DATA SHEET
Issue 4

October 2005

FM256

Upgrades from FM18/36 to FM256 also available

Single / Dual Fluxgate Gradiometer System

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FM256 Features

- Integral data logger, 256000 readings, 15 min. full download
- Integral sample trigger, variable rate : 1m mark beep 0.4s - 4.0s
- Square or rectangular grid sizes : 10 to 100m
- Independent sample and traverse intervals : 1 to 16 samples/m
- Automatic and digital averaging under sample trigger control
- Ranges : +/-20000nT, +/-2000nT, +/-200.0nT
- Logged Resolution : 5nT, 0.5nT, 0.05nT per range
- External compartments for main and memory batteries
- LCD backlight and contrast adjustment for poor light conditions
- Simple one button start/stop control
- NiMH battery, 21 hour operation, 4hr fast charge (LED status)
- International voltage and pin sets for charger
- Rugged, reliable construction, excellent sensor stability

Dual Gradiometer System

- Flexible : use two instruments together for double speed / increased density surveys or use the two instruments separately at different sites as needed
- Master/slave system accepts FM18/36 or FM256 slave
- Interleaving gives 0.5m or 0.25m traverse intervals
- Simple data merge facility in Geoplot
- Open frame design gives rapid operator turn-around (not system) for zig-zag surveys, avoiding introduction of heading errors
- Integral master start/stop controls on frame
- Collapsible, lightweight, well balanced frame
- Removable legs for use in very overgrown areas

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FM256

Single / Dual Fluxgate Gradiometer System

Introduction

The FM256 Fluxgate Gradiometer System is designed as a one man rapid location, mapping and identification system for a wide range of targets, which can be archaeological, environmental, utility services, geological or military in origin. Archaeological targets include fired structures such as kilns, furnaces, hearths and ovens, and structures with an enhanced magnetic susceptibility such as pits, ditches, enclosures, field systems, barrows etc. Other targets include environmental waste, oil drums, pipelines, cables, unexploded ordnance and geological formations.

The FM256 can be operated as a single stand alone gradiometer or in dual gradiometer mode. The dual mode uses two instruments carried together to double the survey speed or, using interleaving, provide increased survey density (double or quad). Integration with Geoplot software provides excellent data capture, processing, analysis, graphics, interpretation and presentation facilities.

FM256 Gradiometer

The FM256 instrument can be used in either scanning mode, to search rapidly for disturbed areas, or in logging mode, where detailed data are collected in parallel or zig-zag traverses. The data-logging facilities, with integral sample trigger, provide powerful functions for fast and efficient surveying, keeping track of survey position, and giving both audible and visual indication of current survey position. Data can be collected at up to 16 samples/m and stored in a 256000 reading memory.

Readings are displayed on an LCD display in either digital or analogue bar-graph form, the latter being useful for scanning. Backlight control for the LCD display enables work to continue in poor light conditions or short winter days; contrast adjustment improves visibility over temperature extremes. A Real Time clock facility is included which can be used to monitor progress since wristwatches are too magnetic for operators to wear. A Hold facility, which freezes the reading, is provided to allow easy sensor balancing. Although not often required, owing to the excellent stability of the instrument, any change in the instrument zero may be logged at the end of each grid and used to correct for drift. Geoplot software has standard processing routines that usually make drift correction logging unnecessary.

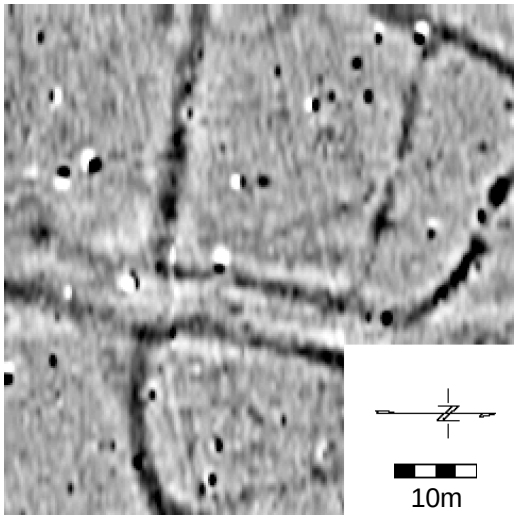
Cost effective upgrade routes allow existing FM18 and FM36 users to convert their instruments to FM256 specifications - see later section.

