



dIdD Suspended System Vector Magnetometer

Precise Earth Monitoring Solutions
for daily changes in Inclination & Declination

Since 1980

Leading the World of Magnetics

GEM Systems is the global leader in the manufacture and sale of high precision magnetometers.

GEM Systems is the only commercial manufacturer of Overhauser magnetometers, that are accepted and used at Magnetic Observatories over the world.

Our Potassium Magnetometers are the most precise magnetometers in the world.

Our Proton sensors are considered the most practical and robust magnetometers for general field use.

Proven reliability based on R+D since 1980.

We deliver fully integrated systems with GPS and additional survey capability with VLF-EM for convenience and high productivity.

Today we are creating the absolute best in airborne sensors and are leading the way with smaller and lighter sensors for practical UAV applications.

GEM Systems large potassium sensors offer the highest sensitivity (20-50 fT) for use in natural hazard research and global ionospheric studies.

Our Leadership and Success in the World of Magnetics is your key to success in applications from Archeology, Volcanology and UXO detection to Exploration and Magnetic Observations Globally.



GEM Systems - Suspended dIdD Vector Magnetometer System

GEM Systems dIdD system was designed to provide precision measurements of the Earth's magnetic field and its components so that accurate changes in the Declination and Inclination of the field could be monitored.

In the past, magnetic observatories relied on a combination of Overhauser, fluxgate and theodolite instruments for obtaining total field and variability measurements. The dIdD system provides both total field and component fields with accuracy that surpasses the current accepted observatory standards.

The suspended dIdD comprises a small diameter (250 mm), spherical Overhauser sensor with a bi-directional set of bias coils. Data is acquired directly to a GEM Systems magnetometer console.

Simplifying Magnetic Measurements

The suspended dIdD simplifies the set-up of magnetic observatory installations by eliminating the need for fluxgate magnetometers and thermally insulating structures. The new system minimizes ongoing system calibrations.

The dIdD Suspended System Vector Magnetometer utilizes GEM Systems Overhauser or Potassium sensor technology and provides enhanced precise measurements for the Earth's changing Declination and Inclination for specialized stationary applications.

The dIdD coil system and sensor are located within the sphere and are suspended to ensure the accurate high quality readings and minimal noise.



The Suspended dIdD Measurement

GEM Systems dIdD employs a mutually orthogonal coil system that measures one unbiased and four biased values of the total magnetic field. The coils are oriented to be perpendicular to the Earth's magnetic field vector, F .

Equal and opposite deflection currents are introduced sequentially in the Inclination (I) coil (i.e. oriented perpendicular to F). The resultant deflected values of F in the geomagnetic meridian plane are called the I_p and I_m values. The magnetometer records these values as well as the undeflected value. Then, equal and opposite currents are sequentially introduced into the Declination coil (D) which is also perpendicular to F . The resultant deflected values of F in the geomagnetic East - West direction are called the D_p and D_m values. The Overhauser (or Potassium) magnetometer records these values as well as the undeflected value. A simple algorithm determines the instantaneous angular changes of the direction of the Earth's vector, F . These angular changes are dI and dD .

Adding dI and dD to baseline values of Inclination and Declination gives instantaneous Inclination and Declination values for F (Baseline values (I_0 and D_0) are determined from an absolute measurement).

Our World is Magnetics.

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The dIdD data output includes; Total Field, Vertical, North and East (Z, X, Y) component fields as well as changes to the calculated declination and inclination of the Magnetic Field. The dIdD system is designed to measure very subtle changes in the Earth's Field.

Data Acquisition & Display Software

GEM Systems custom data acquisition and display software is a Windows interactive interface. The software saves the calculated values to a disk file and displays the values in text and graph modes for easy monitoring of system functions. The dIdD analog display charts the incoming data versus time. Separate charts show Total Field, East, North and Vertical components. Inclination and Declination charts are shown in graphical windows displayed below these values.

