TI 2D Hall-Effect Latches: TMAG5110 &TMAG5111

March-2021

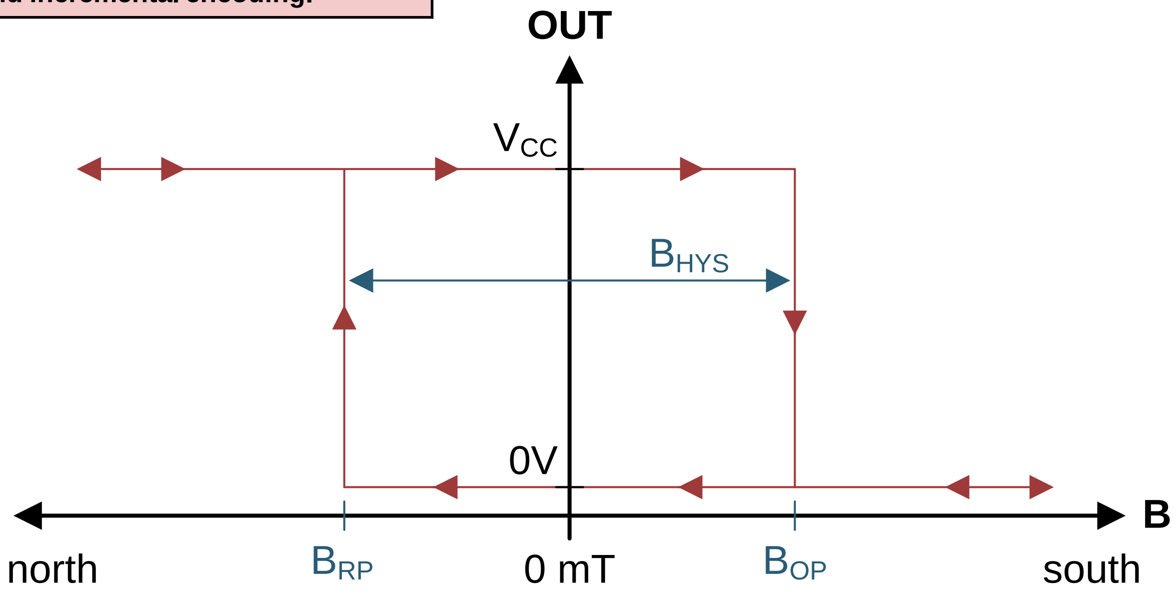
Agenda

- Hall-effect latch functionality overview
- Comparing 1D, dual-planar, and 2D latches
- TI's new 2D Hall-effect ICs: TMAG5110 & TMAG5111
- Example applications
- Key online resources

Hall-effect latch operation

Hall-effect latch

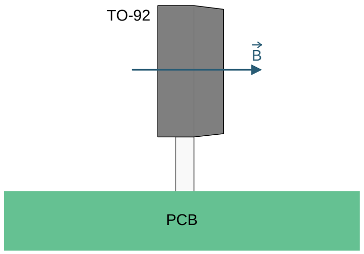
Indicates the most recently measured magnetic flux density. These are used in rotary applications such as BLDC motor sensors and incremental encoding.



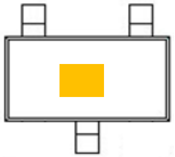
Sensing directions

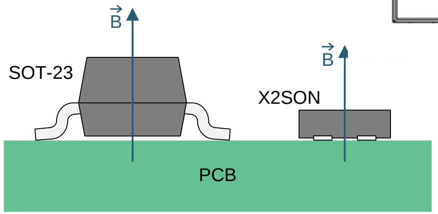
1D latch

- Through-hole package:

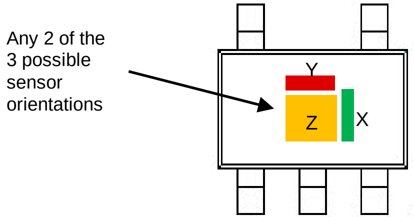


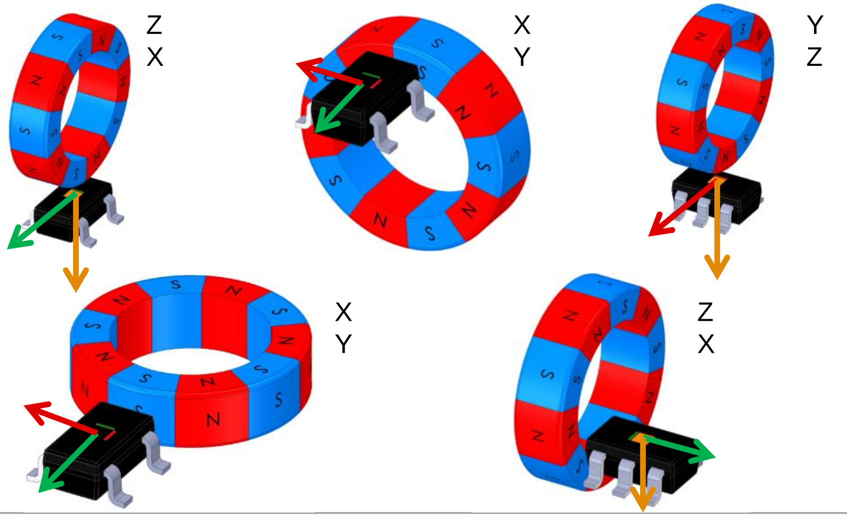
- Surface-mount package:



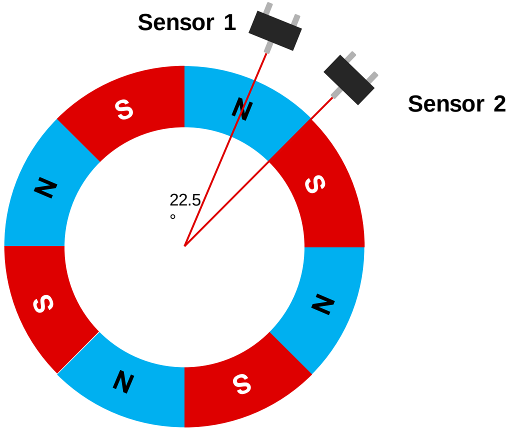


2D latch





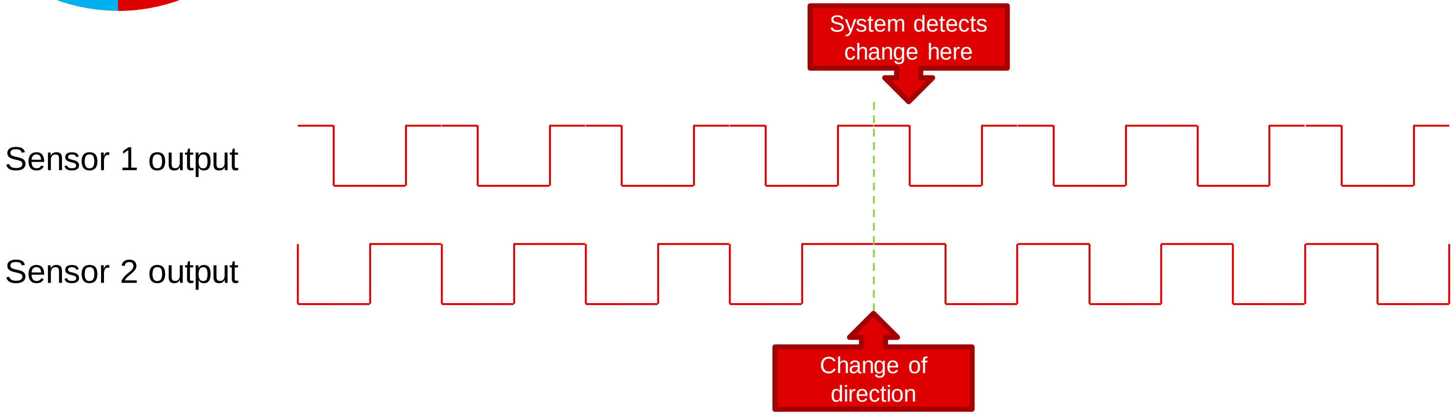
Rotary encoding using 1D latches



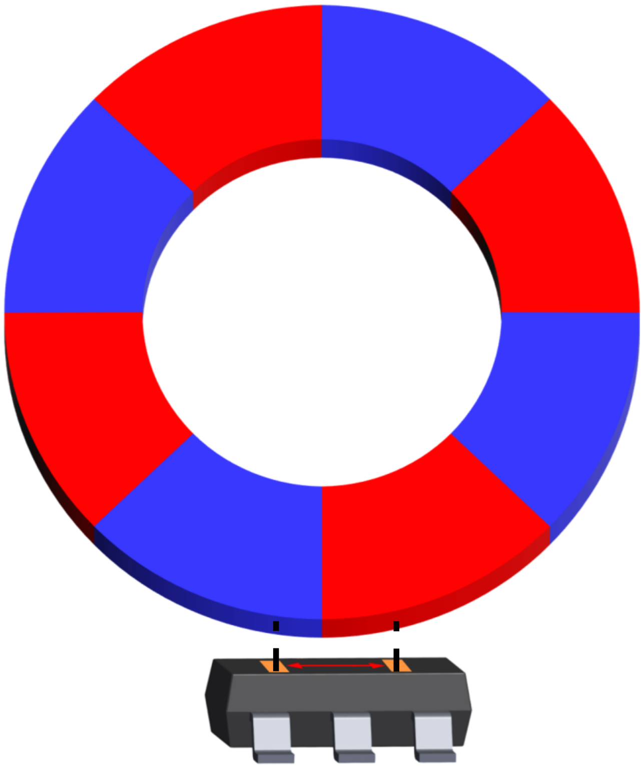
Latch spacing = ½ Pole Length + Integer # of Poles

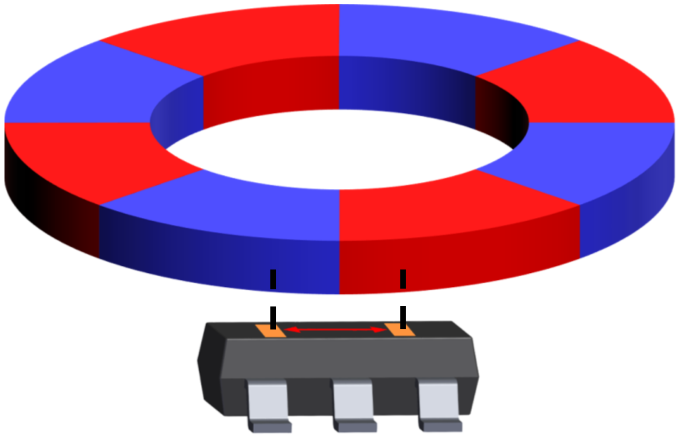
Output transitions = 360° / # poles / # sensors

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.



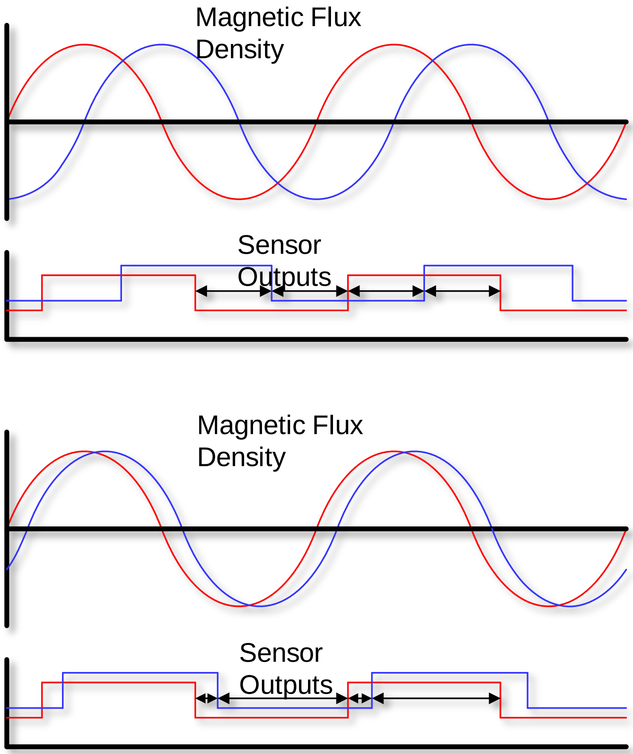
Dual-planar latch



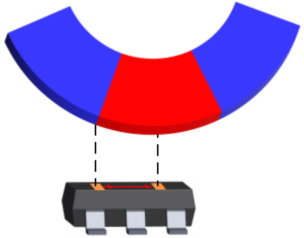


- IC/Magnet placement limited
- Magnet pole-pitch dependent on Hall sensor separation

