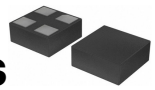
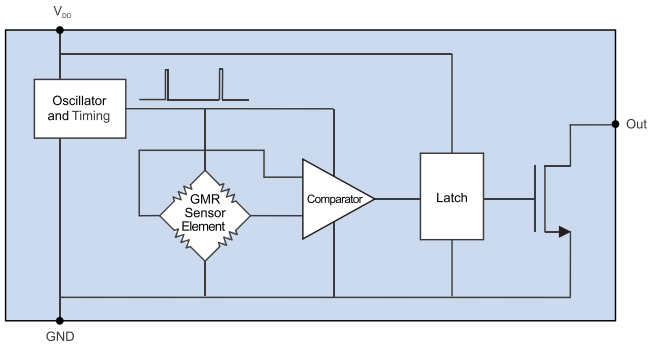
3-Volt Medical-Grade Magnetic Switch Sensors



Functional Diagram



Features

- Sensitive operate points as low as 1.3 mT
- Low hysteresis to prevent magnetic latching
- 2.4 V to 3.6 V operating voltages
- Less than 100 nW power consumption
- –40 to 125°C operating range
- 1.1 x 1.1 mm DFN4 package

Applications

- Implantable medical devices
- Continuous glucose monitoring
- Endoscope power switch
- Medical instruments
- Hearing aids

Description

BD-Series sensors are medical-grade Giant Magnetoresistive (GMR) magnetic switches manufactured with NVE's patented spintronic GMR technology for unmatched miniaturization, sensitivity, precision, and low power.

Most versions are normally open, so the output connects to ground when the magnetic field is applied. A normally-closed version is also available. The parts are internally duty-cycled to minimize power consumption, and an integrated latch ensures the output is available continuously. The outputs can sink up to 100 microamps.

A variety of operating points as well as custom operate points are available. The applied field can be of either polarity, and the operate points are extremely stable over supply voltage and temperature.

MRI-correct versions are available that are guaranteed to provide correct outputs in fields up to 3 tesla. All part types can withstand magnetic fields up to 9 tesla without damage.

The products consist of 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.

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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	135	°C
Junction temperature		135	°C
Applied Magnetic Field	Unlimited		Tesla

Operating Specifications

T_{min} to T_{max}; V_{DD-MIN} to V_{DD-MAX} unless otherwise stated.						
Parameter	**Symbol**	**Min.**	**Typ.**	**Max.**	**Units**	**Test Condition**
Supply voltage	V_{DD}					
BD129-14E		2.2	3	4.2	Volts	
Others		2.4	3	4.2		
Operating temperature	T_{MIN}; T_{MAX}	–40		125	°C	
BD129-14E		0		85		
Others		–40		125		
Magnetic operate point	B_{OP}				mT	
BD020-14E		1	1.3	1.6		
BD024-14E		1.1	1.4	1.7		
BD121-14E		1.5	2	2.5		
BD129-14E		1.7	2.3	2.8		
BDL122NC-14E		3	4	5		
Magnetic release point	B_{REL}	0.5				
Operate/release differential	$B_{OP}–B_{REL}$					
BD020-14E		0.05		0.8		
BD024-14E		0.2		0.8		
BD121-14E		0.2		1.4		
BD129-14E		0.1		1.4		
BDL122NC-14E		0.2		2.5		
Quiescent current (output open)	I_{DDQ}				μA_{RMS}	
BD020-14E			0.03	0.06		$V_{DD} = V_{DD-MIN}$
BD024-14E			0.03	0.06		
BD121-14E			0.05	0.12		
BD129-14E			0.03			
BDL122NC-14E			0.03	0.06		
BD020-14E			0.115	0.16		V_{DD} = 3.6 V
BD024-14E			0.115	0.16		
BD121-14E			0.25	0.38		
BD129-14E			0.13	0.2		
BDL122NC-14E			0.115	0.16		
Peak supply current	I_{DD-PK}		60	100	µA	V_{DD} = 3 V
Output drive current	I_{OL-ON}	100			µA	
Output low voltage	V_{OL}			0.2	V	V_{DD} = 3.6 V; I_{OL-ON} = 100 µA
Output leakage current	I_{OL-OFF}			5	nA	V_{DD} = 3.6V
Update frequency						
BD1xx; BDL1xx		10	30		Hz	
BD0xx		20	55			
Maximum external field for correct output	B_{MAX}				mT	
BD121-14E; BD129-14E		3000	9000			
Others			40			

