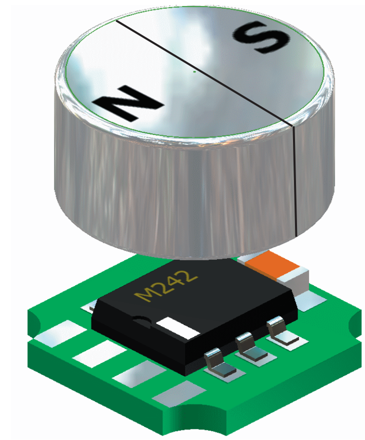
AKM EM-3242 360 Degree Angle Position IC
Application Note: AN_181

Introduction

The AKM EM-3242 Non-Contact Angle Position Sensing IC is a very small, low cost and easy to use angle position sensor with a continuous 360 degree range. The EM-3242 provides an absolute position output which means the power can be removed then reapplied and the output will continue to have the correct angle even if the rotating magnet moved while the power was off. The device requires very little power and operates at 3V+/-10%. The EM-3242 senses the angle of magnetic field component that is parallel to the plane of the device package and provides an analog output voltage of 10% to 90% of the supply voltage for a mechanical angle range of 360 degrees of rotation. The device includes a power down (PDN) function which reduces the current draw to less than 10uA.



EM-3242 on PCB with 0.250" dia. X 0.150 thick SmCo24 magnet (55B0082).

Subject Items

Reference Documents

EM-3242 Specification Sheet - Aug, 2009
55B0082 Spec Sheet (0.25"dia. x 0.15"T SmCo24 Magnet)
55B0081 Spec Sheet (0.15"dia. x 0.15"T SmCo24 Magnet)
55C0126 Spec Sheet (0.25"Sq. x 0.10"T SmCo24 Magnet)
AN_134KIT- Eng Development Kit
RD102-EM3242 Ref Design for Angle sensing with "In Range" Detector

Magnetic flux density (Magnetic Field) units of Gauss and milli-Tesla

1G=100uT or 0.1mT
10G =1mT
100G =10mT

FEATURES of the EM-3242

- 360 Degree Non-Contact Magnetic Angle Position Sensing
- Analog Output 10% to 90% of Vdd
- Nonlinearity less than 1 deg at 3V
- Out of Range Detection (Faults to 0V when Magnetic Field is >60mT or <10mT).
- Power Down (PDN) option reduces current draw to <10uA.
- 2.7 to 3.3V operating voltage range
- Only 1 external component required (0.1uF)
- Less than 10mA operating current
- Ratio-metric output
- Very small 6 pin IC package (3.6mm x 4.2mm x 0.95mm).
- Circuitry fits on a 0.25" x 0.25" PCB.
- 10 Bit Resolution (0.36 deg)
- Fast update speed (40uS/update)
- Up to 8k RPM

Applications

- Valve position
- Motor control
- Remote control encoders
- Door position
- Tank liquid level
- Water level
- Flow meter
- Wind vane direction sensor
- Robotic arms
- Non-contact gauges
- Multiple position selector switch position

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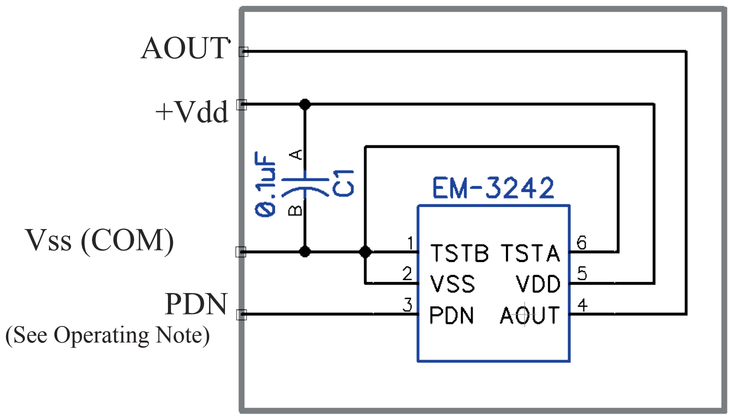
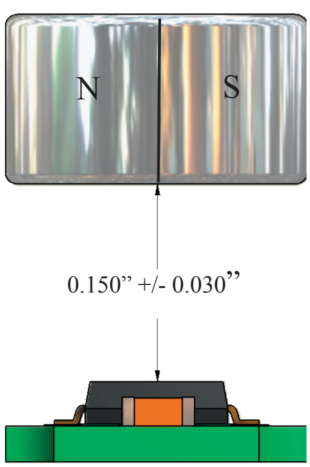
Electrical Connections -Schematic Connection