Data Logger

Readings are logged in a 256000 reading non-volatile memory which may be partitioned into square or rectangular grids with dimensions of 10, 20, 30, 40, 50 or 100m - typically these are 20m or 30m square grids. The wide range of grid sizes allows you to tailor logging to your survey requirements. Sample and traverse intervals can be set to 1, 2, 4, 8 or 16 samples per metre, with 16 samples giving maximum resolution. The data logger keeps track of survey position, displaying the current grid, line and position and provides audio feedback. Instead of menu systems, the front panel has been designed to provide fast and direct access to logging functions using 8 dedicated keys. Readings and lines of readings taken by mistake can be deleted with one keystroke. A dummy reading can be inserted if a physical obstacle prevents a true reading being taken or a line may be completed with dummy readings, again with one keystroke. In zig-zag surveying these “Finish Line” dummy readings can be imaged with one keystroke - see keypad layout opposite. The 256000 reading memory is sufficient for 35 x 30m x 30m grids at 8 samples/m or 80 x 20m x 20m grids at 8 samples/m (about 3 hectares), allowing a full days data collection with no data transfer. Data is downloaded to a PC via an RS232 interface, typically into Geoplot or any other suitable program. Downloading the full 256000 readings takes as little as 15 minutes, depending on the output format chosen - 5 are provided. Logged data can be inspected without having to download first, allowing the user to monitor data quality as the survey proceeds.

Sample Trigger or Manual Logging

Data logging is usually performed under control of an integral sample trigger but can also be done manually, one reading at a time. Logging is usually performed using the start/stop switch or the keypad. If preferred, an external hand-log key is available for manual or sample trigger logging. Sample trigger logging provides increased data sampling and enhances data quality and interpretation without increase in survey time. Pressing the start/stop switch initiates a sequence of "beeps" that sound every metre whilst internally the gradiometer logs readings at the set sample interval. The operator walks along the survey line at a pace that ensures the "beeps" coincide with 1m marks along the tape - with practice the tape can be dispensed with for even faster surveys. The "beep" rate is variable between 0.4s and 4.0s, in 0.02s steps. Data can be logged at 8 samples/m at an average rate of 0.8s/m or faster, according to site. If a reading goes over-range, this is recorded in the data and is distinguishable from dummy readings. Both manual and sample trigger logging can operate in the digital averaging mode for improved data quality.



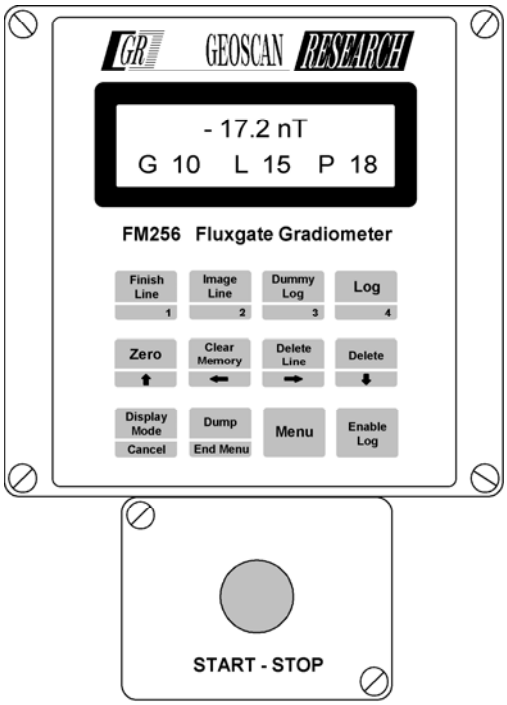
Example FM256 survey over a Romano-British enclosure, field heavily ploughed. Features of 1nT or less are visible. Plot range +3 to -3 nT.

