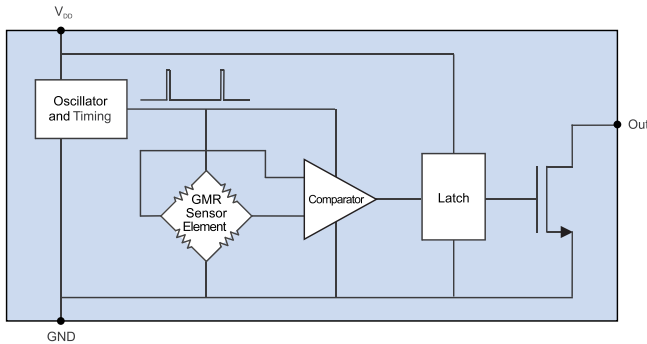


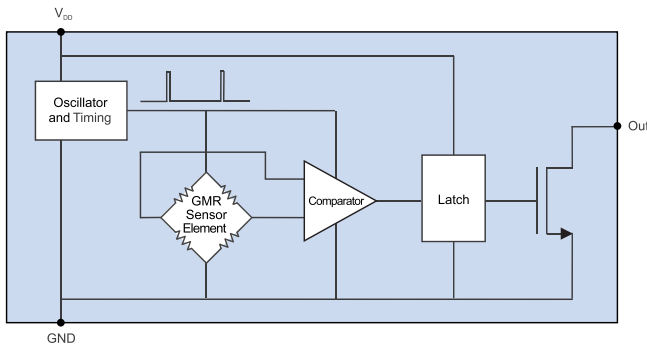
AHLxxx Low-Voltage Nanopower Digital Switches



Functional Diagrams

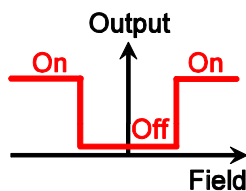


AHL9xx
(continuous duty)



AHL0xx
(duty-cycled)

Magnetic Response



Features

- 0.9 V to 2.4 V operating voltage
- Power as low as 29 nW
- Sensitive operate points as low as 0.5 mT (5 Oe)
- Precise detection of low magnetic fields
- Ultraminiature 1.1 x 1.1 mm DFN4 package

Applications

- Gas and water meters
- Portable instruments
- Single-cell battery or harvested power applications

Description

AHL-Series sensors are Giant Magnetoresistive (GMR) Digital Switch devices designed to run at low voltages and extremely low currents. The devices are manufactured with NVE's patented spintronic GMR technology for 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. Continuous duty versions are available, as well as internally duty cycled versions that further reduce power consumption. An integrated latch ensures the output is available continuously in duty-cycled versions.

The applied field can be of either 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 GMR sensor element, CMOS signal processing circuitry to convert the analog sensor element output to a digital output, and an oscillator and timing circuit for duty cycling.

The parts use NVE's ultraminiature 1.1 mm x 1.1 mm ULLGA DFN4 leadless packages. Bare die are also available.

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

Absolute Maximum Ratings

Parameter	Min.	Max.	Units
Supply voltage		5.5	Volts
Output voltage		5.5	Volts
Output current		200	μA
Storage temperature	-65	170	°C
Junction temperature		170	°C
Applied magnetic field		Unlimited	tesla

Operating Specifications

T _{min} to T _{max} ; 0.9 V < V _{DD} < 2.4 V unless otherwise stated.						
Parameter	Symbol	Min.	Typ.	Max.	Units	Test Condition
Supply voltage (note 1)	V _{DD}	0.9		2.4	Volts	
Operating temperature	T _{MIN} ; T _{MAX}	-40		85	°C	
Magnetic operate point	B _{OP}	0.7	1	1.4	mT	
AHLx25		1.5	2	2.5		
AHLx21		2.1	2.8	3.4		
AHLx24		5	6	7		
AHLx23						
Magnetic release point	B _{REL}	0.2				
Hysteresis		0.05				
Quiescent current	I _{DDQ}		0.032	0.06	μA	V _{DD} = 0.9V
AHL0xx			15	35		
AHL9xx			0.095	0.15		V _{DD} = 1.4V
AHL0xx			35	55		
AHL9xx			0.46	0.65		V _{DD} = 2.4V
AHL0xx			75	130		
AHL0xx peak supply current	I _{DD-PK}		25	55	μA	V _{DD} = 1.4V
Output drive current	I _{OL-ON}	100			μA	
Output low voltage	V _{OL}		0.05	0.2	V	V _{DD} = 1.25V; I _{OL-ON} = 100 μA
Output leakage current	I _{OL-OFF}		0.095	0.5	μA	
Frequency response					Hz	
AHL0xx		30	40	60		V _{DD} = 0.9V
		80	110	160		V _{DD} = 1.4V
		120	260	375		V _{DD} = 2.4V
AHL9xx			100 k			

Notes:

1. Operation from -20°C to -40°C at supply voltages less than 1 V may not meet specifications.
2. Soldering profile per JEDEC J-STD-020C, MSL 1.

