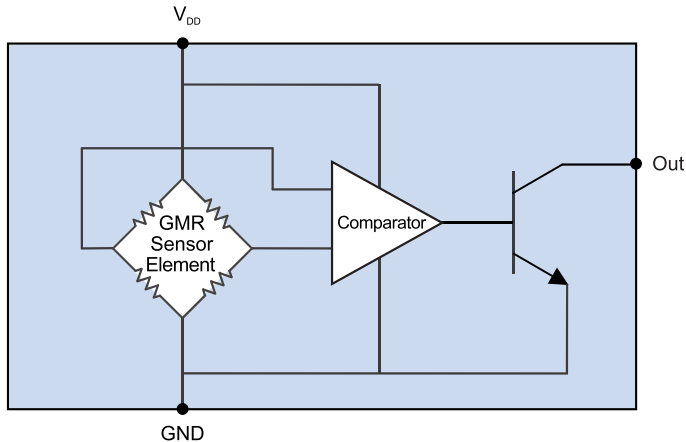
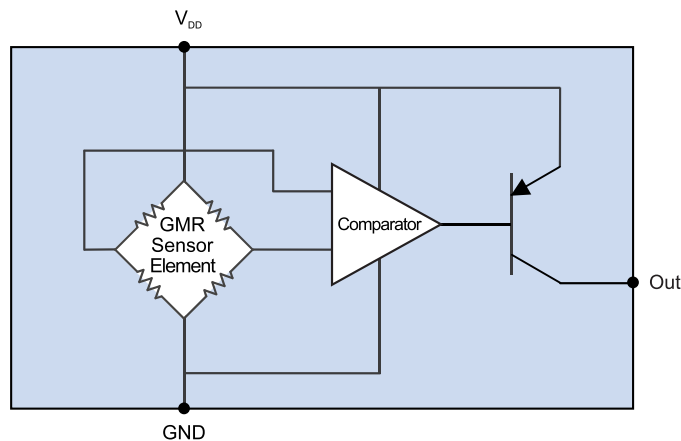


Low Voltage, Low Power Digital Magnetic Sensors

Functional Diagrams



Sinking Output Versions
(AFLx0x-xx/AFLx1x-xx)



Sourcing Output Versions
(AFLx2x-xx/AFLx3x-xx)

Features

- Digital outputs
- Low power
- Precision magnetic operate points as low as 4 Oe (0.4 mT)
- Versions for 1 V through 5 V nominal supplies
- Omnipolar response
- Temperature and voltage stability
- Frequency response to 100 kHz
- TDFN6 and MSOP8 packages

Applications

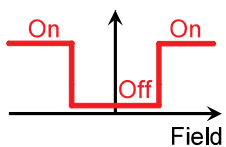
- Motion, speed, and position control
- Proximity sensing
- Portable instruments
- Utility meters
- Noncontact overcurrent protection
- Battery-powered applications

Description

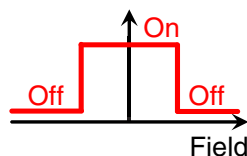
AFL-Series Sensors are GMR digital switches designed to run at low voltages and currents. Versions are available that can operate from single-cell batteries. The outputs switch at specified magnetic fields, and return when the fields are removed.

The sensors are three-terminal devices, available with either current-sinking or sourcing outputs, normally off or normally on configurations, and several supply voltage options.

Idealized Transfer Functions



Normally Off
(AFLx0x-xx/AFLx3x-xx)



Normally On
(AFLx1x-xx/AFLx2x-xx)

Absolute Maximum Ratings

Parameter	Symbol	Min.	Max.	Units
Operating temperature		-20	85	°C
Storage temperature		-65	150	°C
ESD (Human Body Model)			2000	Volts
Applied magnetic field	H _{MAX}		Unlimited	Oe

