Magnetic Sensors

Honeywell

Introduction

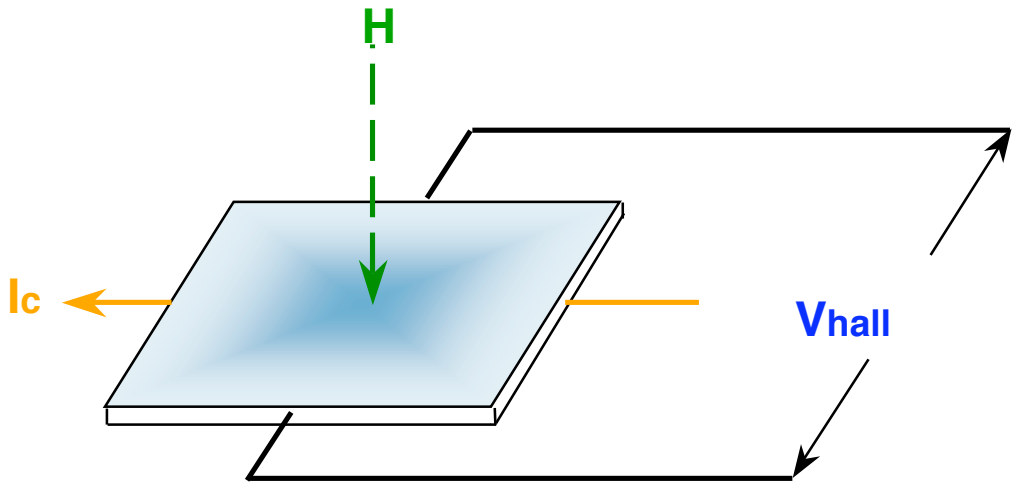
- A magnetic position sensor responds to the presence or the interruption of a magnetic field by producing a proportional output.
- Types of magnetic position sensors include:
  - Hall-effect sensors are constructed from a thin sheet of conductive material with output connections perpendicular to the direction of the current flow.
  - Magnetoresistive digital sensors have a built-in magnetoresistive bridge integrated on silicon and are encapsulated in a plastic package. The integrated circuit (IC) responds to low fields at large distances.
  - Hall-effect vane sensors consist of a magnet and a Hall-effect sensor inside a rugged plastic housing; different package styles provide mounting flexibility.
  - Gear tooth sensors use a magnetically biased Hall-effect IC to sense movement of ferrous metal targets. The specially-designed IC is sealed in a durable plastic probe-type package.
  - Hall-effect basic switches and magnets
  - Digital and analog Hall-effect position sensors

Potential Applications

- Appliances
  - Door lock detection, washer arm RPM, current sensing
- Commercial
  - Vending, automated teller machine, medical
- Consumer
  - RPM measurement in fitness equipment
- HVAC
  - Valve positioning (Variable Air Volume), fan control
- Instrumentation
  - Flux meters, current sensing, remote metering, liquid level
- Infotech
  - Tape drives, copiers, cooling fans, cash registers, uninterruptible power supplies
- Motion control
  - Piston detection in pneumatic or hydraulic cylinders, brushless DC motor commutation, RPM measurement, magnetic encoder, variable speed drives

Magnetic Sensor Technology

$$V_{hall} \propto I_c \times H$$



Vhall = Output Hall-effect voltage

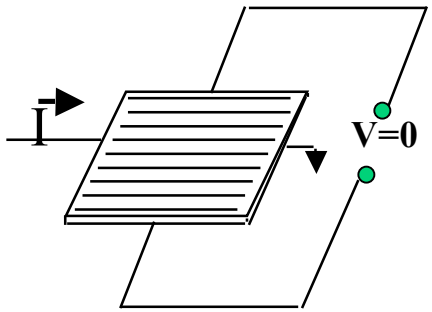
H = Magnetic Flux created by magnet or current-carrying conductor

