

World leaders in high precision magnetic measurements

MS2

Magnetic Susceptibility System



Bartington®  
Instruments



# MS2

## Magnetic Susceptibility System

The MS2 magnetic susceptibility system comprises a meter with a wide range of sensors for measuring the magnetic susceptibility of soils and rocks, in both the field and laboratory, with a resolution to  $2 \times 10^{-6}$  SI units. Equipment is available for the measurement of susceptibility over the temperature range  $-200^{\circ}\text{C}$  to  $+850^{\circ}\text{C}$ .

Applications include geological and soil surveys, palaeomagnetism, archaeological prospecting, palaeoclimatic studies, hydrology, sedimentology, core logging/correlation, pollution surveys and magnetic fabric analysis.

In archaeology, this system can be used to detect the enhancement of magnetic susceptibility in soils produced by human habitation, mainly due to burning, or the digging of ditches. It can also be used in conjunction with magnetic gradiometer surveys, allowing a quick delineation of an area where human activity occurred, when planning the survey.

Further applications are linked to the determination of soil physical properties; of interest for agriculture, soil science and UXO (Unexploded Ordnance) clearance. In agriculture, knowing the exact characteristics of soil allows determination of the best soil cultivating plan, for maximum yield. UXO clearance, using metal detectors, can be strongly affected by soil with high magnetic susceptibility. A good knowledge of the soil's nature allows for the accurate planning of a survey with the proper tools.

Palaeoclimatologists will use the instrument in sediment profiles to determine the climatic conditions at the time of deposit. Additionally, it is possible to use the system to monitor pollution of soils, airborne particles, water and sediments.

All these applications have different requirements, and either aim at measuring a large portion of the ground, or a point sample, in the field or within a laboratory. The wide range of sensors and their unique design, gives the MS2 an unequalled versatility for a whole range of users, in various applications.

The measurements are non-destructive, and the low frequency used ensures that the results are largely unaffected by sample conductivity. The probes are temperature compensated to minimise drift during measurements.

With a unique range of sensors the Bartington MS2 system is well established as the world standard for field and laboratory use.

## MS2 Magnetic Susceptibility Meter



The MS2 meter can be connected to a wide range of individually calibrated sensors. When sample material is placed within the influence of the low frequency, low intensity, alternating magnetic field produced by the sensor, a change in frequency results. This is converted to a value of magnetic susceptibility, which is displayed digitally in SI or CGS units, as selected.

Diamagnetic (negative) values can be measured.

The instrument is powered from internal batteries, rechargeable from the mains or a vehicle dashboard, with indicators for battery status and charging. Push buttons or a toggle switch are used for zeroing or taking measurements. A serial interface provides computer control and data transfer. A range switch adds one place of decimal to the resolution with an increased measurement time. All sockets and switches are environmentally sealed.

The MS2 meter is portable and is supplied with a carrying bag for field use, an instrument stand for laboratory use, a universal mains adaptor, vehicle dashboard connector, RS232 cable and a booklet on Environmental Magnetic Susceptibility measurements.

## Specification - MS2 Meter

Measuring range - volume specific - mass specific	1-9999 x 10 <sup>-5</sup> SI (10 <sup>-6</sup> CGS) 1-9999 x 10 <sup>-8</sup> SI (10 <sup>-6</sup> CGS)
Resolution - volume specific	2 x 10 <sup>-6</sup> SI (2 x 10 <sup>-7</sup> CGS) on x0.1 range. The resolution achieved will depend on temperature drift and environmental noise.
Internal battery	0.7 Ah sealed NiMH give 8 hours continuous use before recharge is required.
Enclosure material	high impact ABS
Operating temperature	-10°C to 40°C
Weight	1.2kg
Dimensions	260 x 158 x 50mm
Sensor cable	50 ohm TNC to TNC, 1m length (alternative lengths to 100m on request)
Battery charger inlet	2.1mm socket, 6-18Vd.c., 100mA maximum, polarity protected
RS232 interface	1200/9600 baud selected on rear panel
Interface connector	4-way rear panel Fischer socket

## MS2B Dual Frequency Sensor

This sensor is designed to measure the magnetic susceptibility in a dual frequency mode, on 10 or 20 ml soil or rock samples, and is used as a standard instrument in the characterisation of soils' magnetic properties. It can also be used in conjunction with the AMSWIN-BAR software and sample adaptor for measurements of the anisotropy of magnetic susceptibility in rocks.

