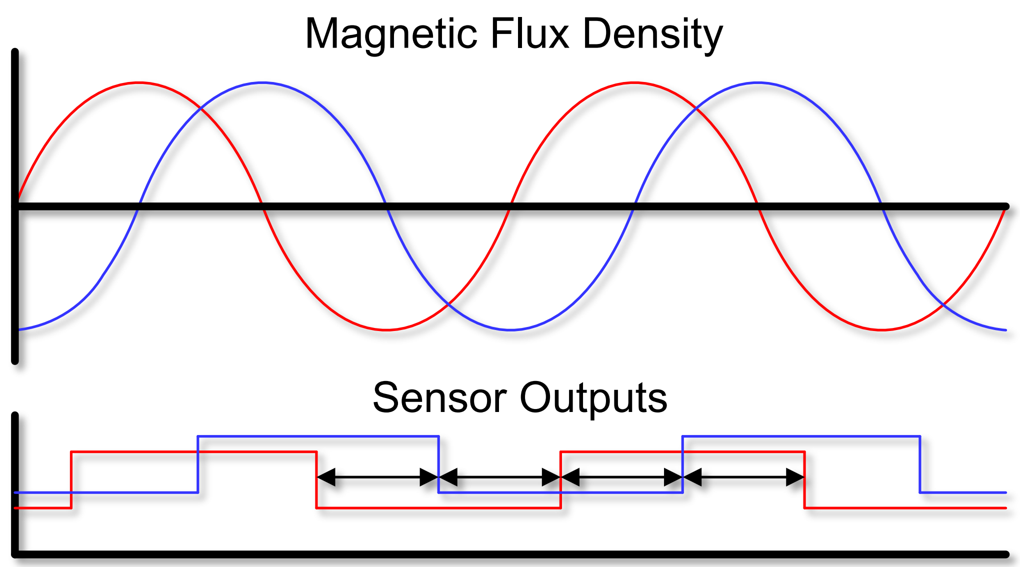
2-Channel latch limitations (2x One Dimensional)

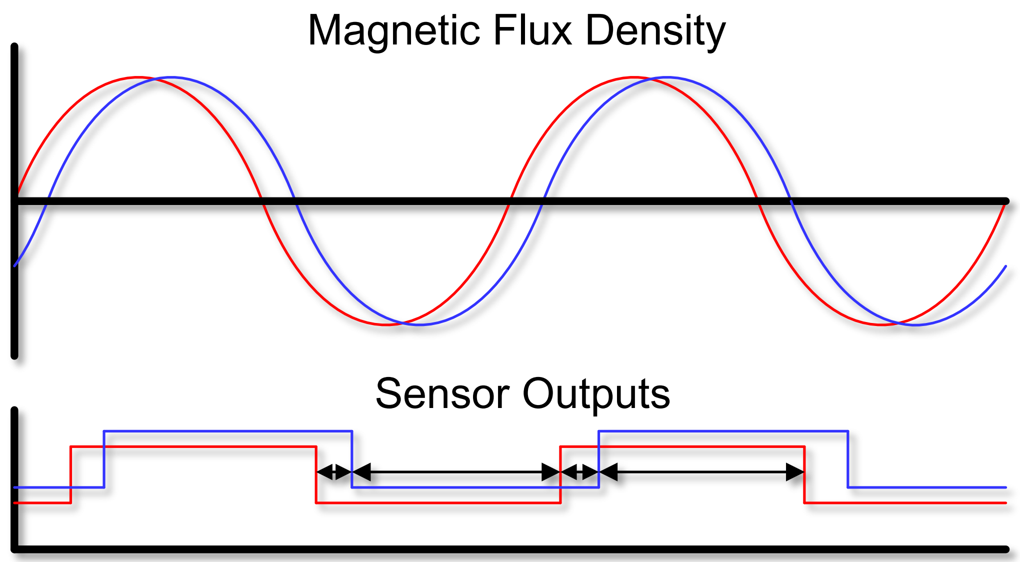




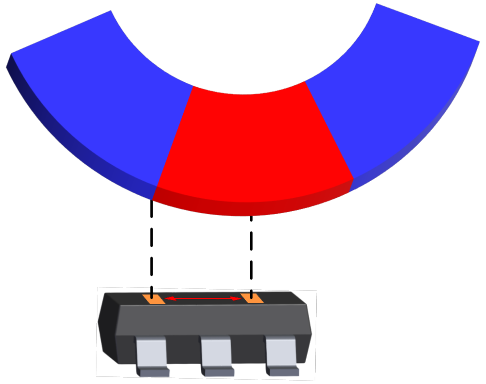
- IC/Magnet placement limited
- Magnet pole-pitch dependent on Hall sensor separation