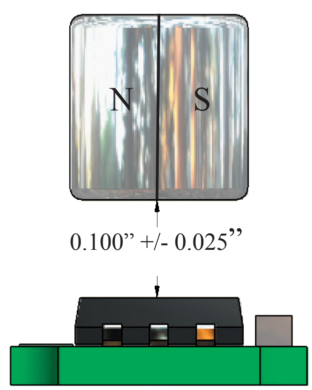
To the left is the connection diagram for the EM-3242. C1 should always be positioned as close to the IC as possible. A standard 0.1uF ceramic capacitor is recommended to mounted close to the IC. Any tolerance will be sufficient. Pins 1 and 6 are test points used in the factory and must be tied to Vss (com). See Operating note below for pin 3, PDN.

Operating Note:
Power Down (PDN) is enabled when PDN is tied to Vss (COM).
Connect PDN to +Vdd activate the sensor for normal operation

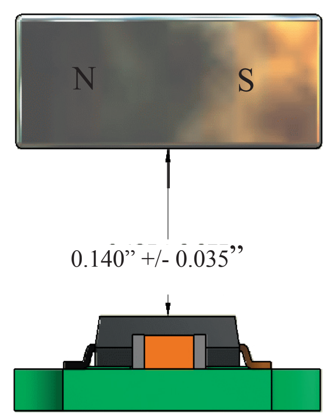
Typical recommended air gap operating distances with the GMW standard magnets.



Air Gap Operating Range for the 55B0082 Cylindrical Magnet



Air Gap Operating Range for the 55B0081 Cylindrical Magnet



Air Gap Operating Range for the 55C0126 Square Magnet

Air-Gap ranges to produce specified linear output. See the magnet characteristics graph below for the three standard magnets

