OhmMapper
TR1
29005-01 REV. F

Operation Manual

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Table of Contents

CHAPTER 5: MAPPED SURVEY. 45

CHAPTER 6: DATA REVIEW 69

Chapter 1: Introduction

System Description

The OhmMapper is a capacitively-coupled resistivity system designed to measure subsurface resistivity in areas with high surface resistivity where exploration using traditional galvanically-coupled (DC) resistivity systems is impractical. The OhmMapper consists of an ungrounded dipole transmitter and receiver. The operating principle is relatively simple: an alternating current is capacitively coupled into the earth at a particular frequency by the alternating voltage applied to the transmitting dipole. The resulting AC voltage coupled to the receiver's dipole is measured. This voltage will be proportional to the resistivity of the earth separating the two dipoles and the current delivered to the transmitter dipole. The transmitter and receiver are deployed in a dipole-dipole configuration where the transmitter and receiver are placed in line and separated by an integer or binary fraction (0.25, 0.5, 1, 1.5, 2, etc.) number of dipole lengths. As with a DC resistivity system, an apparent resistivity is calculated by multiplying the appropriate geometric factor by the OhmMapper's received voltage, normalized by the transmitter current. Two important restrictions exist: 1) The transmitter and receiver antennas must not be located in standing water, and 2) The transmitter-receiver separation must not exceed one skin depth. One skin depth in meters is approximately 500*sqrt (rho/freq). The operating frequency of the OhmMapper is approximately 16.5 kHz.

OhmMapper is designed to be pulled along the ground as a streamer and thereby provide an almost continuous apparent resistivity profile. This design increases the resolving power and productivity of the system relative to DC instruments. The dipole cables and instrument housings are made of tough, wear-resistant plastic. These external components will eventually wear out with extensive field use, but they can be quickly replaced in the field without tools.

The OhmMapper is used with Geometrics' belt-mounted G-858 OhmMapper console. In operation, the OhmMapper receiver is connected to one of the console's serial ports via a fiber optic isolation wand and tow cable. Measurement data are stored as they are received at the serial port and are also graphically displayed in real time on the console's screen. The OhmMapper receiver delivers measurement data (receiver voltage/transmitter current) at a maximum rate of 2 readings per second. At this rate of acquisition the console has non-volatile storage space for about 24 hours of data acquisition. Geometrics' MagMap2000 software is used to upload, edit and process OhmMapper data. The MagMap2000 software will also export apparent resistivity data in several standard formats for presentation or for inversion using commercial DC resistivity interpretation tools. A demonstration version of RES2DINV inversion software is included with the OhmMapper. The latest version of RES2DINV can be downloaded from www.geoelectrical.com.

Overview

This manual is intended to describe the general operation and functions of the Geometrics OhmMapper TR1. This includes the use of the OhmMapper G-858 console as a data logging and mapping console. For information about the operations of the OhmMapper console as the console for the G-858 Cesium Magnetometer please refer to the G-858 MAGMAPPER manual.

The OhmMapper is a professional-quality data mapping tool offering exceptional speed and efficiency. The system presents a "Quick Look" to the operator of up to 5 stacked survey profiles, *as well as a graphical map of the survey grid showing surveyed and unsurveyed portions*. Data is stored in non-volatile memory for playback review and downloading into a host PC. The system includes a comprehensive software package to download, edit and interpolate collected data into 2D or 3D contour-ready formats. Hard copy annotated color maps can be produced within minutes after data transfer to the base computer.

The OhmMapper includes three unique features, each intended to assist the collection of data. First, the system lets you visualize the survey area beforehand, entering in the desired survey location points. Second, it lets you review your locations and your data during the survey. Finally, the unit allows you to edit data, both in the field and in later processing.

Safety Issues

Although the OhmMapper TR1 is designed to be safe to use the operator must be aware that the transmitter can generate up to 1,000 Volts AC at current levels of 16 mA. This can be dangerous under certain circumstances. **Do not operate the OhmMapper out of the protective enclosure. Do not hold both transmitter cables while the instrument is transmitting**. The transmitter is designed such that it will not transmit unless shorting plugs are attached to each dipole cable.

Depth of Investigation

The maximum depth to which the OhmMapper can detect resistivity changes at any given location depends on the maximum separation between the transmitter and receiver at which the transmitter signal can be reliably detected and decoded. This is determined by the resistivity/conductivity of the survey site.

Ground Resistivity: Please see Chapter 13 – "Fundamental and Operational Theory" for a detailed description of the principles of capacitively-coupled, dipole-dipole resistivity. The attenuation of a signal as it travels from the transmitter to the receiver is approximately 1/distance^3. Therefore, if the transmitter-receiver separation is increased from 10 meters to 20 meters the receiver signal is reduced to 1/8 its original strength. If it is doubled again the signal decreases to 1/64 its original strength. The maximum depth of investigation will depend on how far away the receiver can detect the transmitter signal. By Ohm's law we know that the amplitude of the voltage is directly proportional to the resistance through which the current flows, V = IR where V = voltage, I = current, and R = resistance. For a given current, if the ground resistance is high, the voltage generated is also high, making measurements easier. If the ground resistance is low the resulting voltage is low, making measurement more difficult. Attenuation is rapid in both conductive and resistive ground, but since the signal starts out much lower in conductive ground it disappears much quicker, therefore the transmitter can be detected at a much greater separation from the receiver in resistive than in conductive ground.

Skin-Depth Effect of Transmitted Signal: Although the depth of investigation is solely determined by the geometry of the dipole-dipole array, for an AC signal the maximum transmitter-receiver separation that can be used in a conductive environment is a function of skin depth. If the distance from the transmitter to the receiver is greater than a skin depth there is generally not enough signal to be detected by the receiver. A good approximation of skin depth (in meter) is *500*sqrt (ρ/f)* where ρ = resistivity and f = transmitter frequency. The OhmMapper transmits at approximately 16.5 kHz. This is another reason that, in conductive ground (low resistivity), the maximum depth of investigation will be less than in resistive ground. For example, the skin depth of 16.5 kHz in 10 Ohm-meter earth is approximately 12.5 meters. So maximum transmitter-receiver separation should be no more than 12.5 meters. In 100 Ohm-meter earth the skin depth of 16.5 kHz is nearly 39 meters. In 1,000 Ohm-meter ground the skin depth would be 123 meters, which is beyond the practical limits of the OhmMapper based on maximum transmitter-receiver separation for detectable transmitter signal. In practical terms the signal amplitude decreases dramatically once it is beyond a skin depth, so once the transmitter-receiver separation is greater than a skin depth the signal is essentially undetectable.

Instrument and Cultural Noise Environment: Culture and system noise tend not to be a large problem with the OhmMapper because of its very narrow receiver band width, but as described above, as the receiver is moved farther away from the transmitter the OhmMapper signal decreases rapidly. Even though the received signal is attenuated the cultural, environmental, and system noise does not change. At some point there will be a signal-to-noise ratio at which further measurements cannot be made. The distance at which noise overwhelms the transmitter signal is obviously determined by level of cultural noise. In high-noise environments the transmitter must be relatively close to the receiver with a resultant reduction in the depth of investigation.

Applications

The OhmMapper can be used for a number of applications. A few examples are listed below:

Groundwater Exploration: Detect geologic faults, detect fracture zones, image clay layers and aquitards, locate likely aquifer structures, trace salt-water intrusion.

Mineral Exploration: Measure depth to bedrock, detect mineralization zones, find sand and gravel beds, define the limits of clay and marble deposits, define structural geology of potential mine sites.

Engineering Studies: Investigate the integrity of levees, detect permafrost and ice lenses, detect seepage from dams, measure resistivity for power-line grounding, detect voids under roads and building sites.

Environment Investigations: Detect leakage plumes from landfills, map environmental contaminate plumes.

Other Applications: Perform archeological studies, carry out academic research.

OhmMapper Console Mapping Features

The OhmMapper has been designed to greatly simplify geophysical surveying. All of its features are intended to speed up the surveying process and reduce the possibility of mistakes. Toward that end, the following features have been incorporated into the OhmMapper:

- Continuous surveying, where the unit automatically records data at a rate of 2 samples per second.
- Discrete surveying, where the unit takes a reading upon an operator key-press.
- Three modes of operation:
  - ♦ Search mode, for performing a random search for anomalies or system test;
  - ♦ Simple survey, for a simplified method of operation;
  - ♦ Mapped survey, for the full capability of defining and tracking position as readings are taken.
- Real-time analog sweep display of the measurements (in uV/mA).
- Up to five separate surveys stored independently.
- Map displays, showing the survey area, with readings plotted in the correct locations.
- Data profile displays, allowing previous data to be reviewed.
- Data editing capability, where data may be deleted and retaken.
- Downloading of data in compressed format to a host PC.

- Host software for editing data positions, and writing a file for 2D surface plotting with 3rd party software, such as WinSurf or GeoSoft.
- Audible tones indicating a measurement change over the local target, warning of non-valid data, indicating that data was taken and stored, and that location keys have been pressed.
- Storage capacity for more than 250,000 readings and positions, each recorded with the time of the event.
- Logging of data from an RS-232 input port (for example, GPS data).
- Logging of user-defined field notes.

Modes of Operation

Here we present an overview of the modes of operation, along with their advantages and when each should be used.

Search Mode

In Search mode, the OhmMapper operates normally, displaying an analog oscilloscope-like trace, with an audible sound whose pitch indicates changes in the reading (the "woowee" indicator). However, data is not stored in memory. This is useful for manually identifying target locations, much as with a metal detector. It is also useful to check for proper sensor operation and ambient noise.

Simple Survey Mode

In Simple Survey mode, the unit keeps track of MARK (start line, and waypoints) and END LINE (end of line) key presses, and the direction of each line. This allows a full and complete survey. Later, after downloading the data into the PC, the MagMap2000 program will attach an x and y coordinate to each start, stop, and waypoint marks.

Simple Survey mode allows the simplest operation of the OhmMapper, at the expense of a slightly more complicated operation of the PC host software. You must manually keep track of where you are taking data, and enter this information into the host software to locate the readings.

Mapped Survey Mode

Mapped Survey allows you to better visualize the survey area than simple survey, and move around within the area in a non-continuous fashion. Using the arrow keys, you may position the cursor anywhere within the map and acquire data. Default cursor movements are programmed into the unit, so if you follow a normal path across the survey area, you may simply press the MARK and END LINE keys as if you were doing a simple survey.

This method allows the easiest operation of the PC host software. You must enter more information into the OhmMapper, however. This mode will track your position for you automatically, assuming you are following a simple path, while also allowing you to change your position manually, when, for example, you reach an obstruction and wish to start again on the other side.

Surveying Checklist

Here we give a quick checklist for performing a survey. Please see Appendix 1 if you are unfamiliar with surveying techniques. Subsequent chapters will explain in detail the operation of the OhmMapper during the survey.

1. Setting up the survey grid

   - Designate an individual to be responsible for making a sketch of the survey site, with notes and comments on all relevant objects such as power lines, fences, pipes, and surface debris.
   - Establish a base line, which will provide the start or end points for all profile lines. Designate the left hand corner of the base line to be (0,0) for the X and Y axes.
   - Using the smallest search target size, determine the separation of the profile lines. A role of thumb is that if multiple lines are surveyed the parallel lines should be 1 dipole length or less apart.
   - Place brightly colored markers at the start and stop of each profile. If the lines are long or require irregular walking speeds, place a marker at regular intervals (perhaps each 20 or 50 meters) along the profile. These will become positional references or waypoint entries in the data stream.
   - If the survey is to be broken into separate but adjacent areas, it will help you to stitch the sections together if there is at least one profile line of overlap.
   - Locate the survey area corners and reference them to other surface objects. If the site will be resurveyed in the future, it may be useful to permanently mark the corners.

2. Turn on the OhmMapper, using the procedure described in Chapter 2. Select the Search Mode, and look at the serial data displayed in “SYSTEM SETUP”, OHMMAPPER TEST”, i.e. there should be data coming in at a rate of 2 times per second. Alternatively, go to the Search Mode and observe the trace displayed on the screen.

3. You may select a survey "Test Profile" line. This profile may be run in each direction at the start and end of each survey day as a check of data repeatability and quality. It is an excellent check of proper system operation and may be useful as "proof of operation" to the end user. OhmMapper data repeatability can be checked by doing two passes up and down the profile line with the same rope length (same n-space).

4. Perform the data acquisition for all survey profiles and record the direction of each profile on the survey sketch map. Also record the start and end locations and the direction of the first and last survey profiles for each survey day. This may be duplication of effort, but is independent of the data logged in the instrument and may be very helpful in editing the data during processing.

5. During the course of the survey it is important that the operator has adequate support in finding and staying on the line. However, if the operator is disrupted during data acquisition, the OhmMapper easily allows acquisition to be paused and data to be deleted and/or retaken. The OhmMapper has been designed to reduce mistakes and save money.

6. Finally, at the end of the survey, download the data to your host PC via the RS-232 port, edit the positions if necessary, and convert the file to a suitable output for 3rd party software, such as RES2DINV, Surfer for Windows or Geosoft. MagMap2000 formats OhmMapper pseudosection data for inversion using 3rd party inversion software such as RES2DINV or RESIX2D. Exporting to inversion software only applies to pseudosections and not map-view contours.

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Chapter 2: Set Up and Operation

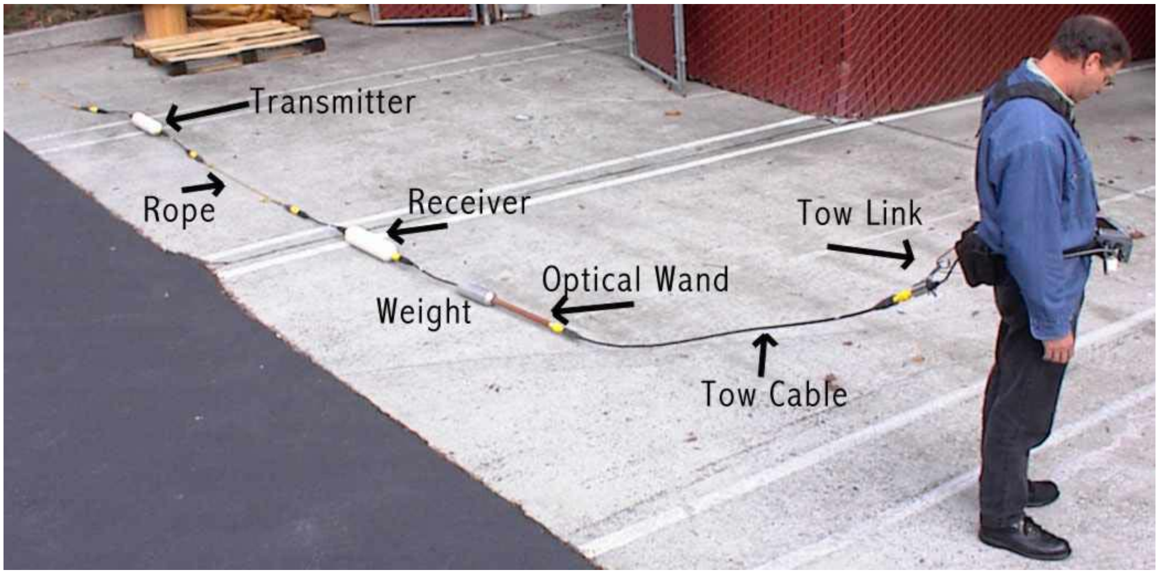
This chapter gives an overview of the entire surveying process. It will describe how to set up the instrument, operate in the *Simple Survey* mode, and download the data into the PC for analysis. Please read Chapter 3 as soon as you can to find out more about your OHMMAPPER.

System Components

Part Number	Name	Description
29030-01	Transmitter	Includes batteries, chassis with connectors, electronics, PCB cover and enclosure.
29030-02	Receiver	Includes batteries, chassis with connectors, electronics, PCB cover, and enclosure.
29034-01 and 29034-02	Transmitter/Receiver Dipole Cables	2.5 meter and 5 m including connectors.
29036-02	Fiber optic communication wand with connectors	Includes integrated electric-to-optical and optical-to-electrical converters.
29033-01	Console Cable Assembly Power/data octopus cable	Provides power to OhmMapper console and to RS232 converter. Provides RS232 link to console
28-960-003	Non-conductive tow-link rope	Allows for the operator to tow the transmitter and receiver simultaneously. Can be cut to length by operator
29035-01	Depressor weight	Maintains receiver dipole cable contact with the ground while being towed.
29054-01	Belt-mounted tow loop	Provides connection and tow point from operator's belt and the towed array
29032-01	Transmitter/Receiver battery charger	Charge transmitter and receiver batteries.
25306-02	OhmMapper console	Logging console containing electronics, keypad and display
25427-01	OhmMapper belt with batteries	Battery belt for carrying the console. Batteries are installed in the belt.
25332-01	OhmMapper shoulder harness	Distributes the load of the batteries and console.
25366-01	OhmMapper battery charger	Charges console batteries
25358-01	RS232 cable	Carries data from console to PC
25376-01	Fuse assembly	Extra fuses
29005-01	OhmMapper Operator's Manual	This document
29006-01	MagMap2000 for OhmMapper Manual	Operator's Manual, MagMap2000 Software
29006-01	MagMap2000 Software	Used to download data from console to host PC, modify positions, and write output files.
69-100-805	Shipping case	Storage and shipping case for the OhmMapper TR1

Assembly

The photograph below depicts the OhmMapper in normal usage.



This section describes the step-by-step procedure for assembly of the individual components of the OhmMapper.

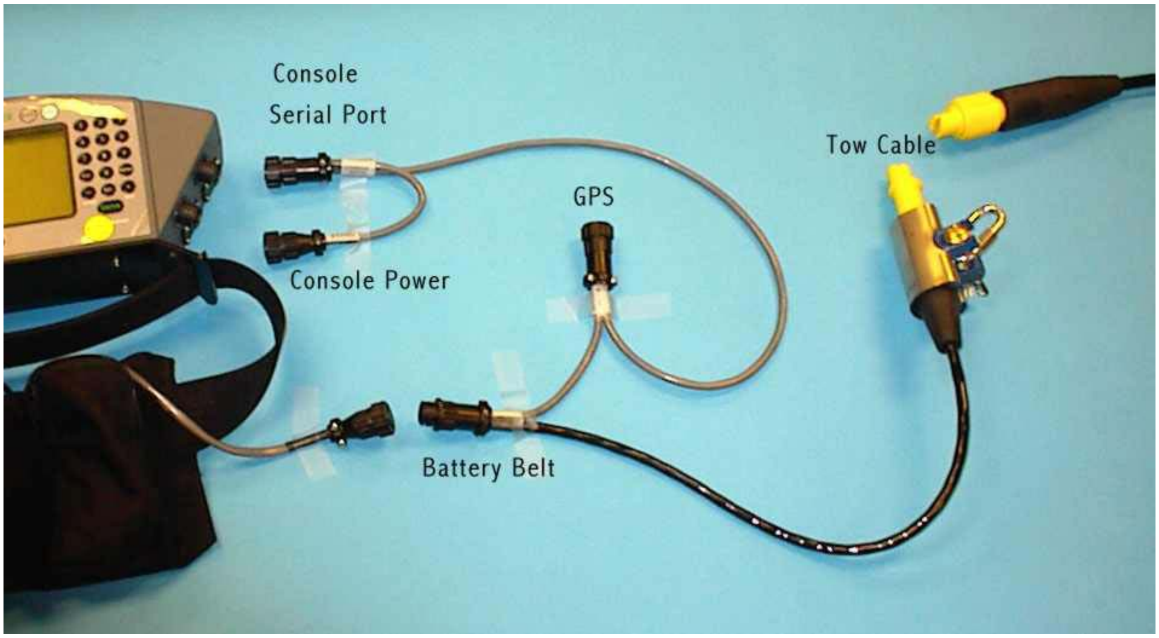
Before assembling and operating the OhmMapper the operator should assure that the transmitter and receiver batteries are fully charged and operational. The batteries are charged by removing the batteries from the transmitter and receiver enclosures and charging them with the supplied 6 V battery charger. (See batteries below.) After charging, replace the batteries into the enclosure. Connect all components as follows:

1. Attach the two dipole cables to the receiver and the two dipole cables to the transmitter. The dipole cable connectors secure the transmitter and receiver modules in their protective shields. Take care the transmitter or receiver does not slide out of the shield, fall to the ground, and become damage when the front dipole cable is not attached.
2. Slide the end of the fiber optic wand through the narrow end of the weight.
3. Attach the fiber-optical wand to the free-end of the receiver dipole cable that is connected to the conical end of the receiver
4. Attach shorting plugs to the free ends of the dipole cables. There is a total of three shorting plugs – one on both transmitter dipole cables, and one of the receiver cable attached to the "flat end" of the receiver.
5. Attach the non-conductive tow rope to one end of the transmitter dipole cable and to the adjacent-end of the receiver cable. The tow rope should be cut to an appropriate length for the desired transmitter/receiver separation.
6. Connect a tow cable to the "OPERATOR" end of the fiber-optic wand. The tow cable can be any standard dipole cable. A 2.5-meter cable is typically used but any

length is acceptable. Please note that different tow-cable length will change the OPERATOR OFFSET value entered in OHMMAPPER GEOMETRY.