Typical Performance Graphs

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

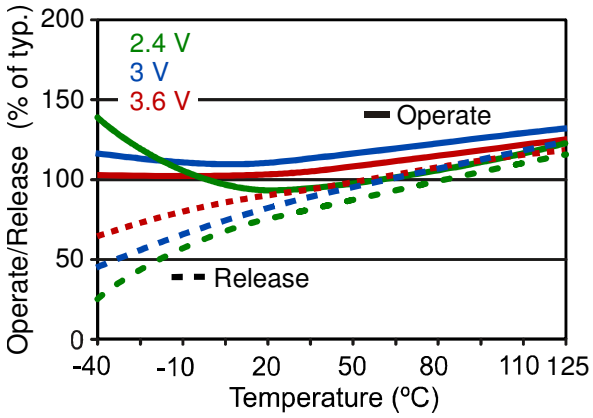


Figure 1. Typical magnetic operate point versus temperature.

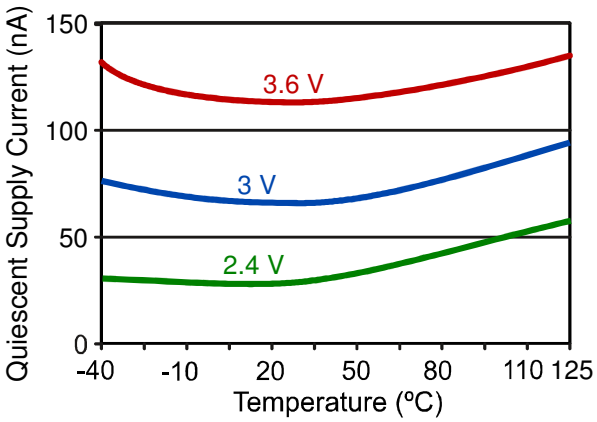


Figure 2. Typical supply current versus temperature (except BD121-14E).

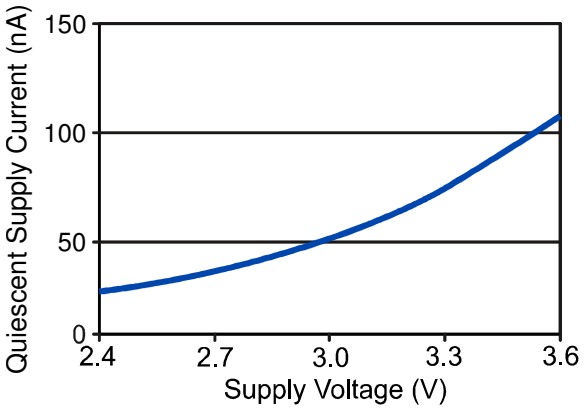


Figure 3. Typical Supply current versus supply voltage (25°C).

Application Information

Rigorous Testing

All parts are 100% tested for electrical and magnetic parameters. To ensure quality and reliability in medical applications, BDxxx parts are preconditioned and tested as follows:

- 100% of the parts receive a 24-hour bake at 150°C prior to final test.
- 100% visual inspection of the parts in the tape after final test.
- Lot qualification test where 200 parts that have passed final test from each production lot are exposed to two thermal cycles using a standard solder reflow profile, then re-tested for correct operation. All parts must pass for the parts to be accepted into inventory.

