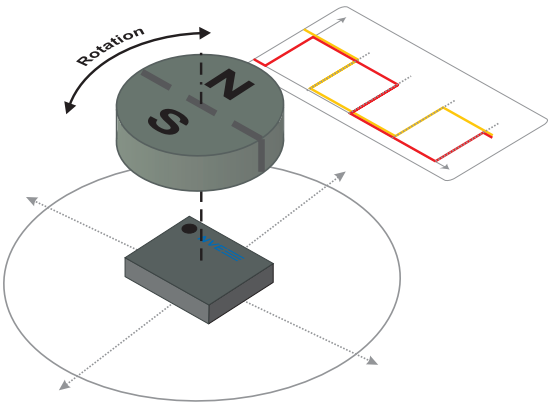
ADT005-10E Ultralow Power Rotation Sensor



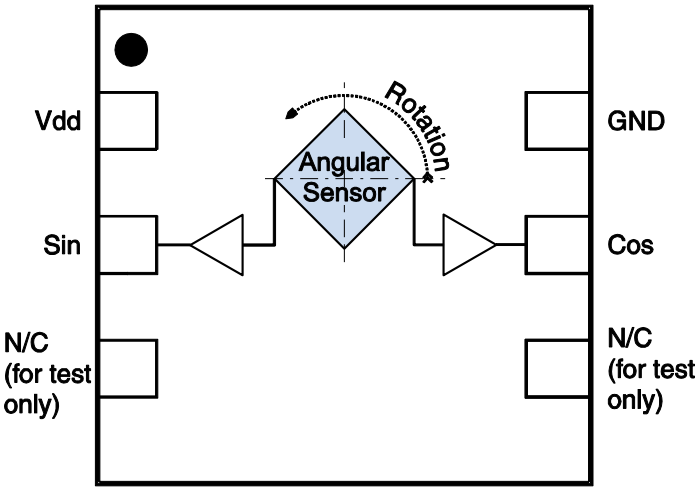
Features

- Tunneling Magnetoresistance (TMR) technology
- Extremely low power (1.4 µA typ. at 2.4 V)
- Precision digital quadrant outputs
- Wide airgap tolerance
- Operates with as little as 3 mT magnet field
- 2.4 V to 5.5 V supply range
- –40°C to +125 °C operating range
- Ultraminiature (2.5 mm x 2.5 mm DFN6)

Applications

- Water meters
- Rotational speed sensors
- Rotational position sensors

Functional Diagram and Pinout



Truth Table

	Output	
Angle	Sin	Cos
0˚-90˚	H	H
90˚-180˚	H	L
180˚-270˚	L	L
270˚-360˚	L	H

Description

The ADT005 rotation sensor is an ultralow power, digital-output magnetic rotation sensor. Tunneling Magnetoresistance (TMR) technology allows small size and ultra-low power, making the sensor ideal for battery operation.

The sensor has two digital, binary outputs. The two outputs are 90 degrees out of phase to provide directional information.

To minimize power, the ADT005 does not include the high-field detection circuitry included in the ADT001, and has slightly less accuracy due to lower-power circuitry.

The ADT005 is higher hysteresis than the ADT002 for high noise immunity in applications such as speed sensing and counting rotations or where motion is in only one direction.

The parts are packaged in NVE's ultraminiature 2.5 mm x 2.5 mm x 0.8 mm DFN6 surface-mount package.

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Absolute Maximum Ratings

Parameter	Min.	Max.	Units
Supply Voltage	–0.5	7	Volts
Storage Temperature	–40	170	°C
ESD (Human Body Model)		2000	Volts
Applied Magnetic Field		Unlimited	tesla