7. Connect the console cable (power/data octopus cable) to the tow cable (A), OhmMapper console power (B), and RS232 connector (C) as shown below.
8. Connect the Console Cable Clamp and threaded chain link to the console cable as shown below.
9. Attach the threaded chain link of the console cable to the chain link on the triangle tow bracket as shown below.
10. Turn on the power to the transmitter by turning the power knob clockwise. If the red light is lit the power to the transmitter is on. If the green light is blinking the transmitter is transmitting. The flashing sequence of the green light on the transmitter is an indicator of transmitter current level. It is a repeated 3-bit binary code, with a pause after 3 blinks, where a short blink represents a 0 and a long blink represents a 1. For example a blink sequence of short –long-short represents 010, or binary 2, and a blinking sequence of long-short-short represents 100, or binary 4. This number should be reflected in the current level shown in the OHMMAPPER TEST MODE screen on the OhmMapper G-858 console (See Chapter 9, System Setup OhmMapper Test for details).
11. Turn on the power on the receiver by turning the power knob clockwise. If the red light is on the receiver power is on. If the blue light is blinking he receiver is detecting the transmitter signal. There is no code in the receiver blue light blinking.
12. Turn on the power to the OhmMapper console by pushing the POWER button.
13. Refer to the section entitled "**Using the OhmMapper Console"** for information about data collection.
14. See photographs below for details of hooking up the fiber optic wand.

Pictorial Summary of Cable Setup




Attach battery cable to console cable


Power and data connections of console cable


Dipole cables to be attached to transmitter

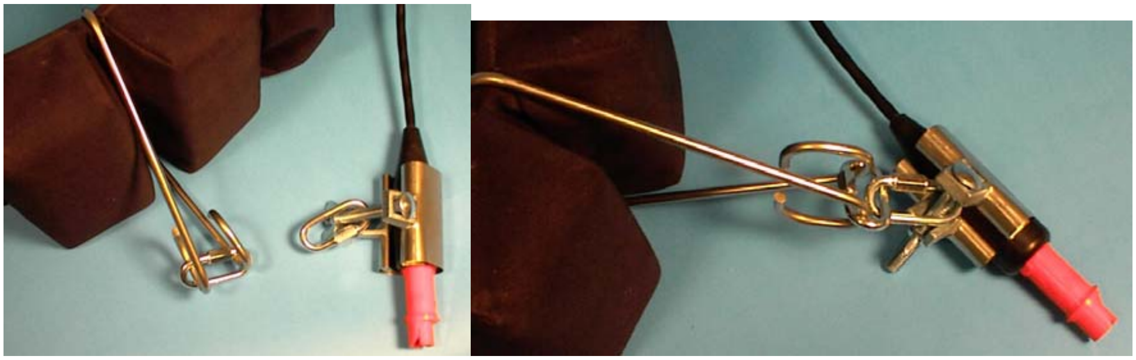

Dipole cables attached to receiver

The shorting plugs must be attached to the transmitter dipole cable for the transmitter to work.

Attach the tow cable clamp to the tow loop as pictured below:

Battery belt, loop, console cable, clamp

Put loop on belt



Attach clamp to console cable. Attach shackles to loop and clamp. Attach clamp shackle to loop shackle.

Batteries

The OhmMapper transmitter and receiver are powered by 12V DC power supplied by two 6 V DC batteries in each of the transmitter and receiver enclosures.

Installing and removing transmitter/receiver batteries

First remove the dipole cables from the transmitter. Slide the transmitter chassis out of the enclosure and remove the batteries by turning the battery clamp to release the batteries. The rubber foot on the side of the battery faces up when it is in the proper position. To replace the batteries in the Tx or Rx chassis slide the batteries back into place and turn the battery clamp such that the enclosure (shield) can be replaced.

How to charge the transmitter/receiver batteries

Remove the batteries from the Tx or Rx chassis. Place the batteries in the charger with the battery terminals against the charging terminals of the charger receptacle. When a battery, that is not fully charged, is placed in the battery charger both lights (red and blue) are on. When the battery is fully charged only the blue light is on.

OhmMapper Console

The OhmMapper console is pictured below. The slots in the spreader bar are designed to slip over the battery belt. The holes are for attaching the front shoulder straps. The connectors are for the power cable, I/O port, and 2 cesium magnetic sensors (the magnetometer connectors are only present if the magnetometer interface board has been purchased and installed for use with the Geometrics G-858 Cesium Magnetometer).

OHMMAPPER Console. The upper left connector is the battery connector, the upper right is the serial I/O port, and the two lower connectors (if present) are for magnetometer sensors.

Wearing the OhmMapper Console

The OhmMapper console is designed for comfortably carrying the batteries and console, and for pulling the resistivity array while making a survey.

1. Attach the triangular tow loop to the battery belt by sliding it over one of the batteries. One angle of the triangle should be pointing out from between the two lumps (batteries) of the belt.
2. After attaching the triangular tow loop to the battery belt, attach the rear shoulder straps to the battery belt. The hooks on the straps attach to the triangular rings above the batteries. The front and rear straps both adjust, so you can position the straps most comfortably. The Velcro fasteners go over the right shoulder.
3. Put the battery belt around your waist. The belt is adjusted with the sliding lock on the left hand side. Due to the stiffness of the webbing, this may be slightly inconvenient, but will need to be adjusted only once for a particular operator. The belt may be easily taken off by unclipping the bracket.
4. Slide the console onto the front of the battery belt, threading the webbing through the slots. You may find it convenient to thread the extra belt length through the console slots as well. Connect the battery cable between the battery belt and the console.
5. Bring the shoulder straps over your shoulders and connect them to the holes on the console. The adjustments at the front and rear of each strap allow you to position the straps most comfortably. If the straps tend to get pulled off your shoulders, it may be more comfortable to cross them in front.

Note: To remove the system, first disconnect the Octopus cable from the orange fiber optic cable to uncouple the resistivity array from the operator. Next unclip the battery belt clasp. If you are wearing the shoulder harness lift the unit over your head by the tops of the shoulder straps, leaving the console attached to the battery belt.

Functional Description

In order to calculate the resistivity of the earth, a reliable measurement of voltage must be made at the receiver using a known current level from the transmitter. This allows us to calculate the earth's resistance between the transmitter and receiver. Then the appropriate geometric factors based on dipole length, dipole type, and transmitter-receiver separation must be applied to convert the raw resistance value to an apparent resistivity of the earth between the points at which the current is injected into the earth and the point at which it is measured.

The OhmMapper transmitter generates an approximate 16.5 kHz current that is transmitted into an ungrounded dipole cable. The capacitive characteristics of the dipole cable allow the transmitter current to flow into the ground.

The OhmMapper receiver dipole cables pick up the transmitted signal where they are measured and decoded by the receiver. A rope or other non-conductive tow-link maintains a constant transmitter/receiver separation as the array is pulled along the ground.

The detected signal is then converted to an optical digital signal that is sent through a fiber optic wand, reconverted to an electrical signal, and sent up the tow cable to the OhmMapper console. The receiver reading (in uV/mA) is then logged into the OhmMapper console. The OhmMapper data can now be downloaded to a PC for further processing, contouring, and mapping.

Operating the OHMMAPPER

Charging the Console Battery Belt Batteries

Use the supplied charger to charge the batteries before use. A full charge will take about 6-8 hours. Connect the battery charger directly to the cable coming out of the battery belt. Two battery belts are supplied so you can continue working after one has discharged. The unit will operate 6 hours on one charge if the magnetometer acquisition card is include, or up to 12 hours with the magnetometer card

Note: To best maintain battery life, you should periodically charge the batteries (about every 4 months) if the unit is not in use.

Powering on and off.

After charging the battery, connect the console to the battery belt cable. This cable may be tucked into the pouch in the battery belt when not in use.

Press the POWER key to power the unit up. You may need to adjust the display contrast (keys marked LIGHT and DARK) in order to see the display. After selecting the "OHMMAPPER" operation, the menu first shown allows the operator to select whether the G-858 data logger is to be used to log MagMapper magnetics data or OhmMapper resistivity data. Select OhmMapper and press enter.

You will now see the OHMMAPPER Main Menu:

```
              ---OhmMapper---

      Use arrow keys to select desired
       function.  Confirm with "ENTER"

                SEARCH MODE

               SIMPLE SURVEY

               MAPPED SURVEY

            OHMMAPPER GEOMETRY

                DATA REVIEW
```

```
              DATA TRANSFER
              SYSTEM SETUP
  18:54:23  02/18/95  Memory free: 99.9%
```

OHMMAPPER Main Menu.

Pressing the POWER key when the OHMMAPPER Main Menu is displayed will shut the unit off. At other times, the POWER key is ignored

---

Note: To shut the unit off, press ESC until the OHMMAPPER Main Menu is shown, then press POWER.

Try not to disconnect the battery cable during use. If the battery cable is disconnected, some of the most recent data may be lost. Every effort has been made to protect your data in this event. However, depending upon what the microprocessor was doing at the time power was interrupted, data corruption may occur.

The unit will power itself off when the batteries reach a low voltage condition. Data back to the last position marker will be lost, however.

Note: The gauges on the left of the display show the battery power and memory left in the OHMMAPPER. You should keep track of these indicators.

High-pitched sounds coming from the OHMMAPPER are normal. Capacitors used on the internal circuit boards exhibit a piezo-electric effect, and create the buzzing noises.

Using the menus

Selecting fields in a menu

Menu fields are highlighted by pressing the up and down arrow keys. There are 3 types of fields which may be highlighted.

Scroll list.

A scroll list is indicated by the angle brackets, < >, on each side (see the “Baud rate” field in the menu example below). Press the left and right arrow keys to scroll through a list of options. You do not need to press the ENTER key. Simply move out of the field with the up or down arrow key, or press ESC to move up an entire menu level.

Numeric entry field.

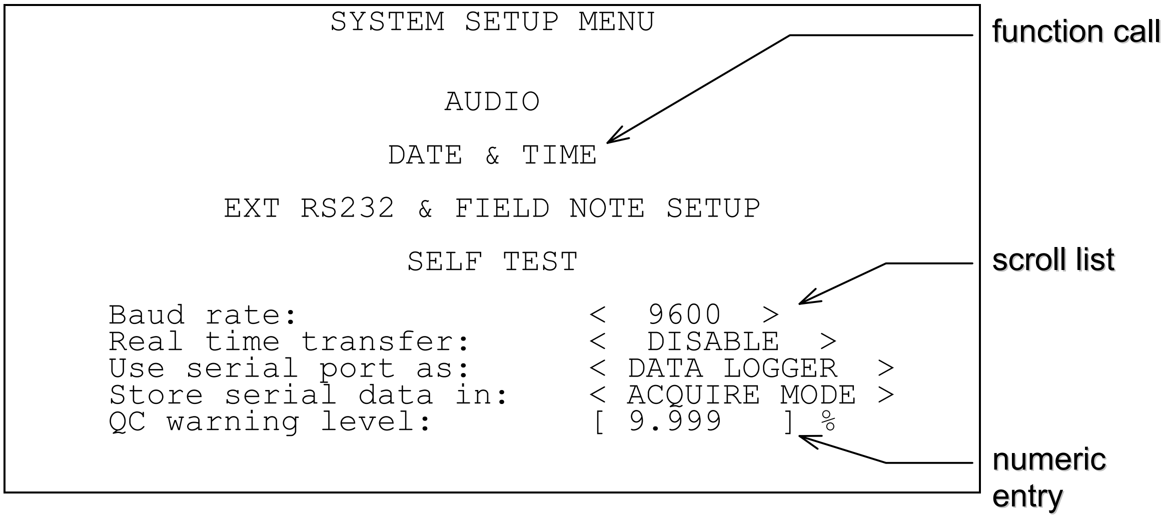
A numeric entry field is indicated by square brackets, [ ], on each side (see the “QC warning level” field in the menu example below). Press the DEL key to delete the number that is there, type a new number, and press ENTER. Using the up and down arrow keys to move out of this field without first pressing ENTER will cause the numeric value to return to the last value.

> **Note:** Don't forget to press the ENTER key after entering the desired value. You can also move the cursor within a field by pressing the arrow keys to select and change individual digits.

Function calls.

Function calls are indicated by a text only box, with no angle or square brackets (see the AUDIO, DATE & TIME, and SELF TEST fields in the menu example below). Pressing ENTER in these fields will cause the indicated action to occur.

Menu Example:



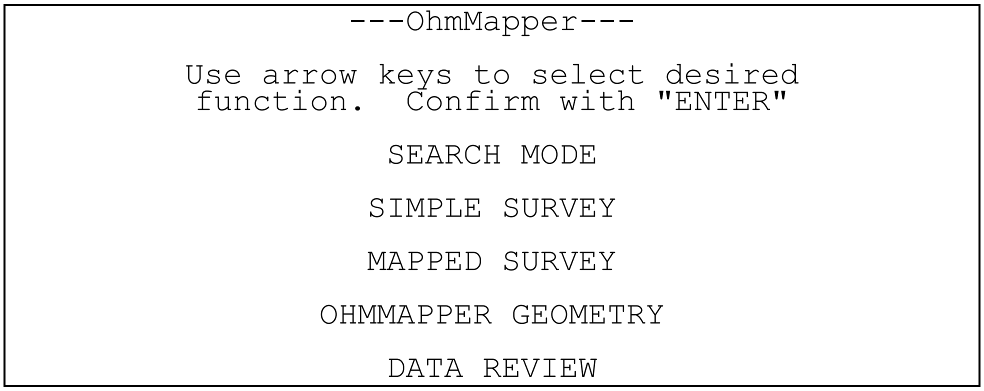
```
                 SYSTEM SETUP MENU

                       AUDIO

                    DATE & TIME

            EXT RS232 & FIELD NOTE SETUP

                     SELF TEST

     Baud rate:                <  9600  >
     Real time transfer:       <  DISABLE  >
     Use serial port as:       < DATA LOGGER  >
     Store serial data in:     < ACQUIRE MODE >
     QC warning level:         [ 9.999   ] %
```

Moving through menus

In this document, "selecting" an item means highlighting it with the arrow keys and pressing ENTER. "Scrolling" to a value refers to highlighting the field item and pressing the left or right arrow keys until the desired value is displayed.

Press the ESC key to back up a menu level.

The first menu displayed on power up is the main menu, shown below.



```
                   ---OhmMapper---

          Use arrow keys to select desired
           function.  Confirm with "ENTER"

                    SEARCH MODE

                   SIMPLE SURVEY

                   MAPPED SURVEY

                 OHMMAPPER GEOMETRY

                    DATA REVIEW
```

```
                    DATA TRANSFER

                     SYSTEM SETUP

         18:54:23  02/18/95  Memory free: 99.9%
```

OHMMAPPER Main Menu.

Setting up the OHMMAPPER

Select the SYSTEM SETUP from the main menu. You will then see the system setup menu.

```
                 SYSTEM SETUP MENU


                       AUDIO

                    DATA & TIME

                  COM PORT SETUP

          COM & FIELD NOTE STRING SETUP

       COM1 PORT: GEOMETRICS MODULE LOGGER

                  OHMMAPPER TEST

                     CONFIGURE

     COM1 port time out:    <  1.0  > S
     Store serial data:     <  when acquire  >
     QC warning level:        [ 60.000  ] %

     Graphic display of       <FIELD1   >
```

System Setup Menu.

Select DATE AND TIME, showing the date and time menu below.

```
                DATE AND TIME MENU


                      Date
                 Month:  [ 02 ]
                 Day:    [ 12 ]
                 Year:   [ 95 ]



                      Time
                Hour:      [ 14 ]
                Minute:    [ 15 ]
                Second:    [ 30 ]


               SET TO ABOVE VALUES


               12:01:12   02/22/99
```

Date and Time Menu.

Enter the correct values in the numeric entry fields, then highlight SET TO THE ABOVE VALUES, and press ENTER. Hit ESC twice to return to the main menu.

COM PORT SETUP, COM1 baud rate should be set to 1200 for OhmMapper data.

COM 1 PORT should be set for "Geometrics Module Logger" to acquire OhmMapper data.

The OHMMAPPER TEST allows the operator to verify that serial data is coming into the RS232C serial port. See Chapter 9 – System Setup for more detailed information about the OhmMapper Test screen.

Getting started with an OhmMapper survey.

1. Assemble the OhmMapper as instructed in this chapter.
2. Attach the OhmMapper G-858 console to the battery belt.
3. Make sure the clamp on the console cable is securely attached to the triangle tow loop as pictured in this chapter.
4. Attach a rope between the transmitter and receiver dipoles
5. Turn on the transmitter and receiver.
6. Snap the battery belt around your waist.
7. Turn on the OhmMapper G-858 console
8. Select OhmMapper Geometry from the main menu, hit enter, and enter the array geometry, and hit the escape key to return to the main menu.
9. Go to System Setup , select OhmMapper Test, and press enter. If the transmitter light is flashing, and the receiver light is flashing, and everything is connected properly you should see a string of readings displayed on the screen. See Chapter 9: System Setup for a description of what these readings mean.
10. Select a survey type. In general a Mapped Survey is the recommended survey type for an OhmMapper survey, although under certain conditions a Simple Survey is easier to configure. .
11. Set up the survey in the G-858 console according to the instructions in Chapter 5: Mapped Survey. Take special note of the section titled "Multiple N-Factor Surveys (for pseudosections).
12. Do a walk-away test as described in the FAQ section below to determine the maximum transmitter/receiver separation that can be used.
13. For an initial test it is recommended that traverses be done in both directions with the same rope length. For example if a profile is to be done on a 100 meter line with separations (rope lengths) of 2.5 meters, 5 meters, 7.5 meters, and 10 meters, the operator should walk the length of the profile up and down with the 2.5 meter rope, then up and down with the 5 meter rope, etc. until a total of 8 traverses have been made. This will allow a quality-control comparison of the data taken over the same line with the same Tx/Rx separation in two different directions.

Frequently asked questions about OhmMapper surveys.

A. Selecting rope length:

The n factor of a dipole-dipole resistivity array is the ratio of the distance between the receiver and transmitter dipoles to the length of the dipole. In terms of the OhmMapper this corresponds to the ratio of rope length to the transmitter and receiver dipoles lengths. For example if you are using 2.5 m cables the dipole length is 5 meters. If the rope separating the transmitter from the receiver is 10 m you have an array of n = 2. If the rope length is 20 meters then n = 4. If the rope is only 2.5 meters then n = 0.5.

Commercial inversion programs require n factors that are an even fractional integer such as 1 n, 2 n, ½ n, ¼ n, etc. Many can only use integer n factors such as 1, 2, 3, 4, etc. Fortunately RES2DINV can handle fractional n factors.

The OhmMapper samples are time based and positioned in space according to either GPS readings or mark positions. You can have different data distribution between two different marks if you walk at a different rate. The inversion software, such as RES2DINV, must have an even data distribution along the whole line. In order to do this we average the data to even distribution of data points along the entire line. In order to get this even distribution MagMap2000 averages the data to a unit called “Smallest Unit Electrode Spacing”. If the smallest unit electrode spacing is 2.5 meters the data is averaged to one data point every 2.5 meters. The largest average you can use is determined by the largest common denominator or the dipole lengths and dipole separations you use. For example if you use 5m dipoles and 5, 10, 15, 20 meter separations the largest common denominator is 5m. But if you use 5, 10, 12.3, 15.1, and 20 the largest common denominator is 0.1 so the data must be averaged to those 0.1 meter, meaning you are forced to have a data point every 10 cm. This will give you a huge data set that the software may have difficulty handling.. Normal practice is to use a separation that is an binary fraction of the dipole length such as 5, 7.5, 10, 12.5, 15 meter separations (with 5m dipoles n = 1, 1.5, 2, 2.5, 3) which would give a maximum “smallest unit electrode spacing of 2.5m”.

B. Selecting survey type (Mapper Survey or Simple Survey)

You can use either the simple or mapped survey. If the survey area is complex and you will be starting or stopping at a different distance along the survey axis for several lines or passes the Mapped Survey is preferable. The Mapped Survey allows you to adjust the start and stop positions of your lines in the field during the time of the survey, instead of being required to move the positions of the individual lines after the data have been downloaded to MagMap2000.

C. What Mark Spacing should I use?

You can use any mark spacing you like. It is only an external reference point to allow the software to correctly position the data. If you have chosen “Continuous” when setting up the survey mode the data sampling is time based at whatever cycle time you have selected. The default is 0.5 seconds, meaning you are recording at a rate of 2 measurements per second. For example, if you have a flag in the ground every 10 meters then you set the mark spacing at 10 meters, and hit the mark button when you pass the flag. The software will correctly position the data at even intervals between the marks. On a Mapped Survey you tell the logger, when you set up the survey, what your mark spacing is. On a Simple Survey you have to remember your mark spacing and tell the MagMap software what you used.

D. What line spacing should I use

If you are only doing multiple passes over the same profile (same x-position) then it doesn't matter what line spacing you use. This is only important if you are doing multiple parallel lines or 3-D surveys where you have multiple lines with multiple passes over each. A good rule of thumb is that in order to detect 3D affects the lines should not be more than one dipole length (n-space) apart. That is, if you are using a 5-meter dipole then the line spacing should be 5-meters or less in order to detect interline affects.

