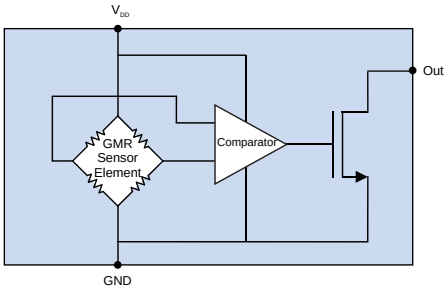
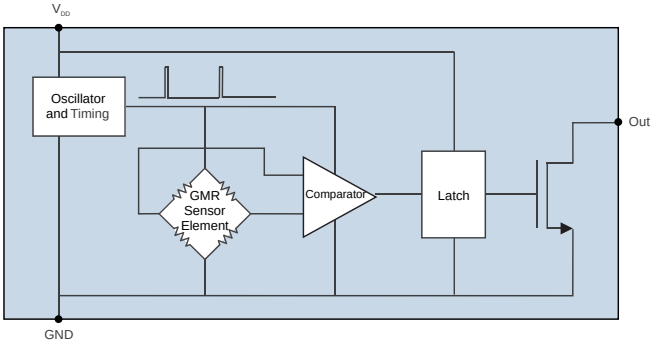
ADLxxx Nanopower Digital Switches

Functional Diagrams

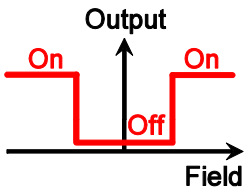


ADL9xx
(continuous duty)



ADL0xx
(duty-cycled)

Idealized Magnetic Response



Features

- 2.4 V − 3.6 V operating voltage
- Continuously operating or duty-cycled versions
- Power as low as 150 nW at 2.4 V
- Operate points as low as 20 Oe
- Precise detection of low magnetic fields
- Ultraminiature 1.1 x 1.1 mm package

Applications

- Portable instruments
- Utility meters
- Lithium cell powered applications

Description

ADLxxx-Series sensors are Giant Magnetoresistive (GMR) Digital Switch devices designed to operate from 3.3-volt power supplies or single lithium cells with extremely supply low currents. The devices are manufactured with NVE's patented spintronic GMR technology and low-power CMOS circuitry 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.

Absolute Maximum Ratings

Parameter	Min.	Max.	Units
Supply voltage		5.5	Volts
Output voltage		5.5	Volts
Output current		200	µA
Storage temperature	−65	135	°C
Junction temperature		135	°C
Applied magnetic field		Unlimited	

Operating Specifications

T_{min} to T_{max}; 2.4 V < V_{DD} < 3.6 V unless otherwise stated.						
Parameter	**Symbol**	**Min.**	**Typ.**	**Max.**	**Units**	**Test Condition**
Supply voltage	V_{DD}	2.4	3	3.6	Volts	
Operating temperature	T_{MIN}; T_{MAX}	−40		125	°C	
Magnetic operate point	H_{OP}					
ADLx21		15	20	25	Oe	
ADLx24		21	28	34		
Operate/release differential	H_{OP}−H_{REL}	2		14	Oe	
Quiescent current	I_{DDQ}				µA	
ADL1xx			0.06	0.12		V_{DD} = 2.4V
ADL0xx			0.13	0.26		
ADL9xx			35	50		
ADL1xx			0.25	0.38		V_{DD} = 3.6V
ADL0xx			0.35	0.65		
ADL9xx			85	120		
ADL0xx / ADL1xx peak supply current	I_{DD-PK}		60	100	µA	V_{DD} = 3V
Output drive current	I_{OL-ON}	100			µA	
Output low voltage	V_{OL}			0.2	V	V_{DD} = 3.6V; I_{OL-ON} = 100 µA
Output leakage current	I_{OL-OFF}			0.005	µA	
Update frequency						
ADL1xx		10	30		Hz	
ADL0xx		20	55			
Frequency response (ADL9xx)			100		kHz	

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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:

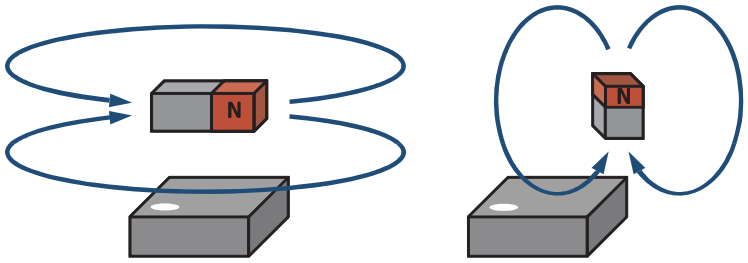


Figure 1. Direction of magnetic sensitivity.