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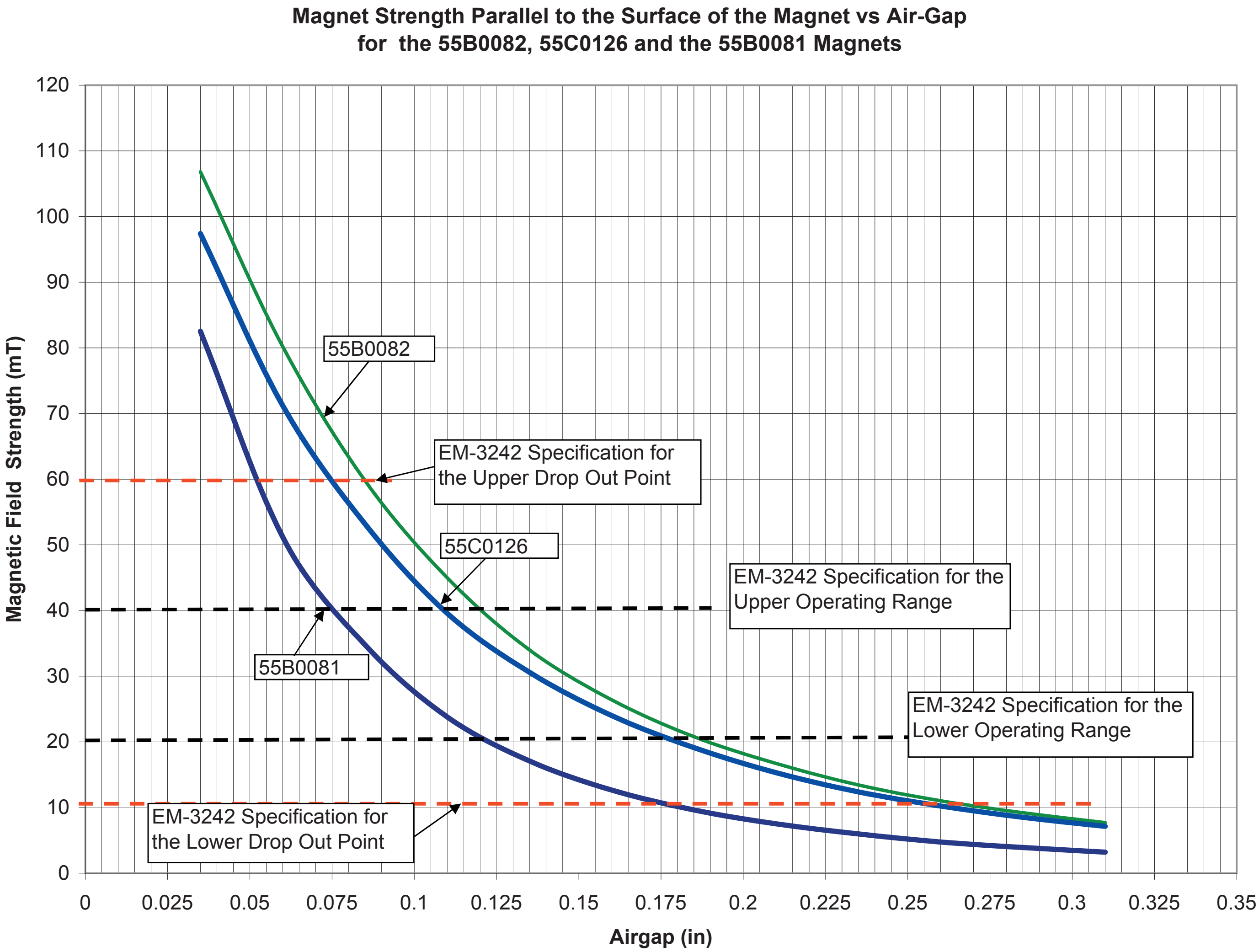
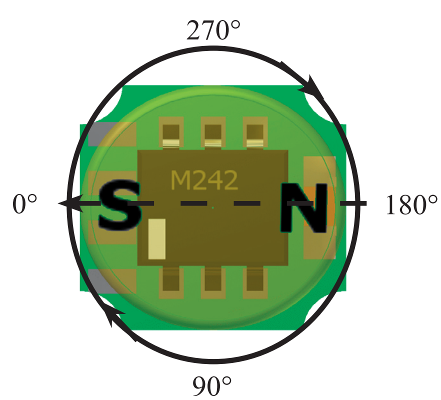
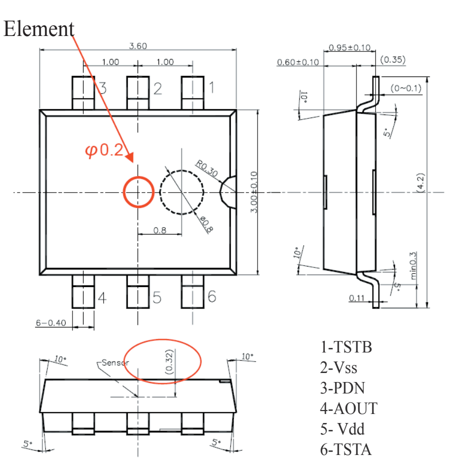


Magnet Orientation

Output decreases as magnet is rotated Clockwise. See output curve below
Zero Degrees occurs when the South Pole of the magnet is in line with pin 1 and 6 of the IC.





EM-3242 Package and location of sensing element (mm)

