

Mag-03

Three-axis Magnetic Field Sensors

For innovation in magnetic measuring 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 range of enclosures as detailed below. 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 exhibits a noise level of $<6\text{pT}$ (rms per $\sqrt{\text{Hz}}$ at 1Hz), the Standard version exhibits 7-10pT, 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 70 μT or 100 μT measuring range, in all enclosure types except MCT. The Basic version has the advantage that it can be supplied worldwide* without export licence control.

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

Accessories include:

- **Spectramag-6** six channel spectrum analyser
- **Mag-03SCU** signal conditioning unit
- **Mag-03PSU** battery power supply unit
- **Mag-03MC-MB** mounting bracket for use with the cylindrical range of sensors.
- Calibration check units can be supplied for the complete range of sensors.
- A full calibration service is also available.



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
- **Mag-03MCUP** - unpackaged - moulded sensor and electronics block with flying leads
- **Mag-03MCTP** - two part construction - separate sensor and cylindrical electronics enclosures
- **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.

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)

e.g. **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-03MSES250 is a Basic sensor with a square section enclosure, an environmentally sealed connector and a range of $\pm 250\mu\text{T}$

*For Standard and Low Noise versions, an export licence is required when shipping to countries outside of European Union, Australia, Canada, Japan, New Zealand, Norway, Switzerland and USA.

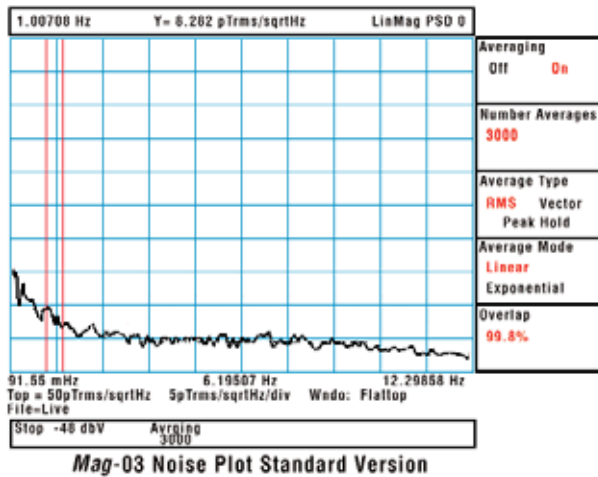
Performance specification

Supply voltage	±12V to ±17V
Analog output	±10V (±12V supply) swings to within 0.5V of supply voltage
Power supply rejection ratio	5 μ V/V
Output impedance	10 Ω
Linearity error	<0.0015%
Frequency response	0 to 1kHz maximally flat, ±5% maximum above 1kHz
Calibration error	±0.5%
Bandwidth	0 to 3kHz (5kHz for <i>Mag-03IEv1&2</i> on request)
Orthogonality error - between sensing axes	<0.5° (<0.1° for <i>Mag-03MS</i> and <i>Mag-03MSES</i>)
Z axis to reference face	<0.1° (<i>Mag-03MS</i> and <i>Mag-03MSES</i> only)
Single sensor axis to body	<3.5° (<i>Mag-03IE</i> sensors only)
Internal noise - Basic version	11-20pTrms/ $\sqrt{\text{Hz}}$ at 1Hz
Standard version	7-10pTrms/ $\sqrt{\text{Hz}}$ at 1Hz
Low noise version	<6pTrms/ $\sqrt{\text{Hz}}$ at 1Hz
Supply current - Standard version & Basic version	+35mA, -6mA (+1.4mA per 100 μ T for each axis)
Low noise version	+26mA, -6mA (+1.4mA per 100 μ T for each axis)