E. What is the relation between n factor and depth of investigation?

You can treat the OhmMapper as you would any standard resistivity meter. It uses the same inversion software as a galvanic dipole-dipole instrument. The relationship between depth and n-factor is not linear with separation (n factor). I have include a set of resistivity course notes by Dr. M.H. Loke. He is the author of RES2DINV and the notes include a good description of n-factor and depth of investigation. Page 13 of the notes gives a very useful chart that includes a depth factor (Z/a) that will allow you to estimate a pseudodepth for the n space and dipole lengths used.

F. How can I determine what is the practical limit to the greatest separation I can use in my particular survey area?

Generally a good idea when trying to determine the dipole lengths and separations you CAN use, not just want to use, is to do a walk-away test. Locate the transmitter somewhere on the test site. Then put a tape measure on the ground, and without attaching the rope, put the transmitter some short distance from the transmitter, and look at the data in OHMMAPPER TEST mode. You should get a good signal, and the transmitter current level and gain level should be very stable, that is not jumping around. For example, start with 5-m dipoles (2.5-m cables) and a separation of 2.5 meters. Then, without moving the transmitter, move the separation to 5m and see if the current is still the same and the readings are stable. As long as you did not move the transmitter the current reading should not change. The voltages readings will decrease, of course, because you are farther away from the transmitter. Then move it to 7.5m, 10m, 15m, 20m, etc. You will eventually reach a separation where the receiver can no longer lock onto the transmitter and the current value and data will be unreliable. You cannot use a rope length equal or great than this separation. If it turns out you cannot use anything greater than 10-m dipoles with a 20m separation your maximum depth of investigation will be limited to 7 meters.

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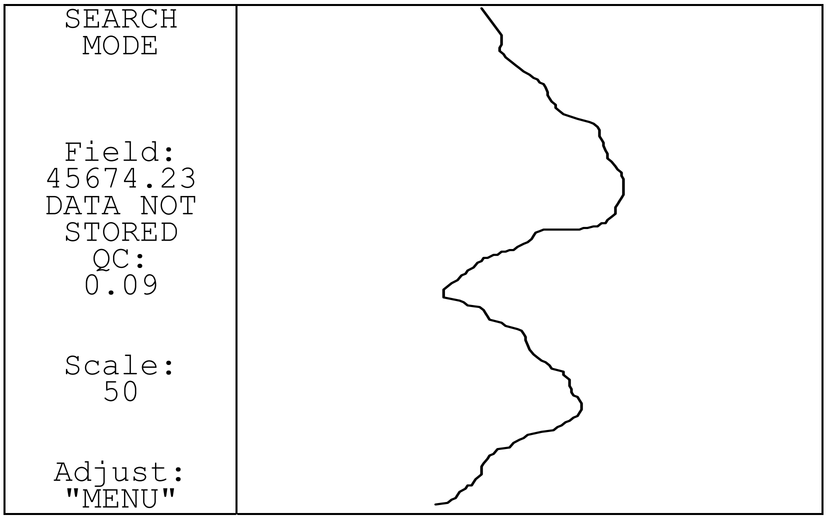
Chapter 3: Search Mode

Search Mode Overview

In search mode, the OhmMapper operates normally, displaying data and the woowee audio tones, but data is not stored in memory. This is useful for manually identifying anomaly locations, much as with a metal detector. It is also useful for checking for proper sensor operation and ambient noise.

Select SEARCH MODE from the main menu. You should see a display similar to that below:



SEARCH MODE

Field:
45674.23
DATA NOT STORED
QC:
0.09

Scale:
50

Adjust:
"MENU"

Example of Search Mode Display

Note: Data is not stored in Search Mode. This is indicated on the display, so you do not confuse it with Simple Survey.

If there is not communication between the OhmMapper receiver and the OhmMapper G-858 console you will receive the following message:

“No data was received from the serial port within the time limit. The cycle time setting is usd as the time limit when COM 1 is being used as Geometrics module.”

Search Mode Adjust Menu

Pressing the MENU key will bring up the Search Mode Adjust Menu. This allows you to adjust the display and audible tones:

```
   SEARCH   |
    MODE    | Master volume: <  4  >
            |
            | Woowee:
            |  Volume:       <  4  >
            |  Sensitivity:  <  4  >  Hz/%
   Field:   |
  49953.1   | QC warning
  DATA NOT  |  Volume:       <  4  >
   STORED   |  Level:        [ 60.000   ] uV
    QC:     |
    0.33    | Full scale:    < 50   > uV
            |
   Scale:   | Readings/screen:  <  25  >
     50     |
            | Cycle Time  [   0.6   ]   s
            |
  ADJUST:   |          CENTER TRACE
  "MENU"    |
```

Search Mode Adjust Menu.

Master Volume

Adjusts the over-all volume. 1 is softest, 9 loudest.

Woowee Volume (indicates signal amplitude)

1 is softest, 9 loudest

Woowee Sensitivity

Adjusts the amount the pitch of the woowee changes with varying field readings.

QC warning volume

1 is softest, 9 loudest

QC warning level

Sets the threshold for the QC warning to be emitted. If the QC exceeds this threshold, the warning is sounded.

Full Scale

Sets the full-scale trace width of the display (in uV/mA).

Readings per screen

Sets the vertical scale of the trace display. Higher values mean the trace moves more slowly down the screen.

CENTER TRACE

Centers the trace in the sweep display.

Pop up Menus

While in Search Mode (and the other modes as well), there are two quick pop up menus that are accessible:

Audio Key

Pressing the AUDIO key will bring up an audio adjust indicator. Then the up- and down-arrow keys will adjust the volume, while the right- and left-arrows will adjust the pitch of the woowee. The audio adjust indicator will disappear after a few seconds.

Scale Key

Pressing the SCALE key will bring up an scale adjust indicator. Then the up- and down-arrow keys will adjust the speed of the sweep (readings shown per page), while the right- and left-arrows will adjust the full scale. The scale adjust indicator will disappear after a few seconds.

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Chapter 4: Simple Survey Mode

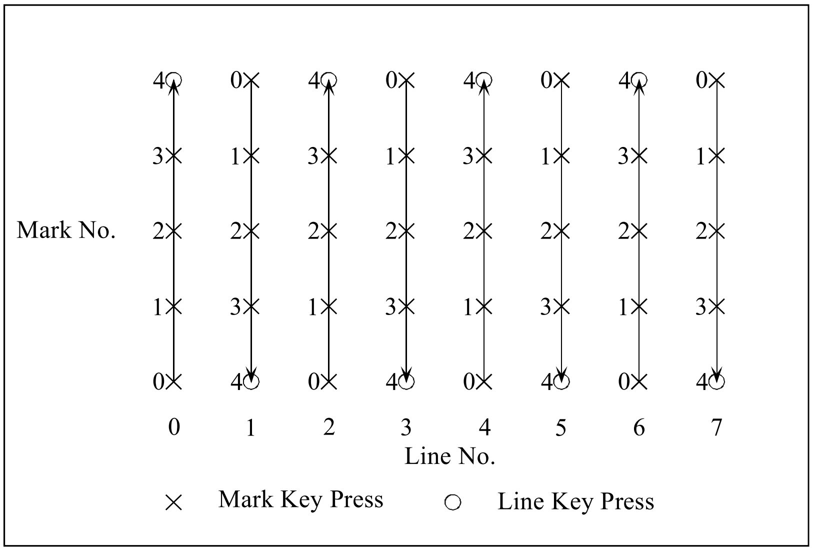
Simple Survey

Once the unit is reading properly in Search Mode, you are ready to begin your survey.

In simple survey mode, the unit keeps track of MARK and END LINE key presses in order to locate the position of the sensor readings. Later, after downloading the data into the PC, you will use the MagMap2000 program to attach an x and y coordinate to each reading.

Survey Overview

Typically, a survey is performed by walking up and down the survey area, surveying a series of lines, as shown below.



Simple Survey Overview

It is most convenient to survey lines walking in both directions, as shown, rather than walking back to the bottom of the map, always surveying up (either method maybe used, however). You will start at the lower left corner of the map, and walk up line 0. pressing the MARK key at each 'X'. At the end of line, press the END LINE key. You will then walk down line 1, and so on until the survey is finished.

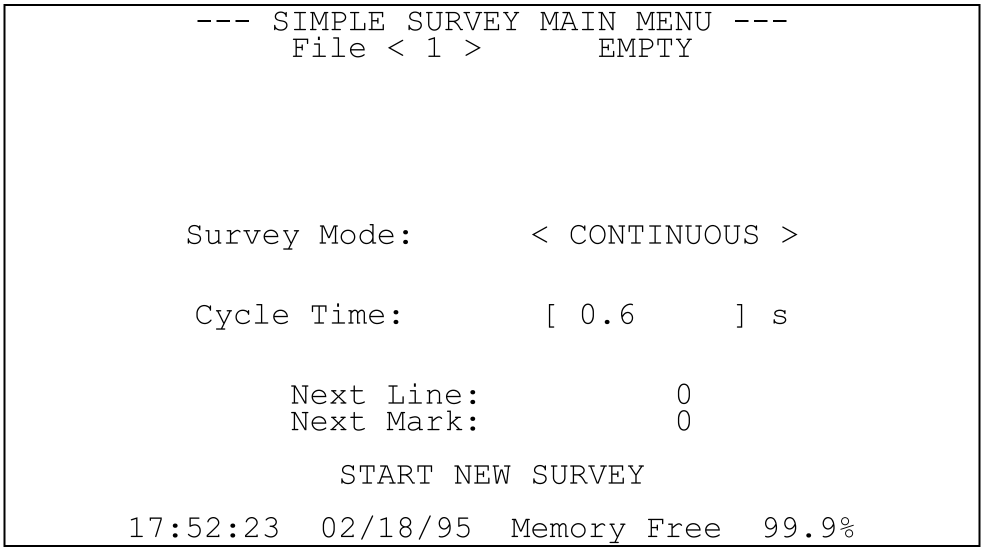
Note: The line and mark numbers begin at zero. This is the most common convention, and the one adopted in the OhmMapper. It is important to remember this, as it is sometimes easy to get confused. The survey shown above has a total of 8 lines, starting with number 0.

The MARK points are numbered sequentially, even in the case of a bi-directional survey, as shown in the previous figure.

> MARK key presses are numbered starting from 0 at the beginning of the line. This is true whether you survey lines walking in both directions or not. The MagMap2000 software will sort out the line direction on the PC.

Setting up a Simple Survey

Select simple survey from the main menu, bringing up the simple survey main menu.



```
              --- SIMPLE SURVEY MAIN MENU ---
                   File < 1 >      EMPTY




            Survey Mode:      < CONTINUOUS >


             Cycle Time:        [ 0.6     ] s


                  Next Line:          0
                  Next Mark:          0

                    START NEW SURVEY

       17:52:23  02/18/95  Memory Free  99.9%
```

Simple Survey Main Menu.

If someone else has already stored some surveys, the menu may not say empty. Highlight the file number, and press the left or right arrow keys until an empty file is displayed. If all 5 files are used, you will need to erase one of them. Please check with whomever has made these surveys to make sure they have downloaded the data. Files may be erased through the DATA TRANSFER section of the Main Menu. See Data Transfer, later in this chapter.

File

File numbers from 1 through 5 may be selected. You may start a new survey from any empty file number, and may continue any Simple Survey file.

Survey Mode:

Set to CONTINUOUS for continuous data acquisition at the rate given by the cycle time, set in the field below. In DISCRETE mode, the unit will take and store a reading at each MARK key press. The cycle time in the DiSCRETE mode determines the length of time (and therefore the number of readings) over which the measurements will be averaged at a sample rate of 2 times per second. For example, if in DISCRETE mode and cycle time is set to 3 seconds the OhmMapper will average 6 readings (three seconds at 2 readings per second) and log that value.

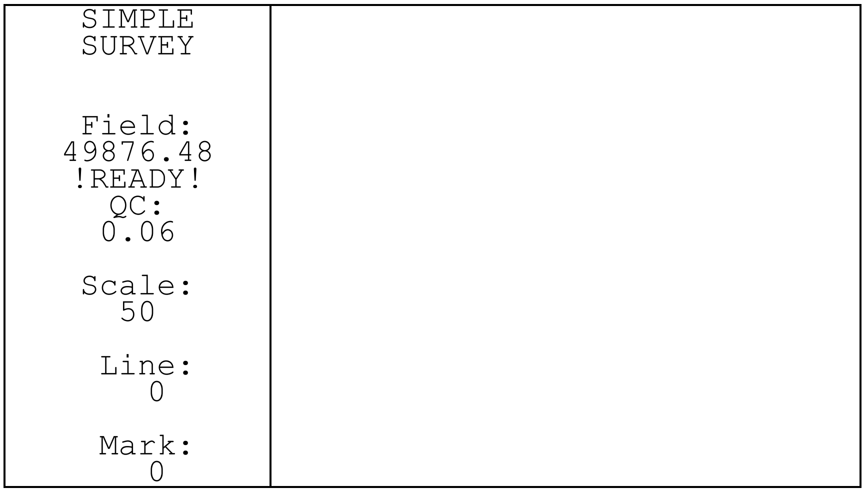
Cycle Time
In continuous mode the maximum rate at which data is stored is 2 Hz. Setting the cycle time higher (for example to 5 seconds) will store data at that rate (once every 5 seconds in the example). In discrete mode, this number sets the length of time the readings are averaged at a sample rate of 2 per second. For example, in discreet mode if the cycle time is set to 5 seconds, 10 readings will be averaged.

Next Line
Next Mark
Where the unit expects you to start or continue the survey.

> **Note:** Every new survey will begin at Line=0, Mark=0. After downloading the data into the PC, you will use the MagMap2000 program to specify the actual starting coordinates.

If you wish to continue a previous data set, scroll the data set number to the desired set, then select CONTINUE SURVEY. Data sets for mapped surveys or base station surveys will be shown as the data set number is scrolled. However, from this menu you may not select CONTINUE SURVEY for anything other than simple surveys.

Acquiring Data
Once START NEW SURVEY or CONTINUE SURVEY has been selected, the display will change to the acquisition display.



```
  SIMPLE
  SURVEY


  Field:
 49876.48
 !READY!
   QC:
  0.06

  Scale:
   50

  Line:
    0

  Mark:
    0
```

Acquisition Display.

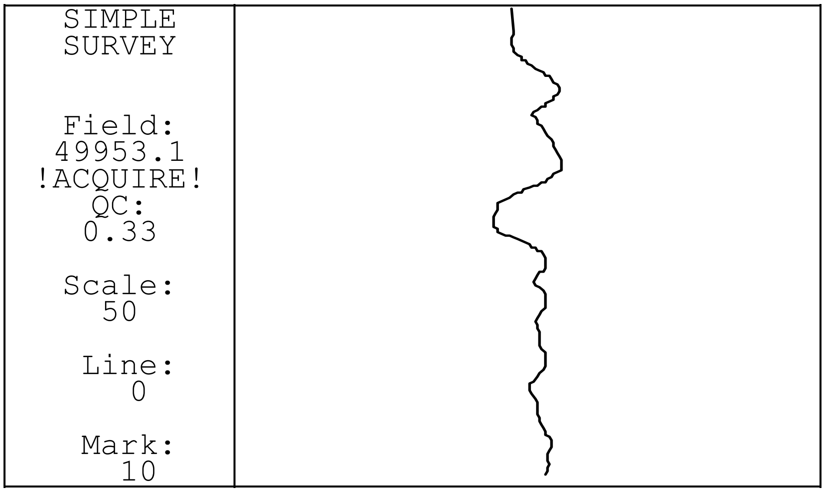
The items shown on the acquisition display are as follows:

Field:
Displays the signal reading. This is set in the Setup Menu (reached through the Main Menu).
READY
Indicates that the instrument is ready to acquire data. Data is not currently being acquired, however.
QC:
Displays a quality check indication. This value grows for rapidly varying fields. If the value exceeds a threshold (set in the system setup menu or the adjust menu) a warning sound will be heard.
Scale
Displays the full-scale width of the sweep trace on the right hand side of the display.
Line
Indicates the line number at which your next END LINE or MARK key press is expected.
Mark
Indicates the mark number at which your next MARK or END LINE key press is expected.

> **Note:** The line and mark number displayed is always the location of the *next* MARK or END LINE key press.

The unit will not be taking data yet. To start data taking, go to the starting or continuing point (indicated on the display) press the MARK key, and start walking. If you have established way points along the profile, press the MARK key at each way point. Press END LINE when you reach the end of a survey line. Press PAUSE if you want to stop recording, and PAUSE again to resume recording (the PAUSE key is effective only in continuous mode). The data display will indicate the reading with a trace display.

> **Note:** The MARK key performs two operations. It starts the storage of data (at the beginning of a line) and logs positions into memory.



```
 SIMPLE
 SURVEY


 Field:
49953.1
!ACQUIRE!
  QC:
  0.33

 Scale:
   50

 Line:
   0

 Mark:
   10
```

Acquisition Display with Reading Trace.

When you reach the end of each line, press the END LINE key. Upon this action, the unit will stop logging data and display a summary of the previous line:

```
      YOU HAVE JUST REACHED THE END OF LINE.
               YOU ARE CURRENTLY AT:
                      LINE: 0
                     MARK: 10

        PRESS ANY KEY TO CLEAR THIS MESSAGE

       THEN PRESS "MARK" TO START NEXT LINE

                        OR

               PRESS "MENU" AND SELECT
                "EDIT LINE AND MARK"
                    FOR EDITING
```

To start the next line, you must first press any key to clear this dialog box, then press MARK as you start walking up the next line. We encourage you to look at this line summary between lines, to make sure you are where the unit thinks you are, and the last line has the right number of mark key presses. If there is a problem at this point, you may edit the most recently taken data. You are not able to edit any data except the most recently acquired data.

Note: Don't forget the key press necessary to clear the dialog box. The END LINE key is handy for this since it was the last key pressed. If you forget to clear the dialog box, the next MARK key press will not start data acquisition (it will only clear the dialog box).

Adjusting Settings while Surveying

Pressing the MENU key from the Acquisition Display will bring up the adjust menu. This allows you to adjust the display and audible tones, and to enter the data editing menu.

```
   SIMPLE     |
   SURVEY     |
              | Master volume: <  4  >
              |
              | Woowee:
              |  Volume:       <  4  >
   Field:     |  Sensitivity:  <  4  >  Hz/%
  49953.1     |
 !ACQUIRE!    | QC warning
    QC:       |  Volume:       <  4  >
   0.33       |  Level:        [ 60.000 ] uV
              |
   Scale:     | Full scale:    < 50   > uV
    50        |
              | Rdngs/screen:  <  25  >
    Line:     |
      0       |       EDIT LINE AND MARK
              |
    Mark:     |          CENTER TRACE
      0       |
```

Simple Survey Adjust Menu.

Master Volume
Adjusts the over-all volume. 1 is softest, 9 loudest.

Woowee Volume
1 is softest, 9 loudest

Woowee Sensitivity
Adjusts the amount the pitch of the woowee changes with varying field readings.

QC warning volume
1 is softest, 9 loudest

QC warning level
Sets the threshold for the QC warning to be emitted. If the QC exceeds this threshold, the warning is sounded.

Full Scale
Sets the trace width full-scale of the display.

Readings per screen
Sets the vertical scale of the trace display. Higher values mean the trace moves more slowly down the screen.

EDIT LINE AND MARK
Opens the data editing menu. See detail below.

CENTER TRACE
Centers the trace in the sweep display.

Pop up Menus

From the acquisition display, there are two quick pop up menus that are accessible:

Audio Key
Pressing the audio key will bring up an audio adjust indicator. Then the up and down keys will adjust the volume, while the right and left arrows will adjust the pitch of the woowee. The audio adjust indicator will disappear after a few seconds.

Scale Key
Pressing the scale key will bring up an scale adjust indicator. Then the up and down keys will adjust the speed of the sweep (readings shown per page), while the right and left arrows will adjust the full scale (in nT). The scale adjust indicator will disappear after a few seconds.

Pausing
Pressing the PAUSE key while acquiring data will temporarily stop data acquisition. At this point, you may do any of the following:

Press PAUSE. This will re-start the acquisition process.

Press MARK. This will enter the current position. Do this only if you are currently at one of your way points. Only one MARK key press is allowed. The instrument will stay in pause mode.

Press END LINE. This will enter the END LINE position. Do this only if you are at the end of the line. The instrument will switch out of pause mode, and into the normal between-line state. Next, press the MARK key to start taking data.

Editing Data
Selecting EDIT LINE AND MARK from the adjust menu (above) will show the edit menu.

```
              SIMPLE SURVEY EDIT MENU

            You are currently going to:
                     Line:   4
                     Mark:   1


             GO BACK TO LAST POSITION:
                     Line:   4
                     Mark:   0

                   DELETE LINE:
                      Line:  4


                 RETURN TO SURVEY
```

Simple Survey Edit Menu.

From this menu, you may delete the most recently acquired data.
The meanings of the menu items are:

GO BACK TO LAST POSITION
Selecting this will delete data to the last MARK or END LINE key press.

DELETE LINE

Selecting this will delete the most recent line. If you are in the middle of a line, the current line will be deleted.

Examples - Recovering From Common Mistakes:

Mistakenly pressing MARK instead of END LINE at the end of a line.

This is a fairly common occurrence, and easily fixed. First, press PAUSE to halt the data acquisition. Then press ESC to close the dialog box. Press MENU, then highlight EDIT LINE AND MARK and press ENTER to bring up the Edit Menu, shown above. Highlight GO BACK TO LAST POSITION and press ENTER. Next, press ESC twice, to show the Acquisition Display. Then press END LINE. You have now corrected your mistake.