The unique dual frequency facility permits identification of ferrimagnetic grains close to the superparamagnetic/stable single domain transition. This information is critical to many aspects of interpretation, for example in studies of weathering and soil formation, fossil soil identification and characterisation, and sediment or dust source investigations.

The sensor accepts 10ml and 20ml cylindrical bottles, 25.4mm and 23mm cubic boxes, 35mm pots and 25.4mm cylindrical cores. A manually operated platen allows the sample to be inserted and positioned centrally within the sample cavity. A calibration sample with low temperature and frequency dependency is supplied with the sensor. Dual frequency cross calibration is quickly accomplished with the use of the calibration sample and adjuster tool.



## Specification - MS2B Sensor

Calibration accuracy	1% (10ml calibration sample provided)
Measurement period: x 1 range x 0.1range	1.5s SI (1.2s CGS) 15s SI (12s CGS)
Operating frequencies: LF HF	0.465kHz ±1% 4.65kHz ±1%
Amplitude of applied field	250µT peak ±10% (LF & HF)
Maximum resolution	2 x 10 <sup>-6</sup> SI (vol) (2 x 10 <sup>-7</sup> CGS) (LF & HF)
HF/LF cross calibration	0.1% worst case (can be adjusted using calibration sample)
Temperature induced drift: sample to sensor differential	±0.05 x 10 <sup>-5</sup> SI/°C/minute (LF& HF) (±0.05 x 10 <sup>-6</sup> CGS/°C/minute)
Enclosure material	high impact ABS
Weight	0.7kg
Dimensions	210 x 145 x 110mm



## MS2C Core Logging Sensor

A series of loop sensors, ranging from 36 to 162mm in diameter is available for high resolution volume susceptibility measurements on whole cores. They are suitable for measuring any type of peat, lake, or marine sediment core, provided it is not metal clad.

These rugged sensors, with a very low temperature induced drift, are designed for laboratory, field or shipboard use. They can be used with manual or automated core analysis systems - details on request.

The MS2C sensors are used in prospection, core correlation and the identification of palaeoclimatic sequences. Optimum measurement accuracy is achieved with 5-10mm core clearance. Calibration graphs are provided for varying core to sensor diameter.

Specification - MS2C Sensor	
Loop internal diameter	36, 40, 45, 60, 72, 80, 90, 100, 125, 130, 135, 140, 145, 150, 160 or 162mm Intermediate sizes can be provided at an additional charge
Calibration accuracy	5% (calibration sample provided)
Measurement period - x 1 range - x 0.1 range	1.1s SI (0.9s CGS) 11s SI (9s CGS)
Operating frequency	0.565kHz
Drift at room temperature	$<2 \times 10^{-5}$ SI (vol) [ $<2 \times 10^{-6}$ CGS] in 10 minutes after 5 minutes operation
Enclosure material	white polyacetal
Weight	2-2.7kg depending on diameter
Dimensions	290 x 200 x 160mm



## MS2D Probe

This loop probe is designed for rapid assessment of the concentration of ferrimagnetic materials in the top 100mm of the land surface. It is used in studies of slope processes, and in archaeological prospection. The probe can only be operated in conjunction with the MS2 probe handle.



Specification - MS2D Probe	
Depth of response	50% at 15mm, 10% at 60mm
Measurement period - x 1 range - x 0.1 range	0.6s SI (0.5s CGS) 6s SI (5s CGS)
Operating frequency	0.958kHz
Drift at room temperature	$<10 \times 10^{-5}$ SI (vol) [ $<10 \times 10^{-6}$ CGS] in 20 minutes after 20 minutes operation
Enclosure material	reinforced epoxy
Weight	0.5kg
Dimensions - Overall - Coil	208mm diameter x 90mm height 185mm mean diameter

## MS2E Sensor

This sensor is designed to perform high resolution measurements on the surface of split drill or soft sediment cores. The sensitive area of the probe, as defined by 50% maximum response, is in the form of a rectangle of 3.8mm x 10.5mm allowing very fine resolution surface measurements. The position of the long axis is identified by marks on the circumference of the sensor. The sensor is supplied in a protective case.



