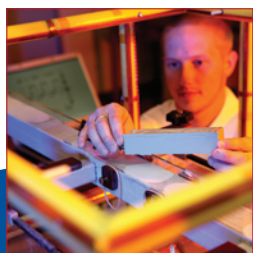


World leaders in high precision magnetic measurements

Mag-03

Three-axis Magnetic Field Sensors



Bartington®
Instruments



Mag-03

Three-axis Magnetic Field Sensors



These compact, high performance fluxgate sensors with integral electronics provide precision measurements of static and alternating magnetic fields in three axes. They are available with measuring ranges of ± 70 , ± 100 , ± 250 , ± 500 or $\pm 1000\mu\text{T}$ in a variety of enclosures. Powered from any $\pm 12\text{V}$ supply, outputs are in the form of three analog voltages from 0 to $\pm 10\text{V}$, proportional to B_x , B_y and B_z .

The sensors are available with three levels of noise performance. The Low Noise version has a noise level of $< 6\text{pT}$ (rms per $\sqrt{\text{Hz}}$ at 1Hz), the Standard version has 6-10pT, and the Basic version 11-20pT. The Standard and Basic versions can be supplied in all measuring ranges and enclosure types. The Low Noise version is available with a measuring range of 70 μT or 100 μT , in all enclosure types except MCT (titanium).

These sensors have a wide range of applications in physics, bioelectromagnetics, geophysical exploration and defence.

Data Acquisition Units and Accessories include:

- Spectramag-6 Six channel spectrum analyser
- Mag-03SCU Signal conditioning unit
- Mag-03PSU Battery power supply unit
- Mag-03MC-BR Mounting bracket for use with the cylindrical range of sensors
- Mag-03-T Tripod
- Mag-03-TA Universal tripod adaptor
- Mag-03-MR Mounting rack
- Mag-03-LP Levelling platform
- Calibration check units can be supplied for the complete range of sensors

A full calibration service is also available



Mag-03 Enclosures

The Mag-03 sensors can be supplied in the following enclosures:

- Mag-03MC - cylindrical
- Mag-03MCES - cylindrical - with environmentally sealed connector
- Mag-03MCFL - cylindrical - with connections via flying leads
- Mag-03MCT - cylindrical - with titanium shielded enclosure (not available in Low Noise version)
- Mag-03MCUP - unpackaged - moulded sensor and electronics block with flying leads
- Mag-03MCTP - two part construction - separate sensor and cylindrical electronics enclosure
- Mag-03MS - square section
- Mag-03MSES - square section with environmentally sealed connector
- Mag-03MSS - square section submersible to 100 metres
- Mag-03IE - a sensor with the three sensing elements on flying leads
- Mag-03IEv1 - an IE sensor with a 9-way 'D' type connector and cable from the electronics enclosure
- Mag-03IEv2 - an IE sensor with a 25-way 'D' type connector and cable from the electronics enclosure
- Mag-03IEHV - an IE sensor suitable for use in high vacuum chamber



Mag-03 Product Identification

Products are specified as Mag-03 followed by the enclosure code (MC, MCES, MCFL, MS, MSES, MSS, IE, IEv1, IEv2, MCT, MCUP, MCTP), followed by L for the Low Noise version or B for the Basic version; if neither L nor B is specified, then this indicates the Standard version. Follow this with the measuring range in μT (70, 100, 250, 500 or 1000).

For example:

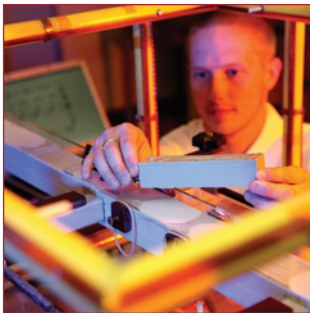
Mag-03MSL70 is a Low Noise sensor with a square section enclosure and a range of $\pm 70\mu\text{T}$

Mag-03MC1000 is a Standard sensor with a cylindrical enclosure and a range of $\pm 1000\mu\text{T}$

Mag-03MSESB250 is a Basic sensor with a square section enclosure, an environmentally sealed connector and a range of $\pm 250\mu\text{T}$

Note: For some Mag-03 magnetometers (Mag-03 MCFL, MCTP, MCUP, IE), it will be necessary to specify the lead lengths (e.g. Mag-03MCFL250-1000 is a Mag-03MCFL with a range of $250\mu\text{T}$, and flying leads of 1000mm).