Sometimes, after pressing the MARK key at the end of a line, you might press the END LINE key instead of PAUSE, as mentioned above. In this case, from the Edit menu you should highlight GO BACK TO LAST POSITION and press ENTER *twice.* The first press takes you back to the position entered by the END LINE key press (which is one mark spacing past where you want it to be). The second press takes you back to where you actually want the end of line to be. Then, you press ESC twice, and press END LINE.

Mistakenly pressing END LINE instead of MARK in the middle of a line.

After pressing END LINE in the middle of a line, press ESC to clear the dialog box. Then, press MENU, highlight EDIT LINE AND MARK and press ENTER. Next, highlight GO BACK TO LAST POSITION and press ENTER. Press ESC twice to bring up the Acquisition Display.

You are now ready to continue the line where you were when you originally pressed the END LINE key. Position the sensor at the proper location, press MARK, and start walking. You are now taking data.

Realizing the data for your current line is erroneous.

Another common reason for editing data is if you realize a line has incorrect data, often either due to missing a MARK key press at a fiducial point, or walking off course. If this occurs, simply press the END LINE key, enter the edit menu, highlight DELETE LINE and press ENTER. Then select RETURN TO SURVEY (or press ESC), walk back to the beginning of the line, make sure the next line number displayed is correct, press the MARK key and begin the line over again.

Note: From the edit menu, you may delete as many lines or segments as you wish, all the way back to the beginning of the survey.

Summary

Data editing in simple survey is somewhat like pressing backspace on a computer. You can delete data and positions going backward from the most recent key presses. Note that this is the only way to alter the counting of marks and lines.

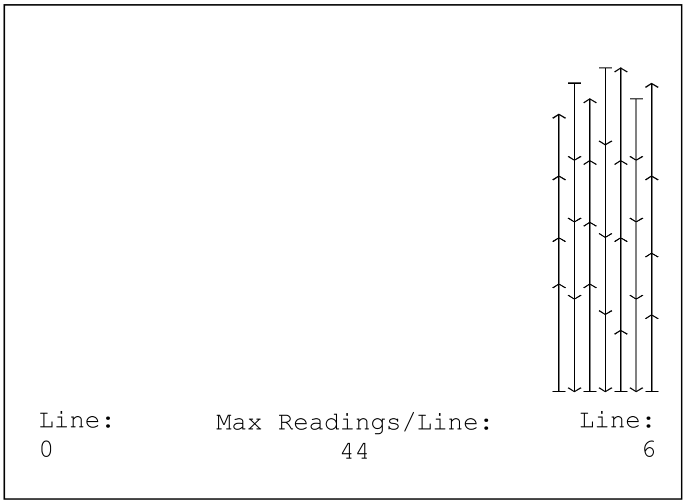
After making data edits, it is very important to make sure the current line and mark number are where you intend to take data. It is strongly recommended that you look at the Map display after editing data. See the next section on viewing data.

Viewing Data

Pressing the MAP or CHART key from the Acquisition Display will bring up a representation of the data acquired. These keys may be pressed at any time. The unit will pause while you look at the display.

Map Display

On the map display, each mark is represented by an arrow in the default direction. The distance between marks is proportional to the number of readings taken. Thus, if you are doing a bi-directional survey, and are walking at a steady pace, this display will correspond to a physical map. Otherwise, it gives an indication of the number of marks in each line and the number of readings taken between marks. The map display, after 7 lines of data have been taken, is shown below:



Map Display in Simple Survey Mode

Data is shifted all the way to the right, with the oldest data shown on the left. The number at the lower left indicates the number of the left-most line, while the right hand number indicates the right-most line on the display. The arrow keys may be used to scroll the display, if necessary.

Pressing ESC will exit the map display.

Chart Display

You may review the data readings as profiles by pressing the CHART key. You may scroll both the map and charts by hitting the left and right arrow keys. If you were logging data when you pressed the MAP or CHART keys, the unit will enter the pause mode while it is displaying the map or profiles. To restart data acquisition, press ESC, then PAUSE. The chart display is shown below:

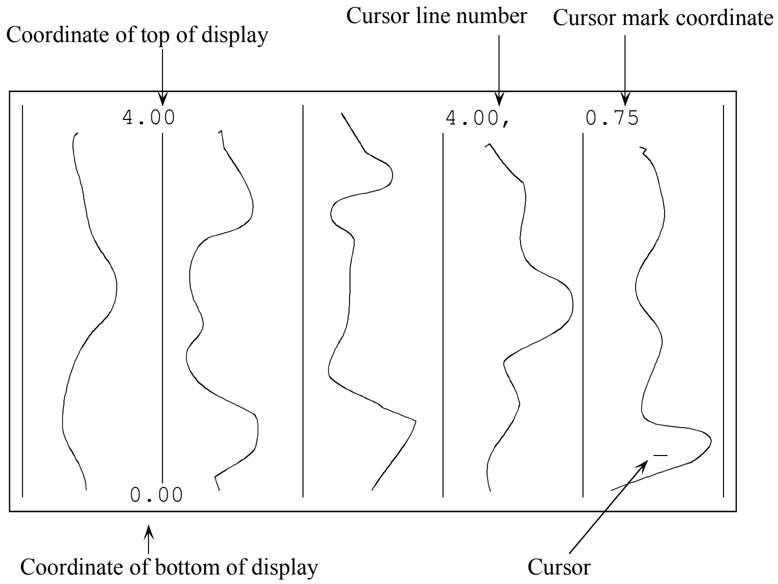


Chart Display in Simple Survey.

On the chart, coordinates are in units of marks. For example, a y-value of 3.5 indicates half way in between mark 3 and mark 4.

Chapter 5: Mapped Survey.

Introduction

Mapped survey allows you to better specify and visualize the survey area than simple survey, and to move around within the area in a non-continuous fashion. Using the arrow keys, you may position the cursor anywhere within the map, and acquire data. Default cursor movements are programmed into the unit, so if you follow a normal serpentine path across the survey area, you may simply press the MARK and END LINE keys as if you were doing a simple survey.

Mapped mode allows you to

- Define a rectangular survey area with pre-defined fiducial, or mark, points on a regular grid.
- Take data in a uni-directional, or bi-directional default pattern.
- Move to any arbitrary position within the survey area to take data.
- Leave gaps in the survey where positions are inaccessible.
- Observe on-screen where all data points have been logged.

Surveying for a depth section or pseudosection

In general there are two types of maps that can be produced. These are the contour map or planview, and the pseudosection or depth section. The planview map is produced when a site is survey by using a constant transmitter-receiver separation on a number of adjacent lines. The pseudosection is produced when the same profile line is surveyed several times with different transmitter-receiver separations. In order to get depth information the line is traversed multiple times, each with a different transmitter/receiver separations. See the section “Array Geometry” for a details of entering the OhmMapper array measurements required for calculation of the operator-measurement point offset.

Array Geometry

The nominal measurement point in a dipole-dipole resistivity measurement is considered to be half way from the center of the transmitter dipole to the center point of the receiver dipole. With 10 meter transmitter and receiver dipoles, a 10-meter tow rope, and a 4 meter fiber optic isolation cable the offset from the operator to the measurement is 19 meters behind the operator, as indicated below. If the operator were to mark the measurement when he was at the same point while traversing the survey area in the opposite direction, the measurement point is still 19 meters behind him, but since he is traversing in the opposite direction there is a difference of 38 meters from one measurement to another as sketched below.

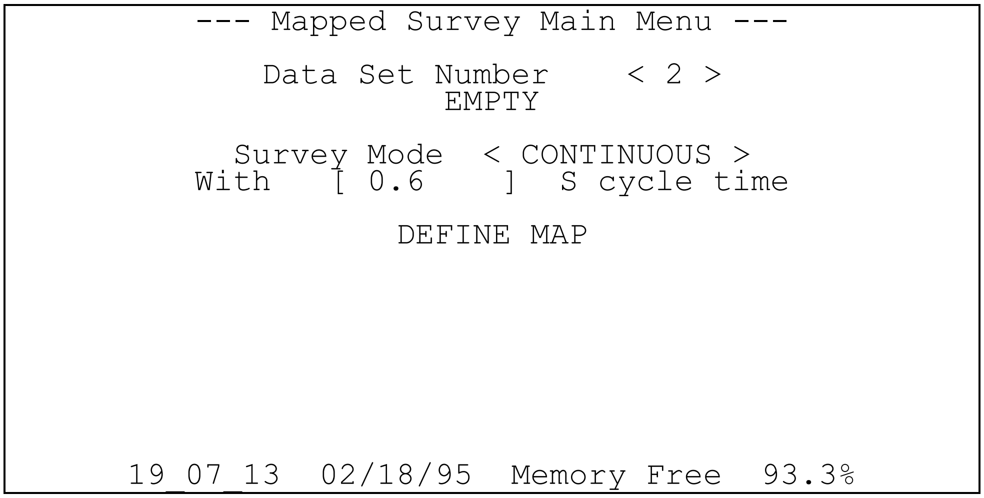
-------Tx-------Center of array------Rx------(fiber cable)Operator (going east to west)
x ←- Measurement point X ←Operator’s marked position

(going west to east) Operator(fiber cable)------Rx------Center of array-------Tx-------
Operator’s marked position -→ X measurement point → X

If the operator presses the MARK key when he is at the same position the total difference in position from the measurement point when the operator is traversing from east to west and from west to east is 38 meters. This layback, or offset, value must be calculated in order to properly position the data on a map or pseudosection.

In order to calculate the layback of the operator position from the measurement point the operator must enter the geometry as described below.

Setting up the survey
From the main menu, select MAPPED SURVEY.



```
          --- Mapped Survey Main Menu ---

              Data Set Number    < 2 >
                       EMPTY

             Survey Mode  < CONTINUOUS >
          With   [ 0.6    ]  S cycle time

                     DEFINE MAP



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```
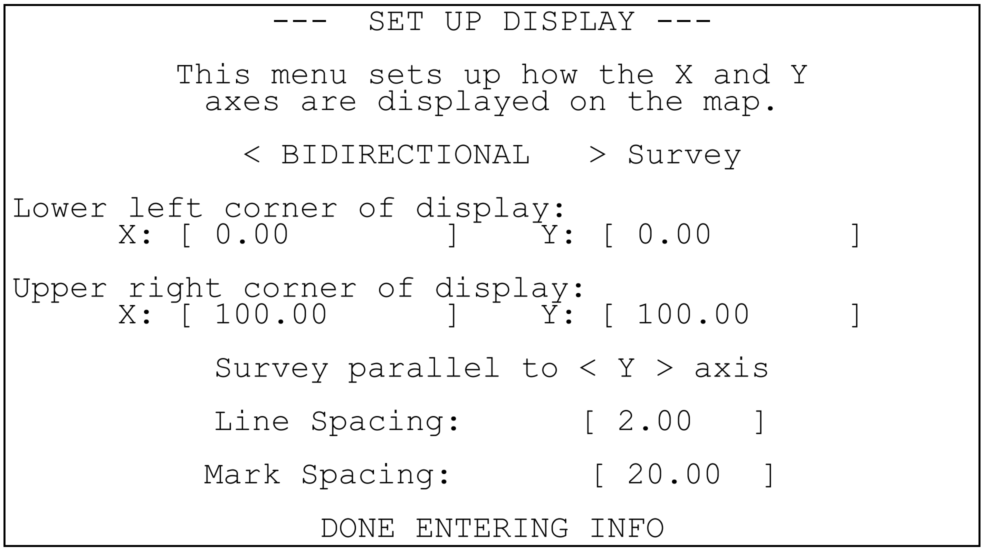

Mapped Survey Main Menu

To start a new data set, press the right or left arrow keys until an empty data set is indicated. The Survey Mode may be set to continuous or discrete. In discrete mode, a reading will be taken only upon the operator pressing the MARK or END LINE keys. In continuous mode, readings are taken at intervals specified by the cycle time. For OhmMapper readings the cycle time may be set from 0.5 to 6553.4 seconds in 0.1 second increments. For other types of data see the appropriate operator's manuals. Adjust the parameters shown, if necessary, then select DEFINE MAP. This brings up the set up display menu.

Defining the Survey Area



```
                 ---  SET UP DISPLAY ---

          This menu sets up how the X and Y
           axes are displayed on the map.

              < BIDIRECTIONAL   > Survey

Lower left corner of display:
      X: [ 0.00        ]    Y: [ 0.00        ]

Upper right corner of display:
      X: [ 100.00      ]    Y: [ 100.00      ]

           Survey parallel to < Y > axis

           Line Spacing:      [ 2.00   ]

          Mark Spacing:       [ 20.00  ]

                DONE ENTERING INFO
```

Set Up Display Menu

The actions of the various fields are as follows:

Bi-directional or uni-directional survey
This field describes whether you will take data walking both up and down lines or walking up the lines only.

Lower left corner

Upper right corner
Here, you must describe the coordinates of the survey area by entering the lower left and upper right extents of the displayed area. If the area is not a rectangular shape, define a bounding rectangle containing the survey site. You may use any units you like.

There are several things you must keep in mind when deciding how to define the survey, and how you will be walking to cover the area. First of all, survey lines are assumed to be shown vertically on the display. This makes it easier to visualize where you are when you are standing at the beginning of a survey line looking towards the end of the line.

Secondly, the unit assumes that you will be surveying lines from left to right across the display. In other words, when the END LINE key is pressed the cursor will move to the next line to the right on the display.

The map height must be an integral number of mark spacings. During the survey, you may manually enter positions at ends of lines which do not reach to the next fiducial mark. See the section “Manually Entering a Position,” later in this chapter.

Note: Remember that you are defining the way the coordinates are viewed on the display of the OHMMAPPER. See the later section “Defining a Physical Area” for more details on how to define your survey.

Survey parallel to X or Y axis
This action defines which axis you want displayed vertically on the screen. This is the axis your lines will be parallel to.
Line spacing
Mark spacing
These items define the distance between lines or marks.

Enter the desired parameters in the set up display menu, then select DONE ENTERING INFO, or press ESC.

> **Note:** If the unit beeps and displays a warning dialog box, you have entered inconsistent information. Usually, this means that the chosen survey direction (x- or y-axis) is not vertical on the display screen. Either change the survey direction or the lower left and/or upper right values for the display. See Defining a Physical Area for more information.

After the OhmMapper accepts the values you have entered, the mapped survey main menu will reappear, with some new options:

```
           --- MAPPED SURVEY MAIN MENU ---

              Data Set Number    < 2 >
                       EMPTY

             Survey Mode  < CONTINUOUS >
           With   [ 0.6    ]  S cycle time

                     DEFINE MAP


                    BEGIN SURVEY
          AT X [0.00      ] Y [ 0.00      ]
                  Going <  UP  >




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```
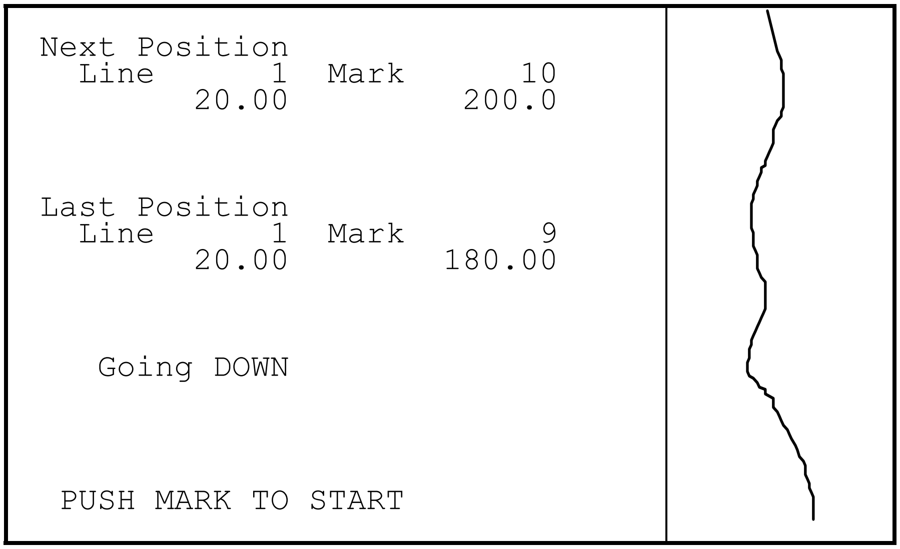

Now you can manually adjust the starting point, if desired. The default starting point will be the lower left corner, and the unit will assume you will be initially walking up the display. You may adjust the starting point and direction, if desired. Then select BEGIN SURVEY.

Continuing a previous mapped survey is done in a similar way. Scroll to the desired data set number, then select CONTINUE SURVEY.

> **Note:** You may redefine the map region for a survey that has data in it. This is done simply by selecting DEFINE MAP from the main map menu, and modifying the data. This allows an enormous amount of flexibility in taking a survey. Please see the section "Multiple Grid Surveys" below.

Acquiring Data

Either beginning a new survey or continuing an old one will bring up the map acquisition display.



```
Next Position
  Line      1  Mark      10
        20.00          200.0


Last Position
  Line      1  Mark       9
        20.00         180.00



   Going DOWN




 PUSH MARK TO START
```

Data Display Screen

Just as in simple survey, data acquisition is started upon the operator pressing the MARK key. Acquisition will stop when the END LINE key is pressed. Position events will be stored when the MARK key is pressed during data acquisition. The PAUSE key will temporarily halt acquisition; pressing it a second time will re-start acquisition.

The top line of the display shows the position where you should next press the MARK or END LINE key. This should, of course, be the position you are walking toward. Below this line is shown the position of the last position event stored.

See the Advanced Features section later in this chapter for more information on specifying your position.

Note: From this display, you may press the MENU key to bring up the acquire menu, the MAP key to bring up the map display , or the CHART key to bring up the data review menu. These functions are described next.

Acquire Menu

Pressing the MENU key will bring up the acquire menu.

```
              --- ACQUIRE MENU  ---


             Next X =   24.00
             Next Y = [ 100.00     ]
           Current Direction  < DOWN >


            Full scale:    < 50   > nT


        <   25   > Readings per screen


               EDIT LINE AND MARK


              Cycle Time  [ 0.1   ] S
```

Next X

Next Y

You may change position along the line you are on. Depending on the direction of your survey, you will be allowed to enter a number into one of these two fields. This is very useful when your path is blocked. See the later section "Advanced Features" for more information on using this feature.

If you are between lines, you will be allowed to adjust both of these numbers. You cannot, however, enter a line position which isn't on the regular grid. To do that, you must re-define the grid. See the section on Multi-Grid Surveys.

> **Note:** You may also change the next position by pressing the arrow keys directly from the acquisition display after an END LINE key press.

Current Direction

You may toggle between up and down.

Full scale

The scale width of the sweep display.

Readings per screen

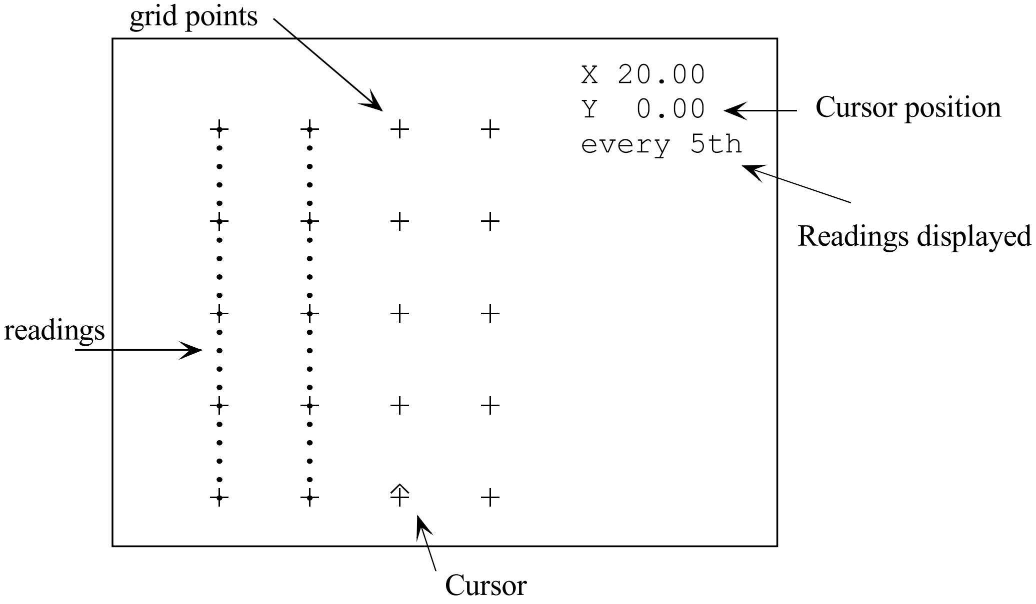
The vertical scale, or sweep rate on the display.

EDIT LINE AND MARK

Brings up the editing menu, see below.
Pressing ESC will return the unit to the acquisition display.

Displaying the Map

The map is displayed by pressing the MAP (.) key from the data display screen:



Map Display. Map is shown after two lines of data have been taken.

Note: To restart data acquisition, first press ESC to clear the map. Then press the MARK key.

