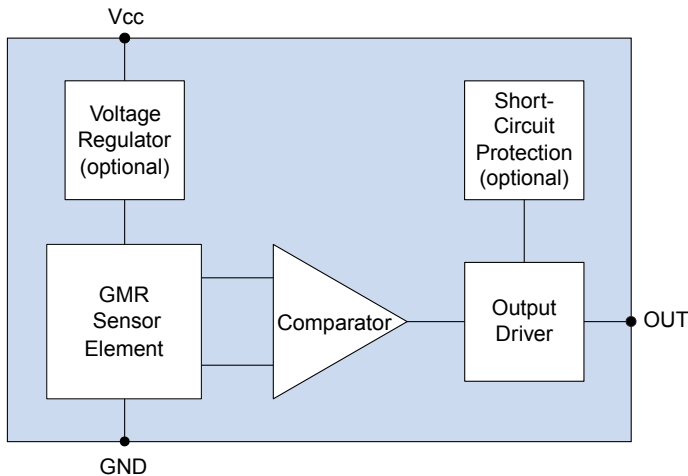


AD-Series GMR Switch™ Precision Digital Magnetic Sensors

Functional Diagram



Features

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

Applications

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

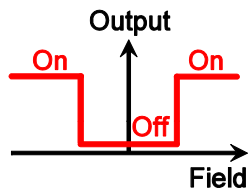
Description

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.

Idealized Transfer Function



Absolute Maximum Ratings

Parameter	Symbol	Min.	Max.	Units	Test Conditions
Supply voltage	V _{CC}	–33	33	Volts	
		–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			2000	Volts	Human Body Model
Applied magnetic field	H		Unlimited	Oe	

Operating Specifications

T _{min} to T _{max} ; 4.5 V < V _{CC} < 30 V unless otherwise stated.							
Parameter	Symbol	Min.	Typ.	Max.	Units	Test Conditions	
Supply voltage	V _{CC}	4.5		30	Volts		
Operating temperature	T _{MIN} ; T _{MAX}	–40		125	°C		
Magnetic operate point ADH025 AD004; AD021; AD621 AD024 AD005; AD022	H _{OP}	8	10	12	Oe		
		15	20	25			
		21	28	33			
		30	40	50			
Operate/release differential ADH025 AD004; AD021; AD621 AD024 AD005; AD022	H _{OP} –H _{REL}	2		8	Oe		
		5		14			
		5		15			
		5		25			
Supply current	I _{CC}	Except AD8xx/AD9xx	2.5	4.5	mA	V _{CC} = 12V; Output Off	
		AD8xx/AD9xx	1.75	3.5			
Output current	I _{O-ON}	Except AD8xx/AD9xx	20		mA	Output On	
		AD8xx/AD9xx	2				
Sinking output voltage	V _{OL}	Except AD8xx/AD9xx		0.2	V	V _{CC} = 12V; I _O = 20mA	
		AD8xx/AD9xx		0.4		I _O = 2mA	
Sourcing output voltage	V _{OH}	Except AD8xx/AD9xx		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-circuit voltage (AD8xx/AD9xx only)	V _{ShortH} / V _{ShortL}	0.12		0.17	V	Output On	
Regulator output	V _{REG}	Except AD8xx/AD9xx		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	θ _{JA}		320		°C/W	Soldered to double-sided board; free air	

Operation

Typical operation is shown in the figures below:

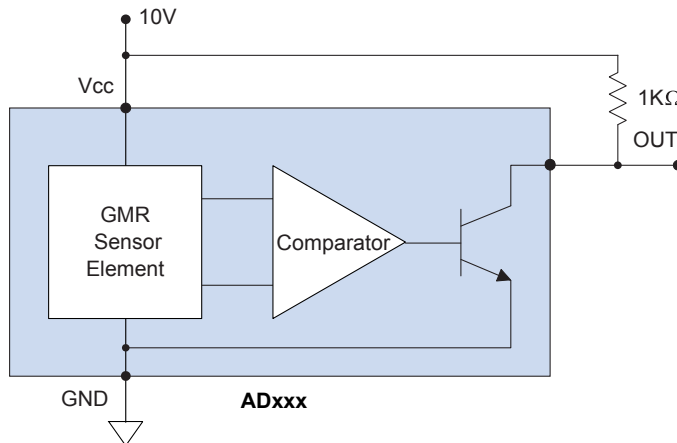


Figure 1. Typical application.