Dual-planar latch challenges: magnet pole pitch



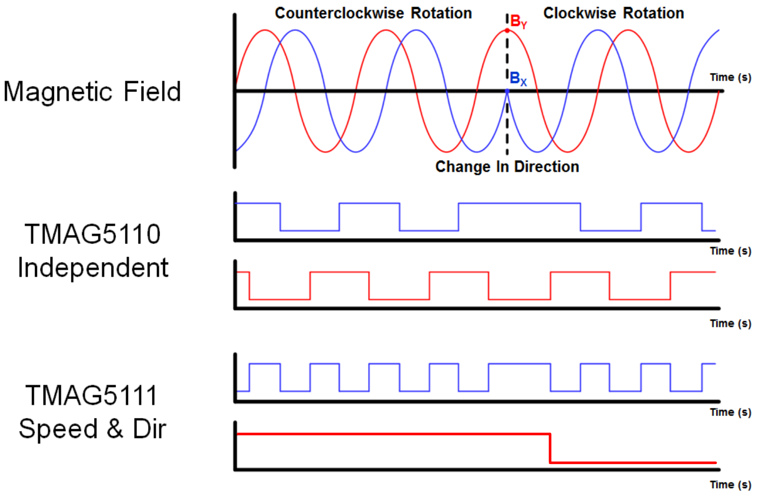
- Direction determination requires definitive quadrature
- Magnet pole placement & strength variation
  - Pole “size” variation up to ±3%
  - Pole field strength variation up to ±25%
- Precise design of pole pitch to optimize switching point needed

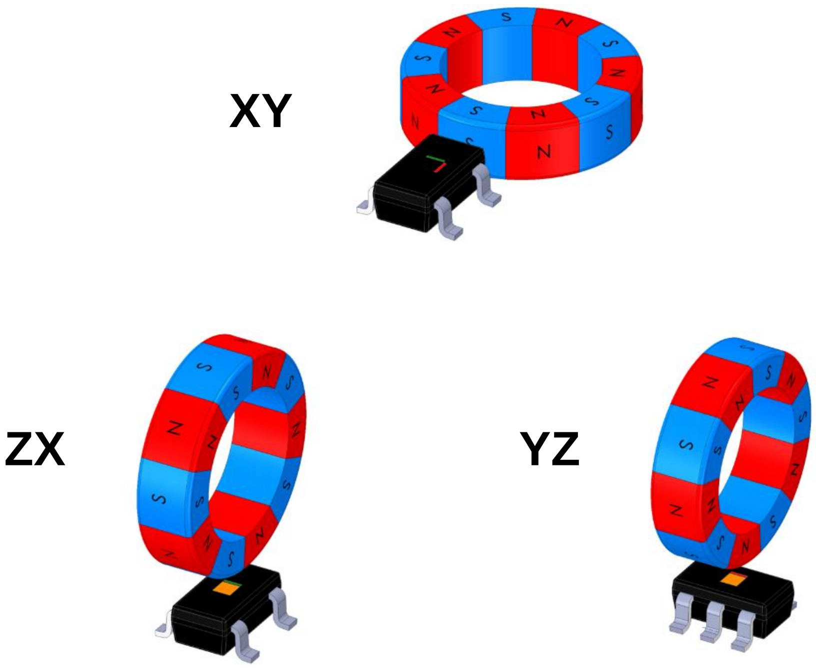


Pole pitch vs. Sensor Spacing

Rotary encoding using a 2D latch

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





TMAG5110 & TMAG5111

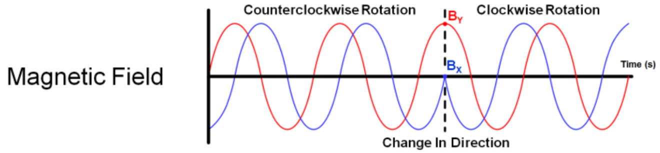
2-dimensional, dual-channel, high-sensitivity Hall-effect latches