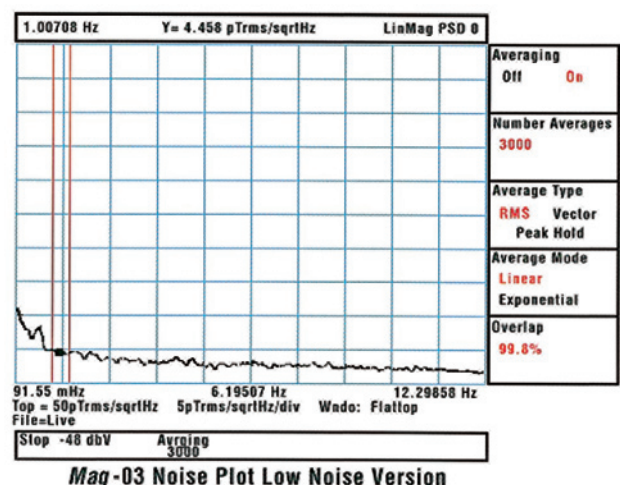
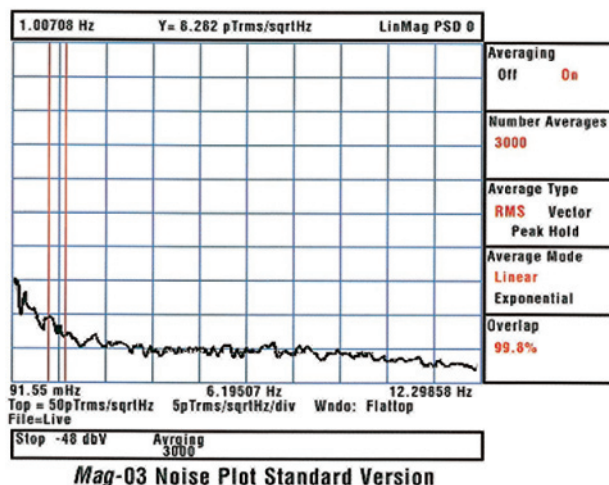


Performance Specification

Supply voltage	$\pm 12V$ to $\pm 17V$
Analog output	$\pm 10V$ ($\pm 12V$ supply) swings to within 0.5V of supply voltage
Power supply rejection ratio	5 $\mu V/V$
Output impedance	10 Ω
Linearity error	<0.0015%
Frequency response	0 to 1kHz maximally flat, $\pm 5\%$ maximum above 1kHz
Scaling error	< $\pm 0.5\%$
Bandwidth	0 to 3kHz at 50 μT (5kHz for Mag-03IEv1&2 on request)
Orthogonality error -	<0.5° (<0.1° for Mag-03MS and Mag-03MSES)
Alignment error (Z axis to reference face)	<0.1° (Mag-03MS and Mag-03MSES only)
Single sensor axis to body	<3.5° (Mag-03IE sensors only)
Internal noise - Basic version Standard version Low noise version	11-20pTrms/ \sqrt{Hz} at 1Hz 6-10pTrms/ \sqrt{Hz} at 1Hz <6pTrms/ \sqrt{Hz} at 1Hz
Supply current - Standard & Basic version Low noise version	+35mA, -6mA (+1.4mA per 100 μT for each axis) +26mA, -6mA (+1.4mA per 100 μT for each axis)

Scaling Dependent Parameters

Measuring range	± 70	± 100	± 250	± 500	± 1000	μT
Scaling	143	100	40	20	10	mV/ μT
Offset error	± 5	± 5	± 12	± 25	± 50	nT
Scaling temperature coefficient	+15	+20	+50	+100	+200	ppm/ $^{\circ}C$
Offset temperature coefficient	± 0.1	± 0.1	± 0.2	± 0.33	± 0.6	nT/ $^{\circ}C$



