Bartington®
Instruments

# *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 ±1000μT in a range of enclosures as detailed below. Powered from any ±12V supply, outputs are in the form of three analog voltages from 0 to ±10V, proportional to Bx, By and Bz.**

The sensors are available with three levels of noise performance. The Low Noise version exhibits a noise level of <6pT (rms per √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 70μT or 100μT 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.

***Mag***-03MC

***Mag***-03MS

***Mag***-03MSS

***Mag***-03IE

## 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 +/-70μT,
***Mag***-03MC1000 is a Standard sensor with a cylindrical enclosure and a range of +/-1000μT,
***Mag***-03MSESB250 is a Basic sensor with a square section enclosure, an environmentally sealed connector and a range of +/-250μT

*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.

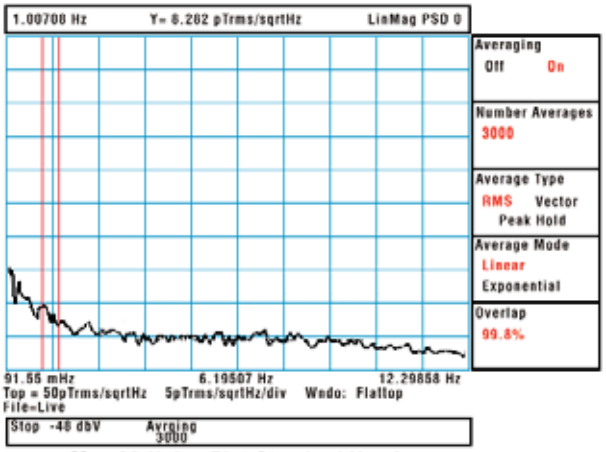
## Performance specification

| | |
|---|---|
| Supply voltage | ±12V to ±17V |
| Analog output | ±10V (±12V supply) swings to within 0.5V of supply voltage |
| Power supply rejection ratio | 5µV/V |
| Output impedance | 10Ω |
| 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 *Mag*-03IEv1&2 on request) |
| Orthogonality error - | |
| between sensing axes | <0.5° (<0.1° for *Mag*-03MS and *Mag*-03MSES) |
| 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 | 11-20pTrms/√Hz at 1Hz |
| Standard version | 7-10pTrms/√Hz at 1Hz |
| Low noise version | <6pTrms/√Hz at 1Hz |
| Supply current - | |
| Standard version & Basic version | +35mA, -6mA (+1.4mA per 100µT for each axis) |
| Low noise version | +26mA, -6mA (+1.4mA per 100µT for each axis) |

## Scaling dependent parameters

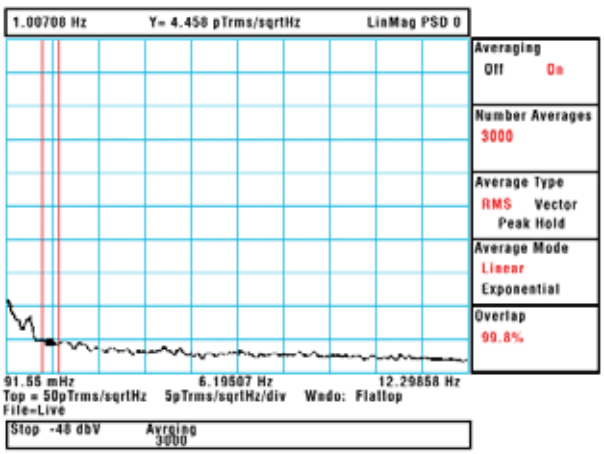
| | | | | | | |
|---|---|---|---|---|---|---|
| Measuring range | ±70 | ±100 | ±250 | ±500 | ±1000 | µT |
| Scaling | 143 | 100 | 40 | 20 | 10 | mV/µT |
| Offset error | ±5 | ±5 | ±12 | ±25 | ±50 | nT |
| Scaling temperature coefficient | +15 | +20 | +50 | +100 | +200 | ppm/°C |
| Offset temperature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

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




*Mag*-03 Noise Plot Standard Version

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




*Mag*-03 Noise Plot Low Noise Version

## 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<br>Electronics - Aluminium alloy | Sensor - Moulded epoxy<br>Electronics - moulded silicone |
| Dimensions (mm) | Electronics - ø25 x 115 length<br>Sensor - ø20 x 54 length<br>Sensor-electronics cable - up to 5000 length to order | Electronics - 21 x 12 x 105 length<br>Sensor - ø20 x 54 length<br>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<br>Electronics - Aluminium alloy | Sensor - Glass tube with epoxy filling<br>Electronics - Aluminium alloy |
| Dimensions (mm) | Electronics - ø25 x 105 length<br>Sensor - ø8 x 30 length<br>Sensor-electronics cable - 750 length | Electronics - ø25 x 105 length<br>Sensor - ø6.5 x 30 length<br>Inner cable - 1100 length (or up to 5000 to order)<br>Outer cable - 140<br>Inner and outer cable joined by re-solderable terminal block |
| Mounting | *Mag*-03MC-BR bracket available* | *Mag*-03MC-BR 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<br>Electronics - Aluminium alloy | Sensors - Alumina cylinder<br>Electronics - Aluminium alloy |
| Dimensions (mm) | Electronics - ø25 x 105 length<br>Sensor - ø8 x 30 length<br>Sensor-electronics cable - 750 length nominal | Electronics - ø25 x 105 length<br>Sensor - ø8 x 30 length<br>Sensor-electronics cable - 750 length nominal |
| Mounting | *Mag*-03MC-BR bracket available* | *Mag*-03MC-BR 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

| | |
|---|---|
| *Mag*-03MSS 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 | 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 | |
| | ***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