Digital Averaging

The FM256 automatically integrates the readings at all times so as to minimise system noise. Digital averaging can be selected to improve further the signal to noise ratio, useful on sites where anomaly strength is comparable with system noise. A wide range of averaging cycles (2 to 32), allows the user to optimise the trade off between significant noise reduction and optimum speed. Digital averaging is automatically used when Zeroing and using Log Zero Drift for improved accuracy.

Power System

The FM256 is powered by 2 "C" sized cells, either a NiMH battery pack with temperature sensor or 2 standard alkaline cells mounted in the holder provided. The instrument operating period with NiMH cells is 21 hours without LCD backlight, 15 hours with LCD backlight (44 hours and 31 hours respectively for alkaline cells). The NiMH cells can be fast charged in 4 hours from the universal voltage power supply which is supplied with worldwide pin adapters (the charging circuit prevents accidental charging of alkaline cells). Charging status (fast or trickle) is shown by a dual colour LED. Operation from standard alkaline cells allows operation in remote locations with no charging facilities. A separate, easily obtained, lithium battery is used to backup the non-volatile memory for up to 10 years. The main and backup batteries are housed under the instrument housing in two separate sealed compartments with external access, making battery changes simple. This preserves environmental seals and isolates any alkaline battery leakage.



Practicality and Design

The FM256 builds upon the rugged and reliable design of its predecessor, the FM36, making it an instrument that can be used in a diverse range of demanding environments, such as harsh desert conditions, the tumbles of student field courses, time critical commercial surveys and peace time military environments. The design retains the proven benefits of a 0.5m sensor separation which gives good mobility, good ground clearance and the option to carry the instrument higher above the ground. This flexibility allows it to operate in scrubland, brushwood, long grass and in other overgrown areas, where other sensor systems operating nearer the ground may be difficult to use. The use of a short tube means it is much less prone to buffeting by the wind which can introduce significant measurement errors. A 0.5m sensor separation provides good rejection of signals from nearby ferrous clutter such as iron or barbed-wire fences allowing you to survey close to such interference.

The versatile and ergonomic design incorporates many features requested by FM36 users, provides an economic upgrade route for existing FM18 / FM36 users and can be expanded into a dual gradiometer system. Environmental sealing to IP65 standard or better is used and a gold connector system is used internally for maximum reliability, especially in higher humidity climates. A rugged tube is used to support the fluxgate sensors which are housed in a robust outer case. A geared alignment system provides excellent stability and very fine control when aligning the sensors for optimum performance.

FM256

Single / Dual Fluxgate Gradiometer System

FM256

Single / Dual Fluxgate Gradiometer System

Dual Gradiometer System

The dual gradiometer system uses two instruments carried together either to double the speed at which a survey can be made or to increase the sampling density of a survey. Basing the system on two individual gradiometers gives optimum flexibility since they can also be used separately at different sites when required.

A three sided carrying frame, the CF6, supports the two gradiometers. One FM256 acts as a master sample trigger which controls a second slave gradiometer - this can be either another FM256 or an FM18/36. Once data sets have been collected in the two gradiometers they are downloaded, and assembled into two individual composites as normal. The two data sets are then easily merged together to form the final composite - Geoplot provides for this in one simple operation.

The system can be used in either parallel or zig-zag survey mode. When used in zig-zag mode the operator, not the frame, turns around at the end of a traverse, thereby avoiding the introduction of direction dependent heading errors. Since there is no need for restrictive harnesses, turnaround is very rapid. The start/stop sample trigger button on the FM256 is replicated twice on the frame to cater for operator orientation during zig-zag surveying. Logging is simply performed by pressing the start/stop button. The four legs allow the system to be rested on the ground anywhere during survey - no need to return to a centralised support tripod. The frame is designed to support just one gradiometer at a time when resting on the ground, allowing each gradiometer to be aligned individually. The frame can also be used with the legs removed for operation over very overgrown areas.

