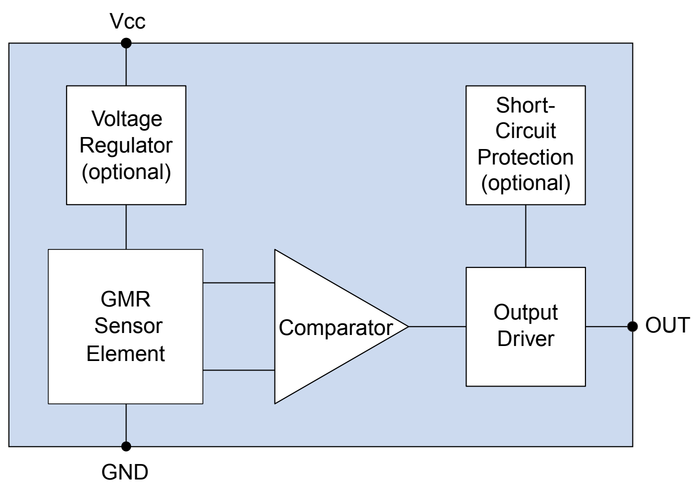
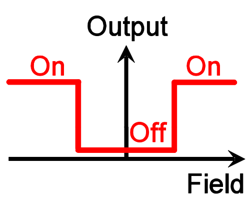
AD-Series GMR Switch™ Precision Digital Magnetic Sensors

Functional Diagram



Idealized Transfer Function



Features

- Digital outputs
- Precision magnetic operate point
- 4.5 V – 30 V supply voltage
- 20 mA output drive
- Temperature and voltage stability
- Versions with short-circuit protection circuitry
- Frequency response to 100 kHz
- Ultraminiature TDFN6 and MSOP8 packages

Applications

- Motion, speed, and position control
- Pneumatic cylinder position sensing
- Speed sensing

Description

AD-Series GMR Switches are the industry standard for sensitivity and precision.

GMR Switches integrate GMR sensor elements with digital signal processing electronics. These sensors are more precise than other magnetic sensors, and magnetic field operate points are stable over voltage and temperature extremes.

AD-Series models available in a wide variety of magnetic operate points and output configurations. Versions are available with short-circuit protection circuitry and with integrated voltage regulators.

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Absolute Maximum Ratings

Parameter		Symbol	Min.	Max.	Units
Supply voltage	Except AD8xx/AD9xx	V_{CC}	−33	33	Volts
	AD8xx/AD9xx		−0.5		
Output voltage			−0.5	33	Volts
Output current (AD8xx/AD9xx only)				5	mA
Operating temperature			−40	125	°C
Storage temperature			−65	150	°C
ESD (Human Body Model)				2000	Volts
Applied magnetic field		H		Unlimited	Oe

Operating Specifications

Tmin to Tmax; 4.5 V < Vcc < 30 V unless otherwise stated.							
Parameter		**Symbol**	**Min.**	**Typ.**	**Max.**	**Units**	**Test Condition**
Supply voltage		V_{DD}	4.5		30	Volts	
Operating temperature		T_{MIN}; T_{MAX}	−40		125	°C	
Magnetic operate point		H_{OP}					
ADH025			8	10	12	Oe	
AD004; AD021; AD621			15	20	25		
AD024			21	28	33		
AD005; AD022			30	40	50		
Operate/release differential		$H_{OP}-H_{REL}$					
ADH025			2		8	Oe	
AD004; AD021; AD621			5		14		
AD024			5		15		
AD005; AD022			5		25		
Supply current	Except AD8xx/AD9xx	I_{CC}		2.5	4.5	mA	V_{CC} = 12V; Output Off
	AD8xx/AD9xx			1.75	3.5		
Output current	Except AD8xx/AD9xx	I_{O-ON}	20			mA	
	AD8xx/AD9xx		2				
Sinking output voltage	Except AD8xx/AD9xx	V_{OL}			0.2	V	V_{CC} = 12V; I_O = 20mA
	AD8xx/AD9xx				0.4		I_O = 2mA
Sourcing output voltage	Except AD8xx/AD9xx	V_{OH}			V_{CC}–2.5		V_{CC} = 12V; I_O = 20mA
	AD8xx/AD9xx				V_{CC}–2		I_O = 2mA
Output leakage current		I_{O-OFF}			10	µA	V_{CC} = 12V; Output Off
Short voltage (AD8xx/AD9xx only)		V_{ShortH}; V_{ShortL}	0.12		0.17	V	Output On
Regulator output	Except AD8xx/AD9xx	V_{REG}		5.8	6.2	V	V_{CC} > 6.6V; 0 < I_{REG} < 20mA
			3.5	V_{CC} – 0.9			V_{CC} < 6.6V
	AD8xx/AD9xx			5.8	6	V	V_{CC} > 6.6V; 0 < I_{REG} < 20mA
			3.5	V_{CC} – 0.9			V_{CC} < 6.6V
Regulator output current		I_{REG}	3			mA	
Frequency response		f_{MAX}	100			kHz	
Junction–Ambient Thermal Resistance	MSOP8 (-00 suffix)	θ_{JA}		320		°C/W	Soldered to double-sided board; free air
	TDFN6 (-10 suffix)			320			

