OPERATOR'S MANUAL

MODEL G-866

RECORDING MAGNETOMETER

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How To Use This Manual

This manual was written for several kinds of users of the G-866 recording magnetometer. If you are unfamiliar with the operation of magnetometers, you should read the introductory materials and the operations information in the manual. If you are familiar with magnetometers and their operation, you will probably want to skip the introductory sections of the manual and move right on to the operations and special applications portions of the text. The appendixes should prove valuable to you, regardless of your level of experience with magnetometers.

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Chapter 1

INTRODUCTION TO THE G-866

This chapter provides a basic introduction to magnetometers and to recording proton precession magnetometers. Finally, it provides a solid and detailed introduction to the G-866.

What Is A Magnetometer?

A magnetometer is an instrument that is used to measure the absolute value of the earth's magnetic field. Measurements are used to identify the physical characteristics of the objects or structures that have produced the readings. For example, a marine search team could use a magnetometer to locate a sunken ship, since shipwrecks produce magnetic "signatures" that appear on magnetometers as "anomalies" or noticeable deviations from the usual intensity of the earth's magnetic field in that sector of the ocean floor.

The unit of measurement used to express the intensity of the earth's magnetic field is the gamma (1 gamma equals 10^{-5} gauss or 10^{-9} tesla or I nanotesla).* Depending on where you are actually measuring it, the earth's magnetic field can range in intensity from 20,000 to 70,000 gammas. The map in Appendix A, The Total Intensity of the Earth's Magnetic Field, illustrates the wide variations in the strength of the field.

Magnetometers can be hand-carried, fixed as base stations, or operated aboard aircraft, marine vessels, or even spacecraft. Data collected from

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* For a more detailed explanation of these units, see a good dictionary of geological terms, such as The Encyclopedic Dictionary of Exploration Geophysics.

magnetometers can be used to describe some characteristics of the geologic structure of specific areas of the earth and thereby locate and retrieve minerals and petroleum. Magnetometers can also provide valuable assistance in locating buried pipelines, electrical cables, or even cultural artifacts such as jewelry, fired pottery, and ancient dwellings.

What Is A Recording Proton Precession Magnetometer?

First, let's distinguish between a basic or non-recording magnetometer magnetometer. Then we'll explain the fundamental concept behind a proton precession magnetometer. A basic magnetometer can be used to take a reading of the earth's magnetic field, but each of its readings must be handwritten in the operator's log --otherwise, the readings are lost. The recording magnetometer provides a record of the readings that have been taken; the operator may only need to annotate the record, oversee the recording process, and collect portions of the record that are of interest. However, the advantages of a recording magnetometer can extend far beyond the automatic collection of data; the data from the magnetometer can be transmitted, recorded, and analyzed with a variety of data handling facilities available to the contemporary scientific community. For example, data from the G-866 can be digitally recorded and interfaced with a computer system. (For a detailed examination of interfacing the G-866 with such data handling facilities, see Appendix B.) Now, let's examine the operating principle of a recording proton precession magnetometer.

The G-866 is one of several kinds of magnetometers, all of which are named by the *way* that they measure the strength of the earth's magnetic field. The G-866 uses 'proton precession' to make this measurement. Other magnetometers are 'flux gate' or 'optically pumped' devices that use operating principles that differ from that used by a proton precession magnetometer. We'll be limiting our discussion to the proton precession principle.

In order to understand the proton precession principle in a magnetometer, one needs to understand what happens inside the sensor of the magnetometer. Sensors come in many shapes and sizes, but for the proton precession magnetometer, sensors share the same operational design: A non-magnetic container is filled with a liquid (water, decane, kerosene) in which a coil is immersed. So long as no current is applied to the coil, protons of the liquid will align themselves with the earth's magnetic field. However, as soon as "polarizing" current is applied to the coil the protons will align themselves with the magnetic field of the energized coil. When the current is removed from the coil, the protons will "turn away" from their alignment with the field of the coil to become realigned with the earth's magnetic field. As they "turn away", the protons don't directly turn to align themselves with the earth's field, but rather "precess", or tumble about their center. As they precess, the protons behave like tiny magnets inside the sensor coil, inducing a small AC signal in the coil. This signal can be amplified and its frequency counted to produce a highly accurate measurement of the intensity of the magnetic field at the sensor. Thus, a recording proton precession magnetometer is an instrument that measures the absolute value of the earth's magnetic field by measuring proton precession frequency, converts that frequency into the units that are used to quantitatively represent the earth's magnetic field (gammas), and records them.

You may want to obtain more information on the operation and application of magnetometers. This information can be found in the Geometrics publication, Applications Manual for Portable Magnetometers, by Sheldon Breiner.

The G-866 Recording Proton Magnetometer

The complete G-866 system includes the G-866 in its weatherproof case, a user-selected complement of sensors, stands, sensor signal cables, tow cable assemblies, power cables; and a power source. Obviously, the kinds of sensors and sensor support/tow apparatus you require will depend on how you will be using the G-866. For now, let's perform a quick familiarization inspection of the basic unit. Later, we'll show you how to configure the G-866 for your specific application.

Physical Description

If you pick up the G-866 by the handle on its carrying case (make sure the lid is latched), one of the first things you'll notice is that it's light-weight. It weighs only 13 lbs (6 kg). The case is very durable aluminum, but it can be dented. At the left end of the case (as you face the case latches) you will find three military-type connectors arranged in a row. At the back of the row is the power input connector, in the center is the data interface connector, and at the front of the row is the sensor connector. If you don't happen to have a G-866 unit with you now as you read, turn to Figure 1-1 on foldout page 1-6 so that you can see how these connectors are arranged on the cases. You may want to keep keep the foldout page open and refer back to it as we complete this physical description of the G-866.

Inside the case you'll find a flat panel with a pressure-sensitive keyboard and a protective window for the dual-range analog recorder/printer. The key-board is divided into four sections: a digital display and three groups of keys that control the functions of the magnetometer, the internal clock, and the recorder. Also on the panel are two knurled panel release knobs. By

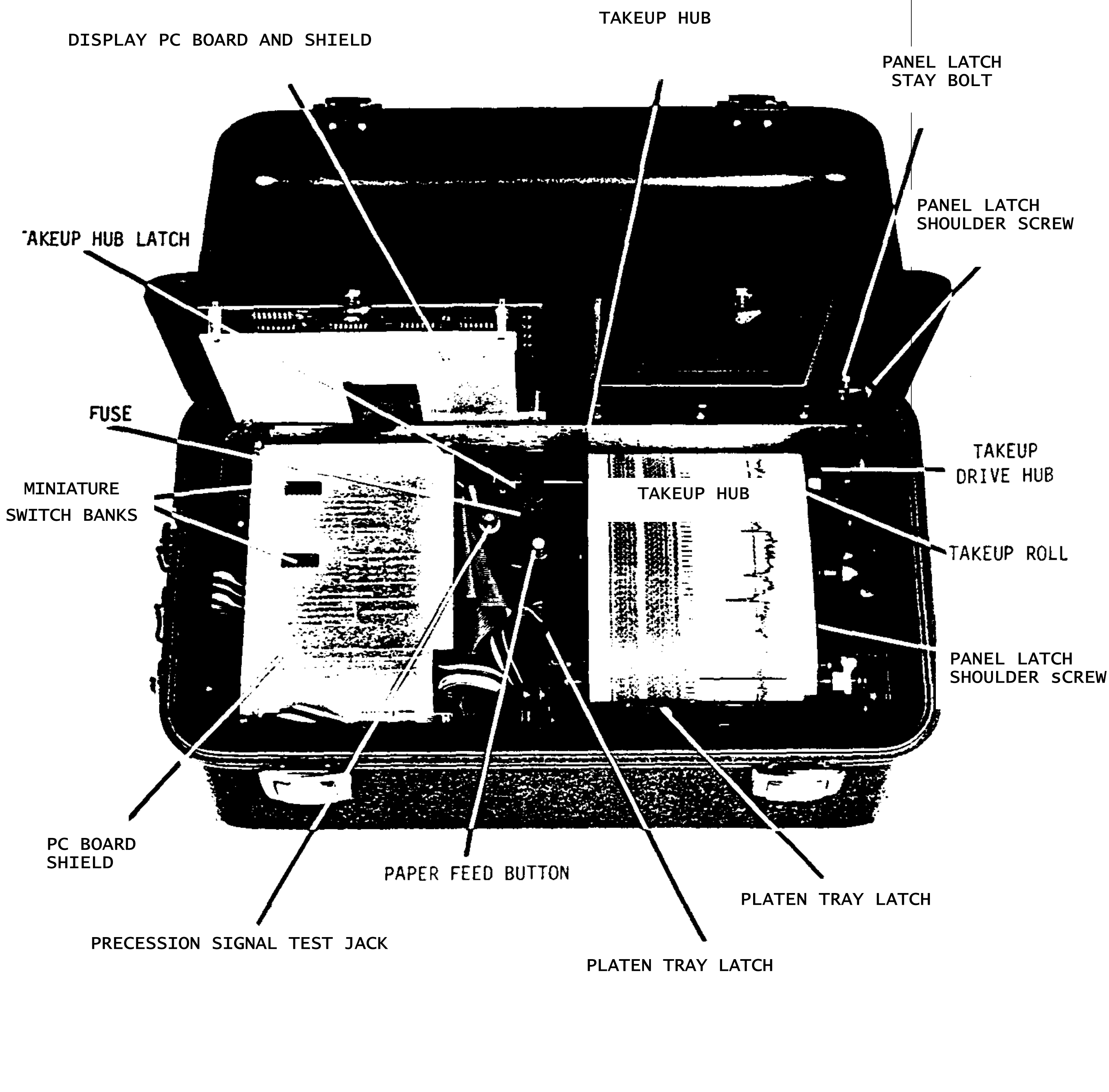

Figure 1-2 Interior of G-866

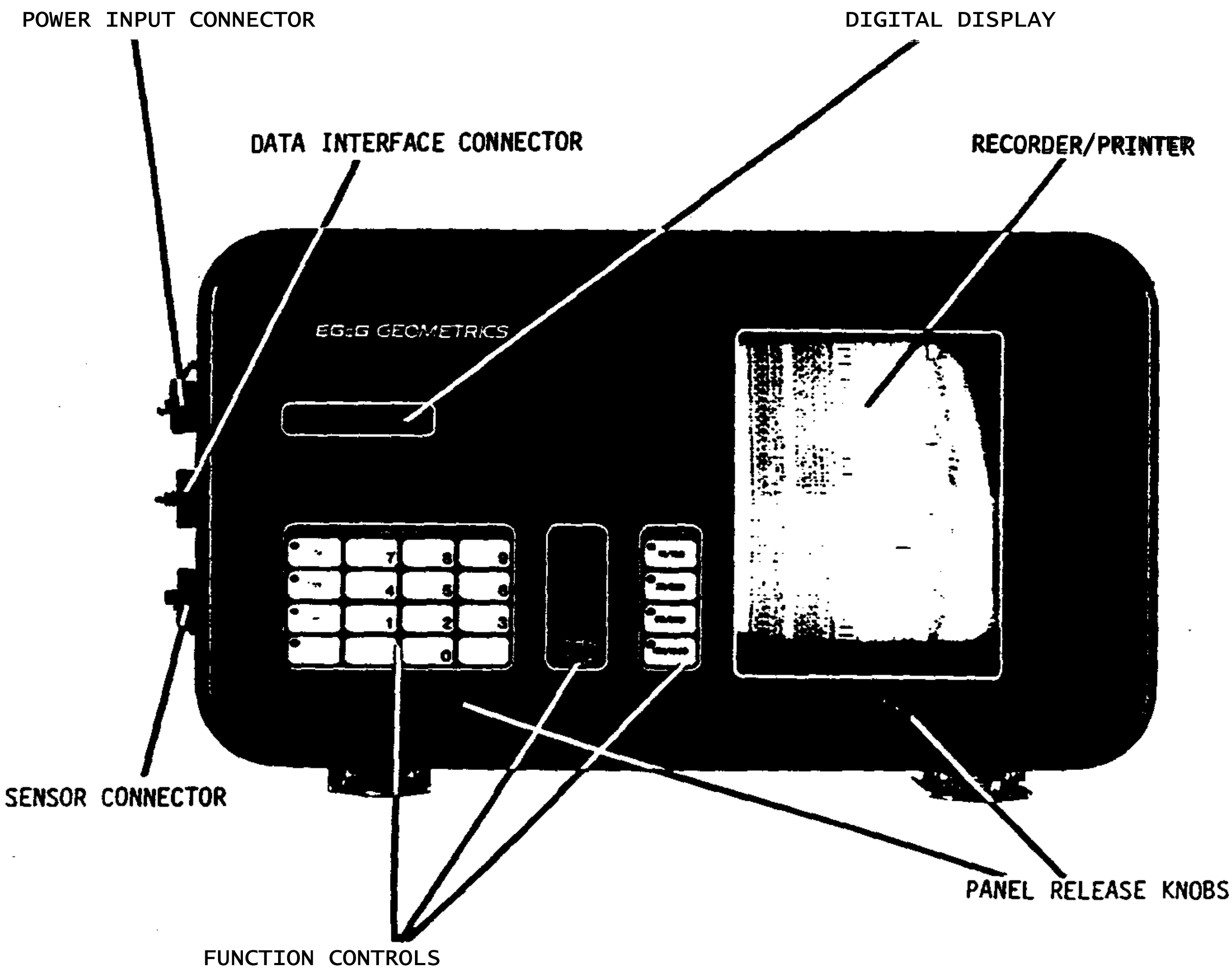

Figure 1-1 Top Panel of G-866

turning and lifting these knobs, you can release the front edge of the panel and swing it up and back on its hinges. Once you have tilted back the panel, you have access to the electronics and the recorder/printer assembly. See Figure 1-2 on the reverse side of the foldout page (page 1-5) for the names and locations of the components you'll find under the panel.

Operational Features

The G-866 is designed to operate with precision, reliability and flexibility. Resolution as high as 0.1 gamma can be expected in the field (depending on the sampling rate chosen; see Table 1-1). Readings can be printed and traced simultaneously on the recorder's permanent strip chart paper. Furthermore, the analog records are "dual range". Readings are plotted at different scale factors to ensure that if one stylus goes off the scale, the other stylus will continue to trace the readings, but at a higher (less sensitive) scale factor. All of the functions of the G-866, including the recorder, are controlled by rugged microprocessor electronics. Control settings are retained in memory, which is powered by a lithium battery so that the data will be retained even if main power is lost.

Table 1-1 Sensitivity vs Sample Interval

Sensitivity (gamma)	Sample Interval (sec)
1.0	0.5-0.9
0.5	1.0-1.7
0.2	1.8-2.9
0.1	3.0 or greater

Because of its designed-in flexibility, the G-866 can satisfy a wide range of search/survey data handling requirements for diverse operations environments. Sampling rates can be varied from one sample every 0.5 sec. to one sample every 999.9 sec. Scale factors can be adjusted to 10/100 (meaning that one pen traces at a scale factor of 10, while the other pen traces at a scale factor of 100), to 20/200, 50/500, or 100/1000 gammas, full scale. Data can be printed on the G-866 printer or transmitted to a digital recorder, or a computer. Readings can be annotated with event marks, and readings can be averaged before they are plotted.

The entire unit can be hand-carried, positioned as a base station for recording diurnal anomalies, or used in an automobile, truck, airplane, helicopter, or sailing vessel. The G-866 will also record data from another magnetometer, such as the G-856. Finally, the G-866 can be operated in any location (0 to 40 degrees Celsius) where an 11 to 28 vdc power supply is available.

Functional Description

The Keyboard

For most operations, the keyboard controls on the top panel of the G-866 will be the only controls you'll need to use this instrument. Additional controls beneath the panel will be described later in this section of the manual.

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In reviewing the functions of the keyboard, you should remember to press each key firmly and definitely, and to make certain that you complete a keying operation before you start another one, particularly at rapid sample rates.

Table 1-2 lists the individual keys of the keyboard, describes what they do, and what kind of data will appear in the display when you depress them. Note that the last field-strength reading will be continuously displayed unless you are actively using the keyboard, taking a new reading, or operating the G-866 in the "power-save" configuration.

The Recorder

The G-866 chart recorder, which is actually a digital plotter, will reliably produce permanent records of magnetic field readings and identification data that accompany these readings. Records can be collected through a variety of input options, presented in various graphic formats, and expressed in four scale factor (sensitivity) combinations.

Paper.

The recorder produces records on electrosensitive paper that is unaffected by heat, cold, sunlight, or aging. The paper, approximately 10 cm wide, is displayed and stored beneath the scratch-resistant window of the keyboard panel. Instructions for loading and unloading the paper are contained in Appendix C.