Specification - MS2E Sensor	
Area of response	3.8mm x 10.5mm at the end of the ceramic cylinder
Depth of response	50% at 1mm, 10% at 3.5mm
Measurement period - x 1 range - x 0.1 range	1.5s SI (1.2s CGS) 15s SI (12s CGS)
Operating frequency	2kHz
Drift at room temperature	$<5 \times 10^{-5}$ SI (vol) ( $<5 \times 10^{-6}$ CGS) in 5 minutes after 5 minutes operation
Enclosure material	diecast aluminium and ceramic
Weight	0.22kg
Dimensions	150 x 50 x 25mm

## MS2F Probe

This miniature probe is ideal for the stratigraphic study of exposed geological and archaeological sections. It is also used where difficult surface conditions prevent good contact with the MS2D loop. The probe can only be operated in conjunction with the MS2 probe handle.



Specification - MS2F Probe	
Area of response	end face and cylinder wall up to the shoulder
Depth of response	10% at 6mm from end face and 4.5mm from outer diameter of end cap
Measurement period - x 1 range - x 0.1 range	1.1s SI (0.9s CGS) 11s SI (9s CGS)
Operating frequency	0.58kHz
Drift at room temperature	$<10 \times 10^{-5}$ SI (vol) ( $10 \times 10^{-6}$ CGS) in 20 minutes after 20 minutes operation
Enclosure material	Nylon 66
Weight	0.05kg
Dimensions - sensitive volume - overall	15mm diameter x 20mm 35mm diameter x 85mm





## MS2G Sensor

This sensor is designed for magnetic susceptibility measurements of 1ml liquid or powder samples. Calibrated volume is 1ml, but scaling correction values allow volumes down to 0.2ml to be measured. The sensor operates at a low frequency and has excellent temperature stability.

It is used for susceptibility measurements where only very small samples of homogeneous fine-grained material are available. Examples are airborne particulates collected in filter papers or particles in colloidal suspension.

The sensor accepts commercially available polythene vials with a diameter of 8mm and a length of 30mm. The sample holder is compatible with other rock measuring equipment allowing for a comprehensive range of measurements to be taken without the need for re-packing the sample. The sample cavity is situated at the tip of a boom mounted on the aluminium electronics enclosure.

### Specification - MS2G Sensor

Calibration accuracy	2% (1ml calibration check sample provided)
Measurement period - x 1 range - x 0.1 range	0.9s SI (0.7s CGS) 9s SI (7s CGS)
Operating frequency	1.3kHz
Drift at room temperature	$<2 \times 10^{-5}$ SI (vol) [ $<2 \times 10^{-6}$ CGS] in 5 minutes after 5 minutes operation
Enclosure	aluminium and ceramic
Sample cavity dimensions	8.5mm diameter x 28mm in height
Sensitive region	5mm height at centre of cavity
Weight	0.67kg
Dimensions (mm)	185 x 93 x 69mm
Sample vial - 1ml volume	Kartell part number 730



## MS2K Probe

This handheld sensor is designed to provide highly repeatable measurements of the volume magnetic susceptibility of moderately smooth surfaces. Applications include description of magnetic stratigraphy and identification of horizons. It can also be used for characterisation of outcrops and logging split cores, with the exception of metal-clad cores. The sensor has applications in materials testing where the relatively low operating frequency permits measurement on some of the less electrically conductive metal alloys, for example stainless steel, without magnetisation.

### Specification - MS2K Sensor

Area of response	25.4mm diameter full-width half-maximum
Depth of response	50% at 3mm, 10% at 8mm
Measurement period - x 1 range - x 0.1 range	1.2s SI (1s CGS) 12s SI (10s CGS)
Drift at room temperature	$<2 \times 10^{-5}$ SI (vol) [ $<2 \times 10^{-6}$ CGS] in 5 minutes after 5 minutes operation
Operating frequency	0.93kHz
Weight	0.32kg, (1.20kg with carrying case)
Dimensions	165 x 145 x 50mm
Environmental	May be used under wet conditions - not suitable for immersion



# MS2H Sensor

The MS2H is a down-hole sensor for profiling the magnetic susceptibility of strata in 25mm nominal diameter auger holes. The detachable probe is fitted to the lower end of a push-tube to give an assembled length of 1 metre. Waterproof screw couplings allow further 1 metre extension tubes to be added to achieve any practical length. The probe assembly is hand-guided within the hole during logging and graduations ensure depth control to a resolution of 1cm. The probe connects to the MS2 meter via a 5mm diameter cable which may be extended to any practical length by up to 100m.