Operation

Typical operation is shown in the figures below:

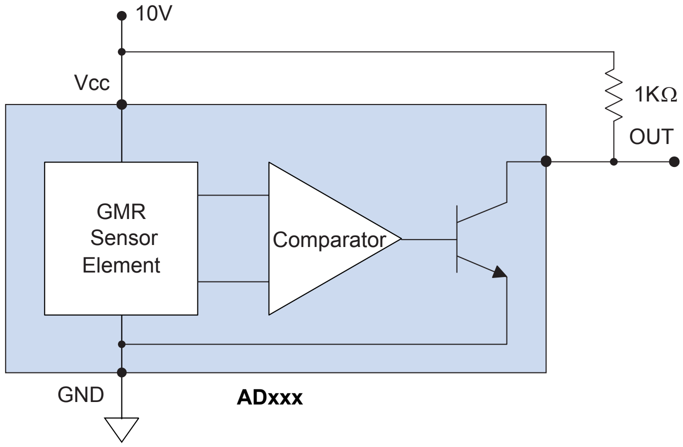

Figure 1. Typical application.

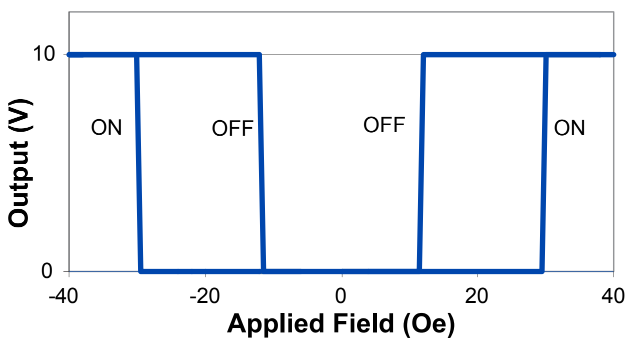

Figure 2a. Typical output vs. magnetic field
(**AD024** with a 10V supply and 1 KΩ pull-up resistor).

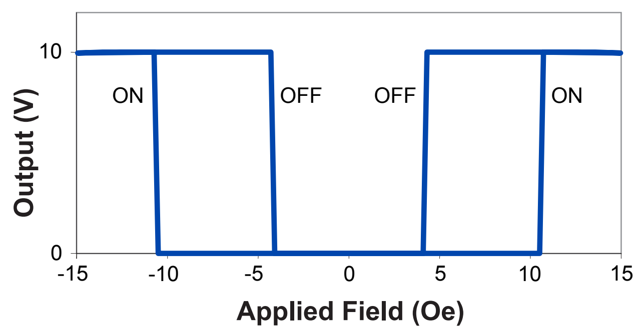

Figure 2b. Typical output vs. magnetic field
(**ADH025** with a 10V supply and 1 KΩ pull-up resistor).

ON / OFF Behavior
AD-Series sensor outputs turn ON when the field exceeds the magnetic operate point, and OFF when the field drops below the operate point minus the release differential.

