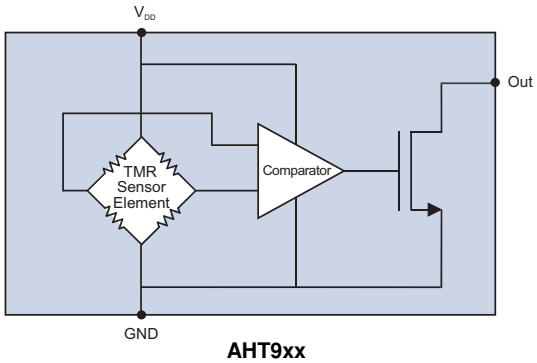
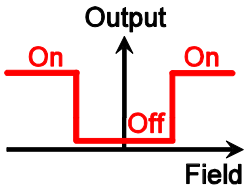
AHT9xx Low-Voltage Nanopower TMR Digital Switches

Functional Diagrams



AHT9xx

Idealized Magnetic Response



Features

- 0.9 V – 1.8 V operating voltage for single-cell operation
- 1 µA typical quiescent current
- Continuous operation for low noise and high-speed
- Sensitive operate points, as low as 1.5 mT
- Ultraminiature 1.1 x 1.1 mm package

Applications

- Single-cell battery or harvested power applications
- Gas and water meters
- Portable instruments
- Wearable electronics
- High speed limit switches
- Mechatronics
- Linear and rotary actuation systems

Description

The AHT9xx-14E series sensors are digital switch devices based on novel Tunnel Magnetoresistance (TMR) technology that provides the lowest quiescent current available in a continuous-duty solid state magnetic switch. The devices also provide unmatched miniaturization, sensitivity, precision, and low power.

The output is configured as a magnetic “switch” where the output turns on when the magnetic field is applied, and turns off when the field is removed. The applied field can be of either magnetic polarity, and the operate point is extremely stable over supply voltage and temperature. The output is current-sinking, and can sink up to 100 microamps.

The product consists of an approximately 0.6 mm x 0.6 mm die containing a TMR sensor element, CMOS signal processing circuitry to convert the analog sensor element output to a digital output.

The parts use NVE’s ultraminiature 1.1 mm x 1.1 mm ULLGA leadless packages. Bare die are also available.

A range of magnetic operate points are available, and custom thresholds can be provided.

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Absolute Maximum Ratings

Parameter	Min.	Max.	Units
Supply voltage		5.5	Volts
Output voltage		5.5	Volts
Output current		200	µA
Storage temperature	−65	150	°C
Junction temperature		150	°C
Applied magnetic field		Unlimited	

Operating Specifications

T_{min} to T_{max}; 0.9 V < V_{DD}<1.8 V unless otherwise stated.						
Parameter	**Symbol**	**Min.**	**Typ.**	**Max.**	**Units**	**Test Condition**
Supply voltage(note 1)	V_{DD}	0.9	1.5	1.8	Volts	
Operating temperature	T_{MIN}; T_{MAX}	−40		85	°C	
Magnetic operate point						
AHT925	H_{OP}	1.1	1.5	1.7	mT	25°C 0.9 V < V_{DD}<1.8 V
AHT924		1.8	2.2	2.5		
AHT922		2.6	3.2	3.5		
AHT923		3.6	4.5	6.4		
AHT925		5.0		2.3		−40°C to 125°C; 0.9 V < V_{DD}<1.8 V
AHT924		1.2		3.2		
AHT922		2.0		4.2		
AHT923		3.0		7.0		
Magnetic release point	H_{REL}	0.2			mT	
Hysteresis		0.05		1	mT	
Quiescent current	I_{DDQ}		0.25	0.5	µA	V_{DD}=0.9V
			0.4	1		V_{DD}=1.15V
			1.0	2		V_{DD}=1.5V
			1.5	5		V_{DD} = 1.8V
Output drive current	I_{OL-ON}	100			µA	
Output low voltage	V_{OL}		0.05	0.2	V	V_{DD}=1.5V; I_{OL-ON}=100 µA
Output leakage current	I_{OL-OFF}		0.095	0.5	µA	
Switching frequency	*f*		1500		Hz	

Notes:

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

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Operation

Direction of 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:

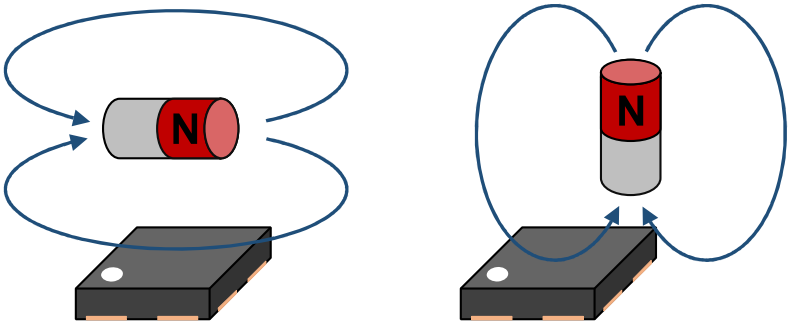


Figure 1. AHT-Series sensor direction of magnetic sensitivity.

AHT-Series Sensors are "omnipolar," meaning the outputs turn ON when a magnetic field of either magnetic polarity is applied.

External Pull-Up Resistor

The output is a logic low when the sensor is activated. The output is open-drain should have an external pull-up resistor. For microcontroller interfaces, the microcontroller's input pull-up resistors can be activated.

Typical Operation

Figure 2 shows typical AHT-Series sensor orientation. The arrow on the circuit board shows the direction of magnetic sensitivity:

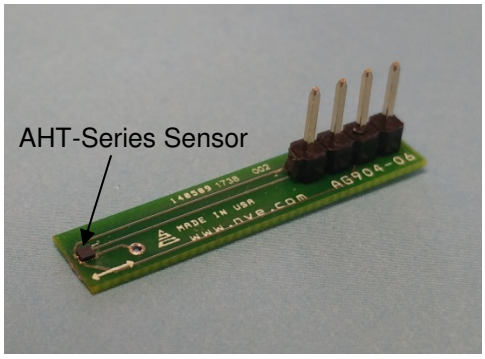


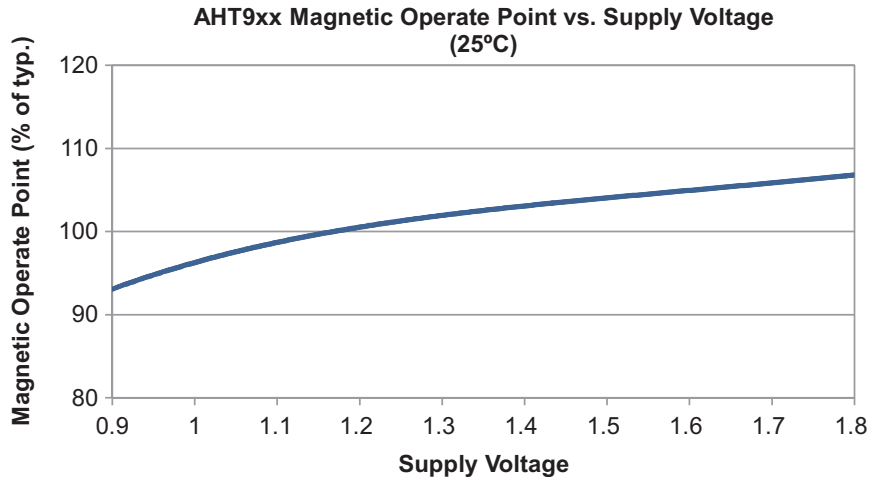
Figure 2. Typical operation; the circuit board arrow shows direction of sensitivity.

