



GMS-2 MAGNETIC SUSCEPTIBILITY METER

User's Manual



# WARRANTY

*Fugro Instruments warrants the GMS-2 Magnetic Susceptibility Meter against defective components and workmanship for repair at the office of Fugro Instruments in Sydney, or authorised repair facilities free of charge for a period of twelve (12) months from date of sale. Shipment costs are to be borne by the customer. Malfunction due to improper use is not covered in this warranty. Fugro Instruments disclaim any liability for consequential damage resulting from defects in the performance of the equipment. The GMS-2 is not warranted as being fit for a particular purpose and there is no warranty of merchantability.*

*This warranty applies only if:*

- 1. The items are used solely under the operating conditions and in the manner recommended in the GMS-2 User's Manual;*
- 2. The items have not been misused or abused in any manner or repairs attempted thereon;*
- 3. Written notice of the failure within the warranty period is forwarded to Fugro Instruments and the directions received for properly identifying items returned under warranty are followed; and*
- 4. The return notice authorises Fugro Instruments to examine and disassemble returned products to the extent Fugro Instruments deems necessary to ascertain the cause for failure.*

*The warranties expressed herein are exclusive. There are no other warranties, either expressed or implied, beyond those set forth herein, and Fugro Instruments does not assume any other obligation or liability in connection with the sale or use of the said product. Any product or service repaired under this warranty shall be warranted for the unexpired portion of the original warranty period only.*

*This warranty does not apply to limited life components such as cables, etc.*



# CONTENTS

	<i>page</i>
1. Quick Operating Instructions .....	2
2. General Information .....	4
3. Description of Instrument .....	6
4. Menu Items.....	7
5. Detailed Operation .....	15
6. RS-232 Serial Interface .....	22
7. Trouble Shooting .....	25
8. Specifications .....	26

# 1. QUICK OPERATING INSTRUCTIONS

✱ The Execute Button

➤ The Scroll Button

⊙ The ON/OFF Button

To turn the instrument on Press ⊙.

To turn the instrument off Press ⊙ twice quickly or go to the Main Menu (press ➤) and select the "OFF" menu item and then press ✱.

When turned on the start-up screen will be displayed for about 2 seconds, then the instrument will go directly into measuring (reading) mode.

It is important to "zero" the meter to compensate for any background effects before the instrument is used to take measurements. To zero the meter, press ⊙ or ➤ to go to the Main Menu. Move the flashing ✕ indicator to select "Zero" if it is not already at this position by pressing the scroll button.



Now hold the instrument clear of any magnetic material and any electronic devices and press  $\odot$  to activate the Zero function. The unit will beep at one second intervals and a number will count in the bottom right of the display, indicating progress. When the number disappears, zeroing has been set. The time taken will depend on how much error must be compensated for and this process could take longer when inside buildings or near extraneous noise.

Readings can now be taken. Place the sensor end of the meter against sample. Measurements will be made where the sensor is indicated by the arrow. The display will include whether the reading is in SI or CGS Units. Either can be selected from the menu (*see section 4*).

It should be noted that to conserve power, the unit will turn OFF after 3 minutes, however this can be cancelled by going to the Main Menu and executing the Stay On item.



## 2. GENERAL INFORMATION

The GMS-2 Magnetic Susceptibility Meter is designed to measure the magnetic susceptibility of rock outcrops, rock samples and drill core.

The mineral that largely governs the magnetic behaviour of a rock, and which accounts for most of the susceptibility observed, is magnetite. The susceptibility of magnetite depends on several factors, such as the intensity of the magnetising field, the chemical composition of the magnetite and its grain size. Susceptibility can, however, be used to determine the magnetic abundance, provided that the Dependence between susceptibility and magnetic abundance is known.



## **Principle of Operation**

The function of the GMS-2 is based on electromagnetic induction. There are two coils placed orthogonally to each other in the detector head, which is mounted in the top of the unit's case. In the non-magnetic environment the voltage induced from the transmitter coil to the receiver coil is zero. When a rock sample is brought near the coils, a voltage which is proportional to the magnetic susceptibility of the sample is induced in the receiver coil. This signal is detected by a phase-locked amplifier and after rectification it is used to drive the circuitry for the display of the magnetic susceptibility readings. The reading is directly calibrated for susceptibility.



### 3. DESCRIPTION OF INSTRUMENT

The GMS-2 is designed as a one piece instrument with a graphics display for the presentation of the magnetic susceptibility values in both digital and analog format and also an audible tone of varying frequency related to the value. This allows the operator to find the peak reading using the analog display or the highest frequency sound and then record a digital value.

