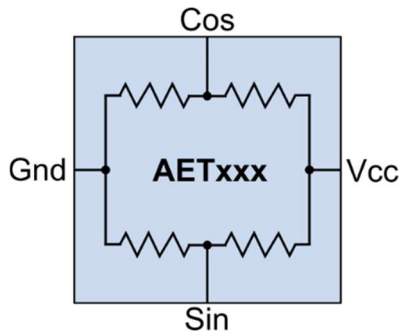


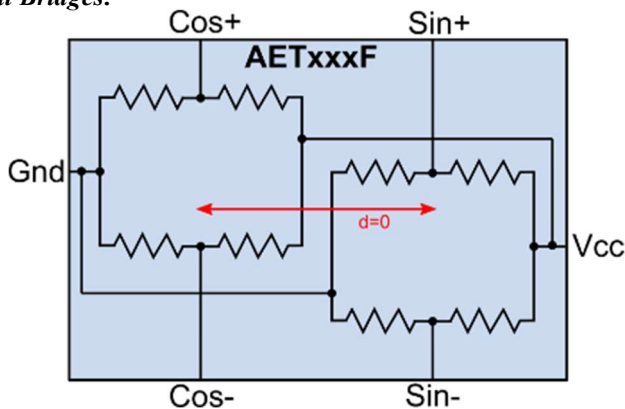
AET-Series TMR Off-Axis Rotational and Linear Sensors

Block Diagram

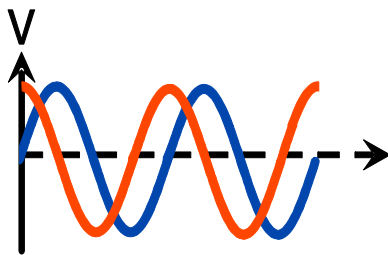
Half-bridges:



Full Bridges:



Outputs



AET-Series operation

Features

- Wide airgap
- Low hysteresis
- Excellent linearity, low distortion
- Large analog peak-to-peak signal
- Operating frequency to 350 kHz
- High 150°C operating temperature

Applications

- Linear and rotational encoders
- Motion, speed, and position sensing
- Closed-loop servo systems
- Motor feedback encoders

Description

NVE's AET-Series sensor elements are versatile, wide-airgap sensors typically used with multipole ring magnets, both radial and face poles, and magnetic linear scale. Standard spacing sensors can detect pole pitches from 0.5 mm to 5 mm. The sensors are Wheatstone bridges comprised of tunneling magnetoresistance (TMR) elements. Both full-bridge and half-bridge versions are available.

The AETxxxF full-bridge sensors offer excellent noise immunity and large differential output signals, and they fully cancel common-mode interference fields.

AETxxx half-bridge sensors combine high performance with a half-bridge outputs interface, ideal for simplicity and miniaturization. They can be influenced by common-mode magnetic fields above 1 millitesla.

Absolute Maximum Ratings

AET-Series TMR Encoder Sensors			
Parameter	Min.	Max.	Units
Supply voltage	-7	7	Volts
Storage temperature	-65	170	°C
ESD (Human Body Model)		2000	Volts
Applied magnetic field		Unlimited	mT

Operating Specifications

Parameter	Symbol	Min.	Typ.	Max.	Units
Operating temperature	$T_{min}; T_{max}$	-50		150	°C
Supply voltage	V_{CC}	0		5.5	V
Resistance		3	5	10	k Ω
Offset voltage	V_O	-20		+20	mV/V
Nonlinearity			1	2	%
Hysteresis			0.5	1	%
Magnetic linear range			± 10		mT
Saturation of TMR sensor elements		± 30			mT
Single resistor sensitivity	$\Delta R/mT$		1%		%/mT
Maximum output					mVpp/V
• AETxxx			200	300	
• AETxxxF (normal mode)			400	600	
• AETxxxF (double pitch mode)			300	450	
Temperature coefficient of device resistance	TCR		-0.08		%/°C
Temperature coefficient of output	TCO	-0.1	0	0.1	%/°C
Operating frequency	f_{MAX}		350		kHz

Magnetic Pitch and Pole Pitch

The AET-Series are linear sensors designed for detecting multipole magnets for off-axis rotational or linear scale applications. The TMR sensor elements are bipolar, meaning they detect both north and south magnetic fields. This gives the sensors large output signals, but it also effectively doubles the “magnetic pitch” from the sensor’s point of view. This concept is shown in Figure 1 below.