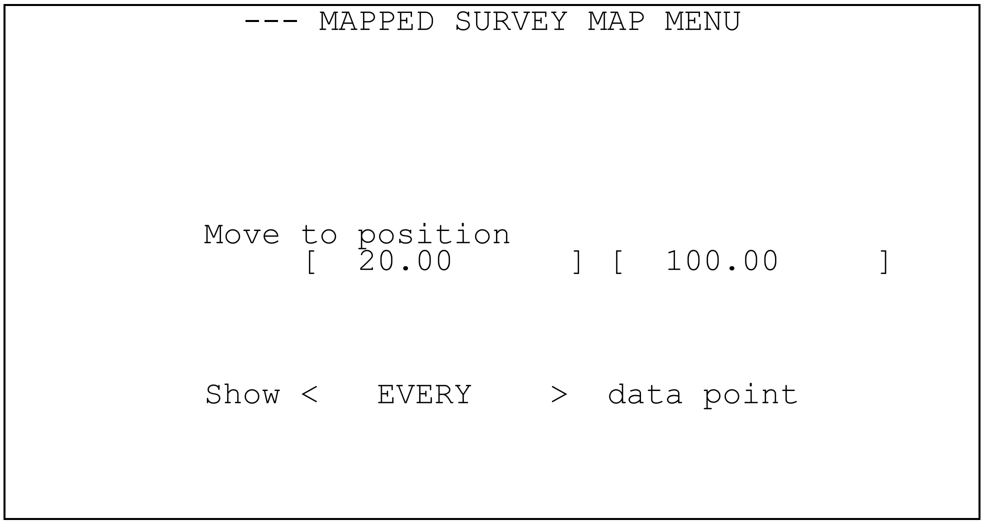
Some care must be taken in orienting the map display with the real world. On the display, the line direction is always up and down. The survey is also assumed to start at the left side of the display. Each time the MARK or END LINE key is pressed, the position is automatically updated on the map, according to whether you have selected a unidirectional or bi-directional survey. The position indicated is where the unit thinks you should be walking toward (where you will next press the END LINE or MARK keys). You may change this to any other fiducial mark by pressing the cursor keys to manually change position.

The baseline of the survey is displayed along the bottom. This is assumed to be a straight line. The edge opposite the baseline may be a more arbitrary shape within the rectangle you specified. This is done by manually entering and changing positions when you are starting or stopping a line at a position other than the back edge of the rectangular map display.

Note: After positioning the cursor, you must make sure it is pointing in the direction you want to go. Pressing "2" will point the cursor upward, and "8" will point the cursor down.

Map Menu

From the map, the MENU key brings up the Mapped Survey Map Menu:



```
             --- MAPPED SURVEY MAP MENU




         Move to position
              [  20.00      ] [  100.00      ]



         Show <   EVERY    >  data point
```

Mapped Survey Map Menu

Move to position
This allows you to position the cursor by entering a position.

Show data point
It also allows you to reduce the number of data points plotted, to speed up the drawing process.

Pressing ESC will return the unit to the map display.

Viewing Data

Data profiles may be reviewed by pressing the CHART (-) key. The arrow keys will scroll through the data. Pressing the SCALE or MENU keys will allow you to adjust the scale.

Each line is plotted in its own lane. Values "wrap around" inside the lane. The scale may be set by pressing the scale key, or by pressing menu and bringing up the Chart adjust menu.

The chart display is shown below.

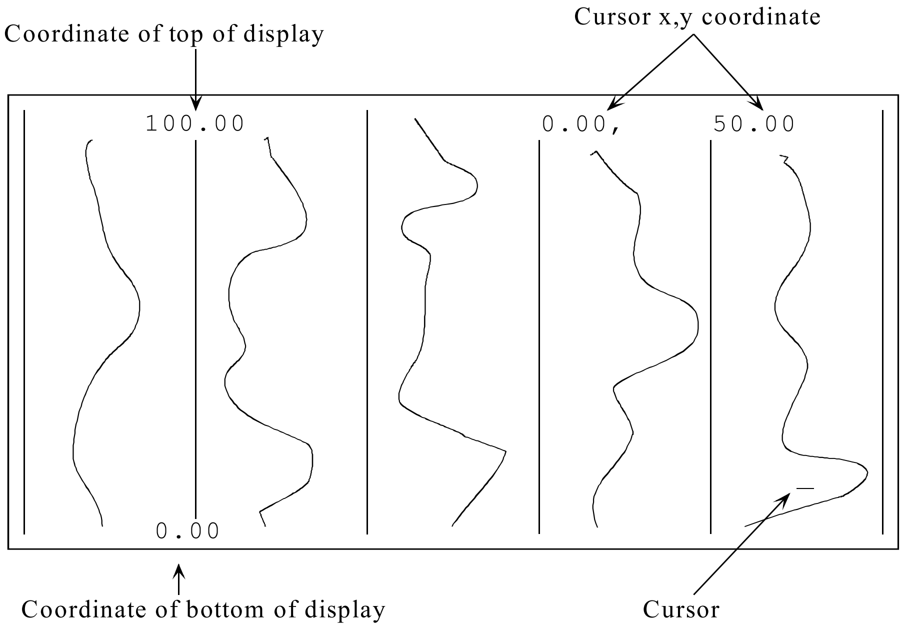


Chart Display for Mapped Survey.

Pressing the MENU key will bring up the data review menu:

```
              --- DATA REVIEW MENU ---



     Move to position:
               X = [  80.00    ]
               Y = [ 100.00    ]



            Full scale:  <  2   >  nT



        Zoom to show  <   ALL  > of line

```

Move to position
This will jump the cursor to a particular position, and scroll the data to that point. This is useful to rapidly page back to a particular point, without having to scroll through the entire file.

Full scale:
Set the full scale of each lane.

Zoom to show portion of line
Sets the vertical scale of the display.

Editing Data

Introduction

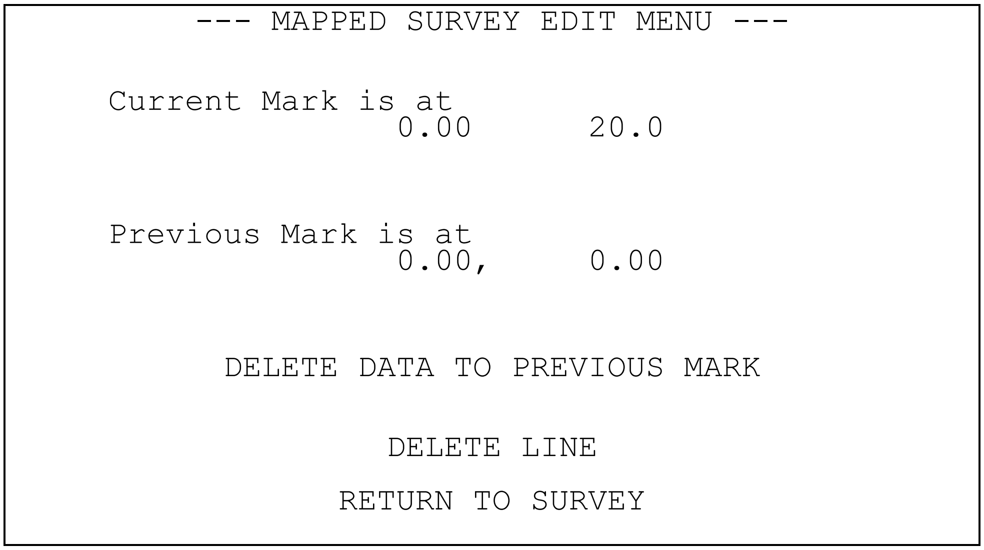
Data editing may be done in two ways. The most-recently taken data may be deleted and retaken, or you may simply retake data from anywhere within the survey. If data has been taken from overlapping locations, the MagMap2000 software will allow you to select which set of data you want. Doing the editing on the PC, however, is an involved process. It is much easier to delete data and retake it on the spot.

Data editing in Mapped Survey is somewhat different from Simple Survey. In Mapped Survey, you have much more flexibility in positioning the cursor where you want when you are finished editing. Thus, if the default position of the cursor is not what you want, you may simply use the map and cursor movement functions to reposition it. You do not need to press the END LINE key, for example, to indicate an end of line. Simply reposition the cursor at the next line.

Also, remember to use the map make sure you deleted the data you intended to. To move from the editing menu to the map, press ESC twice, then MAP. To go back to the editing menu from the map, press ESC, MENU, then highlight EDIT LINE AND MARK (it probably will be highlighted already) and press ENTER.

Procedures

The data editing menu is reached from the acquire adjust menu. From the Acquisition Display, press MENU, then select EDIT LINE AND MARK.



```
          --- MAPPED SURVEY EDIT MENU ---


     Current Mark is at
                    0.00      20.0



     Previous Mark is at
                    0.00,     0.00



           DELETE DATA TO PREVIOUS MARK

                   DELETE LINE

                RETURN TO SURVEY
```

Mapped Survey Edit Menu

DELETE DATA TO PREVIOUS MARK
This function deletes data back to the previous mark. You will then be positioned at that previous mark.

DELETE LINE
This will delete an entire line of data. It will delete the line you are currently on, or, if the current line has no data in it, it will delete the previous line.

Examples - Recovering From Common Mistakes:

Mistakenly pressing MARK instead of END LINE at the end of a line.
First, press END LINE to halt the data acquisition. Press MENU, then highlight EDIT LINE AND MARK and press ENTER to bring up the Edit menu, shown above. Highlight DELETE BETWEEN THESE TWO POSITIONS and press ENTER. Finally, press ESC twice to return to the Acquisition Display. Then press MAP to review where data is still stored on the system, and to make sure the cursor is positioned correctly. You may need to use the arrow keys to place the cursor at the beginning of the desired line.

Mistakenly pressing END LINE instead of MARK in the middle of a line.
This case actually does not require any data or positions to be deleted. In mapped mode, all that is necessary is that you properly re-position the cursor and continue taking data. After accidentally pressing the END LINE key, press MAP to bring up the Map Display. Then, use the arrow keys to position the cursor at the mark position where you pressed the END LINE key. This position will be at the exact end of the last data segment. Next, press ESC twice to move to the Acquisition Display. Now, walk back to where you pressed the END LINE key. Press MARK and start walking. Continue the line normally.

Summary
Data editing in mapped mode is somewhat different than in simple survey mode. In mapped mode, you should visualize the survey area using the map, delete line segments or lines, then reposition the cursor where you want to go next.

To move from the Edit Menu to the Map Display, press ESC twice, then MAP. To go back to the Edit Menu, press ESC, then MENU, make sure EDIT LINE AND MARK is highlighted (it should be) and press ENTER.

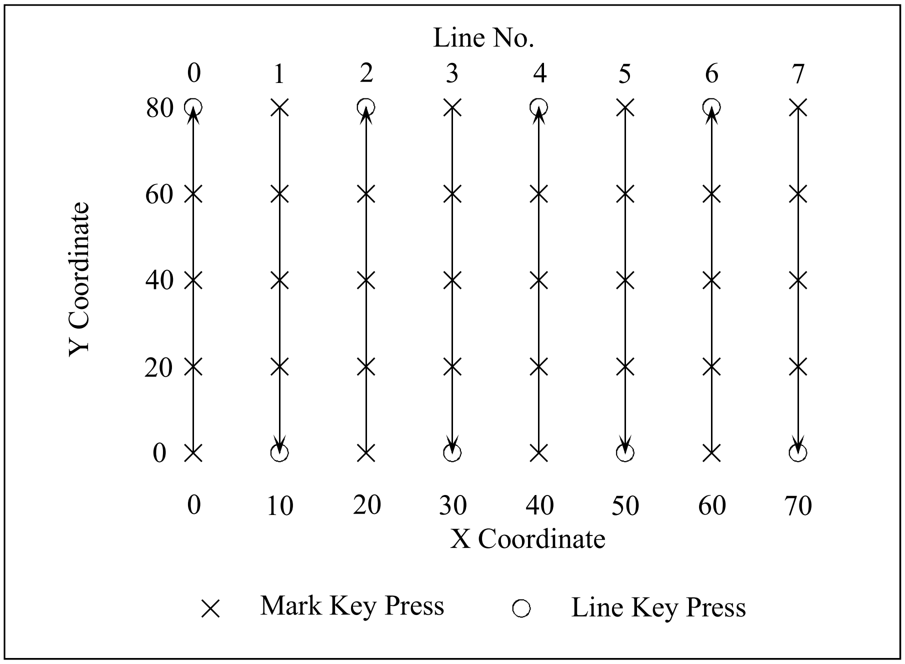
Note: It is strongly suggested that after each segment or line is deleted you bring up the map to see where you now are. Also, don’t forget to check to see where the cursor has been positioned, and its direction, after the deletions are finished.

Defining a Physical Area

In the explanation above, we touched only very briefly on defining the map. This section will more clearly explain how to define the map display so that it corresponds to the mental picture you have of the actual survey site.

Normal Orientation

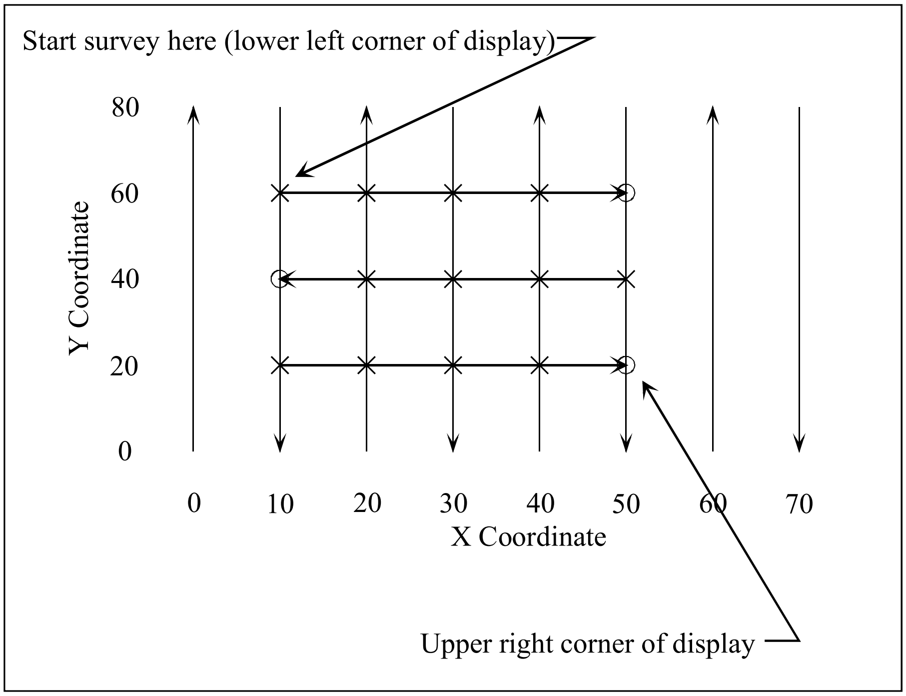
The easiest way to keep the coordinate system clear is to define the Y axis to be the direction along which you are walking, and the X axis perpendicular to that. Then the coordinates will be displayed on the OhmMapper in the way most people are used to seeing x and y axes, with the y axis being vertical, and the x horizontal. An example of this set up is shown below.

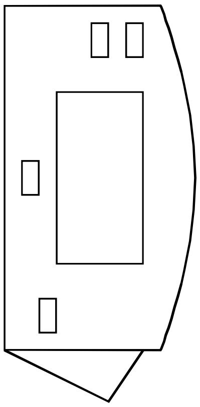


For this case, the lower left coordinate that you should enter in the Define Map Menu would be (0, 0), and the upper right would be (70, 80). The line spacing is equal to 10, and the mark spacing is equal to 20.

90 Degree Orientation

Suppose, however, that you have already defined the x and y coordinates, and do not wish to define the y axis as parallel to the line direction. One good reason to do this is if you are doing a smaller portion of a larger survey, and you wish the coordinates to be consistent. For example, say you want to survey a smaller area within the last survey:





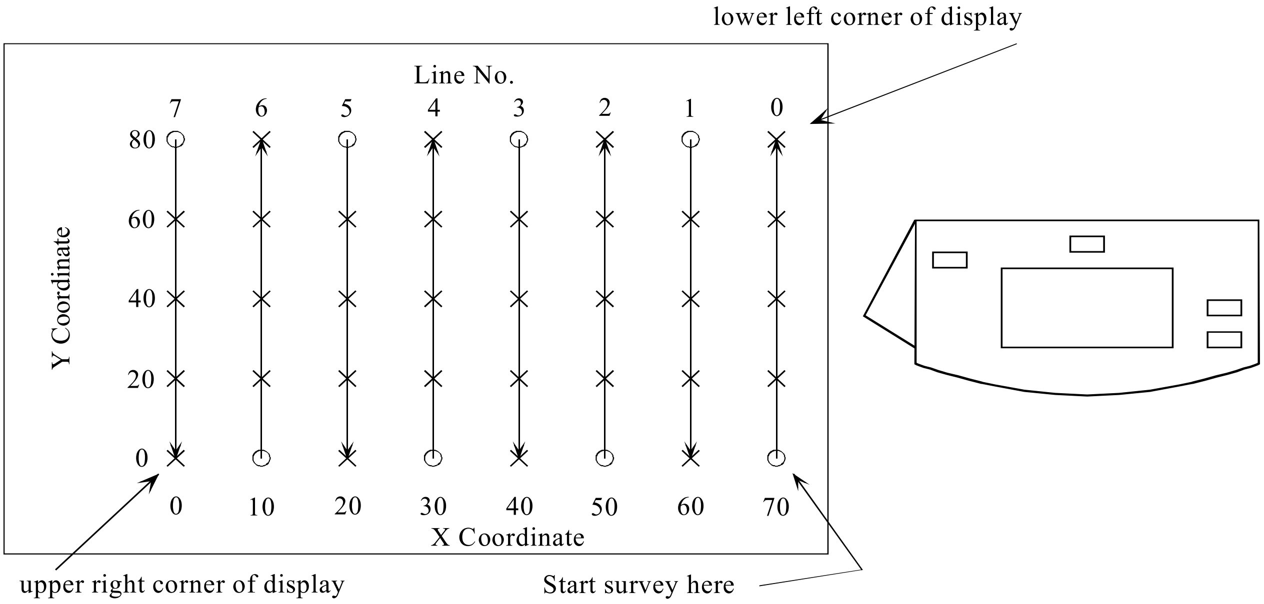
In this case, you would enter the coordinate (10, 60) as the lower left corner of the display, and (50, 20) as the upper right corner of the survey. You would also set the unit to survey parallel to the X axis. You can visualize this by rotating the OhmMapper clockwise 90 degrees and placing it on the map. For the sub-survey shown, the line spacing is now 20, and the mark spacing 10.

Note: Two things must be remembered in setting up the coordinate systems. First, the line direction is always up and down the OhmMapper display. Secondly, lines are surveyed starting from the left of the display, and moving toward the right of the display.

180 Degree Orientation

Please note that the OhmMapper allows you complete freedom in where to start your survey, even though the lines always must move from left to right on the display. You can always rotate the OhmMapper until the line direction is up and down, and the lines move from left to right. This rotation will determine what coordinate you must enter as the lower left and the upper right of the display. Some orientations will require that you start the survey in the upper left corner of the display. This can be set in the Map Setup Menu before starting the survey.

This can be seen in the following example. Suppose you are back to the original survey, shown in Figure 1, but you wish to start in the lower right corner of the site.



This can be accomplished by rotating the OhmMapper 180 degrees relative to the site map. Then you can see that the correct lower left coordinate is (70, 80), while the upper right coordinate is (0,0). The survey should be begun in the upper left corner of the display.

Advanced Features

The OhmMapper has many features allowing a great amount of flexibility in defining your position and viewing the survey site. This section describes the ability to define more arbitrary positions, and re-define the survey grid.

Software States

Before discussing the advanced features, it will be helpful to define some states the OhmMapper can be in, in order to explain when certain operations will work.
There are 3 active states of the OhmMapper in continuous mode:

Acquire State. In this state, the system is storing data, generating the woowee tone, and updating the analog sweep trace of the OhmMapper output. Pressing the END LINE key sends the system to the Ready State.

Ready State. This is the state the system is in between lines, for example. Data is not being recorded, the woowee sound is off, and the sweep trace is frozen. Pressing the MARK key sends the system to the acquire state.

Pause State. The system enters this state from the Acquire State when the pause key is pressed.

Positioning Data

In order to interpolate a position for each individual reading, the system must have a position defined both before and after each segment of readings. Because of this, you cannot press ESC from the acquire state. This would leave a series of readings without an ending position, so the most recent readings could not be properly located.

There are two position recording keys on the OhmMapper: MARK and END LINE. As seen above, these keys, in addition to recording the current position, control the transitions between the Ready and Acquire state. They can therefore be used to start and stop data acquisition.

> Press the MARK key at fiducial positions when you want to start or continue data storage. Press the END LINE key at a position when you want to stop data storage. You don't have to be at the actual end of a line to press the END LINE key.

The END LINE and MARK keys also control the automatic tracking of the position. As you have no doubt seen, the positions are automatically updated after each position key press. The MARK key increments (or decrements) the vertical position on the display. The END LINE key advances the horizontal position 1 line spacing.

> While using the END LINE and MARK keys to control data acquisition when surveying arbitrarily positioned segments, you must manually update the correct positions.

Manually Entering a Position

You may enter new positions from either the Ready or Pause state. One way to do this is to bring up the map display (press MAP) and move the cursor with the arrow keys. This will allow you to move to any fiducial point. Another way is to bring up the acquire menu (press MENU), and type a new coordinate into the OhmMapper. This allows you to enter positions which are not directly at a fiducial point.

