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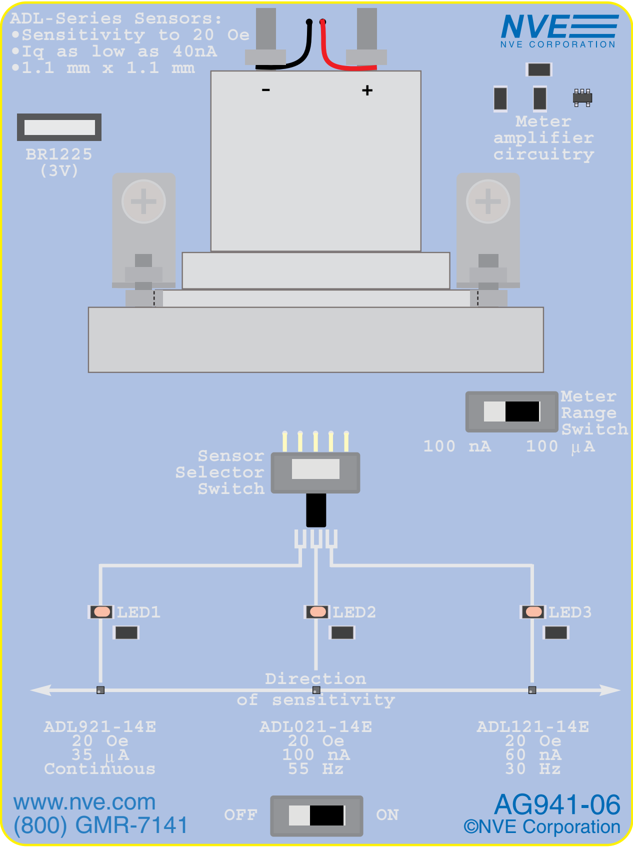
AG941-07E
ADL-Series Nanopower Magnetic Sensor Evaluation Kit



SB-00-052

Kit Overview

This kit contains:

- A battery-powered evaluation board with three models of NVE's ADL-Series Nanopower digital magnetic sensors.

- The board has a 100 µA meter to show sensor current, plus amplifier circuitry to provide a 100 nA meter scale.

- Each sensor has an indicator LED to show its output state.
- A 0.5 x 0.25 x 0.125 inch (13 x 6 x 3 mm) Alnico8 bar magnet (NVE part no. 12030) to actuate the sensors.
- This manual.

The three sensors models on the board are:

	Quiescent Supply		Operate Point (Max.)	Update Frequency (Typ.)	Package
	Typ. (V_{DD} =3V)	Max. (V_{DD} =3.6V)			
ADL021	0.1 µA	0.35 µA	20 Oe	55 Hz	1.1 x 1.1 x 0.45 mm ULLGA
ADL121	0.06 µA	0.16 µA		30 Hz	
ADL921	60 µA	120 µA		Continuous	

ADL-Series Sensor Advantages

- Extremely low power (to 40 nA)
- Ultraminiature (1.1 mm x 1.1 mm x 0.45 mm)
- Sensitive (to 20 Oersteds)

Quick Start

⇒ Turn the power switch ON.

⇒ Select the sensor with the three-position slide switch.

⇒ Set the meter range to 100 µA for the ADL921 or 100 nA for the ADL021/121. ADL021 current can exceed 100 nA depending on the particular part. ***Avoid the 100 nA range with the ADL921*** to prevent meter overstress.

⇒ Position the magnet horizontally over the selected sensor to activate.

⇒ Turn the power OFF when not in use to preserve the battery.

*Visit **www.nve.com** for product datasheets, or **YouTube.com/NveCorporation** for a demonstration of this evaluation kit.*

Sensor Operation

Configuration

Configured as magnetic switches, ADL Sensors turn on (output pulled low) when a magnetic field is applied, and off when the field is removed. Their magnetic operate points are extremely stable over supply voltage and temperature.

Continuous and Duty-Cycled Versions

The ICs consist of a GMR sensor element, CMOS signal processing circuitry to convert the analog sensor element output to a digital output, and optional oscillator and timing circuitry for power management duty cycling. Internally duty-cycled versions, such as the ADL021 and ADL121 in this demonstration conserve power. Two duty-cycle frequencies are available, offering a trade-off between update frequency and power consumption. An integrated latch ensures the output is available continuously. The continuously-operating ADL9xx versions have a 250 kHz frequency response.

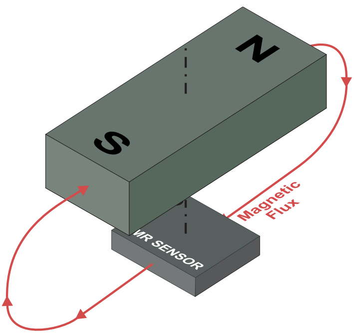


Fig. 3. GMR sensitivity is in the IC plane.

Magnet Orientation

Unlike most other magnetic sensors, GMR sensors are sensitive in the plane of the IC as shown in Figure 3, rather than orthogonal to the IC. This is more convenient for most applications. Sensors such as Hall effect would require a vertical, rather than horizontal, bar magnet.