Key benefits include:

- Long term stability for accuracy and reliability of measurements (drift < 2nT/year)
- Unsurpassed immunity to temperature changes and aging of materials
- High sensitivity, high speed vector measurements using Overhauser or Potassium technology
- Calibrations not required
- Optimized signal to noise ratio through advanced magnetometer design
- Rapid data output using custom Windows-based display software
- Efficient remote control operation / interrogation using RS-232 and USB modem to satellite and phone links
- Internet-based upgrades (from the office or field)



Suspension System

The new Suspended dIdD magnetometer uses a set of two beryllium / bronze springs for suspension. These springs are oriented perpendicular to each other for stability. Even if the base or suspending apparatus is tilted, the two springs ensure that the coil remains oriented vertically.

A Brief history of the development of the dIdD system

The basic concept for these measurements was published by Alldredge, L.R. in 1962 with Helmholtz coils. However, practical applications were not implemented. Over the decades the idea was nearly forgotten. Only a few instruments were ever built but all with Helmholtz coils and all with some stability problems. It was not until the early 1990's thanks to a cooperative project by the USGS (Golden) and ELGI (Hungary) that a compact coil system was designed and built using a simple proton magnetometer.

In the mid 1990's Dr. Ivan Hrvoić, while visiting the Tihany Geophysical Observatory (Hungary), proposed to use GEM Systems Overhauser magnetometer to improve the sensitivity and the three organizations formed a group to continue the development. Finally several early trials with the Overhauser magnetometer proved very effective, but the platform still lacked stability. ELGI designed and built a new suspension system around 2000. The new system had significantly improved overall characteristics. In 2004 GEM Systems came up with a small size sensor for the Overhauser magnetometer and MinGeo redesigned the coil and suspension system. Subsequently, Potassium technology was also introduced to provide additional sensitivity to the measurements. Since that time over 70 systems have been delivered for commercial use in a cooperative between MinGeo and GEM Systems.

Specifications

Overhauser Performance - (Potassium)

Sensitivity: $0.180 \text{ nT} / \sqrt{\text{Hz}}$ (.0002nT/1Hz)
 Resolution: 0.001 nT (.0001nT)
 Absolute Accuracy: 0.1 nT
 Dynamic Range: 20,000 to 120,000 nT
 Gradient Tolerance: $10,000 \text{ nT/m}$ ($50,000 \text{ nT/m}$)
 Sampling Rate: 1, 2, 5 Hz (1, 5, 10, 20 Hz)
 Long term drifts less than 2 nT/year
 Operating Temperature: -40°C to $+45^{\circ}\text{C}$
 Power Consumption: 1.5 W at 12V

Rate of Reading

5 measurements acquired during each full cycle

Overhauser

0.5 sec per parameter, 2.5 sec full reading cycle
 0.4 sec per parameter, 2 sec full reading cycle
 0.2 sec per parameter, 1.0 sec full reading cycle

Potassium Rate of Reading

.02 sec per parameter, .1 sec full reading cycle
 .01 sec per parameter, .05 sec full reading cycle

At 2.5 Sec Cycle

dI uncertainty $\leq 1 \text{ arcsec rms}$
 dD uncertainty $\leq 2 \text{ arcsec rms}$
 for $I_0 \leq 45^{\circ}$
 dD uncertainty $\leq 4 \text{ arcsec}$
 for $I_0 \leq 70^{\circ}$

Range of measurement

$I_0 \leq + / - 90^{\circ}$
 $D_0 \leq + / - 180^{\circ}$

Operating Modes

Automatic: Total Field, North Field, East Field, Vertical Field (Y, X, Z), dI and dD
 Remote Control: optional using RS-232 interface

Dimensions

Console: $223 \times 69 \times 240 \text{ mm}$
 Sensor: 250 mm diameter

Weights

Console: 1 kg
 Sensor and Coil: 3.5 kg

Standard Components

Console, dIdD sensor with cable, dIdD software, 12 VDC power supply, RS-232 cable and instruction manual. Optional GPS for precise time values.

Ultimately, the system also exceeds specifications set by Intermagnet - the global network of observatories monitoring the Earth's magnetic field (www.intermagnet.org).

GEM Systems provide an industry leading 3 year Warranty



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