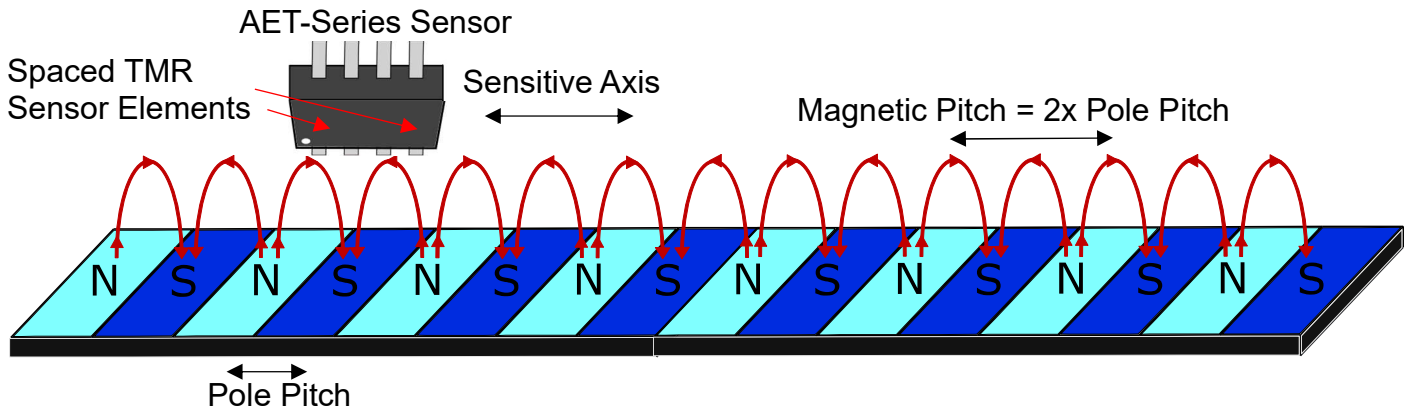


Figure 1: Pole pitch (north to south) vs. magnetic pitch (north to north) on a magnetic linear scale

AET-Series sensors are named based on the north-south “pole pitch” they are optimized to detect. The sensor’s sine and cosine outputs are periodic with the “magnetic pitch.” As an example, to detect a magnetic strip with “pole pitch” (specified by the manufacturer) of 1 mm, choose AET100F-00E. The sensor provides sine and cosine output signals, with a full cycle occurring every 2 mm.

Other common configurations for the AET-Series are illustrated below, where the same comments about “pole pitch” and “magnetic pitch” apply. The sensor output amplitude scales approximately linearly with airgap, reaching the maximum value when the sensor face is at the magnet face. The outputs scale ratiometrically with the supply voltage.

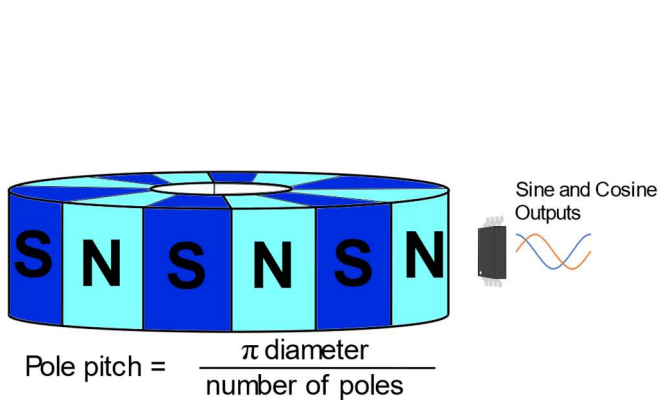


Figure 2: Multipole ring magnet with radial poles.

