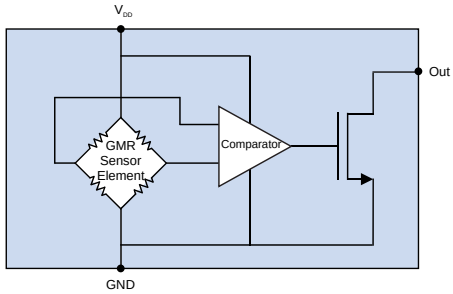
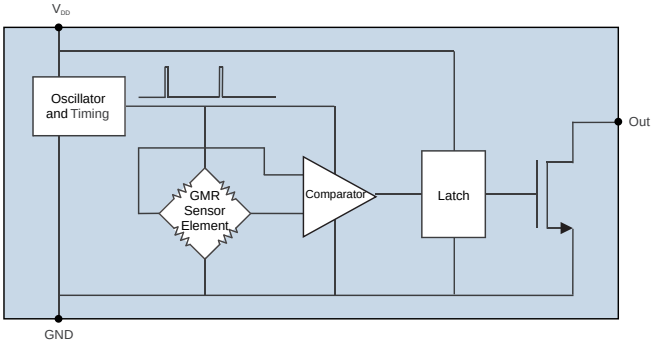
AHLxxx Low-Voltage Nanopower Digital Switches

Functional Diagrams

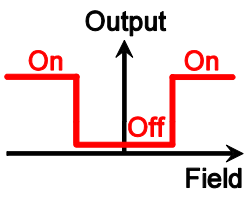


AHL9xx
(continuous duty)



AHL0xx
(duty-cycled)

Idealized Magnetic Response



Features

- 0.9 V – 2.4 V operating voltage
- Power as low as less than 1 microwatt
- Sensitive operate points, as low as 5 Oe
- Precise detection of low magnetic fields
- Ultraminiature 1.1 x 1.1 mm package

Applications

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

Description

The AHLxxx-14E 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. Versions are available that are either continuous duty or internally duty cycled operation to 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 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	

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						
AHLx25	H_{OP}	7	10	14		
AHLx21		15	20	25		
AHLx24		21	28	34		
AHLx23		50	60	70		
Magnetic release point	H_{REL}	2			Oe	
Hysteresis		0.5			Oe	
Quiescent current						
AHL0xx	I_{DDQ}		0.032	0.06	µA	V_{DD} = 0.9V
AHL9xx			15	35		
AHL0xx			0.095	0.15		V_{DD} = 1.4V
AHL9xx			35	55		
AHL0xx			0.46	0.65		V_{DD} = 2.4V
AHL9xx			75	110		
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						
AHL0xx		30	40	60	Hz	V_{DD} = 0.9V
		80	110	160		V_{DD} = 1.4V
		120	260	375		V_{DD} = 2.4V
AHL9xx			100k			

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.

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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:

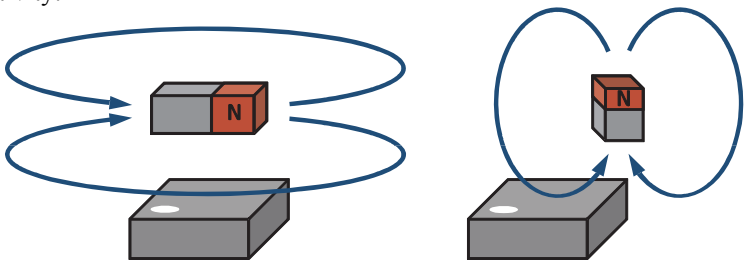


Figure 1. AHL-Series sensor direction of magnetic sensitivity.

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:

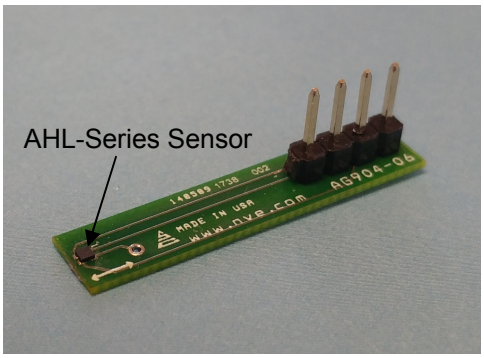


Figure 2. Typical operation; the circuit board arrow shows direction of sensitivity.

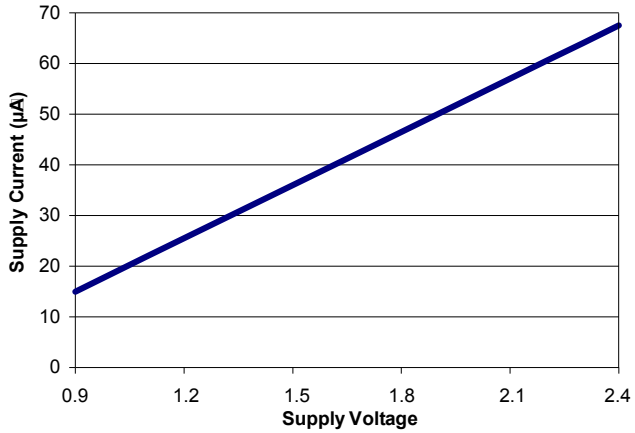
Typical magnetic operate and release distances for an inexpensive 4 mm diameter by 6 mm thick ceramic disk magnet, are illustrated in the following table:

Part	**Operate Point** (typ.)	**Operate Distance** (typ.)	**Release Distance** (typ.)
AHLx25-14E	10 Oe	14 mm	18 mm
AHLx21-14E	20 Oe	10 mm	12 mm
AHLx24-14E	28 Oe	9 mm	11 mm
AHLx23-14E	60 Oe	7 mm	8 mm

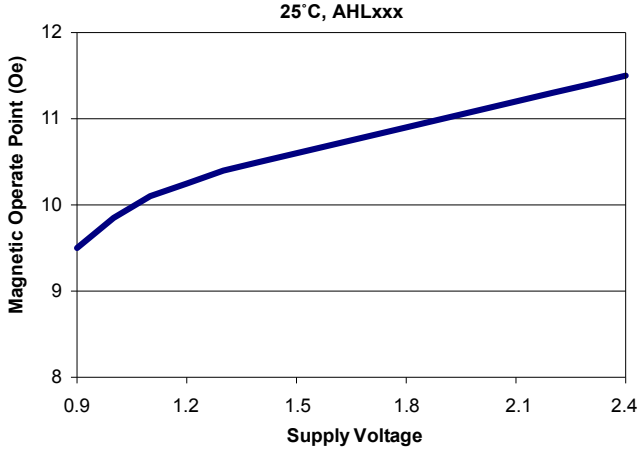
Larger and stronger magnets allow farther operate and release distances. For more calculations, use our digital sensor switching versus distance Web application at: *www.nve.com/spec/calculators.php*.

Typical Performance

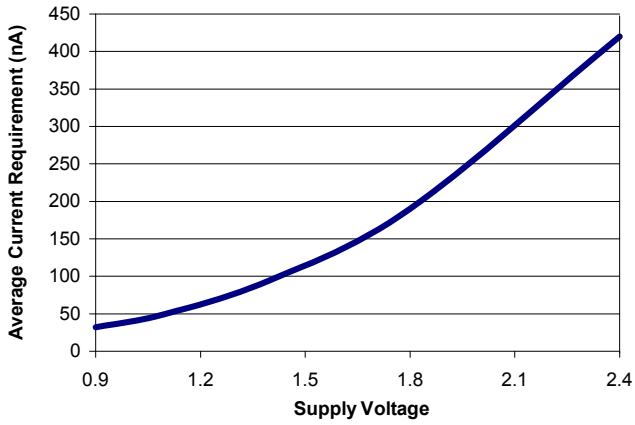
Supply Current vs. Supply Voltage, 25˚C, AHL9xx



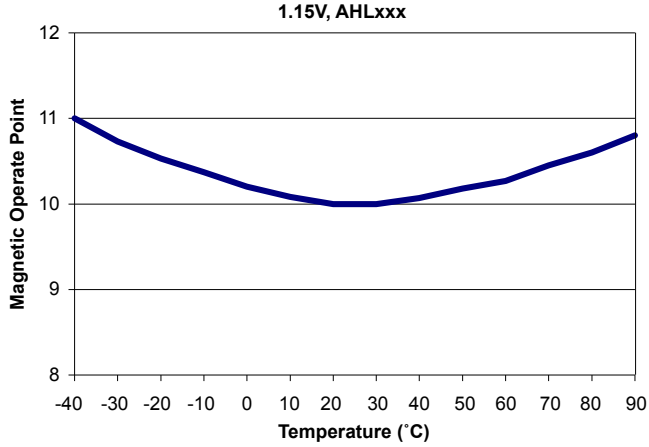
Magnetic Operate Point vs. Supply Voltage
25˚C, AHLxxx



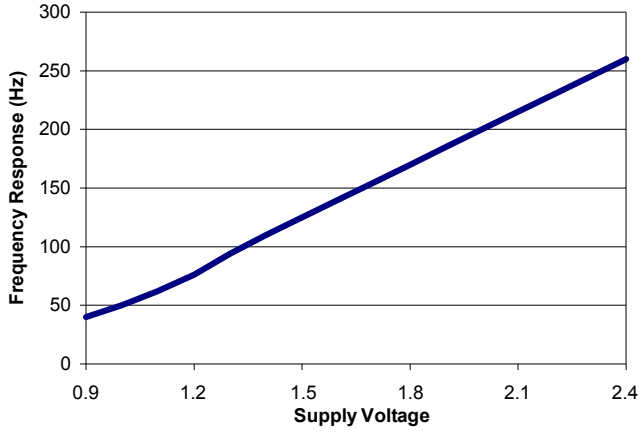
Average Supply Current vs. Supply Voltage, 25˚C
AHL0xx