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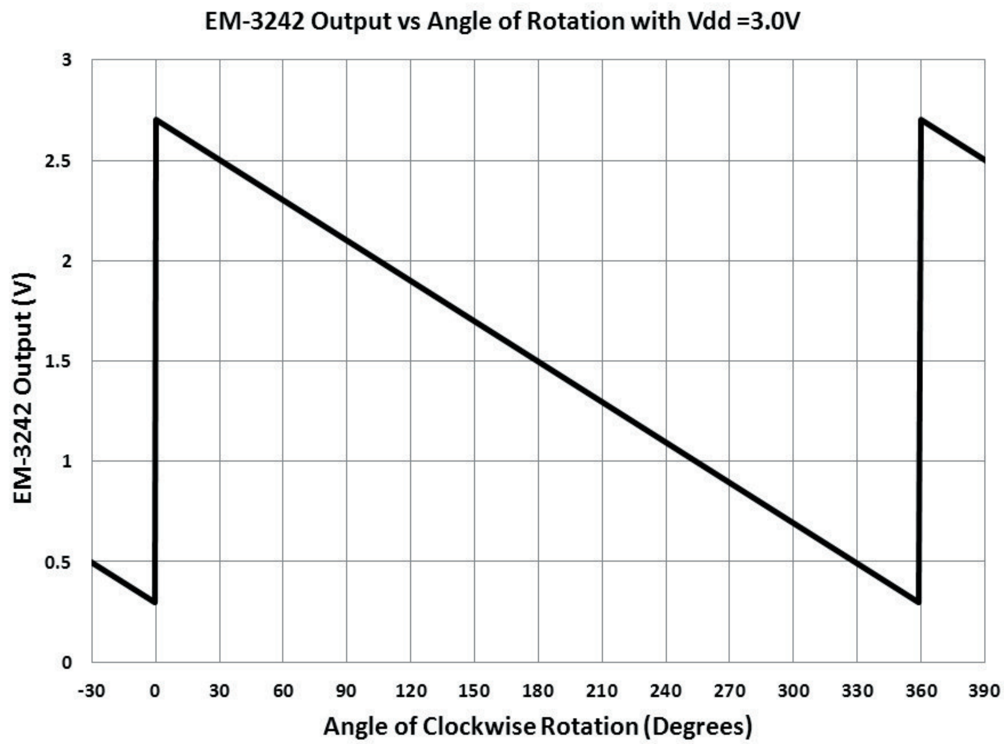
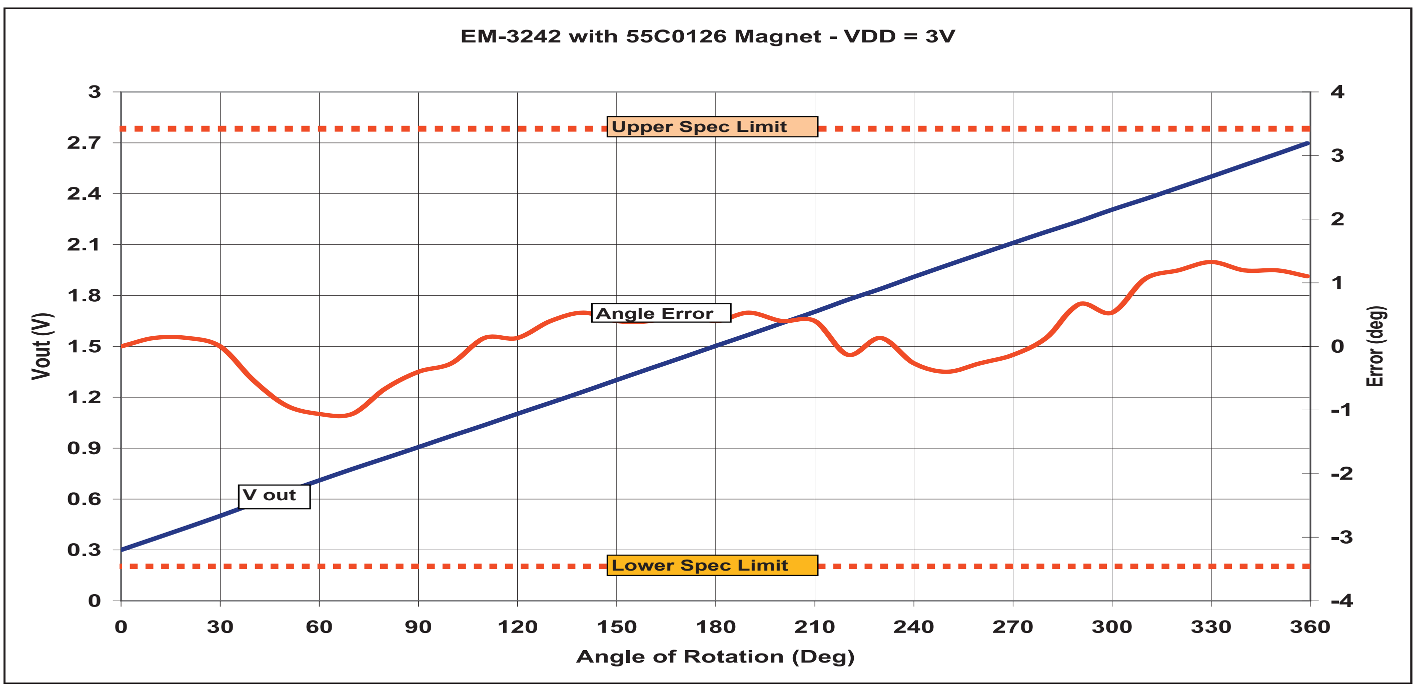
EM-3242 Output Characteristics



Speed Vs Resolution	
RPM	Resolution (bits)
419	10
815	9
1661	8
3401	7
6696	6

Non-Linearity Specifications.

