FREQUENTLY ASKED QUESTIONS

Magnetic Sensors, Compasses and Magnetometers

Q: When using the HMR3500 or HMR3601 compass I've started experiencing a large heading error. What is causing this?

A: The compass may have been exposed to a large magnetic field and the components could be retaining a magnetic field that is being superimposed on the heading output. Refer to application note AN221 for more information.

Q: Can components on my Printed Circuit Board (PCB) bring some perturbation to onboard magnetic sensors?

A: Yes, many components contain ferrous materials. Nickel plating is the most common culprit and is present on lead frames of integrated circuits and solder end caps of surface mount components. Other components such as power transistors may have packages with large amounts of iron in the heat spreading elements. Also, beware of the location of NiCd (Nickel-Cadnium) batteries, and speaker/microphone elements using permanent magnets.

A good rule of thumb is to keep adjacent components at least two end cap lengths away from the magnetic sensor components. This also applies to parts that may be placed on the opposite side of the printed circuit board. For example, a 0603 capacitor with 30mil end caps should be at least 60mils away from the magnetic sensors.

Q: My HMC100X/HMC102X/HMC104X/ HMC105X sensor component does not seem to work. What should I expect to see from these parts?

A: These magnetoresistive sensors are passive components formed as Wheatstone bridge elements to measure magnetic field strengths applied to the component. As a Wheatstone bridge, there are four identically valued resistors configured in a diamond shape and looped together for four circuit nodes (bridge supply voltage, ground, output positive, and output negative). Users must connect the bridge grounds together if multiple grounds exist and apply a modest DC voltage (typically +1.8 to +12 volts) at the bridge supply node. Proper connections are verified if the two output nodes are approximately half the bridge supply voltage.

In typical indoor or outdoor environments, the earth's magnetic field (about 600 milli-gauss) will divide on the single, two or three axis of the magnetic sensors used. The earth's field aligns from south to the north with a downward/upward amount included, depending on your location's latitude. Because the earth's magnetic field is fairly weak, only a couple of millivolts of differential output (measured across the output nodes) will be detected using logic level power supplies.

Rotation of the sensor should vary the output voltage. If it does not, the part may be "permed" due to strong magnetic fields over 20 gauss such as accidental proximity of magnetized tips of some hand tools during assembly. Performing the application of current pulses across the set/reset strap should degauss the sensor(s) and restore performance.

Q: My sensor component has multiple ground pins; do I have to ground all of them or can I just ground one?

A: The multiple grounds are for production test purposes so that each resistive element can be tested individually. All ground connections should be tied together.

Q: The set/reset strap seems to need a lot of power to function. Is there any way to do this at lower power levels?

A: Even though the straps require 400mA to 5 amperes of pulse current, the duration is only a microsecond or two, so the power consumption is very small. Most of the set/reset strap driver circuits use a capacitor charge and dump technique to achieve these higher peak currents. It is also very important to use low-ESR capacitors and transistor switches that have low ohmic losses compared to total impedances of the straps driven. See application note AN213 for further details.

Q: Are the magnetic sensor products RoHS compliant?

A: The Honeywell Magnetic Sensor Product Line produces a family of single, dual and three axis analog and digital sensor components that meet the EU Directive 2011/65/EC (RoHS 2). However, products that are PCB based do not comply with the RoHS directive. These products are the HMC105x series sensors, HMC2003 Analog Magnetometer, HMR2300x Digital Magnetometers, HMR3xxx Compasses and DRM4000L Dead Reckoning Module.

Q: I want to put an electronic compass in my aircraft/UAV. Will it remain accurate when performing turns or pulling gs?

A: No, either fluidic tilt sensors or accelerometers used as tilt sensors on compasses will be disturbed from measuring the earth's gravitational direction when other forces are applied to change the aircraft's attitude. At present, the only method of retaining gravitational direction through acrobatic forces is gyroscopic correction or "gyros." Only flat attitudes will permit accurate compassing aboard aircraft. In addition, some data filtering may be necessary to remove aircraft vibrations.

Q: My HMR2300/HMR3000/HMR3300 does not seem to work. How do I determine if the product is working correctly versus a glitch in my computer running the demo software?

A: The first thing to check is that the interface cable is making good connections with pins 2 and 3 passing RS-232 data and pin 9 having about 9 volts DC on it with respect to ground (pin 5). Check the AC adapter switches for appropriate settings (120/240VAC) (9 volts) (+ polarity) and if required, measure the pin 9 to pin 5 voltage with a voltmeter.

The HMR2300 default data settings are 9600bps, 8-bit data with 1-bit stop and ASCII formatted syntax. Upon power-up, a "BAUD= 9600" is sent and awaiting a command. The HMR3000 default data settings are 19200bps, 8-bit data with 1-bit stop and ASCII formatted syntax. Upon power-up, the HMR3000 begins sending streaming heading, pitch, and roll data (e.g. "$PTNTHPR,227.0,N,-0.3,N,-0.3,N*33") at nearly a once per second update rate.

The HMR3300 default data settings are 19200bps, 8-bit data with 1-bit stop and ASCII formatted syntax. Upon power-up, the HMR3300 sends "Honeywell HMR3300 (0.5)" and "#N", and then completes a one second restart routine (green LED on). After the green LED extinguishes, the HMR3300 begins to send 8Hz streaming data in the heading, pitch, and roll format (e.g. "256.5,5.9,15.4").