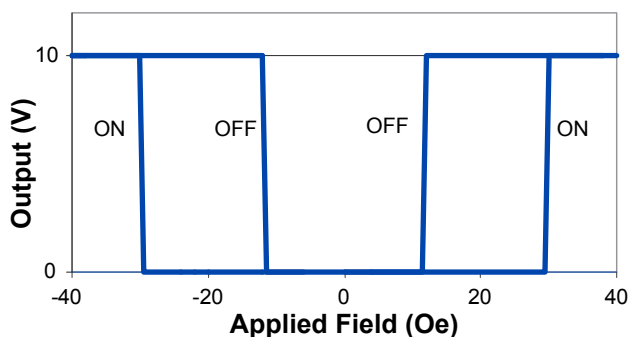


Figure 2a. Typical output vs. magnetic field (AD024 with a 10V supply and 1 KΩ pull-up resistor).

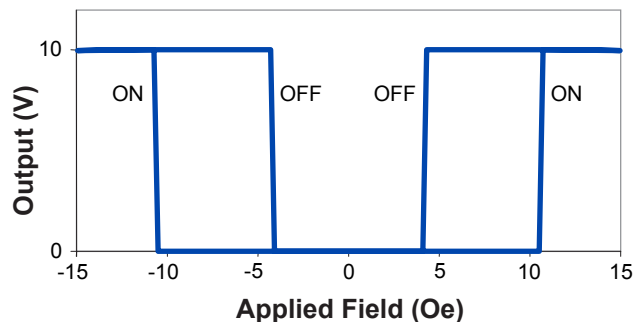


Figure 2b. Typical output vs. magnetic field (ADH025 with a 10V supply and 1 KΩ pull-up resistor).

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.

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:

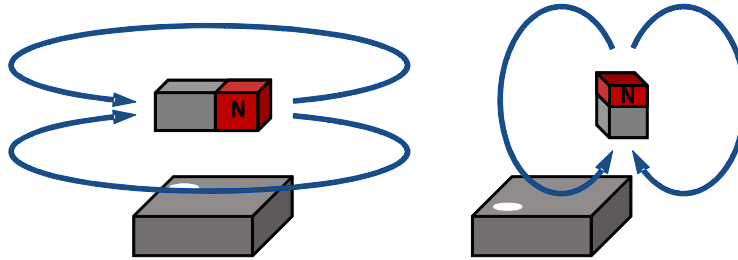


Figure 3. Planar magnetic sensitivity.

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.

