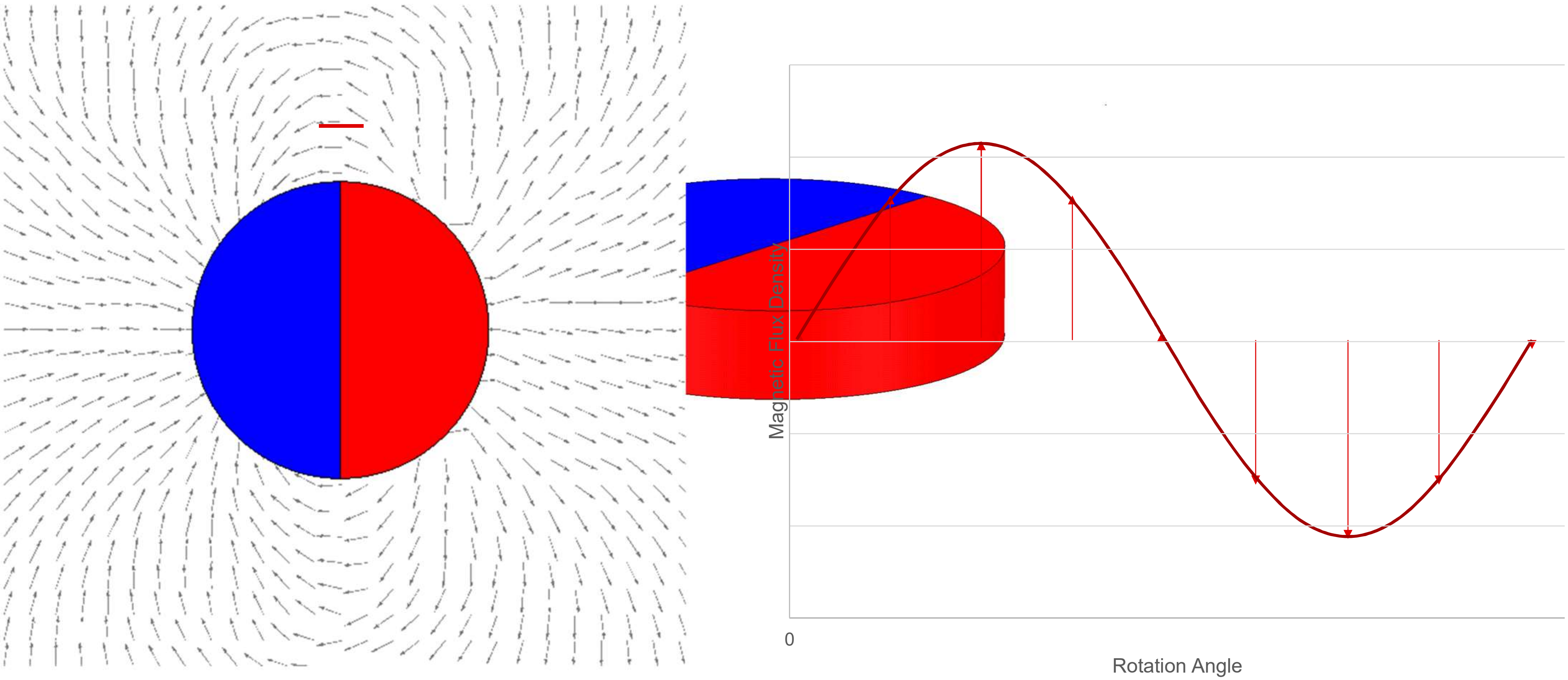
Hall Effect Sensors : Angle Detection

TI Precision Labs – Magnetic Sensors

Presented and Prepared by Scott Bryson

Angle Detection