Variations in angular orientation can introduce heading errors into the data collected. Using a handheld frame, in contrast to other instrument support systems, provides the user with greater awareness and control of angular variations which significantly improves the quality of the data collected. The sturdy frame is well balanced and easy to use even in long undergrowth, and can be lifted easily over other obstacles. The frame is very lightweight, packs flat and is easy to assemble and transport.

Double Speed Surveys

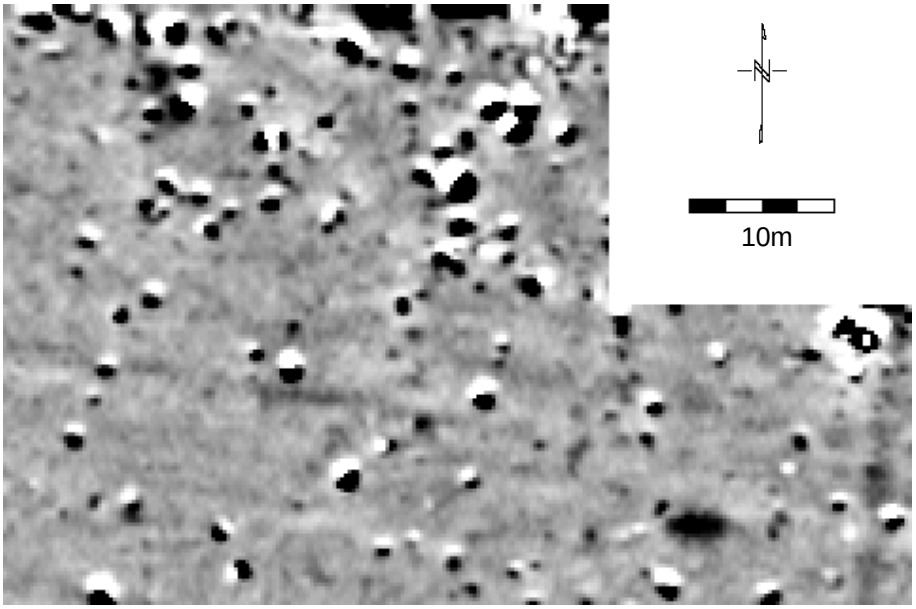
Double speed surveys are carried out by making traverses with the system every 2m, rather than the normal 1m traverse interval for a single gradiometer. This mode is very useful for rapid evaluations. Traverses may be either parallel or zig-zag and sample interval can be up to 16 samples per metre. A guide marker on the centre of the frame helps you maintain alignment with guide tapes (if used). Area coverage for evaluation surveys is very rapid : a 20m x 20m grid can be surveyed in about 3 minutes using zig-zag traverses, sample interval of 0.25m, sample trigger rate of 0.7s/m and 1m traverse interval.

Increased Sample Density Surveys

Increased sample density surveys can be achieved by modifying the traverse pattern. Surveys with traverse intervals of 0.5m (double density) and 0.25m (quad density) can be achieved in half the normal time for a single gradiometer. The increased sampling density mode is useful for detailed evaluations or research applications where high resolution maps of sub-surface structures are required. The quad density mode is especially useful in this respect - see example survey 2 below. Traverses may be either parallel or zig-zag and the sample interval can be up to 16 samples per metre. Walking the modified traverse pattern is straightforward, and guide markers on the frame help you maintain alignment with guide tapes (if used). The resulting interleaved data pattern is simply merged together using software - again Geoplot provides for this in one simple operation.