The EM-3242 is specified to operate within +/-3.5 degrees of non-linearity when the supply is 3V over the magnetic field range of 20mT to 50mT. However the actual linearity performance is much better. Below is a non-linearity plot of a typical sensor. .



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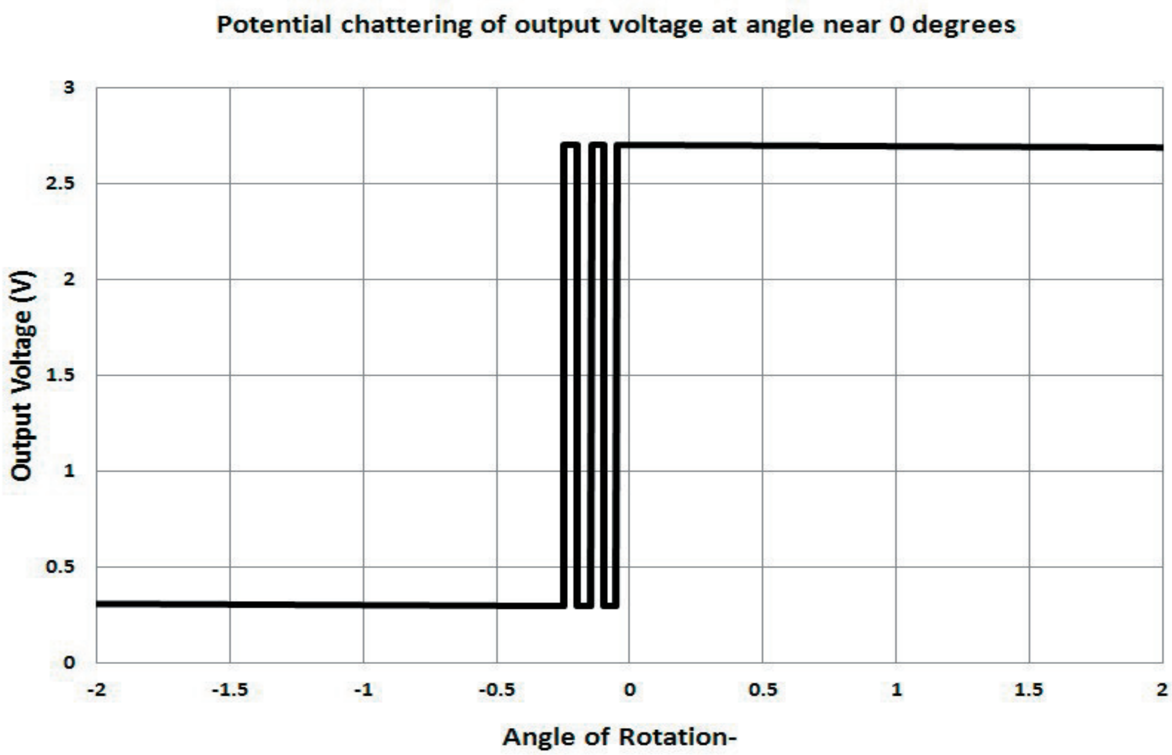
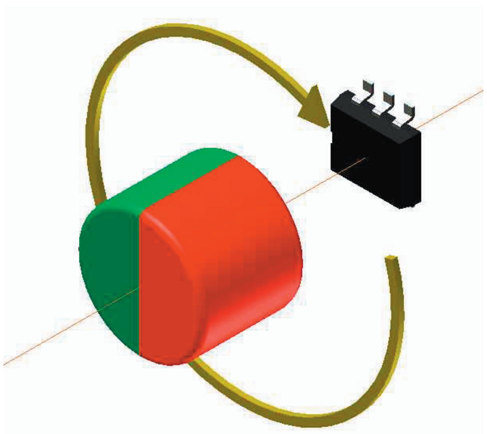
Potential Chattering near zero and recommendations

As the Angle of rotation in a clockwise rotation approaches the 360 degree position, the output will approach 10% of the supply voltage and then abruptly change to 90% of Vdd and then start decreasing again as the angle increases. This transition can be a wide as 0.4deg. If the position of the magnet is held steady at a point within the 0.4 degree range, there is a possibility that the output will randomly switch between the 10% level and the 90% level. Both levels represent the same angle of 0 deg. If the output is filtered with a low pass filter, the average voltage output could measure to be approximately 50% of Vdd, thus creating an error in the reading. This would give you a 180 degree reading vs the correct 0 degree reading. This situation can be avoided by not using a low pass filter at the output. If a uP is used to sample the output, it can simply register a 90%Vdd reading and a 10%Vdd reading as the same angle (zero degrees).