External Pull-Up Resistors
Outputs are open collector, with PNP output transistors for sourcing versions and NPN transistors for sinking versions. Outputs should have external pull-up or pull-down resistors. For microcontroller interfaces, the microcontroller's input pull-up resistors can be activated.

Omnipolar
GMR Switches are "omnipolar," which means the outputs turn ON when a magnetic field of either magnetic polarity is applied.

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In-Plane Magnetic Sensitivity
As the field varies in intensity, the digital output will turn on and off. Unlike Hall effect or other sensors, the direction of sensitivity is in the plane of the package. The diagrams below show two permanent magnet orientations that will activate the sensor in the direction of sensitivity:

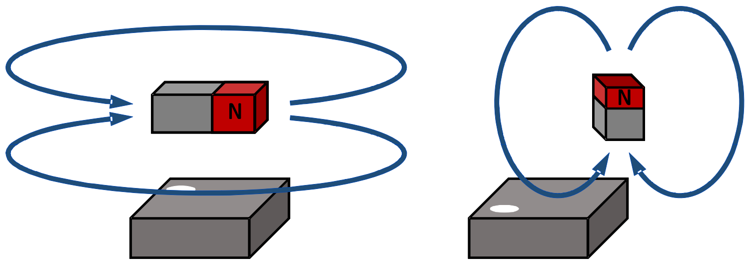

Figure 3. Planar magnetic sensitivity.

Standard and Cross-Axis Sensitivity
Standard AD-Series sensors are sensitive along the part axis as shown in Figure 4b, but a number of versions are available with cross-axis sensitivity (see Figure 4a).

Figure 4a.
Cross-axis sensitivity.

Figure 4b.
Standard sensitivity.

Illustrative Application Circuits

Integrated Short-Circuit Protection

AD8xx and AD9xx models include integrated Short Circuit Protection ("SCP") circuitry. A detailed block diagram of such a device is shown below:

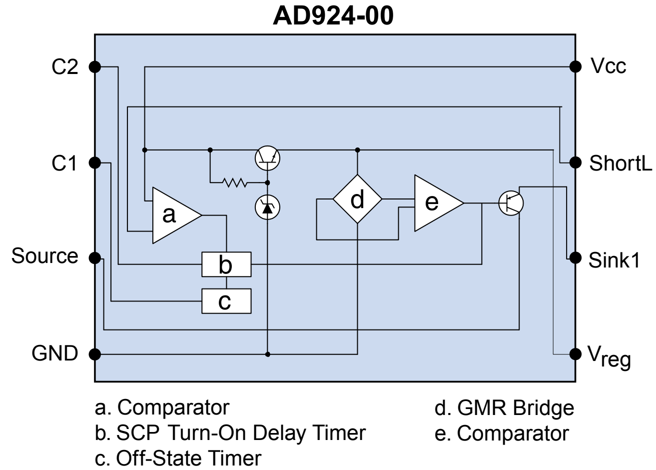

Figure 5. Detailed block-diagram of the AD924 sensor with short-circuit protection circuitry.

Typical external circuitry for sourcing and sinking output configurations are shown in the following schematics:

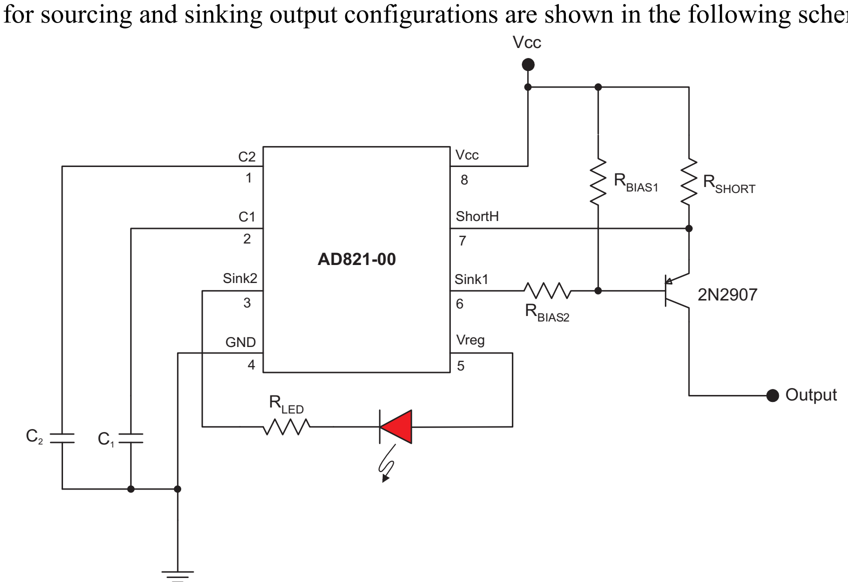

Figure 6. Short-circuit protection circuitry (sourcing output).

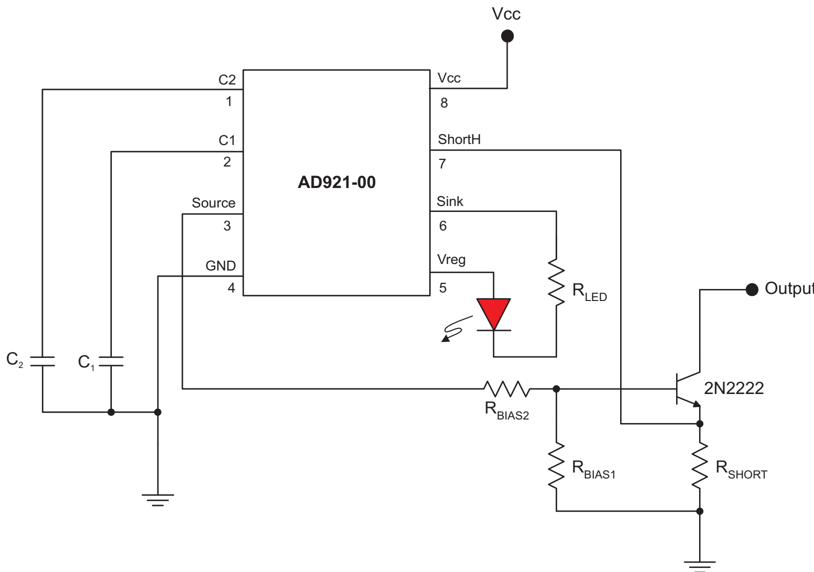

Figure 7. Short-circuit protection circuitry (sinking output).

If the voltage across R_{SHORT} exceeds 145 mV (typical), the SCP circuitry is activated. A typical R_{SHORT} of 0.47Ω results in a protection threshold of approximately 300 mA.

Capacitor C_2 delays the shutdown so normal startup transients do not trigger the circuitry; a 0.001 µF capacitor can be used for a typical 35 µs delay. C_1 is used to set the SCP "OFF" time; typically 0.01 µF for a 15 ms OFF time.

The short-circuit output current using these typical component values is shown below:

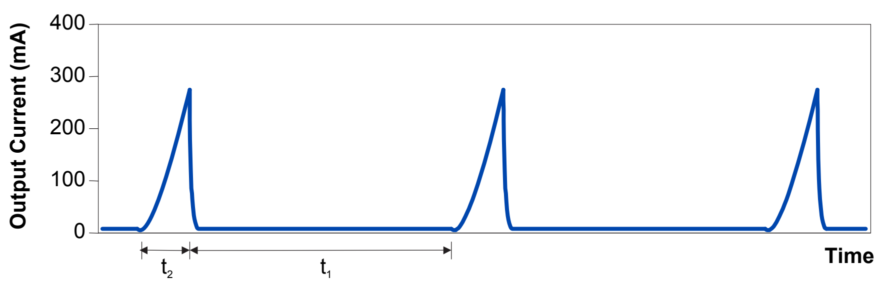

Figure 8. AD821 / AD921 output current with SCP and output shorted (see Figures 5 and 6 for circuits).

R_{BIAS1} and R_{BIAS2} bias the output transistor. Typical values for are 16 KΩ for R_{BIAS1} and 3 KΩ for R_{BIAS2}, which provides 1 mA of transistor base current. R_{LED} sets the LED current up to a maximum of 3 mA.