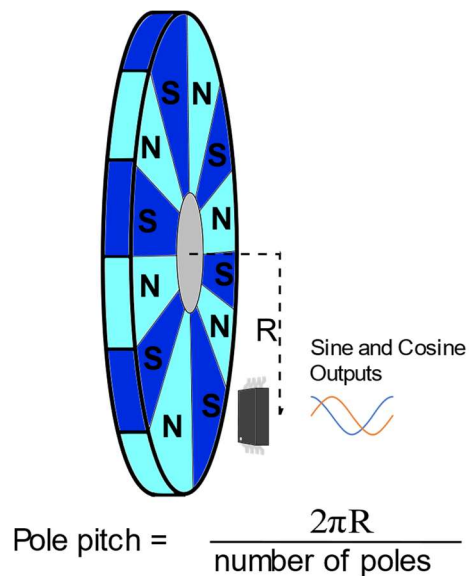


Figure 3: Multipole ring magnet with face poles

AETxxxF Normal Mode and Double Pitch Mode

AETxxxF full bridge sensors can be used in two distinct modes of operation: normal mode and double pitch mode. Double pitch mode optimizes an AETxxxF sensor to measure twice as large a pole pitch as its normal mode. To use double pitch mode, the output signals are rearranged, swapping Sin+ and Cos-. For example, an AET100F-00E sensor is optimized for a 1 mm pole pitch in the normal mode and a 2 mm pole pitch in the double pitch mode connection. Figure 4 illustrates the concept.

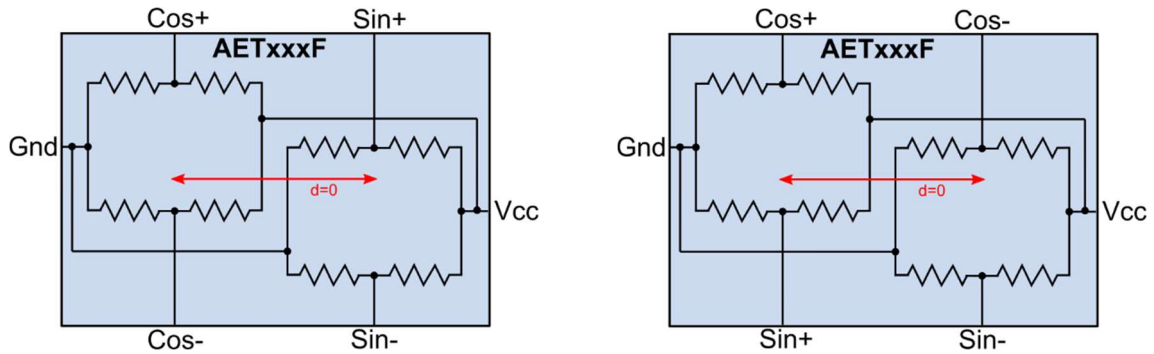


Figure 4: (left) Normal mode and (right) double pitch mode.

Double pitch mode will decrease the maximum output signal by 25% due to the modified effective TMR resistor arrangement, but all other performance characteristics, including common-mode field rejection, are preserved.

Illustrative Application Circuits

Direct Microcontroller Interface

Large output signal and low output impedance allow the AETxxx or AETxxxF to be interfaced directly to a standard microcontroller or ADC. Incremental position information can be obtained with an arctangent function.

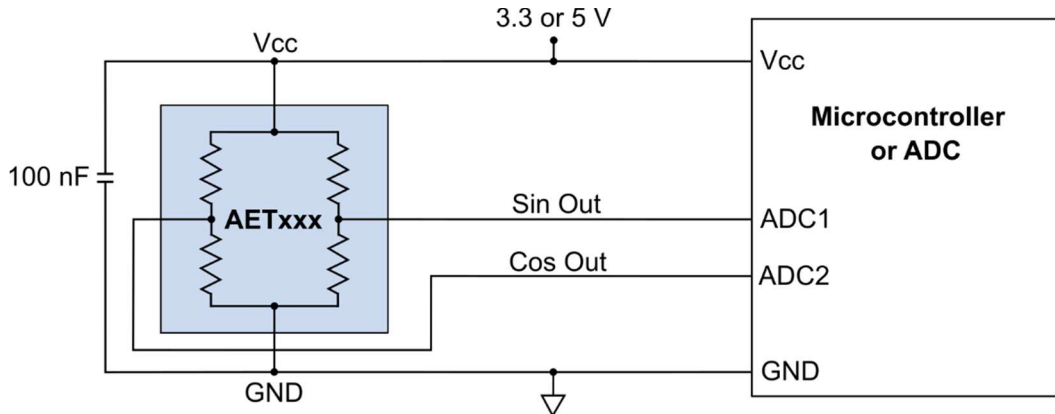


Figure 5. An AETxxx or AETxxxF can be interfaced to an ADC or microcontroller directly, without any external components.

Full-Scale Outputs

While the AET-Series has inherently large output signal, some high-accuracy applications need even larger output signals for better ADC resolution. A low-cost dual op amp circuit like the one in Figure 5 scales the sine and cosine outputs to full scale.