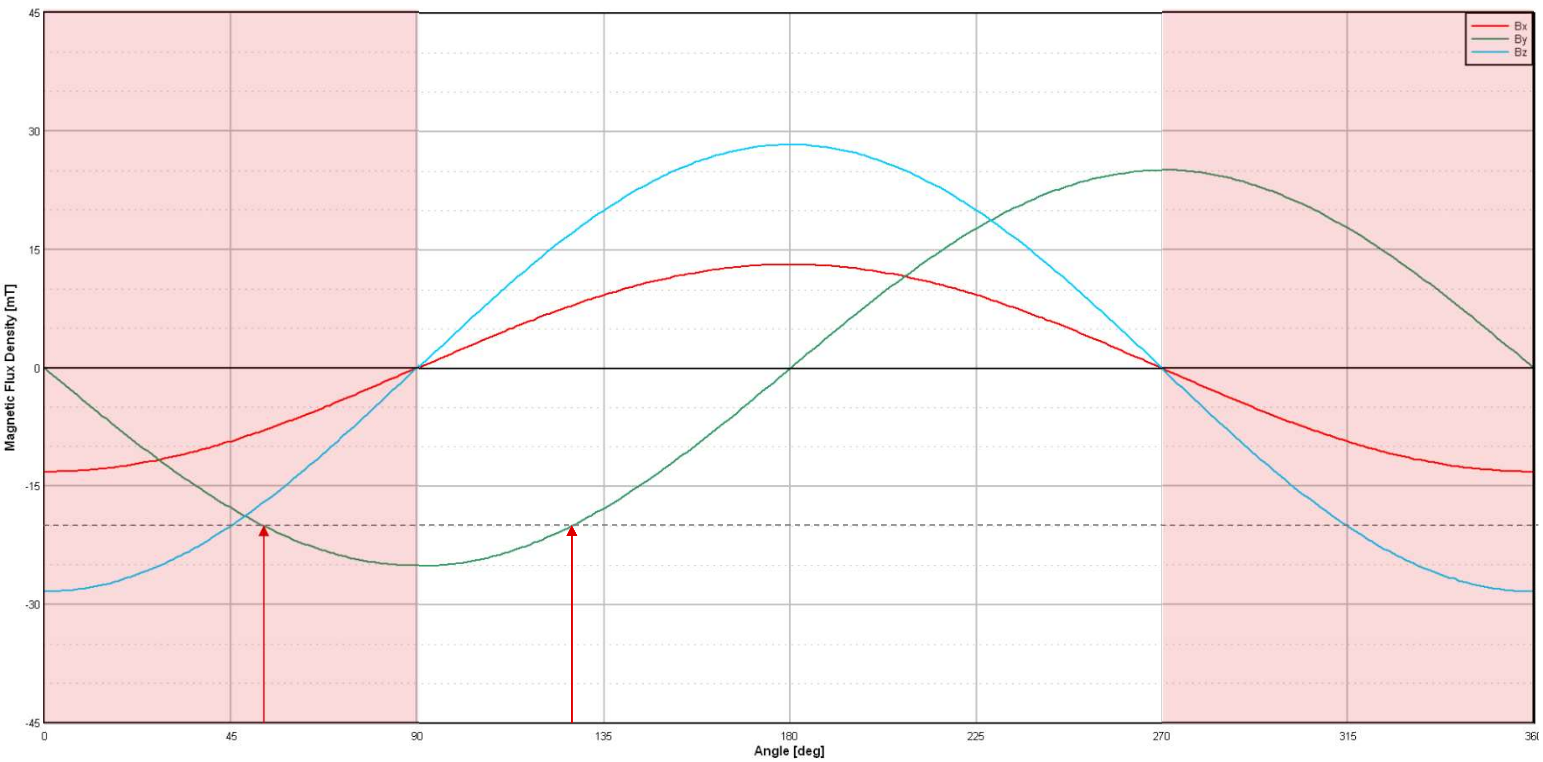
Angle Detection



Angle Detection

$$B_y = \alpha \sin \theta$$
$$\alpha = -25\ mT$$
$$\theta = \sin^{-1}\left(\frac{B_y}{\alpha}\right)$$