Operating Specifications

Over specified Vcc and temperature range otherwise stated.							
Parameter	Symbol	Min.	Typ.	Max.	Units	Test Condition	
Supply voltage	V _{CC}	See table of available parts.					
Operating temperature	T _{MIN} ; T _{MAX}	-20		85	°C		
Magnetic operate point	H _{OP}				Oe*		
AFLxx0-xx		7	10	13			
AFLxx1-xx		15	20	25			
AFLxx2-xx		21	28	34			
AFLxx5-xx		4	7	10			
AFLxx6-xx		3	4	6			
Operate/release differential	H _{OP} -H _{REL}				Oe*		
AFLxx0-xx		1		6			
AFLxx1-xx		3		10			
AFLxx2-xx		3		10			
AFLxx5-xx		4		10			
AFLxx6-xx		1		3			
Supply current	I _{CC}				µA	Max. I _{CC} specified at V _{CC} = 1.3V Over specified V _{CC}	
AFL00x-xx		20	35	55			
AFL02x-xx		30	50	75			
AFL03x-xx		15	35	55			
AFL10x-xx		25	35	45			
AFL20x-xx		30	35	45			
AFL30x-xx		30	40	50			
Output current	I _{O-ON}	100			µA		
Output voltage	Sinking (AFLx0x-xx/AFLx1x-xx)	V _{OL}		0.2	V		
	Sourcing (AFLx2x-xx/AFLx3x-xx)	V _{OH}	V _{CC} -0.15				
Output leakage current	I _{O-OFF}			0.1	µA	Output Off	
Frequency response	f _{MAX}		100		kHz		
Junction-Ambient Thermal Resistance (TDFN6 or MSOP8 package)	θ _{JA}		320		°C/W	Soldered to double-sided board; free air	

*1 Oe = 0.1 mT in air.

Operation

Plane and 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. Standard AFL-Series sensors are sensitive “cross-axis,” that is, across the pins from pin 1 to pin 6 or 8. The diagrams below show two magnet orientations that will activate the sensor in the direction of sensitivity:

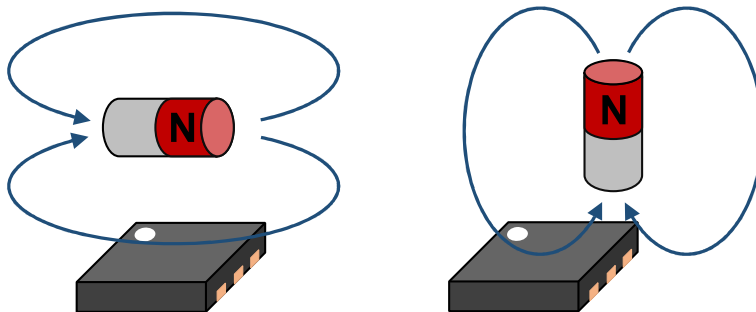


Figure 1. Plane and direction of magnetic sensitivity

Omnipolar

GMR sensors are generally “omnipolar,” meaning the outputs turn ON when a magnetic field of either magnetic polarity is applied.

Normally OFF and Normally ON Versions

For normally OFF versions, the output turns ON when the field exceeds the magnetic operate point, and OFF when the field drops below the operate point minus the release differential. Normally ON versions turn OFF when the field exceeds the operate point and ON when it drops below the operate point minus the differential.

External Pull-Up Resistor

AFL-Series outputs are open collector, with PNP output transistors for sourcing versions and NPN transistors for sinking versions. Outputs should have external pull-up or pull-down resistors. For microcontroller interfaces, the microcontroller’s input pull-up resistors can be activated.

Typical Operation

A typical proximity sensor using an AFL006 sensor and magnet is shown below. The AFL006 is the most sensitive magnetic switch, with a 4 Oe typical operate point, and actuates with a rare-earth magnet at more than two inches (50 mm) from the sensor:

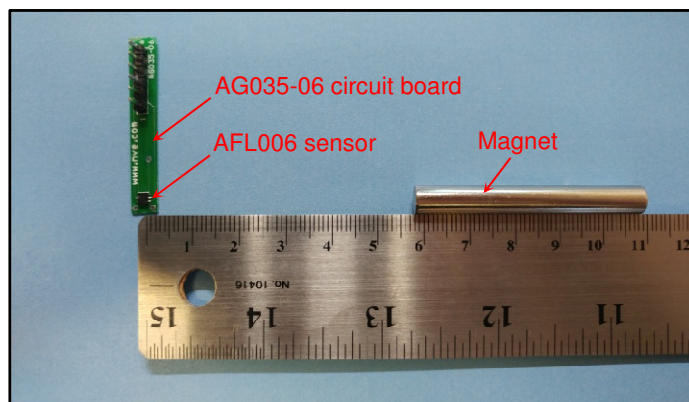


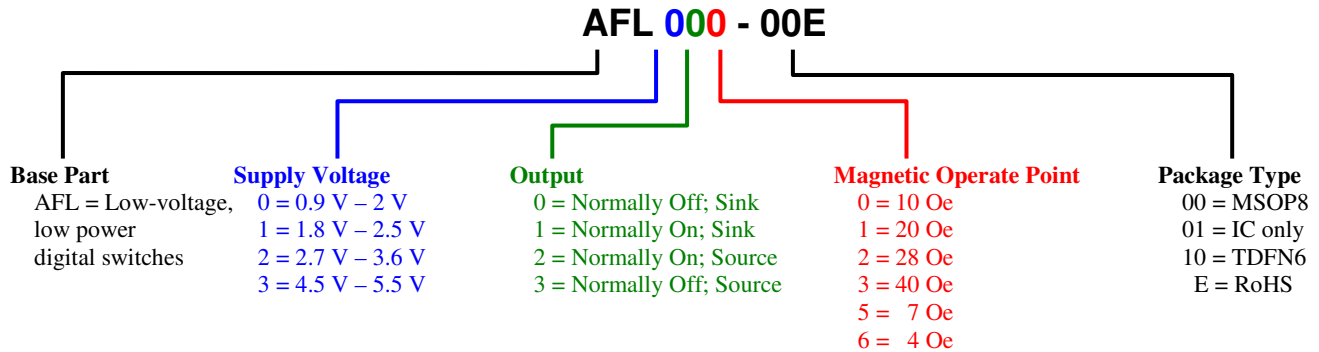
Figure 2. The AFL006 sensor activates at approximately 58 mm.

Smaller or weaker magnets can be used for closer operating distances. Because AFL-Series sensors are omnipolar, the sensor operates with either a north or south magnet pole.

Our free, Web-based application that calculates fields and operating distances for various sensor models and magnet types:
www.nve.com/spec/calculators.php

Part Numbering

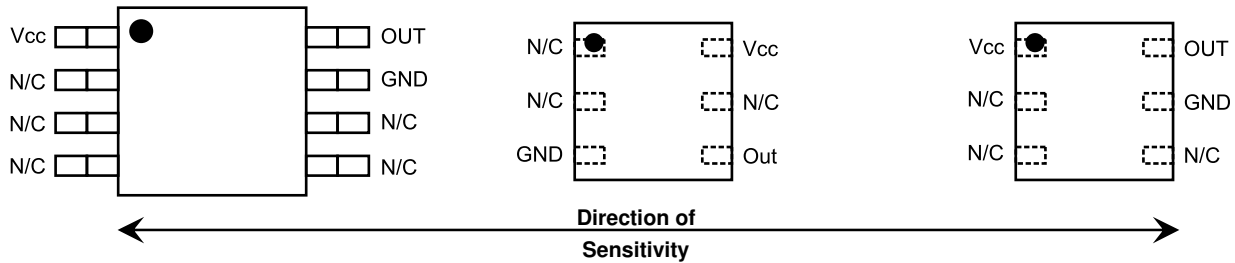
The following example shows the AFL-Series part-numbering system:



Pinouts

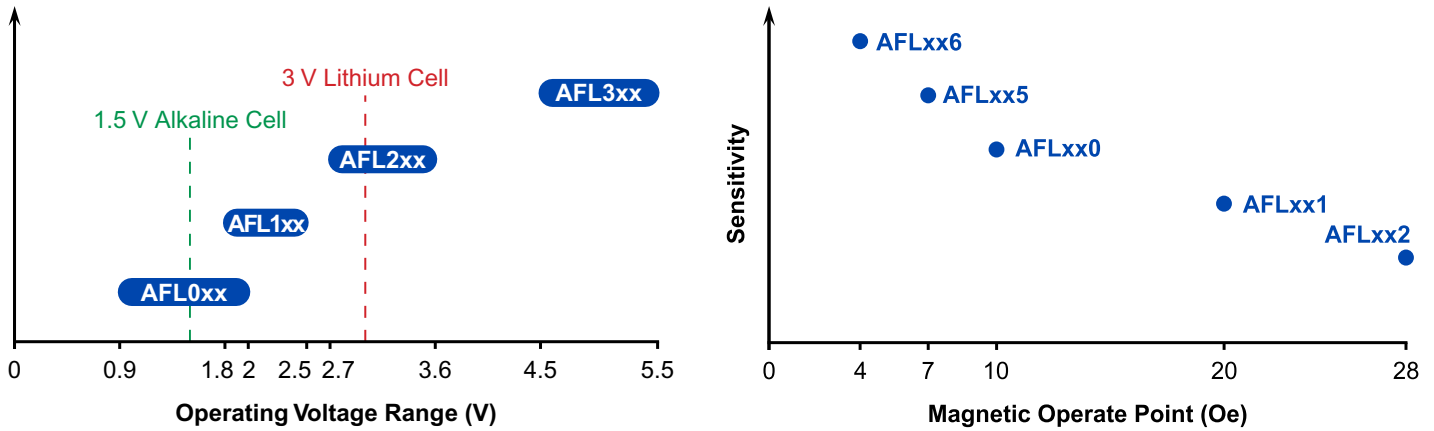
MSOP8TDFN6TDFN6

(-00 suffix)(AFLxx6-10)(Other -10 suffix)



MSOP8 (all part types)	Pin		Symbol	Description
	AFLxx6	AFLxx0 /AFLxx1/ AFLxx2/AFLxx5		
1	6	1	V _{CC}	Power supply
7	3	5	GND	Ground
8	4	6	OUT	Output (open collector)
2, 3, 4, 5, 6	1, 2, 5	2, 3, 4	N/C	No internal connection

Product Range Charts

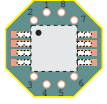


Available Parts

Available Part	Supply Voltage	Output Type	Output Source/Sink	Nominal Operate Point*	Package	Package Marking
AFL000-00E	0.9 V – 2 V	Normally Off	Sink	10Oe	MSOP8	PBBE
AFL000-10E	0.9 V – 2 V	Normally Off	Sink	10Oe	TDFN6	QBBe
AFL001-10E	0.9 V – 2 V	Normally Off	Sink	20Oe	TDFN6	QBXe
AFL002-10E	0.9 V – 2 V	Normally Off	Sink	28 Oe	TDFN6	QBLe
AFL005-10E	0.9 V – 2 V	Normally Off	Sink	7 Oe	TDFN6	QBKe
AFL006-10E	0.9 V – 2 V	Normally Off	Sink	4 Oe	TDFN6	QCHe
AFL020-00E	0.9 V – 2 V	Normally On	Source	10 Oe	MSOP8	PBCe
AFL030-00E	0.9 V – 2 V	Normally Off	Source	10 Oe	MSOP8	PBDe
AFL100-00E	1.8 V – 2.5 V	Normally Off	Sink	10 Oe	MSOP8	PBFe
AFL100-10E	1.8 V – 2.5 V	Normally Off	Sink	10 Oe	TDFN6	QBFe
AFL200-00E	2.7 V – 3.6 V	Normally Off	Sink	10 Oe	MSOP8	PBGe
AFL300-00E	4.5 V – 5.5 V	Normally Off	Sink	10 Oe	MSOP8	PBHe

Bare Circuit Boards for Sensors

NVE offers several bare circuit boards specially designed for easy connections to surface-mount sensors. Popular PCBs are shown below (images are **two times** actual size):