It has solid-state memory with the ability to label (with a flag) readings into groups.

The GMS-2 has an RS-232 port for the down loading of data to a PC computer either from the memory or in real-time.



## 4. MENU ITEMS

To go to the Main Menu press the  or  button. To scroll down through the menu items, press  (scroll button). To execute a menu item, press  when the flashing  indicator is next to the desired menu item.

### 4.1 Main Menu Functions

- |               |  |
|---------------|--|
| <b>OFF</b>    | Switches the GMS-2 OFF.  |
| <b>ZERO</b>   | When used in free air, the zero reference will accommodate any variations due to surrounding interference ( <i>see section 5.1 for more details</i> ).           |
| <b>SI/CGS</b> | Swaps between the display units of SI or CGS Units, for the operator's convenience and preference.<br>The units are related as follows: $k [SI] = 4 \pi k [CGS]$ |

- 
- STEP or SCAN** Switches between the continuous scan and the step modes of display operation.
  - BEEP ON or OFF** Switches the audio tone On or Off (only operates when meter is in SCAN Mode).
  - MEMORY** Selects the Memory Menu.  
*(see section 4.2 on Page 9 for details)*
  - HOST** Selects the host control menu for controlling the RS-232 output to the Host PC computer.  
*(see section 4.4 on Page 11 for details)*
  - STAY ON** Cancels the three minute auto-off power save feature.



## 4.2 Memory Menu

<b>MN MENU</b>	Returns to the Main Menu.
<b>MEMORISE</b>	Stores the currently displayed value to the next free memory location. When the memory is full, no more readings can be stored. Maximum is one hundred (100) readings. Readings are stored through power outages in non volatile memory.
<b>FLAG</b>	Sets a marker to the next free location (the next reading to be stored in memory). There are ten (10) markers available. Markers are stored through power outages in non volatile memory.
<b>RECALL</b>	Selects the memory Recall Menu ( <i>see section 4.3, p10</i> ).
<b>CLEAR</b>	Resets all stored readings and markers to zero.



### 4.3 Recall Menu

MN MENU	Returns to the Main Menu.
READ	Recalls the next reading from the memory.
GO FLAG	Allows you to jump to the next Flag in the memory.
SI/CGS	Swaps the display units for operator convenience.



#### **4.4 Host Menu** (for use when communicating via RS-232)

See also section 6.2 (p23) for details on use of the PC Communications Software.

**MN MENU** Returns to the Main Menu.

**RX MODE** (ie "Rx on") - Enables automatic transmission of readings from the GMS-2 to the PC. A reading will be sent each time the digital display is updated approximately once per second when GMS-2 is in SCAN mode. If unit is in STEP mode (ie. STEP is identified at the bottom of the screen), then readings are only output to the PC screen every time  is pressed.

***NOTE:** with Rx on, the 'R' and 'D' keys on the PC keyboard have no function - the GMS-2 still controls the readings output.*



## TX MODE

(Rx must be off for Tx to work - ie set "Rx off" and then "Tx on"). Enables the readings output to be controlled by the PC. By pressing the 'R' key on the keyboard, the GMS-2 will respond with the current reading (in the display units, SI or CGS). The user may request the GMS-2 to dump the internal memory by pressing the 'D' key on the keyboard. The GMS-2 will respond with the memorised readings (each one on a new line). Any flags that were inserted are indicated by an F (also on a new line).

If GMS-2 is in Step Mode: The last reading is sent to the PC every time the 'R' key is pressed but unless the user presses  each time to take a new reading, the value sent will always be the same. Pressing the 'D' key on the keyboard will Dump the memory.

If in Scan Mode: Values are output to the screen every second (automatically updated). Pressing the 'D' key at any time will dump the memory.



## HST SEND

Enables control of the readings sent to the PC to be controlled by the GMS-2 buttons. It basically sends the current reading to the PC.

If in Step Mode: Readings are output to the screen every time  is pressed if STEP is identified at the bottom of the screen.

If in Scan Mode: Readings are output to the screen every second. ie - same function as "Rx on".

In either modes: Pressing the 'R' key will dump the same reading each time and pressing the 'D' key will dump the memory.

## MEM DUMP

Transmits all readings in memory to the PC computer. Units that are selected on the front display will be those sent to the computer.

In Step Mode: Readings output to the screen every time  is pressed if DUMP is identified at the bottom of the screen.