Specifications

	Mag-03MC	Mag-03MCES
Enclosure	Reinforced epoxy	Reinforced epoxy
Dimensions (ø x L mm)	25 x 202	25 x 207
Mounting	Mag-03MC-BR bracket available	Mag-03MC-BR bracket available
Connector	Hirose RM15TRD10P	Amphenol 62GB-51T10-7P
Mating connector	Hirose RM15TPD10S	Amphenol 62GB-16J10-7S ⁴
Operating temperature range Continuous Intermittent	-40°C to +70°C -40°C to +85°C	-40°C to +70°C -40°C to +85°C
Weight	85g	100g
Environmental protection	IP51	IP64
	Mag-03MCFL	Mag-03MCT
Enclosure	Reinforced epoxy	Titanium
Dimensions (ø x L mm)	25 x 211	25 x 207
Mounting	Mag-03MC-BR bracket available	Mag-03MC-BR bracket available
Connector (mm)	Flying leads 500 length ^{2,3}	Hirose RM15TRD10P
Mating connector	(Up to 5000 length to order)	Hirose RM15TPD10S
Operating temperature range Continuous Intermittent	-40°C to +70°C -40°C to +85°C	-40°C to +70°C -40°C to +85°C
Weight	80g	95g
Environmental protection	IP51	IP64
	Mag-03MCTP	Mag-03MCUP
Enclosure	Sensor - Moulded epoxy Electronics - Aluminium alloy	Sensor - Moulded epoxy Electronics - moulded silicone
Dimensions (mm)	Electronics - ø25 x 115 length Sensor - ø20 x 54 length Sensor-electronics cable - 1000 length ³ (up to 5000 length to order)	Electronics - 21 x 12 x 80 Sensor - ø20.9x56 length Sensor-electronics cable - 610 length ³ (up to 5000 length to order)
Mounting	Mag-03MC-BR bracket available ¹	
Connector (mm)	Hirose RM15TRD10P	Flying leads 500 length ^{2,3}
Mating connector	Hirose RM15TPD10S	(up to 5000 length to order)
Operating temperature range Continuous Intermittent	-40°C to +70°C -40°C to +85°C	-40°C to +70°C -40°C to +85°C
Weight	80g	80g
Environmental protection	IP51	IP64
	Mag-03MS	Mag-03MSES
Enclosure	Reinforced epoxy	Reinforced epoxy
Dimensions (W x H x L mm)	32 x 32 x 152	32 x 32 x 166
Mounting	2 x M5 fixing holes	2 x M5 fixing holes
Connector	ITT Cannon DEM-9P-NMB	Amphenol 62GB-12E10-7P
Mating connector	ITT Cannon DEM-9S-NMB	Amphenol 62GB-16J10-7S ⁴
Operating temperature	-40°C to +70°C	-40°C to +70°C
Weight	160g	160g
Environmental protection	IP51	IP64

	Mag-03MSS	
Enclosure	Polyacetal	
Dimensions (W x H x L mm)	30 x 30 x 208	
Mounting	3 x M3 clearance holes	
Connector	Impulse IE XSJ-7-BCR	
Mating connector	Impulse IE XSJ-7-CCP ⁴	
Operating temperature	-10°C to +50°C	
Weight	185g	
Environmental protection	IP68	
	Mag-03IE	Mag-03IEHV
Enclosure	Sensors - Alumina cylinder Electronics - Aluminium alloy	Sensor - Glass tube with epoxy filling Electronics - Aluminium alloy
Dimensions (mm)	Electronics - ø25 x 115 length Sensor - ø8 x 30 length Sensor-electronics cable - 750 ³ length (up to 5000 length to order)	Electronics - ø25 x 115 length Sensor - ø8 x 30 length Inner cable - 1100 ³ length (up to 5000 length to order) Outer cable - 140 length Inner and outer cable joined by re-solderable terminal block
Mounting	Mag-03MC-BR bracket available ¹	Mag-03MC-BR bracket available ¹
Connector	Hirose RM15TRD10P	Hirose RM15TRD10P
Mating connector	Hirose RM15TPD10S	Hirose RM15TPD10S
Operating temperature range Continuous Intermittent	-40°C to +70°C -40°C to +85°C	-40°C to +70°C -40°C to +85°C
Weight	80g	80g
Environmental protection	IP64	For use in high vacuum chamber
	Mag-03IEv1	Mag-03IEv2
Enclosure	Sensors - Alumina cylinder Electronics - Aluminium alloy	Sensors - Alumina cylinder Electronics - Aluminium alloy
Dimensions (mm)	Electronics - ø25 x 105 length Sensor - ø8 x 30 length Sensor-electronics cable - 750 length ³ (up to 5000 length to order)	Electronics - ø25 x 105 length Sensor - ø8 x 30 length Sensor-electronics cable - 750 length ³ (up to 5000 length to order)
Mounting	Mag-03MC-BR bracket available ¹	Mag-03MC-BR bracket available ¹
Connector	9-way 'D' type on a 5m cable	25-way 'D' type on a 5m cable
Mating connector	9-way 'D' type	25-way 'D' type
Operating temperature range Continuous Intermittent	-40°C to +70°C -40°C to +85°C	-40°C to +70°C -40°C to +85°C
Weight	80g	80g
Environmental protection	IP64	IP64

