NVE CORPORATION

NEW!
Ultrasensitive
TMR Sensors

Magnetic Sensors
Short-Form Catalog

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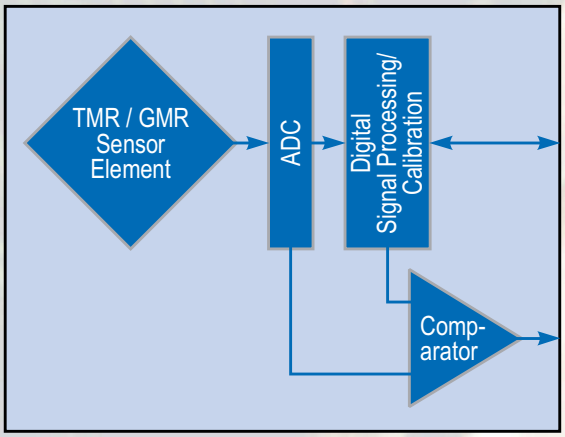
Smart Sensors

Factory Calibrated with I²C and SPI Interfaces

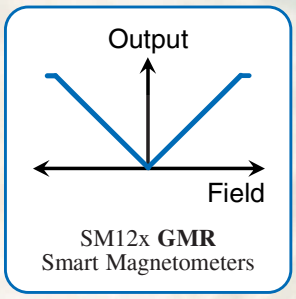
A full line of smart magnetometers and smart angle sensors combine the precision and high sensitivity of our industry-leading GMR/TMR sensors with sophisticated digital signal processing to create devices with unparalleled accuracy. This allows precision magnetic sensing with lower part counts and faster development cycles than ever before. NVE Smart Sensors come in ultraminiature, 2.5 x 2.5 mm DFN6 packages.



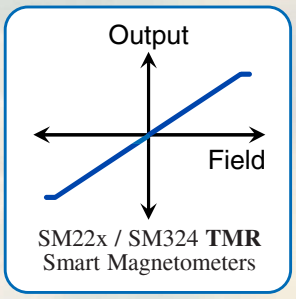
I²C or SPI Interface

Programmable Threshold (I²C magnetometers)

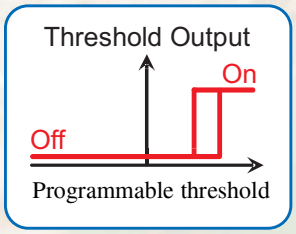
Smart Sensor Block Diagram.



SM12x **GMR** Smart Magnetometers



SM22x / SM324 **TMR** Smart Magnetometers



SM-Series smart magnetometers are ideal for proximity and noncontact current sensing in robotics, mechatronics, and automotive applications. Key specifications are summarized below:

SM-SERIES SMART MAGNETOMETERS						
Part Number	**Technology**	**Accuracy**	**Update Rate**	**Range**	**Outputs**	**Features**
SM124-10	Omnipolar GMR	5%	10 kSps	0 to 1 mT	I²C; Digital Threshold	General Purpose Proximity Sensing
SM125-10				0 to 4 mT		
SM223-10	Bipolar TMR	2%	15 kSps	−1 to +1 mT	I²C; Digital Threshold	Current or Proximity Sensing
SM228-10				−15 to +15 mT		
SM225-10					SPI	
SM324-10	Bipolar TMR	0.3%	300 Sps	−2 to +2 mT	I²C; Digital Threshold	Ultraprecise Current or Proximity Sensing

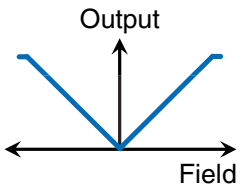
ASR-Series smart angle sensors cover a range of robotics, mechatronics, and automotive applications:

ASR-SERIES SMART TMR ANGLE SENSORS				
Part Number	**Accuracy**	**Update Rate**	**Operating Field Range**	**Outputs**
ASR002-10	2°	12.5 kSps	6 to 20 mT	High-speed SPI
ASR012-10				I²C; PWM
ASR003-10		10 kSps		SPI angle and field magnitude
ASR022-10	±3 LSB	10 kSps		ABZ; DIR (encoder emulation)

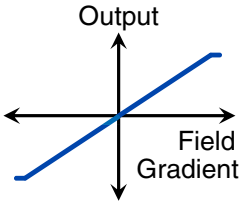
GMR Analog Bridge Sensors

Versatile Industry Standards

GMR analog bridge sensors are ideal for a range of magnetic sensing, including position and current. ***AA-Series*** GMR magnetometers are omnipolar, providing a positive output for either field polarity. ***AB-Series*** sensors are differential devices (gradiometers). ***H-subtype*** magnetometers and gradiometers have higher sensitivity. ***L-subtype*** magnetometers use low-hysteresis GMR for precise low-field measurements. The ***K-subtypes*** are kilooersted range high-field magnetometers.