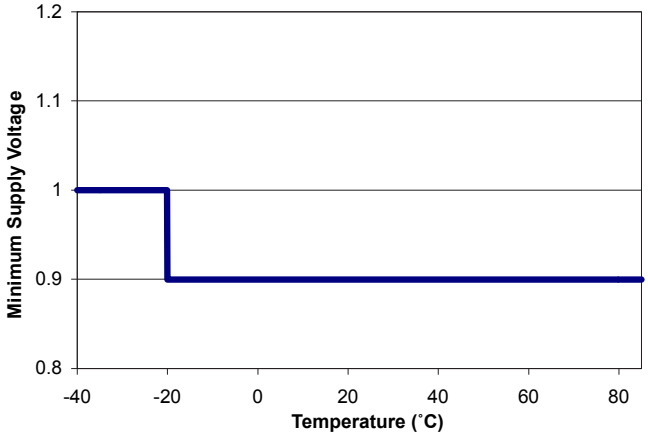
Magnetic Operate Point vs. Temperature,
1.15V, AHLxxx



Frequency Response vs. Supply Voltage, 25˚C, AHL0xx



Supply Voltage vs. Temperature Derating Curve



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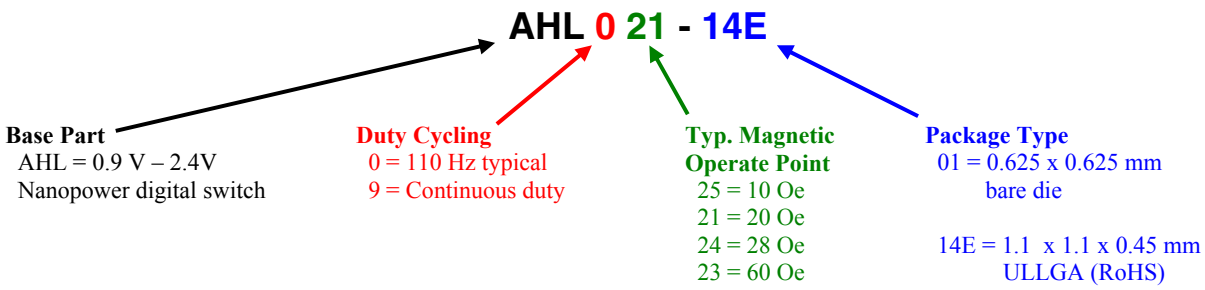
Part Numbering

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	20 Oe	die	
AHL021-14E	Y	110 Hz	20 Oe	ULLGA	b
AHL023-01	Y	110 Hz	60 Oe	die	
AHL023-14E	Y	110 Hz	60 Oe	ULLGA	r
AHL024-01	Y	110 Hz	28 Oe	die	
AHL024-14E	Y	110 Hz	28 Oe	ULLGA	d
AHL025-01	Y	110 Hz	10 Oe	die	
AHL025-14E	Y	110 Hz	10 Oe	ULLGA	e
AHL921-01	N	Continuous	20 Oe	die	
AHL921-14E	N	Continuous	20 Oe	ULLGA	f
AHL924-01	N	Continuous	28 Oe	die	
AHL924-14E	N	Continuous	28 Oe	ULLGA	h
AHL925-01	N	Continuous	10 Oe	die	
AHL925-14E	N	Continuous	10 Oe	ULLGA	Xj / j

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
1.2 x 0.25 inch (30 x 6 mm) PCB for demonstrating 1.1 x 1.1 mm ULLGA4 sensors (-14E sensor suffix).

AG039-06: ULLGA Digital Sensor Demonstration Bare Board
A 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.

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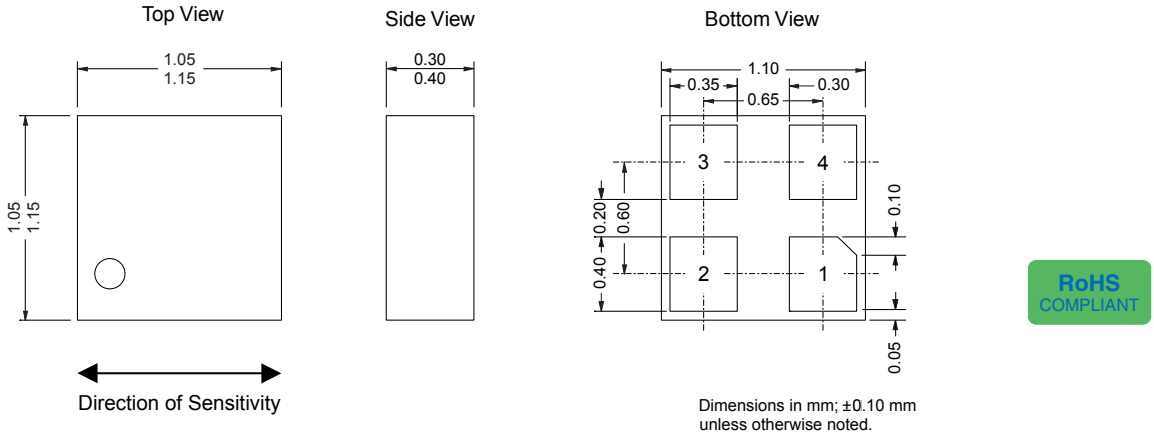
1.1 mm x 1.1 mm ULLGA Package (-14E suffix)



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-00-027
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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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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