¹Bracket is only suitable for the electronics enclosure

²Flying leads are susceptible to EM interference and should be screened wherever possible

³Standard length if not specified in order

⁴Modified to be non-magnetic

Mag-03 Mating Connectors

With the exception of the Mag-03MSS, non-magnetic mating connectors are provided free of charge for all Mag-03 sensors purchased without cables and for sensors and cables purchased without the Mag-03PSU, Mag-03DAM, Mag-03SCU or Spectramag-6.



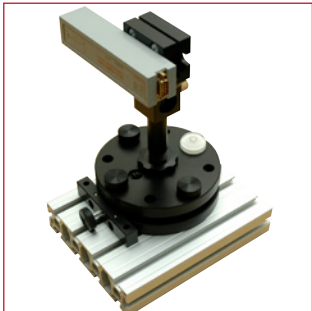
Mag-03 Cables

All cables for connection of the Mag-03 range of sensors to the Mag-03PSU, Mag-03DAM or Mag-03SCU or Spectramag-6 are supplied in 5 metre lengths; alternative lengths to 600 metres can be provided.

Mag-03 Mounting Accessories

A range of accessories are available as detailed below.

Specification	
Mag-03MC-BR	Mounting Bracket for use with the cylindrical range of Mag-03 sensors.
Mag-03-T	Tripod
Mag-03-TA	Tripod adaptor for mounting of the Mag-03 range
Mag-03-LP	Levelling platform for use with the Mag-03TA and Mag-03MR Mounting Rack
Mag-03-MR	Mounting Rack for the installation of Mag-03LP and Mag-03 sensor(s). Available in length of 1 metre and multiples



Mag-03 Calibration Unit

The units provide a reference magnetic field for checking the calibration of the Mag-03 sensors. These battery-powered units produce a sinusoidal, alternating magnetic field of defined frequency and magnitude. A temperature-stabilised constant current is passed through a single Helmholtz coil with guides to align each of the sensor axes in turn. For the Mag-03MC and Mag-03IE sensors, adaptors are available for use with the Mag-03MS unit. These units are not a calibration facility. The sensors must be returned to Bartington Instruments for re-calibration.

Specification	
Sinewave magnitude	50µT p-p (17.5µT rms) ±1% (distortion 5% typical)
Frequency	190Hz ±2%
Battery	PP3 9V alkaline or lithium dioxide (20 hours continuous use) with tri-colour LED indicator
Enclosure	Polyethylene terephthalate
Environmental	IP60 not suitable for use in wet conditions
Dimensions (mm)	Ø 100 x 125 length
Weight (g)	990



Calibration Unit	
Ordering Code	Suitable for use with:
Mag-03MS-CU	Mag-03MS, Mag-03MSES
Mag-03MSS-CU	Mag-03MSS
Mag-03MC-CU	Mag-03MC, Mag-03MCES, Mag-03MCFL, Mag-03MCT, Mag-03MCUP, Mag-03MCTP
Mag-03IE-CU	Mag-03IE



Spectramag-6 Data Acquisition Unit



Spectramag-6 is a six-channel, 24-bit data acquisition and spectrum analysis unit, designed for use with the Bartington Instruments Mag-03 range of 3-axis fluxgate sensors. In addition to magnetic field sensors, the unit also has an ICP® interface, allowing the connection of a range of accelerometers and microphones.

