

Welcome!

Texas Instruments New Product Update

- This webinar will be recorded and available at www.ti.com/npu
- Phone lines are muted
- Please post questions in the chat or contact your TI sales contact or field applications engineer

Linear 3D Hall-effect Sensors

New Product Update

Kevyn Robins
January 27, 2022

Agenda

- Multi-axis linear and angle position sensor portfolio
- Linear Hall-effect sensor overview
 - Single-axis versus multi-axis sensors
- TI's new linear 3D Hall-effect sensor: TMAG5273
 - Dedicated interrupt pin
 - Programmable thresholds and tamper detection
 - Configurability
- Example applications
- Tools and resources

Please message Mekre Mesganaw, Applications Engineer, if you have any questions throughout this presentation.

Linear Hall-effect sensor portfolio

Legend:



Automotive option available



TO-92 option available

Multi-axis

The image shows three overlapping screenshots of the Texas Instruments website. The top screenshot shows the TMAG5170 product page, highlighting its 'High-precision' and 'Automotive, high-precision interface' features. The middle screenshot shows the TMAG5170-Q1 product page, also highlighting its 'Automotive, high-precision interface'. The bottom screenshot shows the TMAG5273 product page, highlighting its 'Low-power linear 3D Hall-effect sensor with I²C interface' and 'ACTIVE' status. A table of parameters is visible in the bottom screenshot:

Parameter	Value
Type	3-Axis linear
Supply voltage (Vcc) (Min) (V)	1.7
Supply voltage (Vcc) (Max) (V)	3.6
Sensitivity error (%)	20
Rating	Catalog
Magnetic sensing range (mT)	40, 80, 133, 266

To learn more about the TMAG5170, watch the previously recorded "Hall Sensors" webinar at

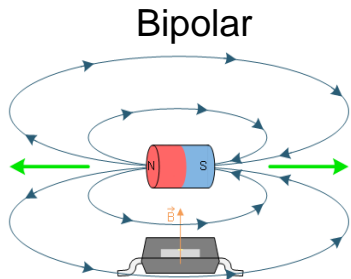
www.ti.com/npu
TMAG5273 to 3.6V; I²C; General use

Digital

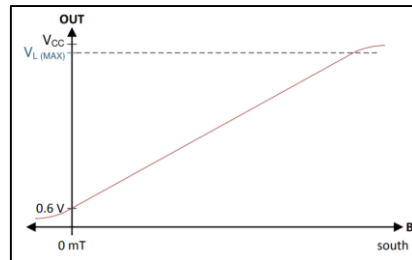
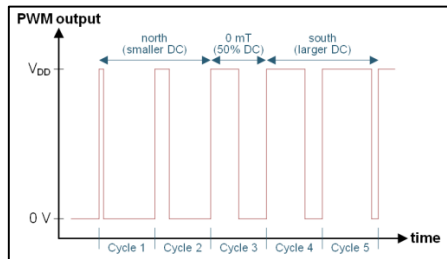
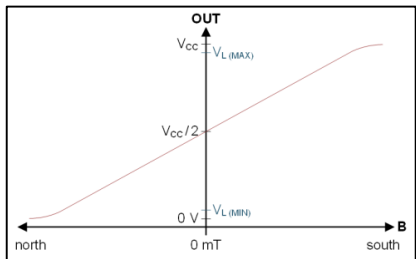
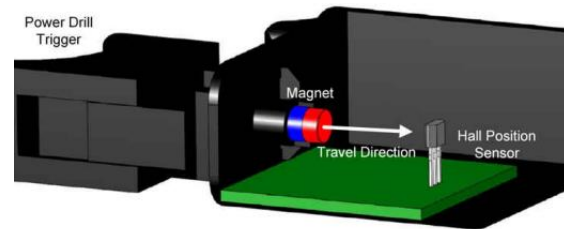
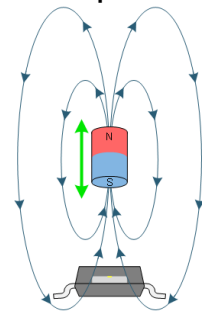
X, Y or Z

Single-axis linear Hall-effect sensors

- Single-axis (1D) sensors output a signal that's proportional to magnetic flux density to measure precise movement
- Typically, only sensitive to magnetic fields that are perpendicular to the surface of the package