Table 1-2

KEY FUNCTIONS

Key Name		Function(s)	Display
TUNE	(depressed)	Displays signal strength of last reading, on scale of 0.0 to 9.9.	3.5 signal strength
	(released)	Displays stored tuning value, in kilogammas.	53.6 tuning value (53.6 kilogammas)
		Initiates retuning sequence when TUNE is followed by variables and ENTER	
TIME		Displays time of day in 24-hour format.	11.15.54 time of day (11:15 a.m.+54 sec)
		Initiates clock setting sequence when TIME is followed with variables and ENTER	10.30 setting time to 10:30 a.m.
DAY		Displays Julian calendar day (numerical day of year).	74 Julian date (15 March)
		Initiates Julian calendar day setting sequence when DAY is followed with variables and ENTER	_15 setting calendar to Julian date of 15 January

Table 1-2 (continued)

Key Name	Function(s)	Display
[●SAMPLE INTERVAL]	Displays last selected interval, in seconds, between readings.	[25.5] sample interval (25.5 seconds)
	Initiates sample interval setting sequence when [●SAMPLE INTERVAL] is followed with variables and [ENTER]. (Note that sample intervals of less than 0.5 seconds cannot be entered.*)	[_ _1.5] resetting sample interval to 1.5 seconds.
[CLEAR]	Clears errors made in using the keyboard. This key has no effect once [ENTER] has been depressed.	None
[ENTER]	Completes a keying operation involving variables. Transfers new variables into memory and erases old variables.	Determined by kind of keying operation being performed.

*Unacceptable entries will be signalled by [Error] display.

Table 1-2 (continued)

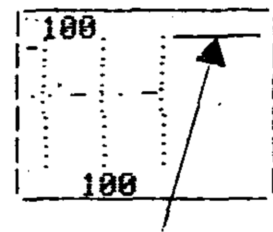
Key Name	Function(s)	Display
MANUAL READ	Causes a reading of the field to be taken and displayed. Reading will not be shown on the recorder. Can only be used with sample interval of 10 seconds or more.	 manual reading of 50,107.5 gammas
EVENT MARK	Displays '- - - - - -' briefly to indicate that a key has been pressed. Prints a short line on the right side of the strip chart to indicate that a reading has particular significance. This mark may be printed shortly after EVENT MARK has been depressed; however, the mark will appear immediately adjacent to the reading recorded after the key was depressed.	 event mark
PAPER FEED	Prints TIME and FIELD column headings, two gridline values, Julian day, sample interval, value of scale division, and the absolute value of graph's baseline (shown as OFFSET on the strip chart). Advances paper.	None.

Table 1-1 (continued)

Key Name	Function(s)	Display
● POWER	Disables keyboard controls and stops recorder. At high sample rates ● POWER must be held down until all functions have ceased.	None.
● 10/100 , etc.	Each key will turn recorder on, print scale in gammas per division, and set full-scale trace sensitivity; for example, ● 10/100 will set one trace at 10 gammas, fullscale, the other at 100 gammas, full-scale. Key will turn off recorder if touched twice in succession.	None.

Five rolls of paper are supplied with the G-866 when it is shipped from the factory. Each roll, which is 40 meters long, will last 13 hours when one line of paper is used to display each reading at 1 reading per second. If the maximum vertical spacing (15 dots) is used between readings, one roll of paper will last only 2 hours at the same sample rate. Additional rolls of chart paper are available from EG&G Geometrics.

Input Options

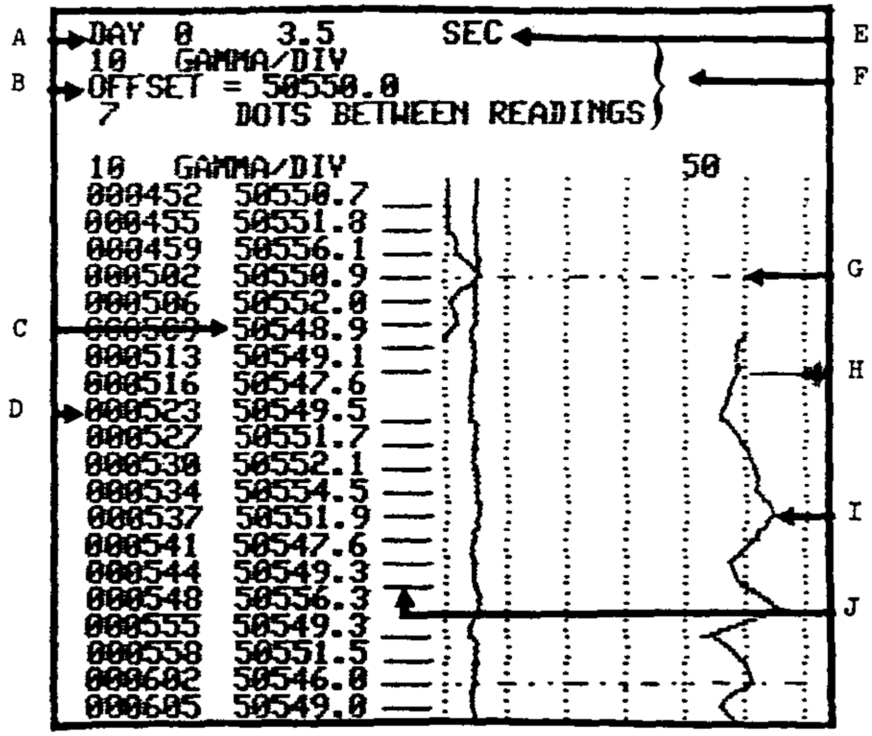
The recorder can accept data from the G-866's own internal magnetometer, from an EG&G Geometrics G-856 Memory-Mag magnetometer, or from an appropriately configured computer interface. (See Appendix B for information on RS-232C interfacing.) The G-866 will automatically record from its own internal magnetometer, providing that (1) the miniature switch banks beneath the keyboard panel have been appropriately configured (See Function Description in this chapter for details on the configuration of these switches.), and (2) the correct cable and connector are used between the 0-866 and the devices to which it will be connected.

The command to record can originate from a device that is external to the G-866; for example, a distance measuring unit. To configure the G-866 for external command cycling, activate the EXTERNAL CYCLE ENABLE switch (one of the miniature switches beneath the keyboard panel), locate Pin S (cycle command) on the I/O connector (pins are identified by letters on the connector). Or, connect a wire to Pin D (ground) of the connector and attach the other end of this wire to a switch. The other terminal of the switch should be connected to Pin S. When the switch is closed, the G-866 will be polarizing. When the connection is interrupted, the unit will record a reading of the magnetic field. Note that closing the switch for periods exceeding approximately 7 seconds will activate an internal, self-resetting breaker and thereby interrupt polarization. Logic circuits of components that are external to the G-866 can also be used to initiate a reading. See Event Marking in the Chart Format Options section that follows.

Chart Format Options

The following formats are available for presenting data on the strip chart:

Narrow. In this format approximately one half of the chart is an analog representation of every reading, which is formed from closely connected dots and simultaneously expressed in two scales. The remaining half of the chart is a list of the periodic readings (in relation to miniswitch setting) and the times of the readings. This format is selected on an internal miniswitch. See Figure 1-3 for a sample of this format.



Legend: A: Julian Date
B: Value of Baseline in Gammas
C: Value of Reading in Gammas
D: Time of Reading
E: Time Between Actual Readings
F: Data printed when PAPER FEED is pressed.

G: Timelines*
H: Event Mark
I: Point of Actual Reading (not a spacing dot)
J: Data Line: Aligns with actual data point on plot.

Figure 1-3 Narrow Chart Format

Wide Analog. As was true for the preceding format, the wide-analog format must be selected via one of the G-866's internal miniswitches, whose functions are detailed in the next section of this manual. In this format, readings are only presented in a pseudo-analog form; however, the analog scale is expanded to include more of the chart paper and thereby to produce a high-resolution chart. An example of this format can be found in Figure 1-4. This format is particularly useful in magnetic search operations.

* - Timeline Code: . . . . 10 sec); . . - (1 min); .-.- (10 min); . - - . - - (1 hr); - - - -(12 hr); .... (1 day).

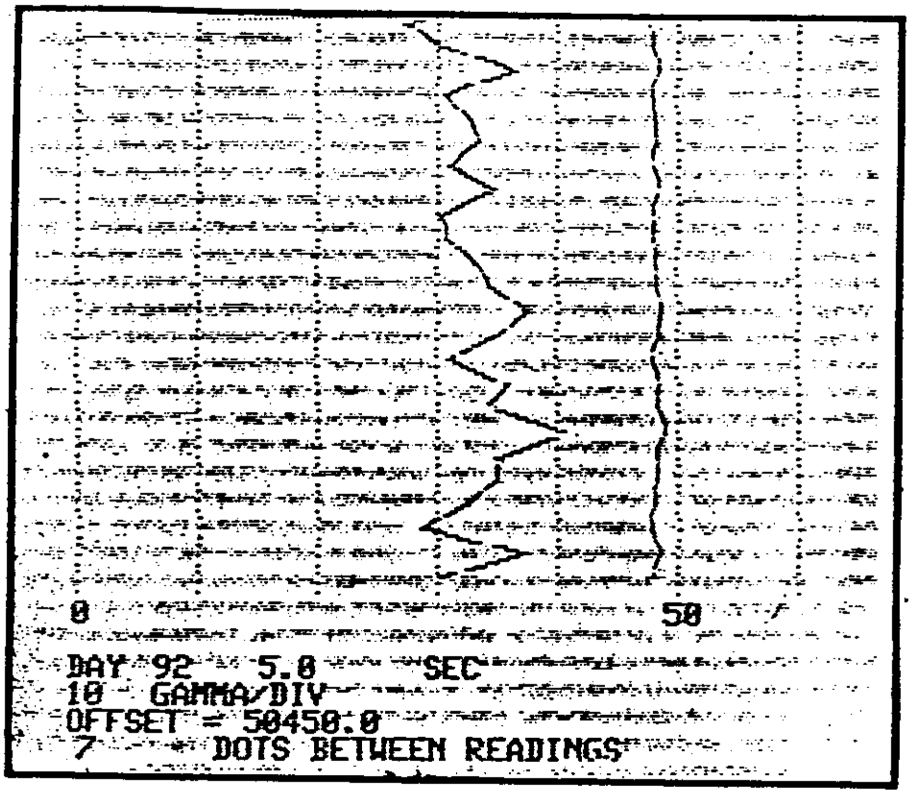
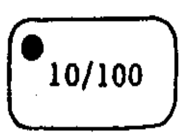


Figure 1-4 Wide Analog Format

<u>Chart Scale Factor/Sensitivity Options</u>

Four scale-factor combinations can be chosen for G-866 charts: 10/100, 20/200, 50/100, and 100/1000. The numerators of these scale-factor 'fractions' represent the full-scale sensitivity (in gammas) of the 'fine' trace, and the denominator represents the sensitivity of the 'coarse' trace. To select a scale factor combination, depress the appropriate 'scale' key e.g. , on the keyboard.



The LED on the key will light. Note that it you depress a lighted scale key, the recorder will shut off. Touching a scale key immediately after touching another one will only reset the scale factor for the chart; the recorder will not be turned off. As soon as a scale key is touched, the recorder will print the revised scale factor express in gammas per scale division; e.g., "2 GAMMA/DIV." See Figure 1-5.

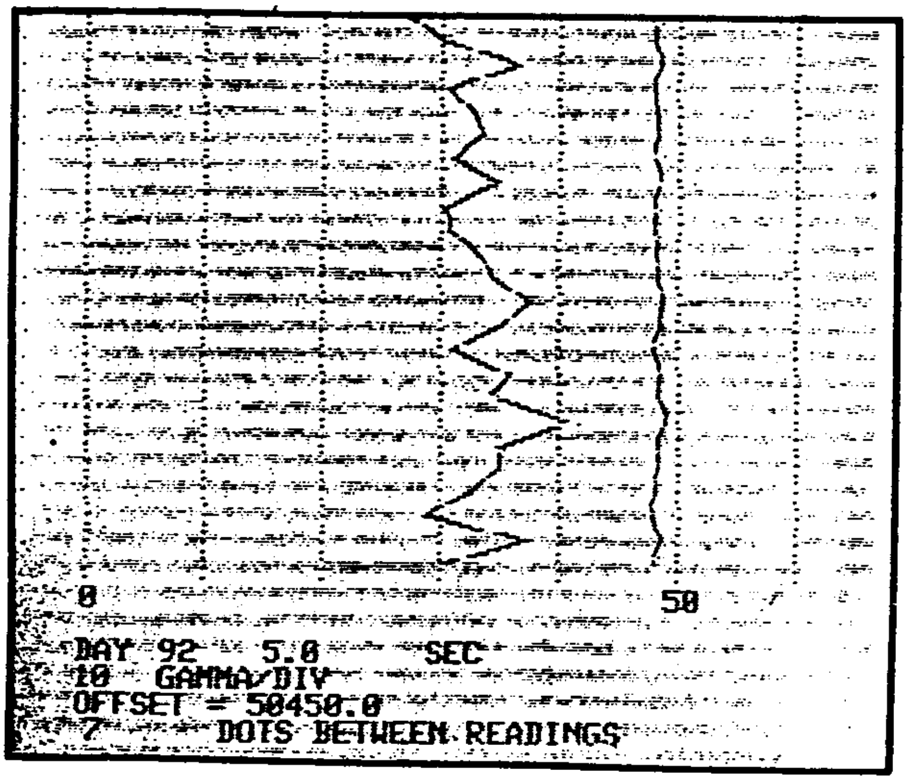


Figure 1-5 Chart with Printed Format Identification

Event Marking

When [EVENT MARK] is depressed, a short line will be printed on the right side of the paper next to the reading that is taken immediately after the key is depressed. The mark may not be printed immediately; however, it will print next to the appropriate reading when the next section of the chart is printed. The event mark can also be printed in response to a command given externally via an operator controlled switch or an automatic switching circuit. This command is activated by momentarily closing a circuit between pins D (ground) and E (event mark) of the I/O connector.

"Chart Speed" Options

Although the chart speed of the G-866 cannot literally be changed, the distance between plotted data points can be increased, just as if the speed of the chart paper had been increased. The spacing between each plot is controlled by the G-866's internal miniswitches (described in detail in the remaining sections of this chapter). Through various switch settings, plots can be separated by as few as 0 dots or as many as 15. It is very important to understand that "spaces" between the plots of actual readings are filled in with dots that are intended to aid in tracing the path of the actual readings. For example, a wide analog chart that is formatted with one reading separated by seven non-readings (spacing data) should look like Figure 1-6.

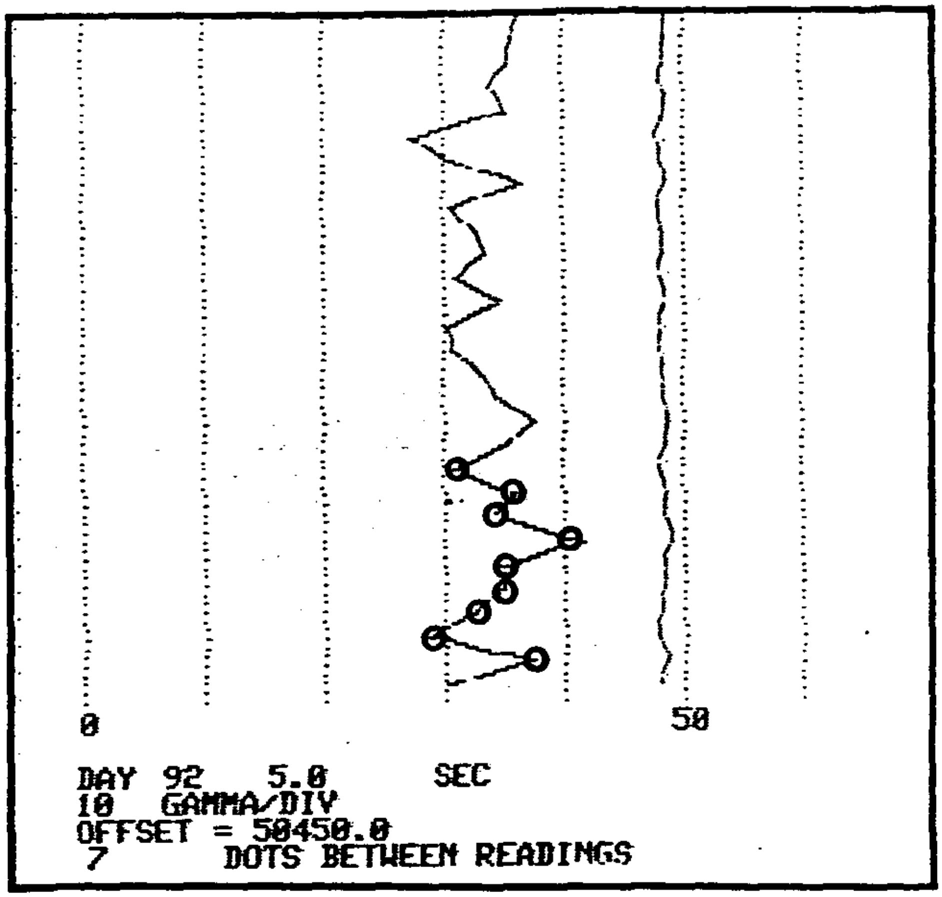


Figure 1-6 Wide Analog Plot with 7-dot Separation Between Actual Readings.