Magnet pole-pitch challenges





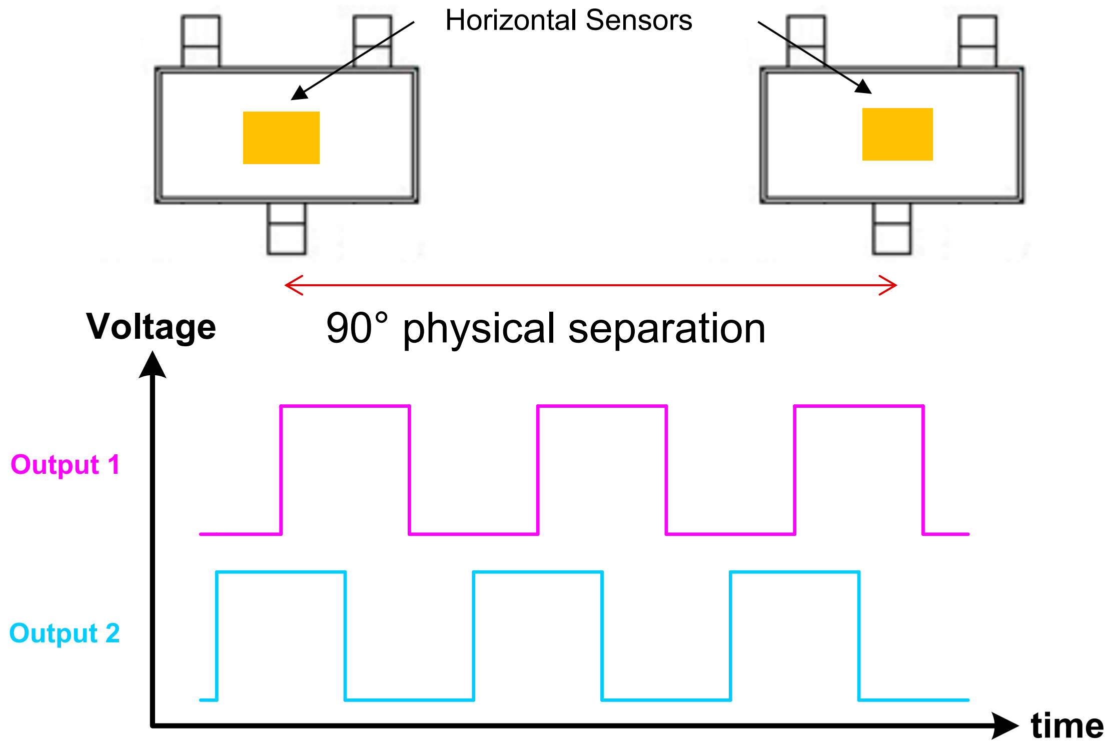
- Direction determination requires definitive quadrature
- Magnet pole placement & strength variation
  - Pole "size" variation up to ±3%
  - Pole field strength variation up to ±25%
- Precise design of pole pitch to optimize switching point needed