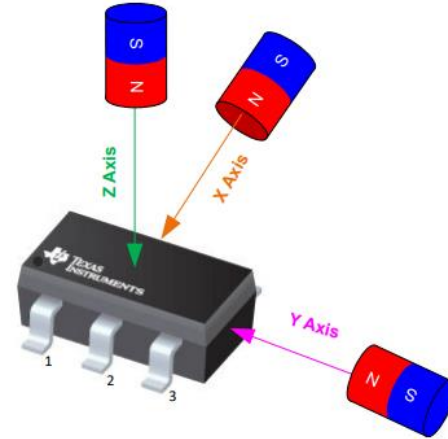
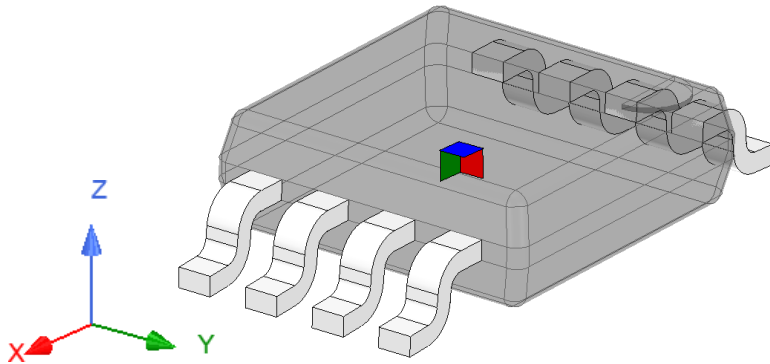


Unipolar



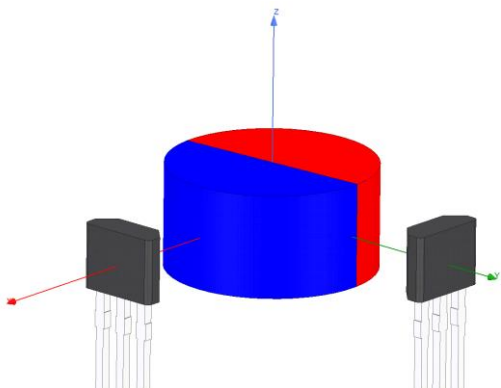
Multi-axis linear Hall-effect sensors

- Three-dimensional (3D) sensors enable optimal absolute position measurements with a high degree of flexibility in function and placement
- Integrates three independent Hall elements in the X, Y and Z axes in a single package

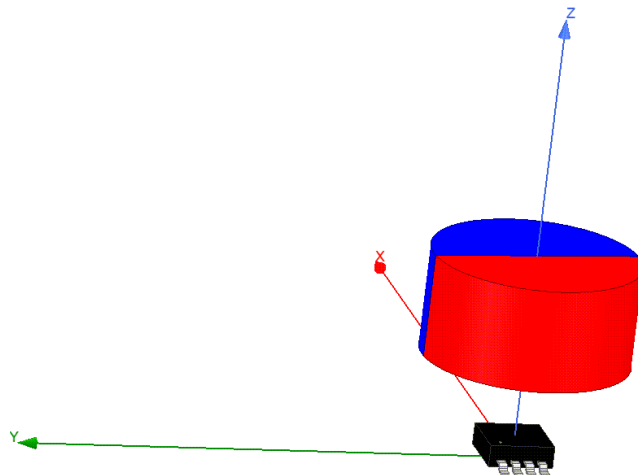


1D versus 3D sensors: angle measurement

1D linear implementation



3D linear implementation



TMAG5273

Low-power, linear 3D Hall-effect sensor with I²C output interface

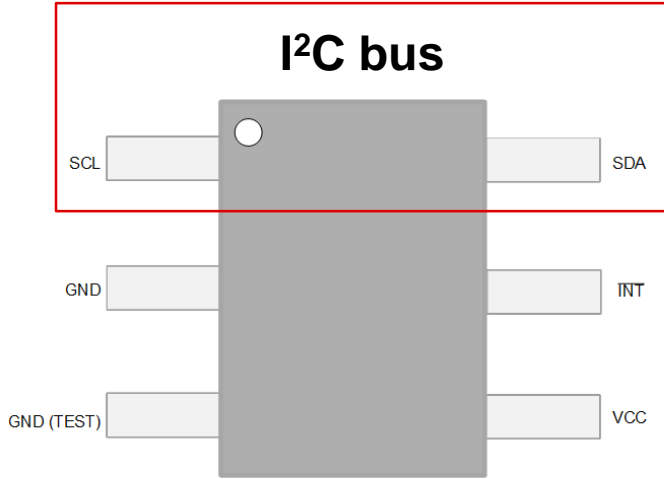
Features

- Dedicated interrupt pin
- Multiple power mode options, including wake-up and sleep mode for low-power operation
- Integrated CORDIC angle calculation
- I²C output interface with cyclic redundancy check (CRC)
- Selectable X, Y and Z magnetic ranges:
 - A1: $\pm 40\text{mT}$, $\pm 80\text{mT}$
 - A2: $\pm 133\text{mT}$, $\pm 266\text{mT}$
- V_{CC} from 1.7 V to 3.6 V