Actual readings can be located in the figure where the curve changes direction The circles, which do not appear on a real plot, are centered on the plotted points that actually represent a reading. The remaining seven points are used to separate the actual readings and to trace the slope of the curve between actual readings.

Setting up various spacings between actual readings is described in Table 1-3 (see miniswitch Bank 2, in the table). This procedure is relatively simple so long as the chart is formatted as a wide-analog presentation. How-ever, once a narrow format is selected, another consideration enters: What reading will actually print? In the following explanation of this consideration, it is important to distinguish between printing (listing a reading numerically) and plotting (graphically locating a value as a point on the chart).

Depending on the vertical spacing chosen, not all of the points that are plotted (drawn) will be printed (numerically expressed) in the list appearing to the left of the "analog" record. Two phenomena cause this: (1) some of the 'dots' are spacing (interpolation) points, not plots of actual readings, and (2) at sample intervals of less than 1 second, readings can be missed by a printing period; i.e. there is not enough time to read and print during short sample periods. To keep the printing cycle from interfering with the reading cycle at higher sample rates, press the SCALE key that corresponds the scale factor you are currently using. The printer will be shut off.

You can tell which plotted point corresponds to an actual reading by looking for a short line to the right and slightly below a printed numerical listing at the left of the pseudo-analog plot. The short line is aligned with the plotted point for an actual reading. A magnifying glass and straightedge will help you locate the plotted reading point. A general rule is that the last plotted reading in a sweep of the print head will be the one printed in the numerical list next to the 'analog' chart.

To make the 'chart speed' options immediately useful to you, here are two easily configured spacing options:

- To print every reading and to plot every reading: Set Miniswitch 1 of Miniswitch Bank 2 to ON, and turn the remaining miniswitches of that bank to OFF.

• To print every ninth reading and to plot e v e reading: Set all miniswitches of Miniswitch Bank 2 to OFF.

The first option simulates a relatively fast chart speed because each sweep of the print head will only be producing one actual point (dot) that represents a reading. The remaining points will be "spacer" points that are physically positioned to help you follow the curve inscribed by the real data points. The second option simulates a relatively slow chart speed, since all points will be plots of actual readings and there will be no "spacer" points on the graph. Note, however, that when the real data points are plotted this close together, the printed list will only reflect 1 point out of the plotted 9 points. (One printed letter takes up eight out of the nine printed lines inscribed by one sweep of the print head of the recorder, and the print head has a maximum sweep rate of one sweep per second.) Again, there is not enough time for the print head to print out and plot every value during one sweep, when ample rate exceeds one sample per second.

Functional Description

The Internal Mini Switches

By rotating and lifting the two knurled knobs at the front edge of the keyboard, you can raise and tilt back the keyboard panel to reveal the recorder mechanism and the electronics board just to the left of the recorder mechanism (see Figure 1-2 on the reverse side of the foldout, page 1-5).

On the electronics board are two banks of miniswitches (see Figure 1-7, below).

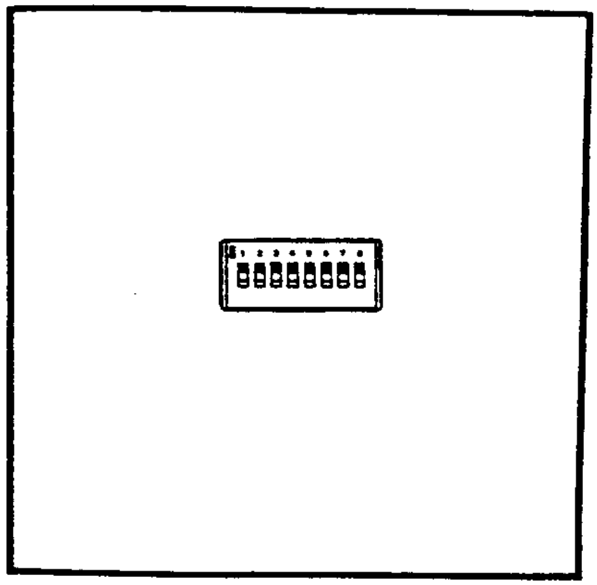


Figure 1-7 Miniature Switch Bank

Miniswitch Bank 1 is positioned closer to the front of the case and Miniswitch Bank 2 is closer to the rear of the case. By using these miniswitches you will have access to functions of the G-866 that cannot be accessed on the key-board panel. Table 1-3 lists the functions of each miniswitch.

> <u>WARNING:</u> NEVER USE A PENCIL TO CHANGE THE MINISWITCH SETTINGS. THE GRAPHITE DUST FROM PENCIL LEAD POLLUTES THE CONTACTS.

Table 1-3

Miniswitch Functions*

Miniswitch Bank 1

Miniswitch	Name	Function (when turned ON)
8.	Baud Rate LSB }	Miniswitches 8 and 7 are used to set the baud rate (rate at which data are transferred from the G-866). See settings on the miniswitch protective cover.
7.	Baud Rate MSB }	
6.	RS-232 Only (G-856 dump)	Disconnects the internal magnetometer from the recorder and connects recorder to RS-232 data from an EG&G Geometrics G-856 magnetometer, as if the G-856 data were from the internal magnetometer of the G-866.

*Note factory settings printed on the protective cover for the miniswitches.

Table 1-3 (continued)

Miniswitch Bank 1

Miniswitch	Name	Function
5.	Narrow Stripchart Format	Converts chart format from wide analog to narrow configuration, consisting of printed readings and plotted readings.
4.	Average 7	Causes the last 7 readings to be processed through a weighted averaging routine (Bartlett-filtering) to smooth the plotted data points as they appear on the stripchart. Does not affect numerals shown on the digital display, on the printed stripchart listing, or the values sent from the data interface.
3.	Average 5	Same function as Miniswitch 4 except five readings are averaged (Bartlett-filtered).

Table 1-3 (continued)

Miniswitch Bank 1

Miniswitch	Name	Function
2.	Average 3	Same function as Miniswitches 4, 2 except three readings are averaged. (Bartlett filtered).
1.	Power Save Option (See Table G-1)	Decreases power consumption. Interrupts power to display, magnetometer, and recorder when readings are not being taken.

Miniswitch Bank 2

Miniswitch	Name	Function
8.	Front Panel Disable	Prevents changing the tuning, time, day, or sample interval by using keyboard panel keys. Discourages unauthorized use of keyboard.
7.	External Cycle Enable	Disables internally initiated cycling function; enables externally initiated cycling function. Unit must be turned off

Table 1-3 (continued)

		(1) before activating or deactivating this function, and (2) when data transfer cable is being disconnected from a unit being externally cycled.
6.	Reserved	----
5.	Test	Disables polarizing function when. switch is ON.
4.	V Scale for Analog LSB 1	Miniswitches 4, 3, 2, and 1 are used to set the spacing between plotted readings. The binary sum of 'values' of these mini-switches will equal the number of dots between the actual plotted readings. For example, if Miniswitch 4 is ON, 3 is ON, 2 is ON, and 1 is OFF, there will be a total of 7 dots between readings.
3.	V Scale for Analog LSB 2	
2.	V Scale for Analog LSB 4	
1.	V Scale for Analog LSB 8	

Chapter 2

OPERATING THE G-866

This chapter contains general instructions for operating the G-866 recording proton precession magnetometer. It also contains special instructions for marine and airborne search and survey operations.

General Operating Instructions

Inventory and Assembly

After you have unpacked the G-866 and its accessories, you should make sure that all of the equipment you ordered is present and that none of it is damaged. Should any equipment be missing or damaged, you should file an appropriate claim with your freight-handling service and/or contact EG&G Geometrics (see Appendix D). In addition to the basic instrument, you should find the following items:

Geometrics Part No.	Item	Quantity
16422-01	Paper Tube, Modified	5 each
21-206-013	Conn SP06A-14-18P I/O	1 each
22687-01	Battery Cable Assembly	1 each
30-410-002	Paper, Printer	5 each
30-410-003	Print Head	2 each
51-601-051	Fuse 7 Amp SLO Blow	5 each
16-902-002	Air Spray Can	1 each
16-902-003	Cleaning Solvent Can	1 each
16-902-004	Spray Tube	1 each
70-201-002	Acid Brush	1 each
	Applications Manual for Portable Magnetometers	1 each

Included is a mating plug for the data I/O connector, unless you ordered an I/O cable. If you ordered them, a sensor and sensor signal cable will also accompany your G-866. Once you have determined that you have the instrument and its accessories, and that no physical damage has been done to them, you can proceed to check out the operation of the system.

System Checkout

Step 1. Paper and Miniswitch Setting. Determine that the G-866 is ready to be connected to a power source. Caution: If you must perform the checkout in inclement weather, protect the G-866 from direct rain with a large, clear plastic bag or work under an umbrella. Open the instrument case lid, rotate and lift the two knurled hold-down knobs, and tilt back the keyboard panel. (See Figures 1-1 and 1-2, should you have difficulty in identifying parts of the G-866). Next, make certain that there is paper on the recorder and that it is threaded correctly. (Paper threading instructions are in Appendix C.) To the left of the recorder mechanism is an electronics board with cutouts for two banks of numbered miniswitches. Bank 1, which is nearer the front of the case should have miniswitches 5, 7 and 8 turned ON. The rest of the miniswitches, on both banks, should be turned OFF. Now reclose the keyboard panel, and proceed to the next step.

Step 2. Power Supply Checkout. Two 12 volt rechargeable batteries make an excellent power source for the G-866. Whatever source you use, it should be checked to ensure that it can produce at least 11 vdc, and at most 32 vdc, at a minimum of 10 amps. If the voltage to the G-866 is too low, the recorder speed will vary excessively and the magnetometer will draw too much current. If the voltage is too high, a fuse in the G-866 will be blown. If the power to the G-866 is between 11 and 32 vdc, connect the power cable to the battery/power supply, next push in and unscrew (counterclockwise) the protective cap from the power connector (located on the left end of the case--use the foldout page to identify the power connector), plug in the power cable plug to the power connector, grasp the plug's lock ring, press it in and twist it clockwise.

Step 3. Sensor Connection. Clean the sensor to remove dirt and any magnetic materials that may adhere. Ensure that sensor is filled with Decane and that the sensor signal cable is connected to the sensor. (See Figure 2-4 for a sensor signal cable wiring diagram).

Once the sensor is readied, plug the sensor signal cable into the sensor connector on the G-866 case. The G-866 is now ready to be tuned.

Step 4. Tuning. Before the G-866 is used to read the strength of the earth's magnetic field, it must be tuned. This tuning process is very similar to the process of tuning a radio; the object in both processes being to obtain the strongest possible signal. The G-866 can be coarse tuned or fine tuned. For most applications, coarse tuning will be adequate; however, some applications may require very precise fine tuning. A description of the fine tuning procedure can be found in Appendix E.

A description of the coarse tuning procedure follows. Note that the tuning does not have to be monitored constantly; one tuning will usually be sufficient for an extended period of readings.

Coarse Tuning

a. Obtain an estimate of the local value of the earth's magnetic field (in kilogammas). You can find this value by consulting the map in Appendix A.

b. Press **POWER** . This will activate the keyboard.

c. Press **TUNE** . The signal strength of an earlier magnetic field reading will be displayed. For example:

4.3

(Equals a signal strength of 4.3, on a scale of 0.0 to 9.9)

Releasing the **TUNE** key will cause the present tuning value, in kilogammas, to be displayed for example:

56.8

(equals 56.8 kilogammas, or 56,800 gammas)

If the two most significant digits of this <u>stored</u> tuning value match the first two digits of the value you obtained in Step A, you may assume that the G-866 can now be rough tuned and proceed to Part d, below. If the first two digits of these values do not match, you must change the stored tuning value: Press the numbered variable key that corresponds to the most significant digit of the estimated value you wish to enter. This digit will appear on the left side of the display and be preceded by a decimal point and two underscore marks. The underscore marks indicate that you should supply additional digits for the spaces they underscore.

For example, suppose that you pressed [● TUNE], and a tuning value of 56.8 (56.8 kilogammas) was displayed. The estimated tuning value you obtained from Step a. was 55.3. To tune the G-866 to this value, press variable key [5] to display:

[_ _ .5]

Since the underscore marks indicate more digits are required, you should depress variable key [5] again, then variable key [3] followed by [ENTER]. The new tuning value, 55.3, will be entered.

d. Coarse tune the G-866. (See Page 2-3)

e. Press [● SAMPLE INTERVAL].

f. Press variable key [9] four times, then press [ENTER].

g. Press [MANUAL READ]. The G-866 will display the battery voltage briefly pause, then display a reading of the field. Write down or memorize the first three digits of this reading.

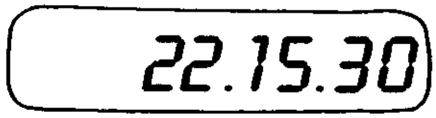
h. Press [● TUNE] and then press the variable keys that correspond to the first three digits of the reading you took in Part f, above. Press [ENTER] the G-866 is now rough tuned and ready to make and record readings.

For some surveys applications, typically base-station recording, you may wish to fine tune the G-866. See Appendix E for instructions.

Step 5. Setting The Clock

The internal clock is used to correlate readings of the earth's magnetic field with the time of day when they were taken. The time is recorded on the strip chart immediately adjacent to the reading that was taken at that time. Time readouts are expressed in 24-hour format, with seconds being displayed as the last two digits of the readout; for example, 22.15.30 would be read as 10:15 pm and 30 seconds.

To set the clock, follow the procedure below:



a. Press 

, unless keyboard power has already been turned on.

b. Press 

and read the display.

c. Note the current chronological time and select a new time value that is one minute ahead of the current time. Press the variable keys in the same sequence as the digits appear for the time value you want to set into the interval clock. The display will immediately show the first digit of the new time you are entering. After the first digit, the display will show underscore marks. These indicate that you should supply digits to fill the underscored spaces. See Figure 2-1.

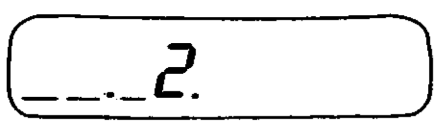


FIGURE 2-1 Clock Display, First Digit Entered For 2315 Hrs.

d. As soon as you have filled in these underscored spaces, wait until the chronological time exactly matches the new time you have keyed in, then press [ENTER]. The clock is now set. Note that seconds cannot be set, although they are displayed.

If values are not keyed in for the underscored spaces, mentioned in Step e., zeroes will automatically be entered. If [CLEAR] is pressed, or if [ENTER] is not pressed, the internal clock will remain at its previous setting; however, it will have incremented appropriately.

Step 6. Setting The Julian DIE

Just as setting the clock allows you to know the time of day when a reading was taken, setting the Julian day (the numerical day in a calendar year) can allow you to identify the day when a reading was taken. When the Julian day is not important to your application, you can use this function to identify survey lines. For example, to identify line 172, simply record 'Day 172' at the appropriate point in your data collection process (you may elect to identify the beginning or the ending of a line).* To set the Julian day (or, if appropriate for you, the line number), use the following procedure:

a. Press [● POWER], unless the keyboard power is already on.

b. Press [● DAY]. The display will show the Julian day that is currently stored in the G-866.

c. Press the first digit of the new day you wish to enter. It will be shown on the left side of the display. Underscored spaces will appear to the left of this first digit. If you press additional digits, they will be entered into the empty, underscored spaces, otherwise the spaces will automatically fill in with zeros.

*Note: the last Julian date/line number will increment at midnight.

d. Press [ENTER] . The Julian day (or line number) is now set.

If [CLEAR] is pressed or if [ENTER] is not pressed, the Julian day that was stored before the new digits were keyed in will remain unchanged.