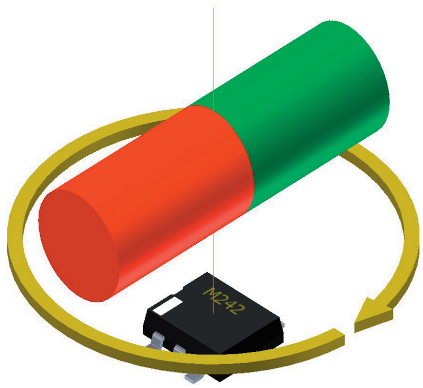


Magnet Target Possibilities

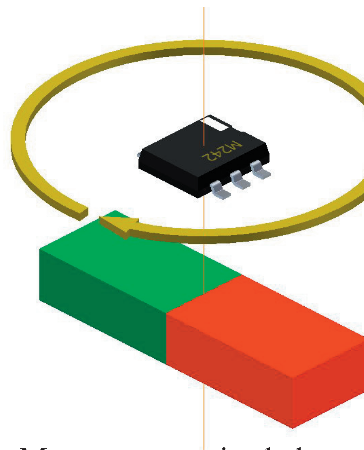
A significant advantage of the EM-3242 is its ability to work with a large range of different magnetic target and locations. The EM-3242 is compatiple with almost any type of magnet or shape as long as the rotating magnetic vector from the magnet is in the parallel plane to the IC. The magnets can surround the IC, can be on top of it or can be on the bottom. Below are a variety of potential magnetic positions.



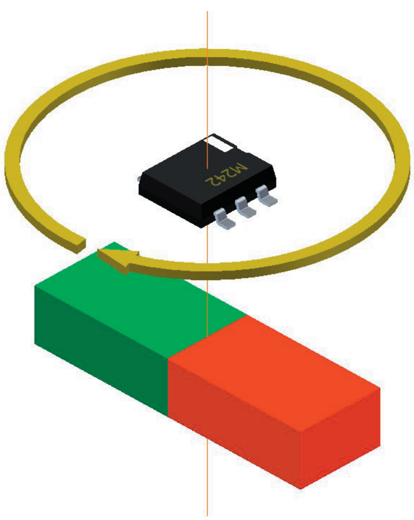
Most common with the magnet above the IC and rotating about the IC center line (ref GMW 55B0082)

