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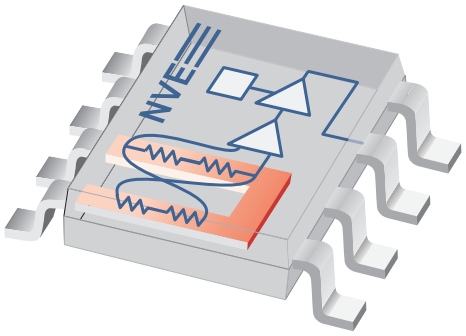
AAV004-02E Isolated Current Sensor

Features

- −5 A to +5 A Current Detection
- 0 V to 5 V Linear Output
- Total Error <0.5%
- 12-bit Resolution
- AC or DC Current Sensing
- Factory Calibrated
- Temperature Compensated −25°C to +85°C
- 2500 V_{RMS} Isolation Voltage per UL1577
- 300 Working Volts (Line Voltage) per VDE 0884-10
- Compact SOIC8 Package



Description

The AAV004-02E is a current sensing device based on a linear bipolar GMR bridge sensor, with on-chip signal processing to amplify, normalize, and temperature compensate the output.

Current is fed into the chip via pins 1 through 4 of the package. Current is sensed by a GMR bridge sensor in close proximity to the package current strap. The output is an analog, rail-to-rail voltage signal proportional to the input current and ratiometric with the supply voltage. An on-chip EEPROM stores temperature and linearity factory calibration data.

These are true isolated current sensors, rated for up to 300 volts line voltage. Isolation is provided by a unique ceramic/polymer composite barrier with an estimated life of a remarkable 44000 years.

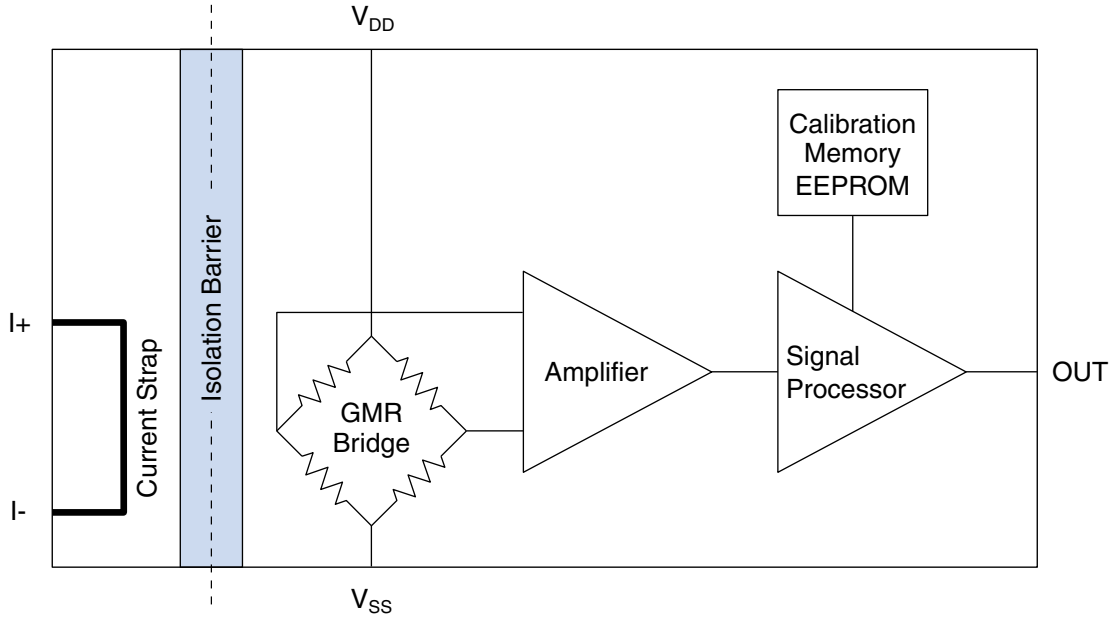


Figure 1. AAV004-02E Block Diagram

Application Information

Current Polarity
The current to be measured is applied to pins 3 and 4. Current enters through 3 and exits through pin 4. Current entering the chip via terminals I+ and leaving the chip via terminals I- results in a voltage output greater than $V_{DD}/2$; current entering the chip via terminal I- and leaving the chip via terminal I+ produces an output less than $V_{DD}/2$.