Example Survey 1

The survey shown below was collected in double density mode. Grid dimensions were 20m, data was collected in zig-zag traverses at 4 samples per metre and the resultant traverse interval of the merged data is 0.5m. Trigger rate was set at 0.8s/m. Roughly a third of the site was covered with grass and nettles to the height of the frame yet this was successfully navigated with the dual system with no obvious signs of impairment in data quality. Several sub 1nT traces of ridge and furrow running E-W are visible, along with many ferrous responses - no destagger corrections were required to align the ferrous responses between adjacent traverses.

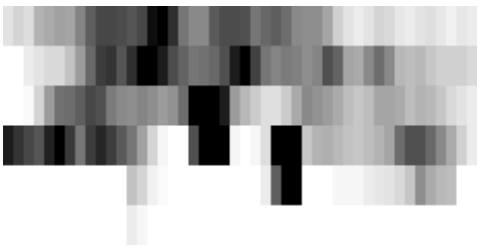


Double density survey made with a dual gradiometer (FM256 and FM36) Plot range +3 to -3 nT

Example Survey 2

The results below compare the difference between raw data collected with a normal 1m traverse interval and data collected in quad density mode. Data were collected with parallel traverses in both cases at 4 samples per metre and with a trigger rate of 1s/m. The resultant traverse interval of the quad density data is 0.25m. The improvement in detail shown in the quad density survey is very striking. Even greater resolution is possible with the FM256 if sampling is increased from 4 to 16 samples per metre.

Quad density survey (0.25m x 0.25m) Plot range +5 to -5 nT



Standard survey (0.25m x 1m) Plot range +5 to -5 nT

FM256

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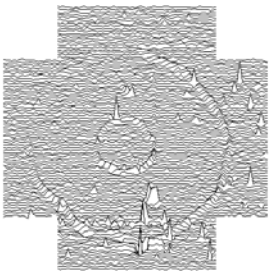

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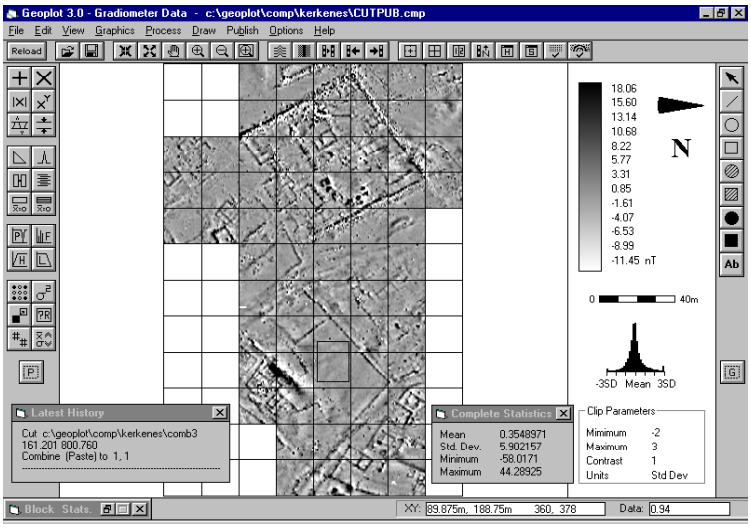
Data Quality - Processing and Analysis with Geoplot

To realise the full potential of magnetometer data, sophisticated data processing and analysis is essential. Geoplot software provides this support in the FM256 system. It provides simple download and dual gradiometer data merge facilities, combined with excellent graphics, editing, processing, analysis, interpretation, presentation, import and export facilities.

Often only minimal processing will be required before analysis and presentation. However, in common with all magnetometers, there will be noise present in the data which reflects a combination of soil noise, instrument noise, and field (operator) noise. This can limit feature detection when operating near measurement limits. Geoplot's comprehensive range of functions provides the means to reduce significantly these noise components, allowing very weak features to be detected. Data analysis can further extend the confidence with which features are identified.