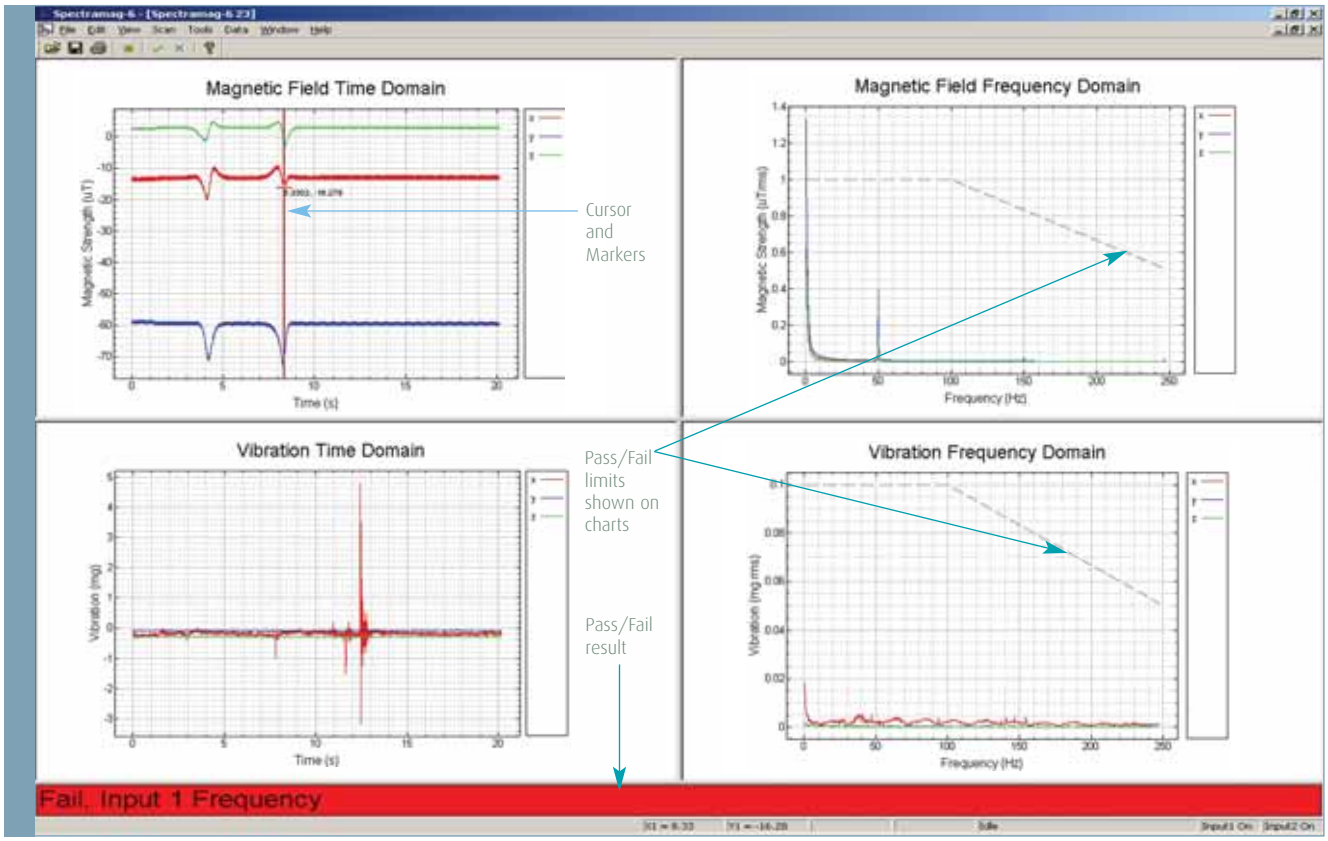
- Averaging for Frequency domain plots,
- Total field magnitude (xyz vector sum)
- Selectable front-end gain amplifier
- Choice of various FFT windowing functions
- Display cursors
- Data can be exported as graphics in bitmap or JPG format, or as time-stamped data values
- Results scaled in engineering 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 ±1000μT (±10Gauss) 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<br>Magnetometers<br>Accelerometers | <br>DC or AC selectable with 0.01Hz (-3dB) high-pass filter<br>AC with 0.1Hz (-3dB) high-pass filter |
| Sampling Interval | 100μs (min) to 10s (max) Up to 100,000 samples (PC dependent)<br>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) | 1MΩ |
| ICP® constant current | 4mA ± 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<br>6 x BNC sockets for ICP® piezoelectric vibration sensors/microphone preamplifiers<br>1 x usb to PC<br>1 x 2.1mm socket for 12V input from mains adaptor for recharging |
| Frequency domain display options | Amplitude spectrum (RMS)<br>Amplitude spectral density (RMS/√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°C to +50°C |
| Storage temperature | -10°C to +70°C |
| Suitable ICP® vibration sensor | PCB Piezoelectronics type 393A03 (1V/g) low-noise rugged<br>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 *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. 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 *Mag*-03 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 | 10 turn potentiometer with polarity switch for each channel |
| fine | 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 ¾ 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 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 | 3-way IEC with integral filter (mains cable provided) |
| sensor input | 10-way Hirose RM15TRD10P |
| analog output | 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 | HRS RM15TRD10P |
| analog outputs | 3 BNC connectors |
| battery charger inlet | 2.1mm socket |

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