Power Supply Decoupling
A 0.1 µF decoupling capacitor is recommended between V_{DD} and V_{SS}.

Maintaining Creepage
Creepage distances are often critical in isolated circuits. Standard pad libraries often extend under the package, compromising creepage and clearance. Package drawings and recommended pad layouts are included in this datasheet.

Recalibration and Reconfiguration

Devices are factory configured and calibrated. Reconfiguration is possible, although recommended only for advanced users.

The AAV004-02E uses the ZMDI ZACwire™ digital one-wire interface. The device can be put in a Command Mode by providing a command on the output pin (pin 7) within 3 milliseconds of power up. Calibration data is typically written from a PC, and data is transferred using Manchester bit encoding at speeds from 8 kbps to 32 kbps.

The following major functions are available:

- Reading the ADC digital output
- Calibration commands
- Reading the entire EEPROM
- Writing to the EEPROM

Recalibration and reconfiguration details are available in the ZMDI ZSC31015 datasheet.

An example output signal is shown in the diagram below:

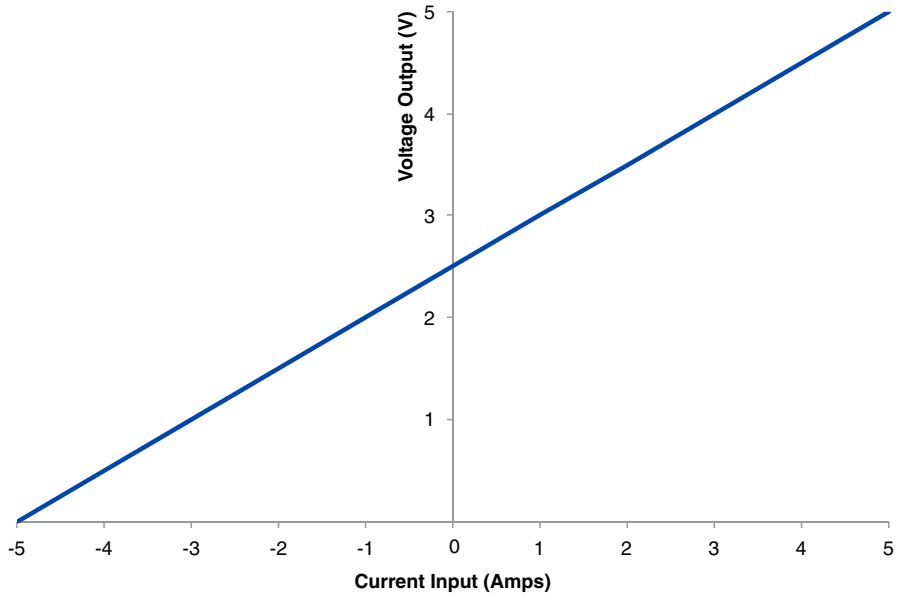


Figure 2. Signal Output Over Input Current Range (5V Supply)

The diagram below shows the sensor output error band:

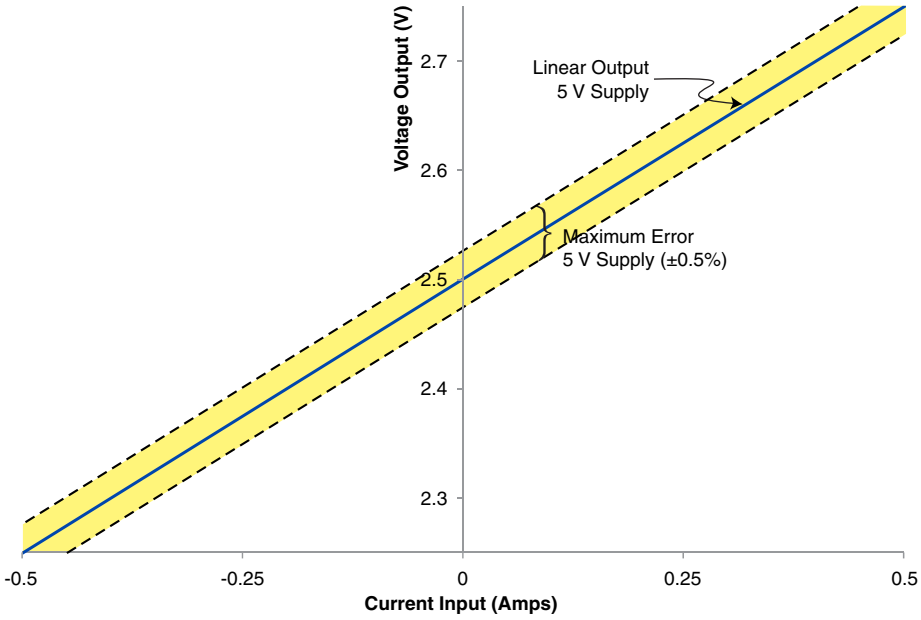


Figure 3. Signal Output Error Tolerance (5V Supply)

Absolute Maximum Ratings[1]

Parameter	Min.	Max.	Units	Test Condition
Absolute Maximum Supply Voltage	−0.3	6.0	V	Operating, All Temperature Conditions
Absolute Maximum Voltage on Output	−0.3	V_{DD} + 0.3	V	Operating, All Temperature Conditions
Absolute Maximum Detection Current	−6	6	A	Operating, Full Temperature Range
Absolute Maximum Ext. Magnetic Field[2]		∞		
Storage Temperature	−40	150	°C	

Operating Specifications

Parameter	Min.	Typ.	Max.	Units	Test Condition
Supply Voltage (V_{DD})	2.7		5.5	Volts	Operating, Full Temp Range
Output Voltage (ratiometric with supply)	2.7		5.5	Volts	Operating, Full Temp Range
Supply Current			4.0	mA	Operating, Full Temp Range
Power-On Rise Time			100	ms	Operating, Full Temp Range
Sensitivity		500		mV/A	Operating, 5V Supply
Linear Range of Current Measurement	−5		5	A	Operating, Full Temp Range
Output Load Resistance to V_{SS} or V_{DD}	5			kΩ	Operating, Full Temp Range
Output Load Capacitance		10	15	nF	Operating, Full Temp Range
Linearity of Output Signal	99.5%			% full scale	Operating, Full Temp Range
Offset Variation of Output Signal			1.5%	% full scale	Operating, Full Temp Range
Frequency Response		1000		Hz	Operating, Full Temp Range
Current Strap Resistance			0.005	Ω	25°C; pin 2 to pin 3
Current Strap TCR		0.39		%/°C	%/◦C
Temperature Range of Operation	−25		85	°C	Operating

Insulation Specifications

Parameter	Min.	Typ.	Units	Test Condition
Working Voltage	300		V_{PK}	Reinforced Insulation; Pollution Degree 2 per VDE 0884-10[3]
Transient Overvoltage	4000		V_{PK}	
Isolation Voltage (pins 1–4 to pins 5–8)	2500		V_{RMS}	1 minute per UL1577
Total Barrier Thickness (internal)	0.011	0.013	mm	
Leakage Current		0.2	µA	240 V_{RMS}, 60 Hz
Barrier Impedance	10^{14}||3		Ω || pF	
Barrier Life		44000	Years	100°C, 1000 V_{RMS}, 60% CL activation energy

Package Specifications

Parameter	Min.	Typ.	Units	Test Condition
Creepage Distance (external)	4.0		mm	
Junction-Ambient Thermal Resistance		240	°C/W	Free Air[4]

Notes:

1. Exceeding Absolute Maximum Ratings may cause permanent damage.
2. Large magnetic fields will not damage NVE GMR Sensors.
3. Each lot sample tested at 4000 V_{PK} for 10 seconds; then 1358 V_{PK} for 1 minute with 5 pC partial discharge limit.
4. Attaching the package to a circuit board improves thermal performance.