Flexible Operation

As the field varies in intensity, the digital output will turn on and off. The sensors are "omnipolar," meaning the outputs respond equally to magnetic field of either north or south polarity. 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:

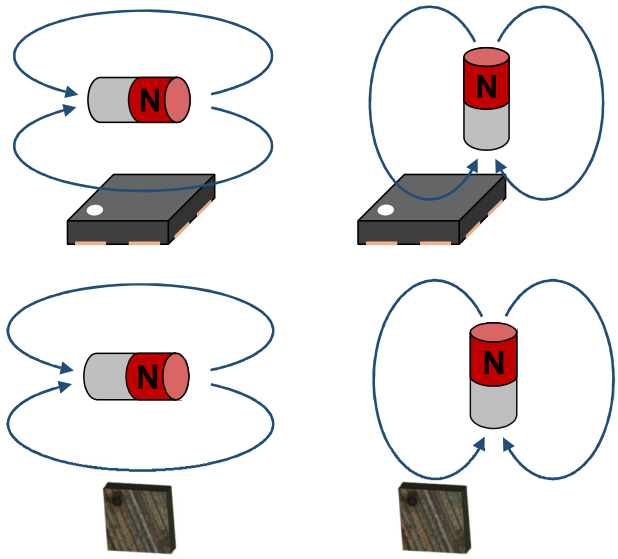


Figure 4. Direction of magnetic sensitivity.

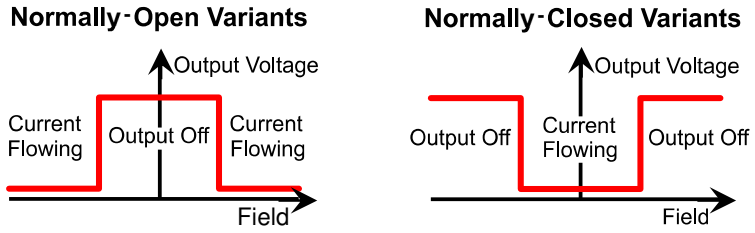


Figure 5. Definition of output state for medical-grade sensors.

MRI Safety

NVE medical-grade sensors are rigorously tested to ensure they cannot be damaged by magnetic fields of any strength up to 9 tesla. Not all sensors will maintain the correct output state when the magnetic field exceeds a certain threshold, typically beginning around ±40 mT, however. NVE medical sensors can be characterized as either MRI Safe or MRI Correct. All NVE medical sensors are MRI Safe, but only select medical sensors are designed to also be MRI Correct. If the output state needs to be sampled while inside an MRI machine, the sensor should be MRI Correct.

