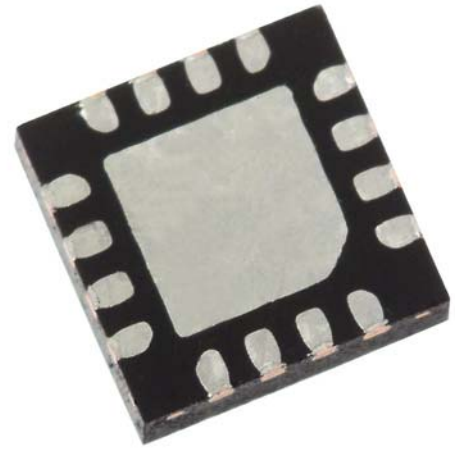


# 2-Axis Magnetic Sensor

## HMC1042L

The Honeywell HMC1042L is a high-performance, two-axis magneto-resistive sensor. It is designed for magnetic compass applications with capability of 0.2 degree accuracy. Stand alone or by adding the companion HMC1041Z sensor, precision two and three-axis magnetometry or compassing solutions are enabled. Pin compatible with the HMC1052L; this miniature, low cost solution is easy to assemble for high volume, cost effective OEM designs. Applications for the HMC1042L include Compassing, Navigation Systems, Magnetometry, and Magnetic Anomaly Detection.



The HMC1042L utilizes Honeywell's Anisotropic Magneto-resistive (AMR) technology that provides advantages over coil based magnetic sensors. They are extremely sensitive, low field, low hysteresis, solid-state magnetic sensors designed to measure direction and magnitude of Earth's magnetic fields, from tens of micro-gauss to 6 gauss. Honeywell's Magnetic Sensors are among the most sensitive and reliable low-field sensors in the industry.

Honeywell continues to maintain product excellence and performance by introducing innovative solid-state magnetic sensor solutions. These are highly reliable, top performance products that are delivered when promised. Honeywell's magnetic sensor solutions provide real solutions you can count on.

### FEATURES

- ▶ Two-Axis Precision Sensors
- ▶ Miniature Surface Mount Two-Axis Magnetic Sensors (3mm x 3mm QFN)
- ▶ Low Voltage Operations (1.8V)
- ▶ Low Cost
- ▶ Available in Tape & Reel Packaging
- ▶ Lead Free Package Construction
- ▶ 4-Element Wheatstone Bridge
- ▶ Wide Magnetic Field Range (+/-6 Oe)
- ▶ Patented Offset and Set/Reset Straps

### BENEFITS

- ▶ Near-Perfect Orthogonality and  $\pm 0.2\%$ FS/gauss Cross Axis Performance
- ▶ Small Size for Low Profile Sensing Applications and Mounting, Compatible with High Speed SMT Assembly
- ▶ Compatible for Battery Powered Applications
- ▶ Designed for High Volume, Cost Effective OEM Designs
- ▶ High Volume OEM Assembly
- ▶ Complies with Current Environmental Standards
- ▶ Low Noise Passive Element Design
- ▶ Sensor Can Be Used in Strong Magnetic Field Environments
- ▶ Stray Magnetic Field Compensation

