ANH012

Application Note
AH180 MicroPower Omnipolar Hall-Effect Sensor Switch

Contents

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1. Introduction

AH180 is a low-power Omnipolar Hall-Effect Sensor Switch fabricated using an advanced CMOS process. The term “micropower” accurately describes the low-power capability of AH180 in both full operating and idle modes. Whether AH180 is used in devices that are battery-powered or in those that are AC-powered, AH180 can meet the new energy consumption requirement imposed by the various government regulations and the energy-conscious consumers.

The AH180 operates with supply voltages of 2.5V to 5.5V. This allows the AH180 to work in mobile or handheld devices powered by a wide range of batteries from the1-cell lithium-ion type to the 2-cell alkaline/zinc type. The AH180 can also be used in a multitude of applications including computer mice, joysticks, portable gaming devices, cover switches in notebook PC / PDA / clam-shell mobile handsets, flow-measuring meters for water / gas / electricity, and reed switch replacements.

The AH180 is available in SC59-3L, SIP-3L, and DFN-6L packages. To ease the design effort, operating temperature range of the AH180 is from -40°C to +85°C. To minimize the BOM cost, capacitors of the MLCC type are supported, and only two external components are needed to complete the application circuit.

2. Key Aspects of AH180

The AH180 is ultra-sensitive and pole independent. The omnipolar nature allows the AH180 to respond effortlessly to the presence of a magnetic field of either north pole or south pole, thus eliminating the need to orient the magnet's polarity during manufacturing. In the absence of a magnetic field, the open-drain output of the AH180 is "off". In the presence of a magnetic field, the open-drain output of the AH180 is "on". Because the output of AH180 is latched, the output state of the AH180 is retained until the next status change to the opposing sides. An innovative clocking scheme is employed to minimize both the active-state operating current and the idle-state operating current. In other words, the on-chip low-power oscillator ensures a duty cycle of only 0.1% during the "on" state, putting most of the circuitries and logics inside AH180 into the "off" state. Once "on", the output state of the Hall-effect sensor is sampled, latched and held until the next sampling. This technique results in an average supply current of 8 μA, making the AH180 a good fit to products that demand low system power consumption.

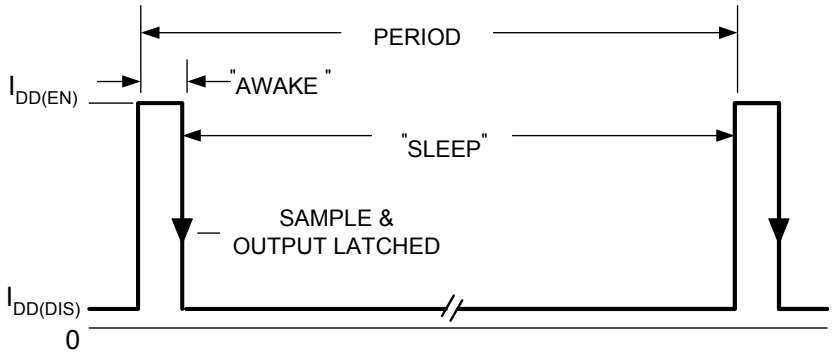
Improved stability is accomplished through the use of chopper stabilization. The resulting dynamic offset cancellation reduces the residual offset voltage normally caused by the physical stress to the device, the temperature dependencies, and the thermal stress.

To ensure reliability of the AH180 during manufacturing and shipping processes, special layouts are adopted to achieve electrostatic discharge protection of no less than 5.5kV.

3. Application Recommendations

3.1 Sample Interval

The clocking scheme employed by AH180 allows for the magnetic field to be sampled at a pre-defined rate. As a result, most of the circuits and logics inside AH180 are being shut down mostly during the “sleep” part of a clock period. In accordance to the pre-defined rate, all the internal circuits and logics wake up to sample the magnetic field observed by the integrated Hall sensors.

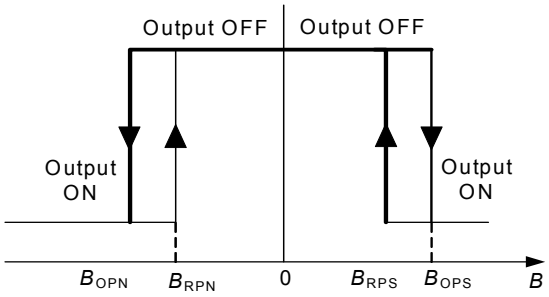


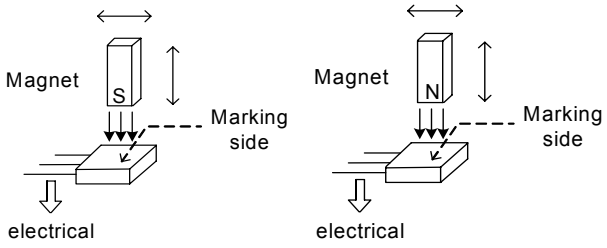
To ensure that the magnetic field presence is correctly interpreted, especially in lieu of the RF switching noise within close proximity, the output of AH180 shall be sampled multiple times before its state can be correctly registered. For instance, in a clam-shell type mobile handset, when ten consecutive samplings of the AH180’s output within a period of 300ms all indicate the presence of a magnetic field, the system software can affirm either “lid closed” or “lid remains closed”. In contrast, the absence of magnetic field can be reliably interpreted by sampling the output of AH180 once.

