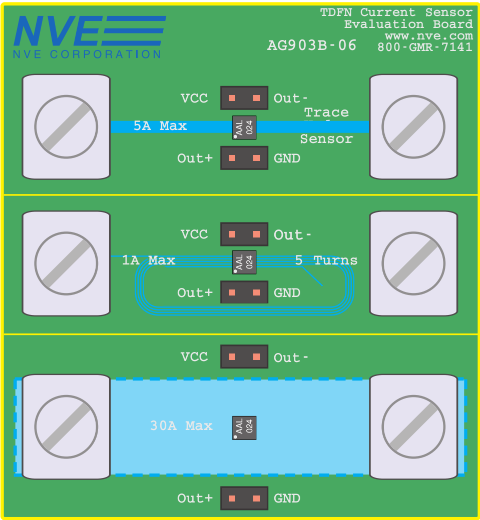
AG903B-07E
TDFN Current Sensor Evaluation Board



SB-00-069B

Overview

This Evaluation Board Includes
- Three AAL024-10E TDFN current sensors
- 2.5" x 2.75" (64 mm by 70 mm), 0.15" (3.8 mm) thick PCB
- Three current measurement configurations
- Sturdy screw connections
- Up to 40 amp 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 kΩ bridge resistance/1.1 kΩ 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*
- Analog Sensor Datasheets: *www.nve.com/Downloads/analog_catalog.pdf*
- Current-Sensing Web Application: *www.nve.com/spec/calculators.php#tabs-Current-Sensing*
- Reference Designs: https://www.nve.com/sensor-reference.php
- Videos: *www.nve.com/Videos.php* ; *www.YouTube.com/NveCorporation*
- Buy Online: *www.nve.com/webstore/catalog*

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 five amps. The 0.05-inch (1.25 mm) wide, one-ounce trace can carry up to five amps, coinciding with sensor saturation.

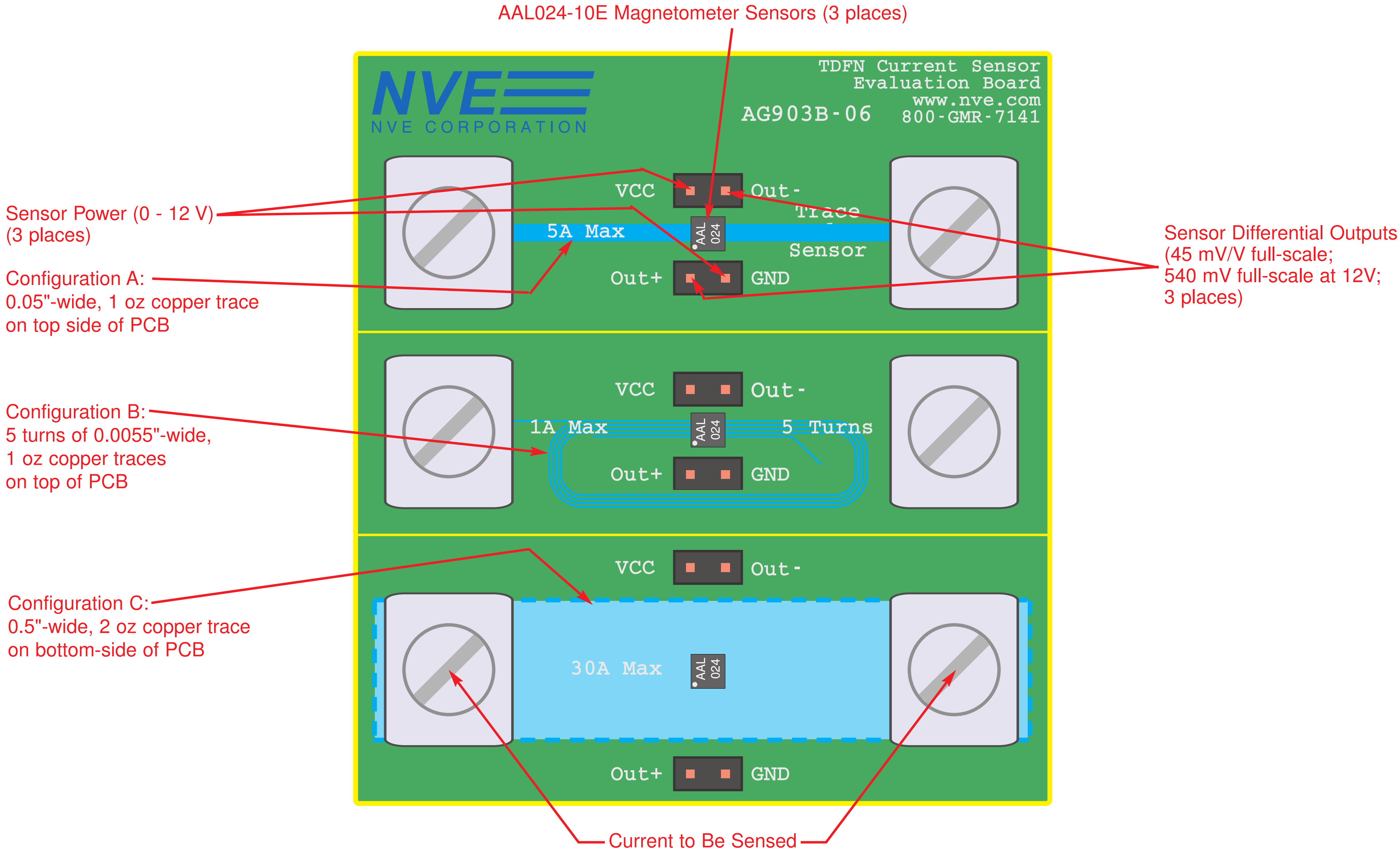
B. ***Five turns on top side of PCB***
Five traces provide approximately five times the field, but they must be narrower to fit under the sensor. The 0.0055-inch (0.14 mm), one-ounce copper traces have a maximum current of approximately one amp.