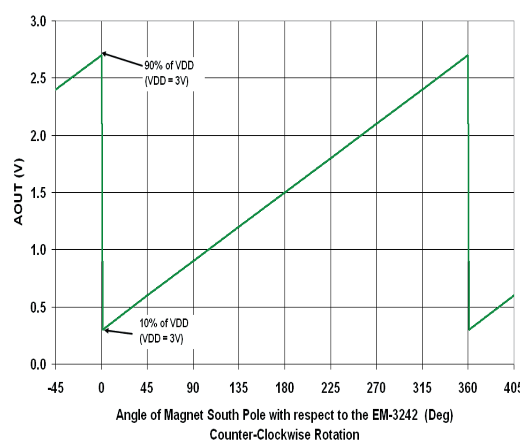


Standard cylindrical magnet magnetized thru the axis

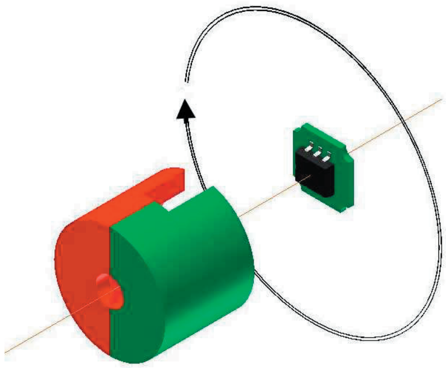


Bar Magnet magnetized along the length

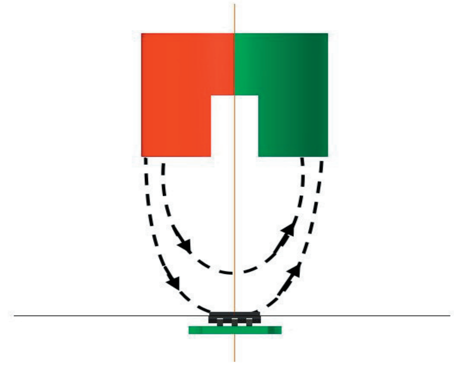


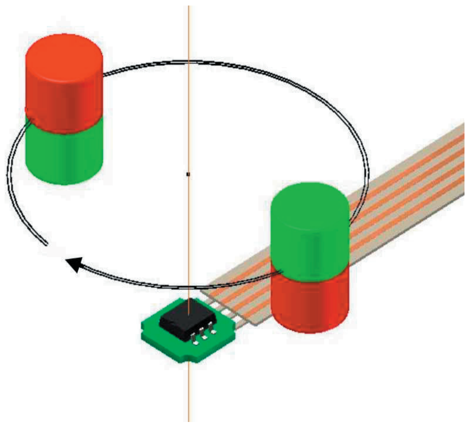


Magnets can be on either side of the IC, top or bottom. When positioned on the bottom side and viewed from the bottom, clockwise rotation will result in the output reversing direction, that is; the output will increase from 10% toward 90% as the magnet rotates in a clockwise direction

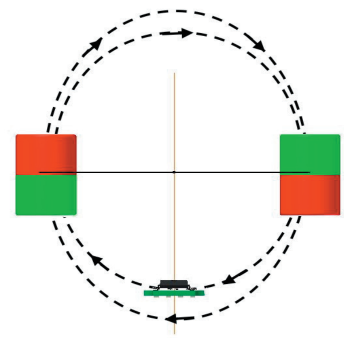


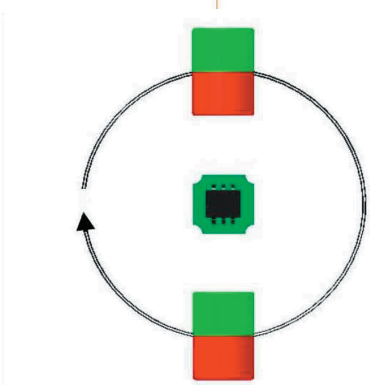
Cup Magnet



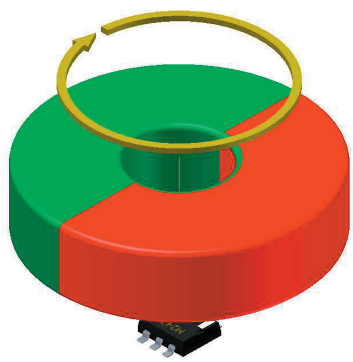


Two vertical magnets rotating around the IC center line. Larger air gaps can be obtained with this method

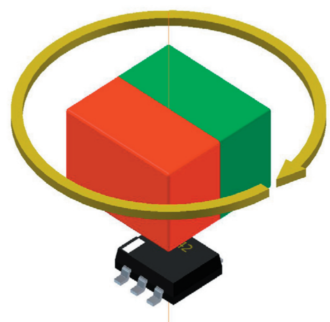




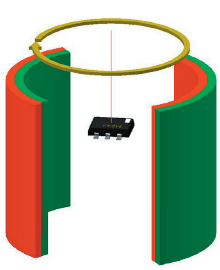
Two magnets rotating around the IC center line.

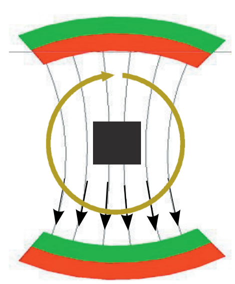


Donut / Ring Magnet



Standard 55C0126 Square magnet 0.25” x 0.150”

