OPERATING MANUAL

MODEL G-816/826 PORTABLE PROTON MAGNETOMETER

GEOMETRICS INC.
2190 FORTUNE DRIVE
SAN JOSE, CA 95131 USA
TEL: (408) 954-0522
FAX: (408) 954-0902

Operating Manual
Model G-816/826
Portable Proton Magnetometer

TABLE OF CONTENTS

LIST OF FIGURES

EG&G GEOMETRICS

WARRANTY

EG&G geoMetrics guarantees this instrument to be in perfect operating condition, fully tested, and complete as described for one full year beginning with the date of receipt but not to exceed fifteen months from the shipping date.

EG&G geoMetrics guarantees that all equipment offered for sale is free from defects in materials and workmanship, carefully tested, and in first class operating condition. In the event of malfunction, geoMetrics, at its own expense, will repair or replace any materials, equipment, or parts which prove defective or deficient under normal operating conditions. Unless altered by contract, the warranty period shall extend for one calendar year beginning with the date of acceptance, but will not exceed fifteen (15) months from the date of shipment.

Every effort has been made to ruggedize and protect the Gamma Ray Detectors for their intended use. Due to the fragile nature of the crystal detector assembly and difficult operating environments, geoMetrics' warranty does not include breakage of the crystal for whatever reason. geoMetrics does, however, warrant the detectors to be complete and fully operational to their published specifications at the time of delivery and to maintain the stated minimum resolution and performance for a period of one year.

EG&G geoMetrics reserves the right to perform warranty services FOB Sunnyvale or at the customer's installation site. EG&G geoMetrics is not responsible for delays or defects in the quality of results from misuse, mishandling, unauthorized modifications, installation, or other operation conditions outside its control.

WARRANTY SERVICE

If warranty service is necessary, or if technical advice is required, contact geoMetrics.

geoMetrics, Inc.
395 Java Drive
P.O. Box 497
Sunnyvale, CA 94086
Telephone: (408)734-4616
Cable: "GEOMETRICS" Sunnyvale
Telex: 357-435

geoMetrics International
Corporation
18 Gertrude Street
Arncliffe 2205 Australia
Telephone: 597-4544
Telex: AA 22624

Exploranium Division of geoMetrics
Services (Canada) Ltd.
436 Limestone Cresent
Downsview, Ontario, CANADA M3J 2S4
Telephone: (416)661-1966

GEOMETRICS, INC.

If any part of this instrument is returned to the factory for any reason, please include this completed form with the complete instrument or any individual part returned for repair. SHIP TO:

GeoMetrics, Inc.
2190 Fortune Drive
San Jose, CA 95131

(408)954-0522

EMAIL:

sales@mail.geometrics.com

support@mail.geometrics.com

Name _____

Company

Address

City, State, Zip, Country _____

Telephone _____

Please describe symptoms of trouble as completely as possible or detailed reason for return (use additional paper if required).

WARNING: This equipment generates, uses, and can radiate radio frequency energy and if not installed and used in accordance with the instructions manual may cause Interference to radio communications. As temporarily permitted by regulation it has not been tested for compliance with the limits for Class A computing devices pursuant to Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against such Interference. Operation of this equipment in a residential area is likely to cause interference in which case the user at his own expense will be required to take whatever measures may be required to correct the interference.

1.0 GENERAL INFORMATION

1.1 INTRODUCTION

The Model G-816/826 Portable Proton Magnetometer is a complete system designed for man-carry field applications requiring simple operation and stable measurements of the total intensity of the earth's magnetic field. The G-816/826 is accurate and has a sensitivity of + 1 gamma over a range from 20,000 to 90,000 gammas. Since the instrument measures total field intensity, the accuracy of each measurement is not affected by sensor orientation. The inherent simplicity of the G-816/826 Proton Magnetometer allows rapid, accurate measurements to be obtained from a rugged, compact field instrument. This is a precision instrument and reasonable attention must be given to handling, battery condition, and magnetic environment.