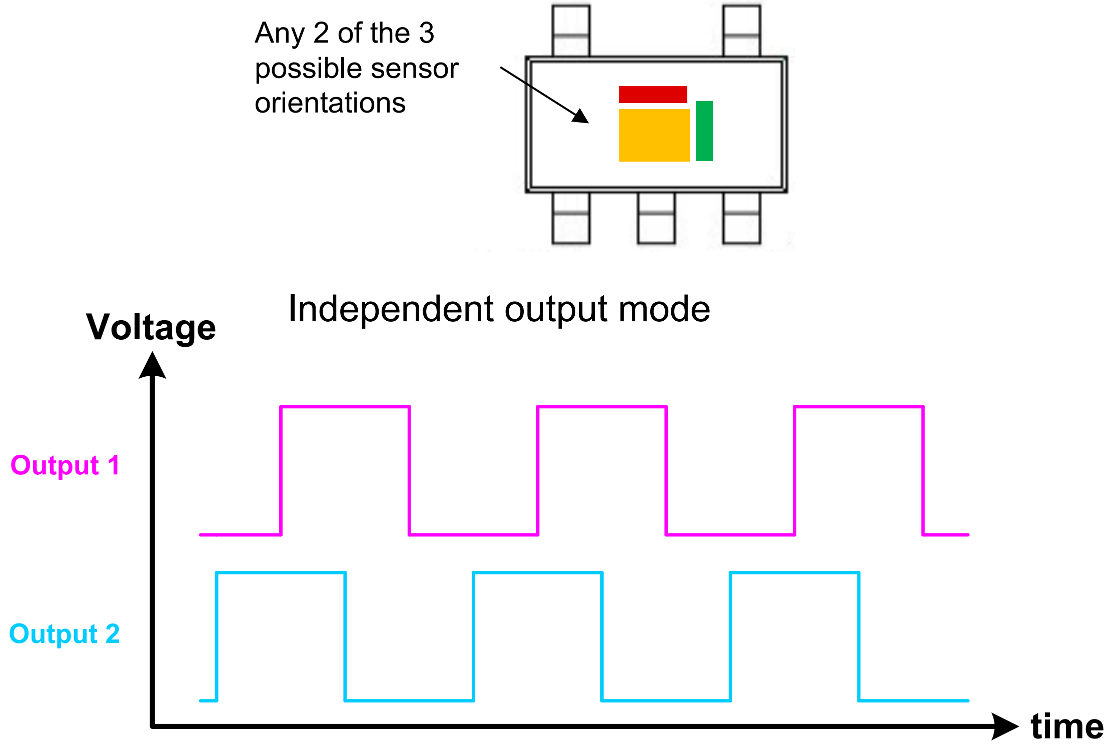
Pole pitch vs. Sensor Spacing

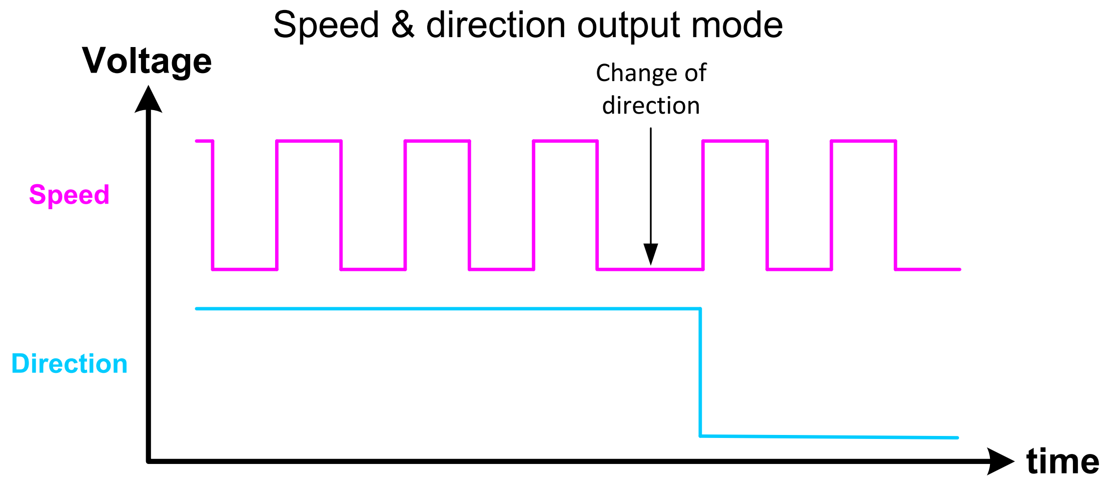
Hall effect latches: 1D vs. 2D

1D latch = 2 Devices