$$B_y = -20\ mT$$
$$\theta = \sin^{-1}(0.8)$$
$$\theta = 127°, 53°$$



Angle Detection

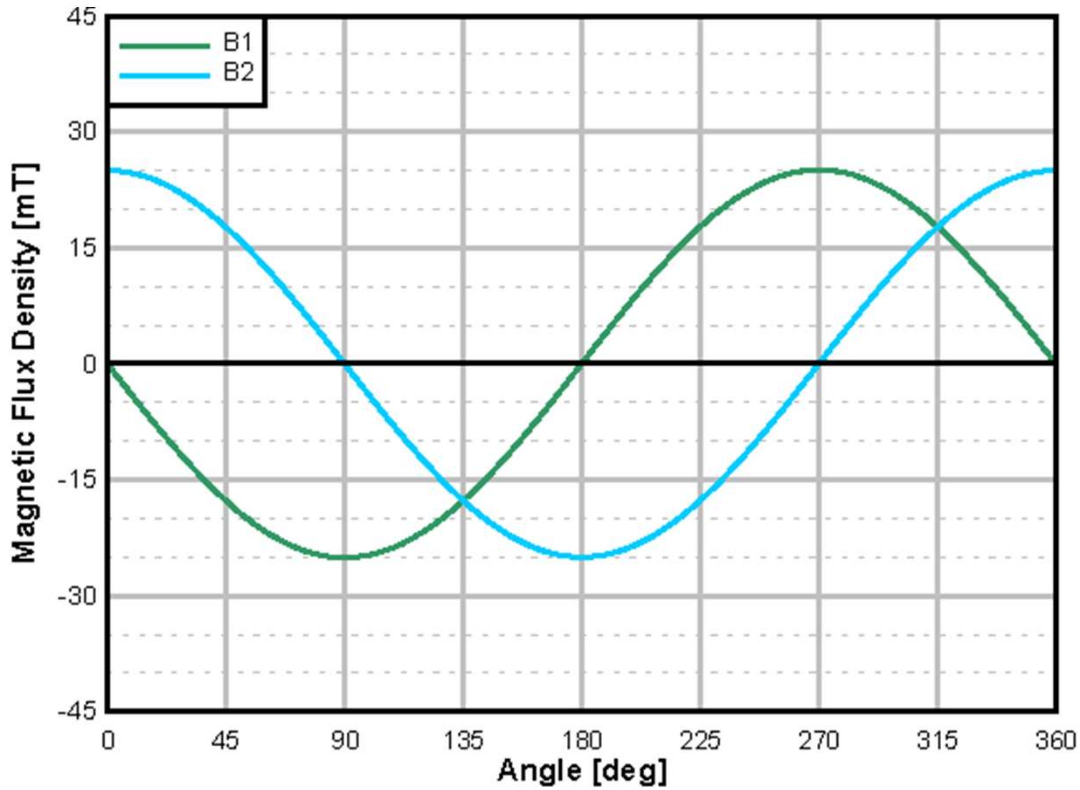
$$B_1 = \alpha \sin\theta$$
$$B_2 = \alpha \cos\theta$$

$$\tan\theta = \frac{\sin\theta}{\cos\theta}$$

$$\tan\theta = \left(\frac{B_1}{B_2}\right)$$

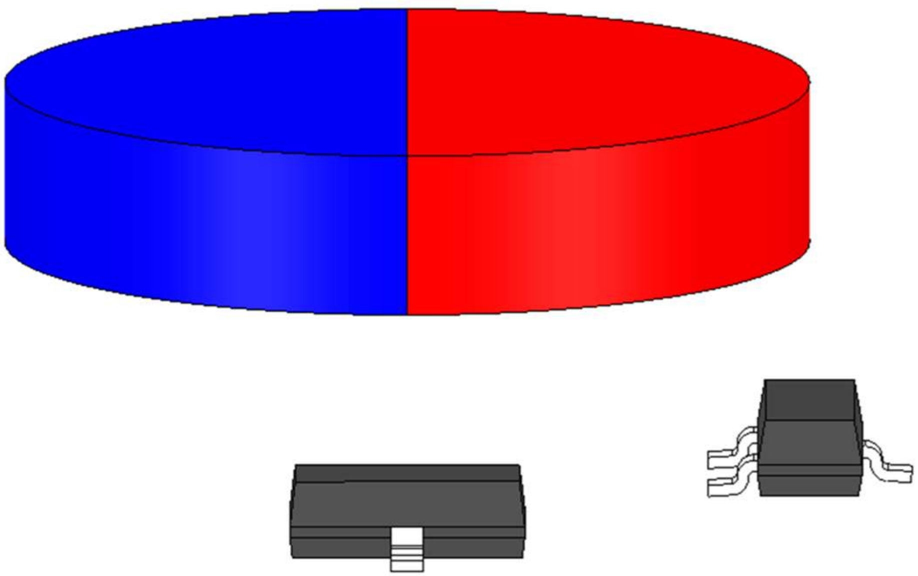
$$\theta = \text{atan}\left(\frac{B_1}{B_2}\right)$$