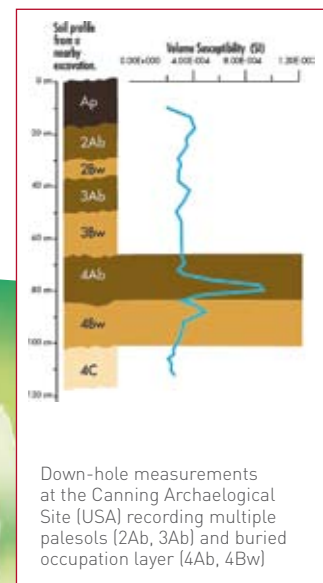
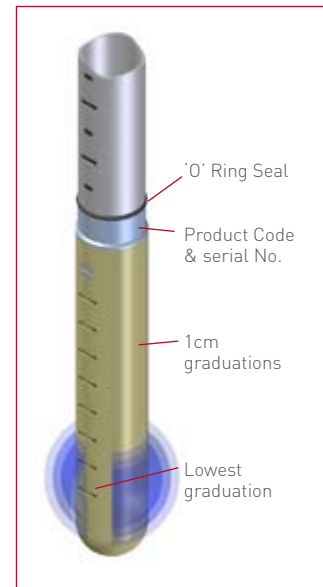


The region of magnetic investigation radiates uniformly around the end of the probe resulting in tolerance to inhomogeneities. Strata as narrow as 12.5mm in thickness can be discriminated. Measurements to a resolution of  $1 \times 10^{-5}$  SI (volume) are obtained in less than one second. A low operating frequency of 1.3 kHz ensures immunity to electrical conductivity effects. Multisus software can be used to log data during surveys.

Suitable augers can be supplied - information on request.

Applications include cultural stratigraphy in archaeology, geomorphology, landslide characterisation, paleosol identification, pedology, erosion studies and stratigraphic correlation.

Specification - MS2H Sensor	
Spatial resolution (vertical FWHM)	12.5mm full-width half-maximum
Depth of horizontal penetration	50%/2mm, 10%/5.5mm, 1%/13mm
Pattern of investigating field	Isotropic radial
Operating frequency	1.3kHz
Resolution	$1 \times 10^{-5}$ SI ( $1 \times 10^{-6}$ CGS)
Calibration accuracy	5% in $\varnothing 22$ mm sample
Measurement period (x1 range)	0.9s SI (0.7s CGS)
Thermal drift (typical)	$2 \times 10^{-5}$ SI/ $^{\circ}$ C (below $20^{\circ}$ C) $-1 \times 10^{-5}$ SI/ $^{\circ}$ C (above $20^{\circ}$ C)
Thermal setting time (typical)	30s/ $^{\circ}$ C (step change)
Markings for plane of sensitivity	Lowest graduation
Probe	
Diameter	21.5mm
Length	153mm
Weight	0.13kg
Connector type	TNC
Push tubes	
Construction	Anodised aluminium alloy with BS015 'O' ring seal and stainless steel threaded couplings
Lengths including union - Extension	101.5cm
- Primary	91.5cm
Weight	0.35kg each
Connecting Cable	
Construction	10m length, 5mm diameter co-axial (may be extended to 100m max)
Weight	0.4kg / 10m
Carrying case	
Dimensions	1380 x 380 x 140mm
Weight (full)	10kg





## MS2 Probe Handle

This handle incorporates the electronics for both the MS2D and MS2F and is required for connection of the sensors to the MS2 meter. The handle is submersible to the depth of the electronics unit (0.6m).

### Specification - MS2 Probe Handle

Weight	0.6kg
Dimensions - upper section	430mm length
- lower section	360mm length



## MS2 Equipment Carrying Case

This is a tough lockable case with cut-outs to provide maximum protection for the equipment. A large range of cases are available, according to the combination of instruments ordered.

### Specification - Equipment carrying case

Weight	8-10kg including equipment
Dimensions	550 x 480 x 280mm
MS2, MS2D, MS2F and Probe Handle carrying case	
Weight	10kg including equipment
Dimensions	620 x 510 x 230mm
MS2 Susceptibility/Temperature system carrying case	
Weight	18.6kg including equipment
Dimensions	710 x 600 x 310mm

## Multisus Software

Multisus is used in conjunction with the MS2 meter and sensors type MS2B, MS2C, MS2E or MS2G. It can also be used with the down-hole probe type MS2H. It includes a facility for drift correction of measurements, performs corrections for the MS2C sensor core/coil diameter ratio and for the MS2B sensor can convert readings to mass specific susceptibility and calculate the coefficient of frequency dependency of susceptibility.

The software operates under Windows® 95/98/2000/NT/XP/Vista. It can be downloaded free from the Bartington website.