AA-Series GMR magnetometer sensors



AB-Series GMR gradiometer sensors

ANALOG MAGNETOMETERS

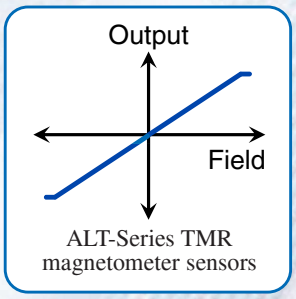
Part Number	Technology	Saturation (mT)	Linear Range (mT) Min.	Linear Range (mT) Max.	Typical Sensitivity (mV/V/mT)	Typical Bridge Resistance	Features	Package
AAH002-02	Omnipolar GMR	0.6	0.06	0.3	150	2 kΩ	Ultra-high sensitivity	SOIC8
AAL002-02	Low-hysteresis Omnipolar GMR	1.5	0.15	1.05	35	5 kΩ	Low hysteresis	SOIC8
AAL004-10						2.2 kΩ		DFN6
AAL024-10								
ALT022-20	Bipolar TMR	±0.3	−0.25	+0.25	200	20 kΩ	High sensitivity; ultraminiature	0.65 mm WLCSP
ALT002-14		±0.3	−0.25	+0.25	200			1.1 mm DFN4
ALT025-14		±10	−10	+10	22.5			
ALT021-10		±0.3	−0.2	+0.2	500		High sensitivity	DFN6
ALT023-10		±1.5	−1	+1	500			
ALT025-10		±10	−10	+10	8			
ALT026-10		±20	−20	+20	4.5			
AA002-02	Omnipolar GMR	1.5	0.15	1.05	35	5 kΩ	General purpose	SOIC8
AA003-02		2	0.2	1.4	26			
AA004-00		5	0.5	3.5	10			MSOP8
AA004-02								SOIC8
AA005-02		10	1	7	5			
AA006-00		5	0.5	3.5	10	30 kΩ	Low power	MSOP8
AA007-00		50	5	45	1	5 kΩ	High field	
AAK001-14		400	40	250	0.033	3.5 kΩ	Very high field	1.1 mm DFN4
AKT001-14	Omnidirectional TMR	1500	50	800	0.025	1 MΩ	Ultrahigh field; low power	

ANALOG GRADIOMETERS

Part Number	Saturation (mT)	Linear Range (|mT|) Min.	Linear Range (|mT|) Max.	Typical Bridge Resistance	Package
AB001-02	25	1	17.5	2.5 kΩ	SOIC8
AB001-00	25	1	17.5	2.5 kΩ	MSOP8
ABH001-00	7	0.5	4	1.2 kΩ	MSOP8

TMR Analog Bridge Sensors

Sensitive, Precise, and Small



ALT-Series TMR magnetometer sensors

TMR analog bridge sensors include the world's most sensitive and smallest magnetic sensors. Their low hysteresis provides unmatched precision. TMR analog bridge sensors have a bipolar response so they can detect filed polarity as well as magnitude.

The unique ***AKT001*** sensor is omnidirectional, meaning it is sensitive to magnetic fields in any direction for the ultimate in operational flexibility.

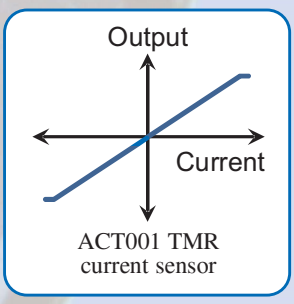
TMR ANALOG MAGNETOMETERS

Part Number	Technology	Saturation (mT)	Linear Range (mT) Min.	Linear Range (mT) Max.	Typical Sensitivity (mV/V/mT)	Typical Bridge Resistance	Features	Package
ALT022-20	Bipolar TMR	±0.3	−0.25	+0.25	200	20 k Ω	High sensitivity; ultraminiature	0.65 mm WLCSP
ALT002-14		±0.3	−0.25	+0.25	200			1.1 mm DFN4
ALT025-14		±10	−10	+10	22.5			
ALT021-10		±0.3	−0.2	+0.2	500		High sensitivity	DFN6
ALT023-10		±1.5	−1	+1	500			
ALT025-10		±10	−10	+10	8			
ALT026-10		±20	−20	+20	4.5			
AKT001-14	Omnidirectional TMR	1500	50	800	0.025	1 MΩ	Ultrahigh field; low power	1.1 mm DFN4

The ***ACT001*** current sensor has a TMR sensor element and an integrated current strap.

