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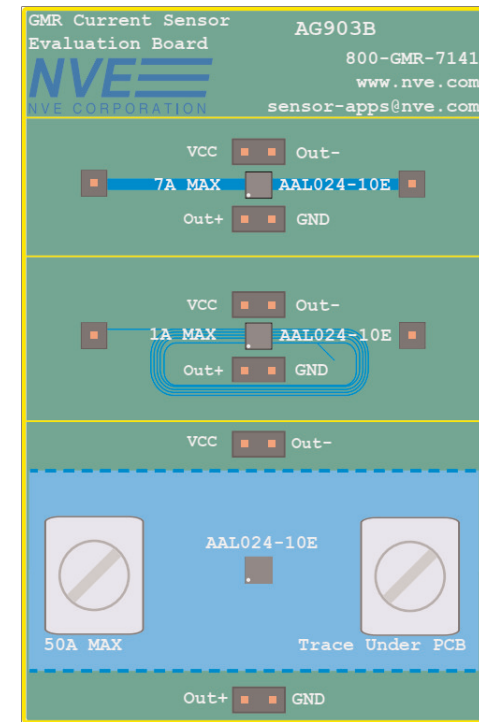
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# AG903B-07E GMR Current Sensor Evaluation Board



## Overview

### This Evaluation Board Includes

- Three AAL024-10E TDFN current sensors
- 1.565" x 2.915" (40 mm by 74 mm), 0.062" (1.6 mm) thick PCB
- Three current measurement configurations
- Sturdy screw connections for high current
- Up to 65 amps AC or DC noncontact current measurement

### AAL024-10E Features

- Wheatstone bridge analog outputs
- High sensitivity: 3.6 mV/V/Oe typical
- Wide linear range: 1.5 to 10.5 Oe; 15 Oe saturation
- 2.2 k $\Omega$  bridge resistance/1.1 k $\Omega$  output impedance for easy interface
- Low offset: 4 mV/V max.
- Low hysteresis: 2% max. for excellent repeatability
- Wide bandwidth: 500 kHz
- -50 to 125°C
- Ultraminiature 2.5 mm x 2.5 mm TDFN6 package

### Advantages of Sensing Current Over Trace

- Negligible insertion resistance
- Usable for a wide current range
- Inherent electrical isolation
- AC or DC operation

### Additional Resources

- Analog Sensor Selector Guide: [www.nve.com/analogSensors.php](http://www.nve.com/analogSensors.php)
- Analog Sensor Datasheets: [www.nve.com/Downloads/analog\\_catalog.pdf](http://www.nve.com/Downloads/analog_catalog.pdf)
- High-Current PCB Design Application Note:  
[www.nve.com/Downloads/SB-00-083\\_Precision\\_High\\_Current\\_Sensing\\_Over\\_PCB\\_Traces.pdf](http://www.nve.com/Downloads/SB-00-083_Precision_High_Current_Sensing_Over_PCB_Traces.pdf)
- Current-Sensing Web Application:  
[www.nve.com/spec/calculators.php#tabs-Current-Sensing](http://www.nve.com/spec/calculators.php#tabs-Current-Sensing)
- Reference Designs: <https://www.nve.com/sensor-reference.php>
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## Sensors Details

### Omnipolar Response

AA-Series sensors are “omnipolar,” meaning the output voltage is positive for either field polarity. This produces an output analogous to half-wave rectification of the current being sensed, eliminating the need for rectification of AC inputs.

### Bridge Offset

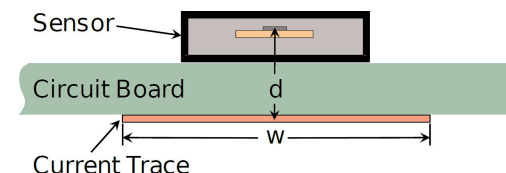
The sensors have a maximum offset of  $\pm 4$  mV/V. This can be trimmed out with an external resistor if necessary.

### Temperature Compensation

The Wheatstone bridge inherently compensates for temperature changes, but there is still some residual temperature coefficient. A constant-current rather than constant-voltage power supply reduces the temperature coefficient of the output considerably. The sensors can also be externally temperature compensated if necessary.

## Ampere's Law

For narrow traces, the magnetic field generated can be approximated by Ampere's law:



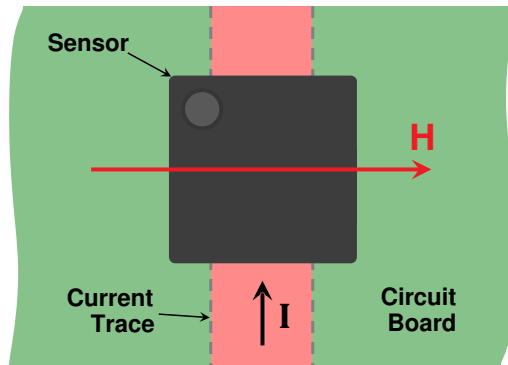
$$B = \frac{2I}{d} \text{ [“B” in Gauss, “I” in amps, and “d” in millimeters]}$$

A more accurate calculation can be made by breaking the trace into a finite-element array of thin traces, and calculating the field from each array element.