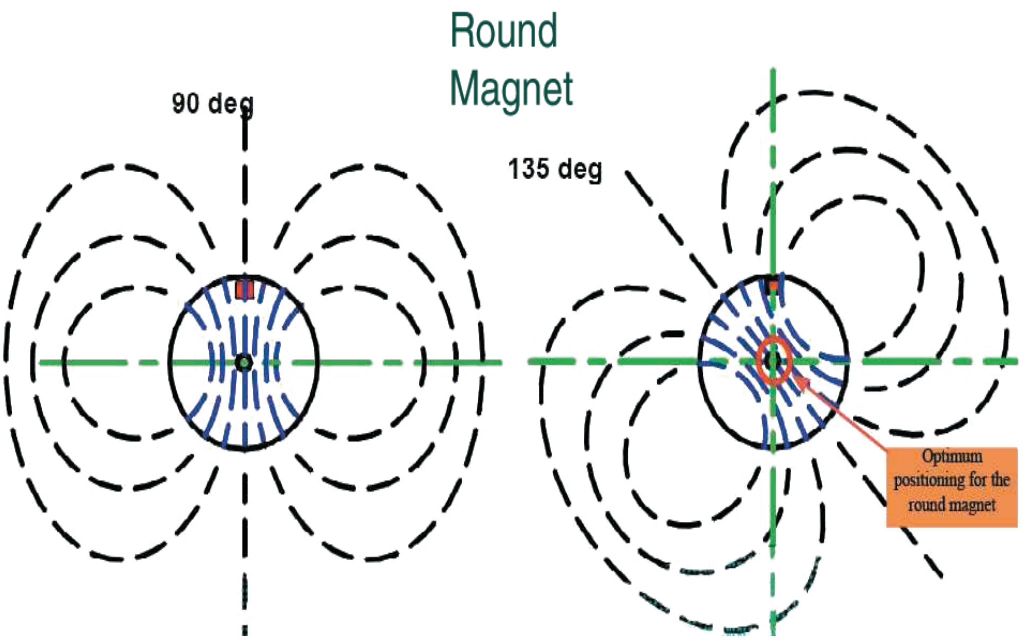




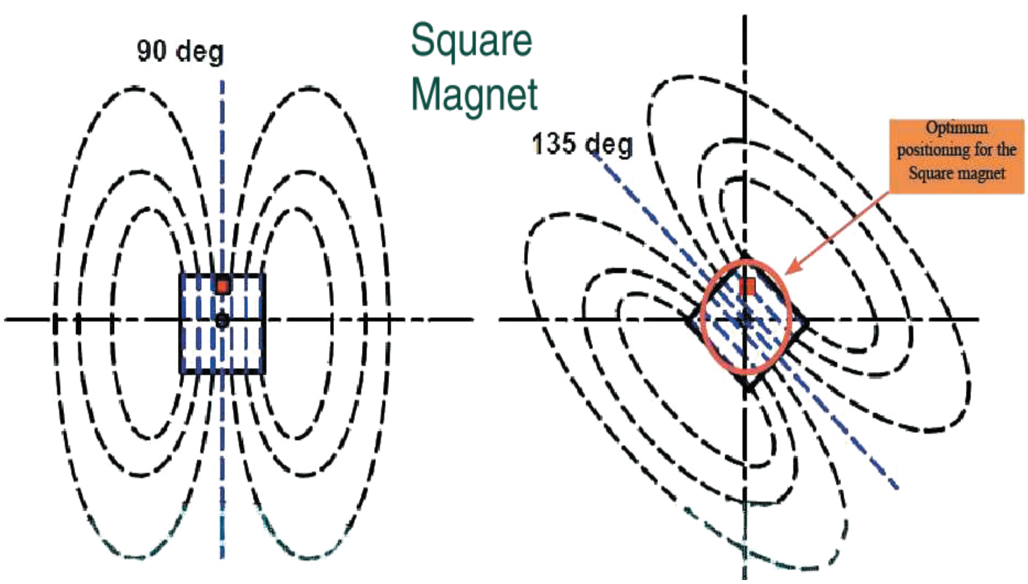
DC Motor magnets. The advantage is the Z axis dynamic range between the sensor and the magnet can be very large (equal to the length of the magnet)

Magnet Axial Alignment Considerations

A question that is often asked is: How close to the center lines of the IC and Magnet need to be? As a rule of thumb for the round magnet; the magnet and IC center lines should be within 10% of the diameter of the magnet. The sensor will continue to work if the off axis is greater than the 10%, however the non-linearity of the angle measurement will increase. If a wider tolerance is needed, then it is suggested, that if practical, a square magnet be used which is much more tolerant of "Off-Axis" misalignment. Below are two diagrams explaining why the Square magnet is better than the Round magnet.



With the Round magnet, the tolerance to the center line mismatch is relatively small. The reason being, the magnetic vectors from the round magnet exit the magnet at right angles to the radial surface. The magnetic vectors then start to curve as they approach the outer radius. If the sensor measures the vectors of the magnetic field at these outer limits of the magnet, then the angle of this field will be different than at the center of the magnet. The "sweet spot" for the round magnet is shown by a red circle



With the Square magnet, the tolerance to the center line mismatch can be much higher. The reason being, the magnetic vectors from the square magnet are parallel over a large portion of the magnet surface and since the sensor measures the vector of the magnetic field, the sensor center line can be located almost anywhere below the magnet as long it is within the edges of the magnet. The larger "sweet spot" for the square magnet is shown by a red circle