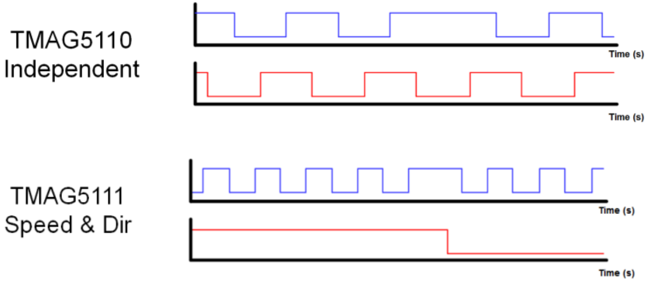
Features

- TMAG5110: Dual Independent outputs
- TMAG5111: Speed and Direction outputs
- Magnetic threshold: 2.6 mT max
- Three 2-axis sensing options:
  - X axis & Y axis
  - X axis & Z axis
  - Y axis & Z axis
- Wide operating V_{cc}: 2.5 V to 38 V
- 40kHz sensing bandwidth (dual continuous channels)
- Open-Drain output
- 5-pin SOT-23 package
- Operating temperature range: -40°C to 125°C

Benefits

- Used in a wide range of applications with multipliable magnetic fields: bar and ring magnets
- High sensitivity reduces the required magnet size or increases the allowable air gap.
- Different sensing directions allows off axis sensing capabilities
- Fast sampling enables use in high-rpm BLDC motors.
- Consistent performance across wide temperature range
- Requires external pull-up, allowing for more flexible implementation.
- Voltage range compatible with many battery types and traditional MCUs.





Example applications for 2D latches

Automotive body motors & power closures

Garage door openers

Thermostat dials

Vacuum robot wheels

Motorized window blinds

Knobs

TMAG5110-5111EVM

2D, Dual-Channel, High Sensitivity Hall Effect Latch EVM

Features

- Two different ICs on same board
  - TMAG5110: independent 2D outputs
  - TMAG5111: speed and direction outputs
- Mount capable of housing a multi-pole ceramic magnet in two orientations
  - Horizontally over device
  - Vertically alongside device
- 10-pole and 20-pole magnets packaged with PCB
- Magnetic viewing film and USB cable included in kit

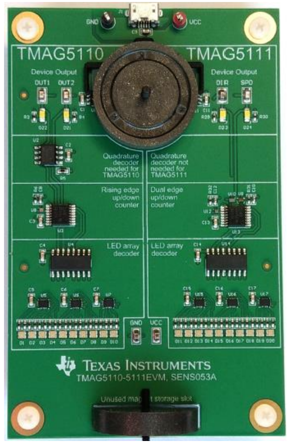
Benefits

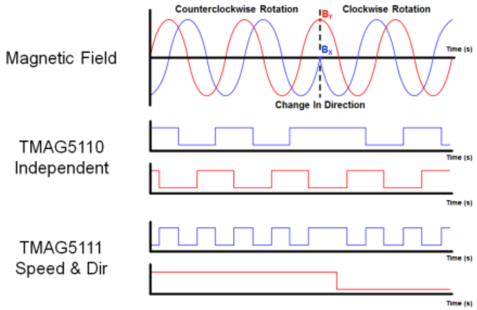
- Ability to test and monitor quadrature decoding circuit and speed and direction circuit side by side
- Independence of magnet placement relative to sensor (allows for experimentation with further magnet placement options)
- Independence of magnet pole pitch
- Conveniently powered from a common micro-USB connector

Applications

- Incremental rotary encoding
- Brushed motor feedback
- Automotive power closures, window/sunroof/seat motors, seatbelt tensioners
- Wheel speed and direction (e.g. vacuum robots, factory logistic robots)
- Home-automated blinds
- E-locks
- Knobs
- Flow meters