# HMC1042L

## SPECIFICATIONS

| Characteristics        | Conditions*  | Min   | Typ               | Max   | Units                                      |
|------------------------|--|-------|-------------------|-------|--|
| <b>Bridge Elements</b> |  |       |                   |       |  |
| Supply                 | Vbridge referenced to GND  | 1.8   | 3.0               | 20    | Volts                                      |
| Resistance             | Bridge current = 1mA   | 800   | 1000              | 1500  | ohms                                       |
| Field Range            | Full scale (FS) – total applied field  | -6    |                   | +6    | gauss                                      |
| Sensitivity            | Set/Reset Current = 0.5A   | 0.8   | 1.0               | 1.2   | mV/V/gauss                                 |
| Resolution             | 1 kHz bandwidth, Vbridge = 5.0 volts   |       | 0.16<br>1.44      |       | milli-gauss (RMS)<br>milli-gauss (pk – pk) |
| Bridge Offset          | Offset = (OUT+) – (OUT-)<br>Field = 0 gauss after Set pulse                                  | -1.25 | ±0.5              | +1.25 | mV/V                                       |
| Bandwidth              | Magnetic signal (lower limit = DC)   |       | 5                 |       | MHz  |
| Disturbing Field       | Sensitivity starts to degrade.<br>Use S/R pulse to restore sensitivity.                      | 20    |                   |       | gauss                                      |
| Max. Exposed Field     | No perming effect on zero reading  |       |                   | 10000 | gauss                                      |
| Operating Temperature  | Ambient  | -40   |                   | 125   | °C   |
| Storage Temperature    | Ambient, unbiased  | -55   |                   | 150   | °C   |
| Humidity               | Tested at 85°C   |       |                   | 85    | %  |
| Sensitivity Tempco     | T <sub>A</sub> = -40 to 125°C, Vbridge=5V  | -3000 | -2700             | -2400 | ppm/°C                                     |
| Bridge Offset Tempco   | T <sub>A</sub> = -40 to 125°C, No Set/Reset<br>T <sub>A</sub> = -40 to 125°C, With Set/Reset |       | ±500<br>±10       |       | ppm/°C                                     |
| Bridge Ohmic Tempco    | Vbridge=5V, T <sub>A</sub> = -40 to 125°C  | 2100  | 2500              | 2900  | ppm/°C                                     |
| Cross-Axis Sensitivity | Cross field = 0.5 gauss, Happlied = ±3 gauss   |       | ±0.2%             |       | %FS/gauss                                  |
| Linearity Error        | Best fit straight line<br>± 1 gauss<br>± 3 gauss<br>± 6 gauss                                |       | 0.1<br>0.5<br>1.8 |       | %FS  |
| Hysteresis Error       | 3 sweeps across ±3 gauss   |       | 0.06              |       | %FS  |
| Repeatability Error    | 3 sweeps across ±3 gauss   |       | 0.1               |       | %FS  |
| Weight                 |  |       | 23.4              |       | milli-grams                                |

### Set/Reset Strap

|                   |   |      |      |      |        |
|-------------------|---|------|------|------|--------|
| Resistance        | Measured from S/R+ to S/R-                    | 3    | 4.5  | 6    | ohms   |
| Current           | 0.1% duty cycle, or less, 2μsec current pulse | 0.4  | 0.5  | 4    | Amp    |
| Resistance Tempco | T <sub>A</sub> =-40 to 125°C                  | 3300 | 3700 | 4100 | ppm/°C |