Benefits

- High level of configurability to:
 - Optimize speed and power consumption
 - Set programmable thresholds for the X, Y and Z axes and temperature sensor
 - Implement offset and gain correction
- Integrated CORDIC angle calculation eliminates need for post-processing in host microcontroller
- Offers flexibility in device functionality and sensor placement

Dedicated interrupt pin

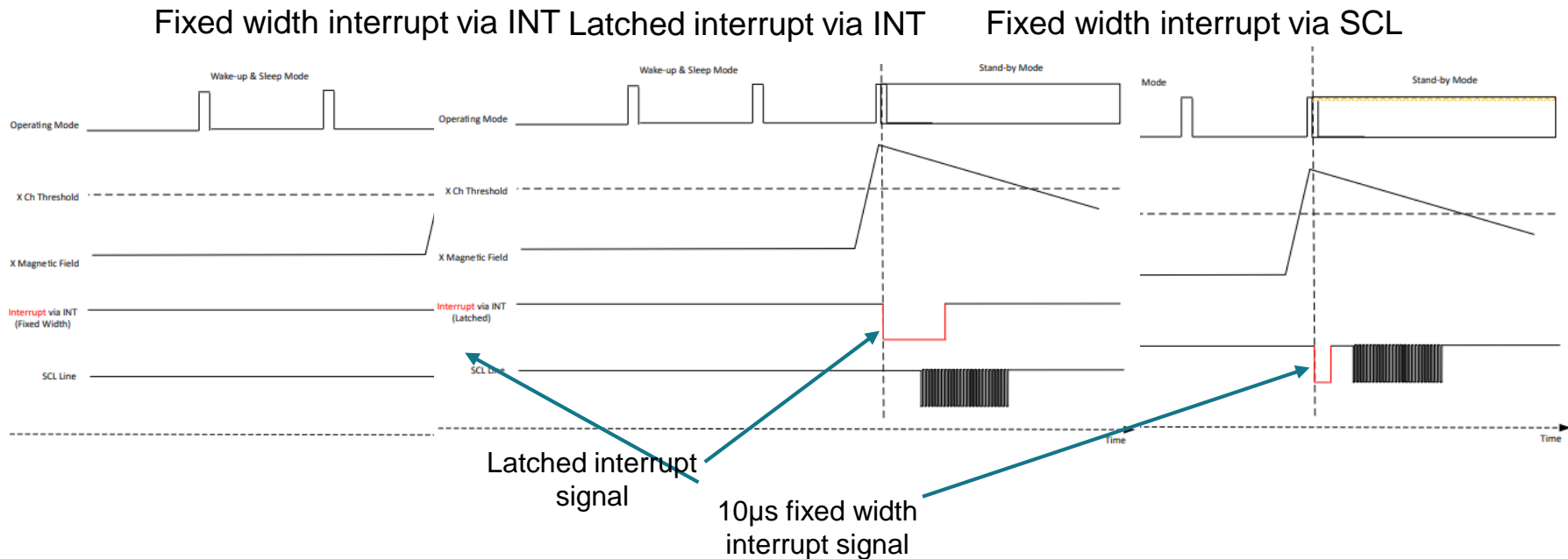


DBV (6-SOT23) package
(2.9mm x 2.8mm)

Interrupt pin functionality:

- Can be used to implement **low power system operation**. The device wakes up periodically to measure the sensor parameters and only wakes up the MCU through the INT\ pin if a predefined threshold is crossed.
- The MCU can **trigger** a new conversion through the INT\ pin

Configurable interrupt functions: \overline{INT} or SCL pin



Programmable thresholds and tamper detection

- Programmable magnetic field thresholds to initiate an interrupt
 - Independent X, Y and Z axis and temperature channel thresholds
 - Thresholds can be monitored simultaneously for all channels
 - Any channels not used for measurement can act as an additional input source to initiate an interrupt and force the MCU to protect the system to:
 - Detect magnetic tampering
 - Reject inputs when stray fields are present

TMAG5273 configurability

- **Selectable linear magnetic ranges:**
 - A1: $\pm 40\text{mT}$, $\pm 80\text{mT}$ or A2: $\pm 133\text{mT}$, $\pm 266\text{mT}$
- **Supported conversion rates:**
 - 20, 13.3, 8, 4.4, 2.4, & 1.2 kSPS single axis conversion rate
- **Integrated temperature compensation for multiple magnet types:**
 - $0.0 \frac{\%}{^{\circ}\text{C}}$, $+0.12 \frac{\%}{^{\circ}\text{C}}$ (neodymium magnets), $+0.2 \frac{\%}{^{\circ}\text{C}}$ (ceramic magnets)
- **Supported wake-up and sleep mode intervals:**
 - 1, 5, 10, 15, 20, 30, 50, 100, 500, 1000, 2000, 5000, and 20000-ms
- **Configurable averaging up to 32x for noise reduction**