## AMSWIN-BAR Software

This package is used with the MS2 meter and MS2B sensor to measure the anisotropy of magnetic susceptibility for magnetic fabric analysis. A sample adaptor, designed for 25mm diameter palaeomagnetic samples is supplied with the software.

The software operates under Windows® 2000/XP/Vista.



## MS2 Susceptibility/Temperature System

This system measures the magnetic susceptibility of samples over the temperature range  $-200^{\circ}\text{C}$  to  $+850^{\circ}\text{C}$ . It is used in the investigation of minerals magnetic properties and for the determination of Curie transition temperatures.

The system comprises the MS2 meter, MS2W sensor, MS2WF furnace, MS2WFP power supply unit and a self-contained water coolant supply, fully interlocked to prevent MS2WF furnace operation without coolant flow. The Geolabsoft software package (running under Windows®) collects data and displays the results during the measurement sequence.

## MS2W Sensor

This water-jacketed sensor has a 30mm diameter sample cavity. The temperature stability of the sensor is excellent and drift during the measurement sequence is exceptionally low as the water jacket thermally isolates the electronics from the sample cavity. The sensor can be used without the furnace or power supply, in conjunction with the MS2 meter and a non-magnetic type T thermocouple (Cu/Cu-Ni), for measurements on 10ml cylindrical samples over the temperature range  $-200^{\circ}\text{C}$  to room temperature. The sample is cooled in liquid nitrogen and allowed to warm slowly to room temperature whilst measurements are taken.

For high temperature measurements the MS2WF furnace and MS2WFP power supply unit are required.



### Specification - MS2W Sensor

Measurement sensitivity	$1 \times 10^{-5}$ SI (vol) [ $1 \times 10^{-6}$ CGS] for 10ml sample, reduced by a factor of 4 for 2.5ml sample
Calibration accuracy	1% (calibrated for 10ml sample)
Measurement period - on x 1 range - on x 0.1 range	2.4s SI (1.9s CGS) 24s SI (19s CGS)
Operating frequency	0.696kHz
Drift during measurement	$<2 \times 10^{-5}$ SI (vol) [ $<2 \times 10^{-6}$ CGS]/30 minutes with 2l/minute water flow through sensor
Weight	0.85kg
Dimensions - probe internal - overall	$\varnothing$ 30mm 255 x 100 x 65mm



## MS2WF Furnace

This furnace is installed inside the cavity of the water-jacketed sensor for heating samples from room temperature to +850°C. The non-inductively wound platinum heating element on a quartz cylinder ensures uniform heating of the sample whilst insulation reduces the maximum external temperature to around 100°C.

The sample temperature is displayed on a digital panel meter to a resolution of 0.1°C when connected to a type S (Pt/Pt-Rh; for measurements up to 1600°C) or type T (Cu/Cu-Ni; for measurement in the range -200°C to +350°C) thermocouple. The sample temperature is also available as an analog voltage.

The sample diameter is restricted to 15mm maximum or circa 2.5ml volume. A ceramic crucible, specially designed to fit onto the thermocouple, is provided for granular or powder samples

### Specification - MS2WF Furnance

Weight	2kg
Dimensions - Overall	350 x 235 x 135mm
- Heating cavity	17mm ID 25mm usable height
- Ceramic crucible cavity	13mm ID 20mm usable height



## MS2WFP Power Supply Unit

This unit supplies power to the MS2WF furnace to heat the sample. The sample temperature can be increased or decreased with a pre-selected linear rate or maintained at a pre-set level using manual controls.

### Specification - MS2WFP Power Supply Unit

Weight	7kg
Dimensions	317 x 210 x 165 mm

## Geolabsoft software

This software, for the Magnetic Susceptibility/Temperature system, runs under Windows® 95/98/2000/NT/XP/Vista. Data is collected via a single RS232 serial interface and plotted in real time. Drift correction is applied at the end of the measurement sequence.





# Bartington®

Instruments

Bartington Instruments Limited  
5 & 10 Thorney Leys Business Park  
Witney, Oxford, OX28 4GE, England.

**T:** +44 (0)1993 706565  
**F:** +44 (0)1993 774813  
**E:** sales@bartington.com

Bartington® is a registered trademark of Bartington Instruments Ltd.  
Windows® is a registered trademark of Microsoft.

The specifications of the products described in this brochure are subject to change without prior notice. Specifications for all Bartington Instruments' products are available on the Internet.

[www.bartington.com](http://www.bartington.com)