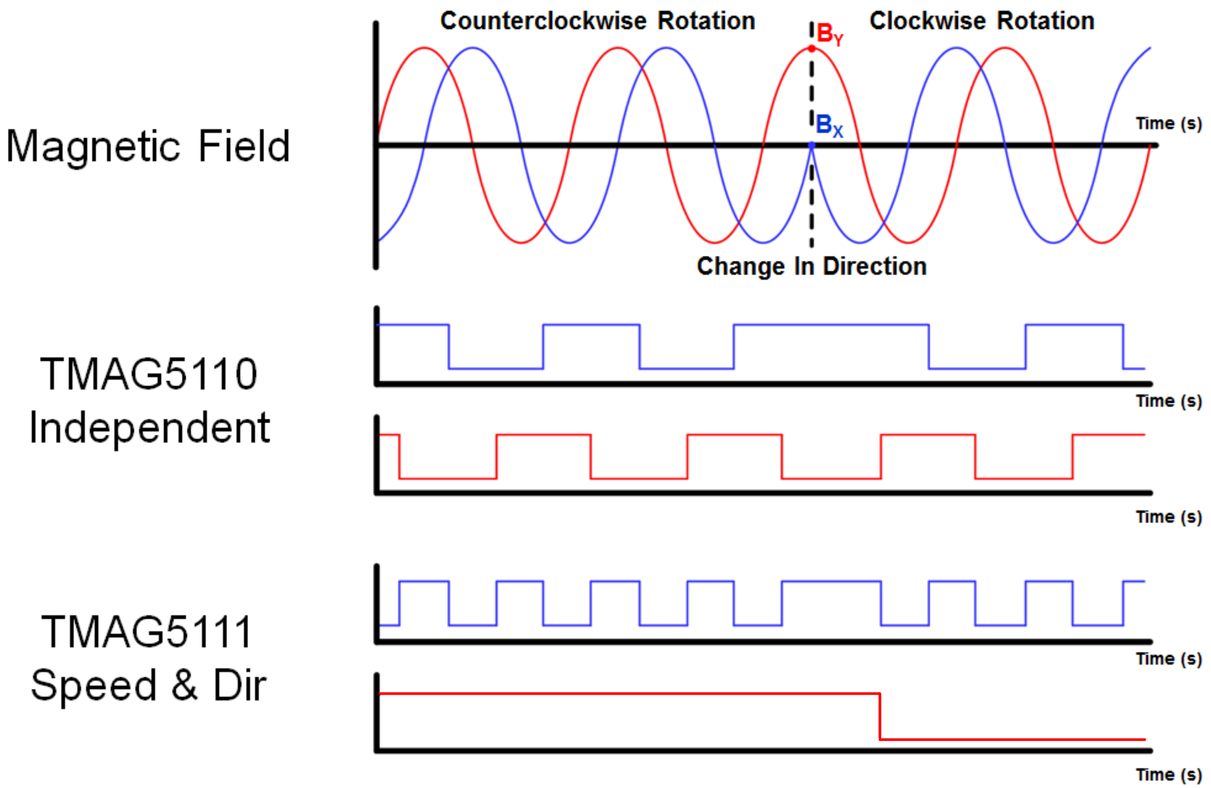
2D latch = 1 Device

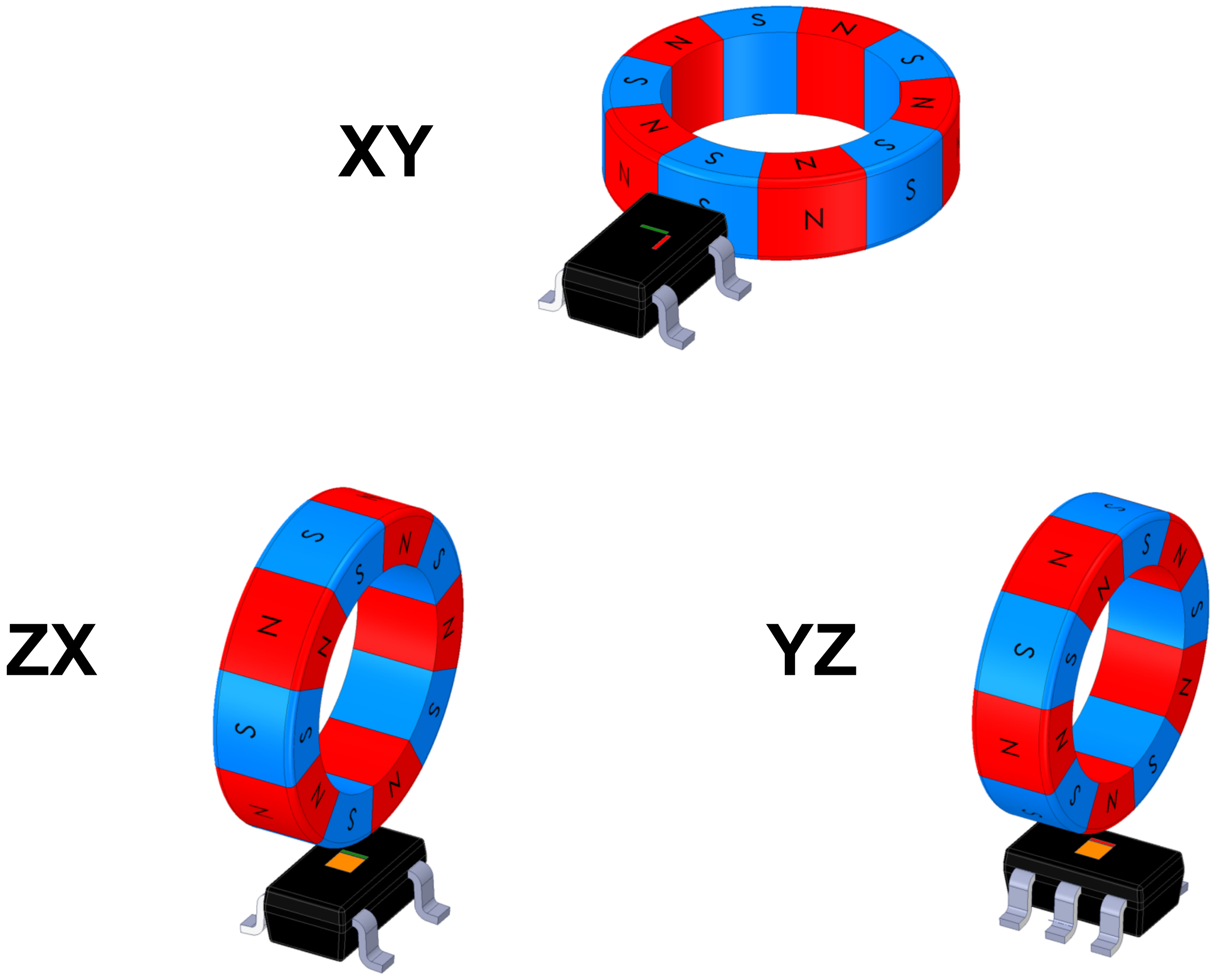




Rotary encoding with a 2D Hall effect latch

- Can be achieved utilizing a single TMAG5111 with speed and direction outputs
- Can also use the TMAG5110, but additional quadrature decoding is needed





