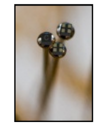
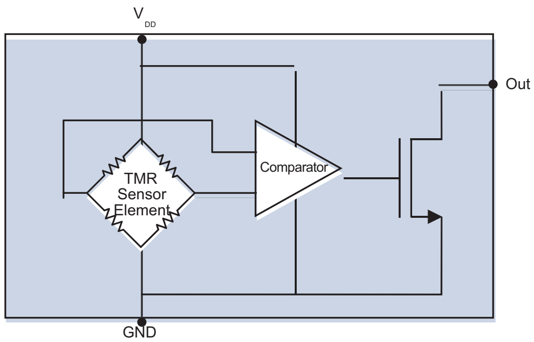


3-Volt Nanopower TMR Digital Switches

Functional Diagram



ADT92x

Features

- 2.4 to 4.2 V operation for lithium or lithium-ion power
- 1 µA typical quiescent current at 3 V
- Continuous operation for immediate response
- Sensitive operate points, as low as 1.5 mT
- Ultraminiature 1.1 x 1.1 mm x 0.35 mm package

Applications

- Implantable medical devices
- 3.3 volt microcontroller interfaces
- Proximity sensing
- Rechargeable sensor nodes
- Wearables
- Portable instruments

Description

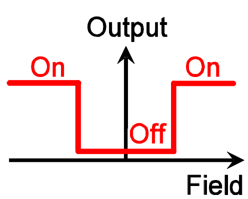
The ADT92x-14E sensors are digital switch devices based on novel magnetic tunnel junction technology that provides extremely low power consumption for 3.3 volt lithium or lithium-ion battery powered applications.

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 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 parts use NVE's ultraminiature
1.1 mm x 1.1 mm x 0.35 mm ULLGA leadless packages.

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

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	135	°C
Junction temperature		135	°C
Applied magnetic field		Unlimited	

Operating Specifications

T_{min} to T_{max}; 2.4 V <V_{DD}<4.2 V unless otherwise stated.						
Parameter	**Symbol**	**Min.**	**Typ.**	**Max.**	**Units**	**Test Condition**
Supply voltage	V_{DD}	2.4	3.0	4.2	Volts	
Operating temperature	T_{MIN}; T_{MAX}	−40		85	°C	
Magnetic operate point[1]						
ADT925	H_{OP}	0.7	1.5	1.8	mT	-40°C to 85°C 2.4 V < V_{DD} < 4.2V
ADT924		1.6	2.2	2.6		
ADT923		2.4	3.2	3.6		
ADT922		3.4	4.5	6.5		
Magnetic release point[1]	H_{REL}	0.2		1	mT	
Operate release differential[1]	H_{OP}-H_{REL}		0.3	0.8	mT	
Quiescent current[2]	I_{DDQ}		0.6	1	μA	V_{DD} = 2.4 V
			1	1.7		V_{DD} = 3 V
			1.2	2		V_{DD} = 3.3 V
			1.4	2.3		V_{DD} = 3.6 V
			1.8	3.2		V_{DD} = 4.2 V
Output drive current	I_{OL-ON}	100			μA	
Output low voltage	V_{OL}		0.05	0.2	V	V_{DD} = 3.3 V; I_{OL-ON} = 100 μA
Output leakage current	I_{OL-OFF}			2	nA	V_{DD} = 3.3 V
Maximum switching frequency	*f*		20		kHz	V_{DD} = 3.3 V; 3 dB reduction in sensitivity

Notes:
1) 1 mT = 10 Oe in air.
2) Value at 25°C, see Figure 4 for I_{DDQ} temperature dependence

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:

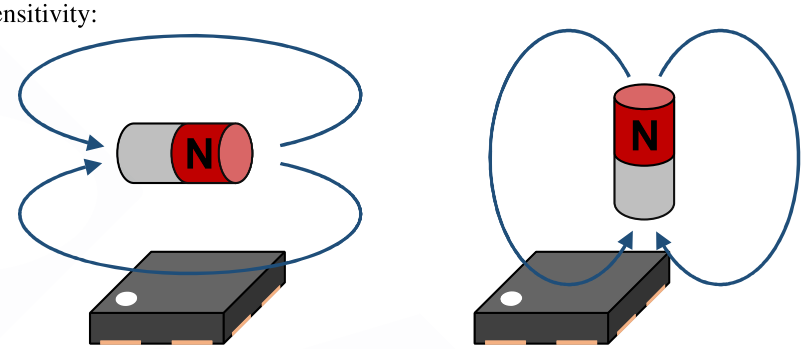


Figure 1. ADT92x sensor direction of magnetic sensitivity.