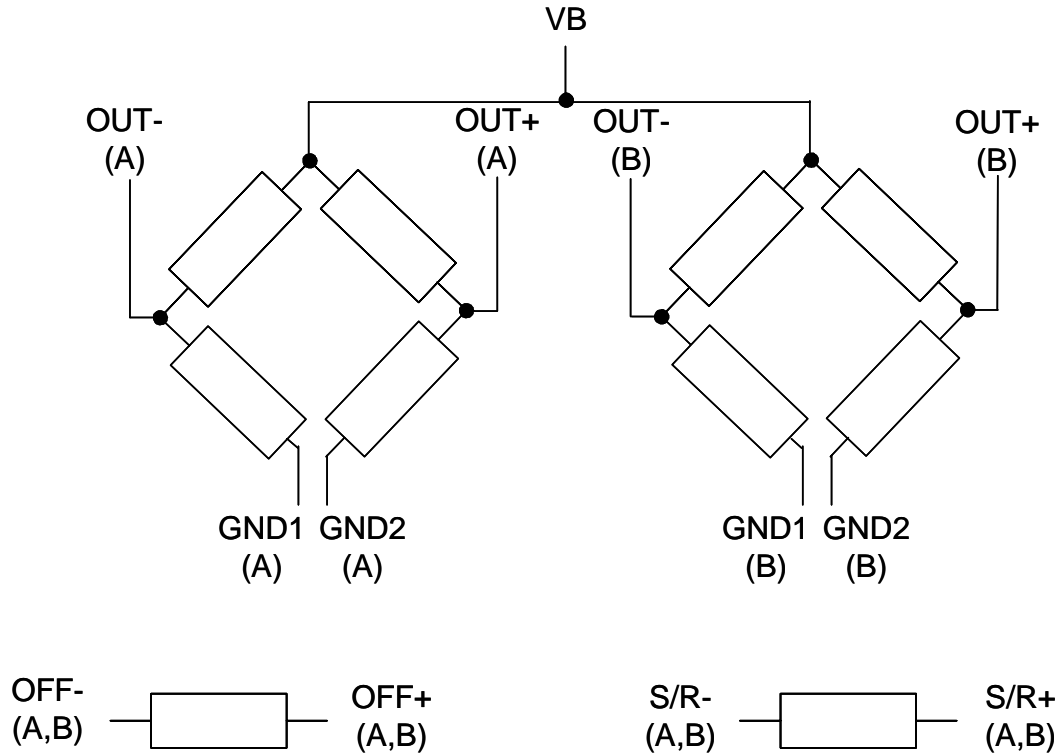
### Offset Straps

|                   |  |      |      |      |          |
|-------------------|--|------|------|------|----------|
| Resistance        | Measured from OFFSET+ to OFFSET-                 | 12   | 15   | 18   | ohms     |
| Offset Constant   | DC Current, Field applied in sensitive direction |      | 10   |      | mA/gauss |
| Resistance Tempco | T <sub>A</sub> =-40 to 125°C                     | 3500 | 3900 | 4300 | ppm/°C   |

\* Tested at 25°C except stated otherwise.

# HMC1042L

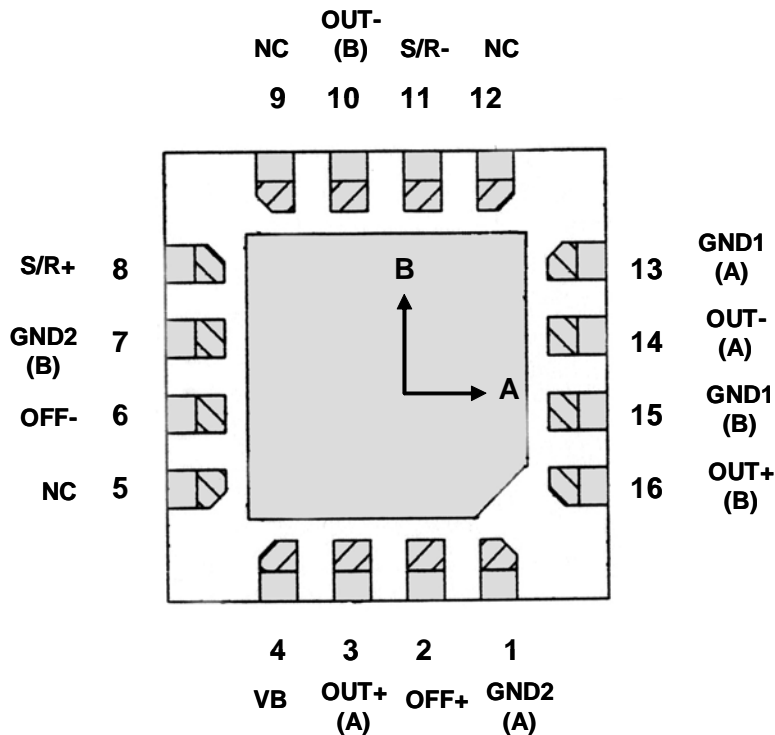
## SCHEMATIC DIAGRAM



## PIN CONFIGURATIONS

(Arrow indicates direction of applied field that generates a positive output voltage after a SET pulse.)