1.2 MAGNETIC ENVIRONMENT

It is important that the earth's magnetic field is not perturbed by allowing unwanted magnetic objects to come close to the sensor. Such objects include rings, keys, watches, belt buckles, pocket knives, metal pencils, zippers, etc. When the sensor is used on the staff, one gamma surveys are easily performed provided the sensor is kept at a distance of three feet (.9 m) from the operator. When the sensor is used in the backpack, certain articles of clothing and some types of batteries within the console will cause a five to ten gamma heading error in the readings. The G-816/826, however, still provides one gamma sensitivity and repeatability despite the presence of such a base line shift. The backpack feature is recommended for use in difficult terrain where "hands free" operation is required.

Prior to survey use, objects that are suspected to be magnetic may be checked in the following manner:

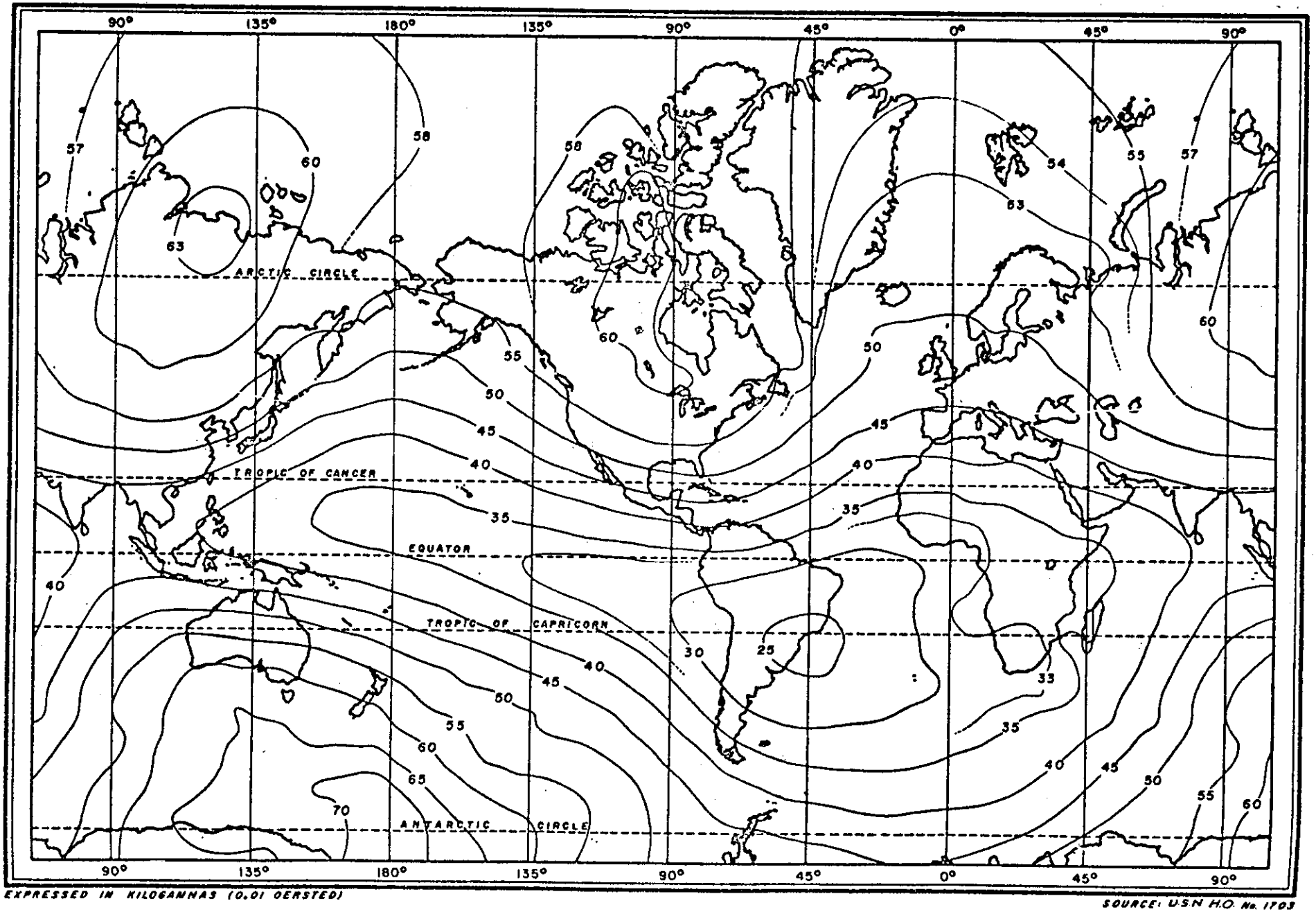
1. Attach sensor to staff and connect coiled signal cable to console. Sensor should not be moved or turned during the test, and the suspected article should be far away initially.