Operating Specifications

T_{min} to T_{max}; 2.4 V < V_{DD} < 5.5 V unless otherwise stated.						
Parameter	**Symbol**	**Min.**	**Typ.**	**Max.**	**Units**	**Test Condition**
Operating Temperature	T_{min}; T_{max}	–40		125	°C	
Supply Voltage	V_{DD}	2.4		5.5	V	
Supply Current	I_{DDQ}		1.5	2.8	µA	V_{DD} = 2.4V
			2.2			V_{DD} = 3V
			2.7	4		3V < V_{DD} < 3.6V
				6		V_{DD} = 5.5V
Applied Magnetic Field Strength		3		20	mT	
Low-Level Output Voltage	V_{OL}	0		0.24	V	I_L = –50 µA
High-Level Output Voltage	V_{OH}	V_{DD} – 0.25		V_{DD}	V	I_L = 50 µA
Angular Precision/Repeatability				±3	deg.	
Angular Hysteresis	$\lvert\theta_H - \theta_L\rvert$	8	20	40	deg.	V_{DD} = 3.6V; 25°C
Frequency Response	f_{MAX}	2			kHz	

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Operation

Overview

The heart of the unique sensor is an array of four Tunneling Magnetoresistance (TMR) elements, one in each quadrant. TMR technology enables low power and miniaturization, making the sensors ideal for battery operation.

In a typical configuration, an external magnet provides a saturating magnetic field (3 to 20 mT) in the plane of the sensor, as illustrated below for a bar magnet and a radially-magnetized disk magnet:

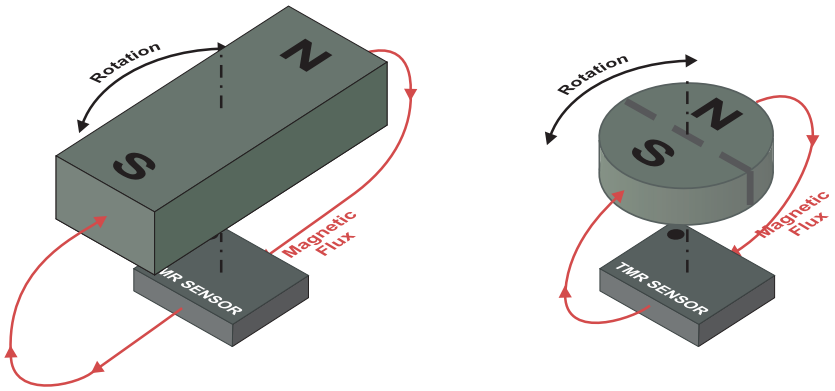

Figure 1. Sensor operation.

Simple output encoding

The rotation is encoded in two quadrature outputs, 90 degrees out of phase. Mathematically, the outputs correspond to the sign of the sine and cosine of the rotation, i.e., sgn(sinθ) and sgn(cosθ), as shown below:

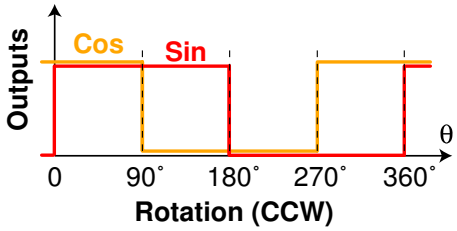

Figure 2. Sensor outputs
(counterclockwise rotation viewed from the top of the sensor).

Thus the binary sensor outputs define the quadrant of rotation:

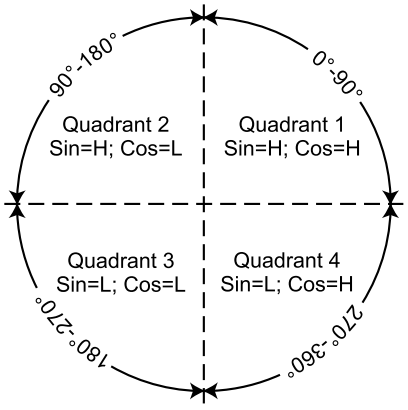

Figure 3. Sensor outputs for each rotation quadrant.

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Wide range of magnets and magnet location

The sensor operates with as little as a 3 mT magnetic field, and is accurate up to 20 mT. This wide magnetic field range allows inexpensive magnets and operation over a wide range of magnet spacing. Larger or stronger magnets require more distance to avoid oversaturating the sensor; smaller or weaker magnets may require closer spacing. Low-cost, radially-magnetized ferrite disk magnets can be used with these sensors. Bar magnets can also be used in some configurations.