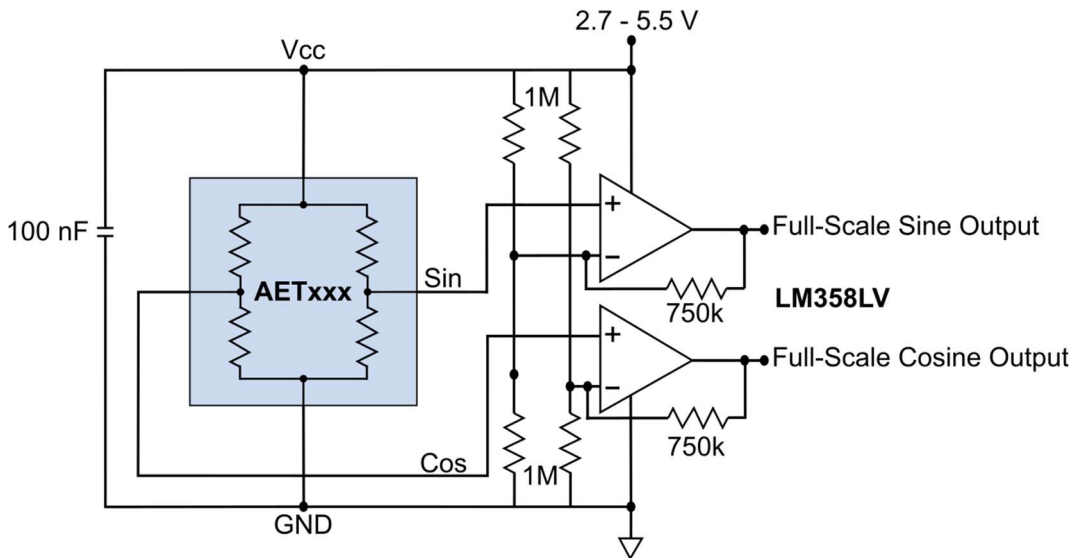
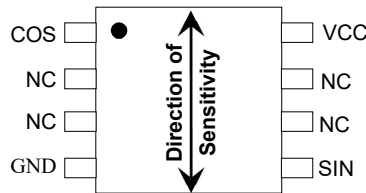


Figure 6. A dual op amp circuit with a gain of 2.5 scales the 300 mVpp/V AETxxx outputs to near full-scale.

AETxxx Pinout (top view)

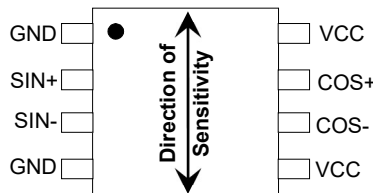
SOIC8
(-02E suffix)



SOIC8	Symbol	Description
8	VCC	Bridge power supply
4	GND	Bridge ground
1	COS	Cosine half-bridge output
5	SIN	Sine half-bridge output
2,3,6,7	NC	Leave floating

AETxxxF Pinout (top view)

MSOP8 / SOIC8
(-00E / -02E suffix)



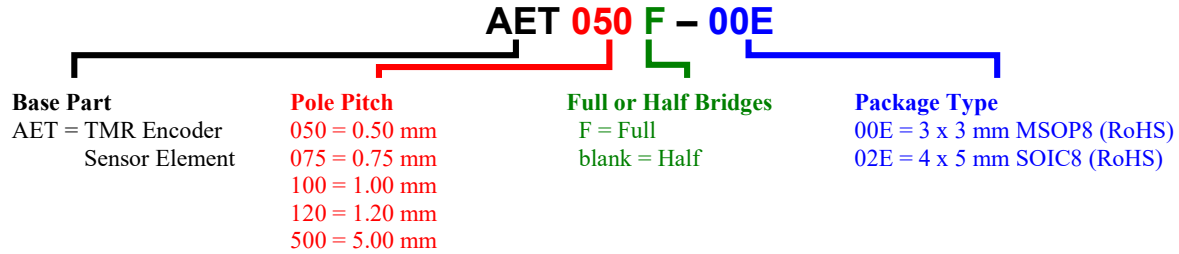
Pin	Symbol	Description
5	VCC	Bridge power supply*
8	VCC	Bridge power supply*
1	GND	Bridge ground*
4	GND	Bridge ground*
2	SIN+**	Sine bridge differential output
3	SIN-	
6	COS+	Cosine bridge differential output
7	COS-**	

*Pin 5 and pin 8 should both have an external connection to VCC, and Pin 1 and Pin 4 should both have an external connection to GND.