Ic = Constant supply current

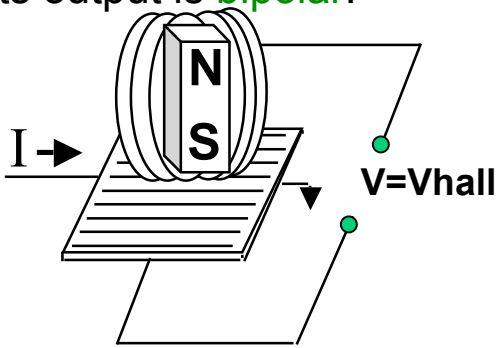
Magnetic Sensor Technology

Hall-effect Sensing Mechanism

- The current source is applied through a thin sheet of semiconductor material.

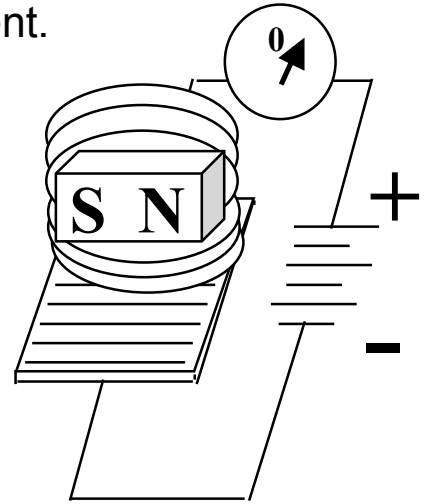


- A magnetic field applied perpendicular to the element creates a voltage change = Vhall. Its output is bipolar.

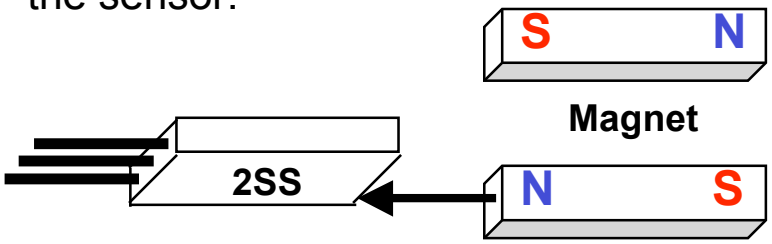


Magnetoresistive Sensing Mechanism

- A magnetic field applied parallel to the element changes its resistance and creates a current.



- MR is omnipolar—either pole will operate the sensor.



Design Factors – Magnetic Types

- Unipolar: Only a south pole will operate the sensor. The sensor turns on with the south pole(+) and off when the south pole is removed.
- Bipolar: Sensor output is pole-dependent. A south pole (+) is designed to activate the sensor; a north pole(-) is designed to deactivate. It's possible that the sensor could turn off and still be within a positive Gauss level.
- Latching: Specifications are tighter on latching. Sometimes it is designed to make certain that when the south pole(+) is removed from the sensor, it will stay on until it sees the opposite pole(-).
- Omnipolar: The sensor is designed to operate with either magnetic pole(+ or -).
- Ratiometric linear: Output is proportional to magnetic field strength. Output sensitivity range is 2.5 – 3.75 mV per unit of Gauss.

SS411A Bipolar Hall-Effect Digital Position Sensor

SS461A Series Latching Hall-Effect Digital Position Sensor

2SS52M Series Omnipolar Magnetoresistive Sensor

SS495A Series Standard Miniature Ratiometric Linear Hall-effect Sensor

SS441A Series Unipolar Hall-Effect Digital Position Sensor

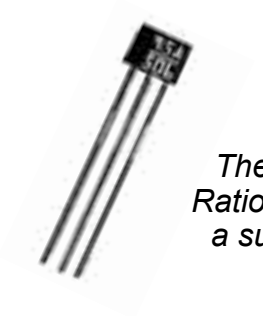
Design Factors – Basic Magnetic Characteristics

- When selecting a magnetic sensor, one must consider how much magnetic field the sensor needs before it turns on or off.
- Gauss levels to operate the sensor:
  - 25 Gauss for omnipolar through 400 Gauss for unipolar, and everywhere in between
    - As these sensors are temperature-sensitive, these ranges are at room temperature.