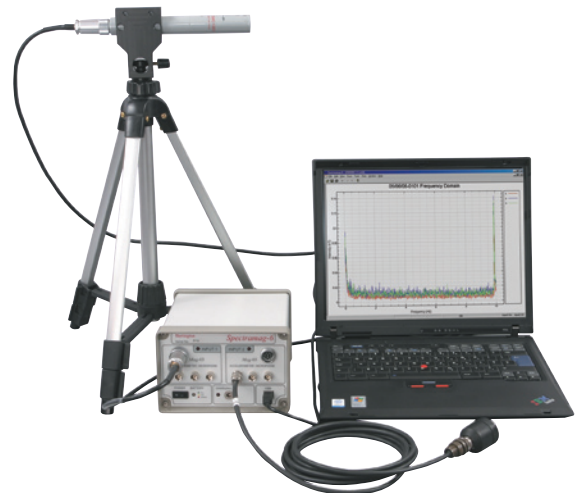
All six-channels are simultaneously sampled, making the Spectramag-6 ideally suited for recording and analysis of magnetic field and/or vibration data in three axes. Typical applications include magnetic and vibration measurements for pre-installation surveys for MRI systems, electron microscopes and similar sensitive equipment. General magnetic measurements, dual magnetometer differential measurements, site surveys and recording

magnetic fields due to 50/60Hz mains supplies can also be performed using this unit.

The interface unit has Windows® based PC software. It is linked to the host PC via a USB2 connection. The software-based nature of the instrument allows for easy upgrading, simply by downloading the latest version of the software from the Bartington Instruments website.

Spectramag-6 Hardware Features

- 6-channel, simultaneously sampled, 24 bit data acquisition
- Operates from mains power or internal, rechargeable battery – use in the field, with a laptop PC
- Magnetic Field input: compatible with the Bartington Mag-03 range of magnetometers and also the Mag648, Mag-01MS and Mag-03RC magnetometers
- Vibration measurement inputs: direct connection of ICP® accelerometers or microphones
- 100µs to 10s sample intervals
- Hardware selectable gain amplifier
- AC/DC Coupling: analog filtering
- USB2 connection





