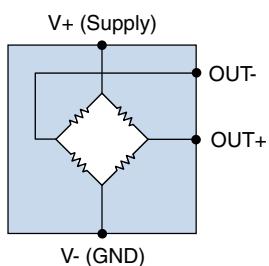
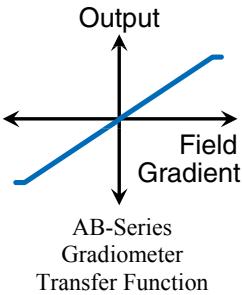
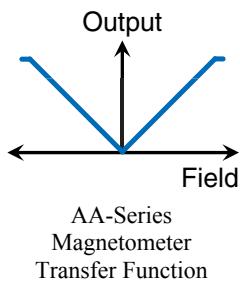


AA/AB-Series Analog Magnetic Sensors

Equivalent Circuit



Idealized Transfer Functions



Features

- Wheatstone bridge analog outputs
- High sensitivity
- Up to 150°C operating temperature
- Operation to near-zero voltage
- Up to 1 MHz
- Magnetometer and gradiometer configurations
- Standard, ultrasensitive, and low-hysteresis versions
- TDFN6, MSOP8, and SOIC8 packages

Applications

- Motion, speed, and position control
- Low-field sensing
- Current sensing

Description

NVE's analog GMR sensors have high sensitivity, excellent temperature stability, and small size. Their versatility makes them an excellent choice for a wide range of analog sensing applications including industrial and automotive position, speed, and current sensors.

The sensors are configured as inherently temperature-compensating Wheatstone bridges.

AA-Series sensors are magnetometers, which detect absolute magnetic field. AB-Series sensors are differential gradiometers. Three subtypes are available: the standard AA-Series; the ultrasensitive "H" subtype; and the low-hysteresis "L" subtype.

Absolute Maximum Ratings

Parameter		Symbol	Min.	Max.	Units
Supply voltage	AAxxxx/ABxxxx/AAL002	V_{cc}		24	Volts
	AAHxxxx/ABHxxxx/AAL004			12	
Operating temperature	AAxxxx/ABxxxx/AALxxxx		-50	125	°C
	AAHxxxx/ABHxxxx			150	°C
Storage temperature	AAxxxx/ABxxxx/AALxxxx		-65	135	°C
	AAHxxxx/ABHxxxx			150	
ESD (Human Body Model)				400	Volts
Applied magnetic field		H		Unlimited	Oe

Operating Specifications

Parameter		Symbol	Min.	Typ.	Max.	Units	Test Condition
Supply voltage	AAxxxx/ABxxxx/AAL002	V_{cc}	<1		24	Volts	Max. limited by power dissipation
	AAHxxxx/ABHxxxx/AAL004				12		
Operating temperature	AAxxxx/ABxxxx/AALxxxx	T_{min}, T_{max}	-50		125	°C	
	AAHxxxx/ABHxxxx				150		
Electrical offset	AAxxxx/AALxxxx/ABxxxx	V_o	-4		+4	mV/V	
	AAHxxxx/ABHxxxx				+5		
Output at maximum field	AAxxxx/ABxxxx	V_{max}		60		mV/V	
	AAHxxxx/ABHxxxx			40			
	AALxxxx			45			
Non-linearity	AAxxxx/ABxxxx/AALxxxx				2	%	Unipolar field sweep
	AAHxxxx/ABHxxxx				4		
Hysteresis	AAxxxx/ABxxxx				4	%	
	AAHxxxx/ABHxxxx				15		
	AALxxxx				2		
Resistance tolerance			-20		+20	%	25°C
Resistance vs. temperature	AAxxxx/ABxxxx	TCR		+0.14		%/°C	No applied field
	AAHxxxx/AALxxxx/ABHxxxx			+0.11			
Output temperature coefficient	AAxxxx/ABxxxx	TCOI		+0.03		%/°C	Constant-current supply
	AAHxxxx/ABHxxxx			+0.1			
	AALxxxx			-0.28			
	AAxxxx/ABxxxx			-0.1			
Operating frequency	AAHxxxx/ABHxxxx	f_{max}	DC	0		%/°C	Constant-voltage supply
	AALxxxx			-0.4			
	AAHxxxx/ABHxxxx				100	kHz	
Junction-Ambient thermal resistance	MSOP8 (-00 suffix)	θ_{ja}			1	MHz	Soldered to double-sided board; free air
	SOIC8 (-02 suffix)				320		
	TDFN6 (-10 suffix)				240		
					320		