> **Note:** Neither method will allow you to enter points which are not on one of the lines of the survey. To fill in more data between lines, you must redefine the grid. See the section Multi-Grid Surveys in this chapter.

If you are currently in the middle of a series of readings, i.e. you pressed the PAUSE key and haven't yet entered a position, you may only position yourself on the same line you are on.

From the Ready state, you may enter any position along the current line. You can then begin a series of readings from that point.

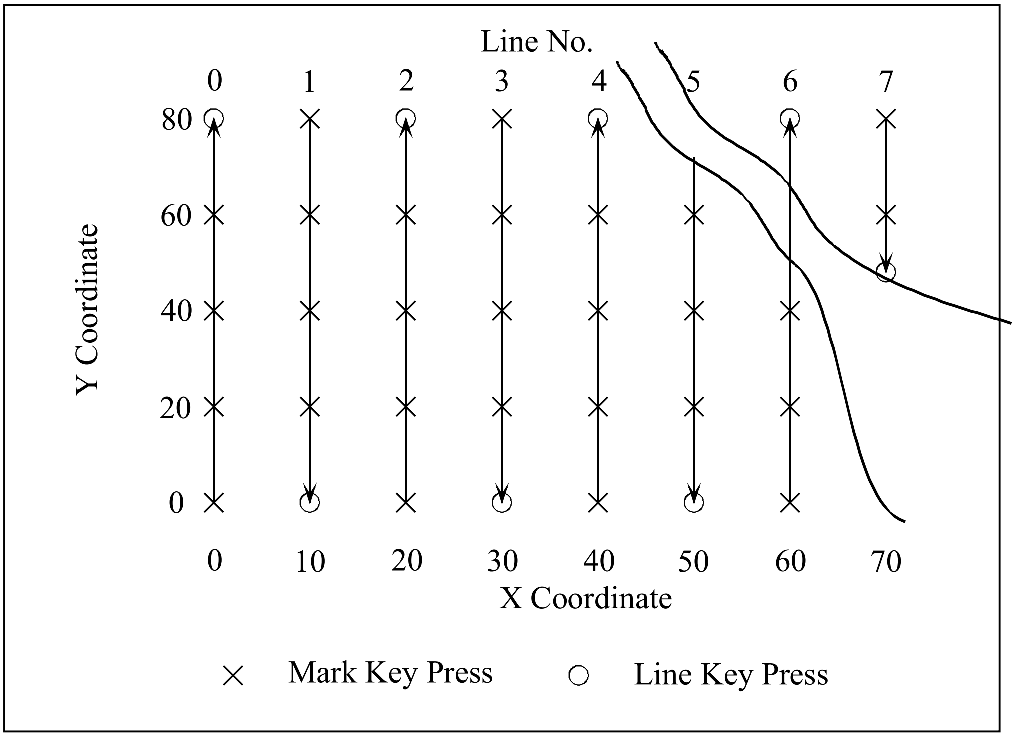
> **Note:** Don't forget to press the ENTER key after entering the value in the numeric entry box.

Example

The principles involved in manually entering positions may best be seen by example. Consider the survey site below, where a stream crosses the survey area. This example shows how to

1. Start a new line at an arbitrary location
2. Leave a gap in the middle of a line.
3. End a line at a specified location

Before going out in the field with your OhmMapper we strongly suggest that you experiment with this example and observe what happens. This will save much potential confusion out in the field.



Sample Survey Containing an Obstruction.

In the above example, conduct the survey normally until you reach the end of line 4. At that point, press MENU to display the Acquire Menu. Highlight the Next Y field, and enter the value 70. (Press DEL, type 70, then press ENTER). Press ESC to return to the Acquisition Display. Position yourself at the beginning of line 5 (Y=70), press MARK, and start walking. Proceed normally down line 5, pressing MARK at Y=60, 40, 20, and END LINE at Y=0.

Now begin line 6, by pressing MARK at Y=0, 20, and 40. Upon reaching the stream, press PAUSE. Press MENU, and enter the value 50 into the Next Y field. Press ESC. Press MARK. You have now correctly ended the previous segment of data. After fording the stream, you must enter the starting position of the next segment as described below.

Note: The position entered by an END LINE or MARK key press is the position labeled Next Position on the display. You must update this value *before* pressing the END LINE or MARK keys. If you end a segment by entering an incorrect END LINE or MARK coordinate, the data for that segment will have to be deleted and re-taken, this time with the correct final position.

Press MENU to bring back the Acquire Menu. Enter the position 65 into the Next Y field. Press ESC, then press MARK. You have now entered the starting position.

Note: Entering a value into the Next Y or Next X field in the Acquire Menu will not record the position**.** The MARK key must be pressed to do this, and MARK key presses are only recorded in the Acquisition Display.

To resume collecting data, press PAUSE, and start walking. Press END LINE at the end of line 6.

Note: Notice that data taking was not resumed when the MARK key was pressed. This is because you pressed the PAUSE key when you reached the stream walking up line 6. This puts the OHMMAPPER into Pause Mode, and a second PAUSE key press is used to resume data collection. Read the text at the bottom of the Acquisition Display to determine if you are in Pause Mode. If you are, it will say “Press pause to resume.” If not, it will say “Press MARK to start” In this latter case, data taking will start when you press MARK. This an important point, so to avoid confusion you should always read the text at the bottom of the display.

Start line 7 normally, by pressing MARK at Y=80 and X=70. When you reach the stream, press PAUSE. Bring up the Acquire Menu (press MENU), and enter 45 into the Next Y field (don’t forget to press ENTER). Press ESC,then press END LINE. Notice that you are no longer in the Pause Mode. The END LINE key press moves the system out of that mode.

To observe your handiwork, press the MAP key. You will see that readings are positioned correctly.

Multi-Grid Surveys

As seen above, horizontal locations are limited to grid lines. However, you can change the grid, even in the middle of a survey. This is useful if you want to fill-in parts of a survey with finer spaced lines, or take lines in different directions.

Note: The current grid is used for the automatic tracking of positions, and to define the display extents and fiducial points of the map.

From the Ready state, press ESC to bring up the Mapped Survey Main Menu. Then select DEFINE MAP. Make the changes you desire, then select CONTINUE SURVEY from the Mapped Survey Main Menu. Press the MAP key to bring up the map, and position the cursor where you desire. Then bring back the acquisition display (press ESC from the map). Pressing the MARK key will begin data storage.

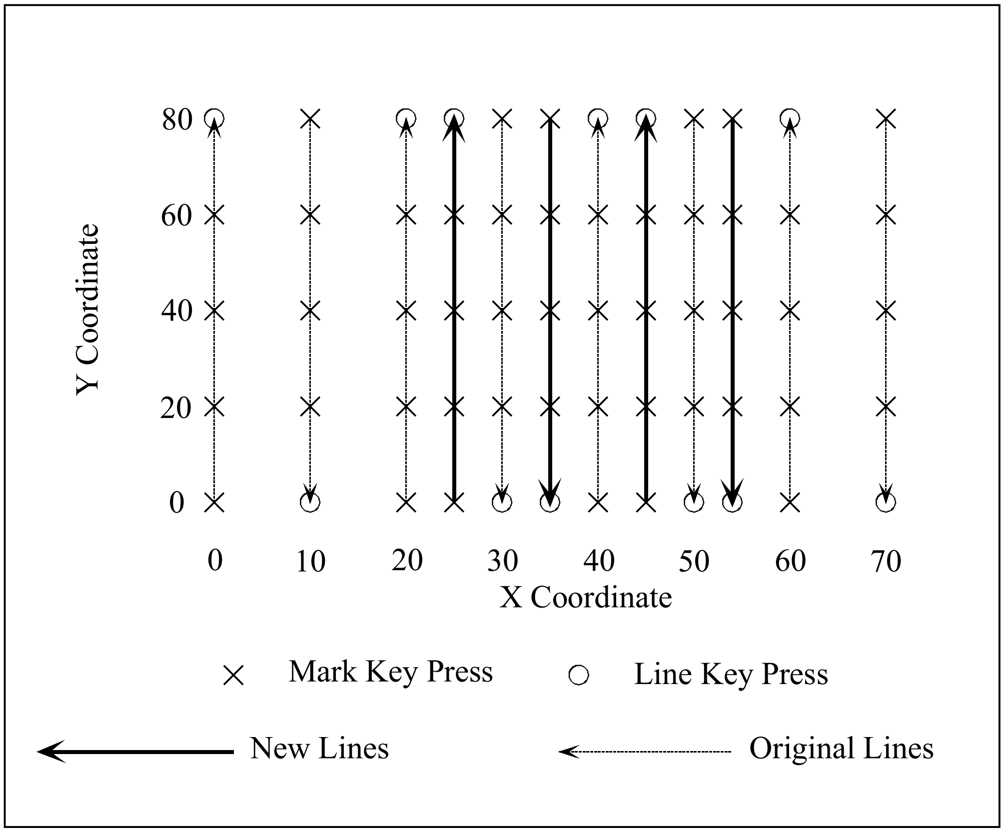
Note: Novices to the OhmMapper should not attempt this procedure. Another way to do this is to define a new file number, as if this were an unrelated survey. Data can then be located and edited separately, and combined in a program such as Surfer for Windows.

Warning: You may not be able to edit positions in MagMap2000 when using a multi-grid survey. If you use this function, make sure you get the positions correct on the OhmMapper. You must use the NOEDIT method within MagMap2000 in order to locate surveys in which the lines are not parallel.

Note: The map display will only show the current grid. Thus, you may not see data points which were gathered in previous grids. In order to see all of your data points, you could re-define the grid to contain the entire area of interest.

Example 1: Filling in more lines

Suppose you have completed your survey and desire to fill in more lines over a certain portion. Consider the survey shown below.



For the first part of the survey, you would have defined the grid as follows:

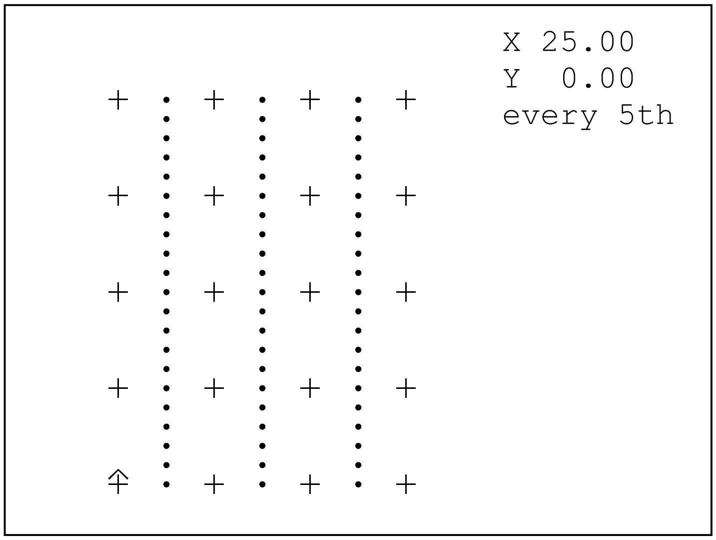
Lower left corner	X= 0.0, Y = 0.0
Upper right corner:	X = 70, Y = 80.0
Survey along	Y axis
Line spacing	10.0
Mark Spacing	20.0

When you have finished the original survey (the light dashed lines), ESC back to the Mapped Survey Main Menu, and select DEFINE MAP. Then enter the following values:

Lower left corner	X= 25.0, Y = 0.0
Upper right corner:	X = 55, Y = 80.0
Survey along	Y axis
Line spacing	10.0
Mark Spacing	20.0

Next, press ESC, then select CONTINUE SURVEY.

Pressing the MAP key will now show what you have done. You should see the following display:



The readings taken for the previous grid are shown. The extent of the map covers only the current grid. However, all data previously taken is still stored in the OhmMapper. You are now ready to survey the new lines in the normal fashion.

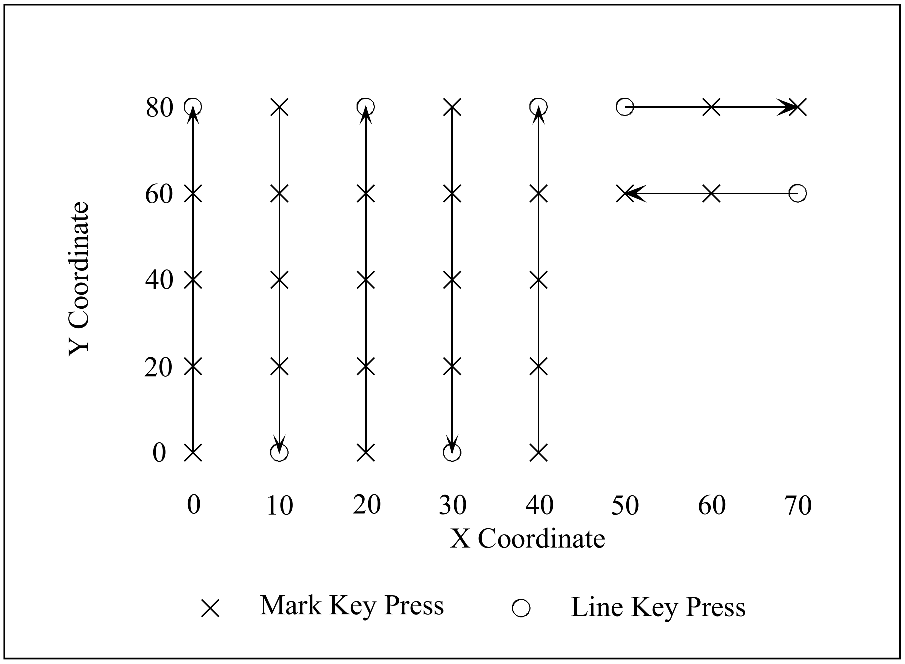
Note: The chart display will not show the old and new lines in the correct order when a multi-grid survey has been performed. The cursor coordinates displayed on the chart display will be correct, however.

Make sure the cursor is positioned where you want it to be. Sometimes, the cursor may not be shown, as it is positioned out of the displayed area. From the map, press MENU, then enter the desired cursor position (X=25, Y=0 in this case). Press ESC to return to the map, and the cursor will be positioned correctly.

After taking all the data of interest, you can confirm that all the data from both grids is still in the OhmMapper. You may do this by re-entering the original grid in the map definition menu, pressing ESC, selecting CONTINUE SURVEY, and pressing MAP.

Example 2

You may also wish to take lines in perpendicular directions. Consider the survey shown below.



For the first part of the survey, define the grid as follows:

Lower left corner	X= 0.0, Y = 0.0
Upper right corner:	X = 40, Y = 80.0
Survey along	Y axis
Line spacing	10.0
Mark Spacing	20.0

When you have finished that, ESC back to the Mapped Survey Main Menu, and select DEFINE MAP. Then enter the following values

Lower left corner	X= 50.0, Y = 80.0
Upper right corner:	X = 70, Y = 0.0
Survey along	X axis
Line spacing	20.0
Mark Spacing	10.0

Then take the next two lines of data. When you download the data, you will be able to locate the points correctly.

Note: MagMap2000 will not be able to edit a survey such as this. You will need to locate the data using the NOEDIT option in MagMap2000. See Chapter 4 for details.

Multiple N-Factor Surveys (for pseudosections)

In order to get data at more than one depth to do a pseudosection the OhmMapper must traverse the same line more than one time using a different transmitter-receiver separation each time. For example if a line is done using 10 meter dipoles and a rope length (separation between the ends of the dipoles) of 10 meters, the N-Factor is assumed to be 1N or 10 meters in this case. If the transmitter-receiver spacings for the first pass is 10 meters, for the second pass 20 meters, and 30 meters for the third pass, a pseudosection can be done with 3 different pseudodepths at 1N, 2N,and 3N.

In order to perform a multiple-spacing survey do the following:

1. Select “VARIABLE” as the survey configuration in the survey setup menu. This will allow the operator to change the array geometric at the end of each line if desired.

2. Collect OhmMapper data with the first transmitter-receiver spacing set to 1N between the end of the transmitter dipole and the beginning of the receiver dipole.

3. When the END OF LINE button has been pushed while in the “VARIABLE ” mode the GEOMETRY menu will be displayed. Enter the new array geometry to correspond to the new transmitter-receiver spacing.

4. Change the transmitter-receiver spacing to 3N between the dipole centers.

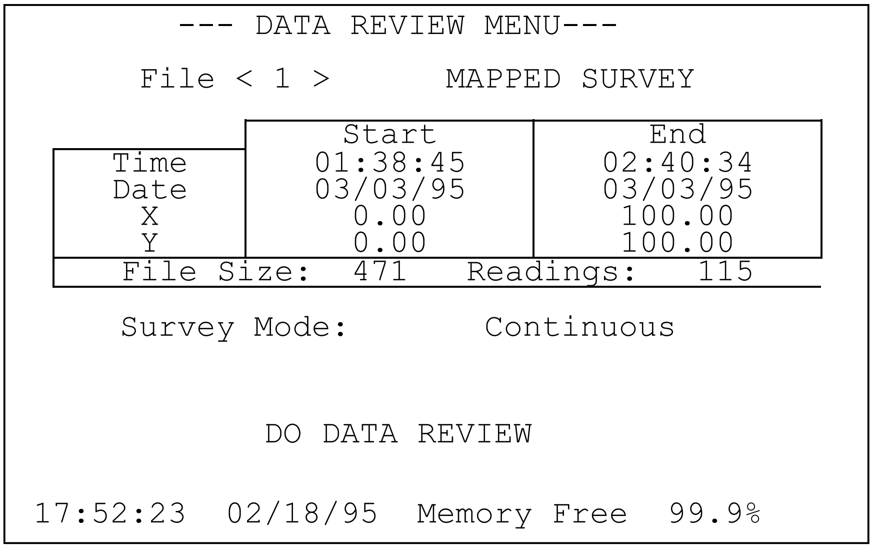
5. Collect OhmMapper data over the same line with the new spacing.

6. Change the GEOMETRY values and the transmitter-receiver separation to 4N and traverse the line again. The number of N-spacings that can be used will depend on the quality of the data. For example, in a noisy environment the maximum Tx-center-to-Rx-center spacing may only be 20 meters with a 10 meter dipole. In this case a pseudosection cannot be done since there will only be a single depth point. To invert multiple N-spacing data to a depth section most resistivity inversion software requires that the transmitter and receiver dipoles be equal.

7. See the MagMap2000 manual for instructions on how to create and export apparent resistivity pseudosections for inversion to depth/resistivity sections.

Chapter 6: Data Review

Enter the Data Review mode by selecting DATA REVIEW from the main menu. An example display is shown below. Your display will differ, depending upon the type of survey used for a particular file number.



```
         --- DATA REVIEW MENU---

      File < 1 >      MAPPED SURVEY

                  Start          End
   Time         01:38:45       02:40:34
   Date         03/03/95       03/03/95
    X             0.00          100.00
    Y             0.00          100.00
     File Size:  471   Readings:   115

     Survey Mode:       Continuous


             DO DATA REVIEW

17:52:23  02/18/95  Memory Free  99.9%
```

This menu shows the directory of each survey stored in the OHMMAPPER. Scrolling the file number will scroll through the files.

Selecting DO DATA REVIEW brings up the chart display for the selected file number.

Chart Display

The chart display varies slightly depending upon whether the survey is a simple survey or mapped survey.