ADT92x 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 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 (note that with a 3.3-volt supply, the pull-up resistor should be a minimum of 33 kΩ for compatibility with the sensor's 100 µA output current).

Typical Operation

Figure 2 shows typical ADT92x sensor orientation. The arrow on the circuit board shows the direction of magnetic sensitivity.

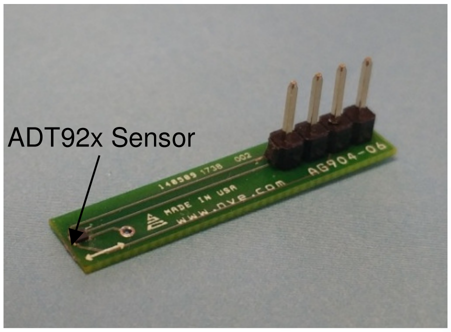


Figure 2. Typical operation; the circuit board arrow shows direction of sensitivity.

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.)
ADT925-14E	1.5 mT	9 mm	12 mm
ADT924-14E	2.2 mT	8 mm	10 mm
ADT923-14E	3.2 mT	7 mm	9 mm
ADT922-14E	4.5 mT	6 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

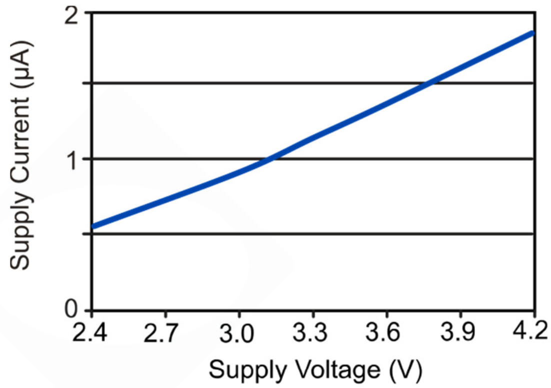


Figure 3. Typical supply current vs. supply voltage (25ºC)

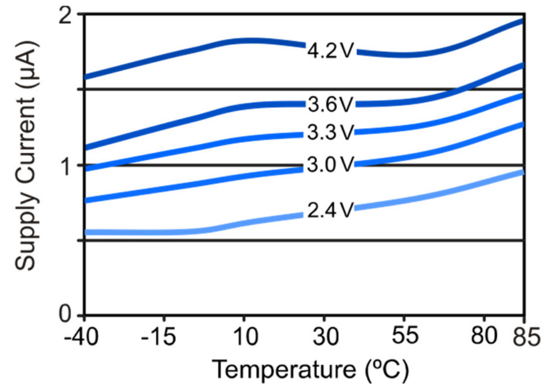


Figure 4. Supply Current versus temperature for VDD between 2.4 V and 4.2 V

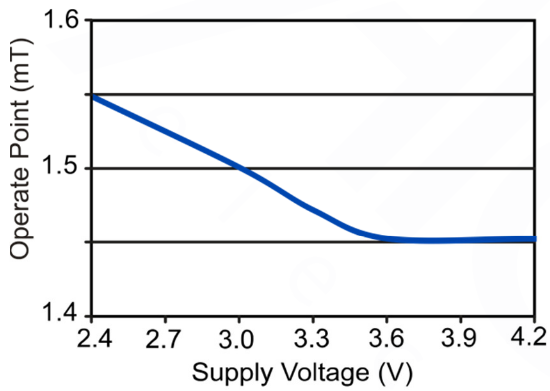


Figure 5. Typical magnetic operate point vs. supply voltage (ADT925, 25ºC)

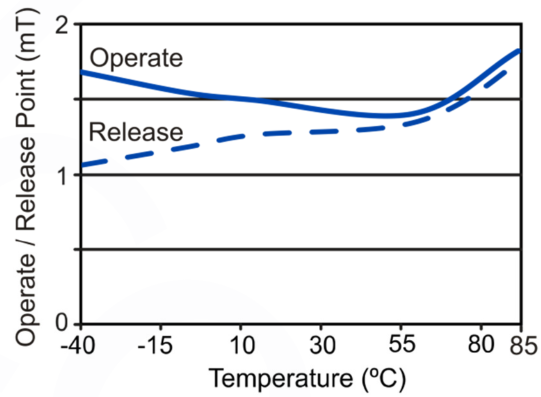


Figure 6. Magnetic operate and release point vs. temperature (ADT925, VDD = 3.3 V)