Operation

Sensor Subtypes

There are three AA/AB-Series subtypes, as summarized in the table below. “H” subtypes are designed for very high sensitivity, and “L” types offer low hysteresis. AAH-Series parts also have a 150°C maximum temperature specification.

Parameter	AAxxx/ ABxxx	AAHxxx/ ABHxxx	AALxxx
Field Sensitivity	High	Very High	High
Operating Field Range	High	Low	Medium
Hysteresis	Medium	High	Low
Max. Temperature	High	Very High	High

Direction of Sensitivity

AA-Series sensors are **magnetometers**, which detect the absolute magnetic field in the plane of the IC along the part axis. These devices are “omnipolar,” meaning the output is equally sensitive to either magnetic field polarity.

AB-Series sensors are differential **gradiometers** that reject common mode magnetic fields, making them ideal for high magnetic noise environments such as near electric motors or current-carrying wires. The devices are sensitive to a field gradient along the part axis. The figure below shows a typical gradiometer response:

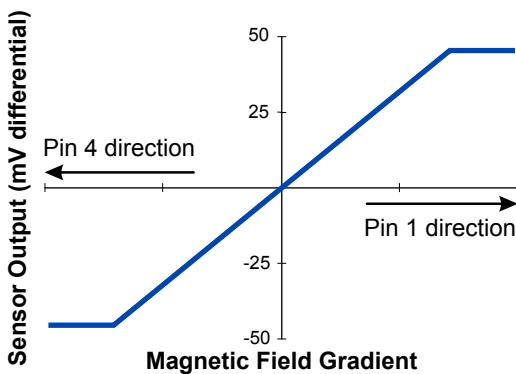


Figure 1. Typical gradiometer response.

Typical Performance Graphs

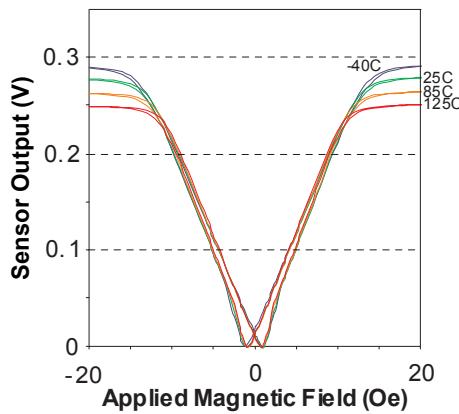


Figure 2a. Typical AA002 output with 1 mA constant-current drive.

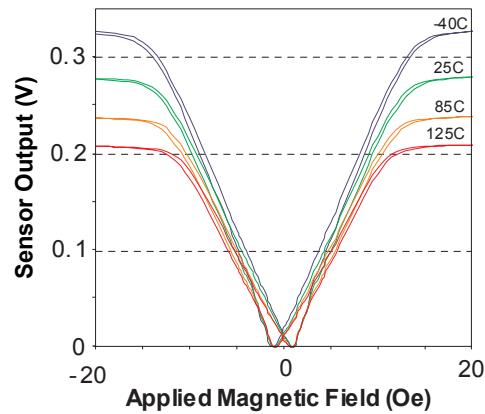


Figure 2b. Typical AA002 output with a 5V supply.