### BOTTOM VIEW

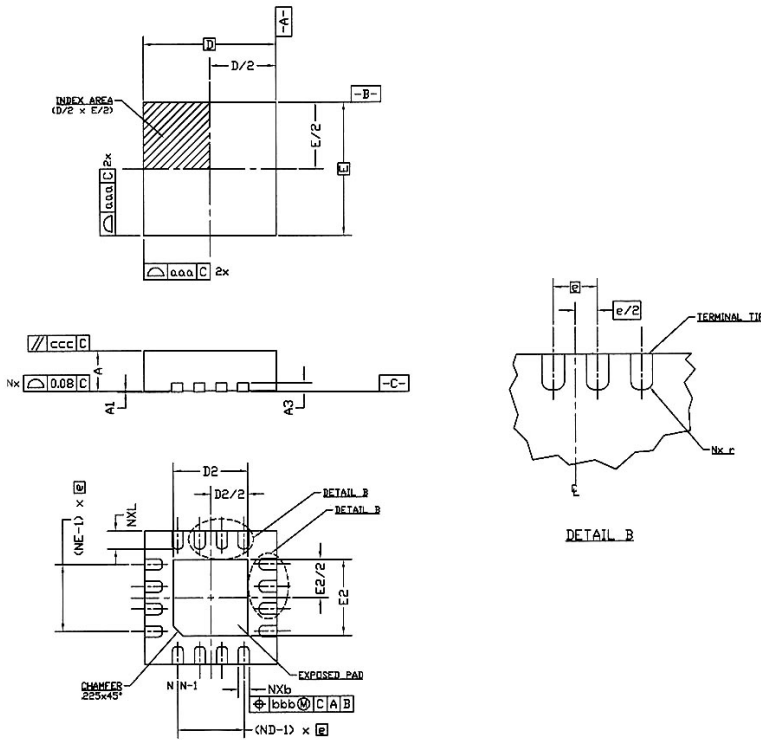


| Pin Number | Function |
|------------|----------|
| 1          | GND2 (A) |
| 2          | OFF+     |
| 3          | OUT+ (A) |
| 4          | VB       |
| 5          | NC       |
| 6          | OFF-     |
| 7          | GND2 (B) |
| 8          | S/R+     |
| 9          | NC       |
| 10         | OUT- (B) |
| 11         | S/R-     |
| 12         | NC       |
| 13         | GND1 (A) |
| 14         | OUT- (A) |
| 15         | GND1 (B) |
| 16         | OUT+ (B) |