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:

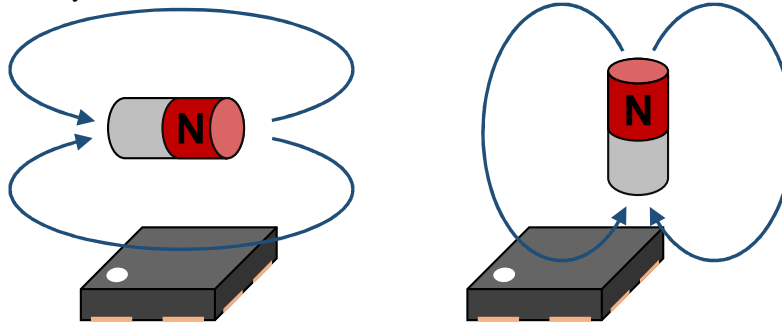


Figure 1. AHL-Series sensor direction of magnetic sensitivity.

AHL-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 AHL-Series sensor orientation. The arrow on the circuit board shows the direction of magnetic sensitivity:

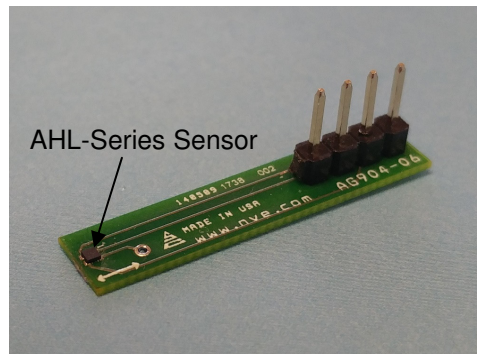


Figure 2. Typical operation; the circuit board arrow shows direction of sensitivity.

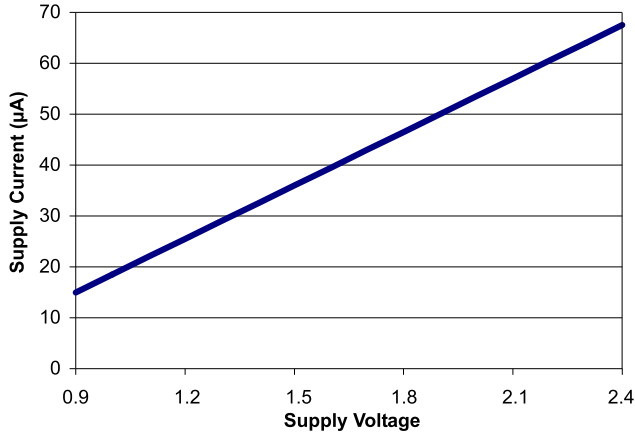
Typical magnetic operate and release distances for an inexpensive 4 mm diameter by 6 mm thick ceramic disk magnet, are illustrated in the following table:

Part	Operate Point (typ.)	Operate Distance (typ.)	Release Distance (typ.)
AHLx25-14E	1 mT	14 mm	18 mm
AHLx21-14E	2 mT	10 mm	12 mm
AHLx24-14E	2.8 mT	9 mm	11 mm
AHLx23-14E	6 mT	7 mm	8 mm

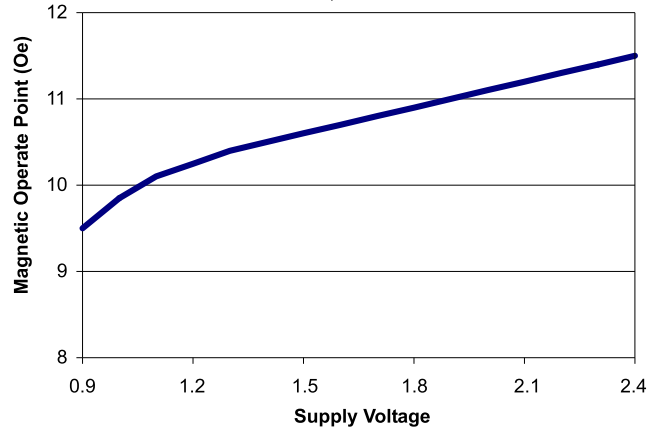
Larger and stronger magnets allow farther operate and release distances. For more calculations, use our digital sensor switching versus distance Web application at: www.nve.com/spec/calculators.php.