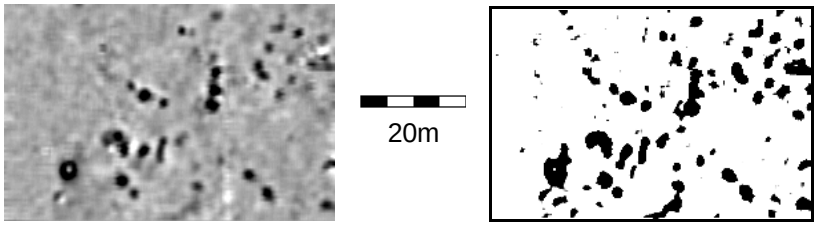
Processing

Geoplot's toolkit of specialised processing functions include the following : Absolute, Add, Clip, Compress, Cut and Combine, Deslope, Despike, Destagger, Edge Match, High Pass, Low Pass and Median Filters, Interpolate, Multiply, Periodic Filter, Power, Randomise, Search and Replace, Spectrum, Standard Deviation / Variance Map, Zero Mean Grid, Zero Mean Traverse. Correct processing of the data shown on the right using Geoplot results in an overall noise level of 0.1nT - this processing was achieved even in the presence of very strong and extensive ferrous responses. In another example, a 50cm thick Pueblo midden was detected (and confirmed by excavation) 1.9m below sand and clay layers and registered as a 0.05nT anomaly after appropriate processing.

Correct processing results in noise levels of 0.1nT, including soil, instrument and field (operator) noise. Plot range -3nT to +3nT.

Analysis

Geoplot provides a number of analytical tools including statistics, spectrum, standard deviation maps. Particularly useful for gradiometer data is statistical detection, illustrated by the data set below. A collection of weak hearths are visible in the left hand plot. A combination of high sampling density and appropriate data processing results in a background noise level of 0.13nT. This includes soil, instrument and field method noise. Setting a detection threshold of 2.5 standard deviations (high statistical confidence), reveals a large number of hearths (right plot) subsequently confirmed by excavation.



Statistical detection reveals a large number of hearths 0.3nT or greater in a background noise of 0.13nT after processing. Plot range -1nT to +2nT.

Upgrading from FM18/FM36 to FM256 System

If you have an FM18 or FM36 then a very cost effective way of improving your survey system is to upgrade your existing instrument to an FM256. If you have two FM18's or FM36's then upgrading only one instrument and using the other as a slave will give you a dual gradiometer system with all its associated benefits. Alternatively, you can purchase a new FM256 and use this with an existing FM18/36 to create a dual system with the FM18/36 again acting as a slave. These routes considerably reduce the overall cost of long term ownership, maintains the value of your investment and improves productivity.

The upgrade involves replacing the electronics housing and its internal electronics (ie half the instrument) but retains the existing sensors in their tube and the carrying handle. We can modify existing carrying cases to take the new outline of the FM256 instrument and the standard FM256 system accessories will be slotted into the existing cut-outs. Alternatively a new carry case can be obtained with cut-outs to the new layout. A new manual, data dump lead and charger is supplied as part of the upgrade. Please note that the upgrade does not include any refurbishment to the existing tube or carrying handle - if these are in very poor condition then this may have an influence on the feasibility of an upgrade. Please consult with Geoscan Research if in doubt.

After confirming suitability for upgrade instruments should be returned to Geoscan Research, except in North America, where instruments will be returned to Geoscan Research (USA). Other overseas customers should consult with their local agent, where applicable, to make arrangements.

Accessories Supplied

A single FM256 is supplied with a robust padded carry case for transportation, an instruction manual, a data dump lead, a universal charger with adapter pins sets, a set of balance alignment tools, a screwdriver and a battery holder for alkaline batteries. The carrying case has compartments designed for the standard items provided plus compartments for any additional items. Dual FM256 systems are supplied with a carrying case which allows for the transportation of two instruments together with a double set of accessories. The carrying case also has a compartment to take the legs of the CF6 dual carrying frame.