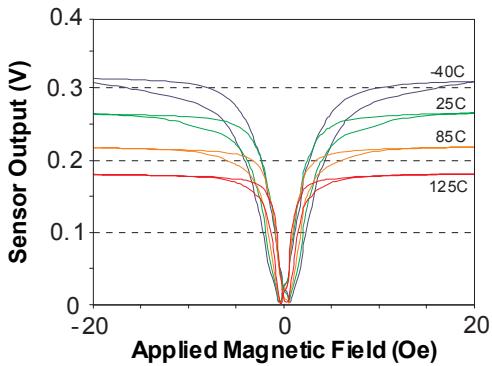


Figure 3a. Typical AAH002 output with 2.28 mA constant-current drive.

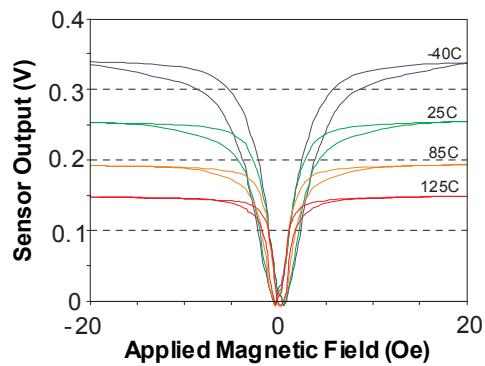


Figure 3b. Typical AAH002 output with a 5V supply.

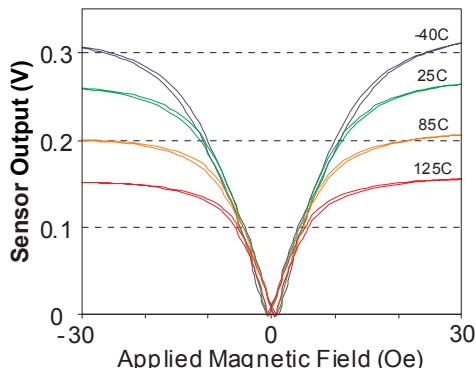


Figure 4a. Typical AAL002 output with 1 mA constant-current drive.

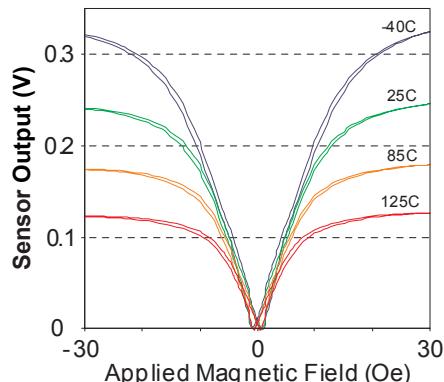


Figure 4b. Typical AAL002 output with a 5V supply.

Illustrative Application Circuits

Traditional Differential Amplifier

Traditional differential amplifiers use low-cost op-amps to provide a single-ended analog output. The circuit below has a gain of 20, which provides a full-scale output at slightly less than the sensor's saturation. A low-cost, low bias current op amp allows large resistors to avoid loading the sensor bridge. The 250 K Ω input resistors are 100 times the 2.5 K Ω sensor output impedance to avoid loading.

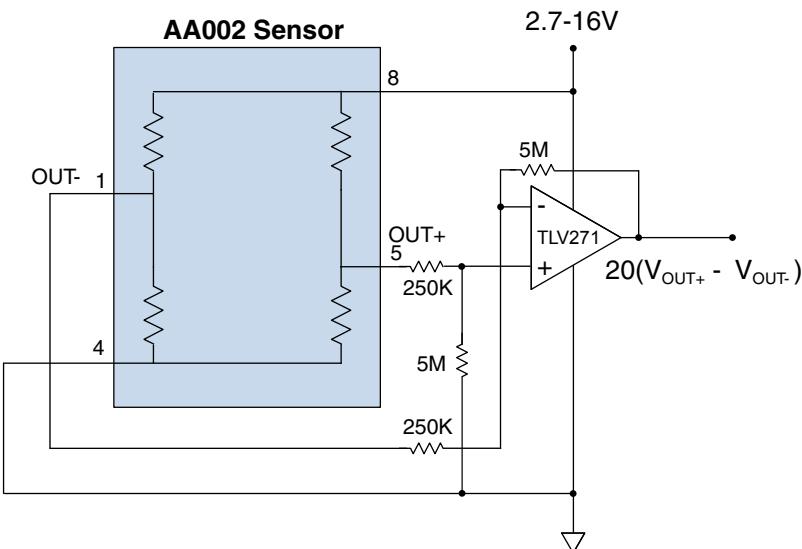


Figure 5. Traditional op-amp differential amplifier.