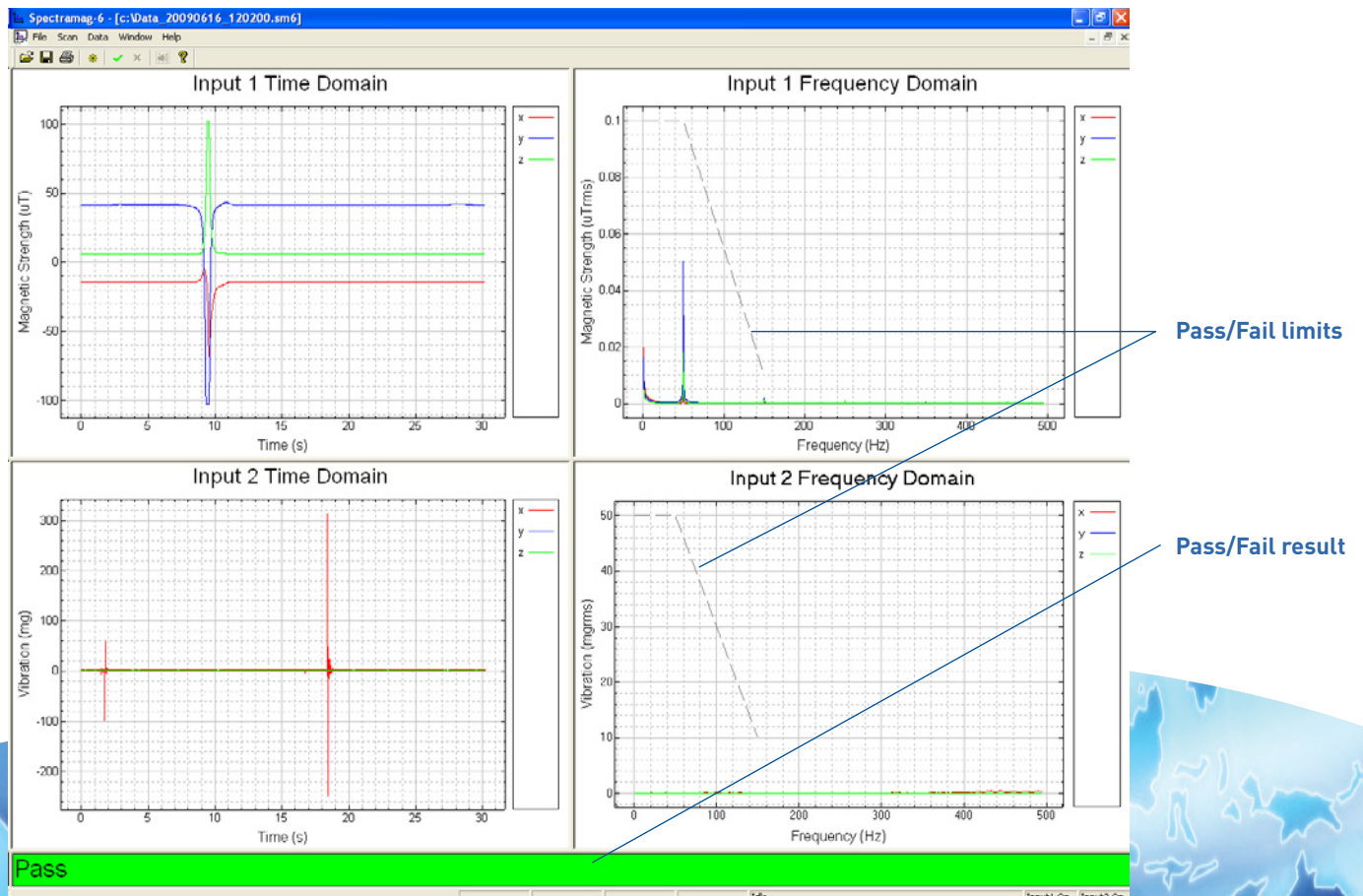
Spectramag-6 Software Features

- Operates under Windows® 98, 2000 or XP
- Fixed scan length or continuous acquisition mode (sample rate dependent)
- Multiple scan logging
- Anti-aliasing oversampling
- Digital Pre and Post-processing filters on time and frequency domains
- Time domain and frequency domain display, with zoom facility
- Averaging for frequency domain plots
- Choice of FFT (Fast Fourier Transform) algorithms
- Results scaled in engineering units for standard range of sensors
- Programmable pass/fail test profiles for time & frequency domains with audio alert
- Total field magnitude (X, Y, Z vector sum)
- Display cursors and markers
- Saving favourite settings as re-usable templates
- Raw data exported as time-stamped data values in text format
- Data can be exported as graphics in BMP, JPG

Spectramag-6 Optional Accessories

- Tripod and adaptor for Mag-03 magnetometers
- Rugged carrying case

Typical Spectramag-6 Display



Spectramag-6 Modes of use

The six input channels are arranged in 2 groups of 3 inputs, which are independently selected for magnetic or vibration measurements. This allows connection of :

- or {
- Two three-axis magnetometers
 - One three-axis magnetometer and up to three single axis accelerometers
 - Up to six single axis accelerometers
 - Up to six microphones
 - Up to three single axis accelerometers and up to three microphones

For MRI pre-installation surveys the Mag-03MS1000 three-axis magnetic field sensor, with a full-scale range of $\pm 1000\mu\text{T}$ ($\pm 10\text{Gauss}$) and a resolution down to a few nT, is recommended. The ICP® interface provides a 4mA constant current source via a BNC connector and a gain between 1 and 1000 can be selected for vibration measurements down to a few μg .

A minimum system for magnetic field measurement comprises:

Spectramag-6 unit + Mag-03 magnetic field sensor + Mag-03 cable + tripod + Mag-03 tripod adaptor. A Windows® PC with USB2.0 is also required.