Carry case for dual gradiometer

The FM256 manual is very comprehensive and provides all the information you need, even for non-technical users new to magnetic surveying. It includes chapters on system assembly, operation, field procedure, data processing, troubleshooting and several appendices. Most users find our manuals more than sufficient for their needs, but if you require additional support this is always available. Our website also provides further information and support.

Optional Accessories

An optional external hand-log key, with a 1.2m lead, is available for manual logging or for controlling the integral sample trigger if preferred. See adjacent photograph. A CF6 carrying frame is available for dual gradiometer systems, complete with legs and spares - see earlier section for details. Spare rechargeable NiMH battery packs are available. For upgrades from single FM256 to dual FM256 systems a dual carrying case can be supplied as an optional extra to accommodate two instruments (moulded sensor tube only).

External hand-log key

Guarantee

The equipment supplied by Geoscan Research is guaranteed against defective material and faulty manufacture for a period of 12 months from the date of despatch. Our responsibility is in all cases limited to the cost of making good the defect in the instrument itself. The guarantee does not extend to third parties or other equipment, nor does it apply to defects caused by abnormal conditions of working, accidents, neglect or wear and tear.

Acknowledgements for use of data
Northamptonshire Archaeology Unit
Towton Battlefield Archaeological Survey Project (T. Sutherland)
Kerkenes Project (Dr. G. Summers)
Geoscan Research USA (Dr. L. Somers)

FM256

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Upgrades from FM18/36 to FM256 also available

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Typical Specifications (FM18/36 can be upgraded to these specifications)

GRADIOMETER

Sensor separation	500mm		
Operating field range	+/- 100 uT, no latch-up for larger fields		
Analogue ranges	+/- 5, 10, 20, 40, 80, 160, 320, 640 nT		
Digital ranges	+/- 20000 nT	+/- 2000 nT	+/- 200 nT
Digital display resolution	10 nT	1 nT	0.1 nT
Data storage resolution	5 nT	0.5 nT	0.05 nT
Response time	20 mS	40 mS	120 mS
Display update rate	Digital - 3 readings/s. Analogue - 9 readings/s		

LOGGER

Memory capacity	256000 readings
Data retention time	> 10 years at 25 degrees C (CR2450 coin cell)
Integral Sample Trigger 1m mark beep rate	0.4 - 4.0 S, adjustable in 0.02S increments
Grid dimensions (length, width independent)	10, 20, 30, 40, 50, 100m
Sample and Traverse Intervals (independent)	0.0625, 0.125, 0.25, 0.5, 1m (plus 2m Traverse Interval)
RS232 baud rate	600, 1200, 2400, 4800, 9600, 14400, 19200 baud
RS232 output	TXD, GND, CTS, RTS with handshake
Typical download time	15 minutes for 256000 readings with fastest data format

GENERAL

Power Supply	2 x C Nickel Metal Hydride, rechargeable 3500 mAH battery pack 2 x C Alkaline cells in holder
Battery life	21 hours (15 hours with LCD backlight) NiMH 44 hours (31 hours with LCD backlight) Alkaline
Working temperature	-10 degrees C to + 50 degrees C
Environmental rating	IP65 or better
Instrument weight (including batteries)	2.5 Kg (5.5 lb)
Instrument dimensions	620 x 380 x 120 mm
Single gradiometer carrying case dimensions	820 x 490 x 230 mm

CHARGER

Output	750mA at 7.5V constant voltage (constant current fast/trickle charge system inside FM256). Can be used with vehicle adapters.
Charging time	4 hours (NiMH only)
Input voltage to charger	100-240 V, 47/63 Hz. International pins, UK, Euro, USA, Japan

DUAL GRADIOMETER

CF6 carrying frame weight, including legs	2.3 Kg (5.1 lb)
CF6 dimensions	1040 x 625 x 60 mm
Dual gradiometer carrying case dimensions	640 x 660 x 220 mm

All specifications subject to change without prior notice.

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