Sensor Instrumentation Amplifier

Instrumentation amplifiers such as the INA826 are popular bridge sensor preamplifiers because they have a low component count and have excellent common-mode rejection ratios without needing to match resistors. These amplifiers can run on single or dual supplies. AC coupling can be used for small, dynamic signals.

The circuit below has a gain of 20. The general equation for the output voltage is:

$$V_{OUT} = (1 + 49.4K / R_G)V_{IN} + V_{REF}; \quad V_{IN} = V_{OUT+} - V_{OUT-}$$

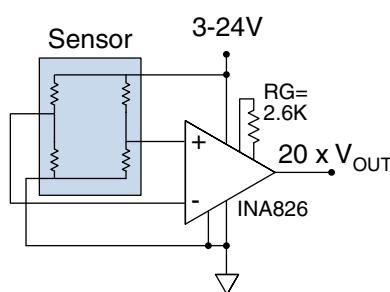


Figure 6. Single-ended analog sensor instrumentation amplifier.

Note that the instrumentation amplifier has a minimum output of 0.1V, so to detect very low fields on a single supply, an offset can be provided by using a non-zero V_{REF} .

Constant-Current Sensor Drive

Using a constant current rather than conventional constant voltage sensor supply can significantly improve temperature stability of AAxxx/ABxxx sensors. AA00x sensors have an output temperature coefficient (TCOI) of 0.03%/°C with constant current, versus -0.1%/°C with constant voltage (TCOV).

A simple constant-current supply is illustrated below:

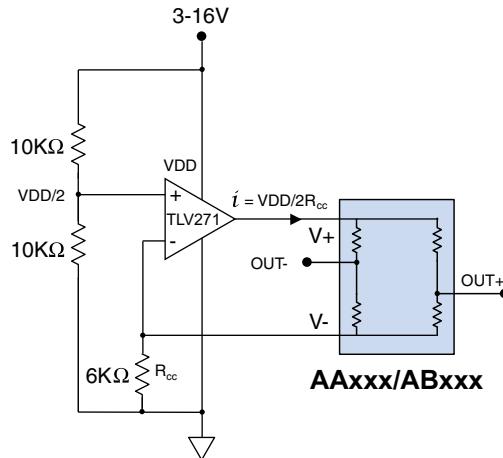


Figure 7. Constant-current supply.

The supply current for the circuit above is $V_{cc}/2R_{cc}$. R_{cc} can be set to the maximum sensor bridge resistance (e.g., 6 KΩ for many sensors) to provide the highest possible output without saturating the op-amp. The sensor will be driven with 1 mA for a 12 V supply in the circuit above. Similar op-amp or instrumentation amplifiers can be used for constant-current or constant-voltage supplies.

Variable Threshold Magnetic Switch

NVE offers AD-Series factory-set GMR Switches, but AA-Series analog sensors can be used for special thresholds or hysteresis, or for variable thresholds. In this circuit, the threshold is varied by changing R_G , which sets the gain of the differential amplifier. The 1 MΩ resistor sets the threshold hysteresis:

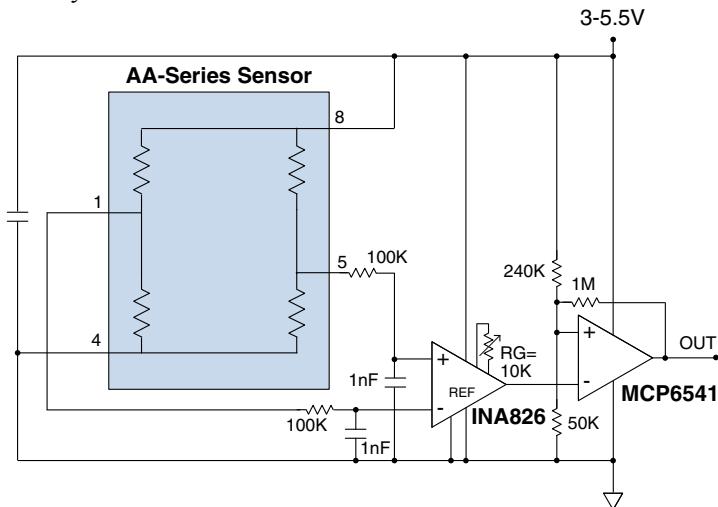
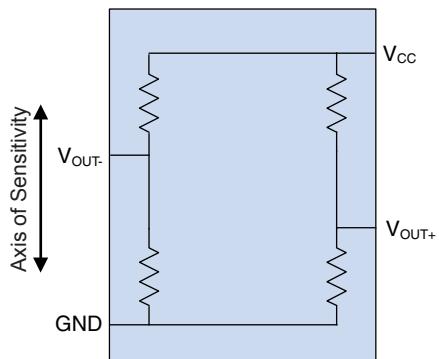


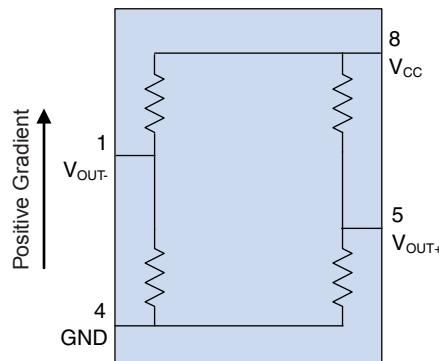
Figure 8. Variable threshold magnetic switch.

AA-Series Pinout



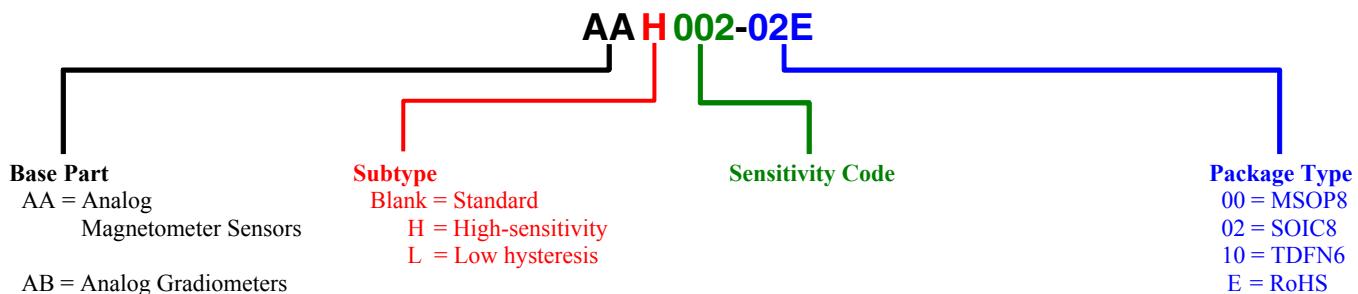
Pin		Symbol	Description
MSOP8/ SOIC8	TDFN6		
1	1	V _{OUT-}	Negative bridge output (decreases with increasing field).
2	2	NC	No internal connection.
3			
4	3	V-/GND	Negative supply or ground.
5	4	V _{OUT+}	Positive bridge output (increases with field).
6	5	NC	No internal connection.
7			
8	6	V+	Positive supply voltage.

AB-Series Pinout



Pin	Symbol	Description
1	V _{OUT-}	Negative bridge output (decreases with gradient).
2	NC	No internal connection.
3		
4	V-/GND	Negative supply or ground.
5	V _{OUT+}	Positive bridge output (increases with gradient).
6	NC	No internal connection.
7		
8	V+	Positive supply.