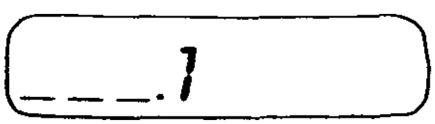
Step 7. Setting The Sample Interval

Sample intervals (the time between sampling cycles) are frequently changed to satisfy new applications requirements. A stationary G-866 that is used to record diurnal changes in the magnetic field may be configured to sample only once every five seconds; while an on-board marine or airborne G-866 may be set to sample once every second. In general, when rapid changes in the magnetic field are being recorded, the sample interval is decreased, which results in an increased sample rate. Sensitivity increases as the sample interval increases. (See Table 1-1.) Use the following procedure to set the sample interval:

a. Press [POWER] , unless the power to the keyboard panel is already on.

b. Press [SAMPLE INTERVAL] . The currently stored sample interval (in seconds) will be displayed.

c. Press the first digit of the new sample interval you want to set on the G-866; it will appear on the right side of the display. For example, to set a sample interval of 123.4 sec., you would first press 1. The following display would be shown:



The underscored spaces signal you to fill in these spaces with the remaining digits.

d. Press the keys corresponding with the remaining digits of the new sample interval.

e. Press [ENTER] . The new sample interval is set.

Note that the smallest sample interval that can be set is 000.5 seconds. The largest sample interval is 999.9 seconds. Finally, you should remember that the sample interval and sample rate are not identical. As the sample interval increases, the sample rate decreases, and vice-versa.

Special Operating Instructions

Marine Search Application*

Tow System

The G-866 may be used for marine search applications to locate submerged cables, pipelines, wellheads, ships, anchors, and other magnetic objects. For such applications, a marine sensor (or 'fish') is towed with a 200 to 600-foot tow system, available from EG&G Geometrics. The length of the tow cable is a function of (1) the anticipated depth at which the object may be found, (2) how far the sensor must be towed behind the tow vessel, and (3) the speed of the tow vessel.

For example, a 200-foot tow system can be used search to 30 or 40 feet below the surface, when the tow vessel is moving at 5 knots. Best data have been produced by attaching a 50-foot cable and drogue parachute ('sea anchor') behind the sensor and towing the entire system at 6 or 7 knots, maximum. At speeds below 5 knots the path of the sensor through the water is too erratic to produce high quality data. At speeds exceeding 8 knots, do not use the drogue chute. The fin assembly of the sensor should be used at all times. Additional tow system stability can be achieved by weighting the tow cable, and/or attaching a 'depressor' hydrofoil device.

To minimize noise, several precautions should be taken with the tow system: If the sensor is to be towed behind a metal-hulled vessel, the sensor must be towed at a distance that is two and one-half to three times the length of the tow vessel. When the magnetometer sensitivity is set high (large sample intervals), the sensor must be towed at a distance that is three times the length of the tow vessel. The towing distance can be reduced for some wooden-or plastic-hulled vessels.

*For more detailed information on marine applications, see EG&G Geometrics Technical Reports Nos. 3 and 7.

Cables up to 200 feet in length can be hand deployed from the tow vessel. Deployment of cables exceeding 200 feet in length should be accomplished with a winch. Hand-deployed cables are tied to the tow vessel or secured with a Kellem grip so that the electrical lead to the magnetometer connector is not strained.

Operation Procedure

1. Deploy the tow system and sensor.

2. Connect the sensor cable to the G-866 sensor input connector.

3. Connect the G-866 to an 11 to 32-volt DC power source.

   To display DC power voltage at sample intervals greater than 5 sec, press **CLEAR** during the display portion of the cycle.

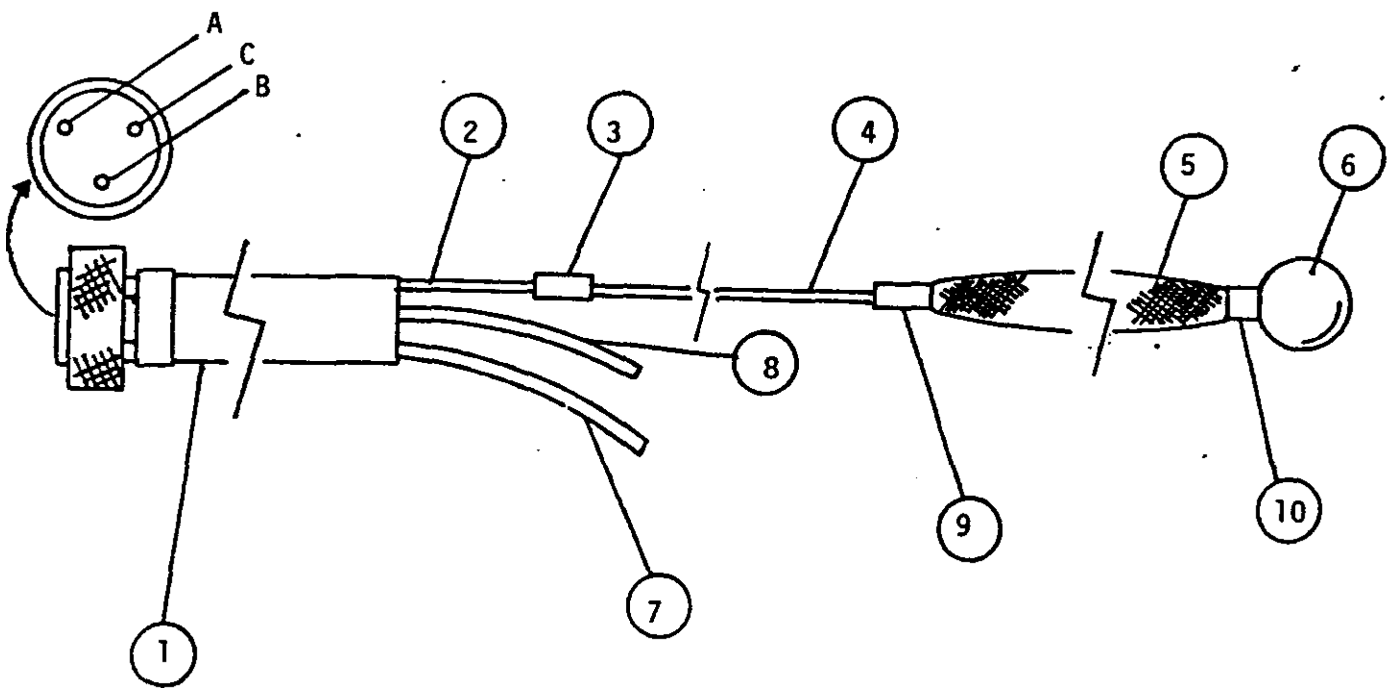
** (Steps 4 - 8 are optional, to be used if problems are encountered) **

4. Set the test miniswitch (Miniswitch 5 of Bank 2) to the ON position (corresponds to turning off the polarizing function). The test miniswitch is identified on the protective plate inside the G-866. See page 1-5.

5. Attach an oscilloscope to the BNC connector (labeled as Precession Signal Test Jack on page 1-5) next to the paper feed button inside the case. Observe the noise level displayed on the oscilloscope; the noise level should measure between 30 and 100 mv. Make this observation during the read cycle, not the polarize-off cycle.

   Excessive noise levels may be caused by (1) having the sensor cable close to AC power or other source of electrical noise, (2) by not grounding the magnetometer to seawater, (See Figure 2-2. Larger vessels may already have a 'sacrificial anode' grounding system in place), or (3) by having a defective sensor, cable, or sensor cable connector.

6. Turn off the test miniswitch (this action turns on the polarizing function).



LEGEND:
1. DC Power Cable, G-866
2.. Green Wire (ground, connects to 'C')
3. Splice.between ground and '4'
4. 14-gauge Hookup Wire
5. 30-ft Copper Braid, 1" wide
6. Lead Ball ("salmon ball")
7. Black Wire (negative DC supply wire, connects to 'B')
8. White Wire (positive DC supply wire, connects to 'A')
9. Splice for Hookup Wire and Braided Wire
•10. Crimp for attaching Braided Wire to Lead Ball

Figure 2-2 Water Ground for G-866 Marine System

7. Look for a precession signal on the oscilloscope. Signal voltage should read 1 1/2 to 3 volts (peak-to-peak during the read cycle) at a typical sample interval of 1 to 2 seconds.

8. Fine tune for maximum signal amplitude.

9. Set miniswitches for 'wide analog' chart format.

10. Set dot spacing to one dot per reading.

11. Press 50/500 .

12. Press PAPER FEED to print chart format legend on strip chart.

13. Begin search operations.

14. If magnetic field variations are minimal, try to increase scale sensitivity.

15. If data scatter is excessive (as in high seas), try setting point - averaging system to a 7-point configuration.

16. Use event marks as appropriate to your operation.

Marine Survey Application

The instructions in the preceding Marine Search section apply to marine survey operations, with one major exception: sample intervals may be greatly increased.

Airborne Survey Application*

While the G-866 has been used in fixed-wing aircraft and helicopter, it

*For more detailed treatment of airborne applications see EG&G Geometrics Technical Reports Nos. 1 and 2.

is more easily installed in helicopters. Helicopters are usually manufactured with some kind of tow apparatus (usually a cargo hook) as part of their original equipment. The tow apparatus can usually be put into service without making modifications to it.

Most fixed-wing aircraft, on the other hand, must be modified for airborne magnetometric survey work. The cost of such modification can be considerable. Information about fixed-wing applications is available from EG&G Geometrics. For the purposes of this manual, we'll confine our discussion of airborne survey applications to helicopter operations.

Helicopter Applications

To conduct magnetic surveys in a helicopter requires (1) a sensor and tow system, (2) a means of attaching the tow system to the helicopter, (3) a means of deploying and retrieving the sensor, (4) power for the magnetometer, and (5) a *way* to secure the magnetometer inside the aircraft. What follow are some suggested ways to meet the preceding requirements. Please remember that these are only suggestions; you should consult your pilot to insure that your operations comply with regulations and safe flying practice.

A finned sensor and tow system are available from EG&G Geometrics. The sensor is towed by a 50-foot nylon sleeve that attaches to the towing system of the helicopter. The sensor is electrically connected to the G-866 by a cable that runs inside the nylon sleeve; the sensor cable does not bear any of the weight of the towed sensor. See Figure 2-3. The nylon tow sleeve can be attached simply by installing a metal ring through the two eyelets found at the top of the tow cord and connecting this ring to the helicopter's tow hook. It is important to assure that the sensor can be released from the helicopter at any time in case it gets snagged on something on the ground. A complete system allowing the towed bird sensor to be mounted on any helicopter tow hook is available from EG&G Geometrics.

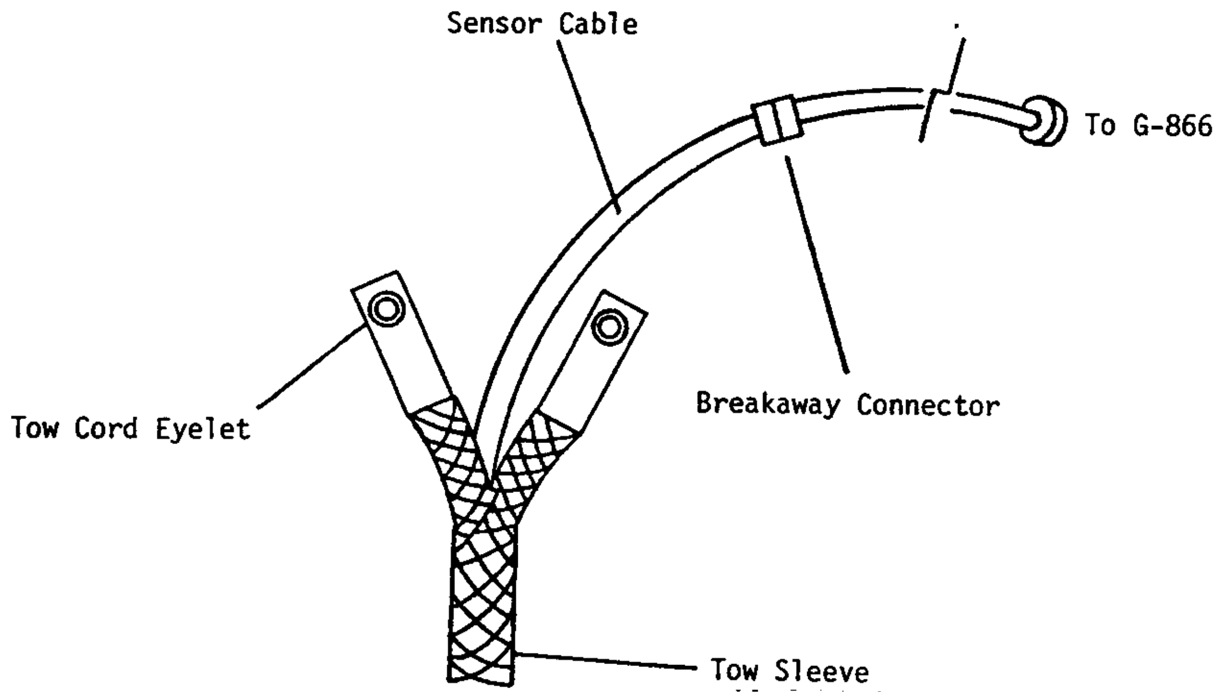


Figure 2-3 Tow Cord and Sensor Cable Attachment Points

The sensor should be deployed once the helicopter is safely airborne. While it is easier for the geophysical personnel to lay out the sensor cable on the ground and take off vertically, this can be an unsafe routine. Were the helicopter engine to fail during this procedure, the pilot would not have enough altitude or airspeed to perform a safe autorotation. The sensor may be lowered from the airborne helicopter via a power winch or by manually lowering the sensor with the tow cable. The operator should use heavy leather gloves when lowering or raising the sensor, both to protect his hands and to assure that the weight of the sensor is borne by the nylon sleeve rather than the signal cable inside. The operation is easiest at an airspeed below 60 kts. Be sure to review this procedure with your pilot before takeoff to make certain it can be conducted safely with the aircraft and equipment you are using. To ensure that the sensor is not jolted by the sudden release of the last few feet of cable, a short second nylon rope may be attached near the top of the tow sleeve, and used to pay out the last few feet of cable. This short rope can also be used to raise the main tow cable to the operator when the sensor is to be brought back aboard the helicopter. **CAUTION: Do not secure this second cord to the air frame of the helicopter. It could prevent dropping the sensor in an emergency. Power to the magnetometer can be supplied from the helicopter's electrical system or from a storage battery brought aboard the aircraft. Since electrolyte leakage could cause damage to the helicopter, a sealed battery should be used. EG&G Geometrics can supply a sealed battery that will power the G-866 for approximately 10 hours between chargings (See Table G-1). Should you wish to use the helicopter's electrical system to power the G-866, make sure the operator of the helicopter can provide power for you (+14 or +28 volts, negative ground). Power should be brought via two wires directly from the battery. The positive wire should be connected through a 10 amp circuit breaker accessible to the pilot. Once you are sure that power is available, you should determine how you will secure the magnetometer on board the helicopter. The simplest way to secure the G-866 in the helicopter is to tie it into a seat. You may be able to tie it in with the seat belt.

CAUTION: As with the tow system, the electrical cable must be easily disconnected from the G-866 to ensure that the tow system and sensor will drop away easily, should an emergency arise. Do not wrap the sensor cable around the seat belt. Ensure that there is a breakaway connector that joins the sensor cable and the cable to sensor connector of the G-866 (see Figure 2-3).

Operation of the G-866 Aboard the Helicopter

1. Connect the G-866 and sensor. The helicopter should be sitting on the ground with its engine shut down. Consult with the pilot on how long you may draw power from the aircraft battery without draining it. The G-866 draws about as much power as a com or navcom radio.

2. Take the sensor as far from the helicopter as the tow cable will permit. Set the sensor about two feet above the ground on a non-ferrous box (cardboard is preferable; wooden boxes are not, since they're usually nailed together).

3. Turn on the power, tune, set the clock, set the sample interval for 0.5 second, and set the chart format for 'wide analog'.

4. Check the noise envelope on the analog chart. It should not be greater than +0.25 gamma. If it is greater, (1) move the sensor to a different location; (2) check battery output; (3) ensure that your test area is not electrically noisy -as would be true of an area crossed by *high* voltage power lines; or (4) check signal strength shown on the G-866.

5. Start helicopter engine and check noise level. If electrical noise is a problem, you may have to experiment with grounding the G-866 to the airframe of the helicopter, or with filtering the DC power.

6. Make a short local flight to an altitude of 1000 feet, hold a steady course for approximately two miles, and check the noise level. A noise problem at this point may indicate that the sensor is not 'flying' smoothly. Check the tow system for fouling.