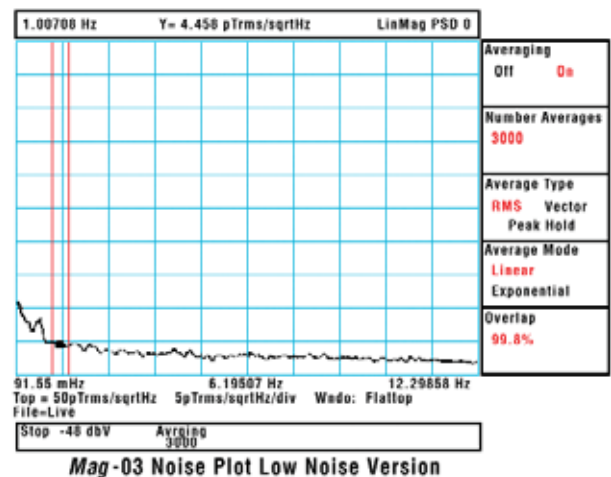
Scaling dependent parameters

Measuring range	±70	±100	±250	±500	±1000	μ T
Scaling	143	100	40	20	10	mV/ μ T
Offset error	±5	±5	±12	±25	±50	nT
Scaling temperature coefficient	+15	+20	+50	+100	+200	ppm/°C
Offset temperature coefficient	±0.1	±0.1	±0.2	±0.33	±0.6	nT/°C

Typical noise spectrum for standard version
(0.1 to 10Hz)



Typical noise spectrum for low noise version
(0.1 to 10Hz)



Specifications (All dimensions in mm)

	Mag-03MC	Mag-03MCES
Enclosure	reinforced epoxy	reinforced epoxy
Dimensions (mm)	ø25 x 202 length	ø25 x 207 length
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
Operating temperature range		
Continuous	-40°C to +70°C	-40°C to +70°C
Intermittent	-40°C to +85°C	-40°C to +85°C
Weight	85g	100g
Special features		splashproof
	Mag-03MCFL	Mag-03MCT
Enclosure	reinforced epoxy	Titanium
Dimensions (mm)	ø25 x 203 length	ø25 x 203 length
Mounting	Mag-03MC-BR bracket available	Mag-03MC-BR bracket available
Connector	Flying leads 500 length**	Hirose RM15TRD10P
Mating connector	(Up to 5000 length to order)	Hirose RM15TPD10S
Operating temperature range		
Continuous	-40°C to +70°C	-40°C to +70°C
Intermittent	-40°C to +85°C	-40°C to +85°C
Weight	80g	95g
Special features		splashproof
	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 - up to 5000 length to order	Electronics - 21 x 12 x 105 length Sensor - ø20 x 54 length Sensor-electronics cable - up to 5000 length to order
Mounting	Mag-03MC-BR bracket available*	
Connector	Hirose RM15TRD10P	Flying leads 500 length**
Mating connector	Hirose RM15TPD10S	Up to 5000 length to order
Operating temperature range		
Continuous	-40°C to +70°C	-40°C to +70°C
Intermittent	-40°C to +85°C	-40°C to +85°C
Weight	80g	80g

	Mag-03MS	Mag-03MSES
Enclosure	reinforced epoxy	reinforced epoxy
Dimensions (mm)	32 x 32 x 152 length	32 x 32 x 166 length
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
Operating temperature	-40°C to +70°C	-40°C to +70°C
Weight	160g	160g
Special features		splashproof
	Mag-03MSS	
Enclosure	polyacetal	
Dimensions (mm)	30 x 30 x 208 length	
Mounting	3 x M3 clearance holes	
Connector	Impulse IE XSJ-7-BCR	
Mating connector	Impulse IE XSJ-7-CCP	
Operating temperature	-10°C to +50°C	
Weight	185g	
Special features	submersible to 100 metres depth	

	Mag-03IE	Mag-03IEHV
Enclosure	Sensors - Alumina cylinder Electronics - Aluminium alloy	Sensor - Glass tube with epoxy filling Electronics - Aluminium alloy
Dimensions (mm)	Electronics - $\varnothing 25 \times 105$ length Sensor - $\varnothing 8 \times 30$ length Sensor-electronics cable - 750 length	Electronics - $\varnothing 25 \times 105$ length Sensor - $\varnothing 6.5 \times 30$ length Inner cable - 1100 length (or up to 5000 to order) Outer cable - 140 Inner and outer cable joined by re-solderable terminal block
Mounting	<i>Mag-03MC-BR</i> bracket available*	<i>Mag-03MC-BR</i> bracket available*
Connector	Hirose RM15TRD10P	Hirose RM15TRD10P
Mating connector	Hirose RM15TPD10S	Hirose RM15TPD10S
Operating temperature range		
Continuous	-40°C to +70°C	-40°C to +70°C
Intermittent	-40°C to +85°C	-40°C to +85°C
Weight	80g	80g
Special features		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 - $\varnothing 25 \times 105$ length Sensor - $\varnothing 8 \times 30$ length Sensor-electronics cable - 750 length nominal	Electronics - $\varnothing 25 \times 105$ length Sensor - $\varnothing 8 \times 30$ length Sensor-electronics cable - 750 length nominal
Mounting	<i>Mag-03MC-BR</i> bracket available*	<i>Mag-03MC-BR</i> bracket available*
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	-40°C to +70°C	-40°C to +70°C
Intermittent	-40°C to +85°C	-40°C to +85°C
Weight	80g	80g