SS490 Series Miniature Ratiometric Linear Hall-effect sensors have a ratiometric output voltage set by the supply voltage that varies in proportion to the strength the magnetic field. The magnetic range of this sensor is -670 Gauss to +670 Gauss.

Design Factors – Electrical Characteristics

- Supply voltage
  - 3.8 to 30 Vdc
- Supply current
  - 10 mA to 30 mA
- Output current
  - 1.5 through 20 mA
- Output voltage
  - .40 volts max.



The SS495A Series Standard Miniature Ratiometric Linear Hall-effect Sensor has a supply voltage of 4.5 to 10.5 V and an output current of 1.5 mA.

Design Factors – Output Type

- Ratiometric linear sinking or sourcing
- Digital sinking or digital sourcing

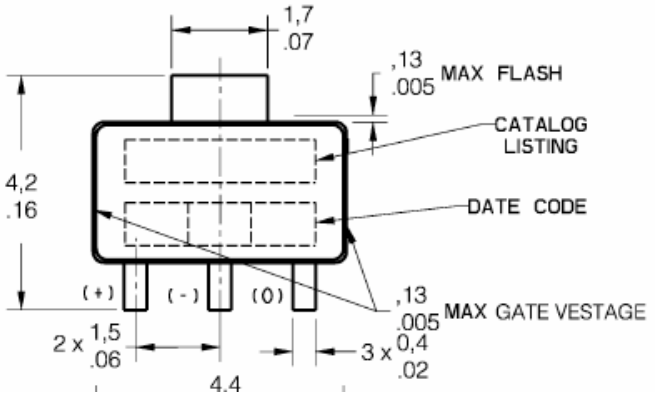
4AV Series Second Level Hall-effect Sensors are digital sinking sensors. They operate via a low-cost, easy-to-fabricate ferrous vane and can be used as limit switches by operating with a single large vane; as tachometer sensors by using multiple vanes; or as synchronizing elements by using cams or sectors.

103SR Series Second Level Hall-effect Sensors are ratiometric sinking/sourcing sensors. These sensors detect the proximity of an external magnet and are available with a current sourcing or and sinking output. They come in a rugged sealed, threaded aluminum housing.

Design Factors – Package Style

- Standard (plastic radial) lead
  - Leads are longer so they can be inserted into a circuit board. If the lead needs to be adjusted, it can be bent which provides flexibility when putting it on a circuit board.
- Plastic surface mount (SOT-89 package)
  - This very low profile package is designed for high speed pick-and-place assembly operations. The sensor is placed on top of the circuit board and wave soldered.

SS441A Series Unipolar Hall-effect Digital Position Sensor



SS541A Series Unipolar Hall-effect Sensor; SOT-89B surface mount package

Design Factors – Packaging Styles

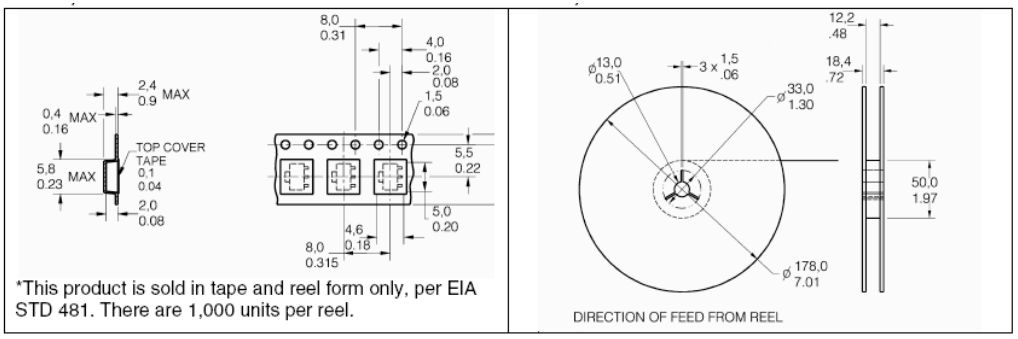
- Reduced lead length
  - Leads are cut short to allow them to be inserted into the circuit board
- Ceramic SIP (single inline package), ceramic with solder bumps
  - Package style allows for increased temperature stability because they're ceramic based, not plastic
    - Ceramic packages with laser trimmed, thin and thick film resistors minimize sensitivity variations and compensate for temperature variations
  - Magnetic ranges ±100 Gauss to ± 2500 Gauss
  - Also available linearly (output proportional to magnetic field)