If possible, make this first flight over a magnetically 'flat' area. An occassional 1 gamma noise level is normal. If your records show no field or noise fluctuations after five successive readings at a 0.5-second sample interval, you should look for a malfunction.

7. Simultaneously operate the G-866 and the helicopter's navigation and communication equipment to make certain that these systems will not interfere with each other. A problem here could be eliminated by grounding the G-866 to the helicopter's airframe.

8. Begin your survey.

See Table 2-1 for a description of sensors available for marine and airborne applications. See Figure 2-4 for a sensor wiring diagram and Figure 2-5 for sensor orientation instructions.

Table 2-1
Magnetometer Sensor/Cable Combinations

Any of the Geometrics 30 mH sensors may be used with the G-866 magnetometer. The only limitation is that some of the smaller portable sensors may overheat as the G-866 can produce 2.5 amps of polarize current. Therefore to prevent overheating, the small portable sensors made for the G-816/826/856 should be used with sample intervals of at least 10 seconds. Some of the other sensor systems available are listed below:

G-866 Base Station Sensor (high-level signal with Faraday Shield)	(PN 16194)
Airborne Towed Bird Sensor (with airfoil and 100 ft low-noise tow system)	(PN 16506)
Airborne Wingtip Sensor (consult EG&G Geometrics)	--
Marine Tow System (with stabilizer fins and 200 ft tow system)	--

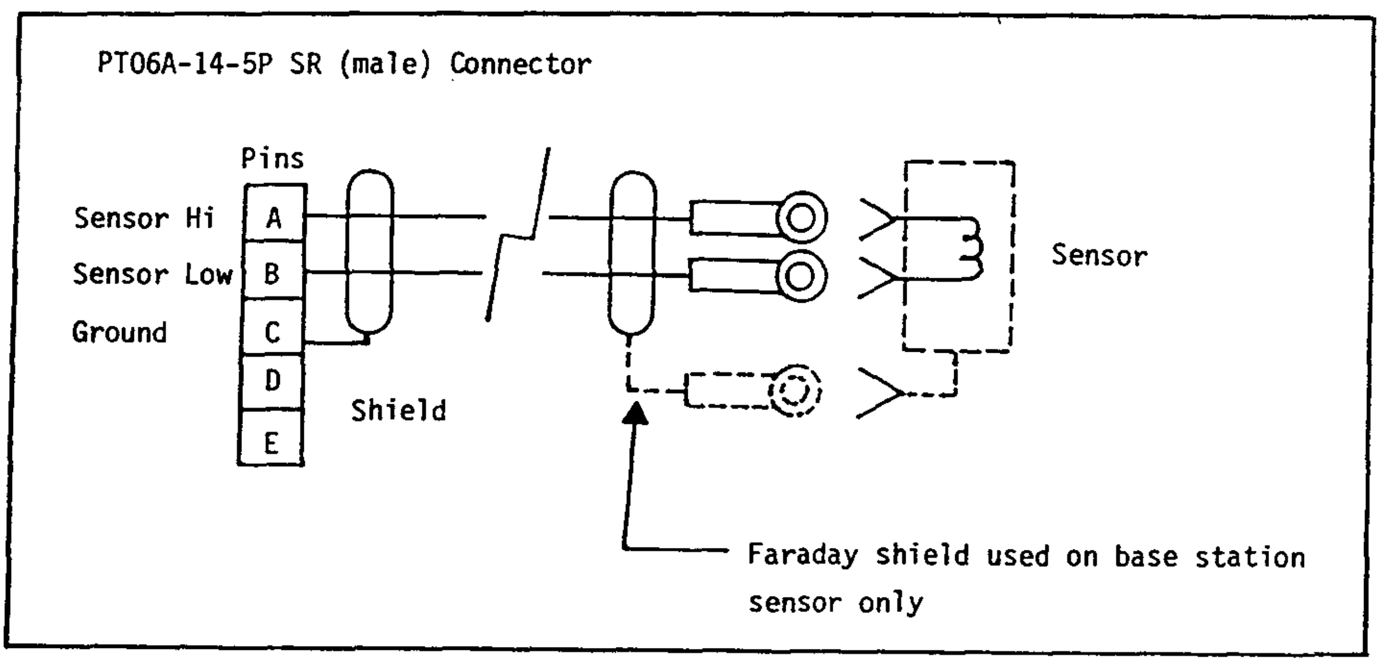
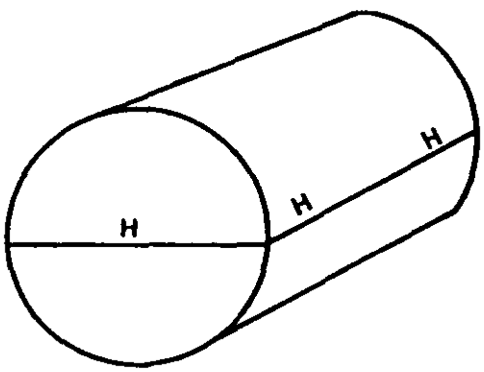
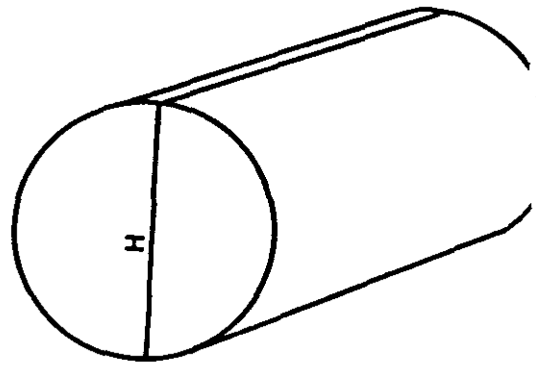


Figure 2-4G-866 Sensor Cable Wiring Diagram

Airborne Configurations



Horizon



Fields Exceeding 45 Degrees
Dip Angle

Fields at or below 45 Degrees
Dip Angle

Portable or Base Station Configuration

Magnetic North

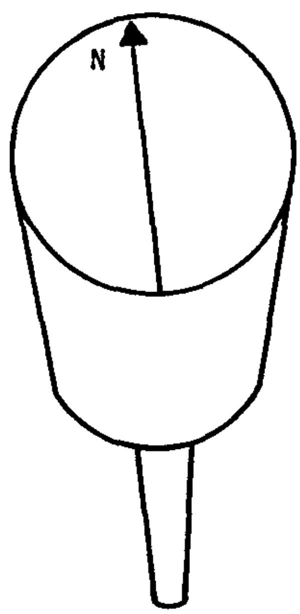
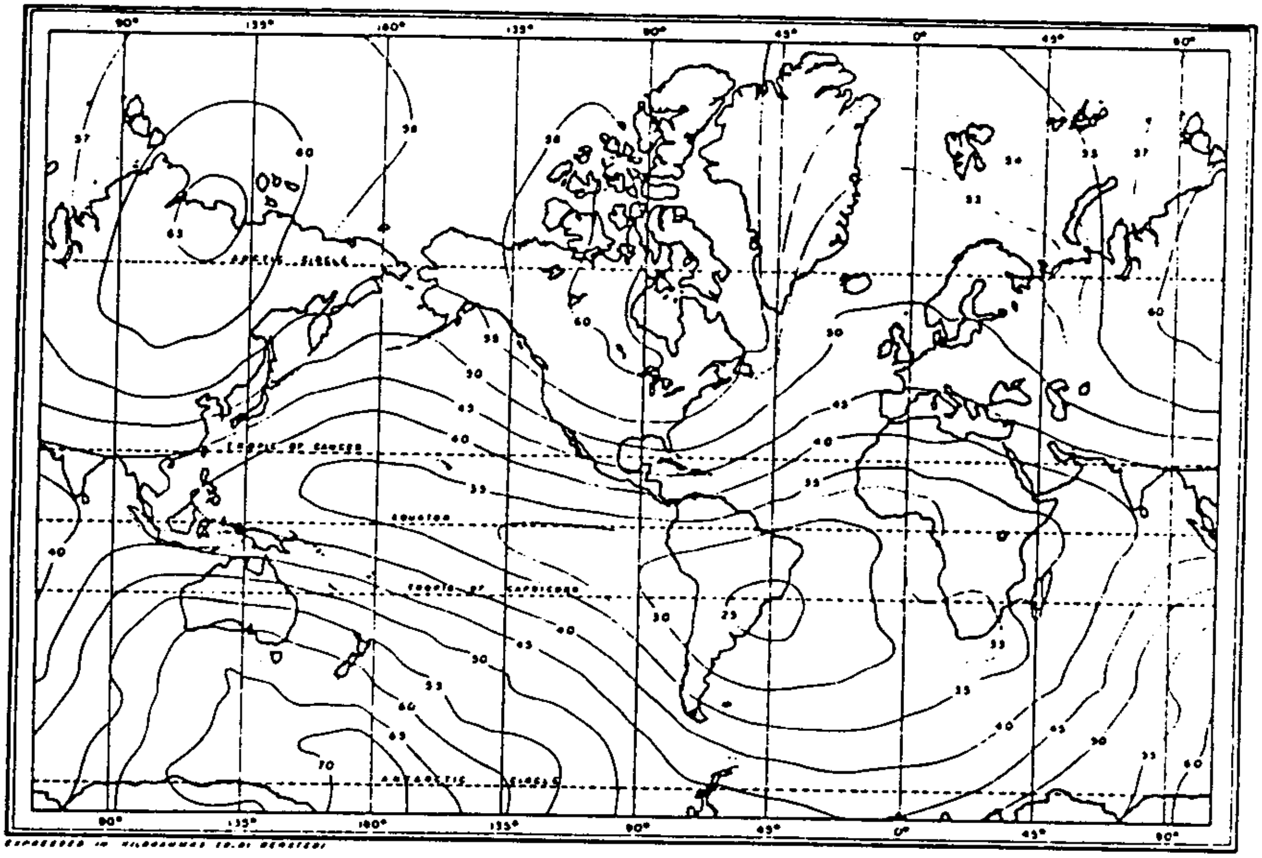


Figure 2-5 Sensor Orientation

Appendix A
Total Intensity Map



The Total Intensity of the Earth's Magnetic Field

Appendix B

The RS-232 Interface

What is RS-232C?

In 1963, the electronic Industry Association (EIA) established a standard to specify levels and protocol for interfacing data terminal equipment and data communications equipment that use serial binary interchange. The latest revision of this standard has been in effect since 1969 and is referred to as RS-232C. While RS-232C specifies a very complex group of data lines and signal levels, most devices equipped with interfaces called "RS-232" in fact offer a subset of the standard as their interface method. The G-866 is one such device.

The RS-232C standard specifies a 25-pin connector for the interface, and assigns functions to 22 of its 25 pins, but the standard does not specify what connector shall be used. The connector most commonly used is a 25-pin "D connector", available from many sources under the generic part number DB-25P (male) or DB-25S (female). The male connector is generally used on data terminal equipment (desktop computers, terminals, etc.) while the female connector is used on data communications equipment (modems, computer multiplexers, etc.) However, these configurations are by no means standardized. The RS-232 cable for the G-866 has a female connector.

Connector Pin Assignment

Only 5 of the 22 RS-232C standard lines are used in the G-866. The EG&G Geometrics standard RS-232C interface cable, part number 16492-01, is wired in the Data Communications Equipment or "DCE" configuration. This cable may only be connected to equipment wired in the Data Terminal configuration; for example, the HP-85 microcomputer with the HP 82939A-001 interface cable, and most printers and terminals. The difference between the two configurations is that pin 3 of the G-866 interface cable (DCE) carries data transmitted from the magnetometer, while pin 3 is used for receiving data on equipment wired in the DTE configuration. Pin 2 is used for transmitting data in DTE and for receiving data in DCE. Pins 4 and 5 also *have* opposite functions for DTE- and DCE-configured equipment. These are used for Clear To Send and Request To Send lines, which allow a transmitting device to send bursts of data to a receiving device that must process these data as it receives them. If the CTS line of the G-866 is grounded, data transmission will be stopped. If it is left open or 'pulled high', data transmission will occur under the control of the G-866 front panel, and at the baud rate selected by the internal programming switch.

The terms DTE and DCE were designated for the original application of the RS-232C interface standard; DCE (originally a modem) is designed to interface with DTE (originally a teletype) and vice versa. One piece of DTE cannot interface with another piece of DTE, only with equipment wired for DCE.

Below is a list of the functions assigned to each pin of the RS-232C cable from the G-866. This list reflects the standard DCE configuration.

RS-232C Connector "DCE"	G-866 Front Panel	Cable Color	Function Description
1	D	Shield	Ground - AC power ground and chassis ground.
2	U	White	Receives Data
3	T	Black	Transmits Data
4	G	Red	Clear To Send - When low, inhibits G-866 output. Leave open if not used.
7	D	Shield	Signal Ground - Zero reference for interface.

The connector for the RS-232C interface cable is supplied with movable pins, and an insertion/extraction tool. If, in order to interface with a modem or mainframe computer, you need to change the connector to the DTE configuration, the white wire should be rerouted to pin 3, the black wire to pin 2, and the red wire to pin 5. The pins are moved by threading a wire through the slot in the red end of the tool while simultaneously inserting the tip of the tool into the socket for the pin being moved. When the tool is fully seated in the socket, pull the wire and the connector pin will come out.

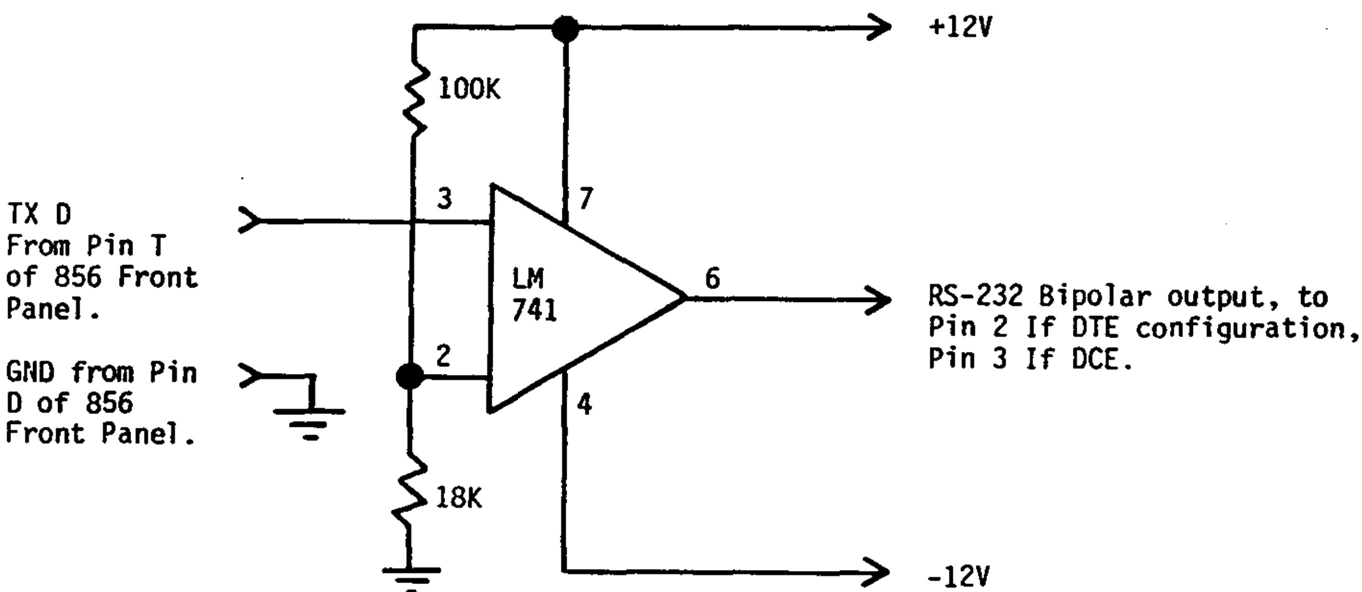
To insert a new pin, use the white end of the tool. The same process is repeated in reverse: the wire is seated in the tool, and the wire pulled in until the shoulder of the pin is at the tip of the tool. Insert the tool and pin in the new socket and withdraw the tool; the pin will remain seated in the body of the connector. The new configuration (DTE) is listed below:

RS-232C Connector "DTE"	G-856 Front Panel	Cable Color	Function Description
1	D	Shield	Ground - AC power and chassis ground.
2	T	Black	Transmit Data
3	D	White	Receive Data
5	G	Red	Clear to Send - When low, inhibits G-866 output
7	D	Shield	Signal Ground - Zero reference for interface

The pin numbers can be found in the molded plastic of the connector body.

