Honeywell

SENSOR PRODUCTS

## APPLICATIONS

- Linear Displacement
- Angular Displacement
- Motor Control
- Valve Position
- Proximity Detection
- Current Spike Detection

# Linear / Angular / Rotary Displacement Sensors

## HMC1501 / HMC1512



*Not actual size*

High resolution, low power MR sensor capable of measuring the angle direction of a magnetic field from a magnet with <0.07° resolution. Advantages of measuring field direction versus field strength include: insensitivity to the tempco of the magnet, less sensitivity to shock and vibration, and the ability to withstand large variations in the gap between the sensor and magnet. These sensors may be operated on 3 volts with bandwidth response of 0-5 MHz. Output is typical Wheatstone bridge.

## FEATURES AND BENEFITS

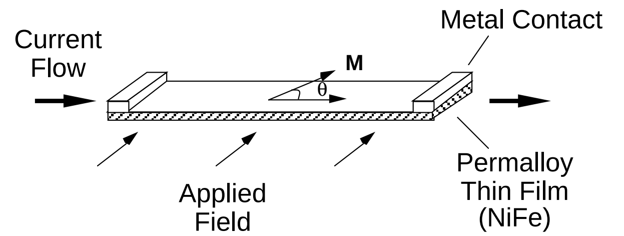
| | |
|---|---|
| **No Rare Earth Magnets** | Unlike Hall effect devices which may require samarium cobalt or similar “rare earth” magnets, the HMC1501 and HMC1512 can function with Alnico or ceramic type magnets. |
| **Wide Angular Range** | HMC1501—Angular range of ±45° with <0.07° resolution.<br>HMC1512—Angular range of ±90° with <0.05° resolution. |
| **Effective Linear Range** | Linear range of 8mm with two sensors mounted on two ends; range may be increased through multiple sensor arrays operating together. |
| **Absolute Sensing** | Unlike incremental “encoding” devices, sensors know the exact position and require no indexing for proper positional output. |
| **Non-Contact Sensing** | No moving parts to wear out; no dropped signals from worn tracks as in conventional contact based rotary sensors. |
| **Small Package** | Available in an 8-pin surface mount package with case dimensions (exclusive of pins), of 5mm x 4mm x 1.2mm total mounting envelope, with pins of less than 6mm square. |
| **Large Signal Output** | Full Scale output range of 120mV with 5V of power supply. |

## PRINCIPLES OF OPERATION

Anisotropic magnetoresistance (AMR) occurs in ferrous materials. It is a change in resistance when a magnetic field is applied in a thin strip of ferrous material. The magnetoresistance is a function of $\cos^2\theta$ where $\theta$ is the angle between magnetization M and current flow in the thin strip. When an applied magnetic field is larger than 80 Oe, the magnetization aligns in the same direction of the applied field; this is called saturation mode. In this mode, $\theta$ is the angle between the direction of applied field and the current flow; the MR sensor is only sensitive to the direction of applied field.

The sensor is in the form of a Wheatstone bridge (Figure 1). The resistance R of all four resistors is the same. The bridge power supply $V_S$ causes current to flow through the resistors, the direction as indicated in the figure for each resistor.

Both HMC1501 and HMC1512 are designed to be used in saturation mode. HMC1501 contains one MR bridge and HMC1512 has two identical MR bridges, coexisting on a single die. Bridge B physically rotates 45° from bridge A. The HMC1501 has sensor output $\Delta V=-V_S S \sin(2\theta)$ and the HMC1512 has sensor output $\Delta V=V_S S \sin(2\theta)$ for sensor A and sensor B output $\Delta V_S=-V_S S \cos(2\theta)$, where $V_S$ is supply voltage, S is a constant, determined by materials. For Honeywell sensors, S is typically 12mV/V.



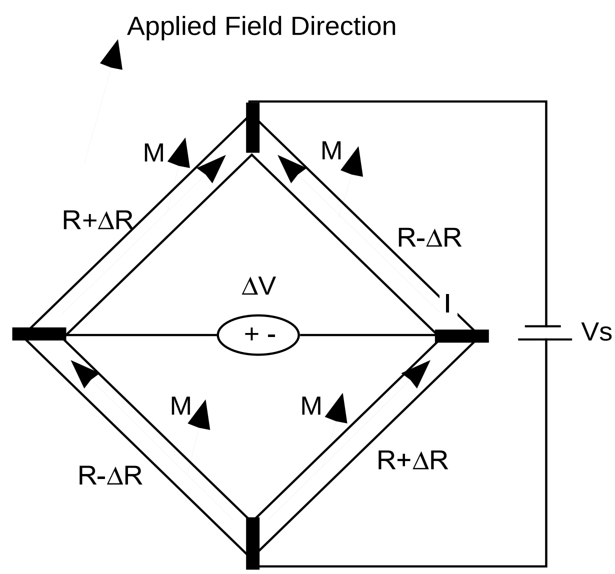
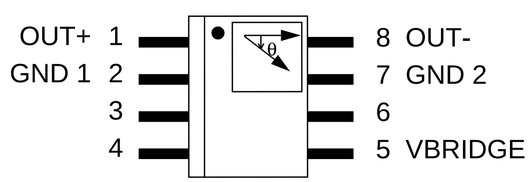