External Short-Circuit Protection

NVE offers a separate Power Switch IC, the DB001-00, for sensor Short Circuit Protection of sensors that do not have SCP support. The DB001 also provides a high-current output, reverse battery protection, and transient protection.

A typical circuit is as follows:

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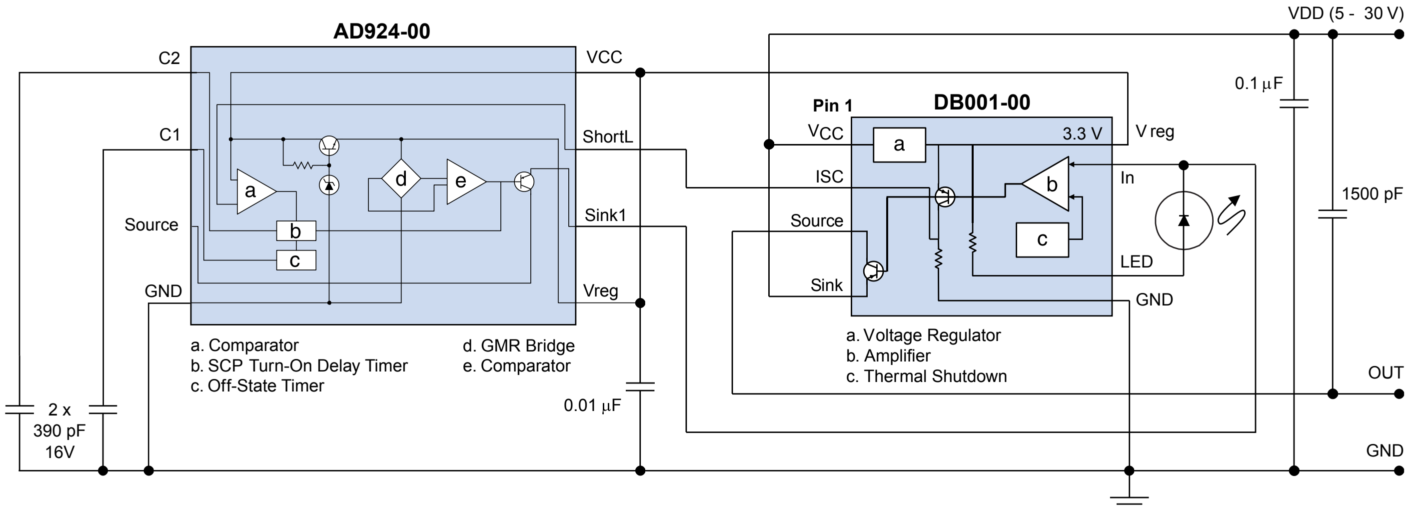

Figure 9. Using an external power switch IC for a high-power output, bullet-proof system.

Typical Performance Graphs

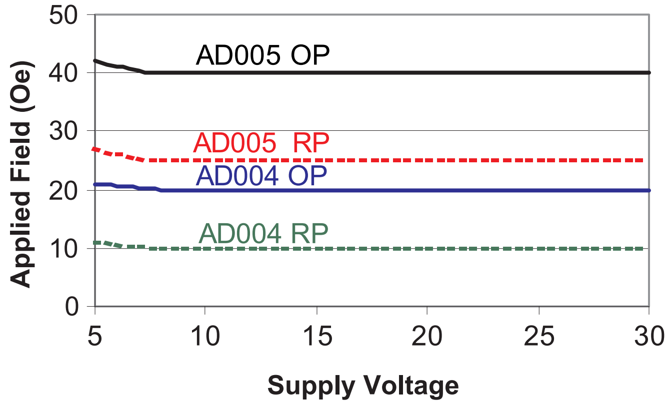

Figure 10. Typical Operate Points (OP) and Release Points (RP) vs. supply voltage (at 25°C).