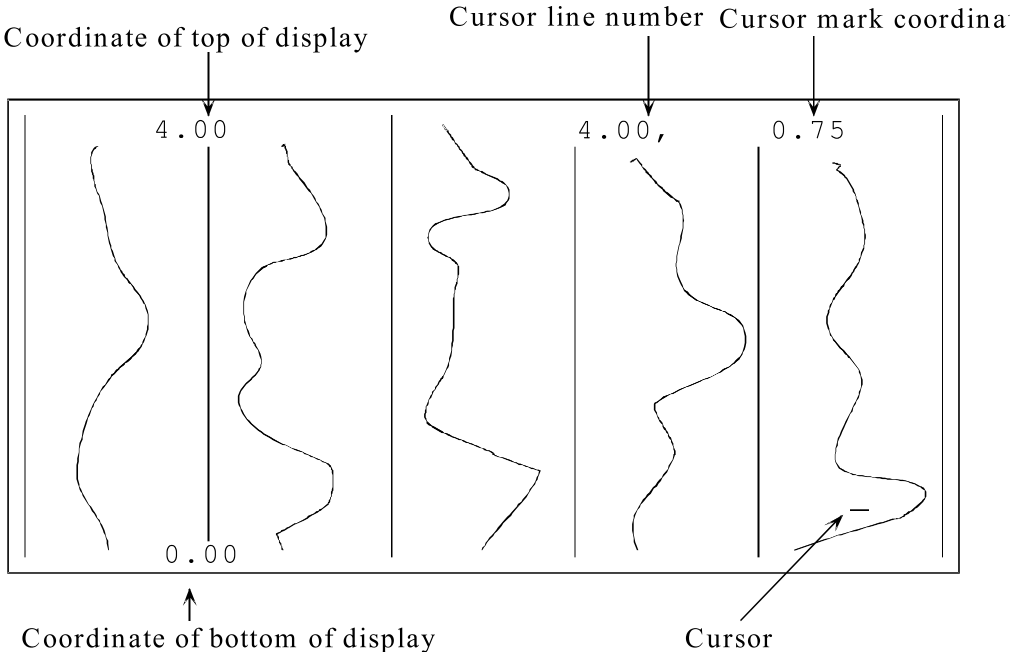


Chart Display for Simple Survey

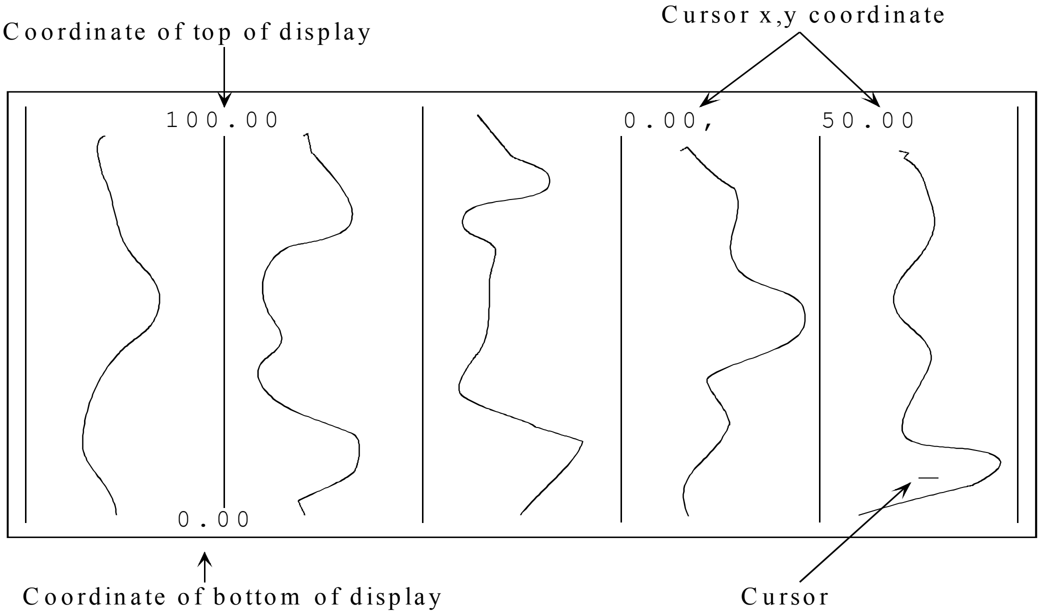
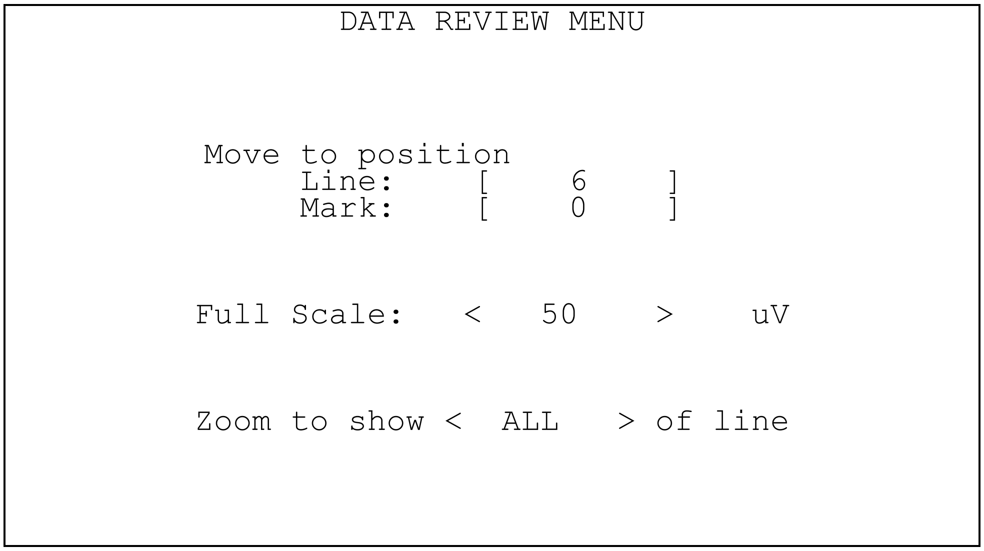


Chart Display for Mapped Survey

The chart display shows profiles of 5 lines of data at a time. The vertical position of the display window is shown on the upper and lower left of the display. The upper right corner shows the x and y position of the cursor.

Data Review Menu

Pressing the MENU key brings up the data review menu



```
                  DATA REVIEW MENU



          Move to position
               Line:    [    6    ]
               Mark:    [    0    ]


          Full Scale:   <   50    >    uV


          Zoom to show <  ALL   > of line
```

Data Review Menu

The data review menu allow you to go directly to a desired position to view the data without tediously scrolling with the arrow keys. You may also change the horizontal scale, or the vertical scale.

Move to position
You may enter the Line and Mark numbers you wish to jump the cursor to in these numeric entry fields. Remember to press the Enter key after entering the number.

Full Scale
This shows the horizontal full scale of each profile column. The data line will "wrap around" to stay within the window. In other words, if the data line moves off the right side of the column, it will reappear at the left side of the column if the field increases slightly.

Zoom
This field sets the vertical scale of the display. You may show all of the line, or portions of a line by scrolling through this scroll box with the left and right arrow keys.

If the vertical scale includes only a portion of the entire line, you may scroll up the display by moving the cursor with the arrow keys.

Chapter 7: Data Transfer

Selecting DATA TRANSFER from the Main Menu will bring up the data transfer menu:

```
                ---DATA TRANSFER MENU ---



                   PC CONTROLLED TRANSFER


                   MANUAL ASCII TRANSFER


                      ERASE DATA SET



       11:52:44  02/22/95  Memory Free 99.9%
```

Data Transfer Menu

This menu allows you to transfer data in either binary form or ASCII form. ASCII data is human readable, but takes about 100 times as long to download. It is suitable only for the smallest files.

Attach the serial cable (supplied with the unit) to the serial port. The other end connects to your PC. Some computers may require a 9 pin to 25 pin serial adapter, available from your computer store. You will need to know which serial port (typically COM1 or COM2) you have attached it to.

PC Controlled Transfer

Allows transfer of data in binary format. Data will be downloaded under the control of the MagMap2000 program on your PC. You must select this option on the OHMMAPPER console, then select download from the MagMap2000 program. See Chapter 11, for details on running MagMap2000. You will also need to know which file number you want to transfer. You may select MANUAL ASCII TRANSFER to page through the files to see which one you want to transfer. Then press ESC to return to this menu, then select PC CONTROLLED TRANSFER.

Manual ASCII Transfer

This allows data to be transferred in ASCII format. See the section below for the sub-menus under this option.

Erase Data Set

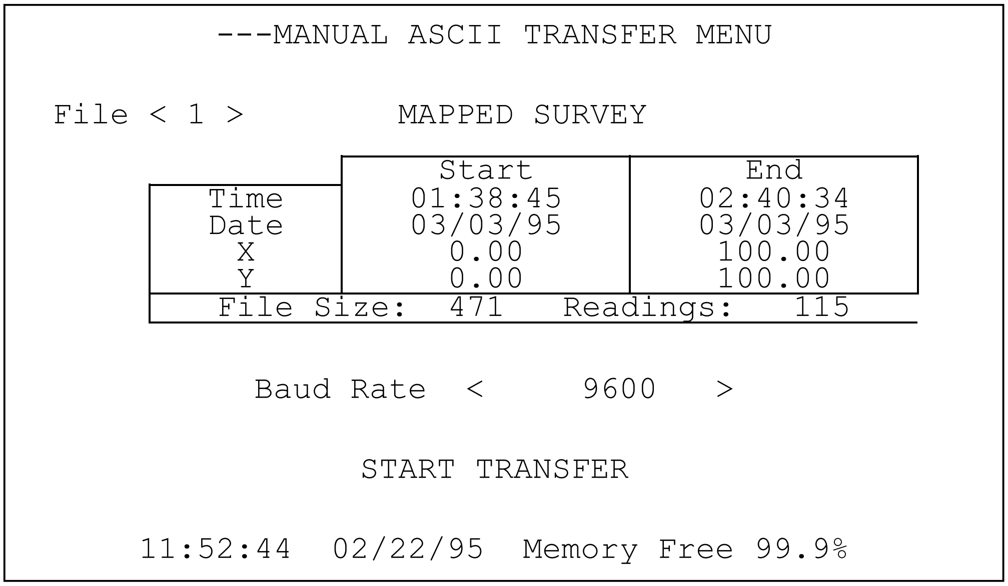
This allows a particular data set (file) to be erased. See the section below for details.

PC Controlled Transfer

Select this option, then run the MagMap2000 software. There, under the Import item of the main menu, you will find options for downloading data. See chapter 11 for more details on running MagMap2000.

Manual ASCII Transfer

Selecting Manual ASCII TRANSFER will bring up the following menu

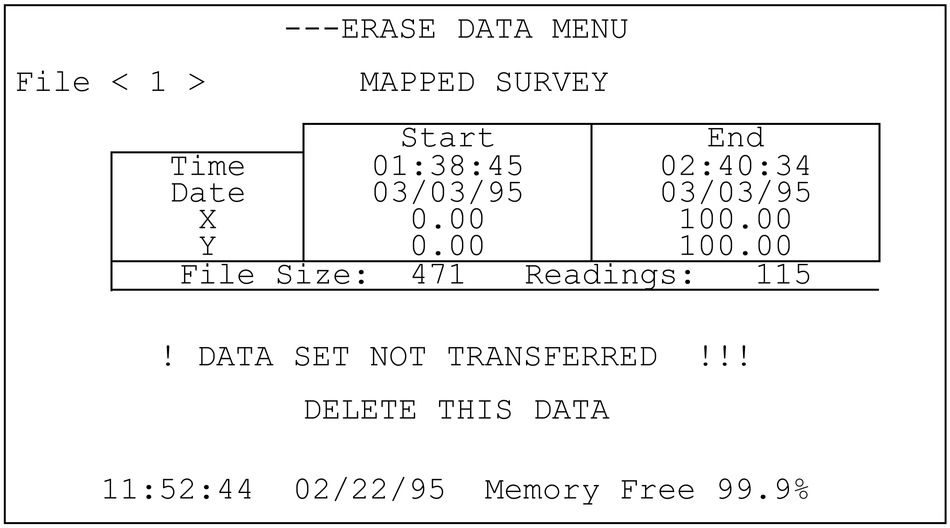


```
          ---MANUAL ASCII TRANSFER MENU

  File < 1 >        MAPPED SURVEY

                    Start         End
          Time     01:38:45     02:40:34
          Date     03/03/95     03/03/95
           X         0.00        100.00
           Y         0.00        100.00
           File Size:  471   Readings:   115

            Baud Rate  <     9600   >

                  START TRANSFER

       11:52:44  02/22/95  Memory Free 99.9%
```

You may scroll through the file numbers to the desired data set. Select the baud rate. Next, you must set up your communications program on your PC. When you highlight START TRANSFER and press Enter, data will be sent out the serial port.

Erasing a Data Set

Selecting ERASE DATA SET will bring up the following menu



```
                ---ERASE DATA MENU

File < 1 >          MAPPED SURVEY

                         Start           End
             Time       01:38:45       02:40:34
             Date       03/03/95       03/03/95
              X           0.00          100.00
              Y           0.00          100.00
               File Size:  471   Readings:   115

        ! DATA SET NOT TRANSFERRED  !!!

                 DELETE THIS DATA

     11:52:44  02/22/95  Memory Free 99.9%
```

Scroll to the desired file number. Select DELETE THIS DATA. You will be prompted with a dialog box before the file is actually erased. You will not be able to recover any file that you have deleted. Notice the warning message on the menu above for file numbers that have not been transferred. If you have transferred data from this file, this message will not be shown.

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Chapter 8: GPS

Overview

The OHMMAPPER may be used to simultaneously acquire GPS positions while it is acquiring magnetic data. In addition, the OHMMAPPER may be programmed to send commands to the GPS receiver when certain keys are pressed. All communication with the GPS takes place through the RS232 port.

This capability is only available on G-858 MagMapper and OhmMapper consoles manufactured after June 15, 1999 which use the multiport processor board. Since the OhmMapper data stream is acquired by the data mapper through the RS232 port, there must be multiple RS232 ports to support simultaneous OhmMapper and GPS data acquisition.

The COM1 RS232 port of the OHMMAPPER is extremely versatile. That feature, and the fact that setting up RS232 communication in general is often confusing, means that you will need to carefully study this section and experiment to get your external equipment to work with the OHMMAPPER.

Before connecting your GPS to the OHMMAPPER, please make sure you completely understand how to operate the GPS system. GPS receivers will send data out in many formats, and you must know what commands will tell it to give you the data you wish. You may then program the OHMMAPPER to send these commands to the GPS receiver.

Note: Please remember that ASCII strings coming from a GPS unit take up a lot of memory space. Select the smallest data format you can for maximum data collection time. With a GPS unit sending a data string every 1 second in NMEA GGA format, for example, and the OHMMAPPER set to collect 10 readings per second, the memory will be full after about 3.5 hours.

Collecting GPS data

The OhmMapper sends its data to COM1. GPS data can only be collected if the OhmMapper console has the multi-port CPU board installed. The GPS data can be sent to ports 2, 3, or 4 but not port 1 since that would conflict with OhmMapper serial data. You will probably want to set the unit to store GPS data only when in the acquire mode. This means it will store GPS data only when data is being stored. Therefore, between lines or within PAUSE mode, no GPS data will be stored. This will save memory, and typically you will not be interested in GPS data during those times.

The next step is to program the commands needed by the GPS unit into the OHMMAPPER. This is done by selecting EXT RS232 & FIELD NOTE SETUP from the main System Setup menu. If you are using the Trimble AG132 GPS contact Geometrics for setup details.

You will need to connect the GPS to the OHMMAPPER console using the proper serial cable. Most GPS units will require a null-modem adapter between the supplied RS232 cable for the OHMMAPPER and the GPS port. Contact Geometrics for the availability of a cable specially designed for connecting directly to a GPS system.

Once the GPS system is connected, you will need to actually send it the commands you have previously programmed into the OHMMAPPER. This is most easily done in the CHAT MODE of the EXT RS232 & FIELD NOTE SETUP. Select CHAT MODE, then press the desired keys to send the associated command. You will be able to observe the response of the GPS system from within chat mode. Make sure it is operating properly.

Now you are ready to log GPS data. Start your desired survey as usual. You willl notice a bar indicator which when moving indicates that data is coming in on the RS232 port.

Using GPS data

The GPS data stored during a survey is stored along with the readings and other positioning data. You may extract this data manually, and use it to adjust the positions given from within MagMap2000, or use the optional GPS analysis package available from Geometrics. Please check with Geometrics for the availability of this package.

In the OhmMapper Test mode you will see both OhmMapper data and GPS data displayed as it is acquired through their respective COM ports.

To manually extract the GPS positions from the file, perform the following procedure. First, download the binary file using the MagMap2000 program. If you wish, you can also do any other MagMap2000 function, such as locating the data or doing a diurnal correction. Remember the name of the binary file (.BIN extension) you used as the output file name when downloading the OHMMAPPER data (Import / Download). Exit the MagMap2000 program.

From the DOS prompt run the following program:

```
BINTOASC input.bin output.gps -R0 -M0 -D0 -P0 -U0 -F0
```

where

input is the name of the file containing the binary downloaded data (you must type the .BIN extension

output is the filename you wish for the GPS data (you must give it an extension. The GPS extension is a suggestion, however, you may use what you wish.)

-R0 ... The options tell the program not to extract everything except the RS-232 serial strings. They are a dash, a letter, and the numeral zero.

You will now have created a file of the GPS strings, along with some OHMMAPPER formatting information. Lines will be as shown below:

21 *DATA_STRING* Date Time

Example (Line is broken only to fit on page. It is actually a single line in the file.)

```
21 $GPGGA,175748.00,3726.0363,N,12210.0318,W,0,6,001.1, 00024.6,M,-028.4,M,031,0000*6C 10:59:14.80 06/01/95
```

The 21 at the beginning of the line indicates this string came in the RS232 port of the OHMMAPPER. The string is followed by a date and time stamp from the OHMMAPPER. This may be used to correlate the positions with the data readings, which are also time stamped.

Note: The BINTOASC program has many other options useful for the advanced user. Type BINTOASC at the DOS prompt for a listing of the other options.

Setup of COM2 Serial Tap Cable for GPS data collection.

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Chapter 9: System Setup

Selecting SYSTEM SETUP from the main menu brings up the following menu.

```
                 SYSTEM SETUP MENU

                       AUDIO

                    DATE & TIME

                  COM PORT SETUP

          COM AND FIELD NOTE STRING SETUP

                  OHMMAPPER TEST

     COM port time out:        [1.0        ]s
     Store serial data:        <  WHEN ACQUIRE  >
     Store serial data in:     < ACQUIRE MODE >
     QC warning level:         [ 60.000   ] %
     Graphic Display of:       < Field 1  >
```

Audio
This allows you to set several parameters relating to the volumes and frequencies of the various audible tones. See below for more details.

Date & Time
Selecting this will allow you to set the date and time.

Com Port Setup

This allows you to set the board rate of the 4 com ports available on the multi-port version of the OhmMapper. COM1 is the OhmMapper port and must be set to 1200 baud. COM2, COM3, and COM4 will be set to the baud rate of the device from which data is to be acquired.

Com & Field Note String Setup
This allows you to define ASCII text strings to be either sent out the serial port or stored as field notes. Sending strings out the serial port is useful for controlling a GPS system. Field notes are useful to mark any desired event.

Each string is associated with a particular key press. During a survey, pressing the key will cause the associated string to be either stored as a field note, or sent out the RS232 port as a command.

OhmMapper Test
This screen allows the operator to view the state of the OhmMapper data as it is sent to the G-858 console. It can be used both as a troubleshoot tool and as a way to verify that the console is acquiring data. The screen display of the OhmMapper is as follows:

```
--------------------------------RECEIVE-------------------------------
PHASE A
PHASE B
PHASE C
PHASE D
                         2.107,124,120,26
                         2.203,120,129,26
                         2.900,123,122,26
```

The PHASE messages indicate that the console is receiving digital data from the receiver but has not yet locked on to the phase of the transmitter signal. The numbers are as follows:

First number (for example 2.107) = value in 10's of microvolts per mA of transmitter current.

The second and third numbers indicate an estimation of receiver and transmitter battery voltage respectively. For example in the first numeric line above, "124" indicates a receiver battery voltage of 12.4 Volts, and "120" is an estimation of transmitter battery voltage of 12.0 Volts.

The fourth number consists of two digits. The first digit indicates the detected transmitter current, and the second digit indicates the receiver gain. The current digit is a binary indication from 0 to 7 representing current settings of 16, 8, 4, 2, 1, 0.5, 0.25, 0.125 mA where 0 indicates a current of 16 mA and 7 indicates a current of 0.125 mA. This number should be the same as the binary code being flashed by the transmitter. For example, if the transmitter green light is flashing long-short-long (101) this is binary 5 and the current digit in the OhmMapper Test should also be 5. The gain digit indicates receiver gain as a power of 4. For example, gain level 0 indicates a gain of 1, level 2 indicates gain of 16 (i.e. 4^2), gain level 3 indicates gain of 64 (i.e. 4^3), etc. For example the value 26 in the last number indicates a transmitter current of 4 mA (current level 2) and a gain of 4,096 (gain level 6).

COM1 port:
This is fixed as a Geometrics Module Logger in the OhmMapper.

COM1 Port time out

This sets the time before a warning is sent indicating that no data has been received on the communication port.

Store Serial Data
In the OhmMapper this is fixed at "When Acquire" meaning the data is stored as it is acquired.

> **Warning:** Data will never be stored if the unit is displaying a menu, the map, or the data review profiles.

QC Warning Level
This sets the level above which the QC will cause a warning tone to be sounded.

Graphic display of :

In the OhmMapper TR1 this should be set to FIELD1 because there is only one channel of data being acquired. In the OhmMapper TR2 is can be either set to FIELD1 to display the data being acquired by receiver 1 or to FIELD2 to display the data being acquired by receiver 2.

Audio Setup

There are several audible indicators on the OhmMapper. Selecting AUDIO will bring up the following menu

```
                 AUDIO SETUP MENU

        Master Volume                     <  4  >
        Metronome Volume                  <  4  >
        Metronome cadence (Beeps/min)     [  60 ]
        Woowee volume                     <  4  >
        Woowee sensitivity                <  4  >
        Warning volume                    <  4  >
        QC warning volume                 <  4  >
        Mark/line key event volume        <  4  >
```

Master Volume

This field adjusts the level of all the sounds. 0 is the quietest, 9 the loudest.

Metronome Volume

This adjust the volume of the metronome. This metronome may be set to help you maintain a steady pace when surveying a site. 0 is the quietest, 9 the loudest.

Metronome cadence

This adjust the frequency of the metronome pace.

Woowee volume

The "woowee' is the audible indicator of field strength. It is particularly helpful when searching for targets in Search Mode. This sound is active only in continuous survey mode.

Woowee sensitivity

The frequency of the woowee noise changes with changing field strength. This number represents the amount of frequency change per increment in field strength. If the field is fairly smoothly varying, set this to a higher number. For fields with large variations, set to a smaller number.