*Bracket is only suitable for the electronics enclosure

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



Mating Connectors

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



Cables

All cables for connection of the **Mag-03** range of sensors to the **Mag-03PSU**, **Mag-03DAM** or **Mag-03SCU** are supplied in 5 metre lengths, with alternative lengths to 600 metres on request.

Specification

<i>Mag-03MSS</i> cable	polyurethane jacket, diameter 10mm, 3 pairs of individually screened conductors
All other cables	PVC jacket, diameter 5.9mm, 6 conductors



Mag-03MC-BR

Mounting Bracket

This bracket is supplied for use with the cylindrical range of **Mag-03** sensors.

Specification

Dimensions (mm)	55 x 55 x 36
Material	Tufnol



Mag-03

Calibration Units

These battery-powered units produce a sinusoidal alternating magnetic field of defined frequency and magnitude. The units provide a reference magnetic field for checking the calibration of the **Mag-03** sensors. 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.

Specification

Sinewave magnitude	50 μ T p-p (17.5 μ T rms) \pm 1% (distortion 5% typical)	
Frequency	190Hz \pm 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	
	Mag-03MSS-CU	Mag-03MS-CU
Dimensions (mm)	100 dia. x 117 length	100 dia. x 125 length
Weight (g)	1100	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-03IECU	Mag-03IE

Spectramag-6

Six-Channel Spectrum Analyser for Magnetic Field and Vibration Surveys



Spectramag-6 is a six-channel, 24-bit data acquisition and spectrum analysis system, designed for use with the Bartington Instruments **Mag-03** range of 3-axis fluxgate magnetometers. In addition to magnetometers, the system 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.

The system consists of an interface unit and Windows® based PC software. The interface unit 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 software version from the internet.

Main Features

- 6-channel, simultaneously sampled, 24 bit data acquisition
- Magnetic Field and Vibration measurement inputs
- Time domain and Frequency domain display, with zoom facility
- 100µs to 10s sample intervals
- Fixed scan length or continuous acquisition mode (sample rate dependent)
- Compatible with all **Mag-03** and **Mag-01MS** magnetometers
- Direct connection of ICP accelerometers or microphones
- Programmable pass/fail test profiles for time & frequency domains
- Software based instrumentation – permits easy upgrades
- Operates under Windows® 98, 2000 or XP
- Operates from mains power or internal, rechargeable battery – use in the field, with a laptop PC