SS441A-R Series Unipolar Hall-effect Reduced Lead Length Digital Position Sensor

SS941A Series General Purpose Ratiometric Linear Sensor; Vdc supply voltage

Design Factors – Packaging Options

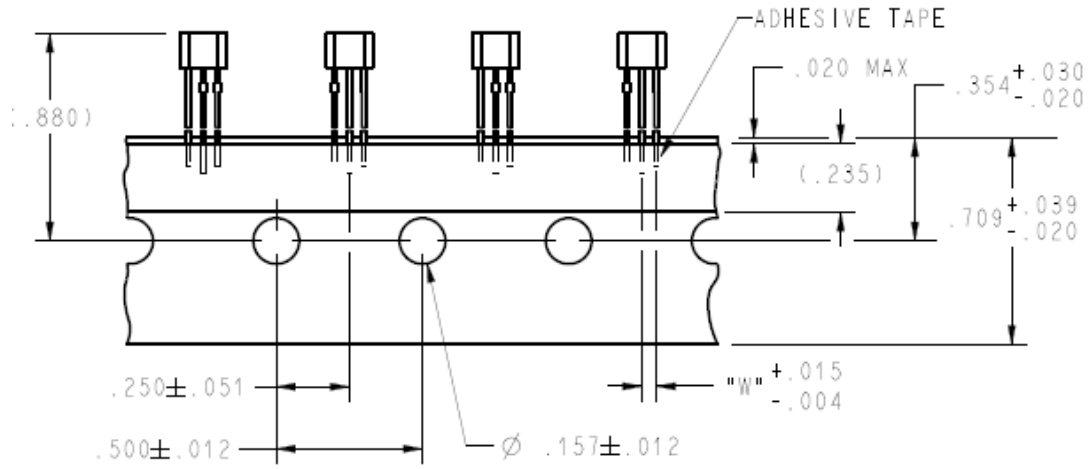
- Tape and reel
  - Often ideal for end customers with pick-and-place manufacturing. Customers can order a surface mount version packaged for shipment on tape and reel so the reel can be put on an automated assembly machine.



Tape and reel packaging for SS500 Series Temperature Compensated Hall-effect Sensors. Any SOT-89 package sensor is available in this tape and reel package.

Design Factors – Packaging Options

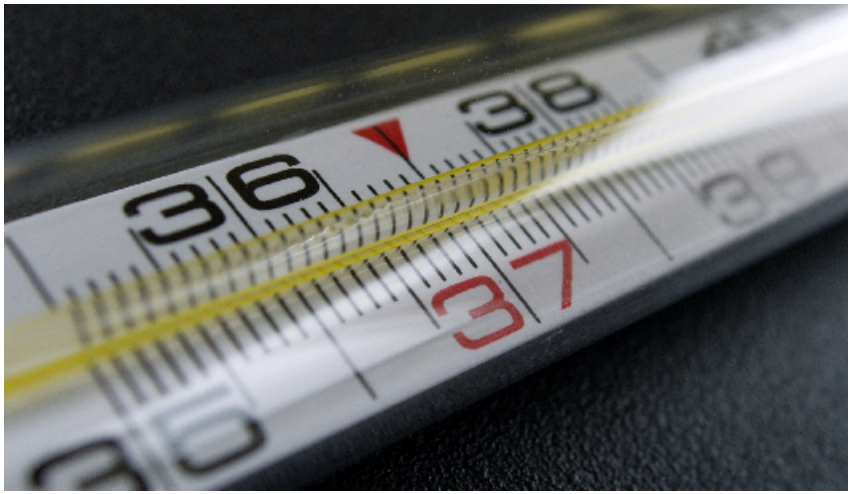
- Bulk pack
  - The sensors are ordered, manufactured and put into a bag for shipping
- Ammopack
  - Parts are mounted on a fan fold that folds back and forth so it can be fed out of a box