# HMC1042L

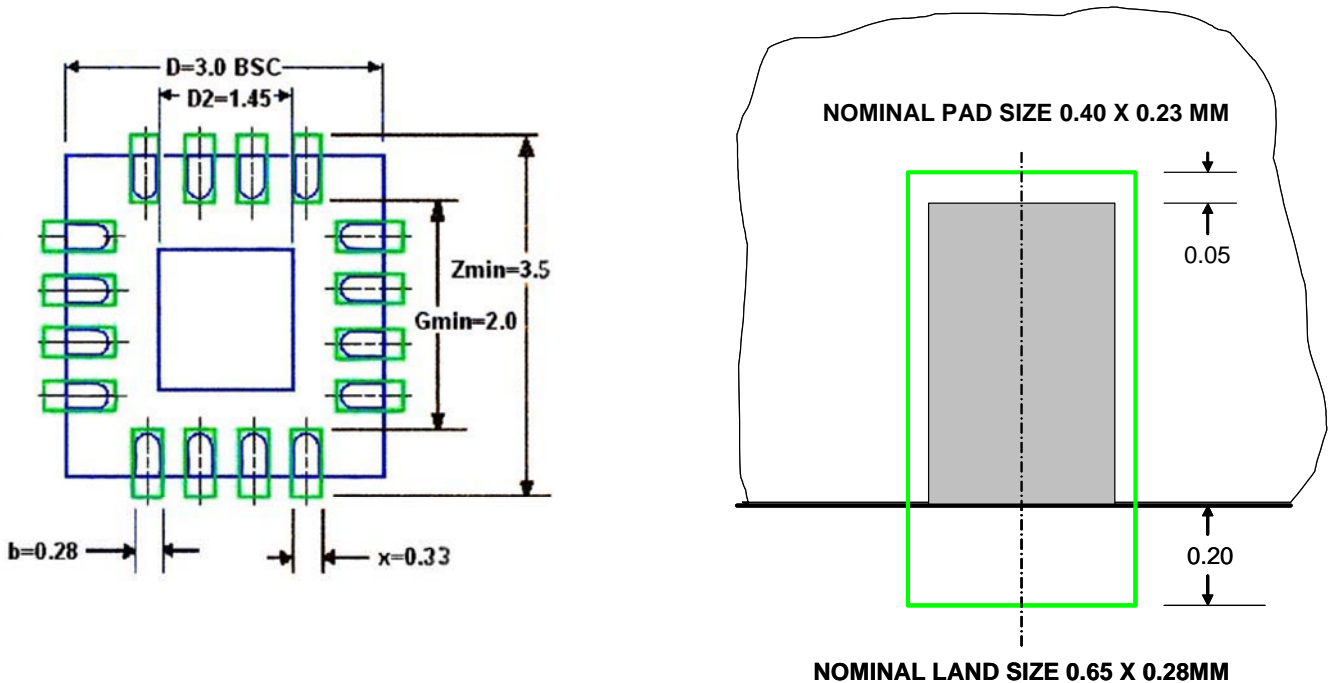
## PACKAGE OUTLINES

### PACKAGE DRAWING HMC1042L (16-PIN LCC, dimensions in millimeters)



| Symbol | Millimeters |      |
|--------|-------------|------|
|        | min         | max  |
| A      | 0.80        | 1.00 |
| A1     | 0           | 0.05 |
| A3     | 0.20 REF    |      |
| b      | 0.18        | 0.30 |
| D      | 3.00 BSC    |      |
| D2     | 1.55        | 1.80 |
| E      | 3.00 BSC    |      |
| E2     | 1.55        | 1.80 |
| e      | 0.50 BSC    |      |
| L      | 0.30        | 0.50 |
| N      | 16          |      |
| ND     | 4           |      |
| NE     | 4           |      |
| r      | B(min)/2    |      |
| aaa    | 0.15        |      |
| bbb    | 0.10        |      |
| ccc    | 0.10        |      |

The following is the recommend printed circuit board (PCB) footprint for the HMC1042L. All dimensions are nominal and in millimeters.



# HMC1042L

## Stencil Design and Solder Paste

A 4 mil stencil and 100% paste coverage is recommended for the electrical contact pads. The HMC1042L has been tested successfully with no-clean solder paste.

## BASIC DEVICE OPERATION

The Honeywell HMC1042L magnetoresistive sensors are Wheatstone bridge devices to measure magnetic fields. With power supply applied to the bridges, the sensors convert any incident magnetic field in the sensitive axis directions to a differential voltage output. In addition to the bridge circuit, the sensor has two on-chip magnetically coupled straps; the offset strap and the set/reset strap. These straps are Honeywell patented features for incident field adjustment and magnetic domain alignment; and eliminate the need for external coils positioned around the sensors. The straps are common in effect to both bridges.

The magnetoresistive sensors are made of a nickel-iron (Permalloy) thin-film deposited on a silicon wafer and patterned as a resistive strip element. In the presence of a magnetic field, a change in the bridge resistive elements causes a corresponding change in voltage across the bridge outputs.

These resistive elements are aligned together to have a common sensitive axis (indicated by arrows on the pinouts) that will provide positive voltage change with magnetic fields increasing in the sensitive direction. Because the output only is in proportion to the one-dimensional axis (the principle of anisotropy) and its magnitude, additional sensor bridges placed at orthogonal directions permit accurate measurement of arbitrary field direction. The combination of sensor bridges in two and three orthogonal axis permit applications such as compassing and magnetometry.

The offset strap allows for several modes of operation when a direct current is driven through it. These modes are: 1) Subtraction (bucking) of an unwanted external magnetic field, 2) null-ing of the bridge offset voltage, 3) Closed loop field cancellation, and 4) Auto-calibration of bridge gain.

The set/reset strap can be pulsed with high currents for the following benefits: 1) Enable the sensor to perform high sensitivity measurements, 2) Flip the polarity of the bridge output voltage, and 3) Periodically used to improve linearity, lower cross-axis effects, and temperature effects.

### Offset Strap

The offset strap is a spiral of metallization that couples in the sensor element's sensitive axis. The offset strap measures nominally 15 ohms, and requires 10mA for each gauss of induced field. The straps will easily handle currents to buck or boost fields through the  $\pm 6$  gauss linear measurement range, but designers should note the extreme thermal heating on the die when doing so.