These data streams are normally invisible to the demo software user, but can be viewed using the Windows Accessory Program called HyperTerminal. Set up HyperTerminal using the COM1 port setting and the required data formatting with no parity bits and no flow control. Direct command exchange can be done with HyperTerminal until the user has developed an application specific set of communication software.

Q: What is an Offset Strap, and what does it do?

A: The offset strap in linear mode magnetic sensors is a spiral of metal located over the magnetoresistive elements of the sensor to form a coil. This spiral coil shaped strap can induce localized magnetic fields upon the sensor when a current is passed through the strap. The purpose of these induced fields is to buck or boost the incident magnetic fields on the sensor. By doing so, these straps induced magnetic fields sum with the external fields, or "offset" the external fields. Use of the offset strap is often to extend the linear range of the sensor, buck stray fields from nearby magnetized metals (e.g. automobile chassis) or become part of an active feedback network that extends the dynamic range of the sensing circuits. Most designers do not use this strap and it can be left unconnected or connected to ground at only one side.

Q: I have metal parts near the sensor. Are they going to interfere with the magnetic sensor performance?

A: Metals can be broken up into two categories, ferrous and non-ferrous. Metals like aluminum, copper, or brass do not shield magnetic fields although currents flowing through them may induce local magnetic fields. Ferrous metals like steel, nickel and iron will distort magnetic fields by attracting them compared to passing through the surrounding air. When using the earth's magnetic field for compassing, ensure the sensors have sufficient standoff distance from ferrous objects that could bend the fields and cause a heading error. This will occur with any type of magnetic sensor. The amount of standoff depends on the size and proximity of the ferrous object. However, there are ways to deal with magnetic field distortion for nearby ferrous content.

For instance, a simple circular calibration routine can be implemented to account for the magnetic distortion effects of the automobile chassis and engine block. If the sensor is mounted in a fixed position in the car, the net effect is to gather minimum and maximum field strengths during the rotation and to determine the offset if the min/max data do not fully balance out.

Magnetic field distortion may be caused by at least two effects. "Soft-iron" effects are given by un-magnetized ferrous materials nearby. "Hard-iron" effects are given by magnetized ferrous materials. Hard-iron effects are especially easy to implement and null-out using a circular calibration routine. Soft-iron effects should be addressed in the design stage by giving the sensors appropriate clearance from ferrous content.

Q: Can I avoid using the set/reset strap in my sensor design?

A: In general, you can NOT avoid implementing some kind of set/reset strap driving circuit. However, if your sensor's measurement accuracy is very loose and you can envision no possible means of getting fields over 10 gauss at the sensor, then the set/reset strap can be left unconnected. Otherwise, a modest set/reset strap circuit should be implemented to revive from an intense magnetic field upset event or to improve the accuracy of the field measurements. Remember, common magnets can generate hundreds of gauss on their pole faces.

A simple manual push-button "charge and dump" circuit could be used to periodically create set pulses at a minimum. In addition, you could opportunistically perform the reset and set pulse train at circuit power-up or when the product enters a user menu for commanding the magnetic sensor function.

The frequency of reset followed by set pulses on the set/reset strap depends a few factors. The most important factor is how long the sensor can be magnetically upset before required to recover via the reset and set pulse function. For consumer electronics, this may be 1 second to several minutes to menu-driven demands. Frequent pulses of many per second are desired when the ultimate of micro-gauss sensitivity is needed. These frequent pulse applications would be security systems, vehicle detection and laboratory-grade magnetometers. See application note AN-213 for further set/reset circuit details.

Q: I have a Honeywell Compass Module (or Sensor) near my radio antennas. Are there any EMI/RFI issues with placing these parts nearby?

A: Normally there are no compatibility issues with having magnetic sensor based electronics located near receiving or transmitting antennas. Precautions should be taken if the electric field strengths are excessive and propagation is observed on the circuit board assembly. Honeywell's magnetic sensors have a nominal bandwidth of 5MHz, so magnetic fields far above that do not have an influence on sensor performance. Shield material selection should be carefully chosen to not block magnetic fields to the sensor or placed too close to the sensors when both electric and magnetic field shielding is necessary.

Q: I plan to mount my compass/sensor on a moving platform with motors/generators close by. Is there any influence on sensor performance in this environment?

A: Yes, electric motors usually generate magnetic fields many times in excess of the earth's magnetic field. By shielding motor/generator housings, these fields can be reduced to an acceptable level of interference. The sensors will detect the sum of these desired and undesired fields as one magnetic field. They may be separated using electronic filters, since the earth's field is DC (or static) and if the motor's field is AC (or oscillating). Some trial and error may be necessary to properly locate the compass/sensors when mounted with motorized assemblies.

Q: What does HMC or HMR mean to me and how do I interpret these model numbers?

A: The HMR prefix was first created to refer to "Honeywell Magneto-Resistive", and generally meant to denote a family of board-level magnetic sensing solutions. The HMC prefix refers to "Honeywell Magnetic Component" and generally pertains to sensor or integrated circuit packaged parts. The four digit numeric suffixes denote the product categories and number of sensors used within.

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