2. Cycle the magnetometer a few times by depressing the READ button--releasing--and waiting for a reading each cycle.

3. Observe measurement readings. Each reading should repeat to + 1 gamma. (A slow shift may occur over several minutes due to a diurnal change in the earth's field.)

4. Place the suspected article at the distance from the sensor expected during actual survey operation.

5. Cycle magnetometer several times and note the readings.



I be "Total Intensity of the Earth's Magnetic Field

6. Remove the article and repeat steps 2 and 3 to check for diurnal shifts in the earth's field. If a diurnal shift is present, repeat entire test.

7. If the readings obtained in step 5 differ by more than + 1 gamma (+ one count) from those obtained in steps 3 and 6, then the article is magnetic.

IF THE ARTICLE IS HIGHLY MAGNETIC, OR IF THE SENSOR IS INSIDE OR NEAR A BUILDING OR VEHICLE, THE PROTON PRECESSION SIGNAL WILL BE LOST, GIVING COMPLETELY ERRATIC READINGS AND LOSS OF + 1 COUNT REPEATABILITY.

The magnetometer should not be operated in areas that are known sources of radio frequency energy, power line noise (transformers), in buildings or near highly magnetic objects. The sensor should always be placed on the staff above the ground, or in the "backpack." The sensor will NOT operate properly when placed directly on the ground.

1.3 SPECIFICATIONS

Sensitivity:	+ 1 gamma throughout range.
Range:	20,000 to 90,000 gammas (worldwide).
Tuning:	Multiposition switch with signal amplitude indicator light on display.
Gradient Tolerance:	Exceeds 800 gammas/feet.
Sampling Rate:	Manual push button, one reading each six seconds.
Output:	Five digit numeric display with readout directly in gammas.
Power Requirements:	Twelve 1.5 volt "D" cell universally available flashlight-type batteries. Charge state or replacement signified by flashing indicator light on display.
Temperature Range:	Console and sensor: -40° to +85° C.
	Battery pack: 0° to +50° C (limited use to -15° C; lower temperature battery belt operation - optional).
Accurary (Total Field):	+ 1 gamma through 0° to +50° C temperature range.

Sensor:	High signal, noise cancelling, mounted on staff or attached to backpack.
Size:	Console: 3.5 x 7 x 11 inches (9 x 18 x 28 cm) Sensor: 3.5 x 5 inches (9 x 13 cm) Staff: 1 inch diameter x 8 ft. length (3 cm x 2.5 m)

Weight:

	Lbs.	Kgs.
Console (w/batteries):	5.5	2.5
Sensor and signal cable:	4	1.8
Aluminum staff:	2	.9
	11.5	5.2

1.4 INVENTORY INSPECTION

When received from the manufacturer, the G-816/826 Magnetometer should include the following items:

1.	G-816/826 Magnetometer console	1 each
2.	Sensor	1 each
3.	Collapsible sensor staff	1 each
4.	Signal cable-staff (long)	1 each
5.	Signal cable-backpack (short)	1 each
6.	Adjustable carrying harness	1 each
7.	Batteries: Type D Premium Carbon Zinc with cardboard jacket (12 each within console)	24 each
8.	Applications Manual for Portable Magnetometers	1 each
9.	Operator's Manual	1 each
10.	Storage/Carrying Case	1 each

2.0 FIELD OPERATION

2.1 INTRODUCTION

The G-816/826 comes complete and ready for field survey operation. A few simple procedures should be observed to obtain optimum results, and it is recommended that the operator follow each step as outlined to initially become familiar with the various controls and survey considerations.