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

External Pull-Up Resistor
Outputs are logic low when the sensor is activated. The outputs are open-drain, and 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 ADL-Series sensor orientation. The arrow on the circuit board shows the direction of magnetic sensitivity:

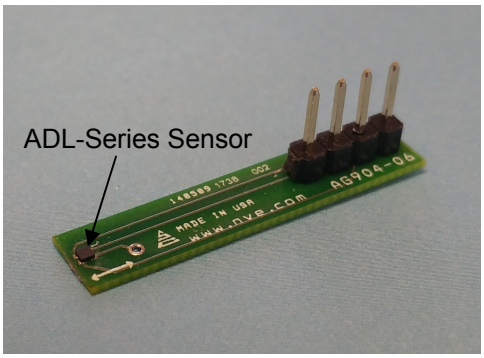


Figure 2. Typical operation; the circuit board arrow shows direction of sensitivity.

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.)
ADLx21-14E	20 Oe	10 mm	12 mm
ADLx24-14E	28 Oe	9 mm	11 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*.

Illustrative Application Circuits

Direct-Drive LED Indicator

Although ADLxxx-14E series sensors are not capable of driving legacy LEDs, high-efficiency LEDs such as the APT3216LSECK are visible with the 100µA drive current provided by the sensors without an external driver.

This circuit illustrates a sensor powered by a single lithium button cell with a surface-mount indicator LED:

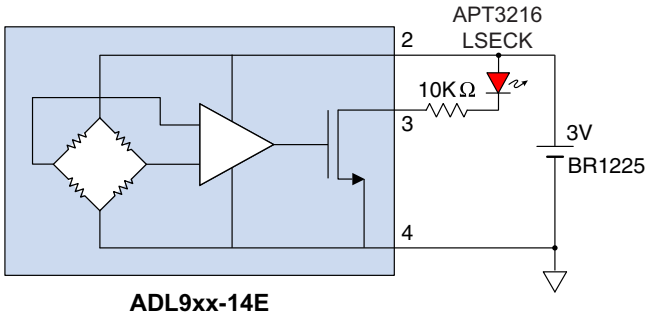


Figure 3. Typical ADLxxx-14E application.

Two-Wire Sensor Interface Using a Voltage Regulator

ADL-Series sensors are perfect for two-wire applications, because their low supply voltage and low quiescent current provide plenty of design margin. Two-wire interfaces need to operate over a wide power supply range. With the sensor off, the circuit must draw a minimal residual current, typically less than 1.5 milliamps. With the sensor on, the circuit must provide enough current to drive a significant load such as a motor or solenoid:

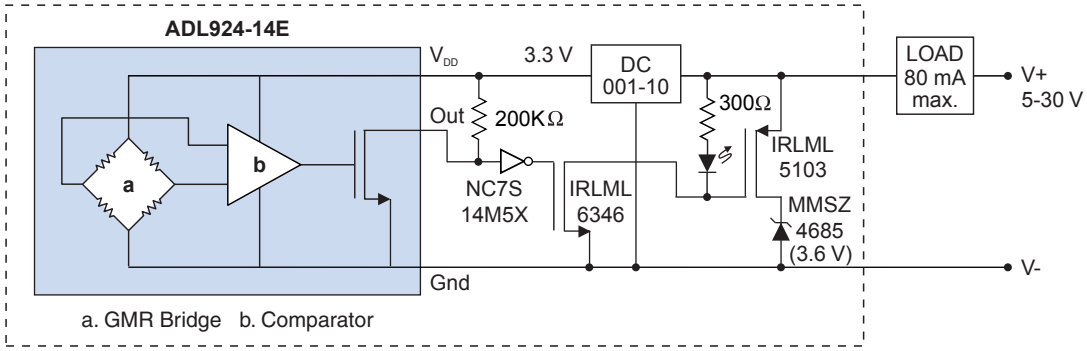


Figure 4. Typical two-wire circuit.

In this circuit, when a magnetic field is applied to the sensor, the MOSFETs turn on, turning on the LED and powering the load. This circuit uses an NVE DC001-10 regulator, which provides better regulation and operating latitude over the input voltage range than a Zener diode.

With no magnetic field and the sensor off, the residual current of the circuit is dominated by the DC001 regulator's quiescent current, which is less than one milliamp and relatively constant over input voltage. The Zener diode provides enough voltage to power the circuitry when the load is powered.

