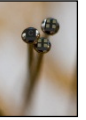
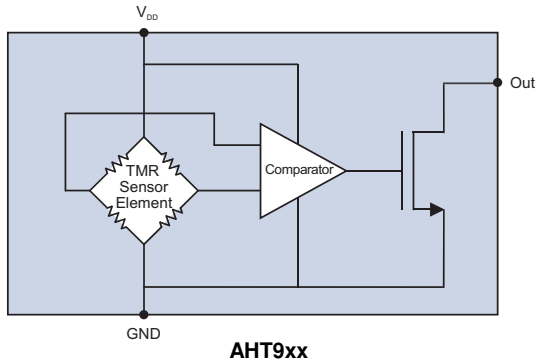


# AHT9xx Low-Voltage Nanopower TMR Digital Switches



## Functional Diagram



## Features

- 0.9 V – 1.8 V operating voltage for single-cell operation
- 1  $\mu$ A 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.

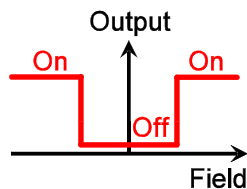
The output is configured as a magnetic “switch” where the output turns on when the magnetic field is applied, and turns off when the field is removed. The applied field can be of either magnetic polarity, and the operate point is extremely stable over supply voltage and temperature. The output is current-sinking,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

## Idealized Magnetic Response



**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	

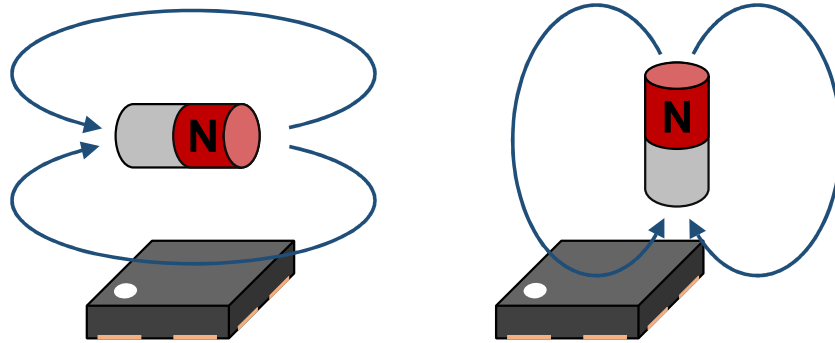
**Operating Specifications**

T <sub>min</sub> to T <sub>max</sub> ; 0.9 V < V <sub>DD</sub> <1.8 V unless otherwise stated.						
Parameter	Symbol	Min.	Typ.	Max.	Units	Test Condition
Supply voltage	V <sub>DD</sub>	0.9	1.5	1.8	Volts	
Operating temperature	T <sub>MIN</sub> ; T <sub>MAX</sub>	-40		85	°C	
Magnetic operate point						
AHT925	H <sub>OP</sub>	1.1		1.7	mT	25 °C 0.9 V < V <sub>DD</sub> < 1.8 V
AHT924		1.8		2.5		
AHT923		2.6		3.5		
AHT922		3.6		6.4		
AHT925		0.5	1.5	2.3		-40 °C to 85 °C; 0.9 V < V <sub>DD</sub> < 1.8 V
AHT924		1.2	2.2	3.2		
AHT923		2.0	3.2	4.2		
AHT922		3.0	4.5	7.0		
Magnetic release point	H <sub>REL</sub>	0.2			mT	
Hysteresis	H <sub>OP</sub> - H <sub>REL</sub>	0.05		0.1	mT	
Quiescent current	I <sub>DDQ</sub>		0.25	0.5	μA	V <sub>DD</sub> = 0.9V
			0.4	1		V <sub>DD</sub> = 1.15V
			1.0	2		V <sub>DD</sub> = 1.5V
			1.5	5		V <sub>DD</sub> = 1.8V
Output drive current	I <sub>OL-ON</sub>	100			μA	
Output low voltage	V <sub>OL</sub>		0.05	0.2	V	V <sub>DD</sub> =1.5V; I <sub>OL-ON</sub> =100 μA
Output leakage current	I <sub>OL-OFF</sub>		0.095	0.5	μA	
Maximum switching frequency	f		3000		Hz	

**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.**

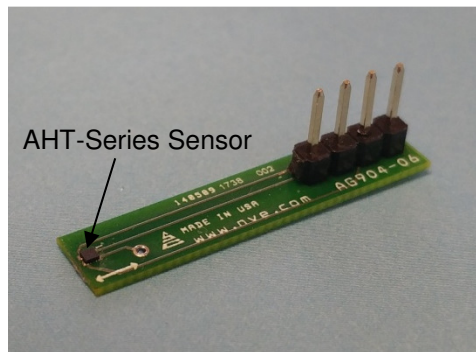
AHT-Series Sensors are “omnipolar,” meaning the outputs turn ON when a magnetic field of either magnetic polarity is applied.