2.2 TURN ON PROCEDURE

PRELIMINARY CONSIDERATIONS: BEFORE OPERATING THE G-816/826, CHECK FOR:

1. Presence of sensor fluid:

   Shake sensor and listen for "sloshing" sound. If it is necessary to add or replace the sensor fluid, remove blue "cap plug" and fill with STRAINED unleaded gasoline to within 1/2 inch of top. (Fluid should be strained several times through paper filters, i.e., paper towels, coffee filters, etc.)

2. Batteries in place and fully charged:

   Remove cover, check battery polarity, and insure that batteries are held firmly in place by retaining straps (see Figure 2-1). Check battery charge by depressing push button and counting the blinks of the BAT charge indicator light (refer to Section 3.2).

THE FOLLOWING **STEPS SHOULD BE** PERFORMED TO CORRECTLY TUNE AND TURN ON THE MAGNETOMETER:

1. Attach signal cable to sensor. There are two cables provided: a long coiled cable for staff use and a shorter cable for use with the **"backpack."**

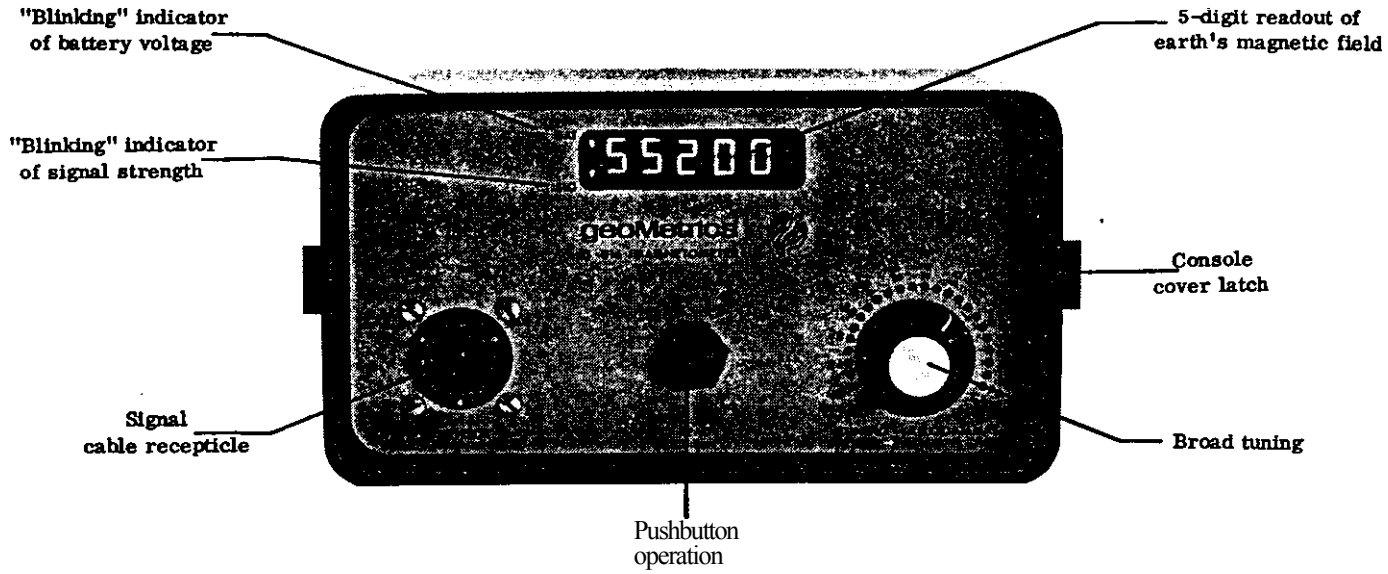
2. Attach sensor to staff and assemble sections or place sensor in **"backpack"** pouch attached to carrying harness.