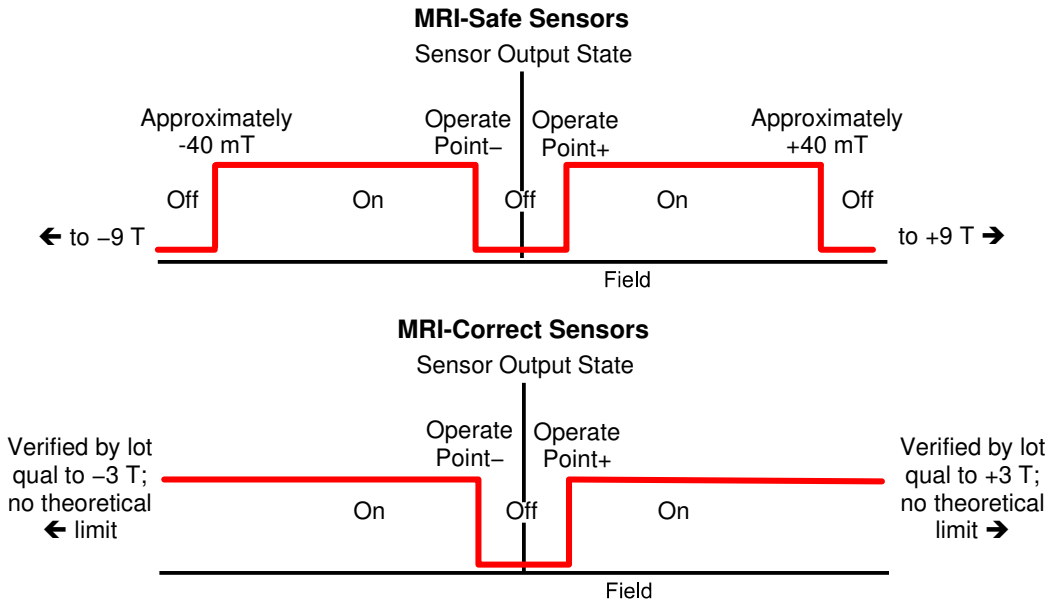
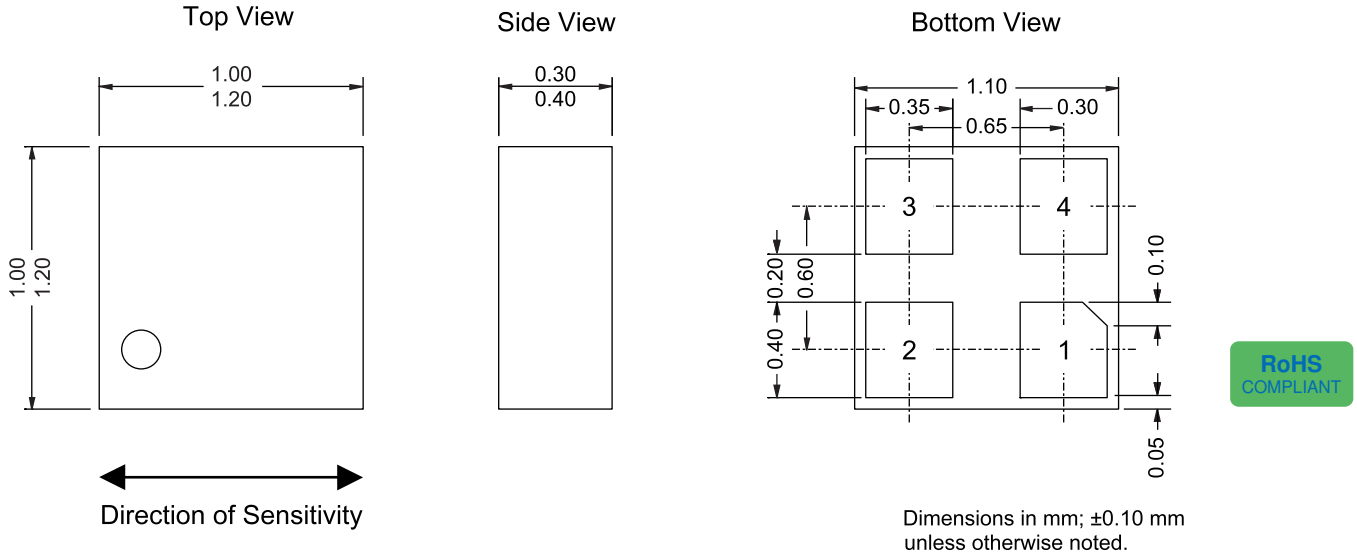


Figure 6. MRI-safe and MRI-correct.

Summary of Available Parts

Part Number	Typ. Operate Point	Power Consumption	MRI Tolerance	Features
BD020-14E	1.3 mT	2.4 to 3.6 V 30 nA	MRI-safe	Precise operate point
BD024-14E	1.4 mT	2.4 to 3.6 V 30 nA	MRI-safe	Precise operate point
BD121-14E	2 mT	2.4 to 3.6 V 50 nA	MRI-correct to at least 3 Tesla	MRI-correct
BD129-14E	2.3 mT	2.2 to 3.6 V 25 nA	MRI-correct to at least 3 Tesla	MRI-correct 100% tested at 2.1 V
BDL122NC-14E	4 mT	2.4 to 3.6 V 30 nA	MRI-safe	Normally Closed High Temperature

1.1 mm x 1.1 mm DFN4 Package (-14E suffix)



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.

Revision History

December 2025	**Change** • Initial release of consolidated BD-Series 3-volt medical sensors.

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