$$\theta = \text{atan2}(B1, B2)$$

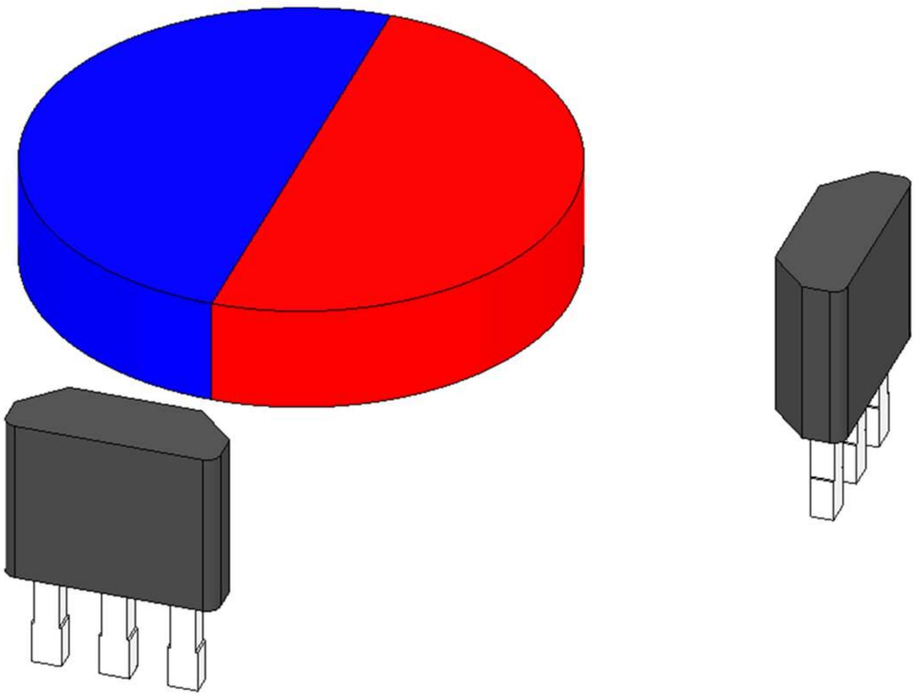


One Dimensional Sensor Configurations

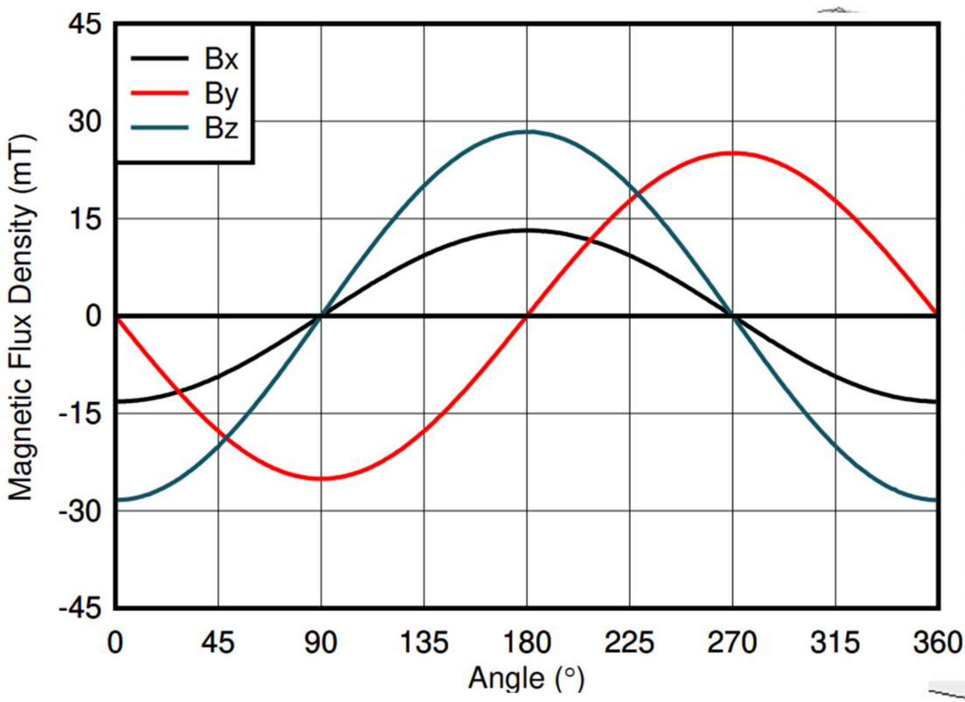
Sensor Out-of-Plane

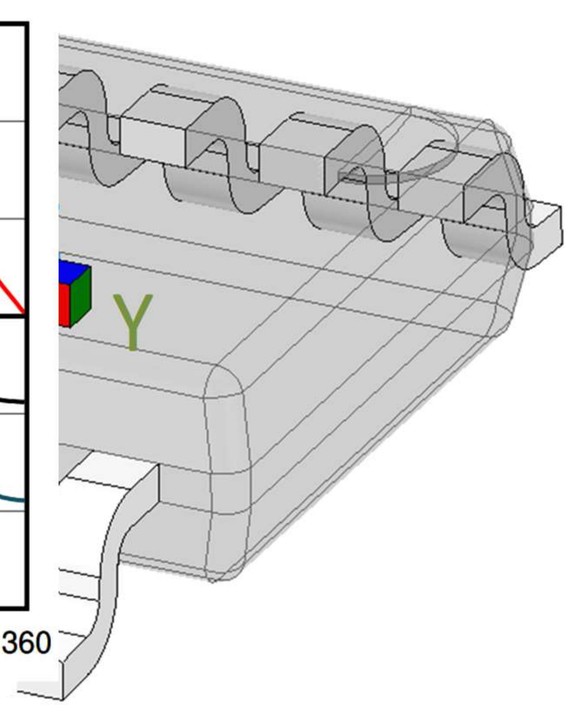


Sensor In-Plane

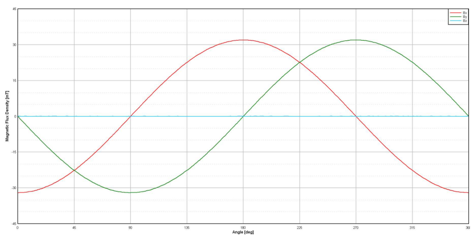


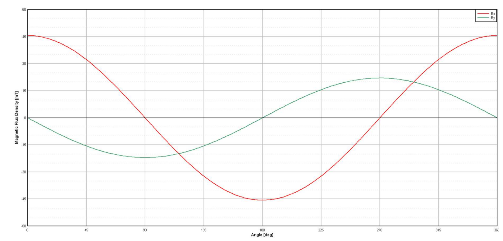
Three Dimensional Sensor

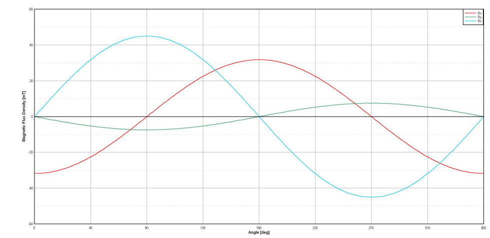




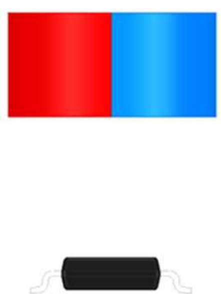
Three Dimensional Sensor Configurations



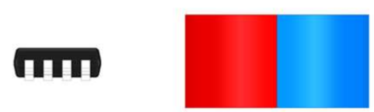




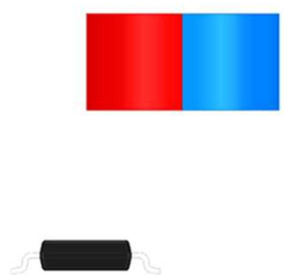
Sensor On-Axis



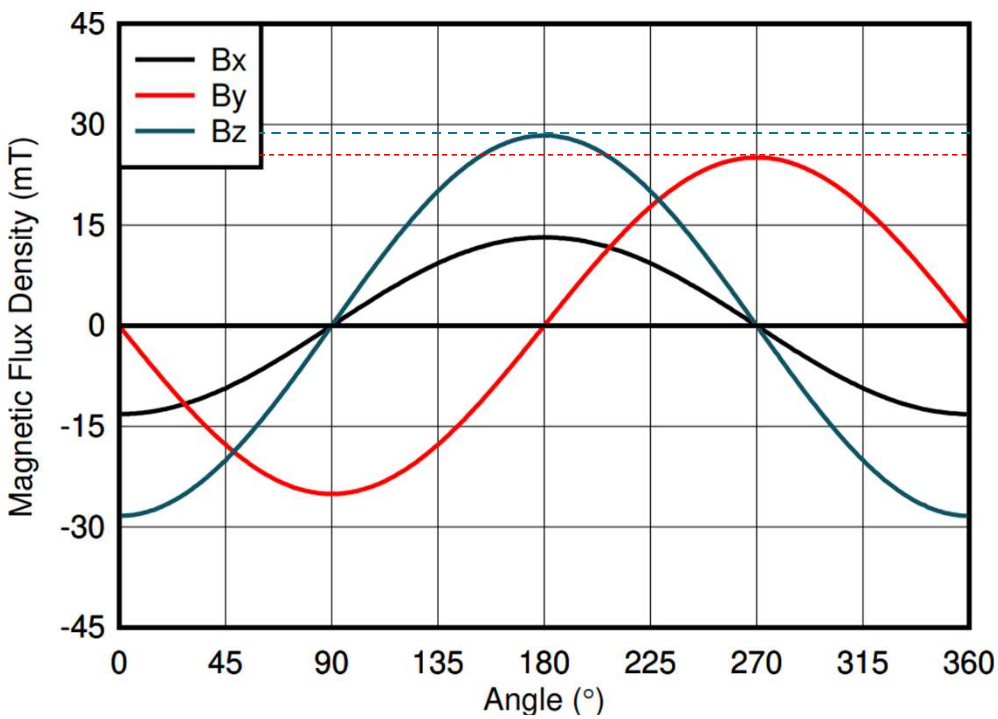
Sensor In-Plane

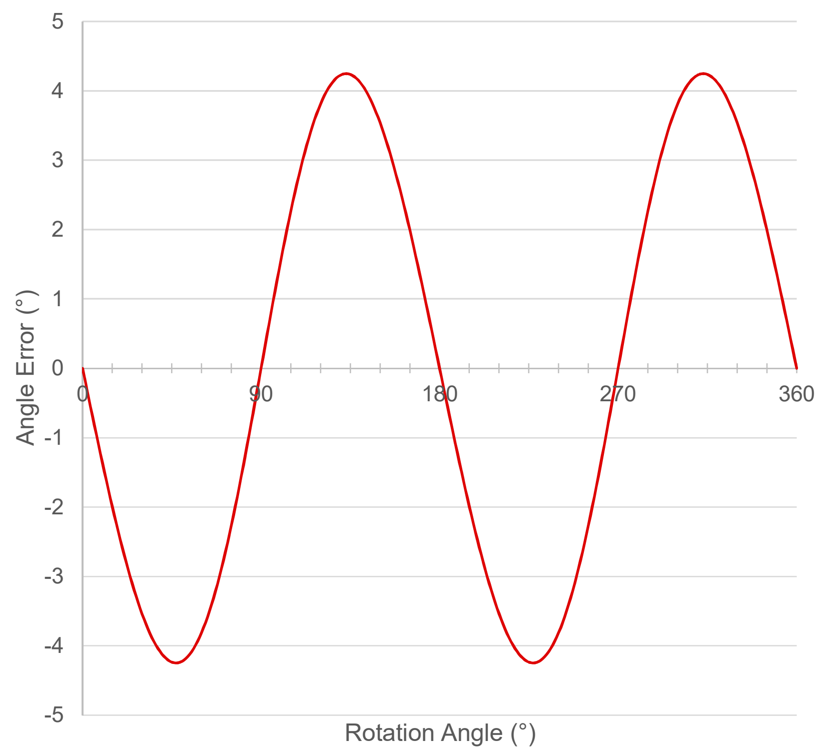


Sensor Out-of-Plane



Amplitude Correction





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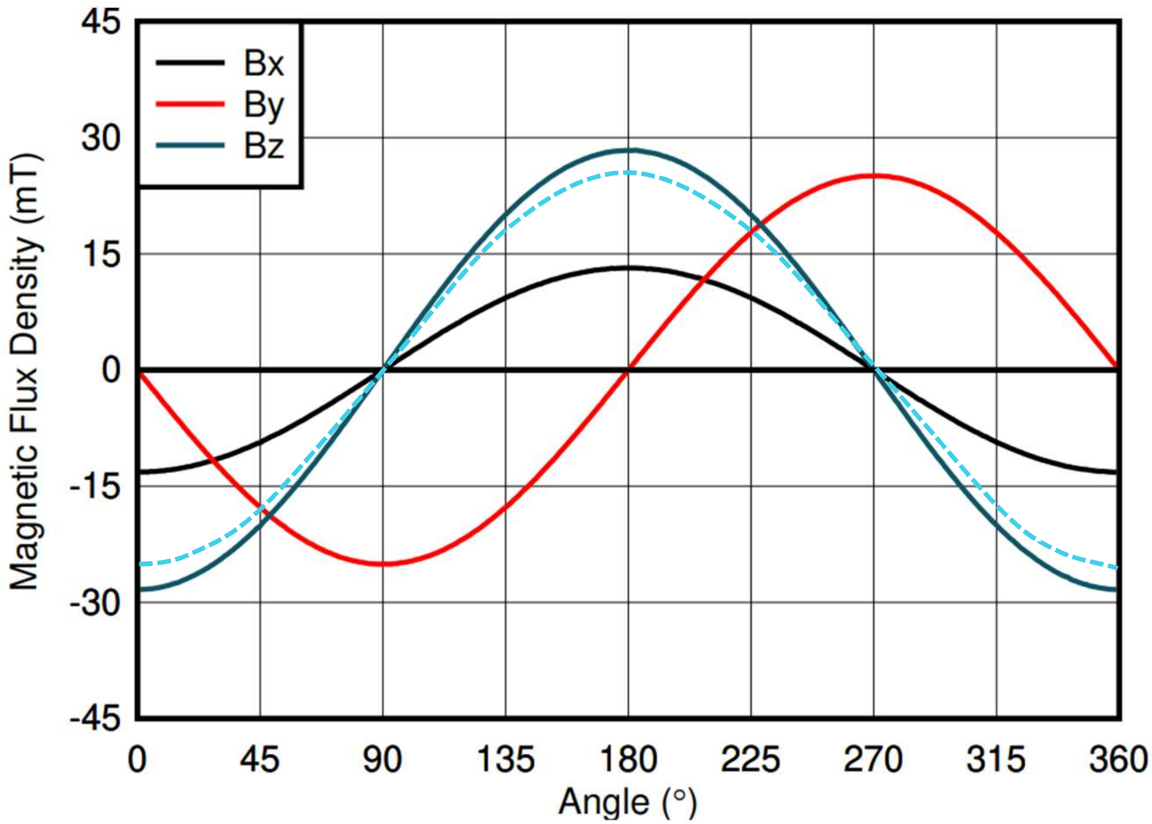

$$B_y = 25\ mT$$