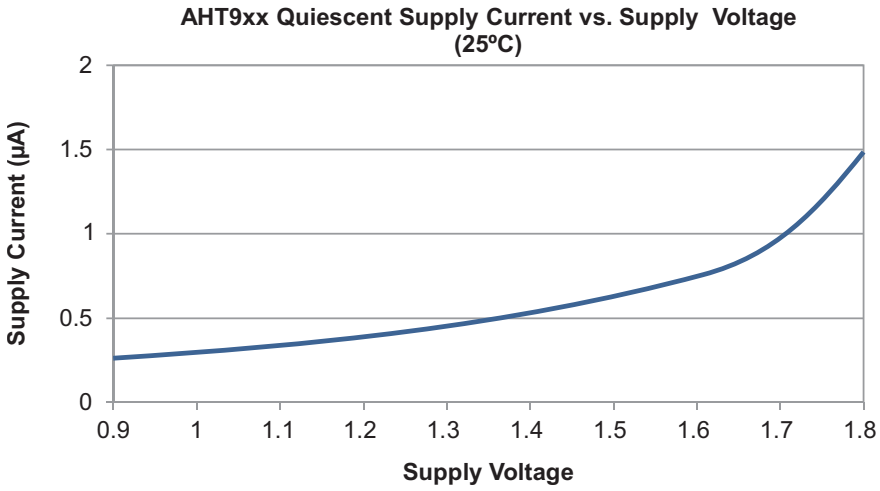
Typical magnetic operate and release distances for an inexpensive 4 mm diameterby6 mm thick ceramic disk magnet, are illustrated in the following table:

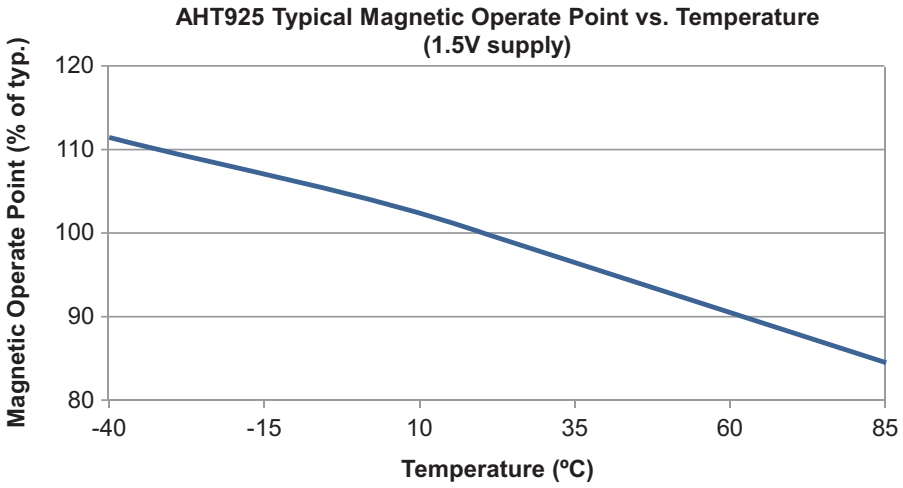
Part	Operate Point (typ.)	Operate Distance (typ.)	Release Distance (typ.)
AHT925-14E	1.5 mT	11 mm	18 mm
AHT924-14E	2.2 mT	10 mm	14 mm
AHT922-14E	3.2 mT	9 mm	11 mm
AHT923-14E	4.5 mT	7 mm	8 mm

Larger and stronger magnets allow farther operate and release distances. For more calculations, use our digital sensor switching versus distance Web application at: *www.nve.com/spec/calculators.php*.

Typical Performance

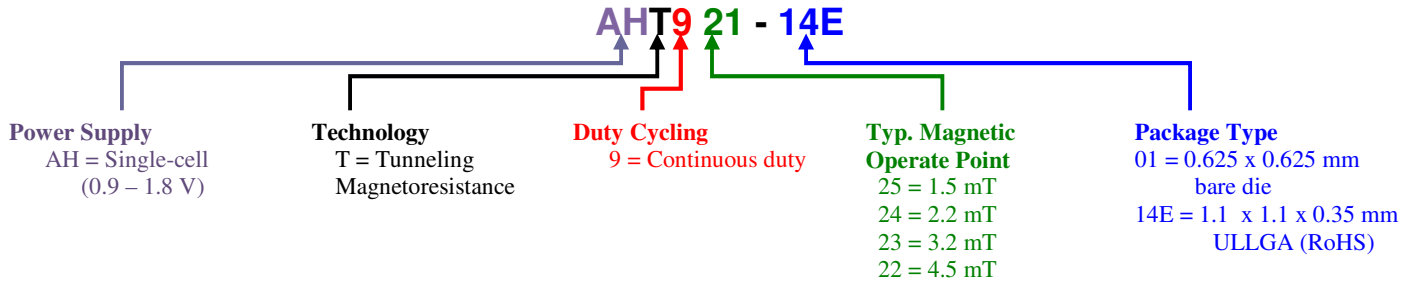






Part Numbering

The following example shows AHT-Series part numbering:



Available Parts

Available Part	Operate Point (typ.)	Package
AHT925-01	1.5 mT	die
AHT925-14E	1.5 mT	ULLGA
AHT924-01	2.2 mT	die
AHT924-14E	2.2 mT	ULLGA
AHT923-01	3.2 mT	die
AHT923-14E	3.2 mT	ULLGA
AHT922-01	4.5 mT	die
AHT922-14E	4.5 mT	ULLGA

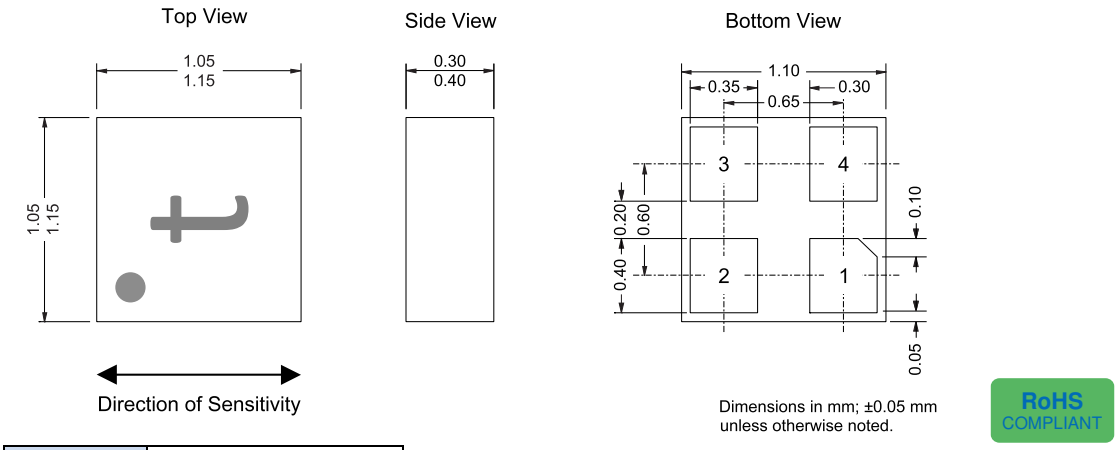
Bare Circuit Boards

NVE offers two bare circuit boards designed for easy connections to ULLGA sensors. Note that since these boards use very small sensors, they require reflow or hot-air soldering techniques. Images are actual size:

AG904-06: ULLGA General-Purpose PCB
A 30 x 6 mm (1.2 x 0.25 inch) PCB for demonstrating 1.1 x 1.1 mm ULLGA4 sensors (-14E sensor suffix).

AG039-06: ULLGA Digital Sensor Demonstration Bare Board
A 40 x 6 mm (1.57 x 0.25 inch) PCB for demonstrating AHT-Series sensors (sensors sold separately). In addition to space for the sensor, the boards have locations for 0402-size pull-up resistors and bypass capacitors.

1.1 mm x 1.1 mm ULLGA Package (-14E suffix)



RoHS COMPLIANT

Pin 1	No Connect
Pin 2	V_{DD}
Pin 3	Out
Pin 4	Ground

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

These products have been tested for electrostatic sensitivity to the limits stated in the specifications. However, NVE recommends that all integrated circuits be handled with appropriate care to avoid damage. Damage caused by inappropriate handling or storage could range from performance degradation to complete failure.

Revision History

SB-00-098D
October 12, 2019

Changes

- Broadened magnetic operate and quiescent current specs. based on more production data.
- Changed AHT925 operate point to 1.5 mT based on customer demand.
- Removed−20°C minimum temperature restriction for supply voltages less than 1 V.
- Typographic corrections and cosmetic changes.

SB-00-098C
May 24, 2019

Changes

- Changed package marking to “t.”
- Reduced maximum operating voltage to 1.8 Vto tighten quiescent current specs.
- Revisions and cosmetic changes to performance graphs.

SB-00-098B
May 21, 2019

Change

- Typographic corrections and cosmetic changes.

SB-00-098A
May 20, 2019

Change

- Initial release.

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NVE Corporation
11409 Valley View Road
Eden Prairie, MN 55344-3617 USA
Telephone: (952) 829-9217

www.nve.com
e-mail: sensor-info@nve.com