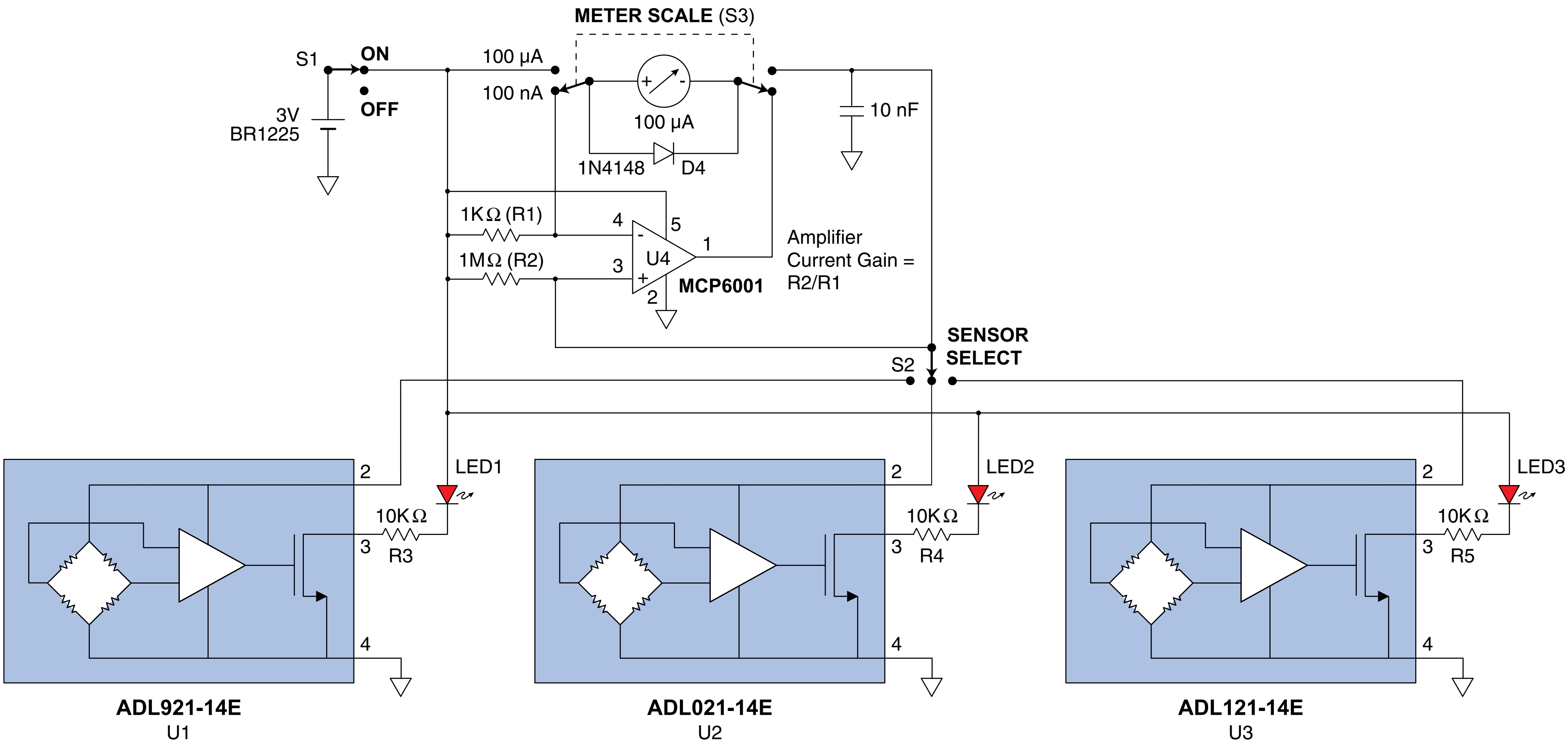
Omnipolar Response

ADL-Series sensors are omnipolar, meaning they are activated by either a North or South field. This avoids having to track the magnet's pole orientation.

Magnetic Field and Distances

GMR sensors are quite sensitive, allowing large distances between the sensor and the magnet. The 0.5 x 0.25 inch (13 x 6 mm) magnet supplied with this demo operates the 20 Oe sensors used on the board from approximately 0.75 inches (19 mm). Stronger magnets (such as rare earth) operate farther away, while weaker magnets (such as ferrite or ceramic) may need closer spacings. ADL-Series sensors are also available in 28 Oe versions.