**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:



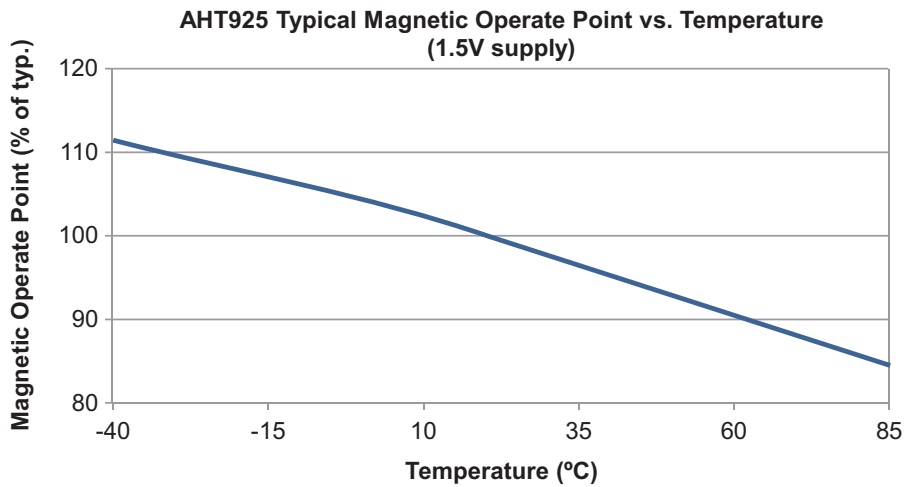
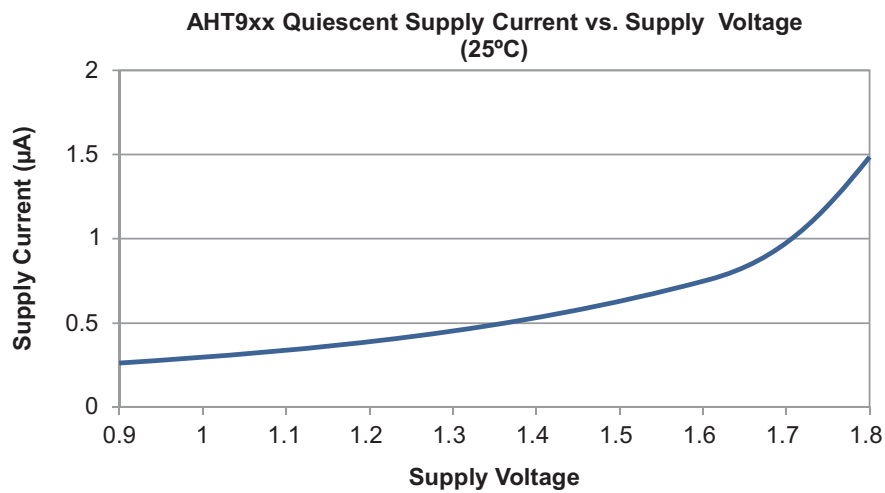
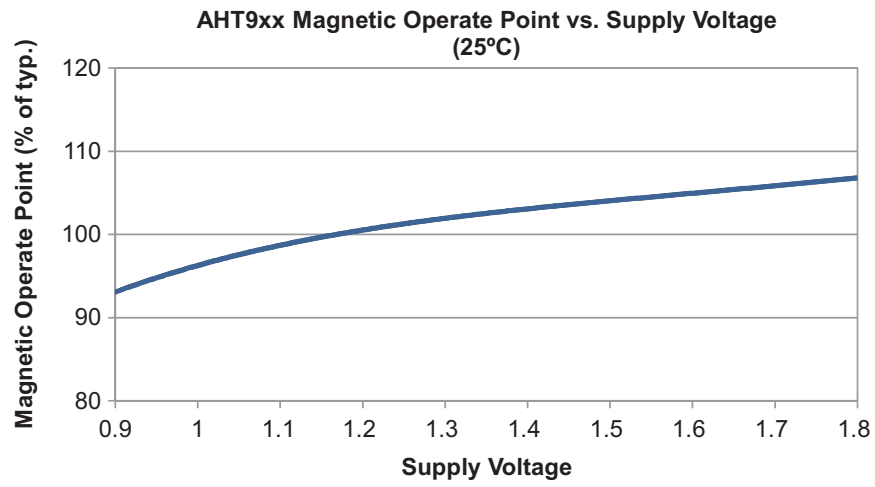
**Figure 2. Typical operation; the circuit board arrow shows direction of sensitivity.**