Part Numbering



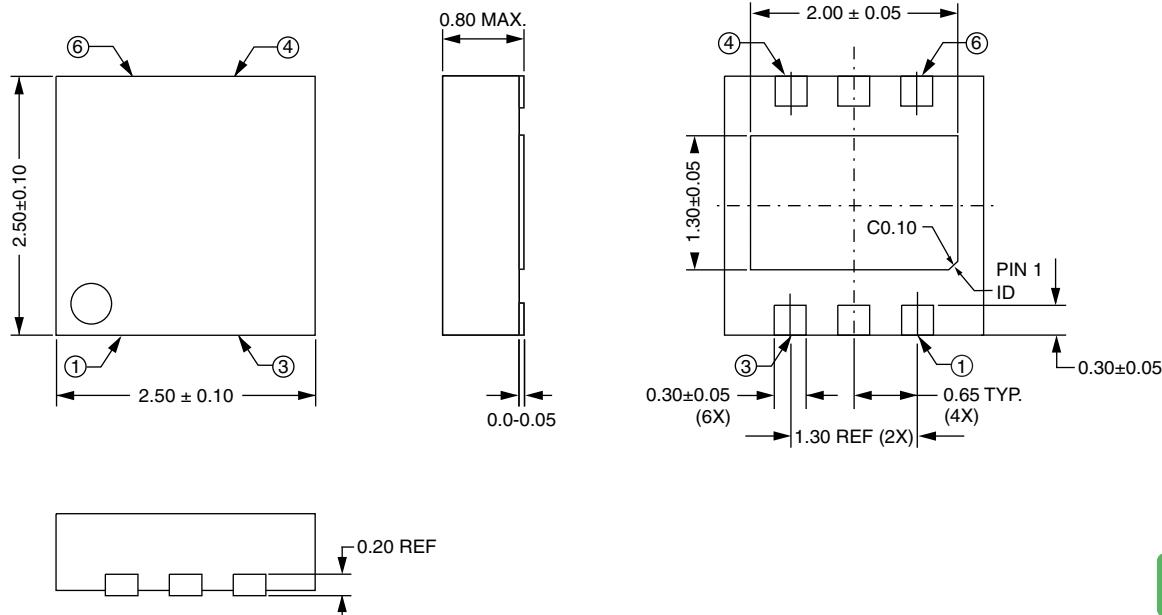
Available Parts

Magnetometers (AA-Series)									
Available Part	Linear Range (Oe)		Saturation (Oe)	Sensitivity (mV/V-Oe)		Max. Non-linearity (% Uni.)	Max. Hysteresis (% Uni.)	Max. Operating Temp.	Typ. Resistance
	Min.	Max.		Min.	Max.				
AA002-02	1.5	10.5	15	3	4.2	2%	4%	125°C	5 kΩ
AA003-02	2	14	20	2	3.2	2%	4%	125°C	5 kΩ
AA004-00	5	35	50	0.9	1.3	2%	4%	125°C	5 kΩ
AA004-02	5	35	50	0.9	1.3	2%	4%	125°C	5 kΩ
AA005-02	10	70	100	0.45	0.65	2%	4%	125°C	5 kΩ
AA006-00	5	35	50	0.9	1.3	2%	4%	125°C	30 kΩ
AA006-02	5	35	50	0.9	1.3	2%	4%	125°C	30 kΩ
AAH002-02	0.6	3	6	11	18	4%	15%	150°C	2 kΩ
AAH004-00	1.5	7.5	15	3.2	4.8	4%	15%	150°C	2 kΩ
AAL002-02	1.5	10.5	15	3	4.2	2%	2%	125°C	5.5 kΩ
AAL004-10	1.5	10.5	15	3	4.2	2%	2%	125°C	2.2 kΩ
									TDFN6