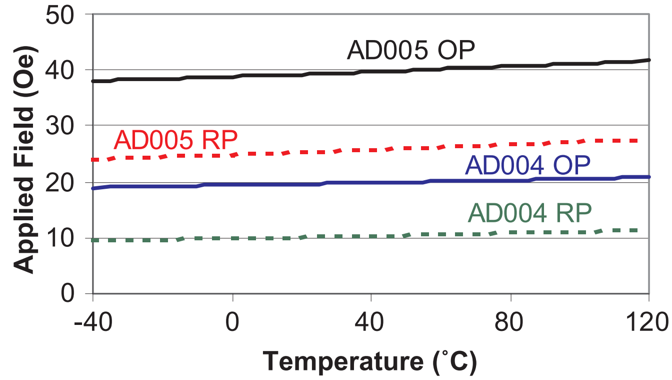

Figure 11. Typical Operate Points (OP) and Release Points (RP) vs. temperature.

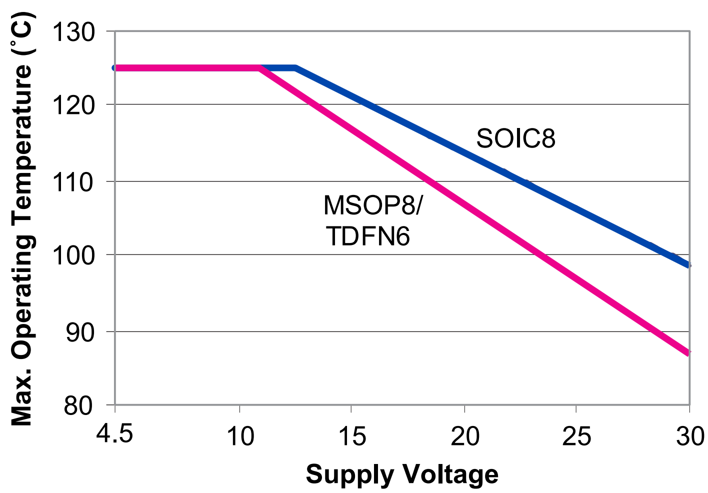

Figure 12. Operating temperature derating (free air).

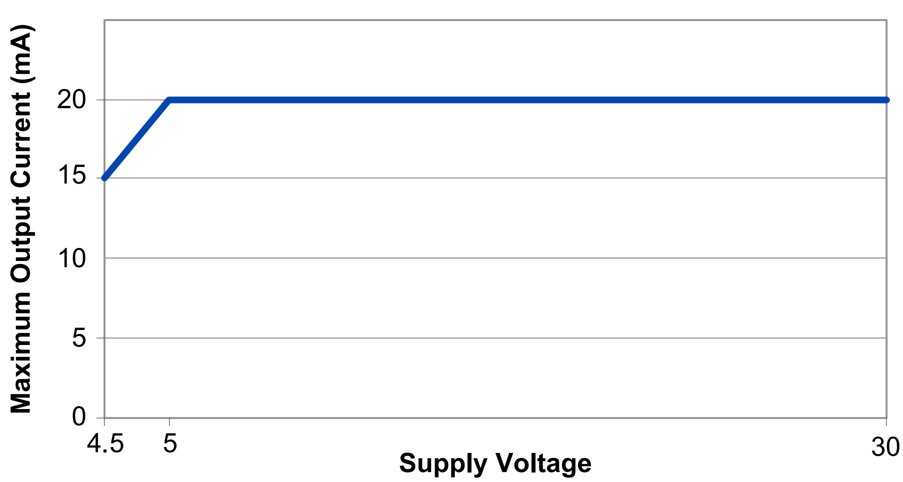

Figure 132. Output current vs. supply voltage.

