

MS2

Magnetic Susceptibility System

For innovation in magnetic measuring 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 2×10^{-6} SI units. Equipment is available for the measurement of susceptibility over the temperature range -200°C to $+850^{\circ}\text{C}$.

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

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^{-5} SI (10^{-6} CGS) 1-9999 x 10^{-8} SI (10^{-6} CGS)
Resolution	- volume specific	2×10^{-6} SI (2×10^{-7} CGS) on x0.1 range. The resolution achieved will depend on temperature drift and environmental noise.
Internal battery		0.6 Ah sealed Ni-Cad 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 used for mass or volume specific susceptibility measurements of standard palaeomagnetic samples in studies of rock and mineral magnetism. It is also used in conjunction with the AMSWIN-BAR software and sample adaptor for measurements of the anisotropy of susceptibility.

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	1.5s SI (1.2s CGS)
x 0.1range	15s SI (12s CGS)
Operating frequencies: LF	0.465kHz \pm 1%
HF	4.65kHz \pm 1%
Amplitude of applied field	250 μ T peak \pm 10% (LF & HF)
Maximum resolution	2 x 10 ⁻⁶ SI (vol) (2 x10 ⁻⁷ CGS) (LF & HF)
HF/LF cross calibration	0.1% worst case (can be adjusted using calibration sample)
Temperature induced drift: sample to sensor differential	\pm 0.05 x 10 ⁻⁵ SI/ $^{\circ}$ C/minute (LF& HF) (\pm 0.05 x 10 ⁻⁶ CGS/ $^{\circ}$ 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 <i>Intermediate sizes can be provided at an additional charge</i>
Calibration accuracy	5% (calibration sample provided)
Measurement period - x 1 range	1.1s SI (0.9s CGS)
- x 0.1range	11s SI (9s CGS)
Operating frequency	0.565kHz
Drift at room temperature	<2 x 10 ⁻⁵ SI (vol) (<2 x 10 ⁻⁶ CGS) in 10 minutes after 5 minutes operation
Enclosure material	white polyacetal
Weight	2-2.65kg 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 prospecting. 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	0.6s SI (0.5s CGS)
- x 0.1 range	6s SI (5s CGS)
Operating frequency	0.958kHz
Drift at room temperature	<10 x 10 ⁻⁵ SI (vol) (<10 x 10 ⁻⁶ CGS) in 20 minutes after 20 minutes operation
Enclosure material	reinforced epoxy
Weight	0.5kg
Dimensions	mean diameter 185mm, overall height 90mm



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	1.5s SI (1.2s CGS)
- x 0.1 range	15s SI (12s CGS)
Operating frequency	2kHz
Drift at room temperature	<5 x 10 ⁻⁵ SI (vol) (<5 x 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	1.1s SI (0.9s CGS)
- x 0.1 range	11s SI (9s CGS)
Operating frequency	0.58kHz
Drift at room temperature	<10 x 10 ⁻⁵ SI (vol) (10 x 10 ⁻⁶ CGS) in 20 minutes after 20 minutes operation
Enclosure material	Nylon 66
Weight	0.05kg
Dimensions - sensitive volume	15mm diameter x 20mm
- overall	35mm diameter x 85mm



MS2G

Sensor

This sensor is designed for magnetic susceptibility measurements of 1ml liquid or powder samples. Scaling correction values are given for volumes down to 0.2ml. 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	0.9s SI (0.7s CGS)
- x 0.1 range	9s SI (7s CGS)
Operating frequency	1.3kHz
Drift at room temperature	<2x10 ⁻⁵ SI (vol) (<2x10 ⁻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	670g
Dimensions (mm)	185 x 93 x 69mm
Sample vial - 1ml volume	Kartell part number 730



MS2K

Sensor

This 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	1.2s SI (1s CGS)
- x 0.1 range	12s SI (10s CGS)
Drift at room temperature	<2 x 10 ⁻⁵ SI (vol) (<2 x 10 ⁻⁶ CGS) in 5 minutes after 5 minutes operation
Operating frequency	930Hz
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.

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 precision of 1×10^{-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
Precision	1×10^{-5} SI (1×10^{-6} CGS)
Calibration accuracy	$\pm 5\%$ in $\varnothing 22$ mm sample
Measurement period (x1 range)	0.95s (on SI range)
Thermal drift (typical)	2×10^{-5} SI/ $^{\circ}$ C (below 20° C) -1×10^{-5} SI/ $^{\circ}$ C (above 20° 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

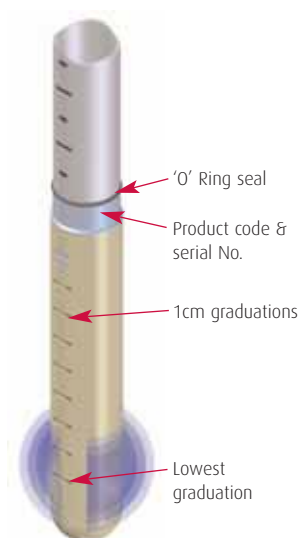
Construction	Anodised aluminium alloy with BS015 'O' ring seal and stainless steel threaded couplings
Lengths including union	Upper - 101.5cm (extension) Lower - 91.5cm
Weight	0.35kg each

Connecting Cable

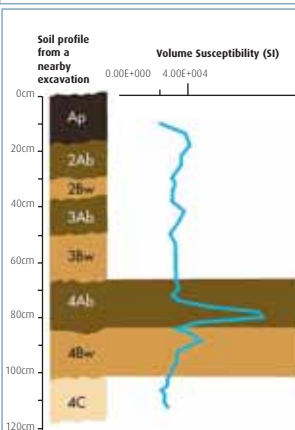
Construction	10m length, 5mm diameter co-axial (may be extended to 100m max)
Weight	0.4kg / 10m

Carrying case

Dimensions	1380 x 380 x 140mm
Weight (full)	10kg



Lower push-tube and probe showing region of investigation



Down-hole measurements at the Canning Archaeological Site (USA) recording multiple paleosols (2Ab, 3Ab) and buried occupation layer (4Ab, 4Bw)



MS2

Probe Handle

This handle is required for connection of the sensors type **MS2D** and **MS2F** 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.

Specification - Equipment carrying case

Weight	8-10kg including equipment
Dimensions	550 x 480 x 280mm

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 dependence of susceptibility.

The software operates under Windows® 95/98/2000/NT/XP. It can be downloaded free of charge from the Bartington web site.

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. A demonstration version can be downloaded from the Bartington web site.

MS2

Susceptibility/Temperature System



This system is used in the investigation of magnetic mineralogy and grain size and for the determination of Curie transition temperatures. It permits magnetic susceptibility measurements to be made on 15mm diameter (2.5ml) samples over the temperature range -200°C to +850°C.

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°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 x 10 ⁻⁵ SI (vol) (1 x 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	2.4s SI (1.9s CGS)
- on x 0.1 range	24s SI (19s CGS)
Operating frequency	0.696kHz
Drift during measurement	<2 x 10 ⁻⁵ SI (vol) (<2 x 10 ⁻⁶ CGS)/30 minutes with 2l/minute water flow through sensor
Weight	0.85kg
Dimensions - probe internal ø	30mm
- overall	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) or type T (Cu/Cu-Ni) 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 Furnace

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. 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.

Specifications of the products described in this brochure are subject to change without prior notice. Windows® is a registered trademark of Microsoft Corporation. Bartington® is a registered trademark of Bartington Instruments Ltd.

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