AG915-06:
0.25" (6 mm) octagonal
MSOP8



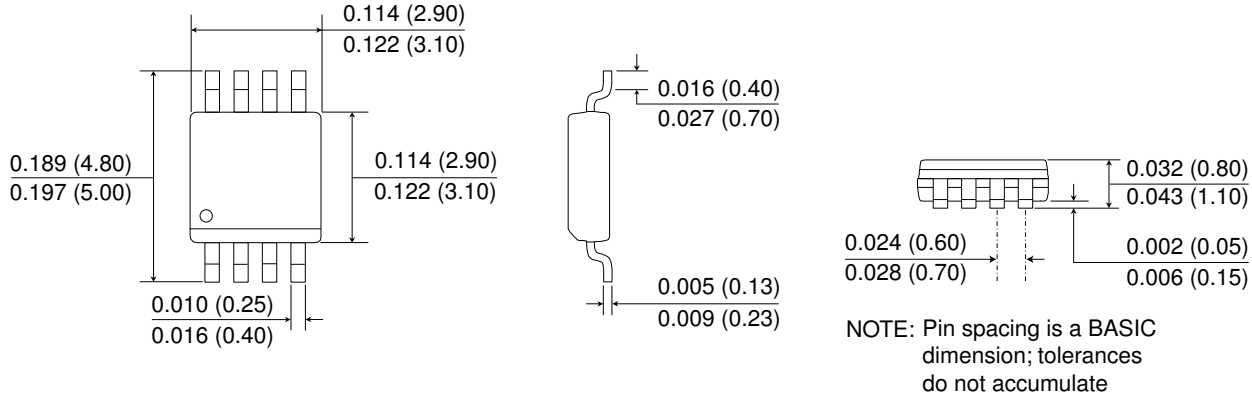
AG918-06 (standard) / **AG919-06** (cross-axis):
2" x 0.25" (50mm x 6 mm) MSOP8



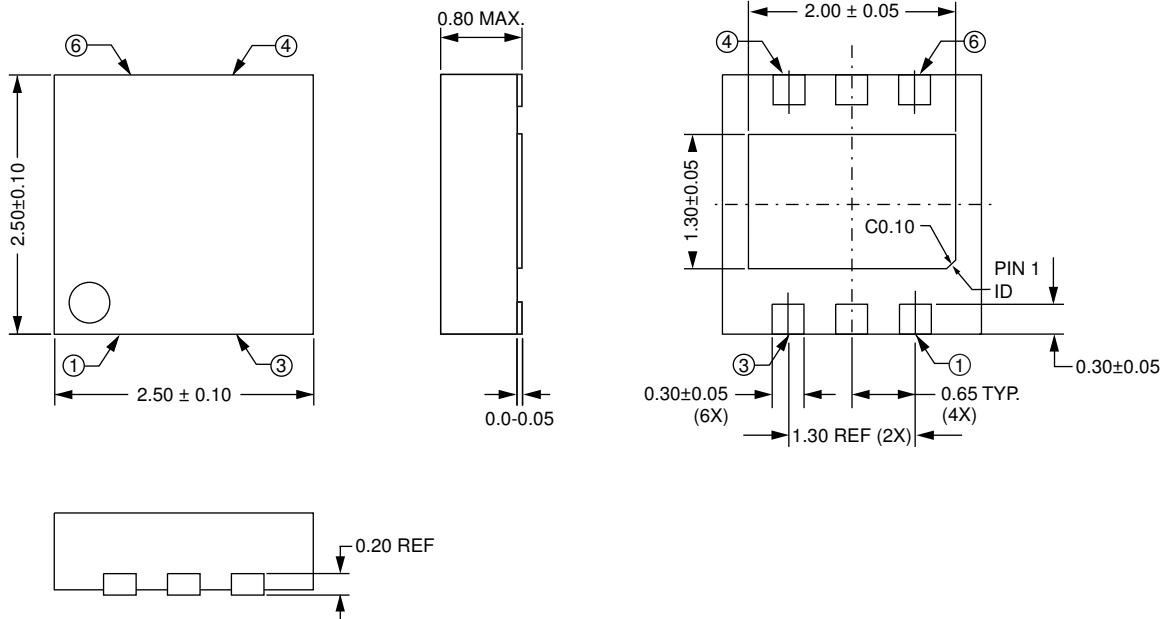
AG035-06:
1.57" x 0.25" (40mm x 6 mm) TDFN6

Package Drawings

MSOP8 (-00 suffix)



TDFN6 (-10 suffix)



Soldering profile per JEDEC J-STD-020C, MSL 1.



Revision History

SB-00-015-D

October 2017

Change

- Added “typical operation” description and illustration (p. 3).
- Added product range charts (p. 5).
- Added page with bare circuit boards (p. 6).

SB-00-015-C

June 2017

Change

- Added AFL006 high-sensitivity version.
- Increase maximum supply voltage for AFL0xx to 2 V.

SB-00-015-B

March 2017

Change

- Cosmetic datasheet changes.

SB-00-015-A

June 2007

Change

- Initial release.