Typical Performance

Average current increases with supply voltage but remains extremely low. The magnetic operate and release points are stable over temperature and supply voltage. Update frequency increases somewhat with supply voltage.

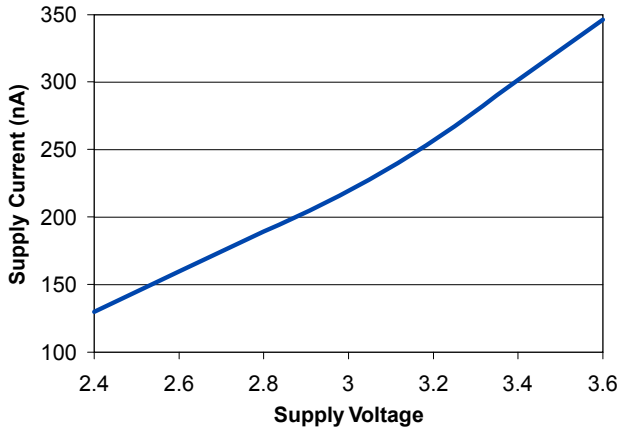


Figure 5. Typical supply current vs. supply voltage (ADL0xx; 25°C).

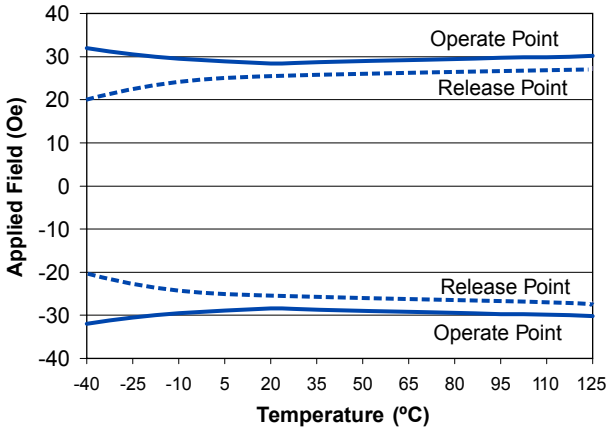


Figure 6. Typical magnetic operate and release points vs. temperature (ADLx24; Vdd=3V).

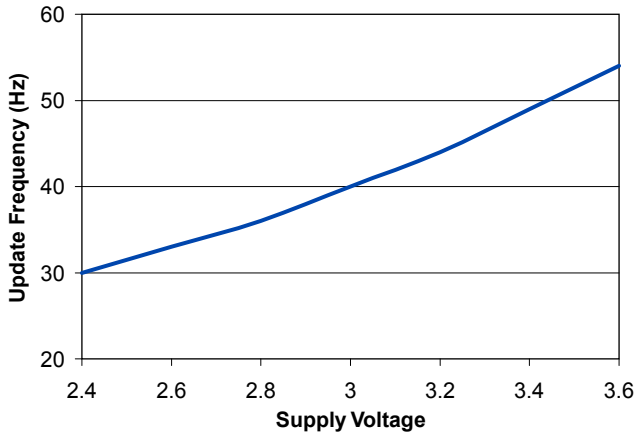


Figure 7. Typical update frequency vs. supply voltage (ADL0xx; 25°C).

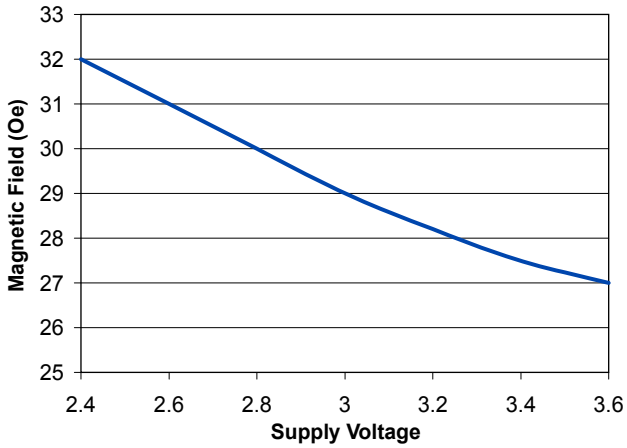
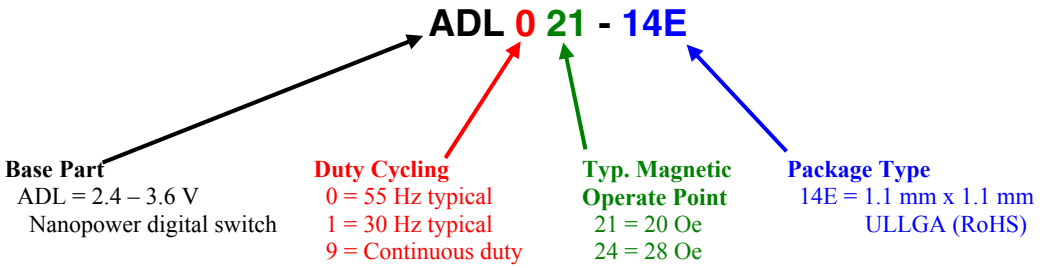