Typical operate and release distances for an inexpensive 6 mm diameter by 4 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
AHT923-14E	3.2 mT	9 mm	11 mm
AHT922-14E	4.5 mT	7 mm	8 mm

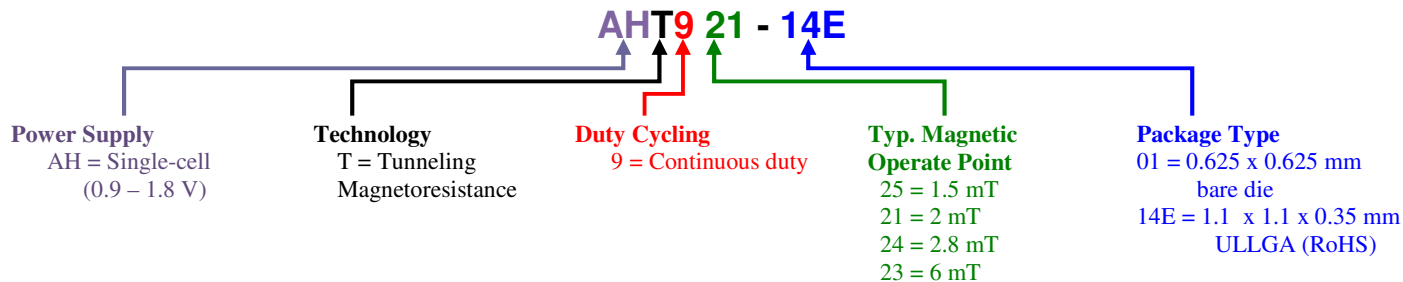
Larger and stronger magnets allow farther operate and release distances. For more calculations, use our digital sensor switching versus distance Web application at: [www.nve.com/spec/calculators.php](http://www.nve.com/spec/calculators.php).

**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

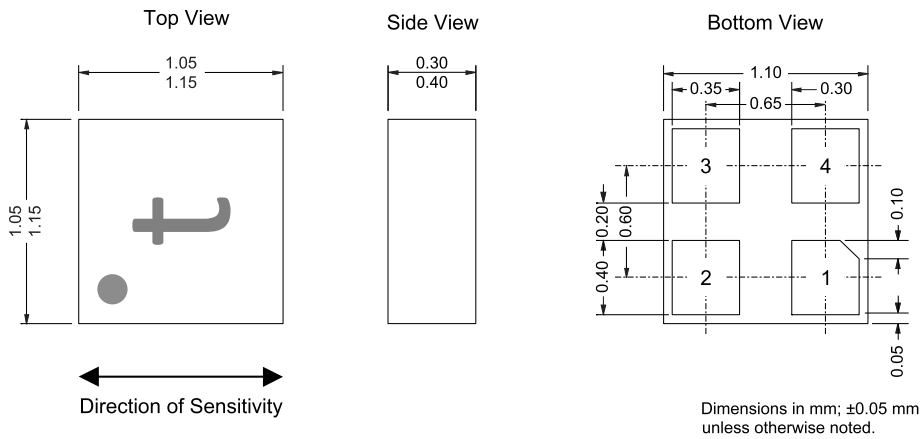
A 30 x 6 mm (1.2 x 0.25 inch) PCB for demonstrating 1.1 x 1.1 mm ULLGA sensors (-14E sensor suffix).



### 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)**



Pin 1	No Connect
Pin 2	V <sub>DD</sub>
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**

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**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 V to 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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SB-00-098

*October 2019*