ANALOG CURRENT SENSOR

Part Number	Linear Range	Output Sensitivity	Package
ACT001-10	±0.5 A	40 mV/V-A	DFN6



ACT001 TMR current sensor

Magnetic Switch Sensors

Sensitive and Precise

NVE Magnetic Switch Sensors provide more precise operate points than Hall-effect or other conventional sensors. Magnetic operate points range from 0.4 mT (the world's most sensitive magnetic switches) to 8 mT.

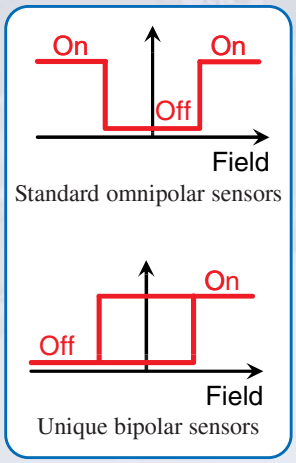
AD-Series switch sensors are available with a variety of switch points and output configurations, and come in DFN6 and MSOP 8 packages. They are omnipolar, so a field of either polarity switches the sensor ON, and the sensor turns OFF when the field is removed. The parts have a wide 4.5 to 30 volt supply range.

AFL-Series sensors have three supply voltages ranging from 0.9 to 3.6 volts for low-voltage and battery-powered applications.

ADA-Series Advanced Digital Switch sensors have unique omnitdirectional sensor elements that prevent double-switch artifacts common in conventional magnetic switches. A version is available with two outputs, with two different operate points.

POPULAR AD-SERIES DIGITAL SWITCHES

Part Number	Typ. Operate Point (mT)	Supply Voltage Range	Typ. Supply Current (mA)	Output Type	Package
AD004-00	2	4.5 to 30 V	4	Sink	MSOP8
AD005-00	4				
AD006-00	8				
AD021-00	2				
AD022-00	4				
AD024-00	2.8				
AD024-10	2.8				TDFN6
AD621-00	2			Sink+Source	MSOP8
AD824-00	2.8		3	2 Sinks+SCP	
ADH025-00	1		4	Sink	



NEW!
Advanced Digital Switch Sensors

ADA-SERIES ADVANCED DIGITAL SWITCHES

Part Number	Typ. Operate Point(s) (mT)	Supply Voltage Range	Max. Supply Current (mA)	Output Type	Package
ADA021-10	2	4.5 to 30 V	5	Sink	MSOP8
ADA021-00					TDFN6
ADA32124-00	2 / 2.8		10	2 Sinks	MSOP8

POPULAR AFL-SERIES DIGITAL SENSORS

Part Number	Typ. Operate Point (mT)	Supply Voltage Range	Output Type	Package
AFL000-10	1	0.9 to 2 V	Sink	DFN6
AFL006-10	0.4			
AFL100-00	1	1.8 to 2.5 V		MSOP8
AFL100-10				DFN6
AFL200-00		2.7 to 3.6 V		MSOP8

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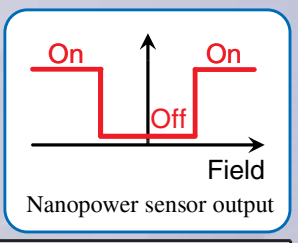
GMR and TMR Nanopower Digital Switches

Ultraminiature; Ultralow Power

NVE **Nanopower Magnetic Switches** and low enough power to run forever on a button cell. TMR and internally duty-cycled GMR versions reduce power consumption to nanowatts. The sensors are available with a variety of operate points and come in 1.1 by 1.1 mm DFNs or tiny 0.65 by 0.65 mm WLCSPs.

ADL- and ***ADT-Series*** sensors have a 2.4 to 4.2 volt supply range for lithium batteries or 3.3-volt supplies. ***AHL-, AHT-***, and ***AHK-Series*** sensors operate as low as 0.9 volts for use with 1.5-volt batteries.

The sensors are omnipolar, meaning they respond to fields of either polarity. Additionally, ***AHK-*** and ***ADK-Series*** sensors are omnidirectional, meaning they are sensitive to magnetic fields in any direction for the ultimate in operational flexibility.