When locating the magnet in relation to the sensor, note that the rotational center of the sensor is offset slightly from the package center (see Figure 5).

Absolute position

Unlike some encoder types, the ADT005 sensor detects absolute position and maintain position information when the power is removed. The sensor immediately powers up indicating the correct position.

Power supply decoupling and noise filtering

A 10 nF ceramic bypass capacitor can be used on V_{DD} if the sensor is powered by a power supply or a battery with long connections.

Because the sensor uses high-impedance circuitry and often operates in noisy environments, designers should consider filtering or debounce circuitry on the sensor outputs if possible, especially if the application relies on triggering or counting edges.

Power Consumption

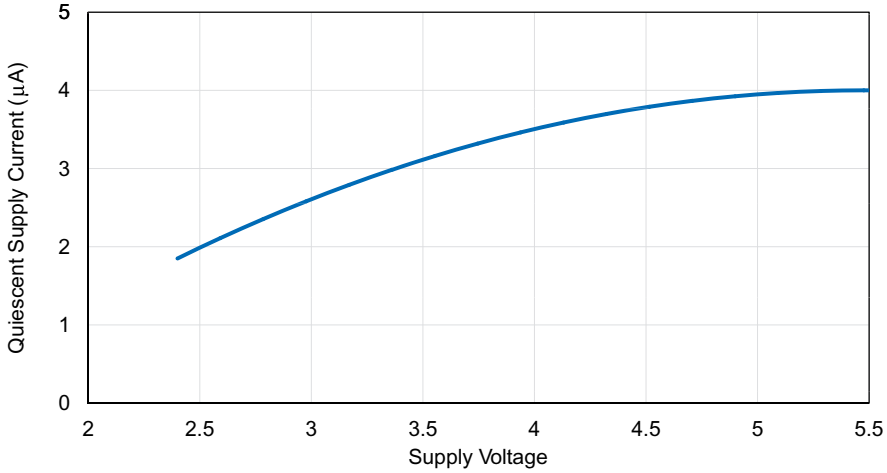

Figure 4. Typical Quiescent Supply Current (25 °C).

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Pinout

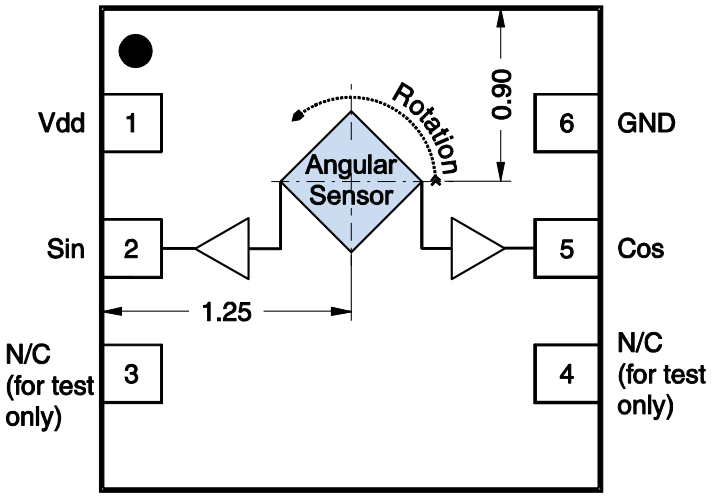

Figure 5. ADT005-10E pinout and center of rotation.

Pin	Symbol	Description
1	V_{DD}	Supply voltage (2.4 V to 5.5 V).
2	Sin	HIGH CMOS output when the sine of the rotation angle is positive (0 to 180°).
3	DNC	Do not connect (for test only).
4	DNC	Do not connect (for test only).
5	Cos	HIGH CMOS output when the cosine of the rotation angle is positive (0 to 90° or 270° to 360°).
6	GND	Ground.