Specification	
Resolution	24 bit A-D Converter
Input channels	6 selectable in groups of 3 for magnetometer or accelerometer
Input coupling Magnetometers Accelerometers	DC or AC selectable with 0.01Hz (-3dB) high-pass filter AC with 0.1Hz (-3dB) high-pass filter
Sampling Interval	100 μs (min) to 10s (max) up to 700,000 samples (PC dependent) Continuous sampling mode (slower sample rates only)
Frequency range	DC to 3.5kHz (-3dB point), reduced to 1kHz for gain of 1000
Input impedance (magnetometer inputs)	1M Ω
ICP® constant current	4mA \pm 20% for cables up to 1km in length
Gain control	Software selected x1/x10/x100/x1000
Spectrum range	Software selected as sample rate or maximum frequency
Output interface	USB2
Software	Windows® 98/2000/XP compatible
Controls	Power on/off switch
Connectors	2 x Hirose RM15TPD10P fixed plug to magnetic field sensors 6 x BNC sockets for ICP® piezoelectric vibration sensors/microphone preamplifiers 1 x USB to PC 1 x 2.1mm socket for 12V input from mains adaptor for recharging
Frequency domain display options	Amplitude spectrum (RMS) Amplitude spectral density (RMS/ $\sqrt{\text{Hz}}$)
Power supply	Internal rechargeable battery with universal mains adaptor for charging
Battery charging time	10 hours for full charge
Battery life (typical)	8 hours
Enclosure	Aluminium
Dimensions (D x W x H)	210 x 170 x 112mm
Weight	2.85kg
Operating temperature	-10°C to +50°C
Storage temperature	-10°C to +70°C
Suitable ICP® vibration sensor	PCB Piezoelectronics type 393A03 (1V/g) low-noise rugged PCB Piezoelectronics type 393B31 (10V/g) low-noise rugged
Carrying case dimensions (W x D x H)	610 x 230 x 200mm
Total weight with carrying case	12kg with Spectramag-6, Mag-03 magnetometer, 5m cable and tripod.

Mag-03SCU Signal Conditioning Unit

This unit provides power for any Mag-03 sensor and signal conditioning of the sensor outputs. High-pass and low-pass filters are selectable from switches located on the front panel. A gain can be applied independently to the three channels together with an offset facility. The conditioned signal is available as an analog output on the back panel of the unit. The unit, which is suitable for mounting in a 19 inch rack, operates from a 220 or 110V AC supply. The power supply voltage for the sensor can be increased for operation over very long cables.

Specification	
Input channels	3 from Mag-03 three-axis magnetic field sensor (X, Y & Z)
Input signal range	$\pm 18V$ maximum - surge protection with $\pm 18V$ clamp
Common mode rejection ratio	>70dB - fully differential input
Signal output	Three unfiltered analog, three filtered analog
Signal coupling	AC or DC depending upon filter selection
Low pass filter	1, 10, 100, 1000 or 10000Hz switch selected
High pass filter	0 (DC), 0.01 or 1.0Hz switch selected
Filter roll off	-18dB/octave for low and high pass
Gain	1, 50, 100, 300, 500 or 1000 switch selected
Offset range	1 to $\pm 10V$
Offset control - coarse fine	10 turn potentiometer with polarity switch for each channel centre-off position potentiometer
Thermal drift	$\leq 6mV/hour$ for filtered/null signal output with gain = 300
System noise	Minimum discernible input signal variation of $\pm 0.1mV$ with signal/noise ratio of $\geq 10dB$ at all gain settings
Operating temperature	-20°C to +70°C
Humidity	0 - 50% (non-condensing)
Power input	110/220V AC selectable
Fuses	1A, 250V rating, 20mm or 3/4 inch
Power output to sensors	$\pm 12V$, $\pm 15V$, $\pm 17V$ at 250mA, ripple <1mV p-p, short circuit protected, surge protection provided with $\pm 18V$ clamp
Dimensions (W x H x D)	483 (19" rack) x 88 (2U) x 300mm
Weight	5.5kg
Display	3 x 3½ digit LCD
Controls	Power ON, low pass filter, high pass filter, supply voltage, gain (3), offset coarse (3), offset fine (3), polarity (3)
Connectors - power input sensor input analog output	3-way IEC with integral filter (mains cable provided) Hirose RM15TRD10P 6 x BNC sockets



Mag-03PSU Power Supply Unit

The Mag-03PSU provides power to any Mag-03 sensor via the mains adaptor or the internal rechargeable battery and contains high and low pass filters for the analog signals from the Mag-03 sensor. The low pass (<4.5kHz) filter removes HF noise from feedthrough of the sensor excitation frequency and any external sources. The high pass (>0.1Hz) filter can be switched to provide AC or DC operation.

Specification	
Enclosure	high strength ABS
Dimensions (D x W x H)	133 x 84 x 46mm
Weight	550g
Battery	sealed lead acid
Connectors - sensor analog outputs battery charger inlet	HRS RM15TRD10P 3 BNC connectors 2.1mm socket



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