Nanopower sensor output

NANOPOWER SENSORS						
Part Number	**Technology**	**Typ. Operate Point** (mT)	**Supply Voltage Range**	**Typ. Supply Current** (μA)	**Typ. Update Frequency**	**Packages**
ADL021	GMR	2	2.4 to 4.2 V	0.05	55 Hz	1.1 mm x 1.1 mm DFN4 OR 0.65 mm x 0.65 mm WLCSP
ADL022		4				
ADL024		2.8				
ADL121		2		0.035	30 Hz	
ADL122		4				
ADL124		2.8				
ADL921		2		35	Continuous	
ADL922		4				
ADL922NC		4 (normally closed)				
ADL924		2.8				
ADT922	TMR	4.5		0.6		
ADT923		3.2				
ADT924		2.2				
ADT925		1.5				
ADK991	Omnidirectional TMR	350		1		
AHL021	GMR	2	0.9 to 2.4 V	0.095	110 Hz	
AHL024		2.8				
AHL025		1				
AHL921		2		35	Continuous	
AHL924		2.8				
AHL925		1				
AHT922	TMR	4.5	0.9 to 1.8 V	0.3		
AHT923		3.2				
AHT924		2.2				
AHT925		1.5				
AHK991	Omnidirectional TMR	350		2		

Angle and Rotation Sensors

Precise, Small, and Low Power

NVE noncontact angle and rotation sensors are based on spintronic TMR elements for large signals, small size, and low power. Parts come in ultraminiature 2.5 by 2.5 mm DFN6 packages.

AAT-Series angle sensors provide sine and cosine outputs defining the absolute angle of rotation. Outputs are proportional to the supply voltage, and output signals are much larger than conventional sensors. Available bridge resistances range from 40 kilohms for direct interface to low-cost microcontrollers, to six megohms for ultralow power. ***AAT00x*** sensors use half-bridges, while ***AAT10x*** sensors have two full bridges with differential outputs. The ***AAT006*** works with fields as low as 1.5 mT; other AAT-Series sensors operate over a range of 3 to 20 mT.

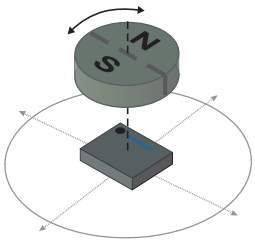
Rotation sensors have two digital outputs 90 degrees out of phase to provide directional information. The ***ADT001*** and ***ADT005*** are high hysteresis for noise immunity in applications such as speed sensing; the ***ADT002*** is low hysteresis to provide accurate, absolute rotational information. The ***ADT001*** and ***ADT002*** have high-field fault detection. ***ALT521-10*** sensors detect the magnitude and direction of the applied magnetic field, as well as rotation. ADT-Series sensors work with fields from 3 to 20 mT. ALT521-10 sensors operate with fields from less than 0.1 mT to more than 40 mT.

Key features of these sensors include:

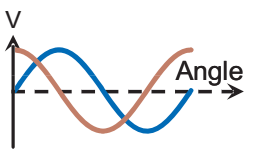
- Extremely low power
- Wide airgap tolerance
- Repeatability to 0.5°
- −40°C to 125°C operating range
- Ultraminiature DFN6 package

Popular applications include:

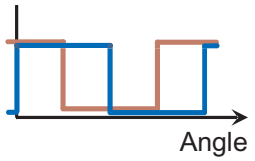
- Absolute rotational position sensors
- Rotational speed sensors
- Water meters



Typical configuration



Analog angle sensors



Rotation sensors

ROTATION SENSORS					
Part Number	**Max. Error**	**Typ. Hysteresis**	**Typ. Supply Current**	**Field Detection**	**Package**
ADT001-10	1.5°	20°	2.2 µA	Excess Field	DFN6
ADT002-10		4°			
ADT005-10		20°		None	
ALT521-10	1.5°	None	1.7 µA	Field Strength	

	Output	
Angle	**Sin**	**Cos**
0° to 90°	H	H
90° to 180°	H	L
180° to 270°	L	L
270° to 360°	L	H

ADT-Series rotation sensor truth table.