Safety and Approvals

IEC 60747-5-5 (VDE 0884) (File Number 5016933-4880-0001; pending)

- Working Voltage (V_{IORM}) 600 V_{RMS} (848 V_{PK}); basic insulation; pollution degree 2
- Transient overvoltage (V_{IOTM}) and surge voltage (V_{IOSM}) 4000 V_{PK}
- Each part tested at 1590 V_{PK} for 1 second, 5 pC partial discharge limit
- Samples tested at 4000 V_{PK} for 60 sec.; then 1358 V_{PK} for 10 sec. with 5 pC partial discharge limit

IEC 61010-1 (Edition 2; TUV Certificate Numbers N1502812; N1502812-101)

- Reinforced Insulation; Pollution Degree II; Material Group III
- Working Voltage 150 V_{RMS}

UL 1577 (Component Recognition Program File Number E207481; pending)

- Each part tested at 3000 V_{RMS} (4243 V_{PK}) for 1 second
- Each lot sample tested at 2500 V_{RMS} (3536 V_{PK}) for 1 minute

Soldering Profile

Per JEDEC J-STD-020C, MSL=1

Pinout

The AAV004-02E pinout is given below:

Pin	Terminal	Description
1	N/C[1]	No internal connection
2	N/C [1]	No internal connection
3	I+	Current In[2]
4	I-	Current Out[2]
5	N/C[1]	No internal connection
6	V_{SS}	Ground
7	Out	Signal Voltage Output
8	V_{DD}	Supply Voltage

Notes:

1. "N/C" pins are not to be energized to ensure high-voltage performance and safety.

2. Current entering the chip via terminals I+ and leaving the chip via terminals I- will result in a signal voltage output greater than $V_{DD}/2$; current entering the chip via terminal I- and leaving the chip via terminal I+ will result in a signal voltage output less than $V_{DD}/2$.

Illustrative Applications

In the following typical application, the AAV004-02E is in series with line-voltage operated single-phase AC motor. The current sensor detects the AC current waveform in real time, and provides an isolated output proportional real-time motor current:

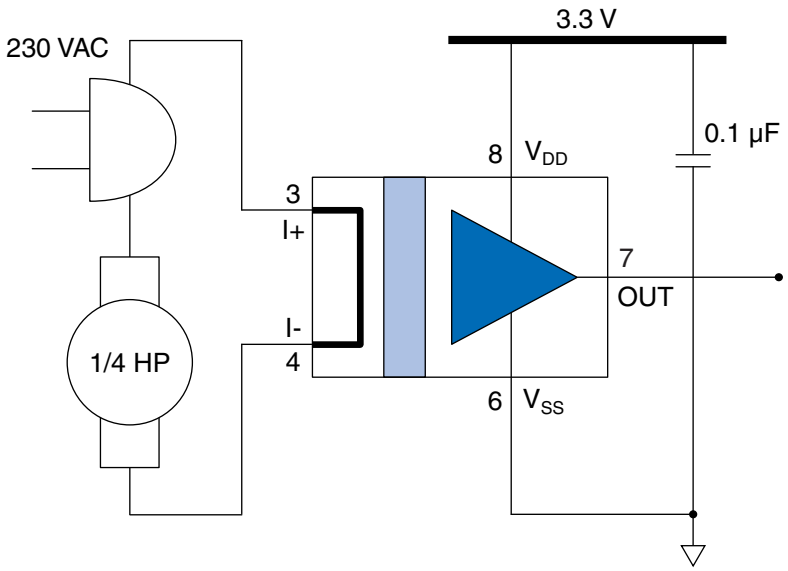


Figure 4. AC Motor Current Sensor

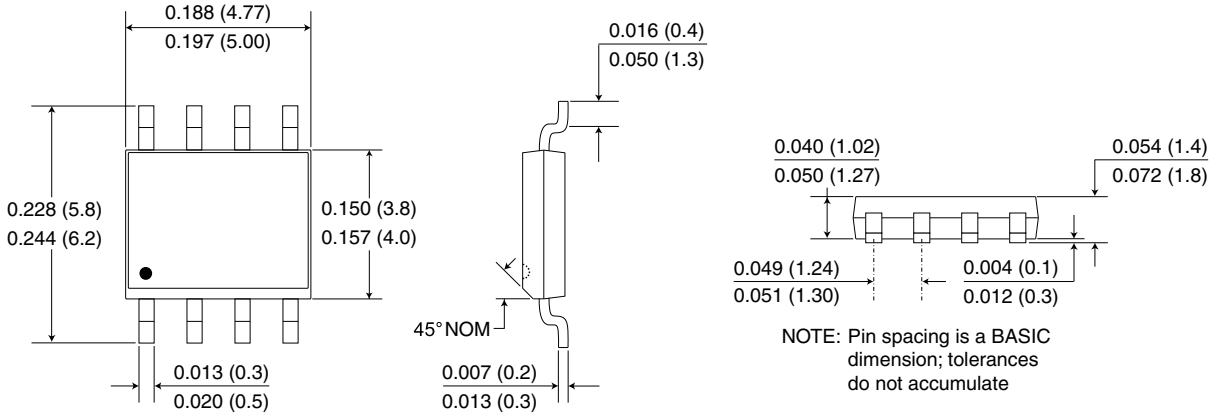
Full-load current for a 230 V, 1/4 horsepower motor is typically 2.9 A_{RMS} or 4.1 A_{PK}, within the 5 A sensor range.

Power through the sensor shunt at full motor load will be approximately 42 mW based on the 5 mΩ typical current strap resistance. The package temperature rise from shunt heating will be only 10°C based on a typical junction-to-ambient thermal resistance of 240°C/W.

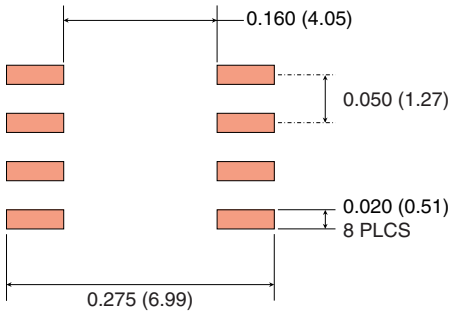
Three current sensors can be used for three-phase motors, where the 5 amp range allows control of motors up to one horsepower at 230 volts.

Package Drawing and Recommended Pad Layout (SOIC8)

Dimensions in inches (mm); scale = approx. 5X



NOTE: Pin spacing is a BASIC dimension; tolerances do not accumulate



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Revision History

SB-00-035-D
December 12, 2014

Changes
- Corrected pins 7 and 8 reversed.

SB-00-035-C
July 17, 2014

Changes
- Increase isolation voltage to 2500 V.
- Added pending safety approvals.
- Note clarifying that Pins 1 and 2 should not be energized.

SB-00-035-B
June 27, 2014

Changes
- Pins 1 and 2 N/C.
- Changed working voltage specification to 300 V; isolation voltage to 1200 V.
- Updated pinout and drawings to reflect internal layout changes.

SB-00-035-A
September 18, 2013

Changes
- Clarified use of pins 1 and 4 (V+ and V-).
- Added 600 WV isolation spec.; changed isolation voltage spec. to 1800 V.
- Added Current Strap TCR specification.
- Added “Recalibration and Reprogramming” section.
- Added “Applications” section.
- Added “Illustrative Applications” section.
- Added “Package” and “Insulation” specification sections.
- Updated package drawing.
- Added recommended solder pad layout.
- Cosmetic changes.

SB-00-035-PRELIM
May 10, 2013

Changes
- Preliminary release.

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