With most applications, the offset strap is not utilized and can be ignored. Designers can leave one or both strap connections (Off- and Off+) open circuited, or ground one connection node. Do not tie both strap connections together to avoid shorted turn magnetic circuits.

### Set/Reset Strap

The set/reset strap is another spiral of metallization that couples to the sensor elements easy axis (perpendicular to the sensitive axis on the sensor die. Each set/reset strap has a nominal resistance of 4.5 ohms with a nominal required peak current of 500mA for reset or set pulses. With rare exception, the set/reset strap must be used to periodically condition the magnetic domains of the magneto-resistive elements for best and reliable performance.

A set pulse is defined as a positive pulse current entering the S/R+ strap connection. The successful result would be the magnetic domains aligned in a forward easy-axis direction so that the sensor bridge's polarity is a positive slope with positive fields on the sensitive axis result in positive voltages across the bridge output connections.

A reset pulse is defined as a negative pulse current entering the S/R+ strap connection. The successful result would be the magnetic domains aligned in a reverse easy-axis direction so that bridge's polarity is a negative slope with positive fields on the sensitive axis result in negative voltages across the bridge output connections.

Typically a reset pulse is sent first, followed by a set pulse a few milliseconds later. By shoving the magnetic domains in completely opposite directions, any prior magnetic disturbances are likely to be completely erased by the duet of pulses. For simpler circuits with less critical requirements for noise and accuracy, a single polarity pulse circuit may be employed

# HMC1042L

(all sets or all resets). With these uni-polar pulses, several pulses together become close in performance to a set/reset pulse circuit. Figure 1 shows a quick and dirty manual pulse circuit for uni-polar application of pulses to the set/reset strap.

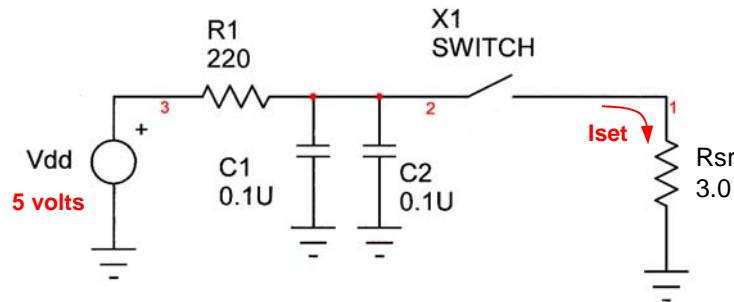
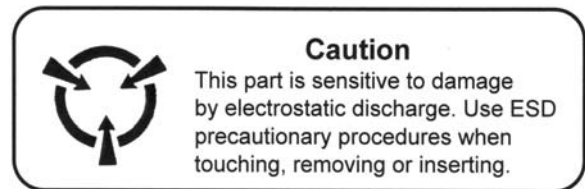


Figure 1  
Manual Set Pulse Circuit

## ORDERING INFORMATION

| Ordering Number   | Product                      |
|-------------------|------------------------------|
| HMC1042L          | Two Axis Magnetic Sensor     |
| HMC1042L T/R 3k   | Tape and Reel 3k pieces/reel |
| HMC1042L Cut Tape | Cut Tape                     |



**CAUTION: ESDS CAT. 1B**

## FIND OUT MORE

For more information on Honeywell's Magnetic Sensors visit us online at [www.magneticsensors.com](http://www.magneticsensors.com) or contact us at 800-323-8295 (763-954-2474 internationally).

The application circuits herein constitute typical usage and interface of Honeywell product. Honeywell does not warranty or assume liability of customer-designed circuits derived from this description or depiction.

Honeywell reserves the right to make changes to improve reliability, function or design. Honeywell does not assume any liability arising out of the application or use of any product or circuit described herein; neither does it convey any license under its patent rights nor the rights of others.

U.S. Patents 4,441,072, 4,533,872, 4,569,742, 4,681,812, 4,847,584 and 6,529,114 apply to the technology described

# Honeywell