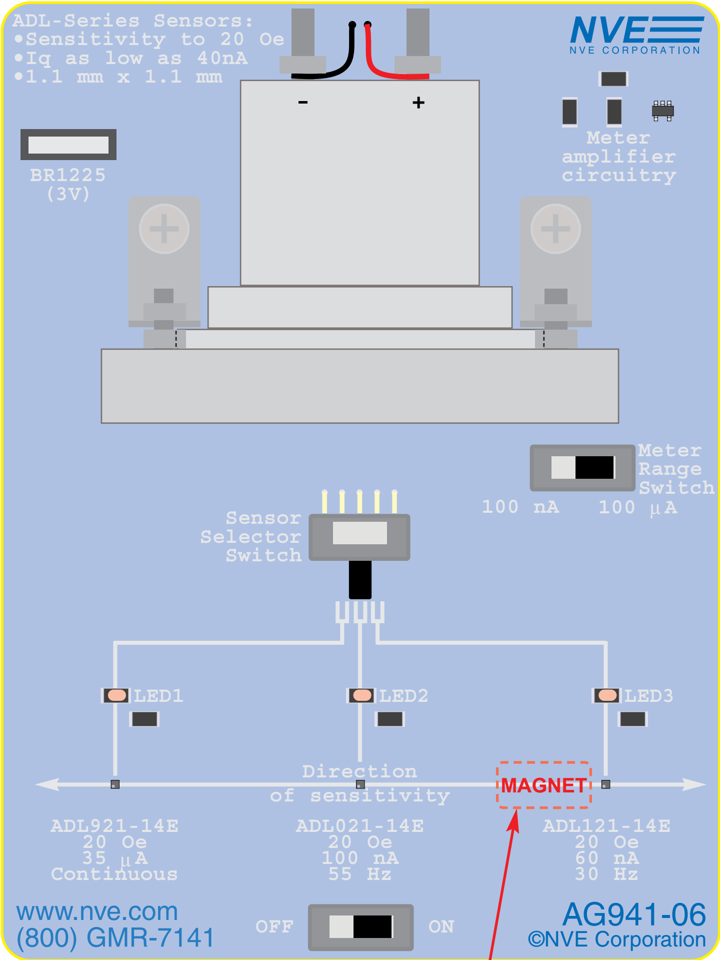
Evaluation Board Schematic



Each of the three sensors drive a high-efficiency LED to indicate its output. R3, R4, and R5 limit the sensor output current to less than the sensors' 100 µA rating. External transistors can be used in applications requiring higher output current. S1 is an on/off switch; S2 selects the sensor to be powered, and S3 selects the 100 µA or 100 nA meter range. An op-amp circuit amplifies the current to provide the ultralow 100 nA scale. The current gain is equal to the ratio of R2 to R1, or 1000. A common 3-volt lithium coin cell powers the board.

D4 protects the meter in case of overcurrent, for example if the ADL921 sensor is selected with the 100 nA meter range. Note ADL021 current can exceed 100 nA depending on the particular part and the exact battery voltage. Also note that the ADL921 sensor will not operate properly on the 100 nA meter range because the impedance of the measurement circuitry limits the supply to less than what is required to power the sensor.

Evaluation Board Layout



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Center the magnet
over a sensor to test

How GMR Works

Revolutionary Technology
The key to NVE’s sensors is Giant Magnetoresistance (GMR), which produces a large change in resistance in response to a magnetic field. “Giant” refers to the very large output signals. GMR resistance depends on the relative magnetic alignment of the ferromagnetic pinned and free layers separated by a conducting, non-magnetic spacer (see Figure 1a):

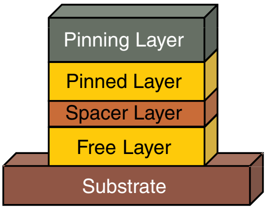

Fig. 1a. GMR Structure.

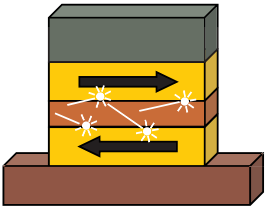
Fig. 1b. Anti-aligned magnetic moments (high resistance).

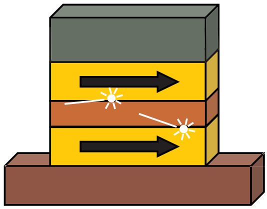
Fig. 1c. Aligned magnetic moments (low resistance).

The conducting spacer layer is typically less than two nanometers, or five atomic layers, thick.

Electrons scatter more frequently when their quantum spin differs from the magnetic orientation of the layer through which they are traveling, as in Figure 1b. If the magnetic moments of the ferromagnetic layers are aligned, as in Figure 1c, electron scattering is minimized and resistance is lowest. If the magnetic moments of the ferromagnetic layers are in opposing directions (anti-aligned), electron scattering is a maximum and resistance is highest.

Integrated Circuitry
NVE sensors are configured as Wheatstone bridges of GMR to increase sensitivity and cancel temperature variation. Digital sensors integrate GMR bridges with comparators. Ultralow power digital sensors (such as the ADL021 and ADL121 in this kit) also add duty cycling and latching to minimize average power consumption.

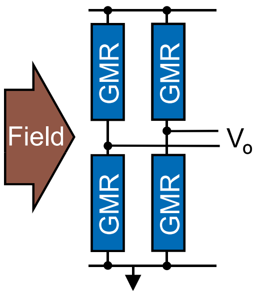

Fig. 2. Wheatstone bridge configuration.

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NVE Corporation
11409 Valley View Road
Eden Prairie, MN 55344-3617

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