Voltage Levels

The RS-232C standard specifies voltage levels for the various data and protocol lines of the interface as + 12 volts nominal, with voltages from 5 to 25 volts being acceptable. A logical "1" (mark, off or false state) is indicated when the voltage at the interface point is more negative than -3 volts; a logical "0" (space, on, or true state) is indicated when the voltage is more positive than +3 volts. Many "RS-232" devices, including the G-866, use 0 and +5 volts for these two logic levels ("T M level") instead of +12 volts. Most devices designed to work with +12 volts will operate correctly with "TTL levels" but there are exceptions. Many large mainframe computers and some minicomputers require the full positive and negative swing of voltage, especially when transmitting data over long cables. If your external equipment requires full +12 volt RS-232C levels, you will need to construct or purchase a TTL-to-bipolar interface driver. A schematic of such an interface driver is shown in Figure B-1.



The interface driver will work well on two 9-volt transistor radio batteries for +9 volts.

Figure B-1 TTL-to-RS-232C Interface Driver

RS-232 Input/Output Functions

The G-866 provides both input and output functions through its RS-232C port. During auto-cycle magnetometer readings, complete readouts of the time,day and field value are output on the RS-232C port as described in the preceding pages. These readouts may be used to drive an external printer or data acquisition system. (cables for transferring data to peripheral devices and to a digital tape recorder are shown in Figures B-2 and B-3). Connector pins are identified in Table B-1.

When Miniswitch 6 of Switch Bank 1 is set to ON, the G-866 will accept data from a G-856 portable magnetometer, and generate a printed record with analog chart just as if the data were being collected with the G-866. Turning on Miniswitch 6 however, disables the magnetometer. The switch must be returned To the OFF position to use the G-866 in the normal mode. Input from the G-856 must be at 300 baud for the G-866 to accept it. A special cable, EG&G Geometrics part number 16625-01 may be used to transfer data from a G-856 to a G-866. See Figure B-4. Note that all printer format options may be used to display these data.

Input/Output Data Format

Output from the G-866 on the RS-232C port will have the following form: ibb6bDDDbHHMMSSbbbb6bNNNNNN CR/LF, where % denotes G-866 datastream, b is blank or space, 6 is zero, DDD is day. HHMMSS is the time, and NNNNNN is the field reading in gammas.

Output from the G-856 is similar: * AAAbDDDbHHMMSSbBBBBbNNNNNN. AAA is the line number, BBBB is the station number. The * character is absent from the G-856 output when the mag is being used to output single manual field readings or readings from memory. It is present only on readings taken when the G-856 was in the auto cycle mode.

The last blank (b) preceding the field readings may be a "?" if the gradient flag in the G-856 was triggered during read, i.e. high noise condition.

SP06A-14-18P (SR) Male Connector (PN 21-206-013)

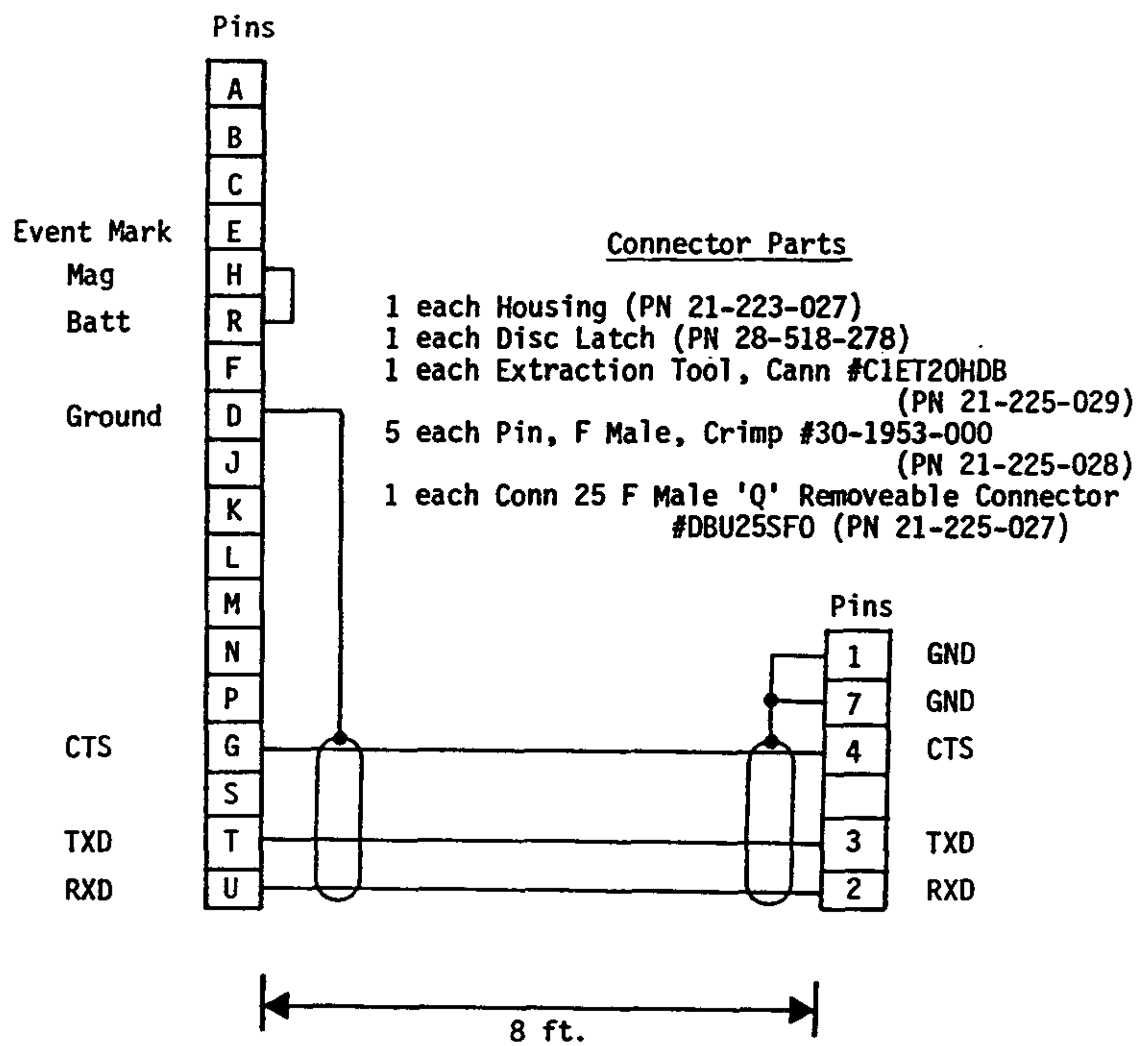


Figure B-2 G-856/G-866 RS-232 Output Cable to

Peripheral Device (P/N 16492-01)

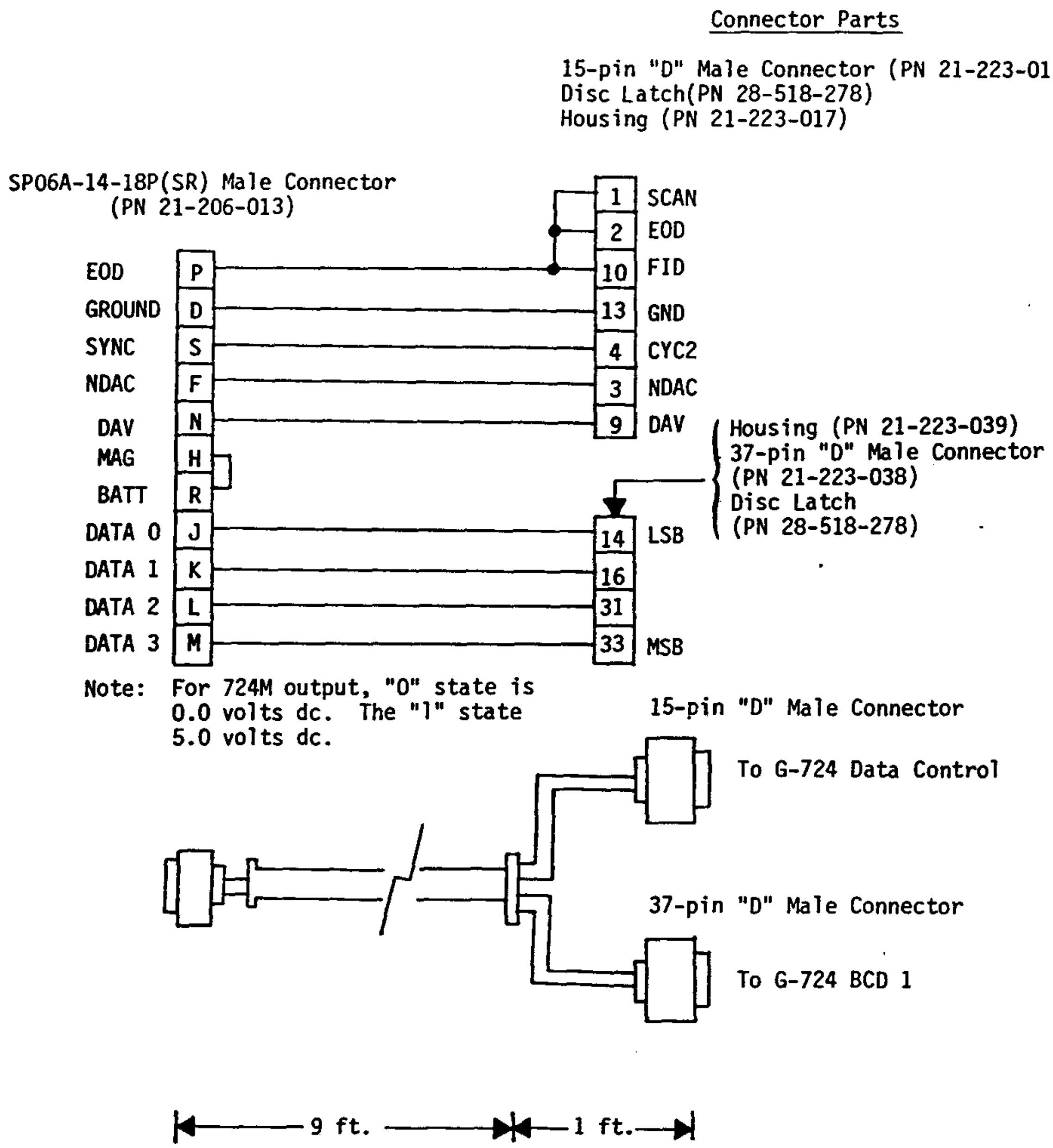


Figure B-3 Data Cable*to G-724M Digital Tape Recorder

*Assembly part number for this cable is 16496-01.

P/N 21-206-013 | P/N 21-206-013

SP06A-14-18P(SR) Connector Pins | SP06A-14-18P(SR) Connector Pins

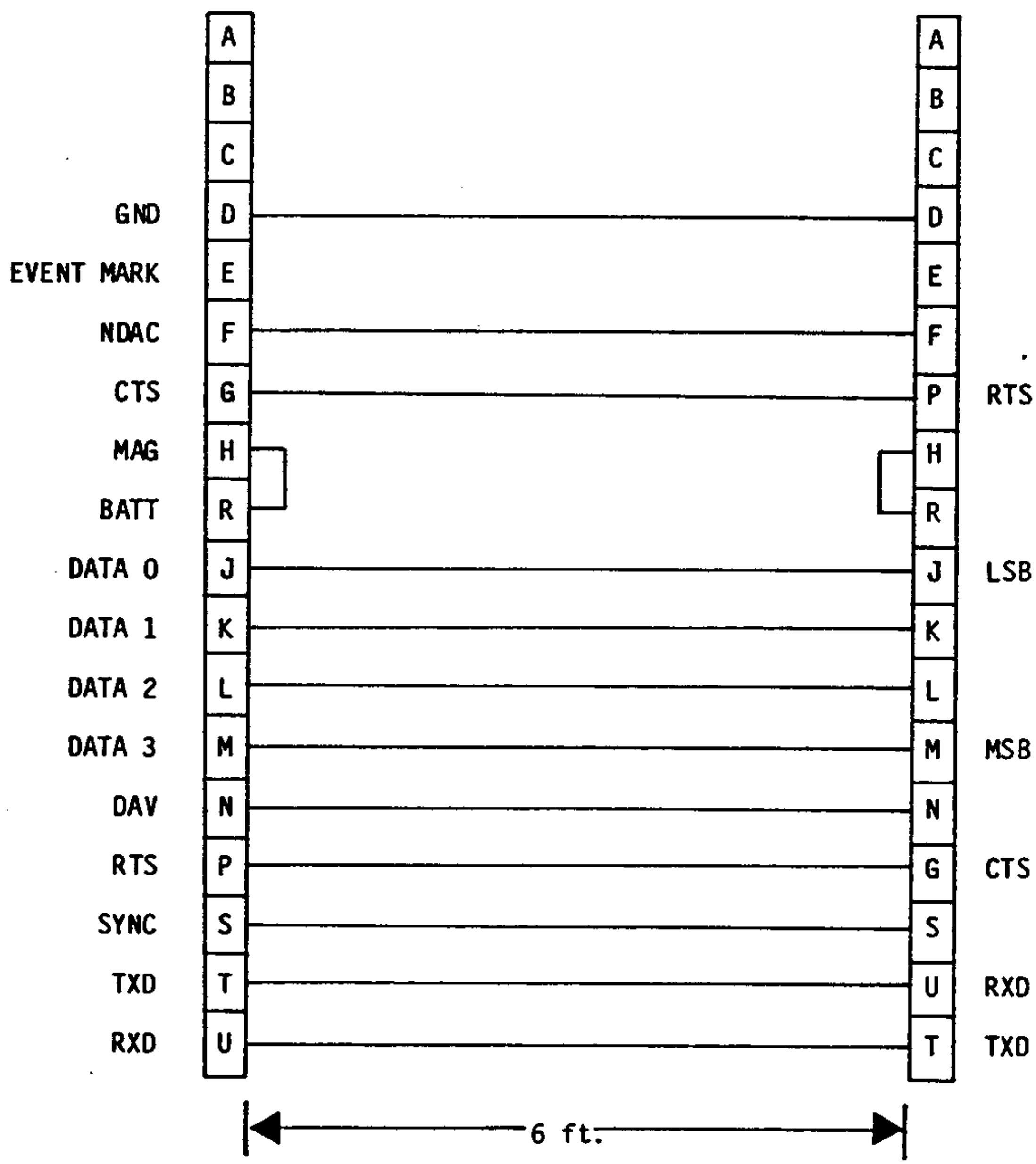


Figure 8-4   G-856 to G-866 Data Cable (P/N 16625-01)

Table B-1

Connector Pin Identification

Data Interface Connector
(Hating Connector SP06A-14-18P(SR), PN 21-206-013)

A	N/C		
B	N/C		
C	N/C		
D	--	Ground	
E	In	Event Mark	
F	In	NDAC	(724 handshake)
G	In	CTS	(RS-232 control)
H	N/C		
J	Out	DAT 0	(724 data)
R	Out	DAT 1	(724 data)
L	Out	DAT 2	(724 data)
H	Out	DAT 3	(724 data)
N	Out	DAV	(724 handshake)
P	Out	EOD/RTS	(724/RS-232)
Q	N/C		
R	N/C		
S	I/O	Synch	(Cycle control)
T	Out	TXD	(RS-232 output data)
D	In	RED	(RS-232 input data)

Sensor Cable Connector
(Mating Connector SP06A-14-5P(SR), PN 21-206-010)

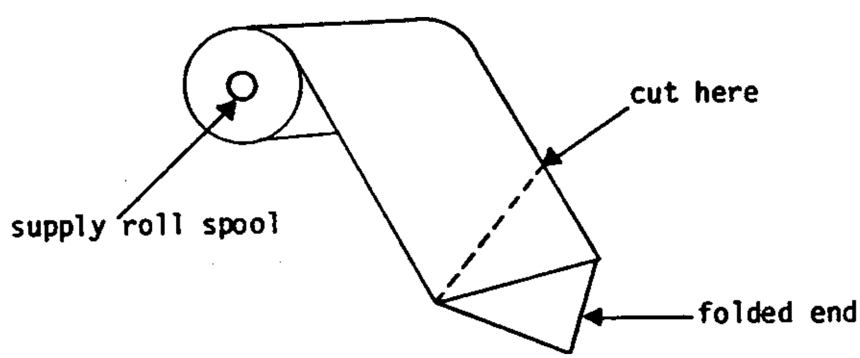
A	Sensor
B	Sensor
C	Shield

Power Connector
(Mating Connector SP06A-12-3S(SR), PN 21-201-014)

A	+11 to +32 Volts DC
B	Supply Voltage Return (-)
C	Chassis Ground

Appendix C
G-866 Paper Loading Instructions

1. Turn the unit on.
2. Disengage recording function (press any illuminated SCALE key).
3. Lift the platen tray.
4. Remove the supply roll spool and insert it into the center of the new roll of paper.
5. Tear or cut off the exposed end of the new roll of paper. Make the tear or cut at a slight angle (see illustration).