Datasheet Limitations

The information and data provided in datasheets shall define the specification of the product as agreed between NVE and its customer, unless NVE and customer have explicitly agreed otherwise in writing. All specifications are based on NVE test protocols. In no event however, shall an agreement be valid in which the NVE product is deemed to offer functions and qualities beyond those described in the datasheet.

Limited Warranty and Liability

Information in this document is believed to be accurate and reliable. However, NVE does not give any representations or warranties, expressed or implied, as to the accuracy or completeness of such information and shall have no liability for the consequences of use of such information.

In no event shall NVE be liable for any indirect, incidental, punitive, special or consequential damages (including, without limitation, lost profits, lost savings, business interruption, costs related to the removal or replacement of any products or rework charges) whether or not such damages are based on tort (including negligence), warranty, breach of contract or any other legal theory.

Right to Make Changes

NVE reserves the right to make changes to information published in this document including, without limitation, specifications and product descriptions at any time and without notice. This document supersedes and replaces all information supplied prior to its publication.

Use in Life-Critical or Safety-Critical Applications

Unless NVE and a customer explicitly agree otherwise in writing, NVE products are not designed, authorized or warranted to be suitable for use in life support, life-critical or safety-critical devices or equipment. NVE accepts no liability for inclusion or use of NVE products in such applications and such inclusion or use is at the customer's own risk. Should the customer use NVE products for such application whether authorized by NVE or not, the customer shall indemnify and hold NVE harmless against all claims and damages.

Applications

Applications described in this datasheet are illustrative only. NVE makes no representation or warranty that such applications will be suitable for the specified use without further testing or modification.

Customers are responsible for the design and operation of their applications and products using NVE products, and NVE accepts no liability for any assistance with applications or customer product design. It is customer's sole responsibility to determine whether the NVE product is suitable and fit for the customer's applications and products planned, as well as for the planned application and use of customer's third party customers. Customers should provide appropriate design and operating safeguards to minimize the risks associated with their applications and products.

NVE does not accept any liability related to any default, damage, costs or problem which is based on any weakness or default in the customer's applications or products, or the application or use by customer's third party customers. The customer is responsible for all necessary testing for the customer's applications and products using NVE products in order to avoid a default of the applications and the products or of the application or use by customer's third party customers. NVE accepts no liability in this respect.

Limiting Values

Stress above one or more limiting values (as defined in the Absolute Maximum Ratings System of IEC 60134) will cause permanent damage to the device. Limiting values are stress ratings only and operation of the device at these or any other conditions above those given in the recommended operating conditions of the datasheet is not warranted. Constant or repeated exposure to limiting values will permanently and irreversibly affect the quality and reliability of the device.

Terms and Conditions of Sale

In case an individual agreement is concluded only the terms and conditions of the respective agreement shall apply. NVE hereby expressly objects to applying the customer's general terms and conditions with regard to the purchase of NVE products by customer.

No Offer to Sell or License

Nothing in this document may be interpreted or construed as an offer to sell products that is open for acceptance or the grant, conveyance or implication of any license under any copyrights, patents or other industrial or intellectual property rights.

Export Control

This document as well as the items described herein may be subject to export control regulations. Export might require a prior authorization from national authorities.

Automotive Qualified Products

Unless the datasheet expressly states that a specific NVE product is automotive qualified, the product is not suitable for automotive use. It is neither qualified nor tested in accordance with automotive testing or application requirements. NVE accepts no liability for inclusion or use of non-automotive qualified products in automotive equipment or applications.

In the event that customer uses the product for design-in and use in automotive applications to automotive specifications and standards, customer (a) shall use the product without NVE's warranty of the product for such automotive applications, use and specifications, and (b) whenever customer uses the product for automotive applications beyond NVE's specifications such use shall be solely at customer's own risk, and (c) customer fully indemnifies NVE for any liability, damages or failed product claims resulting from customer design and use of the product for automotive applications beyond NVE's standard warranty and NVE's product specifications.

An ISO 9001 Certified Company

NVE Corporation
11409 Valley View Road
Eden Prairie, MN 55344-3617 USA
Telephone: (952) 829-9217
www.nve.com
www.youtube.com/nveCorporation

e-mail: sensor-info@nve.com

©NVE Corporation

All rights are reserved. Reproduction in whole or in part is prohibited without the prior written consent of the copyright owner.

SB-00-015_RevD

October 2017