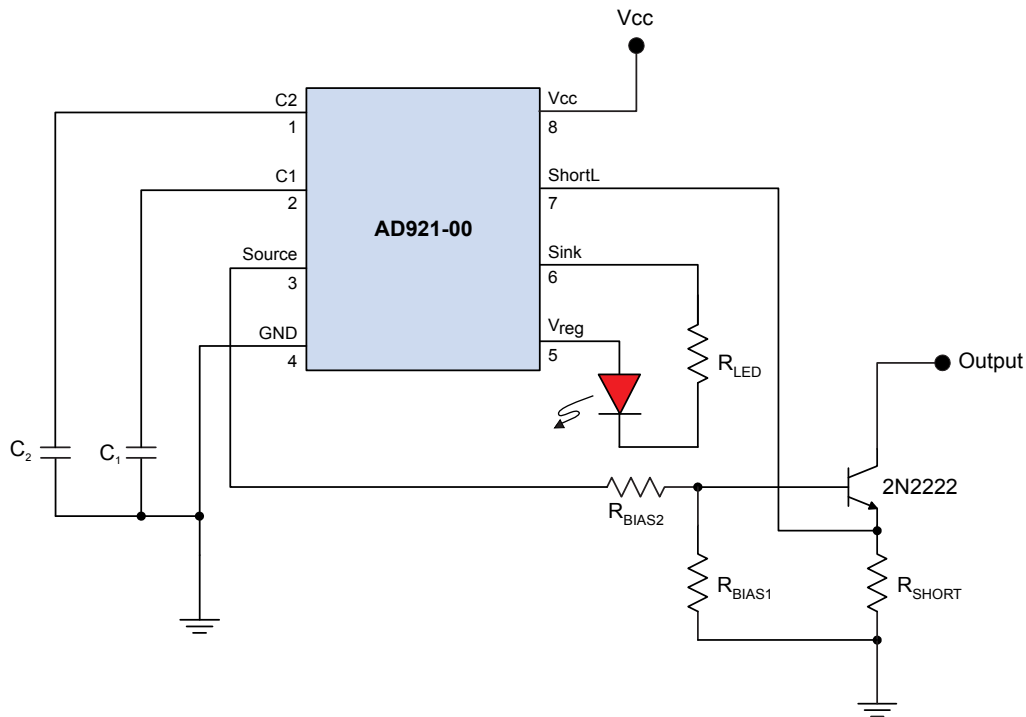


Figure 7. Short-circuit protection circuitry (sinking output).

If the voltage across R_{SHORT} exceeds 145 mV (typical), the SCP circuitry is activated. An R_{SHORT} of 0.47Ω then 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 $0.001\ \mu\text{F}$ capacitor can be used for a typical $35\ \mu\text{s}$ delay (t_2). C_1 sets the SCP “OFF” time (t_1), which is typically $0.01\ \mu\text{F}$ for 15 ms OFF time.

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

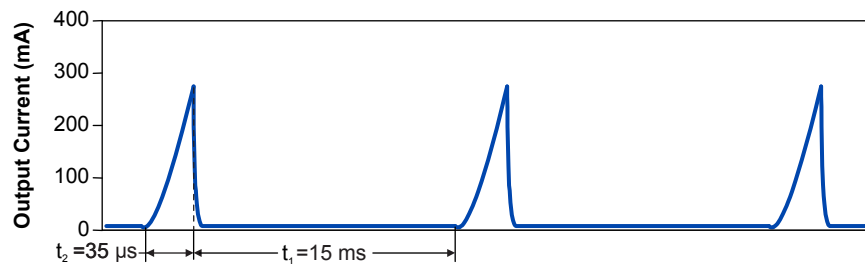


Figure 8. AD821 / AD921 output current with typical SCP components and output shorted (see Figures 5 and 6 for circuits).

R_{BIAS1} and R_{BIAS2} bias the output transistor. Typical values for are $16\ \text{K}\Omega$ for R_{BIAS1} and $3\ \text{K}\Omega$ 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:

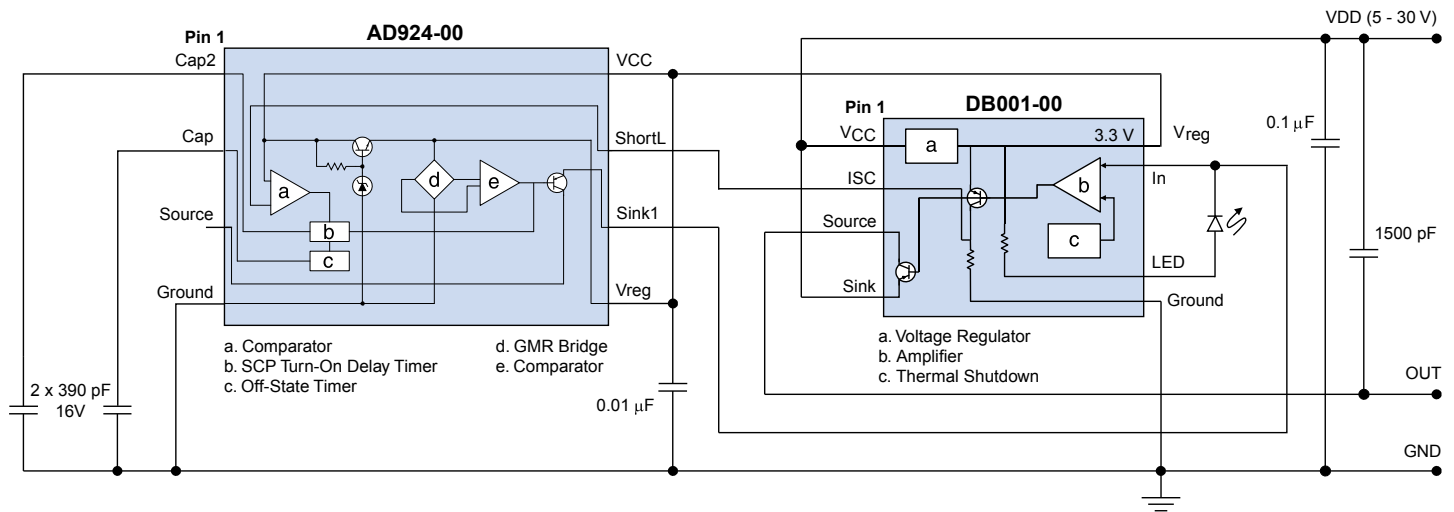


Figure 9. A GMR Switch with an external power switch IC for a high-power output, bullet-proof system.

Typical Performance Graphs

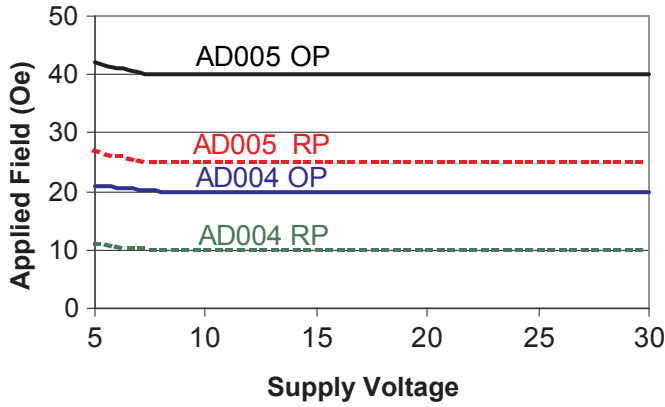


Figure 10. Typical Operate Points (OP) and Release Points (RP) vs. supply voltage (25°C).

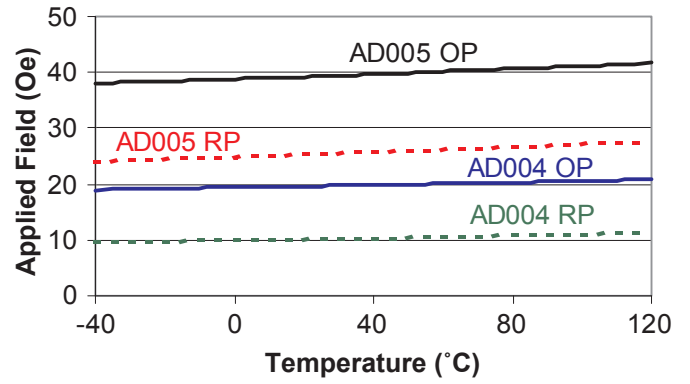


Figure 11. Typical Operate Points (OP) and Release Points (RP) vs. temperature.

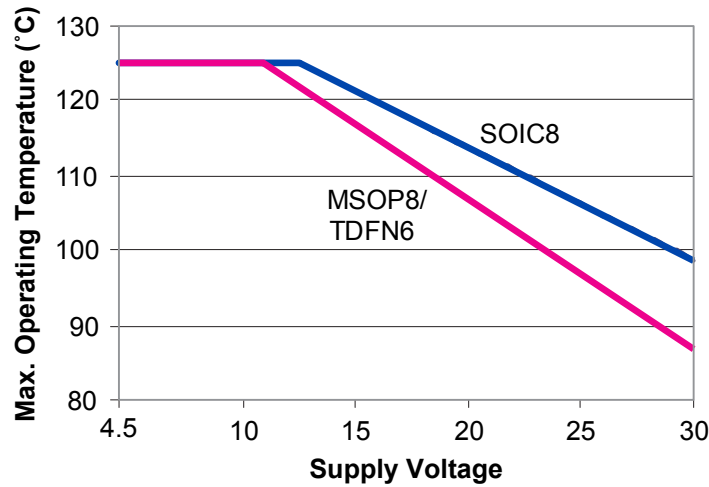


Figure 12. Operating temperature derating (free air).