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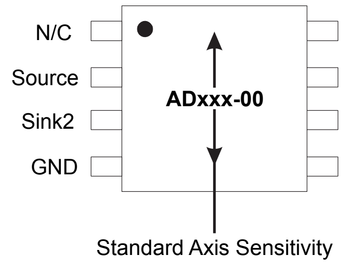
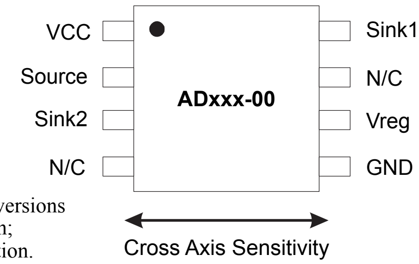
Pinouts

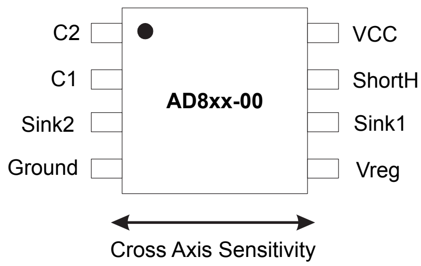
MSOP GMR Switches Without Short-Circuit Protection (AD0xx-00– AD7xx-xx; ADH0xx-00):

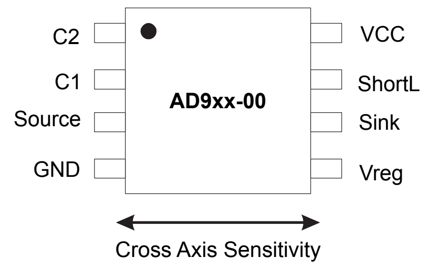


*Sink1 on pin 7 for versions without Vreg option; pin 5 with Vreg option.

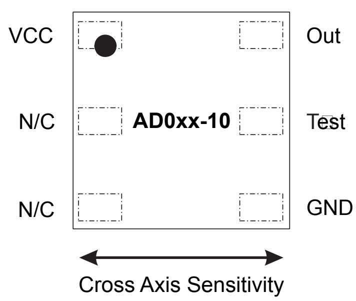


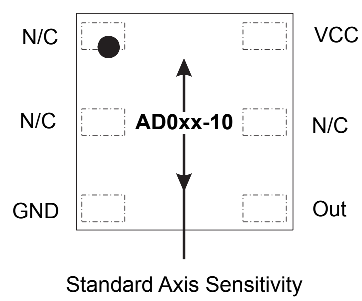
MSOP GMR Switches With Short-Circuit Protection (AD8xx-00– AD9xx-00):





TDFN GMR Switches (AD0xx-10):





Part Numbering

AD 0 21 - 00E

Base Part
AD = Standard digital switches

Outputs
0 = Sink
1 = Source
2 = Sink + Source
3 = Two Sink Outputs
4 = Sink + Regulated Output
5 = Source + Regulated Output
6 = Sink + Source + Regulated Output
7 = Two Sinks + Regulated Output
8 = Two Sinks + Regulated Output + Short-Circuit Protection
9 = Sink + Source + Regulated Output + Short-Circuit Protection

Operating Field
04 = 20 Oe; Standard Direction
05 = 40 Gauss; Standard Direction
20 = 28 Oe; Standard Direction
21 = 20 Oe; Cross-Axis Sensitivity
22 = 40 Oe; Cross-Axis Sensitivity
24 = 28 Oe; Cross-Axis Sensitivity
25 = 10 Oe; Cross-Axis Sensitivity