In Scan Mode: Memory dumped every time  is pressed but values still output every second.

In either modes: 'R' key presses will dump the same reading and 'D' key presses will dump the memory.



## 5. DETAILED OPERATION

### 5.1 Start Up

To turn the GMS-2 on, push the  button and the start-up screen will appear for approx. 2 seconds. The unit will then go directly to the “display” screen with the analog and digital readings and the operating parameters visible.

It is recommended at this time to zero the unit in free-air by moving to the Main Menu screen by pressing the  or  key. Move the flashing  indicator to the “Zero” menu item and execute this function by pressing the  key making sure the instrument is clear of any surrounding metal objects.

The unit will beep at one (1) second intervals and a number will count in the bottom right of the display indicating progress. When the numbers disappear, the zeroing has been set. The time taken will depend on how much error must be compensated.



*NOTE: If it is desirable to bias out the effect of an interfering object (such as a core tray etc.) perform the 'zero' procedure in the relative position that the desired object will be in during readings but without the object and then measure the desired object. The sensor response is very narrow laterally but the depth of sensing can be more than 3 cm's. depending on the strength of the magnetic susceptibility.*

## **5.2 Modes of Operation**

The GMS-2 operates in two modes being continuous SCAN mode or single reading STEP mode.

**SCAN** updates the readings continuously for locating peak readings.

**STEP** reads each time the  button is pressed whilst STEP is displayed in the lower right corner of the display. The SCAN/STEP modes may be swapped by going to the Main Menu and selecting STEP/SCAN. The SCAN or STEP modes are annunciated in the bottom right hand corner.



As the STEP mode essentially takes a snap-shot of the magnetic susceptibility of the sample it may be preferable to use SCAN mode in most circumstances as it is easier to gain a feel in SCAN mode for the average reading on the sample before storing the value, due to normal fluctuations.

### **5.3 Bar Graph**

The bar graph is a log scale to base ten (10) and is capable of showing values between  $1 \times 10^{-5}$  SI units and 9.999 SI units. There are six bar columns displayed with values rising as the bar grows from the bottom to the top. The first column on the left displays values from  $1.0 \times 10^{-5}$  to  $10.0 \times 10^{-5}$  units, the second bar from the left displays values from  $10.0 \times 10^{-5}$  to  $100.0 \times 10^{-5}$  units and so on until the right most bar displays values from 1.0 to 10.0 units. The logarithmic nature of the bar columns is designed for easy discrimination over the range of meter operation.



## 5.4 Other Items on Front Display

To the right of the Bar Graph are the setup parameters and the memory and flags that have been used.

Starting from the top of this section is the following:

- The large digital display of the reading
- The displayed units ie. SI or CGS
- The mode of operation ie. STEP or SCAN
- The Beeper on or off ie. BEEP or MUTE
- The stay On Mode ie. OFF or ON
- Number of Flags used ie. F ##
- Number of Memories used ie. M####
- If the Batteries are low then this will be indicated by the word BATT
- The bottom right displays the function where the cursor is at in the Menus and which will action when the  button is pressed.



## **5.5 Battery Replacement**

The GMS-2 will display the message "BATT" to the right of the bar graph display when the batteries are exhausted. To replace the batteries, on the back face of the meter remove the lid by unscrewing the two screws and replace the batteries with two (2) Alkaline "AA" type batteries ONLY.

## **5.6 Other Important Points**

Selecting STEP mode when using memorise will freeze the display with the value just stored in memory. This saves the operator having to swap between memory save and recall when taking readings in inconvenient locations.



## 5.7 Drill Core Correction Factors

In general, if samples are too small so that air is sensed by the detector, the reading will be somewhat less than the true value. How much depends on actual dimensions but it is rarely more than half.

Correction factors for certain drill core sizes are given below:

### DRILL CORE CORRECTION FACTORS

CORE	DIAMETER	CORRECTION FACTOR
AQ	27mm	1.82 ± 0.02
BQ	33mm	1.77 ± 0.02
NQ	48mm	1.51 ± 0.02
HQ	62mm	1.44 ± 0.02
PQ	85mm	1.24 ± 0.02



## **5.8 Re-Zeroing the Meter**

When taking readings on samples of high magnetic susceptibility it may be necessary to re-zero the meter before taking readings again on samples of much lower sensitivity. This is due to remanent energy being stored in the sensor coil which will make readings with low magnetic susceptibility appear too high. The meter should be re-zeroed according to procedures outlined previously in Section 5.1 Start Up.