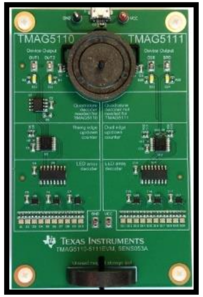
TMAG5110-5111EVM



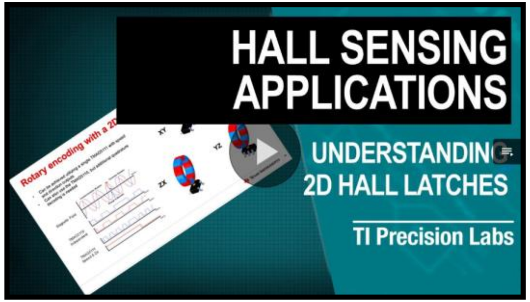


Tools and resources

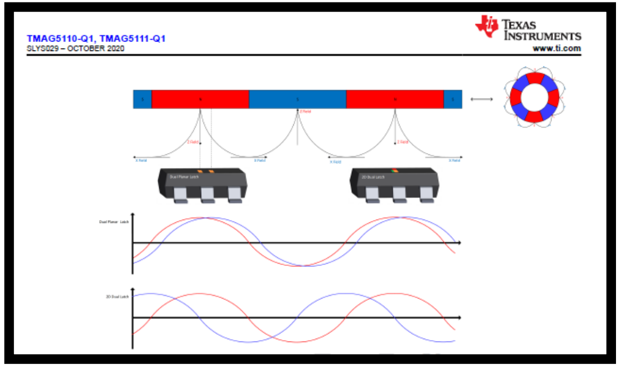
TMAG5110-5111EVM



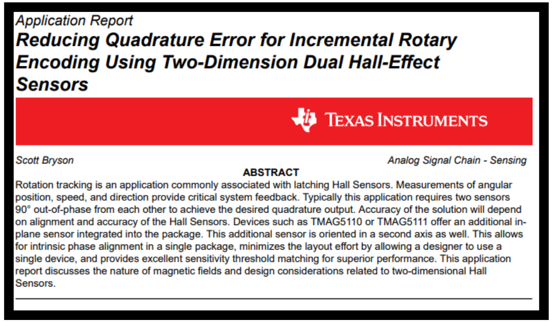
TIPL Video



TMAG511x Datasheet



App Notes



Application Report

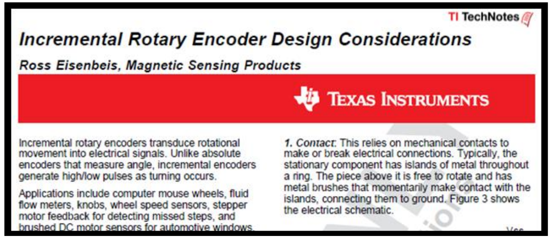
Reducing Quadrature Error for Incremental Rotary Encoding Using Two-Dimension Dual Hall-Effect Sensors

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.



TI TechNotes

Incremental Rotary Encoder Design Considerations

Ross Eisenbeis, Magnetic Sensing Products

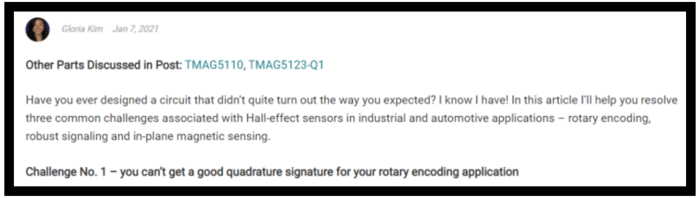
TEXAS INSTRUMENTS

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.

Technical Article



Gloria Kim Jan 7, 2021

Other Parts Discussed in Post: TMAG5110, TMAG5123-Q1

Have you ever designed a circuit that didn't quite turn out the way you expected? I know I have! In this article I'll help you resolve three common challenges associated with Hall-effect sensors in industrial and automotive applications – rotary encoding, robust signaling and in-plane magnetic sensing.

Challenge No. 1 – you can't get a good quadrature signature for your rotary encoding application

Thank you!