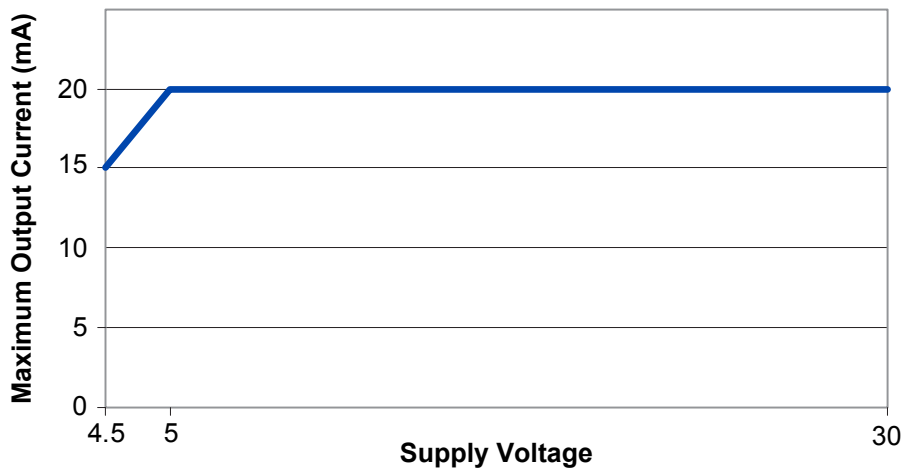
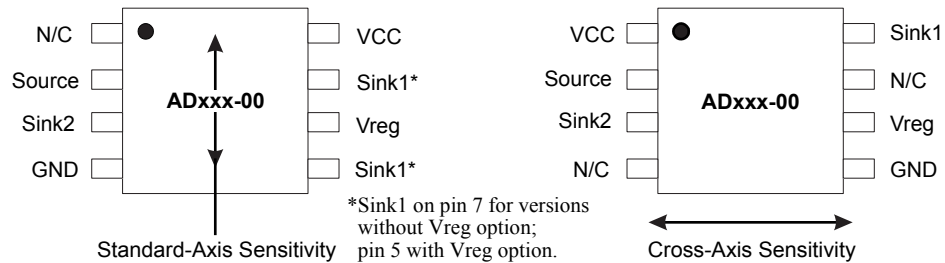


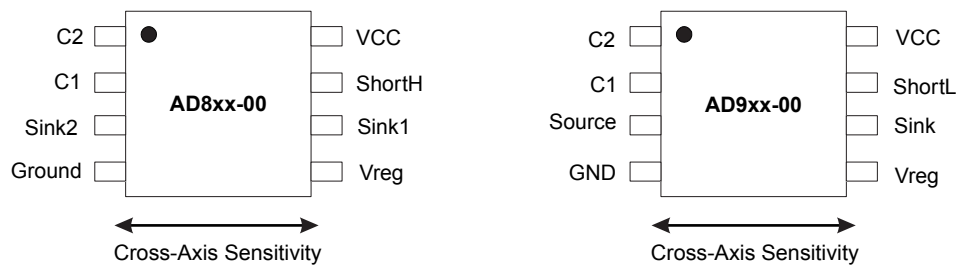
Figure 13. Output current vs. supply voltage.