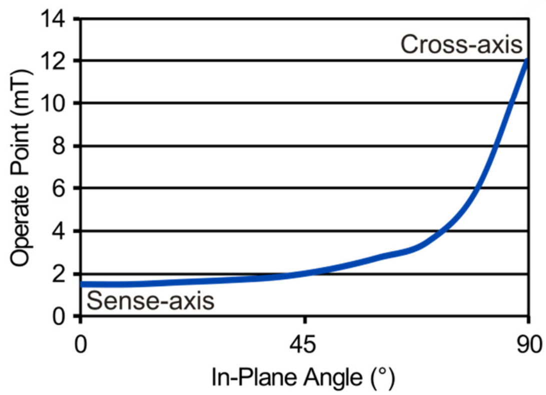


Figure 7. Typical magnetic operate point vs. in-plane applied field angle (ADT925, 25°C)

Part Numbering

The following example shows ADT92x part numbering:

ADT925 - 14E

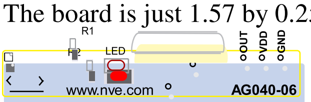
Power Supply	Technology	Duty Cycling	Typ. Magnetic Operate Point	Package Type
AD = Lithium (2.4 - 4.2 V)	T = Tunneling Magnetoresistance	9 = Continuous (not duty cycled)	25 = 1.5mT 24 = 2.2mT 23 = 3.2mT 22= 4.5mT	14E = 1.1 x 1.1 x 0.35 mm ULLGA (RoHS)

Available Parts

Part Number	Operate Point (typ.)	Package	Marking
ADT925-14E	1.5mT	ULLGA	7
ADT924-14E	2.2 mT	ULLGA	7
ADT923-14E	3.2 mT	ULLGA	7
ADT922-14E	4.5mT	ULLGA	7

Demonstration Board

The AG040T Demonstration Board is powered by a three-volt lithium coin cell (included). It has an ADT923-14E magnetic switch and an LED to show the sensor output. The sensor's low quiescent power allows the battery to last at least several years with occasional LED use. A miniature bar magnet is included so you can see for yourself how these remarkable sensors work.
The board is just 1.57 by 0.25 inches (40 x 6 mm).The image is actual size:



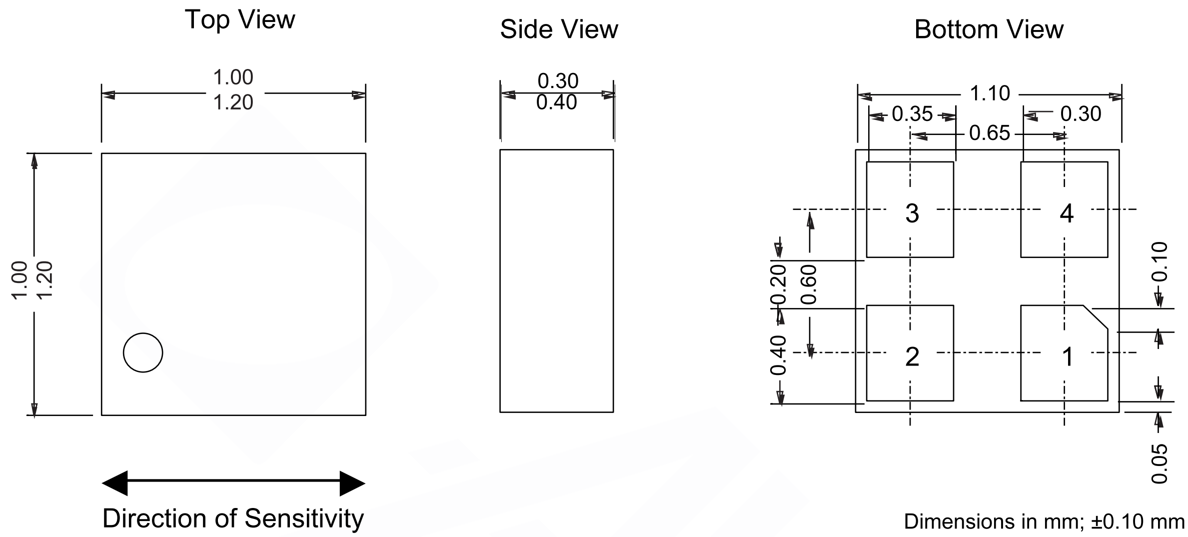
Bare Circuit Boards

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 connecting to 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 ADT92x or similar 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 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-00-109D
February 2021

Change
- Updates for reduced operating point variations over temperature.

SB-00-109C
May 2020

Change
- Widened quiescent current specifications.

SB-00-109B
November 2019

Change
- Updates for new part types.

SB-00-109A
September 2019

Change
- Initial release.

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