$$B_z = 29\ mT$$

$$\frac{B_y}{B_z} = 0.86206$$

Additional Resources

TEXAS INSTRUMENTS

Application Report

SLYA036A–July 2018–Revised August 2018

Linear Hall Effect Sensor Angle Measurement Theory, Implementation, and Calibration

Mitch Morse

Current and Magnetic Sensing

ABSTRACT

This application report discusses how linear Hall effect sensors can be used to measure 2D angles, including both limited-angle and 360° rotation measurements. This report provides details on some calibrated and uncalibrated implementations to help meet angle measurement accuracy requirements. This report also covers the number of sensors needed, and the preferred magnet types for each method.

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Application Report

Angle Measurement With Multi-Axis Linear Hall-Effect Sensors

TEXAS INSTRUMENTS

ABSTRACT

As the demand for automated precision control systems increases there is a similar increase to design systems that are more reliable and less likely to fail from mechanical wear. Many of these applications require the detection of angular rotation. While this function can be implemented using multiple one-dimensional sensors, a new class of three-dimensional sensors offers more flexibility and accuracy while allowing more compact solutions.

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Hall Effect Sensors : Angle Detection

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Angle Detection

1) Which of the following does not impact absolute angle measurement accuracy?
   a) Sensitivity Matching
   b) Magnet Wobble
   c) Sensor Alignment
   d) Magnet angle at power on

2) What is the maximum angle sense range for a single Hall effect sensor
   1) 90
   2) 180
   3) 270
   4) 360

Angle Detection

3) What Sensor alignments are suitable for 1D Sensors?
   a) In-Plane
   b) On-Axis
   c) Out-of-Plane
   d) Coincidental

4) What force causes an unequal charge distribution in the Hall Element
   a) In-Plane
   b) On-Axis
   c) Out-of-Plane
   d) Coincidental

Angle Detection

5) T/F: A 3D sensor with perfectly matched inputs does not need to worry about output matching
   a) True
   b) False

Angle Detection

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Angle Detection

5) T/F: A 3D sensor with perfectly matched inputs does not need to worry about output matching for precision measurements
   a) True
   b) False Sensitivity mismatch can result with angle error that would otherwise be reduced by normalizing the outputs.

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