## 6. RS-232 SERIAL INTERFACE

The GMS-2 can communicate to a PC via an inbuilt RS-232 serial interface supplying RS-232 data to the host computer.

### **6.1 Operation**

The RS-232 on the GMS-2 operates at 2400 baud rate. Connect the serial interface cable supplied using the DB9 connector to go to the host computer.

Select "Host" from the Main Menu on the GMS-2 to set up the RS-232 output to the computer. See section 4.4 (p11) of this Manual for details regarding the Host Menu.



## 6.2 GMS2LINK.EXE

The software program GMS2LINK.EXE is used on the Host PC to set-up and communicate with the GMS-2. The program will allow for receiving and storing the downloaded data to a file. To install, simply copy the files from the floppy disk provided to a suitable directory on your computer and type GMS2LINK at that directory prompt and press ENTER.

The program has a pulldown menu system accessed by pressing the 'ALT' key on the PC keyboard with the appropriate command key:

- FILE (ALT-F)**      Open File - to open a valid file name to store the data.  
                         Save File - to store data into the open file.  
                         View File - to view the data in a particular file.  
                         Exit - to exit out of the program, the ESC key has the same result.



**COMMUNICATION (ALT-C)** Allows Communications with the GMS-2. Use this after the Open File Command have been set (as above). The GMS-2 controls what is being sent to the Host computer. If the Tx is set to ON (with the Rx set to OFF) in the GMS-2 then the R and D keys on the keyboard can be used. The Host Menu on the GMS-2 may be changed while in Communication. To get out of the Communication menu, use the ESC key. This will automatically save the data to the open file.

**UTILITIES** Insert Holder - allows for the insertion of a line header into the open file whenever required. You must first escape out of the Communications Menu.

When a file is open its name and path will be displayed below and to the right of the Menu line. The word SAVING will be present when data is being transferred to the file.



## 7. TROUBLE SHOOTING

The GMS-2 is a sophisticated measuring instrument and as such trouble shooting is rather complicated without special electronic equipment. Any unauthorised modifications or adjustments to the GMS-2 electronics will void the Warranty (see page 1).

If any operation described in this manual does not work, check the following:

1. Check that the battery has sufficient power.
2. Check and clean the battery contacts to make sure they are making a good contact.

If this does not rectify the problem, it will be necessary for the unit to be returned to Fugro Instruments for repair.

***IMPORTANT NOTE: Always ship the instrument without batteries.***



## 8. SPECIFICATIONS

### **Controls**

Three push button controls for the operation of the menu system and the complete control of the unit.

### **Analog / Digital Display**

- 128 x 64 pixel LCD Graphics Display.
- Displays both the digital and analog magnetic susceptibility readings and other menu item functions.
- Digital readout updates approx. 1 times per second Analog graphics readout updates approx. 10 times per second.
- Displays results in either SI Units or CGS Units.



## Technical Specifications

Sensitivity:	1 x 10 <sup>-5</sup> SI units
Resolution:	1 x 10 <sup>-5</sup> SI units
Signal Frequency:	760Hz
Sampling Rate:	10Hz
Power Source:	Two (2) Alkaline Type 1.5 volt "AA" Battery
Battery Life:	Better than ten (10) hours continuous use
Temperature Range:	Operating 0°C to 50°C Storage -40°C to 60°C
Humidity:	10 - 90% relative



## **Dimensions**

LENGTH	15cm
WIDTH	8cm
HEIGHT	3cm
WEIGHT	350g (incl. battery)

## **Accessories**

Leather carrying case

User's Manual

Serial Interface cable and software to give an RS-232 output for recording of data onto a PC from memory or in real-time.

*Due to a continual product development policy specifications are subject to change without notice.*



## **GMS-2 Magnetic Susceptibility Meter User's Manual**

© Fugro Instruments 2004

All rights reserved. No part of this manual may be reproduced, copied, stored or transmitted without prior written permission of the copyright holder.

This manual has been written to help users of the GMS-2 Magnetic Susceptibility Meter, to gain the most from the equipment. Whilst all reasonable efforts have been taken to ensure that facts are correct and advice given is sound, the user must accept full responsibility for the operation of their equipment and the interpretation of data.

Manufactured by:

**Fugro Instruments**

21 Mellor Street, West Ryde NSW 2114, Australia.

Phone: +61 2 8878 9000

Fax: +61 2 8878 9012

Email: [sales@fugroinstruments.com](mailto:sales@fugroinstruments.com)

Website: [www.fugroinstruments.com](http://www.fugroinstruments.com)