AAT-SERIES ANGLE SENSORS					
Part Number	**Bridge Configuration**	**Typ. Output** (ea. output; p-p)	**Operating Field Range**	**Typ. Device Resistance**	**Package**
AAT001-10	Half-bridge	200 mV/V	3 to 20 mT	1.25 MΩ	DFN6
AAT003-10				40 KΩ	
AAT006-10			1.5 to 10 mT	1.5 MΩ	
AAT009-10			3 to 20 mT	6 MΩ	
AAT101-10	Full-bridge	400 mV/V		625 KΩ	

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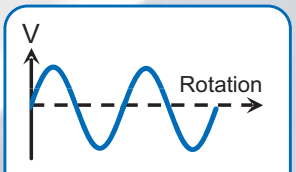
Gear-Tooth and Encoder Sensors

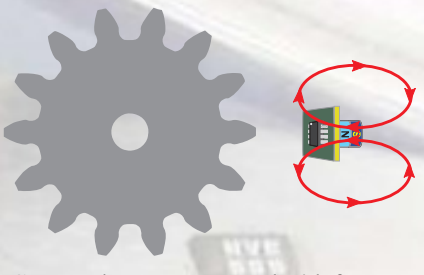
Robust, Precise, and Small



ABL, ABT, and AET-Series analog sensors

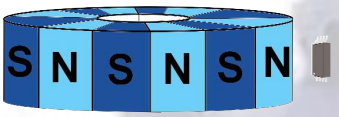
NVE has a full line of gear-tooth and encoder sensors. **Gear-tooth sensors** are used with steel gears and bias magnets. **Encoder sensors** are used with multipole magnets. These unique parts feature large signals, wide airgap tolerance, and high operating temperature.

ABL- and ***ABT-Series*** **gear-tooth sensors** have analog differential sensor elements that provide sinusoidal outputs. Various sensor spacings are available to match a variety of gear pitches. Double bridges generate sine and cosine outputs to provide direction information. **ABL-Series** sensors use venerable GMR; ***ABT-Series*** sensors use state-of-the-art TMR elements.

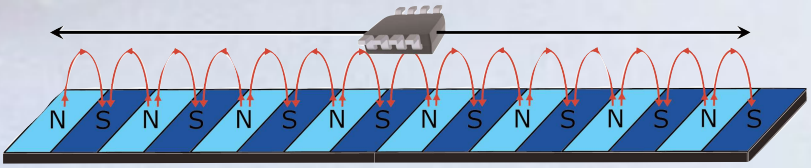


Gear-tooth sensors are used with ferromagnetic gears and bias magnets.

AET-Series encoder sensors have differential TMR sensor elements that provide sinusoidal outputs from cyclic magnet poles on multipole magnets or linear scale tape. Various spacings are available for various pole pitches. Interpolation allows extremely precise rotational or linear position sensing. Dual-bridge versions provide direction information.



An AET-Series encoder sensor used with a multipole magnet.



An AET-Series encoder sensor used with magnetic linear scale tape.

TMR Encoder Sensors				
Part Number	**Half/ Full Bridges**	**Pole Pitch** (normal mode)	**Pole Pitch** (double-pitch mode)	**Package**
AET500-02	Half	5 mm	N/A	SOIC8
AET050F-00	Full	0.5 mm	1 mm	MSOP8
AET075F-00		0.75 mm	1.5 mm	
AET100F-00		1 mm	2 mm	
AET120F-00		1.2 mm	2.4 mm	
AET200-10	Half	2 mm	N/A	DFN6

GMR ANALOG GEAR-TOOTH SENSORS			
Part Number	**Single or Dual Bridge**	**Gear Pitch** (mm)	**Package**
ABL004-00	Single	1.7 to 6	MSOP8
ABL005-00		0.8 to 1.7	
ABL006-00		0.5 to 0.8	
ABL014-00	Dual	1.7 to 6	
ABL015-00		0.8 to 1.7	
ABL016-00		0.5 to 0.8	
ABL004-10	Single	1.7 to 6	DFN6
ABL005-10		0.8 to 1.7	
ABL006-10		0.5 to 0.8	
ABL014-10	Dual	1.7 to 6	
ABL015-10		0.8 to 1.7	
ABL016-10		0.5 to 0.8	

TMR ANALOG GEAR-TOOTH SENSORS			
Part Number	**Single or Dual Bridge**	**Gear Pitch** (mm)	**Package**
ABT250-00	Dual	0.6 to 2	MSOP8
ABT375-00		1 to 3	
ABT500-00		1.3 to 4	
ABT600-00		1.6 to 4.8	

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On the Cover
NVE sensors facilitate the Internet of Things with miniaturization, high sensitivity, low power, and simple, smart interfaces.

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