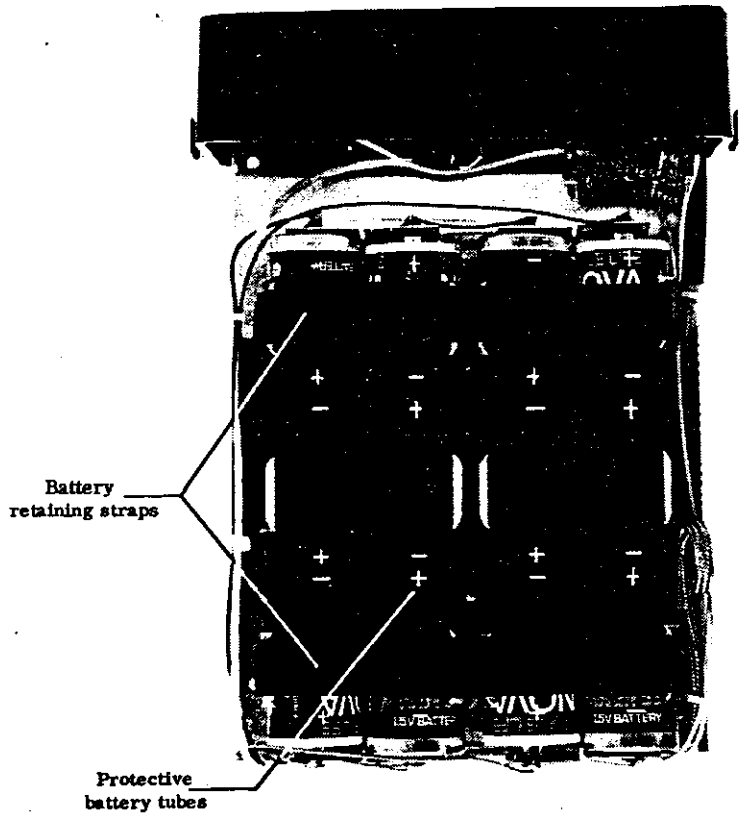
3. Locate the nominal magnetic field strength for your area on the map on the cover inside the instrument. Set the front panel tuning switch to this value. Minor returning may be necessary to achieve peak signal strength (signal blinks).

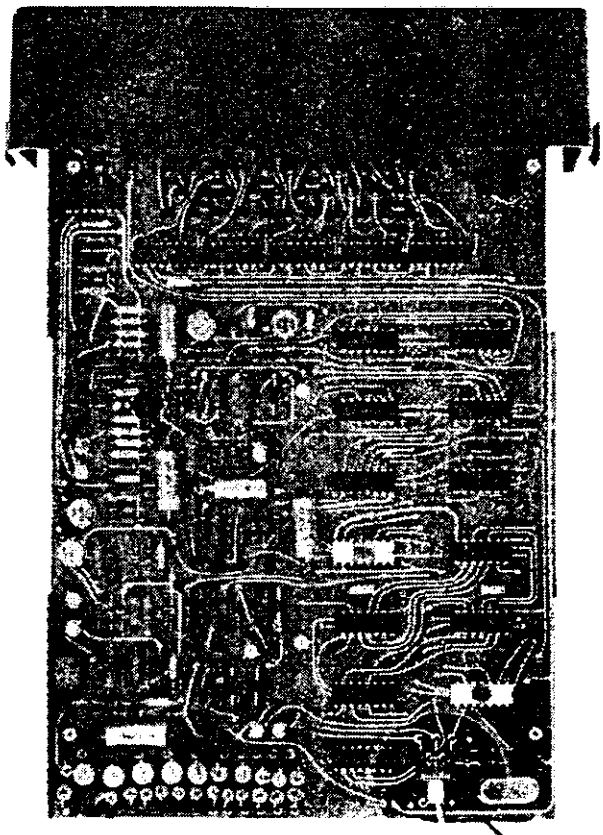
THE INSTRUMENT IS NOW READY FOR FIELD SURVEY OPERATION.