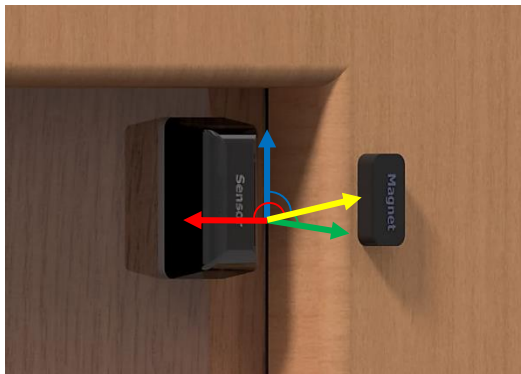
Wake-up duty cycle	Sleep interval	Temp and 3-ch operation I_{average} @ 3.3 V	Temp and 1-ch operation I_{average} @ 3.3 V
1,000 Hz	1 ms	240.17 μA	160.90 μA
100 Hz	10 ms	28.19 μA	18.64 μA
20 Hz	50 ms	6.58 μA	4.64 μA
1 Hz	1,000 ms	1.37 μA	1.28 μA

Example applications

Electricity meters



Door and window sensors



Electronic smart locks



HMI knobs

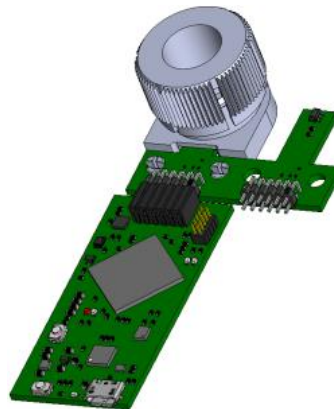


Joysticks



Tools and resources

- Visit the TMAG5273 [product folder](#)
- Start evaluating with the [TMAG5273EVM](#)
 - Includes a 3D printed rotate and push module
 - Compatible with our additional 3D print attachment design files ([slide-by](#), [joystick](#), [head-on linear](#) and [orbital](#) attachments)
 - Watch our EVM getting started [video](#)
- Magnetic sensors TI Precision Labs [video series](#)
 - Tamper detection TI Precision Labs [video](#)
- Limit detection for tamper detection [application brief](#)
- Reed switch replacement with Hall-effect sensors [application note](#)
- Magnetic sensing proximity [tool](#)



Application Brief Limit Detection for Tamper and End-of-Travel Detection Using Hall-Effect Sensors

TEXAS INSTRUMENTS

An advanced diagnostics are increasingly being installed in various applications. It is often desired to detect when a unique or anomalous event occurs in a system. Examples events to detect could include the detection of when a normally closed system is opened, detection of an unlabeled or unidirectional reaching its end of travel, or even detection of a large external magnetic field. In all these cases, a simple Hall-effect sensor can often solve this problem in a reliable and robust manner. This article discusses how the precision sensors in this application note can be used for tamper detection, end-tamper detection, and end-of-travel detection.

low power sleep mode to reduce the average current consumption.

As an example, in electricity meters, a strong magnet can penetrate any current transformer current sensors or power supply transformers. As a result, strong magnets can penetrate power and electricity meters to steal electricity. The tampering magnet can be captured magnets to drive a Figure 1, an event happens. To counteract magnetic tampering, meter manufacturers often use Hall position sensors to detect whenever external magnetic fields are beyond a predefined limit. In some cases, the meter deals with detected magnetic tampering by overcharging the customer on a pro-rata basis.

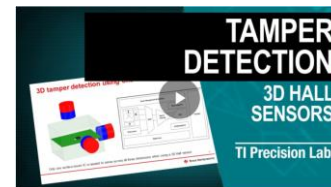
Magnetic tamper detection

External magnetic fields may affect magnetically-sensitive components in many systems. Examples applications may include electricity meters, gas meters, door and window sensors, cordless power tools, and electronic smart locks. To deal with external magnetic fields tampering with the system, a Hall position sensor can be used to provide an alert to the system when the external magnetic field is beyond a predefined limit. This limit should be dependent on the Hall position sensor detection external magnetic fields before they are strong enough to significantly affect the operation of the system.

To detect strong magnetic fields from either the North or South poles of the magnet, an omnidirectional Hall position sensor is often used. The omnidirectional sensor will sense fields associated with both poles of the magnet. In addition, these 1-dimensional Hall sensors are arranged across three dimensions or 3-dimensional. Hall sensor can be used to detect strong magnets across all three dimensions. If only unidirectional magnets need to be detected, flat switches are commonly used and the magnetic field is applying. The polarization of the flat switch requires that an AC magnetic field must also be detected. Linear Hall sensors can be used instead if the system is powered from a battery, a duty cycle mode operation is also common, where the Hall position sensor alternates between active measurement mode and



Figure 1. Magnet Tampering in Electricity Meters



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