Figure 8. Typical magnetic operate point vs. supply voltage (ADLx24; 25°C).

Part Numbering

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



Available Parts

Available Part	Duty Cycled?	Update Freq. (typ.)	Operate Point (typ.)	Package	Package Marking
ADL021-14E	Y	55 Hz	20 Oe	ULLGA	V
ADL024-14E	Y	55 Hz	28 Oe	ULLGA	C
ADL121-14E	Y	30 Hz	20 Oe	ULLGA	B
ADL124-14E	Y	30 Hz	28 Oe	ULLGA	D
ADL921-14E	N	Continuous	20 Oe	ULLGA	M
ADL924-14E	N	Continuous	28 Oe	ULLGA	N

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Evaluation Kits

NVE offers two ADL-Series Demonstration Boards, one with a battery and one without. These inexpensive evaluation kits include demo boards with the ultraminiature, ultralow-power ADL021 magnetic switch included. An LED shows the sensor output. A miniature bar magnet is included so you can see for yourself how these remarkable sensors work. These miniature evaluation boards are just 1.57 by 0.25 inches (40 x 6 mm). Images are actual size:

AG040C: ADL021 Externally-Powered Evaluation Board
This board has a digital output, and can be powered from a 3.3-volt nominal supply. An LED shows the output.

AG040B: ADL021 Battery-Powered Demonstration Board
This board is powered by a three-volt lithium coin cell (included), and the sensor quiescent power consumption is so low that the battery will last indefinitely.

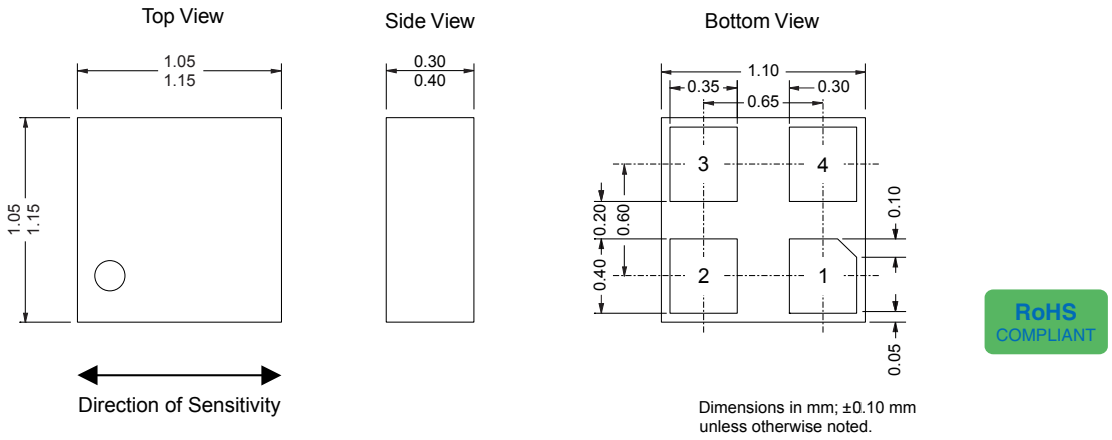
Bare Circuit Boards

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 ADL-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)



Dimensions in mm; ±0.10 mm unless otherwise noted.

RoHS COMPLIANT

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

Soldering profile 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.

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Revision History

SB-00-017 November 2017	**Change** • Added "Typical Operation" section and image (p. 3). • Added Evaluation Kits and bare boards (p. 7).
SB-00-017 October 2017	**Change** • Revised package outline dimensions.
SB-00-017 May 2017	**Changes** • Added application circuit. • Revised quiescent current specifications. • Added selector guide. • Obsoleted ADLx22 versions/ • Cosmetic changes.
SB-00-017 December 2008	**Change** • Initial Release.

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