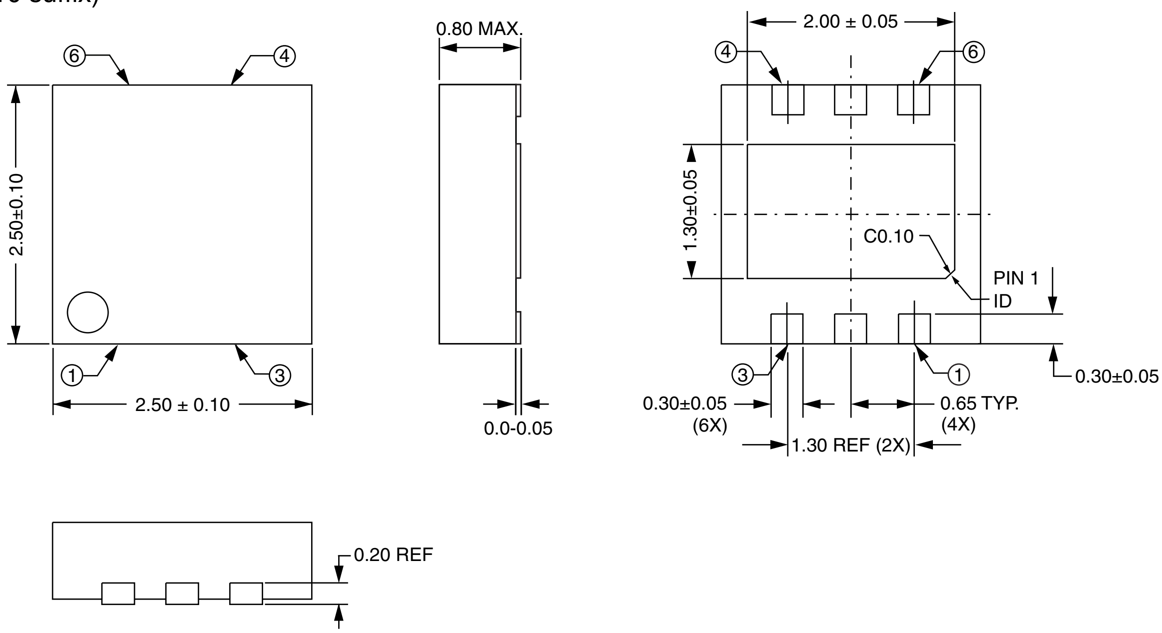
Package Type
00 = MSOP8
02 = SOIC8
10 = TDFN6
E = RoHS

Stock Parts

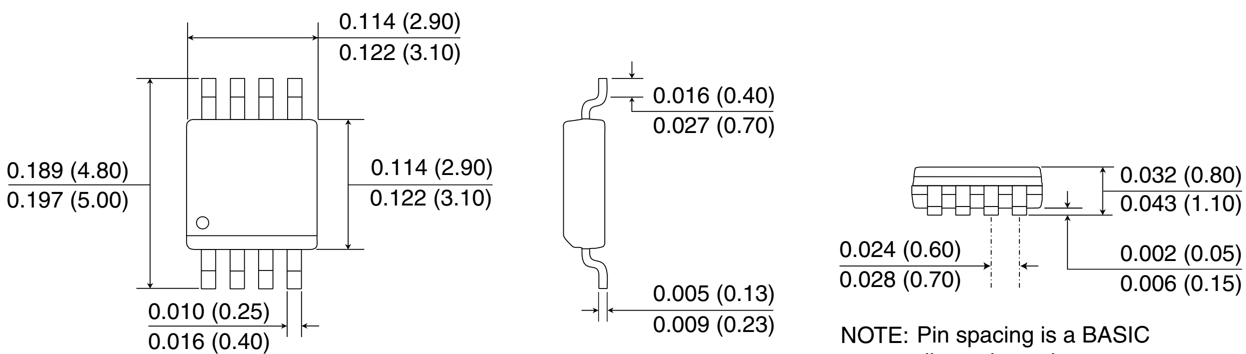
Available Part	Operate Point (typ.)	Release Point (typ.)	Output Type	Max. Operating Temperature	Package
AD004-00	20 Oe	10 Oe	Sink	125°C	MSOP8
AD005-00	40 Oe	25 Oe	Sink	125°C	MSOP8
AD021-00	20 Oe	10 Oe	Sink	125°C	MSOP8
AD022-00	40 Oe	25 Oe	Sink	125°C	MSOP8
AD024-00	28 Oe	14 Oe	Sink	125°C	MSOP8
AD024-10	28 Oe	14 Oe	Sink	125°C	TDFN6
AD621-00	20 Oe	10 Oe	Sink+Source	125°C	MSOP8
AD824-00	28 Oe	14 Oe	2 Sinks + Short-Circuit Protection	150°C	MSOP8
ADH025-00	10 Oe	5 Oe	Sink	150°C	MSOP8

Package Drawings

TDFN6 (-10 suffix)



MSOP8 (-00 suffix)



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

Soldering profiles per JEDEC J-STD-020C, MSL1

RoHS COMPLIANT

Revision History

SB-00-060-A
March 2017

Change

- Initial datasheet release superseding catalog.

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