Typical Performance Graphs

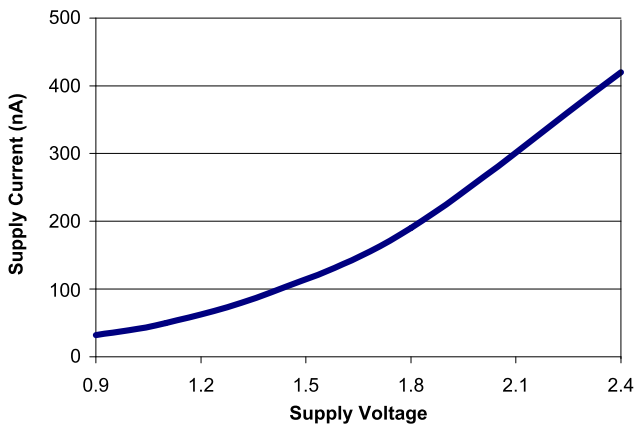
Supply Current vs. Supply Voltage, 25°C, AHL9xx



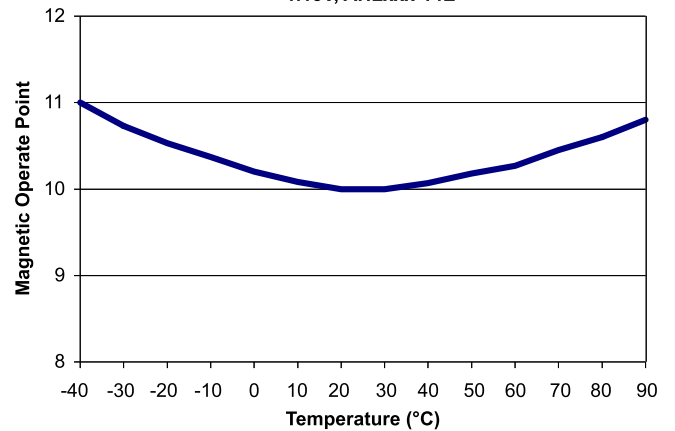
Magnetic Operate Point vs. Supply Voltage
25°C, AHLxxx-14E



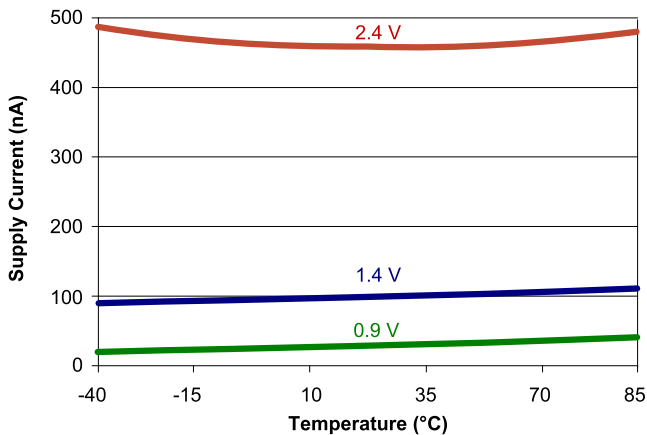
Supply Current vs. Voltage, 25°C
AHL0xx-14E



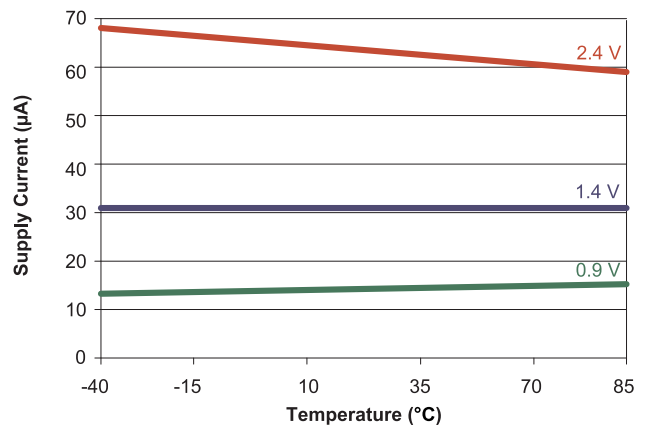
Magnetic Operate Point vs. Temperature,
1.15V, AHLxxx-14E