Example applications for 2D latches

Automotive body motors & power closures

Garage door openers

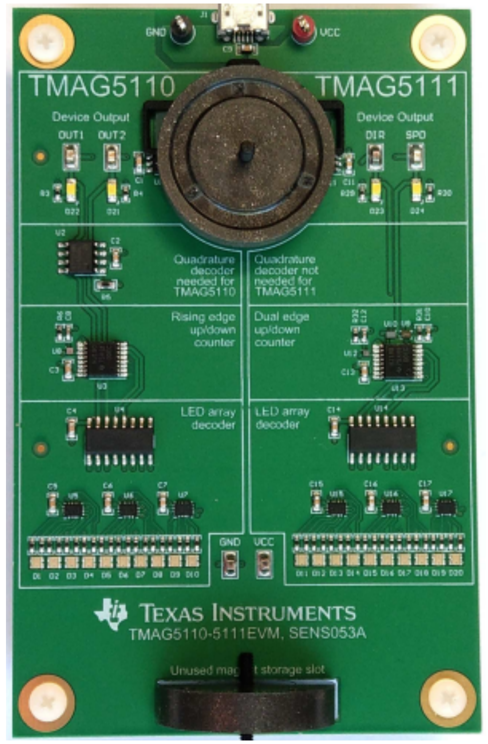
Thermostat dials

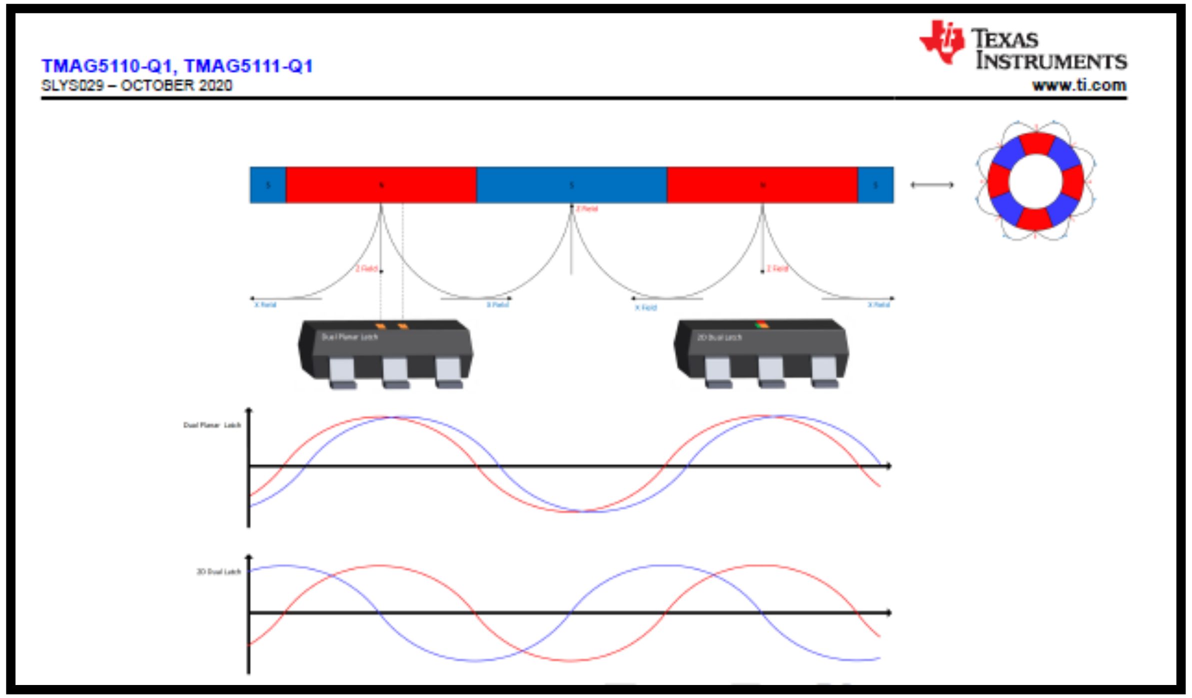
Vacuum robot wheels

Motorized window blinds

Supporting Material

TMAG5110-5111EVM





TI TechNotes

Incremental Rotary Encoder Design Considerations

Ross Eisenbeis, Magnetic Sensing Products

TEXAS INSTRUMENTS

Incremental rotary encoders transduce rotational movement into electrical signals. Unlike absolute encoders that measure angle, incremental encoders generate high/low pulses as turning occurs.

Applications include computer mouse wheels, fluid flow meters, knobs, wheel speed sensors, stepper motor feedback for detecting missed steps, and brushed DC motor sensors for automotive windows.

1. Contact: This relies on mechanical contacts to make or break electrical connections. Typically, the stationary component has islands of metal throughout a ring. The piece above it is free to rotate and has metal brushes that momentarily make contact with the islands, connecting them to ground. Figure 3 shows the electrical schematic.

Application Report

Reducing Quadrature Error for Incremental Rotary Encoding Using Two-Dimension Dual Hall-Effect Sensors

TEXAS INSTRUMENTS

Scott Bryson *Analog Signal Chain - Sensing*

ABSTRACT

Rotation tracking is an application commonly associated with latching Hall Sensors. Measurements of angular position, speed, and direction provide critical system feedback. Typically this application requires two sensors 90° out-of-phase from each other to achieve the desired quadrature output. Accuracy of the solution will depend on alignment and accuracy of the Hall Sensors. Devices such as TMAG5110 or TMAG5111 offer an additional in-plane sensor integrated into the package. This additional sensor is oriented in a second axis as well. This allows for intrinsic phase alignment in a single package, minimizes the layout effort by allowing a designer to use a single device, and provides excellent sensitivity threshold matching for superior performance. This application report discusses the nature of magnetic fields and design considerations related to two-dimensional Hall Sensors.

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

Two Dimensional (2D) Latches Quiz

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2D Hall Latch

1 Q) 2D Hall Effect Latches can be used to calculate absolute angular position

a)True

b) False

2 Q) Which of the following combination of axes is not available for TMAG5110

a)XY

b)YZ

c)ZX

d)None of the Above

2D Hall Latch

3 Q) What is the ideal phase separation for two sensors with quadrature or incremental encoding measurements?

a)90°

b)67.5°

c)45°

d)22.5°

4 Q) Changing direction of rotation results in what change to the output behavior

a)amplitude

b)phase

c)frequency

d)duty-cycle

2D Hall Latch

5) A 20 pole magnet will have an incremental resolution of

a) 18°

b) 20°

c) 9°

d) 36°

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2D Hall Latch

5) A 20 pole magnet will have an incremental resolution of

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b) 20°

c) 9° (360° / 2 sensors / 20 poles = 9°)

d) 36°

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