If the end of the new roll has been folded, cut off the folded portion.

6. Pull straight up on the take-up hub latch located on the left side of the printer.
7. Move the take-up hub to the left so that the take-up spool can be installed. Insert the take-up spool so that the spindle drive slots are engaged by the right-hand take-up drive hub pins. If paper has been installed and the take-up spool must be replaced, you should stop the rotation of the take-up hub by grasping it. The spool can then be replaced.

8. Return the take-up hub right, to its original position, and push down the hub latch until the take-up shaft is latched. Make sure hub latch retaining pin is secure in the groove of the take-up shaft.

9. Insert the end of the paper aluminized-side-down under the rubber roller. Press the red paper feed button until the end of the paper reaches the printhead.

10. Set the new roll of paper into the slots of the support arms. Push the platen tray down, into its original position. Depress the paper feed button until approximately 8 inches of paper extend past the printhead.

11. Check that the take-up spool turns freely, and will not stall with minor friction.

12. Remove the protective covering from the adhesive strip on the take-up spool and position the free end of the paper over the adhesive strip on the take-up spool. Ensure that both edges of the paper are squarely aligned with the edges of the take-up spool, then press the paper against the adhesive strip. Press the paper feed button and ensure that the paper is feeding and winding correctly.

Appendix D

WARRANTY AND SERVICE

Warranty

EG&G Geometrics fully warrants this instrument to be free of defects in material and workmanship for a period of one year from the date of acceptance, but no longer than fifteen months from the date of shipment from the factory. EG&G Geometries maintains good commercial practices in the manufacture of equipment. In the event of malfunction, EG&G Geometrics, at its own expense will repair or replace any materials, equipment, work, or parts that prove defective or deficient under normal operating conditions.

Except for the express warranty stated above, EG&G Geometrics disclaims all warranties of merchantability and fitness, and any stated express warranties herein are in lieu of all obligations or liability on the part of EG&G Geometrics for damages, including but not limited to special, indirect, or consequential damages arising out of, or in connection with the use or performance of the equipment.

Warranty Service (continued)

Geometrics reserves the right to perform warranty services FOB Sunnyvale or at the customer's installation site. 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.

Should warranty service or technical advice be required, contact EG&G Geometrics. No warranty service will be performed unless customer secures authorization from EG&G Geometrics prior to returning equipment. If this instrument or any part of it is returned to the factory for any reason, please complete this form and include it with the instrument or part being returned.

SHIP TO:

Geometrics
2190 Fortune Dr.
San Jose, CA 95131
(via San Francisco International Airport)
Phone: (408) 954-0522
Fax: (408) 954-0902
Email: support@mail.geometrics.com

Name____

Company______________________________________

Address______________________________________

City, State, Zip, Country____________________________

Telephone____________________________________

IMPORTANT

Please explain why this instrument or part is being returned; include a complete description of any malfunction (use additional paper if necessary). Thank you.________________________________

____

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Appendix E

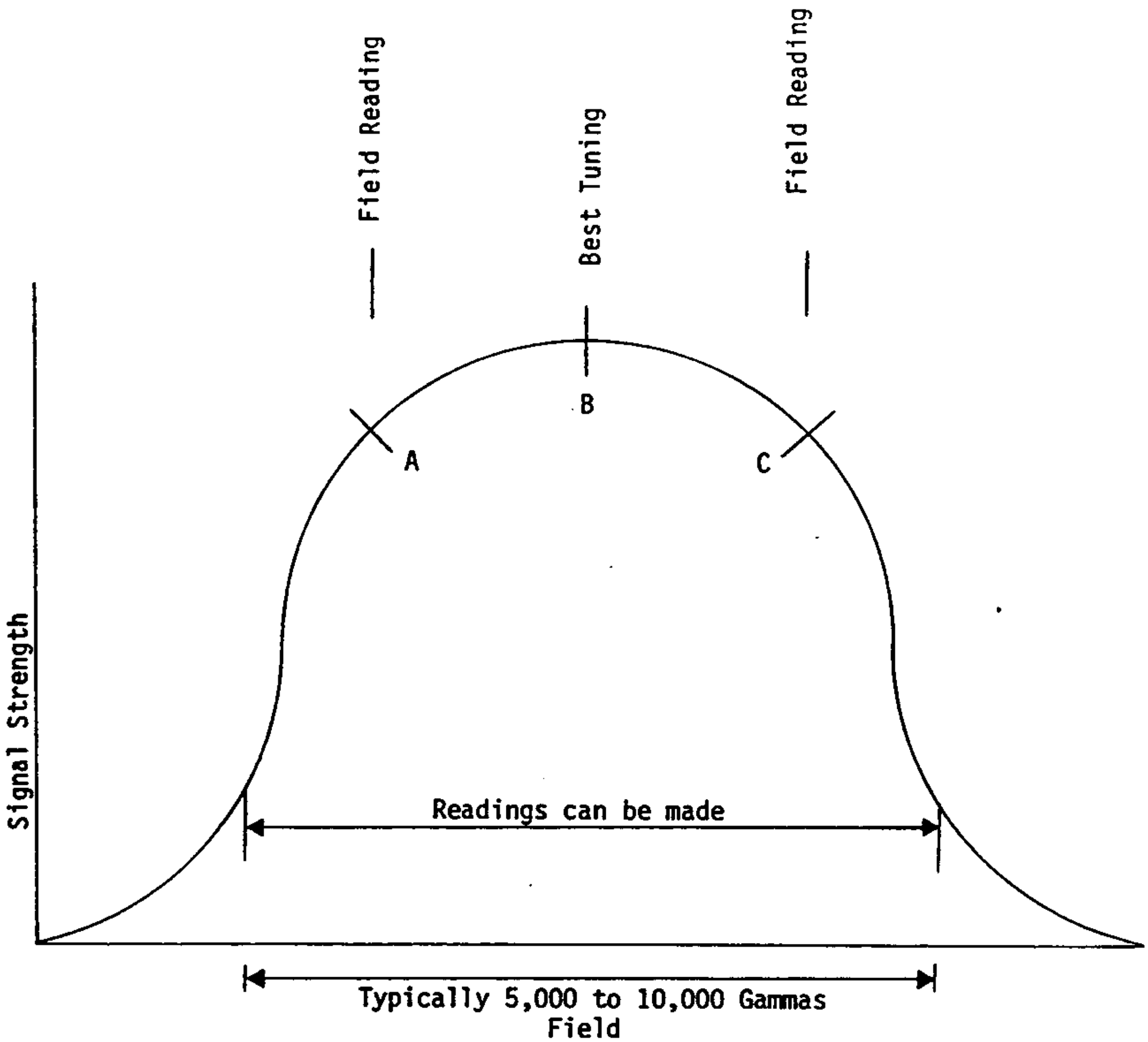
FINE TUNING

Fine tuning, as opposed to coarse tuning, is a process of narrowing down the choices of tuning values until you find a tuning value that will allow the G-866 to obtain the strongest readings of the field. Fine tuning is-particularly important when readings must be taken in high-noise environments, when the detection of small fluctuations in the field is required, and when you change the size and type of sensor, cord, or tow apparatus.

The fine tuning process has one objective: To find an optimum tuning value for the G-866. Except at its beginning, the process involves changing only one value: the tuning value. New variables (digits) will be entered for the tuning value until a maximum signal strength is achieved. Once that maximum has been determined, the process is complete. Remember that signal strength can only be read by taking a field-strength reading and pressing 

.

At any one physical location the G-866 may detect a magnetic field that varies as much as 10,000 gammas. However, only a portion of that field will produce the strongest signals on the G-866, usually the center of the field range. Figure E-1, The Tuning Spectrum, demonstrates the range and where the 'best tuning' and acceptable 'field reading' can be taken. Note that the signal-strength curve is relatively flat so that acceptable field readings can be made on either side of the 'best tuning' point. The fine tuning process centers the operation of the G-866 about the 'best tuning' segment of the signal-strength curve. We will refer to this figure again after we complete the actual fine tuning procedure.



p.

Figure E-1 The Tuning Spectrum

Fine tuning the G-866 involves adjusting a resonant circuit in the G-866 (this circuit includes the sensor and its cable, as well as the actual components of the circuit) until it can best resonate with the precession of the protons in the sensor fluid. (See Figure E-2.) Optimum resonance is indicated by the highest signal-strength reading and is achieved by first coarse- tuning the circuit to an approximation of the total intensity for the location where readings will be taken. Next, the tuning value is either increased or decreased in 100-gamma increments until an optimum match is obtained between the proton precession frequency and the configuration of the resonant circuit (changing the tuning value changes the capacitance in the resonant' circuit). Once the G-866 is tuned, routine readings can be made and recorded. A word of caution is in order here: Since the tuned circuit includes the sensor and its cable, you must retune the G-866 if you change sensors or cables.

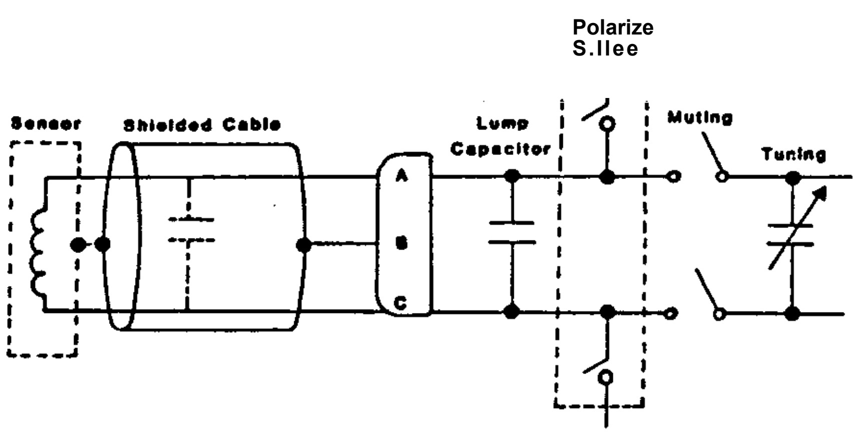


Figure E-2. Resonant Circuit

The procedure for fine tuning the G-866 is shown below on Table E-1. Before you try it, make sure you can write down the tuning values, signal strengths, and readings of the magnetic field. What you write down will become a fine tuning table that you'll eventually use to determine the tuning value for reading and recording with the G-866. Changes in the length of the sensor cable can alter the optimum tuning value by as much as 5,000 gammas above or below the magnetic field reading.

Table E-1

Fine Tuning Procedure

a. Coarse tune the G-866. (See Page 2-3)

b. Press SAMPLE INTERVAL .

c. Press variable key 9 <u>four times</u>, then press ENTER .

d. Press MANUAL READ . The following sample data might be displayed (<u>values shown are only for illustration</u>):

18.5 (The voltage of your power source; here, 18.5 volts.)

then,

53641.4 (The reading of the earth's magnetic field; here, 53,641.4 gammas.)

e. Write down the first three digits of the above field reading.

f. Press the TUNE key and hold it down. The signal strength will be displayed. This is the strength of the reading you just took in Step c. Write down the value of the signal strength on Line 1 of the table you'll find discussed in Step h.

g. When you release the [TUNE] key, the tuning value, in kilo-gammas, will be displayed. Write down the tuning value on Line 1 of the table you'll find discussed in Step h. Press the appropriate variables keys to enter the first three digits of the magnetic field reading you recorded in Step d., and press [ENTER].

h. Make a chart like Figure E-3. Enter the tuning value from Step g, and the signal strength from Step f. on the first line of your table.

TUNING VALUE	SIGNAL STRENGTH
1.	1.
2.	2.
3.	3.
4.	4.
5.	5.
6.	6.
7.	7.
8.	8.
9.	9.
10.	10.

Figure E-3 Fine Tuning Table

i. Increase the first tuning value that you entered in Step g., by 100 gammas; (Do this by pressing TUNE, then keying in the increased tuning value on the variable keys and pressing ENTER.)

Write down the new value on Line 2, under Tuning Value on your table.

j. Now press MANUAL READ, wait for the reading, then press TUNE.

Write down the displayed signal strength opposite the tuning value you just wrote down in Step i.

k. Notice if the signal strength of the reading you recorded on Line 2 represented an increase, decrease, or no change from the signal strength of your first reading, which you recorded on Licie 1. If the signal strength increased, proceed to Step I. If it decreased, proceed to Step m. If it didn't change, consider the G-866 to be fine tuned; however, you may want to try a few more tuning values to verify your initial findings.

I. Continue <u>increasing</u> the tuning value by 100-gamma increments, writing down each increased tuning value, taking a reading, and writing down the signal strength of each reading until your table has a total of ten increasing tuning values and ten corresponding signal strengths.

m. Now make up another Fine Tuning Table and <u>decrease</u> the tuning value you entered in Step g by 100-gamma decrements, writing down each decreased tuning value, taking a reading, pressing , and writing down the signal strength of each reading until your new table has a total of ten decreasing tuning values and ten corresponding signal strengths.

n. Review your table (or tables) and select the tuning value with the highest signal strength and enter it as the tuning value you will use to begin reading and recording with the G-866. The G-866 is now fine tuned.

Figures E-4, E-5, and E-6 are tuning tables that were completed in the field. If you follow the progression of the entries and refer back to Figure E-1, The Tuning Spectrum, you will see that by adding 100 gammas (in Step i) to the tuning value and noting the results, you can immediately determine where your last reading fell on the signal-strength curve. If adding 100 gammas did not produce a change, then your tuning value was very close to Point *B* bhown in the illustration. If adding 100 gammas increased the signal strength, then your reading was to the left of the Point **B,** in the sector between Point A and Point **B.** If adding 100 gammas decreased the signal strength, your first tuning value lay to the right of the best tuning point (Point **B).**

Accordingly, we added or subtracted 100-gamma units until the best tuning point was crossed. (Since the curve is quite flat, this exact point will generally only be approached in the tuning process).

TUNING VALUE		SIGNAL STRENGTH
1. 50.5	Tuning Value Chosen	1. 8.2
2. 50.6		2. 8.2
3. 50.7		3. 8.2
4. 50.8		4. 7.8
5. 50.9		5. 7.7
6. -		6. -
7. -		7. -
8. -		8. -
9. -		9. -
10. -		10. -

Figure E-4 Tuning Table Record of Tuning Value That Was Left Unchanged (Operator had used G-866 on day before.)

TUNING VALUE		SIGNAL STRENGTH
1. 50.5		1. 6.9
2. 50.6		2. 7.5
3. 50.7		3. 7.8
4. 50.8		4. 7.1
5. 50.9	<-- Tuning Value Chosen	5. 8.2
6. 51.0		6. 7.4
7. 51.1		7. 6.5
8. 51.2		8. 6.9
9. 51.3		9. 5.8
10. 51.4		10. 5.9

Figure E-5 Tuning Table Record of Tuning Values Increased In 100-Gamma Increments

TUNING VALUE		SIGNAL STRENGTH
1. 50.5		1. 7.1
2. 50.6		2. 6.9
3. 50.5		3. 6.9
4. 50.4	<-- Tuning Value Chosen	4. 7.1
5. 50.3		5. 7.1
6. 50.2		6. 6.7
7. 50.1		7. 6.9
8. 50.0		8. 6.9
9. 49.9		9. 6.7
10. 49.8		10. 6.1

Figure E-6 Tuning Table Record of Tuning Values Decreased In 100-gamma Decrements

Appendix F
G-866 Troubleshooting Guide

Section I

Control- or Connector-Related Problems	Probable Cause	Corrective Action
Will not turn on	1. No input power	1. Check input connections and voltage: 11 to 32 volts.
	2. Fuse blown	2. Check fuse, if blown, see cause no. 3.
	3. Power polarity reversed	3. Check polarity. Incorrect polarity will blow internal fuse or cause power source to 'current limit'. Correct power connection is: + to A, - to B } 11 to 32 volts; earth to C
	4. Keyboard input signals are not reading logic circuits.	4. Check for loose cables on front panel.
	5. Failure of power-up control circuitry.	5. See Section II

Control- or Connector-Related Problems	Probable Cause (cont'd)	Corrective Action
Turns on, but will not cycle	1. External cycle switch is on.	1. Turn off the switch
	2. Sync input line is shorted to ground.	2. Check external cables and correct any short.
	3. Cycle time is too long.	3. Press SAMPLE INTERVAL and ensure that interval isn't set for an extremely long cycle time, such as 999 seconds.
	4. Unit is set to receive RS-232 input (G-856 dump).	4. Turn off the RS-232 input switch.
	5. Clock is not running.	5. Set clock each time unit is turned on. Replace lithium battery.
	6. Failure of CPU circuitry or I/O circuitry.	6. See Section II.