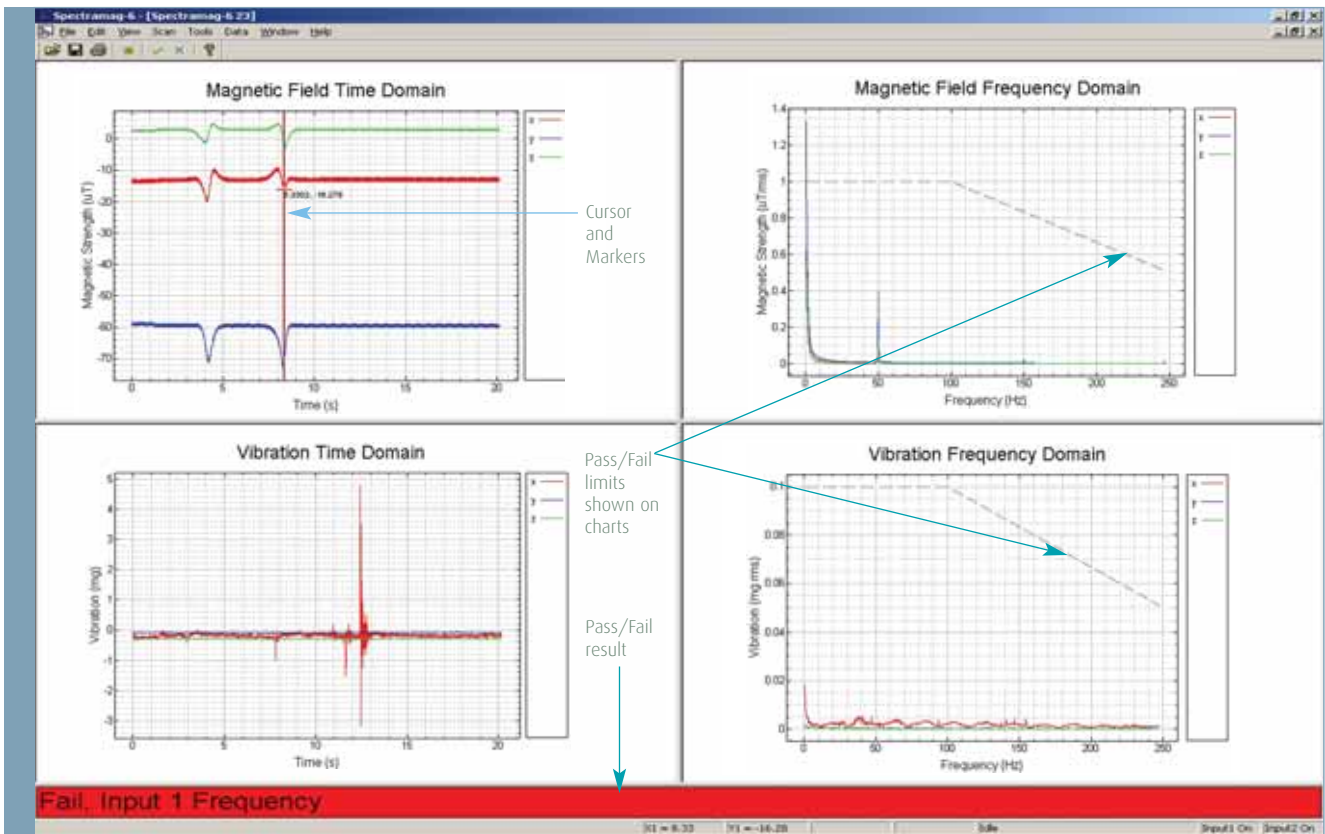
Additional features

- Averaging for Frequency domain plots,
- Total field magnitude (xyz vector sum)
- Selectable front-end gain amplifier
- Choice of various FFT windowing functions
- Display cursors
- Data can be exported as graphics in bitmap or JPG format, or as time-stamped data values
- Results scaled in engineering units for standard range of sensors.

Optional accessories

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

Typical Spectramag-6 Display



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 3-axis magnetometers
 - One 3-axis magnetometer and up to three single-axis accelerometers
 - Up to six single-axis accelerometers

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	DC or AC selectable with 0.01Hz (-3dB) high-pass filter
Accelerometers	AC with 0.1Hz (-3dB) high-pass filter
Sampling Interval	100 μ s (min) to 10s (max) Up to 100,000 samples (PC dependent) Continuous sampling mode (slower sample rates only)
Frequency range	0-3.5kHz (-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 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 (mm)	210 x 170 x 112
Weight (kg)	2.85
Operating temperature	-10 $^{\circ}$ C to +50 $^{\circ}$ C
Storage temperature	-10 $^{\circ}$ C to +70 $^{\circ}$ 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 (mm)	610 x 230 x 200
Total weight with carrying case	12kg with <i>Spectramag-6</i> , <i>Mag-03</i> 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. 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 and separate controls are provided for each channel.

Specification

Input channels	3 from <i>Mag-03</i> three-axis magnetic field sensor (X, Y & Z)
Input signal range	±18V maximum - surge protection with ±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 ±10V
Offset control - coarse fine	10 turn potentiometer with polarity switch for each channel centre-off position potentiometer
Thermal drift	≤6mV/hour for filtered/null signal output with gain = 300
System noise	minimum discernible input signal variation of ±0.1mV with signal/noise ratio of ≥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	±12V, ±15V, ±17V at 250mA, ripple <1mV p-p, short circuit protected, surge protection provided with ±18V clamp
Dimensions (mm)	483 width (19" rack) x 88 height (2U) x 300 depth
Weight	5.5kg
Display	3 x 3 1/2 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) 10-way Hirose RM15TRD10P 6 x BNC sockets



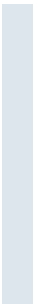
Mag-03PSU

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 (mm)	133 x 84 x 46
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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