Ammopack for SS400 Series Temperature Compensated Hall-effect Sensors.

Design Factors – Operating Temperature Range

- An important design characteristic because a wide operating temperature range often offers the end user the ability to design into more applications
- Typical operating temperature range: -40 °C to 150 °C

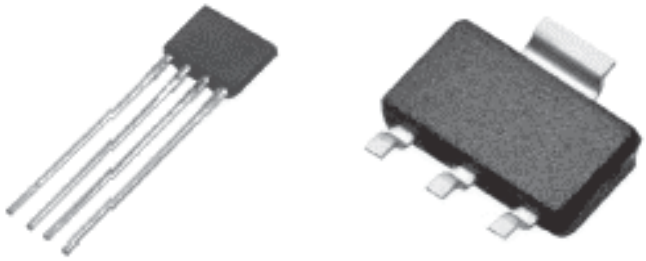


Summary

- Magnetic sensors are designed to provide:
  - Digital and analog Hall-effect position, magnetoresistive, Hall-effect vane, gear tooth, and Hall-effect basic switches and magnets
  - Unipolar, bipolar, bipolar latch, omnipolar, and linear magnetics
  - Digital sourcing, digital sinking (open collector), digital sinking and sourcing, and ratiometric sinking or sourcing
  - Plastic surface mount (SOT-89 style), ceramic SIP, ceramic with solder bumps, plastic radial lead IC, aluminum threaded barrel, plastic probe, plastic dual tower wire exit, plastic dual tower with connector, plastic mechanical switch
  - Wide continuous operating temperature range

Engineered Excellence

- Part Innovation
  - A global leader in cost-effective, problem-solving sensors and switches
- Part Engineering
  - Over 50,000 products ranging from humidity, position, speed, pressure, torque and airflow sensors to snap action, limit, toggle, pushbutton and pressure switches
- Total Solutions
  - 75 years of developing solutions to meet millions of customers' needs



Warranty and Remedies

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Warranties and Remedies

⚠ WARNING

PERSONAL INJURY

DO NOT USE these products as safety or emergency stop devices or in any other application where failure of the product could result in personal injury.

Failure to comply with these instructions could result in death or serious injury.

WARRANTY/REMEDY

Honeywell warrants goods of its manufacture as being free of defective materials and faulty workmanship. Honeywell's standard product warranty applies unless agreed to otherwise by Honeywell in writing; please refer to your order acknowledgement or consult your local sales office for specific warranty details. If warranted goods are returned to Honeywell during the period of coverage, Honeywell will repair or replace, at its option, without charge those items it finds defective. **The foregoing is buyer's sole remedy and is in lieu of all other warranties, expressed or implied, including those of merchantability and fitness for a particular purpose. In no event shall Honeywell be liable for consequential, special, or indirect damages.**

While we provide application assistance personally, through our literature and the Honeywell web site, it is up to the customer to determine the suitability of the product in the application.

Specifications may change without notice. The information we supply is believed to be accurate and reliable as of this printing. However, we assume no responsibility for its use.

⚠ WARNING

MISUSE OF DOCUMENTATION

- The information presented in this product sheet is for reference only. Do not use this document as a product installation guide.
- Complete installation, operation, and maintenance information is provided in the instructions supplied with each product.

Failure to comply with these instructions could result in death or serious injury.