

Noise in NVE TMR Magnetometers

Detecting Ultra-Low Magnetic Fields

NVE's world class Tunneling Magnetoresistance (TMR) magnetometers have the important competitive advantage of low noise. With a wide linear range of ± 10 mT and only 250 nT RMS noise in a 0.01 Hz – 300 kHz bandwidth, the NVE ALT025 TMR Magnetometer resolution is 12.5 ppm, which is the equivalent of better than 16-bit resolution.

Two Types of Sensor Noise

Noise in TMR magnetometers consists of a low frequency $1/f$ flicker noise due to thermal resistance fluctuations and thermal magnetic fluctuations, and frequency invariant Johnson-Nyquist white noise, due to thermal electron motion. These effects combine to result in a detectivity spectrum with $1/f$ frequency dependence at low frequency and constant white noise at high frequency. The noise density referred to the sensor input determines the minimum detectable field, and is called the *detectivity*.

High Resolution Low Field Sensors

NVE's TMR Magnetometers have high sensitivity, high output, and low noise, allowing precision measurements over a wide field range. A typical noise spectrum for the ALT025 is shown in Figure 1 with a typical sensor output curve inset. The detectivity saturates at the white noise corner frequency near 50 kHz.

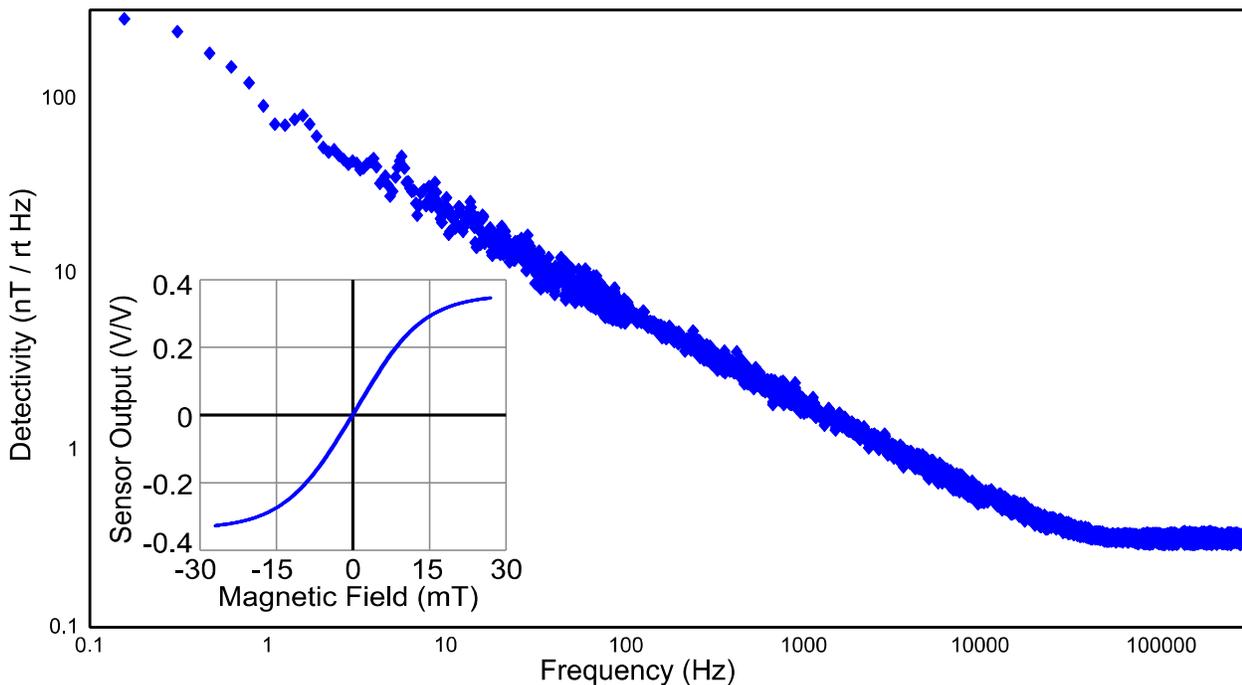


Figure 1: A typical detectivity spectrum for NVE's ALT025 TMR magnetometer. Above 50 kHz, the noise spectrum is white, with a typical detectivity of 490 pT/ $\sqrt{\text{Hz}}$.

Current Sensing Use Case

NVE’s ALT025 TMR magnetometer is ideal for precision current sensing. With low hysteresis, wide linear range, high sensitivity, low power, and low noise, it is a versatile current-sensing solution. A typical configuration features the ALT025 mounted above a PCB trace with its output connected to the input of an inexpensive microcontroller/ADC. Figure 2 shows an example, with five turns directly beneath the ALT025 for high resolution. Conditioning circuitry is unnecessary due to the sensor’s large signal and low output impedance.

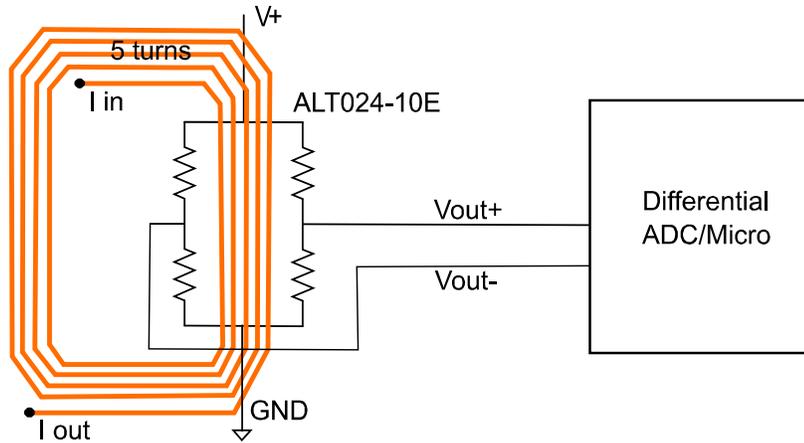


Figure 2: A typical high-resolution current sensing configuration, featuring the ALT025 above a five-turn trace for increased sensitivity. The sensor has a low 7.5 kΩ output impedance and high output amplitude, so it can be wired directly to an ADC without conditioning circuitry or buffers.

With a 3V supply, the 0.01 Hz – 300 kHz integrated RMS voltage noise of the ALT025 is 16.8 μV, and its sensitivity is 66 mV/mT. The resulting 250 nT integrated RMS field noise is the limit for detecting arbitrary AC signals in this frequency range. For the configuration in Figure 2, this corresponds to the detection of currents as low as 100 μA. For higher currents, the full linear range of the ALT025 can be used, and external field noise will determine the resolution.

Customer Support

NVE engineers are experts in low noise, precision magnetic field sensing and are eager to help. For precision magnetometry, current detection, and other analog sensing inquiries, contact sensor-apps@nve.com.