**Swap COS- and SIN+ connections for AETxxxF double pitch mode.

Part Numbering

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

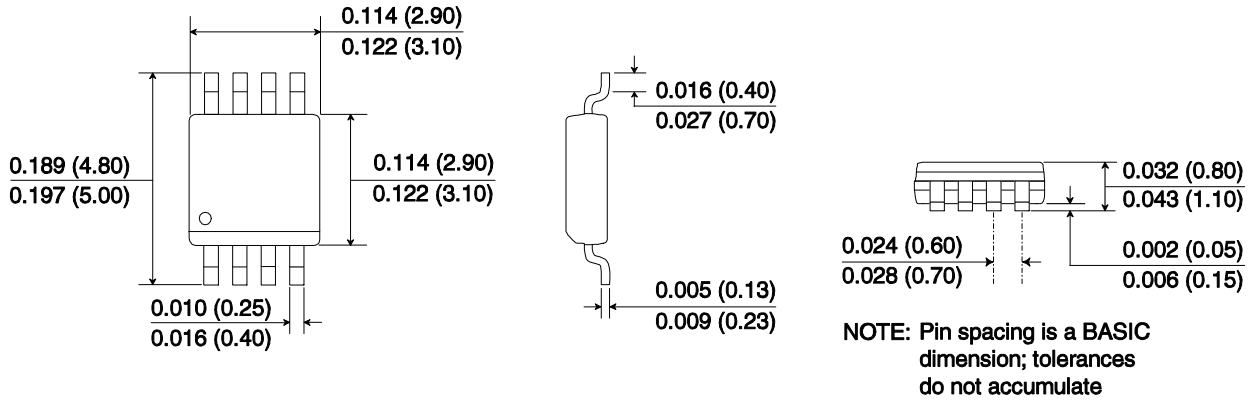


Available Parts

AET-Series TMR Sensors					
Part No.	Half or Full Bridges	Pole Pitch (normal mode)	Pole Pitch (double pitch mode)	Package	Package Marking Code
AET500-02E	Half	5 mm	N/A	SOIC8	AET500
AET050F-00E	Full	0.5 mm	1 mm	MSOP8	FTDe
AET075F-00E	Full	0.75 mm	1.5 mm	MSOP8	FTCe
AET100F-00E	Full	1 mm	2 mm	MSOP8	FTBe
AET120F-00E	Full	1.2 mm	2.4 mm	MSOP8	FTEe

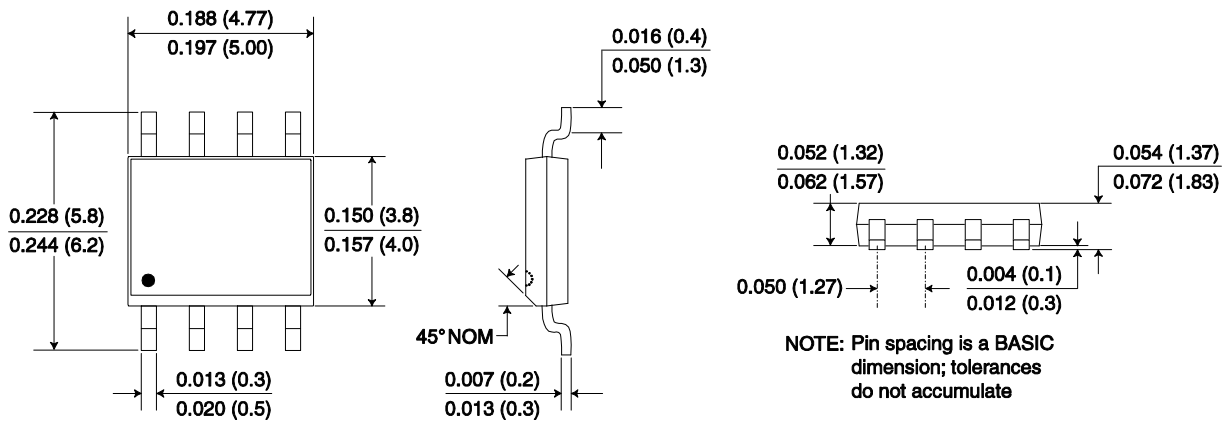
Package Drawings

MSOP8 (-00E suffix)



RoHS
COMPLIANT

SOIC8 (-02 suffix)



RoHS
COMPLIANT

All soldering profiles per JEDEC J-STD-020C, MSL 1.

Revision History

SB-00-118-A
September 2020

Change

- Initial datasheet release.

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SB-00-118

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