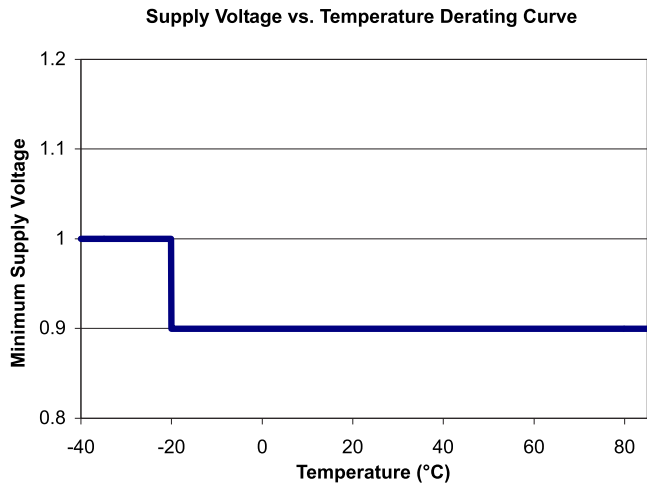
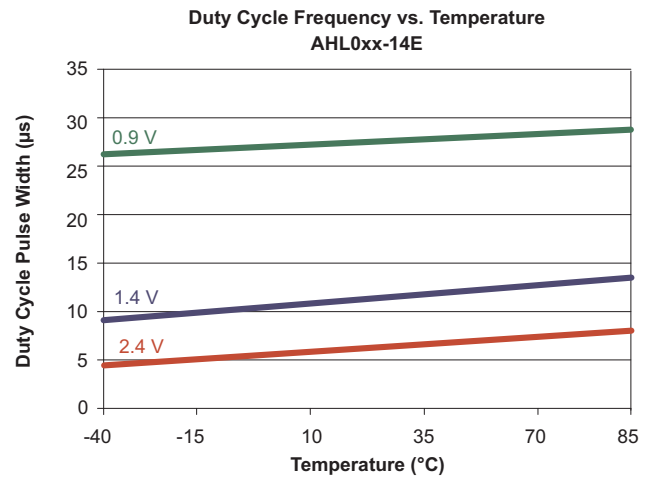
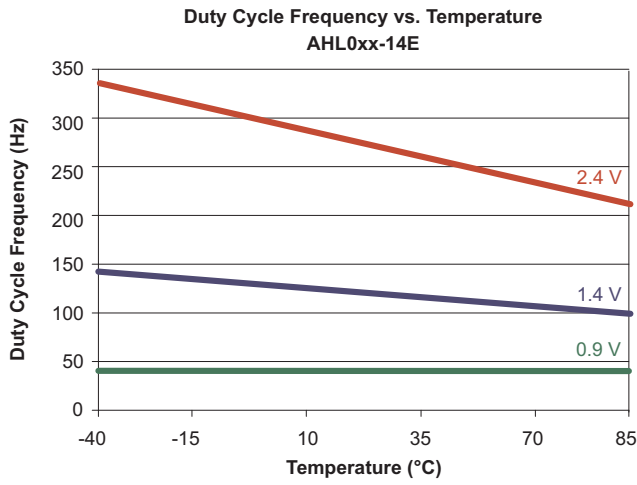


Supply Current vs. Temperature
AHL0xx-14E



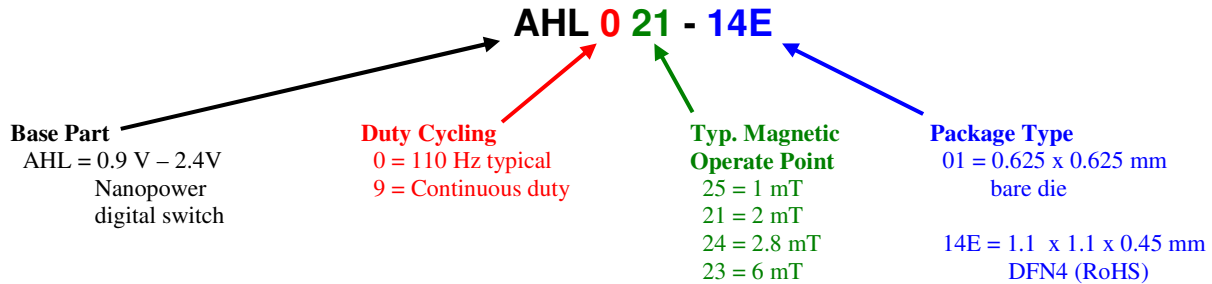
Supply Current vs. Temperature
AHL9xx-14E





Part Numbering

The following example shows the AHL-Series part-numbering system:



Available Parts

Available Part	Duty Cycled?	Update Freq. (typ.)	Operate Point* (typ.)	Package	Package Marking
AHL021-01	Y	110 Hz	2 mT	die	
AHL021-14E	Y	110 Hz	2 mT	DFN4	b
AHL023-01	Y	110 Hz	6 mT	die	
AHL023-14E	Y	110 Hz	6 mT	DFN4	r
AHL024-01	Y	110 Hz	2.8 mT	die	
AHL024-14E	Y	110 Hz	2.8 mT	DFN4	d
AHL025-01	Y	110 Hz	1 mT	die	
AHL025-14E	Y	110 Hz	1 mT	DFN4	e
AHL921-01	N	Continuous	2 mT	die	
AHL921-14E	N	Continuous	2 mT	DFN4	f
AHL924-01	N	Continuous	2.8 mT	die	
AHL924-14E	N	Continuous	2.8 mT	DFN4	h
AHL925-01	N	Continuous	1 mT	die	
AHL925-14E	N	Continuous	1 mT	DFN4	Xj / j

*1 mT = 10 Oe in air.

Bare Circuit Boards

NVE offers two bare circuit boards designed for easy connections to ULLGA DFN4 sensors. Note that since these boards use very small sensors, they require reflow or hot-air soldering techniques. Images are actual size:



AG904-06: DFN4 General-Purpose PCB

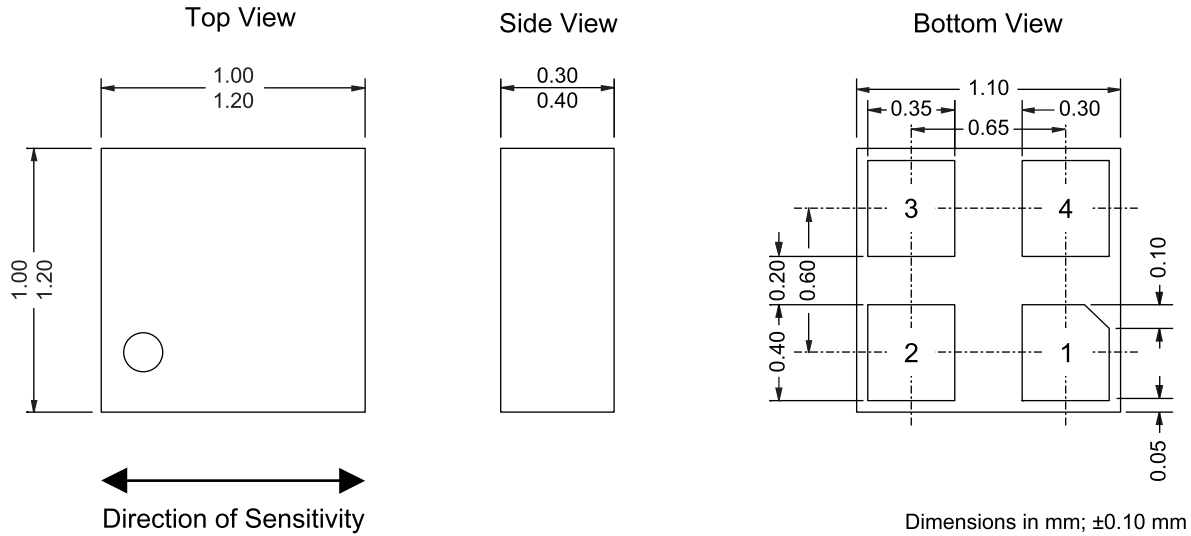
A 30 x 6 mm (1.2 x 0.25 inch) PCB for demonstrating 1.1 x 1.1 mm DFN4 sensors (-14E part number suffix).



AG039-06: DFN4 Digital Sensor Demonstration Bare Board

A 40 x 6 mm (1.57 x 0.25 inch) PCB for demonstrating AHL-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 DFN4 Package (-14E suffix)



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-00-027
March 2020

Change

- Changed AHL9xx I_{DDQ} at 2.4 V max. specification from 110 μA to 130 μA (p. 2).
- Added performance graphs (pp. 4 - 5).
- Changed magnetic units from Oe to mT.

SB-00-027
November 2017

Change

- Added “Typical Operation” section and image (p. 3).
- Added bare boards (p. 5).

SB-00-027
October 2017

Change

- Revised package outline dimensions.

SB-00-027
July 2017

Change

- Deleted AHL927 (replaced with AFL006).

SB-00-027
April 2017

Changes

- Added AHL927 part type.
- Added package marking codes.
- Specified minimum ULLGA package thickness.
- Cosmetic changes.

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An ISO 9001 Certified Company

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

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SB-00-027

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