We have a free, Web-based application with a finite-element model to estimate magnetic fields and sensor outputs in this application:  
[www.nve.com/spec/calculators.php#tabs-Current-Sensing](http://www.nve.com/spec/calculators.php#tabs-Current-Sensing)

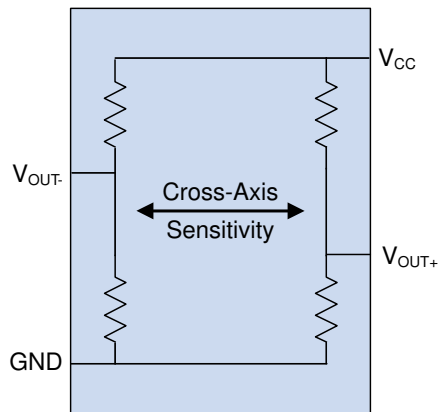
## Principles of Operation

Current through a circuit-board trace will produce a magnetic field proportional to the current, in a direction at a right angle to the trace:



Current sensing over a circuit-board trace.

The AAL024 sensor has cross-axis sensitivity to detect this field orientation. The sensor is a Wheatstone bridge, which produces a differential output proportional to the field and the power supply:



AAL024-10E Wheatstone bridge configuration.

Since the output is proportional to field and supply, sensitivity is generally expressed as  $\text{mV/V/Oe}$  for field or  $\text{mV/V/A}$  for current.

## Quick Start

- ⇒ Connect  $V_{CC}$  and GND for a sensor to a power supply (12V max.) or a battery.
- ⇒ Connect the sensor “Out+” and “Out-” to a meter.
- ⇒ Connect an AC or DC current via the screw terminals
- ⇒ Compare the sensor output to the circuit-board trace current.

## Three Configurations

The evaluation board demonstrates three current-trace configurations:

### A. Single trace on top side of PCB

This configuration will saturate the sensor at about seven amps. The 0.05-inch (1.25 mm) wide, one-ounce trace can carry up to seven amps, coinciding with sensor saturation.

### B. Five turns on top side of PCB

Five traces provide approximately five times the field, but they must be narrower to fit under the sensor. The 0.0055-inch (0.14 mm), one-ounce copper traces have a maximum current of approximately one amp.

### C. Heavy, wide trace on bottom of PCB

This is the highest-current configuration, with a one-inch (25 mm) wide trace of one-ounce (35  $\mu\text{m}$  thick) copper that can carry up to 50 amps with a 50°C temperature rise, which coincides with the sensor saturation. Using a wide trace on the opposite side of the board from the sensor allows large currents to be detected without overheating the board trace or the sensor.

Typical characteristics of the three configurations are summarized in the following table:

Configuration	Typical Sensitivity	Linear Range	Sensor Saturation	Isolation
A. Trace on top of PCB	8.6 mV/V/A	0 – 4.5 A	7 A	>300V
B. 5 turns on top of PCB	43 mV/V/A	0 – 0.75 A	1 A	>300V
C. Wide trace under PCB	0.9 mV/V/A	0 – 50 A	55 A	>6 kV

## Evaluation Board Layout (2x Actual Size)

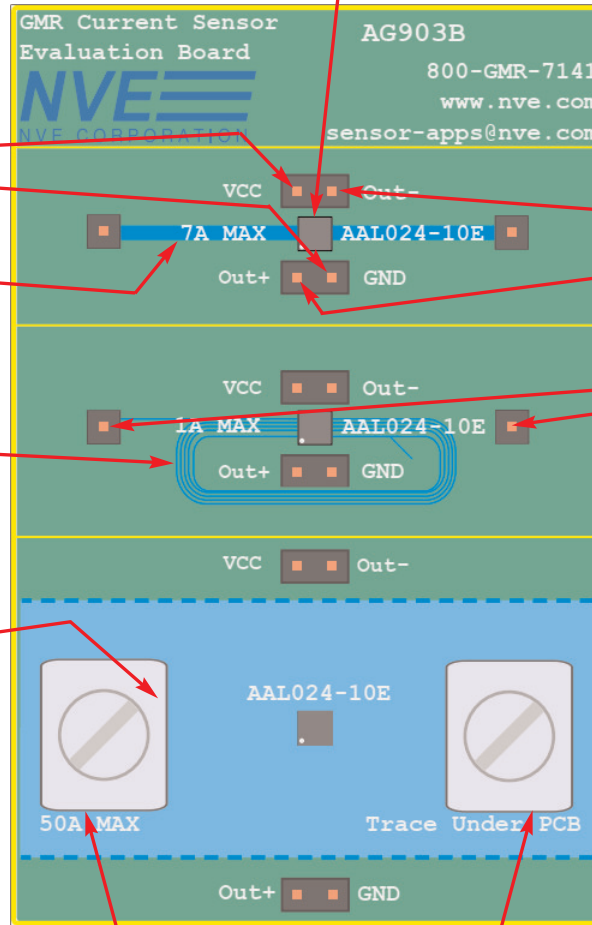
AAL024-10E Magnetometer Sensors (3 places)

Sensor Power (0 - 12 V)  
(3 places)

Configuration A:  
0.05"-wide, 1 oz copper trace  
on top side of PCB

Configuration B:  
5 turns of 0.0055"-wide,  
1 oz copper traces  
on top of PCB

Configuration C:  
1"-wide, 1 oz copper trace  
on bottom-side of PCB



Sensor Differential Outputs  
(45 mV/V full-scale;  
540 mV full-scale at 12V;  
3 places)

Connections for  
Current to Be Sensed

Current to Be Sensed