



# Suspended dIdD

δ Inclusion / δ Declination Observatory System

The Suspended dIdD system is designed for specialized stationary applications that require the most demanding survey specifications.

Key benefits include:

Integrated system that replaces combined fluxgate / total field installations

Long term stability for accuracy and reliability of measurements

Unsurpassed immunity to temperature changes and aging of materials

High sensitivity, high speed vector measurements using Overhauser technology

Optimized signal to noise ratio through advanced Overhauser design

Rapid data output using custom Windows-based display software

Efficient remote control operation / interrogation using RS-232

Flexibility to enable real-time transmission via RS-232 and modem to satellite and phone links

Internet-based upgrades (from the office or field)



dIdD integrated 3 component coil system with enclosed Overhauser sensor designed for long-term observatory monitoring applications.

## Suspended dIdD for Observatories

In the past, magnetic observatories relied on a combination of Overhauser, fluxgate and theodolite instruments for obtaining total field and variability measurements. GEM then introduced the dIdD (delta Inclusion / delta Declination) vector system for high precision results.

Now, the dIdD has been enhanced significantly with the development of the Suspended dIdD system.

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

## 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. In addition, the new system minimizes ongoing system calibrations, which, in turn, frees personnel to concentrate on more essential tasks (such

as interpreting and understanding data).

These important new benefits are achieved through system design:

- \* Temperature coefficients that reduce drift to less than 0.1 nT / °C (compared with 0.5 nT / °C for high-end fluxgate magnetometers)

- \* Physical suspension of the Overhauser sensor (shown experimentally to contribute to reduced drift)

- \* Long term drifts that are less than 2 nT / year - matching or exceeding the best component measurement at any observatory

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

GEM's Suspended dIdD is implemented in the world's newest magnetic observatory as the sole instrument for continuous, stable measurement. The system will be calibrated by theodolite on a reduced basis (i.e. in comparison with older technology installations).

## Suspension System

The new 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 part is tilted, the two springs ensure that the coil remains in the same position.

The benefit is that the axis between the coils and the planes of measured magnetic fields does not change - ensuring precision measurement.

## Sensor and Coils

A key engineering design consideration was development of Overhauser sensors that were optimally shaped to better interact with the magnetic fields surrounding the coil. Below is an image of the revolutionary spherical sensor that was implemented in the Suspended dIdD.



The external casing is impact resistant plastic. An upper support plate ensures that there is no movement of the sensor. The smaller sized sensor has advantages in terms of robustness (i.e. it is more durable than previous generations of larger, cylindrical sensors).

It is also easier to suspend and can be transported more readily using an immobilizing mechanism.

## Suspended dIdD Measurement

The Suspended dIdD is a vector magnetometer for continuous monitoring of the inclination, declination and total intensity of the Earth's magnetic field. This combination differentiates it from fluxgate

instruments (i.e. that only provide inclination and declination).

GEM's 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** (i.e. one coil is in the horizontal plane and one coil is in the vertical geomagnetic meridian plane).

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 Overhauser 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 magnetometer records these values as well as the undeflected value.

A simple algorithm determines the subsequent 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 are determined from absolute measurement.)

## Data Acquisition & Display Software

GEM's custom data acquisition and display software is a Windows 98 / NT 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.

## Specifications

### Performance

Sensitivity:	< 0.01 nT @ 5 sec
Resolution:	0.01 nT
Absolute Accuracy:	0.2 nT
Dynamic Range:	20,000 to 120,000 nT
Gradient Tolerance:	Over 10,000 nT/m
Operating Temperature:	-40C to +55C
Power Consumption:	1.5 W at 12V

### Rate of Reading

1.0 sec per interval, 5.0 sec full cycle  
0.5 sec per interval, 2.5 sec full cycle  
0.2 sec per interval, 1.0 sec full cycle  
2.5 or 5.0 sec full cycle recommended for reduced noise. 5 measurements acquired during each full cycle.

### At 2.5 Sec Cycle:

$dI$  uncertainty less than / equal to 1 arcsec rms  
 $dD$  uncertainty less than / equal to 2 arcsec rms for  $I_0$  less than / equal to  $45^\circ$   
 $dD$  less than / equal to 4 arcsec for  $I_0$  less than / equal to  $70^\circ$

### Range of measurement

$I_0$  less than or equal to  $+ / - 90^\circ$   
 $D_0$  less than or equal to  $+ / - 180^\circ$

### Operating Modes

Automatic: X, Y, Z,  $dI$  and  $dD$ .  
Remote Control: Optional remote control using RS-232 interface.

### Dimensions

Console:	223 x 69 x 240mm
Sensor:	250 mm diameter

### Weights

Console:	1 kg
Sensor and Coil:	3.5 kg

### Standard Components

GSM-90 console, dIdD sensor with cable, dIdD software, 12 VDC power supply, RS-232 cable and instruction manual.  
Optional GPS for precise time values.



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