C. ***Heavy, wide trace on bottom of PCB***
This is the highest-current configuration, with a 0.5-inch (12.7 mm) wide trace of two-ounce (70 µm thick) copper that can carry up to 40 amps with a 30°C temperature rise, which coincides witth the sensor saturation. Using a trace on the opposite side of the board from the sensor decreases the field at the sensor, increasing the current that saturates the sensor. The relatively thick board also maximizes the measurable current.

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

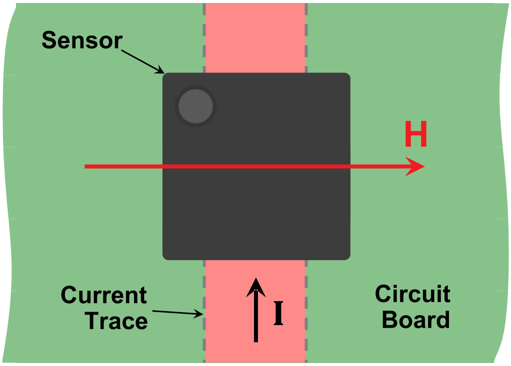
Configuration	Typical Sensitivity	Linear Range	Sensor Saturation	Isolation
A. Trace on top of PCB	8.6 mV/V/A	0 – 3.5 A	5 A	>300V
B. 5 turns on top of PCB	43 mV/V/A	0 – 0.75 A	1 A	>300V
C. Wide trace under PCB	1.2 mV/V/A	0 – 30 A	40 A	>6 kV

Evaluation Board Layout (2x Actual Size)



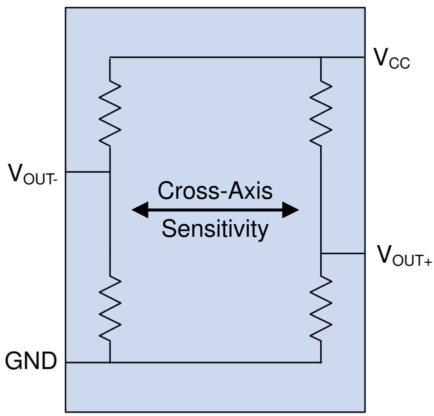
Principles of Operation

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 mV/V/Oe for field or mV/V/A for current.

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

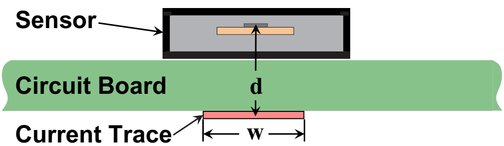
The sensors have a maximum offset of ±4 mV/V. This can be trimmed out with an external resistor if necessary.

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:



$$B = \frac{2I}{d}$$ ["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

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