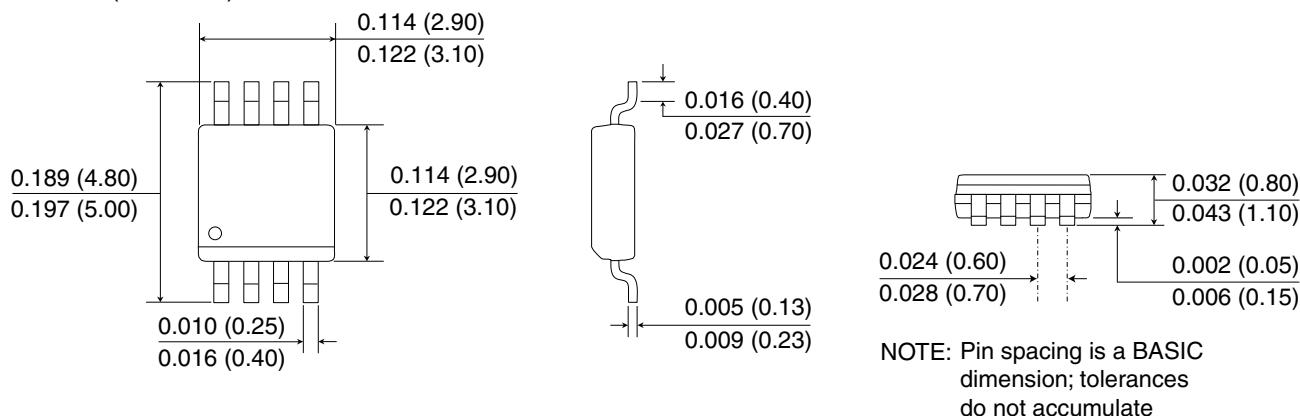
Gradiometers (AB-Series)									
Available Part	Linear Range (Oe)		Saturation (Oe)	Sensitivity (%R/Oe)		Max. Non-linearity (% Uni.)	Max. Hysteresis (% Uni.)	Max. Operating Temp.	Typ. Resistance
	Min.	Max.		Min.	Max.				
AB001-02	10	175	250	0.02	0.03	2%	4%	125°C	2.5 kΩ
AB001-00	10	15	250	0.02	0.03	2%	4%	125°C	2.5 kΩ
ABH001-00	5	40	70	0.06	0.12	4%	15%	150°C	1.2 kΩ
									MSOP8

Package Drawings

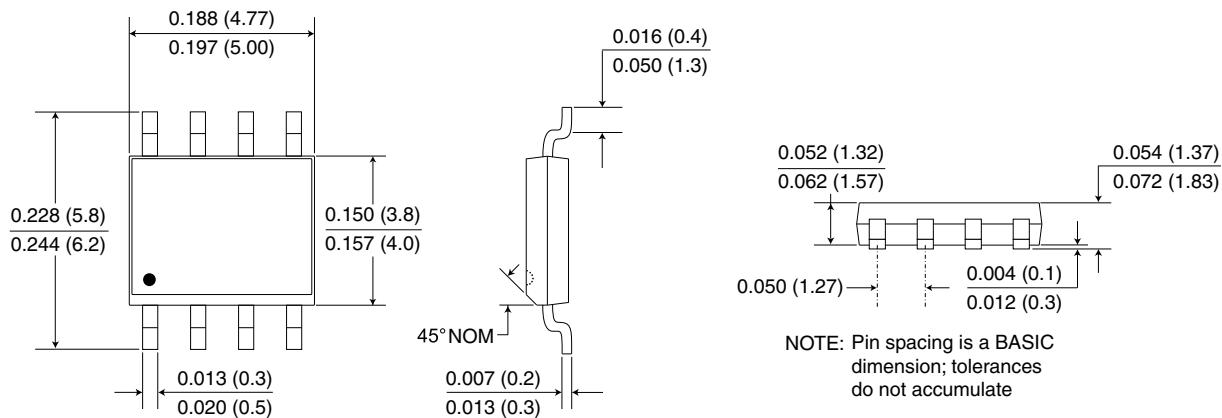
TDFN6 (-10 suffix)



MSOP8 (-00 suffix)



SOIC8 (-02 suffix)



Soldering profiles per JEDEC J-STD-020C, MSL 1.

**RoHS
COMPLIANT**

Revision History

SB-00-059-A

April 2017

Change

- Initial datasheet release superseding catalog.

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