Control- or Connector-Related Problems	Probable Cause (cont'd)	Corrective Action (cont'd)
Turns on and cycles, but readings are irregular and intermittent.	1. Sensor or cable to sensor is disconnected	1. Check cable and connections.
	2. Test switch is on.	2. Turn off test switch.
	3. Sensor is positioned in a high-gradient area.	3. Move sensor to another location.
	4. Power supply output signal is noisy.	4. Observe signal with oscilloscope and try grounding the system. Filtering out noise from other instruments may also be necessary.
	5. Sensor fluid leaked out.	5. Check sensor-fluid level.
	6. Unit may be incorrectly tuned.	6. Tune to the local field. See field intensity map in operator's manual.
	7. Magnetometer circuitry failed.	7. See Section II.

Control- or Connector-Related Problems	Probable Cause (cont'd)	Corrective Action (cont'd)
Reads and cycles correctly but will not print.	1. Printer may not be turned on.	1. Press one of the scale keys.
	2. Paper supply is exhausted.	2. Check paper supply.
	3. Printer-related circuitry failed.	3. See Section II.
Prints, but runs slowly.	1. Residue on printhead guide rails.	1. Clean rails with aerosol from the shipping kit.*
	2. Input voltage is below 11 volts (See Table G-1).	2. Check power supply.
	3. Operating temperature is below 0'C.	3. Raise temperature to correct range of O'C to 50'C.

*WARNING: Wear eye protection when using either the pressurized solvent or freon cleaners contained in the shipping kit.

Control- or Connector-Related Problems	Probable Cause (cont'd)	Corrective Action (cont'd)
Print quality is poor, or dots may be missing.	1. Residue on printhead.	1. Clean head with brush or high-pressure gas from shipping kit. Be very careful: the head is fragile. Be sure to turn off the printer before you clean it.
	2. Worn printhead.	2. After about 30 rolls of paper have been printed the printhead will have to be replaced.
	3. Broken or bent print-head stylus wire.	3. Replace the printhead.
	4. Intermittent internal ground to paper.	4. Printer may have to be replaced.
	5. Printer related circuitry failed.	5. See Section II.

Control- or Connector-Related Problems	Probable Cause (cont'd)	Corrective Action (cont'd)
Printer will not stop; printhead is on left half of chart.	1. Metallic residue is blocking the optical choppers.	1. The printer may have to be removed, but first try blowing out the area below the supply paper tray. Use the high-pressure gas in the shipping kit.
	2. Beta gate is mis-adjusted.	2. Return unit to EG&G Geometrics for realign-ment of gate.
	3. Circuit on I/O board has failed.	3. See Section II.
Data output to external printer is broken up.	1. Baud rate of either G-866 or the external printer may be set incorrectly.	1. Correct the baud rate (300 input; 100, 600, or 9600 output).
	2. I/O or CPU circuit failure.	2. See Section II.

Control- or Connector-Related Problems	Probable Cause (cont'd)	Corrective Action (cont'd)
External printer will not print, though baud rates are correct.	1. The handshake lines may be connected incorrectly.	1. Consult the external printer manual and the RS-232 section of this manual for handshake information.
	2. I/O or CPU circuit failure.	2. See Section II.
Data will not transfer to a G-724M.	1. Cables are not connected.	1. Check cables and plugs.
	2. The G-724M is incorrectly configured.	2. Consult the G-724M manual to ensure that the BCD configuration is correct.
	3. I/O board circuit failure.	3. See Section II.
Magnetometer cycling cannot be initiated from the G-724M.	1. No external cycle command.	1. Check setting of G-724M cycle timer.
	2. External cycle switch has been turned off.	2. Turn on external cycle switch.
	3. I/O board circuit failure.	3. See Section II.

Control- or Connector-Related Problems	Probable Cause (cont'd)	Corrective Action (cont'd)
The G-866 cycles the G-724M, but data are not always recorded.	1. The G-866 sample interval is set to less than 1 second.	1. Extend the cycle time of the G-866 so the G-724M will record data.
The G-866 'forgets' settings when power is disconnected.	1. The lithium battery may be dead.	1. Replace the lithium battery. This battery should normally last 8 to 10 years.
	2. I/O board circuit failure.	2. See Section II.
Printer action suddenly becomes erratic.	1. Diminishing battery voltage.	1. Check and recharge battery, as required.
	2. Circuit failure on the printer interface board.	2. See Section II.

Section II

Wiring- or Circuitry-related Problems

Problem	Probable Cause	Corrective Action
Will not turn on.	a. Keyboard internal failure.	a. Replace keyboard/panel assembly.
	b. Keyboard connector loose.	b. Check connector.
	c. Front panel cable loose.	c. Check connector.
	d. Power-up circuit display board failed.	d. Replace display board.
	e. Power control relay or driver failed.	e. Replace printer interface board.
	f. Keep-alive supply failed.	f. Replace I/O board.
	g. Cable from power input to printer interface is loose.	g. Check connector.
	h. Cable from printer interface to I/O is loose.	h. Check connector.
Turns on, but will not cycle.	a. Failure of CPU circuitry or I/O circuitry.	a. Replace CPU or I/O board.
	b. Loose cables from Hag 1 or Mag 2 board.	b. Check cables.

Problem	Probable Cause	Corrective Action
Powers up and cycles, but readings are irregular and intermittent.	a. Failure of the magnetometer circuitry. b. Loose cables between Mag 1 and Mag 2.	a. Replace Mag 1 and replace Mag 2 board. b. Check cables.
Reads and cycles correctly but will not print.	a. Circuitry on I/O board failed. b. Circuitry failure on printer interface, c. Loose cables.	a. Replace I/O board. b. Replace printer interface. c. Check cables to/from printer.
Print quality is poor, or dots may be missing.	a. Printer-related circuitry failed. Head driver circuits on Printer interface board failed. b. Driver circuits on I/O failed.	a. Replace printer interface. b. Replace I/O board.
Printer will not stop; printhead is on left half of the chart.	Failure of circuit on the I/O board.	Replace the I/O board.

Problem	Probable Cause	Corrective Action
Data output to external printer is broken up.	Circuitry failure on I/O or CPU board.	a. Replace I/O board. b. Replace CPU board.
External printer will not print, though baud rates are correct.	Circuit failure on I/O or CPU board.	a. Replace I/O board. b. Replace CPU board.
Data will not transfer to a G-724M.	Circuit failure on I/O board.	Replace I/O board.
Cycling of the G-866 cannot be initiated from the G-724M.	Circuit failure on I/O board.	Replace I/O board.
The G-866 'forgets' settings when power is disconnected.	Circuit failure on I/O board.	Replace I/O board.
Readings and printer action suddenly become erratic.	The 12-volt regulator on the printer interface board failed.	Replace printer interface board.

G-866 Printer Maintenance Schedule (See Page F-13)

Frequency	Maintenance Required
Whenever paper supply is replenished	Check for buildup of metallic coating on the printhead carriage. Remove any buildup with soft-bristled brush.
After every 10 rolls of paper	Clean the top rail by spraying it with the aerosol cleaner contained in the shipping kit that was delivered with the G-866.
After every 30 rolls of paper	Replace the printhead assembly (see instructions in this appendix). Thoroughly remove metallic coating residue from all parts of the printer. Use compressed air or a soft brush to remove the residue.
	Apply one small drop of light oil to (1) the printer shaft bearings, (2) the shaft pass, and (3) the oil pad. Apply a small amount of silicon grease to springs and to components of the gear group.
WARNING:	Excessive oil or grease can impede the operation of the printer.

Removal of Circuit Boards or Printer Assembly

CAUTION: Remove a1l external cables before proceeding!

I. Display Board Removal

1. Unplug the ribbon cable to the I/O board.
2. Remove the protective plate.
3. Unplug the cable to the keyboard - very fragile, be careful.
4. Remove standoffs and screws, and

   pull the board straight away from the panel.

II. Removal of the Connector Plate Asssembly

1. Unscrew the six screws on the left side of the case.
2. Remove the I/O circuit board protector.
3. Unplug cables from the I/O Board the display board and the printer and the cable from the fuse bracket to the power input connector.
4. Locate and remove the shoulder screw from the staybolt on the right end of the panel.
5. Push the assembly in toward the center of the case so that it can be swung up and out of the subchassis. Do not pull it up too far until the cable plugged into the front edge of the Mag 1 board is unplugged.
6. Continue removing the assembly.

III. Removal of the Printer Assembly and/or Printer Interface

1. Proceed with all of the operations in Section II before going on to the remainder of Section III.
2. Remove the four large screws from the bottom of the case.
3. Lift the subchassis out of the cabinet case.
4. On the bottom of the subchassis, locate the five screws holding the printer assembly to the subchassis. Remove these screws while the unit is upright, so the printer isn't damaged by falling against the sides of the subchassis.
5. Lift printer interface PCB and printer out of the subchassis as a unit. Be careful to tilt the printer so that area around the the printhead doesn't strike the chassis.

IV. I/O Board Removal

1. Remove the circuit board protector.
2. Unplug all connectors from the board.
3. Unscrew the standoffs and pull the board straight up.

V. CPU Board Removal

1. Perform all operations in II, above.
2. Unplug connector from the board.
3. Unscrew the standoffs and pull the board straight up.

V1. Mag 2 Board Removal

1. Perform all operations in II and III.
2. Unplug the signal test connector and unscrew the BNC bracket.
3. Unscrew the standoffs and tilt the board up to the right to gain access to the next board.
4. Unscrew the standoffs and remove the Mag 1 shield.
5. Unplug the cables to the Hag 1 board from Mag 2 board and remove the Hag 2 board.

VII. Mag 1 Board Removal

1. Perform all operations in II, III, and IV, above.
2. Unplug the remaining two connectors.
3. Remove screws from bottom of connecting plate.
4. Unscrew standoff.
5. Remove board.

Servicing The Printer

To Remove the Printhead:

1. Perform all operations in Sections II and III.
2. Unplug the head cable from its socket on the printer interface.
3. Locate the copper-colored cable retaining clip, lift it and pull it out of the head carriage.
4. Unhook the coil spring from the head carriage, pull the head assembly away from the carriage, and lift it off its post.

CAUTION: The printhead is quite delicate and must be handled carefully to prevent bending the stylus wires or the ribbon cable.

The printhead is cemented into the black carrier and must be pried out if it is to be replaced. The cement is only meant to prevent the white nylon head from working out of the carrier. Clear fingernail lacquer or model cement can be used to cement a new head in place.

To Clean the Head (can be performed without disassembling the instrument):

Carefully pull the printhead away from the platen roller and brush off or blow it clean with either compressed air or the compressed gas from the canister in the shipping kit.

To Clean The Head Guide Rail (can be performed without disassembling the instrument):

Spray the rail with the Freon TF solvent contained in the shipping kit.

To Clean the Optical Choppers in the Printer (can be performed without disassembling the instrument):

1. Remove the supply and takeup paper rolls.
2. Remove the two screws located on the paper supply tray (behind the printer). Be careful not to lose the two spacers on the inside of this tray (behind the printer).
3. Blow out the area around the chopper wheels and gears with compressed gas from the shipping kit, or with compressed air.

<u>To Remove the Printer Interface Board</u>

1. Perform a11 operations for Sections II and III.
2. Remove the five screws holding the printer interface board to the printer mounting plate.
3. Unplug all cables from the board: remove the head cable first, then remove the take-up motor cable.

Note: If the board only needs to be partially removed (e.g., for troubleshooting the power supply sections): unplug the cable and swing the board down on its two hinged standoffs.

Appendix G

SPECIFICATIONS

Display: Six-digit, seven-segment, numeric display of magnetic field with 0.1 gamma resolution. Same display used to set or view time-of-day and date, signal strength, battery voltage, and variables.

Resolution: Varies from 0.1 to 1 gamma depending on sample interval. 1 gamma for 0.5 to 0.9 second, 0.5 gamma for 1.0 to 1.7 seconds, 0.2 gamma for 1.4 to 2.9 seconds, and 0.1 gamma for 3.0 or more seconds.

Accuracy: One-half gamma.

Controls: Pressure-sensitive keyboard to control operation and to select variables. All control clock settings are stored in non-volatile memory, powered by a lithium battery.

Clock: Julian clock with stability of 5 seconds per month at room temperature and 5 seconds per day over a temperature range of -20 to +50 degrees Celsius.

Tuning: Push-button tuning from keyboard. Current tuning value displayed on request. Tuning range is 20 to 90 kilogammas.

Gradient Tolerance: Tolerates gradients to 5000 gammas/meter. When high gradients reduce signal quality, a partial reading is maintained at a resolution consistent with implied accuracy.

Sample Interval: Push-button selection of sample interval from 0.5 to 999.9 seconds. Resolution of 0.1 seconds.

Manual Read: Readings may be initiated by a front panel pushbutton.

External Cycling: Can be initiated by external cycling device.

Recorder: Electrosensitive recorder producing permanent records insensitive to heat, cold, sunlight or age. Chart width approximately 10 cm with the following formats available.

Narrow: Approximately one half of chart is an analog representation of every reading formed from closely connected dots in two overlapping scales. Remain-der of chart is a numerical listing of periodic reading (e.g., every ninth reading) and time.

Wide Analog: The printed table may be deleted and the analog scale expanded when a high resolution analog chart is the preferred format (e.g., in magnetic search).

Variable 'Chart Speed': Simulates changes in chart speed by varying time-axis spaces between plotted readings.

Recorder Scale: Four, push-button selected scales of 10/100, 20/200, 50/500 or 100/1000 gammas full scale. The analog records are dual range, as though there were two overlapping pens recording at different scale factors. The scales overlap by 20% with hysteresis so that there is no jitter at the scale edges.

Event Mark: A front panel push button or external input will cause an extra mark to be added for identification of special events.

Paper Feed: Advances paper rapidly for loading and unloading paper. Also causes the printer to annotate the record with sensitivity, scale factors, sample interval, and date.

Special Functions: Internal switch, accessible by hinging up the front panel, allows selection of variations in operation:

a) Vary 'chart speed' (see recorder).
b) Narrow chart (see recorder).
c) Wide analog chart (see recorder).
d) Power conservation. Display will automatically shut off 7 seconds after a reading has been taken, or 2 minutes after a key has been depressed.
e) 3-point running average (smooths data by taking running average).*
f) 5-point running average (smooths data by taking running average).*
g) 7-point running average (smooths data by taking running average).*
h) Control disable (disable all front panel controls which might be used to modify the stored parameters, prevents operator errors), saves power.

Outputs: (1) BCD character serial output of time, day and field readings for use with external digital recorder. (Also outputs suitable handshaking signals for interfacing.) and (2) RS-232-C-compatible ASCII output of time, day, and field reading; followed by a carriage return and line feed at three selectable baud rates (110, 300, 9600). This output is for an external printer or computer-based acquisition system.

*Via Bartlett Filtering.

Inputs: Accepts data from G-856 Memory-Magnetometer° for printing tabular record. Accepts external sample and event signals.

Physical Dimensions: Approximately 7-1/2 x 9 x 16 inches (19 x 23 x 41 cm) with lid closed. Weight approximately 13 lbs (6 kg).

Environmental: Operates from 0 to 40 degrees Celsius. Withstands moderate rain with lid open and driving rain with lid closed. Military type connectors on external case.

Power: Operates from 11 to 28 vdc. Designed for minimum power consumption in base station mode. (See Table G-1).

Standard Accessories: Power cord with battery clips, instruction manual, five rolls recording paper.

Optional Accessories: Portable or base station sensor, marine tow systems (sensor and cable), airborne sensors (bird, stinger, and wingtip), digital tape recorder, battery pack and charger.

Table G-1

Power Consumption vs Sample Rate vs Battery Life

Sample Interval (seconds)	Average Power Consumed (watts)		Battery Life/ (hours/amp-hour)*	
	Power Save ON	Power Save OFF	Power Save ON	Power Save OFF
0.5	36	36	0.33	0.33
1	33	33	0.36	0.36
5	33	33	0.66	0.66
10	18	18	0.67	0.66
50	3.6	7.6	3.6	1.6
100	1.6	6.3	7.5	1.9
500	0.33	5.3	36.4	2.3
1000	0.33	5.0	36.4	2.3
5000	0.33	5.0	36.4	2.3

*To calculate battery life, multiply the battery life value by the ampere-hour rating of the battery you will be using; for example, a 33 amp hour battery, would have a life of approximately 10 hours (33 x .33 = 10.89 hours).