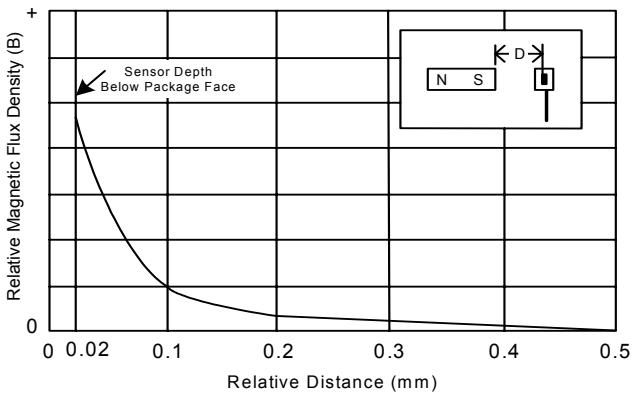
When power is initially on, the operating Vdd (2.5V to 5.5V) must be applied to be guaranteed for the output sampling. The output state is valid after the second operating phase (typical 150ms).

3.2 Magnetic Induction

The diagrams below show the Gauss versus Output State, typical lateral and vertical magnet movement with respect to AH180 (in SIP-3 package), relative magnetic flux density versus distance between the magnet and AH180.

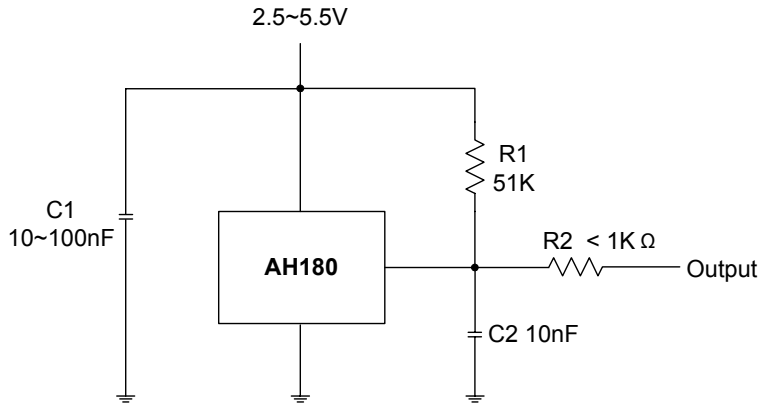






In reference to the diagrams above, the further the magnet is positioned from AH180, the lesser are the magnetic flux density. This shall result in decreasing sensitivity.

3.3 Reference Circuit



C1 serves two purposes: minimizing ripples on the input voltage and enhancing immunity from RF transmission noises within close proximity. Recommended values are between 10nF and 100nF (in special case, the C1 value shall be tuned to bigger as the next description in 3.4 Noise Immunity). The larger the capacitance, the better the noise immunity is for the AH180. R1 is meant to be pulled high to the input supply voltage, and its recommended value of R1 is 51KΩ. The use of R2 and C2 is optional because their main purpose is to reduce the ripples at the output of the AH180.

3.4 Noise Immunity

In any electronic circuit, there exist random variations in current or voltage caused by the random movement of the electrons carrying the current as they are jolted around by thermal energy which causes noise. In applications of the AH180, care is needed to avoid interference with noise which can cause the device to not operate properly over the operating voltage range 2.5~5.5V and temperature range.

The AH180 operates under the following conditions when noise is injected:

When operating from 3V - the AH180 output state is possible but not valid when the change in power source (Vdd/Vdd) is over +/- 7% @ room temperature. The same conditions apply when operating temperature increases to 85C, the AH180 output state is possible but not valid when power source (Vdd /Vdd) is over +/- 5%. Increasing the capacitance of C1 in reference circuit will stabilize the AH180 - with a power source Vdd with-in +/- 5% (Vdd/Vdd).

Even the power source regulation is within 5%, it is strongly recommended that an external bypass capacitor be connected (in close proximity to the Hall sensor) between the supply and ground of the device in reference circuit to enhance the noise immunity.

To improve the immunity of the Hall sensor operation from the RF switching noises within close proximity, custom low-pass filters were integrated into AH180. Nonetheless, it is a good practice to position AH180 as far away from the sources of RF switching noises as it is practically allowed.