Note that a true and repeatably correct reading is obtained in three or four tuning positions surrounding the estimated local magnetic fields, (i.e., the tuning is quite broad and noncritical in most cases). Better operation is obtained in problem areas or high gradient areas if the instrument is properly tuned initially. Unless high field changes

CONTROLS AND INDICATORS







test ram
(Factory test only)

on the order of four or five thousand gammas occur during operation, it will not be necessary to retune.

2.3 SENSOR ORIENTATION

To insure optimum results, the sensor is marked with an arrow and the letter "N." The arrow should be roughly pointed north or south. This procedure will allow the sensor axis to be placed perpendicular to the earth's field and produce optimum signal. However, proper operation will be obtained in fields above 40,000 gammas with the sensor arrow pointed in any direction.

In low magnetic latitudes (where the field dips less than 40° and generally below 40,000 gammas), such as near the magnetic equator where the field is close to horizontal, the sensor should be mounted horizontally (saddlemount) on the staff. In this manner the sensor coils will be properly oriented for maximum signal in all directions.

2.4 SURVEY OPERATION

During survey operation and after the instrument is tuned to the local field intensity (refer to Section 2.2), the operator need only depress the READ button and note the reading in a log. If the reading is in question, (i.e., a sudden shift of several hundred gammas) another reading should be taken.

THE ONE COUNT **REPEATABILITY AND SENSITIVITY** OF THE **G-816/826 CAN ALWAYS BE VERIFIED BY REPEATING A MEASUREMENT WITH THE SENSOR IN THE EXACT** SAME LOCATION.

The G-816/826 will operate accurately in areas where the magnetic gradient is as high as 800 gammas per foot. The only precaution is that the sensor be held very still. With the sensor mounted on the staff, surveys with + 1 gamma sensitivity and repeatability are easily achieved.

The sensor may also be mounted in the backpack for surveys requiring lower mapping accuracy and rapid operation through rugged terrain. Because of the magnetic properties of most "D" cell batteries, however, only the cardboard or plastic jacketed batteries should be used in the console for this application (refer to Section 3.1).

2.5 LOW TEMPERATURE OPERATION

At temperatures below 0°C, battery life decreases rapidly to only a hundred readings per set of batteries at -20°C. At these lower temperatures, an optional Battery Belt (P/N 16069) should be used, or the console may be held close to the operator's person - under warm clothing.

2.6 READOUT FILAMENT TEST

Occasionally, it is advisable to check the numeric readout display to guard against an erroneous reading due to a nonilluminating filament(s). Simply depress and hold down the READ button until all number 8's appear (88888) - check each segment. If any segments are missing, notify geoMetrics for repairs.

2.7 INSTRUMENT STORAGE

After use, all of the components should be stored in the shipping container to prevent damage, loss of components, or possible contact with magnetic particles that could be imbedded in the sensor. The sensor signal cable must be DISCONNECTED from the console to prevent constant battery drainage. If long term storage is anticipated, the batteries should be removed from the console to prevent any damage from electrolytic leakage or corrosion of contacts. After long storage, always inspect the batteries.

2.8 POSSIBLE SURVEY DIFFICULTIES

The following is a list of possible survey difficulties, probable causes, and recommended corrective action.

Survey Difficulty	Probable Cause	Corrective Action
No reading on display	1. Poor battery contact	1. Check for loose batteries and retainer straps.
	2. Dead batteries	2. Replace batteries.
	3. Test switch in "test" position	3. Flip switch to "run" position as shown in Figure 2-1.
	4. Readout display board unplugged	4. Check readout display board for tight fit in socket.
Console will not tune	1. Loose tuning knob	I. Tighten set screw.
	2. Broken wire between tuning switch and circuit board	2. Inspect tuning switch and resistors, resolder wire or resistor.