Pinouts

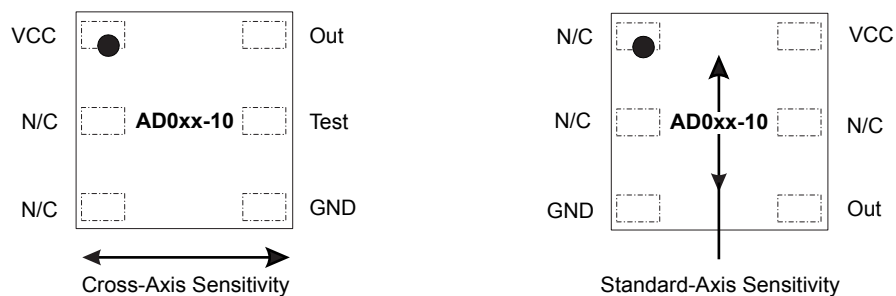
MSOP GMR Switches Without Short-Circuit Protection (AD0xx-00 – AD7xx-00; ADH0xx-00):



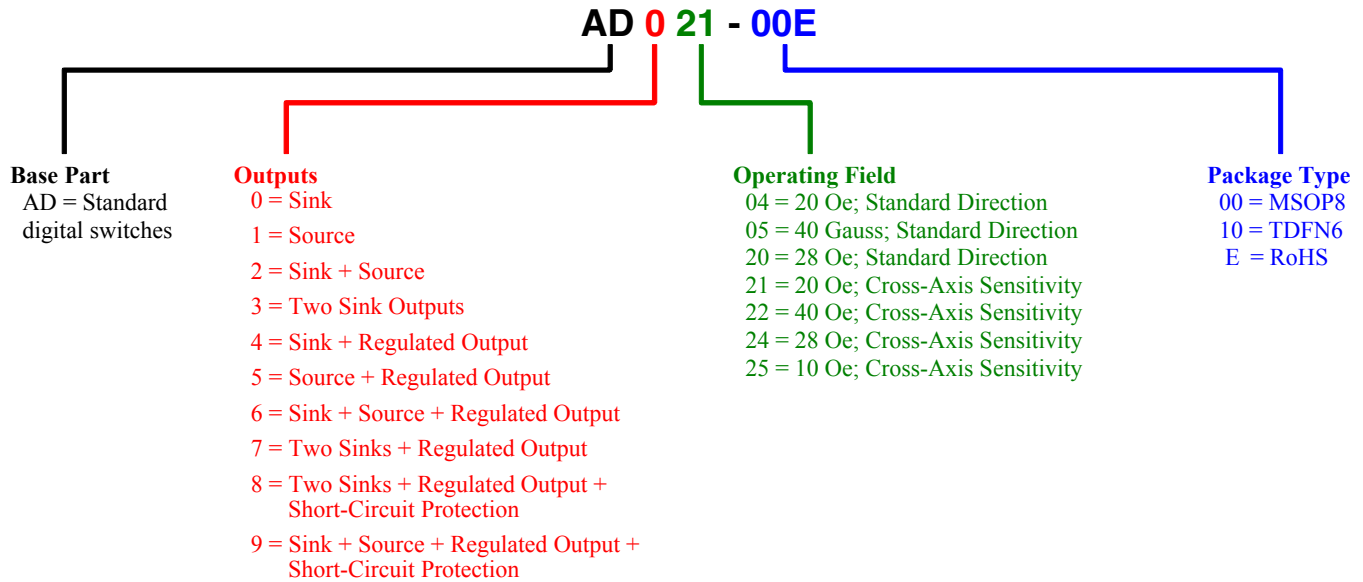
MSOP GMR Switches With Short-Circuit Protection (AD8xx-00 – AD9xx-00):



TDFN GMR Switches (AD0xx-10):