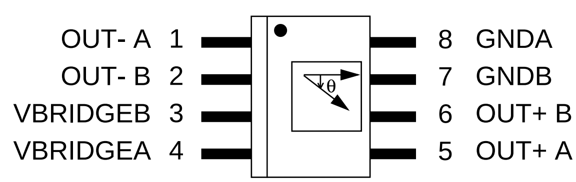

**Figure 1**

## PINOUT DRAWINGS

### HMC1501

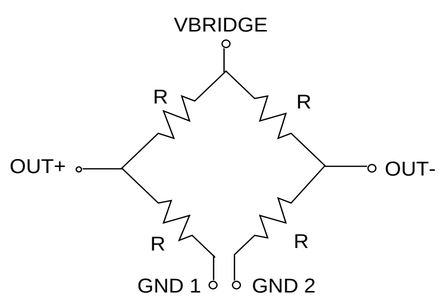


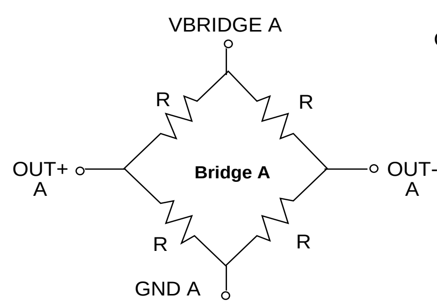

### HMC1512

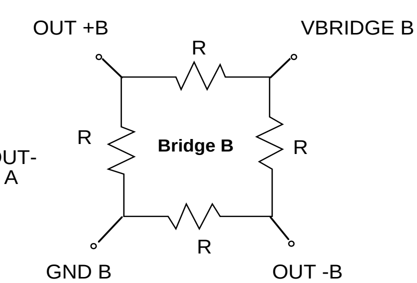



Caution: Do not connect GND or Power to Pin 3,4 &6.