	3. Open signal cable	3. Check signal cable for continuity.
	4. High noise area	4. Move to different location.
Partial numeric blackout	Segments not illuminating	Depress READ button and hold down until all number 8's appear - check each segment. If any segments are missing, notify and return the readout board (P/N 16026) to geoMetrics immediately.
Slow blinking BAT	Low battery voltage	Replace batteries.
Erratic readout	1. Sensor located in high noise area	1. Move sensor away from generators, power lines; buildings, highways, etc.
	2. Highly magnetic environment	2. Check for magnetic articles (hats, knives, belts, eye glass straps, pencils, etc.) that are close to or im-bedded in sensor (steel chips, magnetic dirt, etc.). Unit will not make valid readings inside buildings (refer to Section 1.2).
	3. No fluid in sensor	3. Shake sensor and listen for fluid. Fill as required (refer to Section 2.2).
	4. Sensor not connected or signal cable is broken	4. Check Bendix connector and sensor signal cable for damage. Use another signal cable to check console operation.
	5. No polarize power	5. Weak or "dead" battery - replace.
	6. Intermittent battery contact for corrosion and	6. Check battery contacts tighten retaining straps.
	7. Sensor not properly oriented to north or south	7. Point sensor arrow (refer to Section 2.3).

	8. Some segment(s) in display not lighting	8. Depress READ button, hold down, and check segment(s).
	9. Diurnal shift or magnetic storm	9. Wait for several hours - repeat readings when field is stable.
All 8's appear on readout	1. Poor battery contact	1. Check that every battery is correctly positioned.
	2. Bad Battery	2. Check each battery for optimum charge.

3.0 BATTERY REPLACEMENT

3.1 INTRODUCTION

When the magnetometer is used with the sensor mounted on the staff, readily available standard "D" cell batteries will work satisfactorily. The following chart compares the expected number of readings possible for different battery types. Because most standard batteries use a steel jacket, when the sensor is used in the "backpack" only cardboard or plastic jacket batteries should be used. If standard carbon zinc or alkaline batteries (steel jacketed) are used in the console during "backpack" operation, a directional dependent shift of several gammas will occur and will bias the measurement.

The G-826 will still provide one gamma sensitivity, but actual readings will be several gammas higher or lower than the "real" value.

Figure 3-1

Battery Type	Brand Name	Readings at 25°C	Readings at 0°C	Jacket Type
Alkaline	Burgess, Eveready Ray-O-Vac	4,200	3,400	Steel
Standard Carbon-Zinc (flashlight)	Burgess, Eveready Ray-O-Vac	1,200	900	Card-board
Premium Carbon-Zinc	Eveready #1250*	2,250	1,700	Card-board

*Available from geoMetrics, Inc.

Figure 3-1 is based upon one reading every 30 seconds. Faster sampling rates will yield fewer readings, especially at lower temperatures. Photoflash and "Energizers" are not designed for this type of application, by may be used until proper batteries are available. It should be noted that battery capacity decreases rapidly below 0°C to only a few hundred readings at -20°C. These battery types will recover, however, when warmed above 0°C.

3.2 BATTERY VOLTAGE INDICATOR

Before starting, and occasionally during a survey, the battery voltage indicator lamp (BAT) should be observed with the sensor connected, and the number of blinks counted. Fully charged batteries will cause about ten rapid blinks. As battery voltage decreases, the number of blinks

will also gradually decrease until the BAT lamp remains illuminated for approximately three seconds. At this time, the batteries MUST be replaced, as the voltage available is below that required for adequate operation.

When new batteries are installed, the number of (BAT) blinks should be noted. As the battery life decreases, the remaining battery life can easily be estimated.

3.3 BATTERY REPLACEMENT

The following steps should be followed for correct replacement of batteries:

1. Unsnap and remove instrument cover.

2. Loosen battery retaining straps.

3. Replace batteries, see Figure 2-1 for correct polarity. The positive contact has a Teflon tip.

4. Tighten battery retaining straps.

5. Replace instrument cover.

APPENDIX A

HIGH SENSITIVITY FEATURE (0.25 GAMMA)

INTRODUCTION

When the G-826 is optionally equipped with 0.25 gamma sensitivity, the "Test/Run" slide switch (see Figure 2-1) is utilized to allow operation in either the 1.0 gamma or 0.25 gamma mode. A special access hole is provided on the aluminum circuitry shield for convenience. It is, therefore, necessary for the operator to unsnap and remove the outer instrument cover, flip the "Test/Run" slide switch, and replace the instrument cover whenever the G-826's sensitivity is to be changed.