Part Numbering

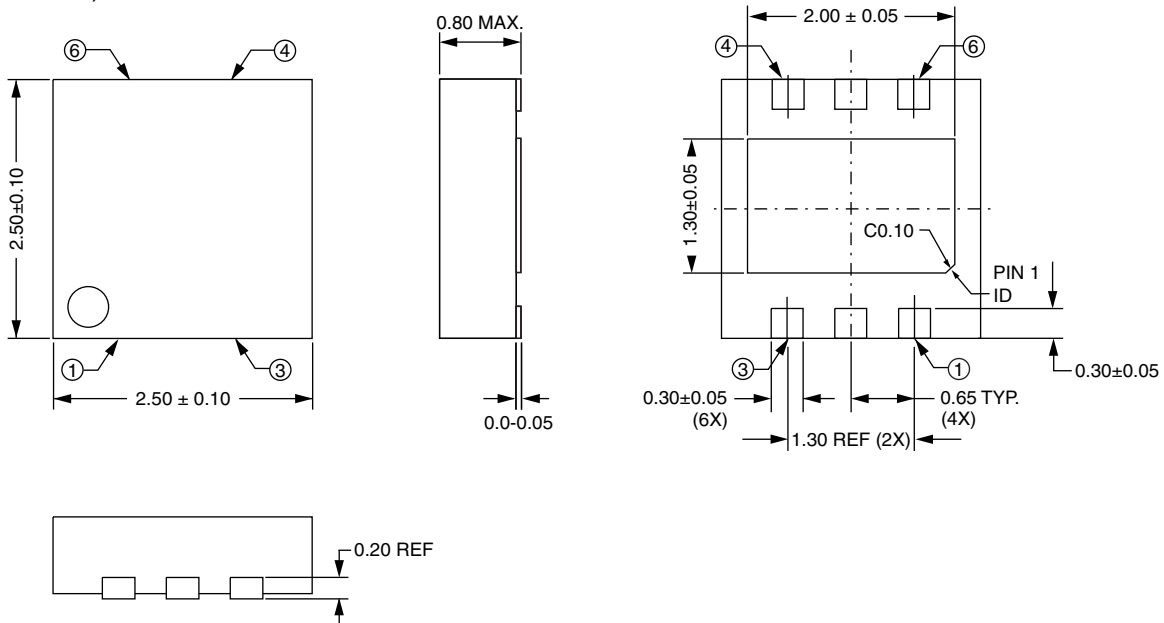


Stock Parts

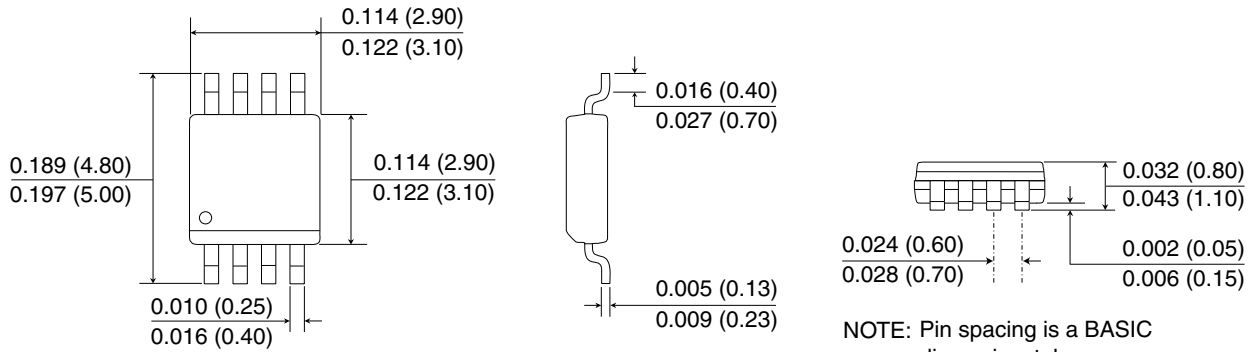
Available Part	Operate Point (typ.)	Release Point (typ.)	Output Configuration	Max. Operating Temperature	Package
AD004-00E	20 Oe	10 Oe	Sink	125°C	MSOP8
AD005-00E	40 Oe	25 Oe	Sink	125°C	MSOP8
AD021-00E	20 Oe	10 Oe	Sink	125°C	MSOP8
AD022-00E	40 Oe	25 Oe	Sink	125°C	MSOP8
AD024-00E	28 Oe	14 Oe	Sink	125°C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



Revision History

SB-00-060-B
August 2017

Change

- Eliminated SOIC package option.
- Misc. cosmetic changes.

SB-00-060-A
March 2017

Change

- Initial datasheet release superseding catalog.

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