## MR SENSOR CIRCUITS

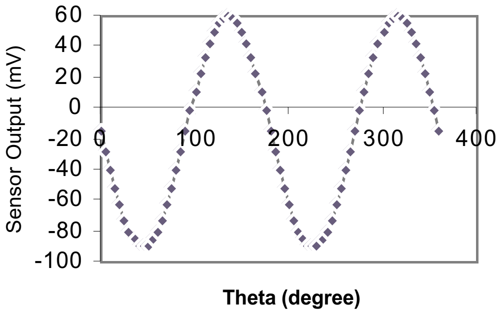


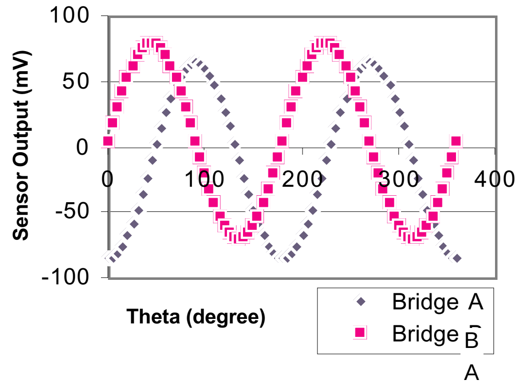



## TYPICAL SENSOR OUTPUT

HMC1501 output voltage vs. magnetic field angle

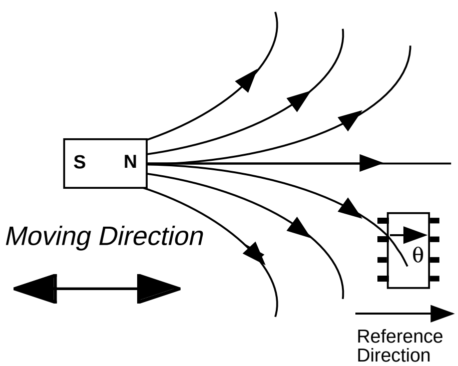



HMC1512 output voltage vs. magnetic field angle

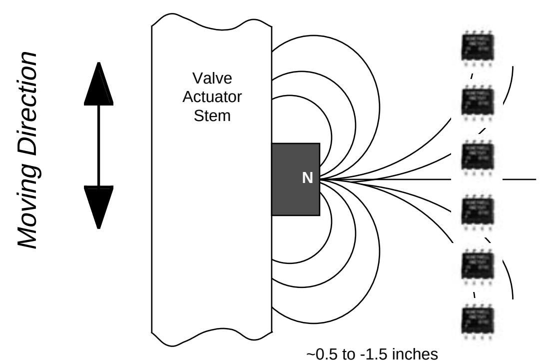



## APPLICATION CONFIGURATION

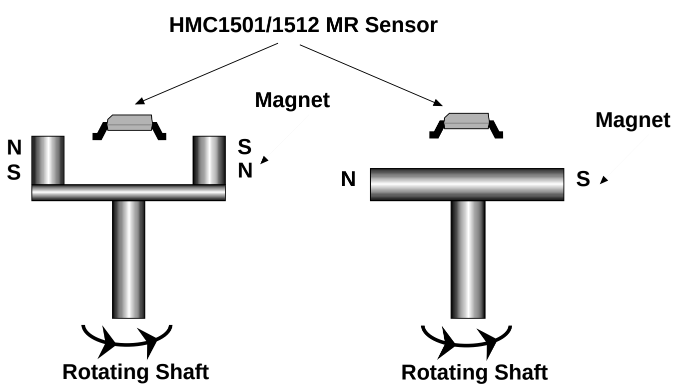
### Proximity Position



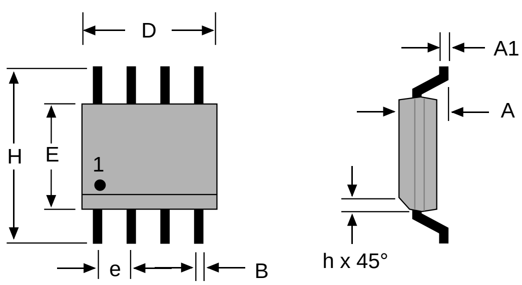

### Linear Position




### Rotary Position




## PACKAGE DRAWING 8-Pin SOIC




| Symbol | Millimeters Min | Millimeters Max | Inches Min | Inches Max |
|---|---|---|---|---|
| A | 1.371 | 1.728 | .054 | .068 |
| A1 | 0.101 | 0.249 | .004 | .010 |
| B | 0.355 | 0.483 | .014 | .019 |
| D | 4.800 | 4.979 | .189 | .196 |
| E | 3.810 | 3.988 | .150 | .157 |
| e | 1.270 ref | | .050 ref | |
| H | 5.816 | 6.198 | .229 | .244 |
| h | 0.381 | 0.762 | .015 | .030 |

## SPECIFICATIONS

| Characteristics | Conditions* | HMC1501 Min | HMC1501 Typ | HMC1501 Max | HMC1512 Min | HMC1512 Typ | HMC1512 Max | Units |
|---|---|---|---|---|---|---|---|---|
| Bridge supply | Vbridge referenced to GND | 1 | 5 | 25 | 1 | 5 | 25 | V |
| Bridge resistance | Bridge current—1 mA | 4 | 5 | 6.5 | 2.0 | 2.1 | 2.8 | KΩ |
| Angle range | ≥ Saturation field | -45 | | +45 | -90 | | +90 | deg |
| Sensitivity | Vbridge = 5V, field 80 Oe,<br>(1) @ zero crossing<br>(2) @ Zero crossing, averaged in the range of 45° | | 2.1<br>1.8 | | | 2.1<br>1.8 | | mV/° |
| Peak -to-peak Voltage | Vbridge = 5V, field = 80 Oe | 100 | 120 | 140 | 100 | 120 | 140 | mV |
| Bridge offset | Field 80 Oe, θ =0° Bridge A<br>Bridge B | -7 | 3 | 7 | 0<br>-4 | 2.5<br>0 | 5<br>1 | mV/V |
| Saturation field | Repeatability <0.03% FS | 80 | | | 80 | | | G |
| Bandwidth | Magnetic signal | 0 | | 5 | 0 | | 5 | MHz |
| Resolution | Bandwidth =10Hz,Vbridge =5V | | 0.07 | | | 0.05 | | ° |
| Hysteresis error | Magnetic field ≥saturation field, Vbridge = 5V | | 30<br>$1.7\times10^{-2}$ | | | 30<br>$1.7\times10^{-2}$ | | µV<br>deg |
| Bridge Ω tempco | $T_A$ = -40° C to +125° C | | 0.28 | | | 0.28 | | %/° C |
| Sensitivity tempco | $T_A$ = -40° C to +125° C<br>Vbridge = 5V | | -0.32 | | | -0.32 | | %/° C |
| Bridge offset tempco | $T_A$ = -40° C to +125° C | | -0.01 | | | -0.01 | | %/° C, FS |
| Noise Density | Noise at 1Hz, Vbridge = 5V | | 100 | | | 70 | | nV Hz |
| Power Consumption | Vbridge = 5V | | 5 | | | 23 | | mW |

*Tested at 25°C except stated otherwise.

Sensitivity tempco $C_s = \frac{S_t - S_o}{S_o * t} = -0.32\%/°C$

Where $S_o$ = sensitivity at zero temperature
t = temperature in the range -40°C to 125°C
$S_t$ = sensitivity at temperature t

Offset tempco $C_o = \frac{V_o(t) - V_o(o)}{V_{P\text{-}P} * t} = -0.01\%/°C$

Where $V_o(o)$ = bridge offset at zero temperature
$V_{P\text{-}P}$ = peak-to-peak voltage
t = temperature in the range -40°C to 125°C
$V_o(t)$ = offset at temperature t

Power consumption $P = \frac{V^2}{R}$

Where V = Bridge supply voltage
R = Bridge resistance

1 KA/m = 12.5 Gauss
1 Tesla = $10^4$ Gauss





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