For 1.0 gamma sensitivity, the "Test/Run" slide switch should be flipped to the "2" position. For 0.25 gamma sensitivity, flip the "Test/Run" slide switch to the "1" position.

READOUT DISPLAY

In the 0.25 gamma mode, the readout display does not include the Most Significant Digit* (extreme left-hand number), but does indicate the Least Significant Digit* (extreme right-hand number to reflect 0.25 gamma changes within the earth's field. As such, the displayed 0.25 gamma measurement is four times higher than an equivalent 1.0 gamma display and must be divided by four (4) whenever the actual total field intensity is desired.

Because the earth's field intensity can be estimated in the survey area (refer to total field map on aluminum circuit shield or page II of this manual), the operator can easily predetermine the constant Most Significant Digit by multiplying the estimated field by four (4).

* Least Significant Digit: abbreviated L.S.D.
Most Significant Digit: abbreviated M.S.D.

EXAMPLE:

Estimated Earth's Field (1.0 gamma)	M.S.D. (four [4] times higher)
50, ---	200,---

Therefore, the displayed measurement will normally appear as:

1.0 gamma sensitivity	0.25 gamma sensitivity
50,314	01256

As such, any changes in the Least Significant Digit (01256) represent a true 0.25 gamma change in the earth's field intensity.

EXAMPLE:

First Measurement	Second Measurement
01256	01257

Divided by four (4) for actual field:	50,314 gammas	50,314.25 gammas

The following table indicates which Most Significant Digit is constant for a specific field intensity.

Total Field (gammas)	M.S.D.	Display
20,000	0	8----
30,000	1	2----
40,000	1	6----
50,000	2	0----
60,000	2	4----
70,000	2	
80,000	3	2---
90,000	3	6----
100,000 .	4	0----

A "Display" Conversion Chart is provided on the next page for quick reference in converting the displayed 0.25 gamma measurement to the actual total field.

DISPLAY CONVERSION CHART

0.25 Gamma Measurement		Total Field Equivalent	0.25 Gamma Measurement		Total Field Equivalent
M.S.D.	Display	(Gammas)	M.S.D.	Display	(Gammas)
0	80000	20,000	2	40000	60,000
0	80800	20,200	2	40800	60,200
0	81600	20,400	2	41600	60,400
0	82400	20,600	2	42400	60,600
0	83200	20,800	2	43200	60,800
1	20000	30,000	2	80000	70,000
1	20,800	30,200	2	80800	70,200
1	21600	30,400	2	81600	70,400
1	22400	30,600	2	82400	70,600
1	23200	30,800	2	83200	70,800
1	60000	40,000	3	20000	80,000
1	60800	40,200	3	20800	80,200
1	61600	40,400	3	21600	80,400
1	62400	40,600	3	22400	80,600
1	63200	40,800	3	23200	80,800
2	00000	50,000	3	60000	90,000
2	00800	50,200	3	60800	90,300
2	01600	50,400	3	61600	90,400
2	02400	50,600	3	62400	90,600
2	03200	50,800	3	63200	90,800

APPENDIX B
Connector Pin Out

The following list describes the pin-out of the G-826 portable magnetometer connector. Many of the connections are used for an interface to the G-826 Counter/Timer which allow the instrument to be used as a recording base station. Information in square brackets is for Counter/Timer interface, and not required for normal operation.

Pin	Signal
A	Sensor
B	Sensor
C	Sensor Shield
[D	Ground]
E	18 Volt Interlock (Jumper E & F together on the sensor plug for battery operation)
F	18 Volt Interlock
G	13.5 Volt Interlock (Jumper G & H together on the sensor plug for battery operation)
H	13.5 Volt Interlock
[J	Display Inhibit]
[K	Reset]
[L	Ground]
[M	Ground]
[N	Regulated 10 Volts]
[P	Polarize Inhibit]
[R	Polarize Power]
[S	Pushbutton]
[T	Counter Gate Enable]
[U	VCO Output (Shielded wire)]