Notes:

- The package center pad may be left floating or connected to ground.
- This product has 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.
- Part marking: **FEBe**

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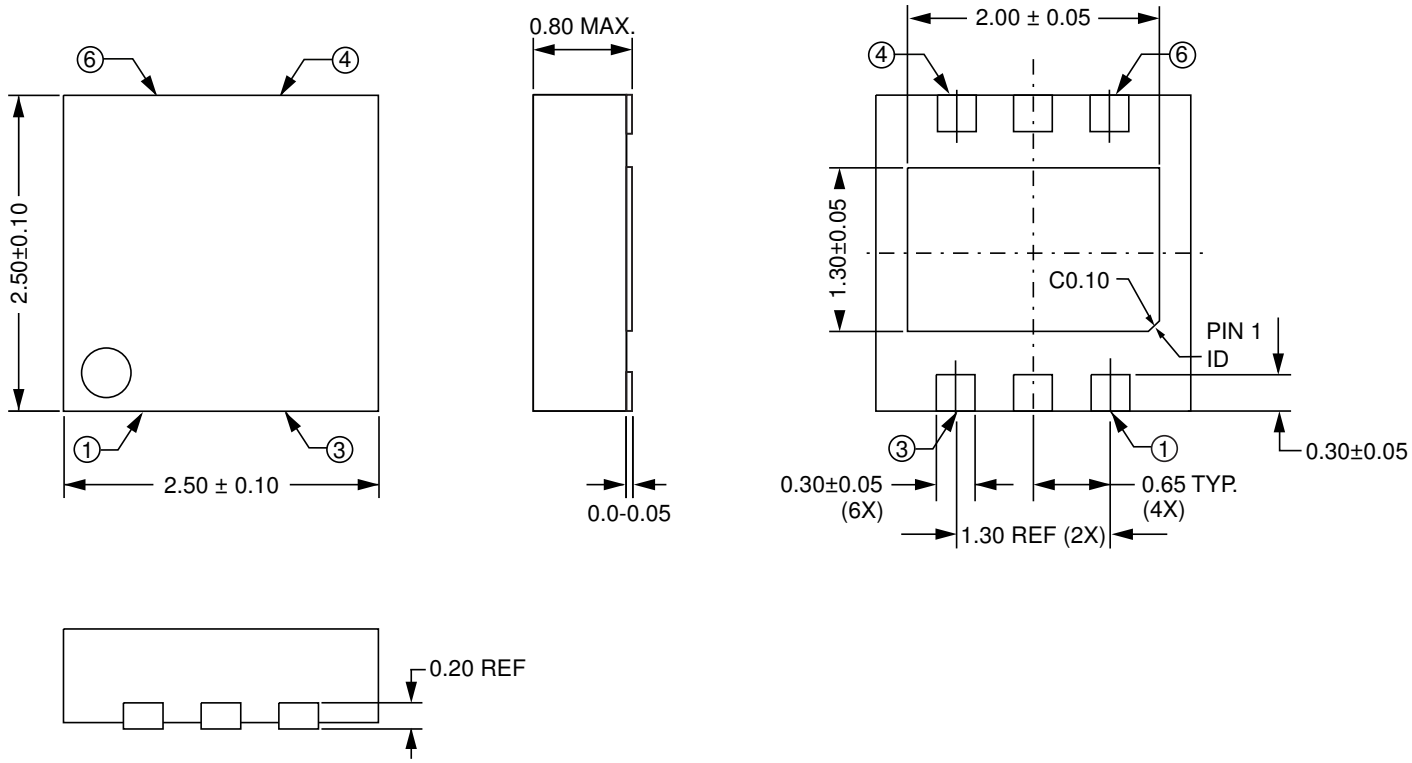
2.5 mm x 2.5 mm DFN6 Package



RoHS COMPLIANT

Notes:

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

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Revision History

SB-00-145-RevA Nov. 2022	**Change** • Initial release.
SB-00-145-PRELIM Nov. 2021	**Change** • Preliminary release.

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