P24 - High-Sensitivity Tunnel Magnetoresistance Sensors: A Breakthrough in Non-Invasive Biomedical Applications

2. MT vetenskap
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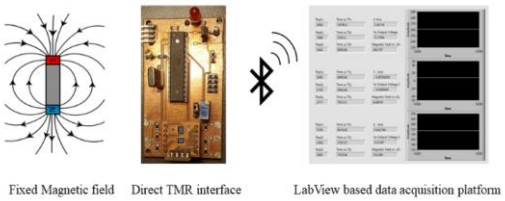
Abstract text*: Tunnel Magnetoresistance (TMR) sensors, known for their high sensitivity, thermal stability, and low noise, show promise in biomedical diagnostics such as Magnetic Cardiography (MCG) and Magnetoencephalography (MEG). The purpose of this study is to evaluate the TMR2905 model for measuring both DC and AC magnetic fields, aiming to enhance non-invasive biomedical applications.

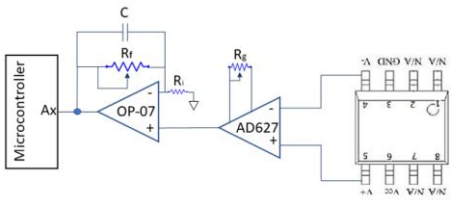
To achieve this, a microcontroller-based timing circuit was used for experimental analysis. DC fields were measured via capacitor discharge, while AC fields were evaluated using signal amplification and conversion. The experimental setup involved interfacing each sensor with a microcontroller and pairing it with a reference capacitor to evaluate the unknown resistance required for magnetic field measurements. A permanent magnet served as the source of the magnetic field, while a magnetometer measured the field in three dimensions. Data from the sensors were transmitted to the LabVIEW system via Bluetooth for further analysis.

The circuit design incorporated an Atmel ATmega328 microcontroller operating with a 16MHz crystal oscillator, and a 16-bit timer/counter was used to measure the discharge time of the capacitor. For AC magnetic field measurements, the sensor was powered by a DC source, and the signal was processed through a pair of amplifiers to amplify the differential signal and shift the negative portion of the AC signal to the positive axis. The final output from the operational amplifier was read by the microcontroller's ADC, and the magnetic field was calculated based on the averaged AC signal.

The main results showed 99% accuracy in low-frequency magnetic field detection with excellent linearity across three axes. The AC field detection exhibited a logarithmic distance relationship, maintaining accuracy across frequencies. These findings highlight the potential of TMR sensors in advanced, non-invasive biomedical and industrial applications.



Experimental setup for the direct sensor interface



Basic configuration of TMR sensors with Microcontroller