Warning volume

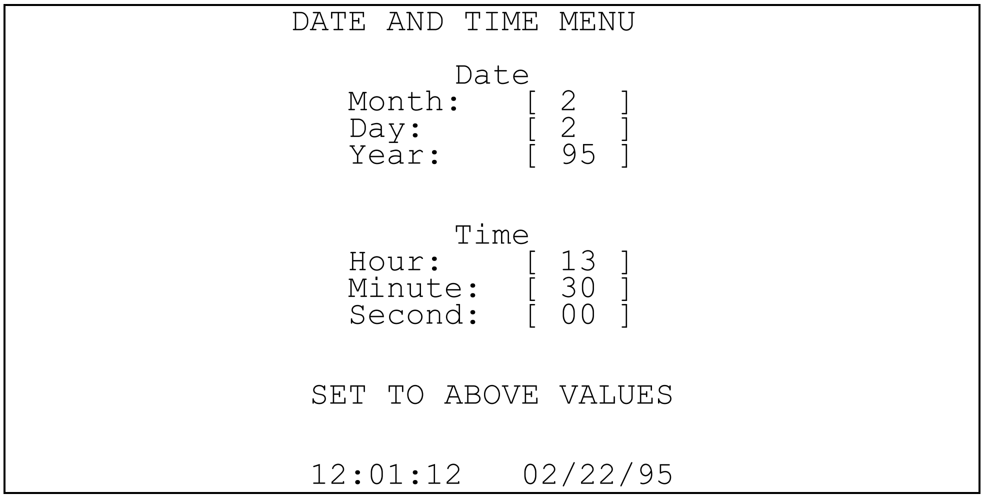
This sets the volume for warning tones.

QC warning volume

This sets the volume of the QC warning tone.

Mark/line key event volume
This sets the volume of the key click noise when you press a position key

Setting the Date and Time
Selecting DATE & TIME form the System Setup Menu will bring up the following display.

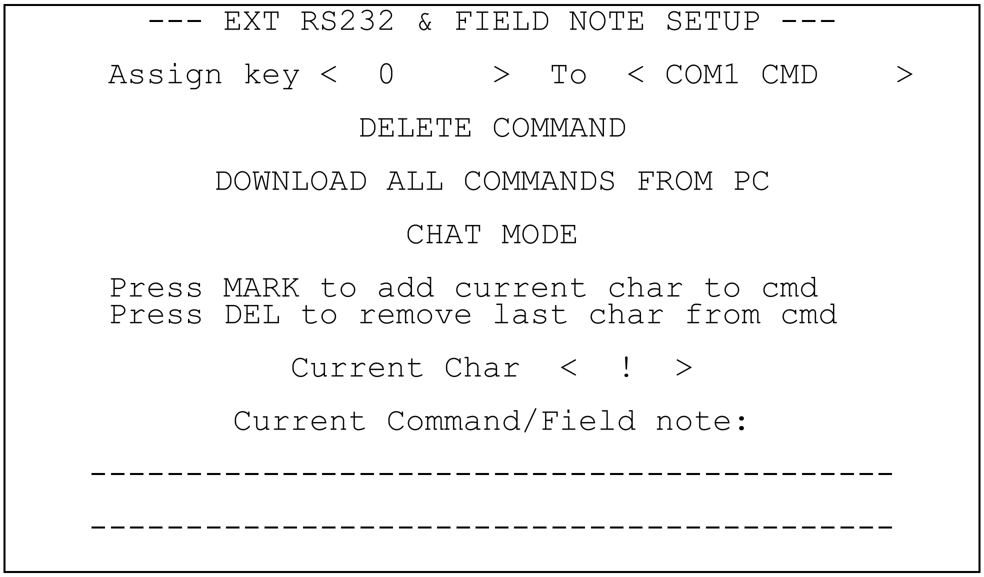


```
               DATE AND TIME MENU

                    Date
               Month:    [ 2  ]
               Day:      [ 2  ]
               Year:     [ 95 ]


                    Time
               Hour:     [ 13 ]
               Minute:   [ 30 ]
               Second:   [ 00 ]


                SET TO ABOVE VALUES


                12:01:12   02/22/95
```

Date and Time Menu.

Enter the correct values in the numeric entry fields. Don't forget to press Enter after entering the value. Then highlight SET TO ABOVE VALUES and press Enter.

External RS232 and Field Note Setup
Selecting this item will bring up the following menu:



```
    --- EXT RS232 & FIELD NOTE SETUP ---

Assign key <  0     >  To  < COM1 CMD    >

              DELETE COMMAND

     DOWNLOAD ALL COMMANDS FROM PC

                CHAT MODE

Press MARK to add current char to cmd
Press DEL to remove last char from cmd

         Current Char  <  !  >

       Current Command/Field note:

 ------------------------------------------

 ------------------------------------------
```

Assign Key Field
This scroll list sets which key press is associated with the ASCII string.

Function Field
This scroll list sets up the key as either a RS232 Command or a Field Note. RS232 commands are sent out the serial port, while field notes are stored in the internal memory.

Delete Command
Pressing ENTER on this field will delete the entire command from memory.

Download all commands from PC
You may download an ASCII file from your PC to set up the entire set of commands. This is strongly recommended, since entering them from the scroll list below is very tedious. See the section below on how to set up and transfer a file of commands from your PC.

Chat Mode
This will enable you to observe the ASCII text coming from whatever device is connected to the serial port. The OhmMapper test will display data in the Chat Mode Window. The format of the display is the same as described in OHMAPPER TEST above.

Current Character
You may scroll through this list to the desired character to add to the present command. Pressing the MARK key will add it to the end of the command. As a handy shortcut, you may press any numeric key to add a numeric character. There is no way to insert characters in the middle of the command. This manner of entering a command is so tedious, we recommend using it only if you forgot to download a needed command when you were near a PC.

How to Download Commands from the PC
Use your favorite ASCII text editor (DOS Edit or Windows Notepad are easy and readily available) to create a file as shown below:

```
G858CMD,00,$PASHS,NME,SAT,A,ON
G858CMD,01,$PASHS,SPD,B,2
G858CMD,02,$PASHS,RTC,REM,B
G858CMD,03,$PASHS,RTC,BAS,A
G858CMD,04,$PASHS,RTC,TYP,9,1
G858CMD,05,$PASHS,NME,GGA,A,ON
G858TXT,06,Fell into a hole
G858TXT,07,Dropped the magnetometer
G858END
```

The first six lines set up RS232 commands. The keyword G-858CMD determines this. The second field, the two digit number, specifies which key the command or note is associated with. The numbers 00 through 09 correspond to the number keys on the console. The other keys are as shown below:

10	MARK	15	CHART
11	LINE	16	MAP
12	PAUSE	17	ENTER
13	ESC	18	POWER
14	MENU		

Note: The ASCII commands or field notes will only be active during the one of the active modes of operation. These are the Ready state, Acquire state, and Pause state, as explained on page 53.

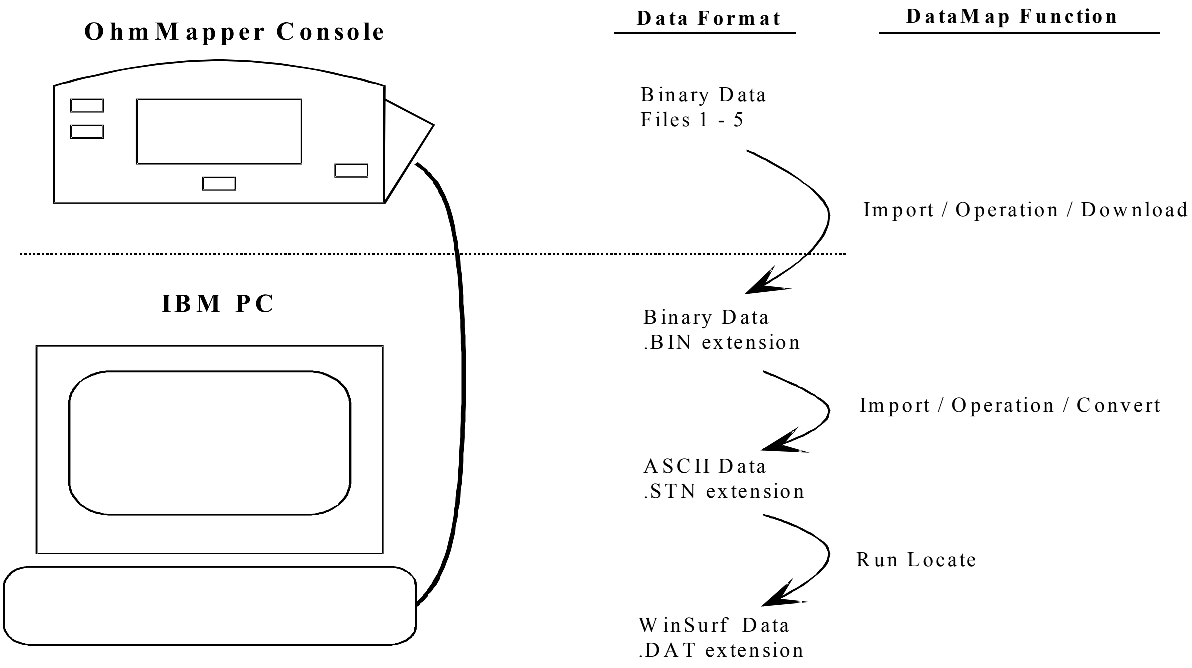
Each key also retains its normal function. For example, if the MARK key is assigned to an RS232 command, pressing it will still perform the normal MARK key function. This is useful, for example, if you wanted to store a GPS reading only at each MARK location. Then, you would program the MARK key with the command to query the GPS for the current position. In doing this, you would probably also want to program the END LINE key with the same command. Then, you will get a GPS confirmation at each fiducial point.

Chapter 10: MagMap2000 for OhmMapper Software

For a detailed discussion of the MagMap2000 software please refer to the separate MagMap2000 OhmMapper User's Manual. The software program provides the OhmMapper user with data downloading and editing capability. Acquired data is downloaded via high speed RS-232 communications link and then manipulated to generate or edit X-Y position information. The resulting data grid is graphically displayed on the PC screen as a Quality Control measure and to assure coherence between the original acquisition parameters and the final locations. Output files are produced for gridding, contouring and plotting which are compatible with Surfer for Windows (*.DAT) or Geosoft (*.XYZ). Editing functions include shifting lines, changing the direction of lines, appending or cutting lines, and deleting or inserting segments of lines or entire lines. Vertical and horizontal (longitudinal and transverse) gravimeter data is supported.

Program Flow Overview

The operation of the MagMap2000 program is intuitive and controlled by a straightforward menu system. The data processing flow diagram below is provided for reference in the following discussions and will assist the user in understanding each processing step of the procedure. Select G-858 as the device after selecting IMPORT in MagMap2000.



Data Flow for the MagMap2000 program

Downloading Data from the OHMMAPPER
The time, position and measured data are stored in the OhmMapper in one of 5 files numbered 1 through 5. The data are stored in a compressed binary format for maximum use of the available RAM. While the user may select ASCII download via RS-232 with a program of his choosing (i.e. Procom), this can take up to 20 times longer than downloading the compressed binary file with the MagMap2000 Import program and is not recommended. MagMap2000 Import provides an "Autospeed" function that will make RS-232 connections at up to 115 KBaud on compatible systems.

PC File Formats
The transmitted binary data is stored in a binary file with the extension .BIN on your PC. This file requires about 100 KBytes of hard disk storage per hour of data collection (at 10 readings per second). An intermediate file is necessary for the MagMap2000 program to operate on this data. The binary data is converted into ASCII format and stored in an ASCII file with the extension .STN. This file is readable by an ASCII text editing program such as a spreadsheet, but most editing functions can be accomplished with the MagMap2000 program. These files may be very large, typically 1MB per hour of data collection.

Accurately Positioning Data
After conversion, MagMap2000 Locator is used. This program will interpolate readings between known position points called "marks". You have great latitude in defining how the survey data was acquired and in editing the individual positions of the readings. During the location process, the user may perform several corrections to the data including rescaling and offsetting.

Finally, after positioning the data, MagMap2000 will write an ASCII file suitable for input to a 3D surface plotting program, such as Surfer for Windows™ or Geosoft™. Such files consist of x and y coordinates, field values, difference between values (in the case of two-channel data), and time and date for each reading. <u>These files are typically about 3 MB per hour of data collected.</u>

To save disk space we recommend that you delete the intermediate ASCII data file (the one with the .STN file type extension) after location. It can always be regenerated from the original binary .BIN file.

Requirements
The OHMMAPPER can collect an enormous amount of data. Even modest size surveys will require large computer resources in terms of RAM and hard disk space. You will need a minimum of 4 MB of RAM installed on your computer, and up to 15 MB of free disk space which will be required for a working swap file. The amount of hard disk space actually depends on the amount of RAM you have. The program requires about 13 MB of either RAM or hard disk space to run, so the installation procedure will set aside

enough hard disk swap file space for this, depending upon how much RAM it finds on your computer.

For serious survey work, we recommend a fast 486 or Pentium computer, with 16 MB of RAM and about 100 MB of free disk space for your files. At a minimum, you will need a 386-based computer. However, the programs will take a very long time to run on a 386.

This program will not run under MS-Windows. Also, no other DOS Protected Mode Interface (DPMI) program should be operating such as QEMM's QDPMI Host Services provider. If you experience difficulties on startup, check your Config.sys file and place a "rem" statement before any DPMI device driver statement.

Frequently asked MagMap2000 questions:

A. What is the meaning of Peak Threasold and Maximum Spike readings in the Despike Setup:

If you look at the raw data by right clicking on the green background of the survey-line screen you can select PLOT OHMMAPPER READINGS. This will show you all the raw data in uV/mA (vertical axis) against time (horizontal axis). Because of the high data rate and the fact you are moving while sampling you can have spikes in the data. The Despike filter is a very narrow running average filter. If you select Maximum Spike Readings of 1 for example, it does a running average of three points, the point in the center and two on the sides. If you select 2 the average is 4 points, the two points and one on each side. Three would be a 5 point average, etc. The Peak Threshold is the amplitude of the variation of the single point from the average. If you have it set to 1 and 1 it will filter single point that spike out from the average by more than 1uV/mA and replace it with the average. If you decrease the Peak Threshold to 0.2, for example, the threshold will be more sensitive and filter spikes of 0.2 uV/mA.

B. What is the OhmMapper data format?

Below is an example of an OhmMapper data file. The format is as follows for the first few lines:

Line 1: 99 = start of file, 1 = mapped survey, 0 = no GPS data

Line 2: 3 = position information, 70.00 = x position, 0.00 = y position, then time and date, 0 = number of readings, 7 = line number, 0 = mark number, 5 = status

Line 3: 33 = field note, GOHM = OhmMapper Geometry, 3.50 = operator offset, 5.00 = receiver dipole, 40.00 rope length, 5 = transmitter dipole, then time and date

Line 4: 0 = OhmMapper data reading, 0.726 = receiver 1 reading in Ohm-meters, 0.000 = receiver 2 reading in Ohm-meters, time and date, status

```
99 1 0
3       70.00       0.00 19:16:15.80 05/21/00   0  7     0   5
33  GOHM      3.50      5.00      40.00      5.00 19:16:15.80 05/21/00
0      0.726      0.000 19:16:15.50 05/21/00   0
0      0.728      0.000 19:16:15.00 05/21/00   0
0      0.735      0.000 19:16:14.50 05/21/00   0
0      0.782      0.000 19:16:14.00 05/21/00   0
0      0.727      0.000 19:16:13.50 05/21/00   0
0      0.683      0.000 19:16:13.00 05/21/00   0
3       70.00      20.00 19:15:52.80 05/21/00  46   7     1   4
0      0.558      0.000 19:15:46.00 05/21/00   0
0      0.592      0.000 19:15:45.50 05/21/00   0
0      0.628      0.000 19:15:45.00 05/21/00   0
0      0.615      0.000 19:15:44.50 05/21/00   0
0      0.615      0.000 19:15:44.00 05/21/00   0
0      0.597      0.000 19:15:43.50 05/21/00   0
0      0.579      0.000 19:15:43.00 05/21/00   0
3       70.00      40.00 19:15:29.40 05/21/00   47    7    2   4
0      0.195      0.000 19:15:29.00 05/21/00   0
0      0.204      0.000 19:15:28.50 05/21/00   0
0      0.214      0.000 19:15:28.00 05/21/00   0
0      0.358      0.000 19:15:14.00 05/21/00   0
0      0.572      0.000 19:15:08.50 05/21/00   0
0      0.591      0.000 19:15:08.00 05/21/00   0
0      0.606      0.000 19:15:07.50 05/21/00   0
3       70.00      60.00 19:15:07.10 05/21/00    44  7     3   4
0      0.599      0.000 19:15:07.00 05/21/00   0
0      0.599      0.000 19:15:06.50 05/21/00   0
0      0.572      0.000 19:15:06.00 05/21/00   0
0      0.545      0.000 19:15:05.50 05/21/00   0
0      0.518      0.000 19:15:05.00 05/21/00   0
0      0.464      0.000 19:15:04.50 05/21/00   0
0      0.391      0.000 19:15:04.00 05/21/00   0
0      0.448      0.000 19:15:03.50 05/21/00   0
0      0.438      0.000 19:15:03.00 05/21/00   0
3        0.00       0.00 18:25:20.40 05/21/00    44  0      0  38
```

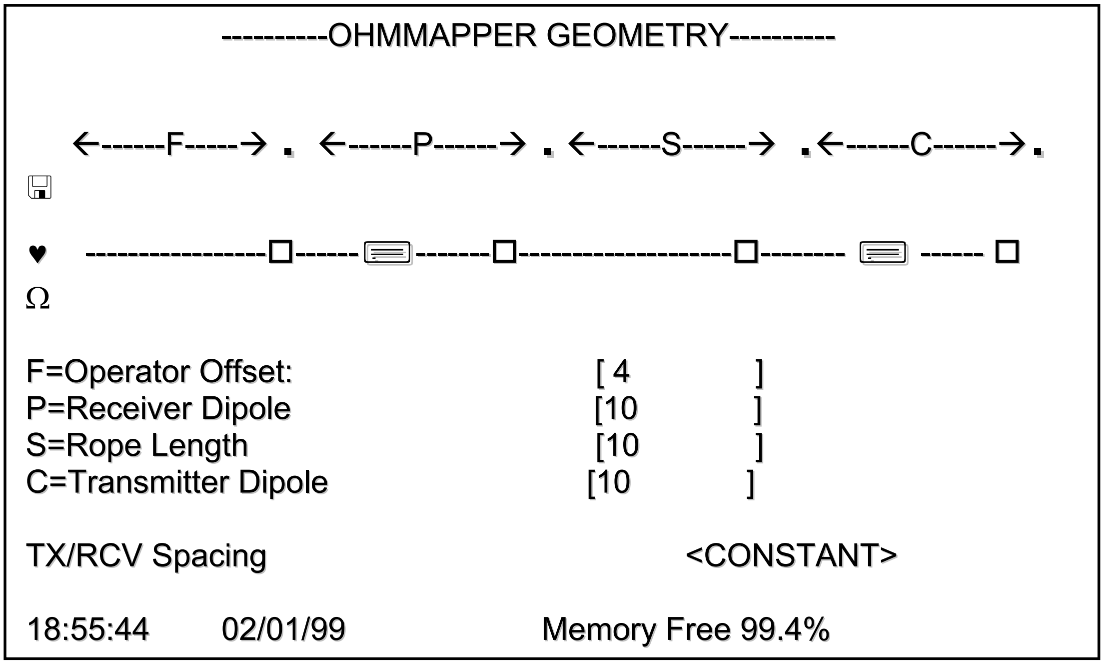
For details of the MagMap2000 (MagMap2000) software please refer to the OhmMapper's MagMap2000 Manual

Chapter 11: OhmMapper Geometry

Purpose of OhmMapper Geometry

In order to properly determine the position of the data, as opposed to the position of the operator when data is taken, the MagMap2000 software must know the geometry of the OhmMapper array. This information is also used to calculate the "N-factor" used both for pseudosections and to export to third-party inversion software programs.

Screen Display



```
----------OHMMAPPER GEOMETRY----------

  ←------F-----→ .  ←------P------→ . ←------S------→  .←------C------→.
🖫
♥   ----------------□------▤-------□-------------------□-------- ▤ ------ □
Ω

F=Operator Offset:                    [ 4         ]
P=Receiver Dipole                     [10         ]
S=Rope Length                         [10         ]
C=Transmitter Dipole                 [10         ]

TX/RCV Spacing                                   <CONSTANT>

18:55:44      02/01/99              Memory Free 99.4%
```

As is explained in the screen itself, F is the distance from the operator to the beginning of the receiver dipole, P is the length of the receiver (potential) dipole, S is the separation between the end of the Rx dipole and the beginning of the Tx dipole, and C is the length of the transmitter (current) dipole.

TX/RCV Spacing

If a "VARIABLE" spacing is selected the OhmMapper Geometry screen is displayed at the end of each line when the "END LINE" button is pushed. This allows the operators to change the transmitter/receiver separation before beginning the line once more or doing another line. If "CONSTANT" is selected the OhmMapper Geometry is not displayed at the end of each line. The CONSTANT entry will normally be selected if the operator plans to do multiple lines at a single transmitter-receiver separation. If "CONSTANT" has been selected the operator will need to press the ESC key to exit to the main menu to change the OhMapper geometry.

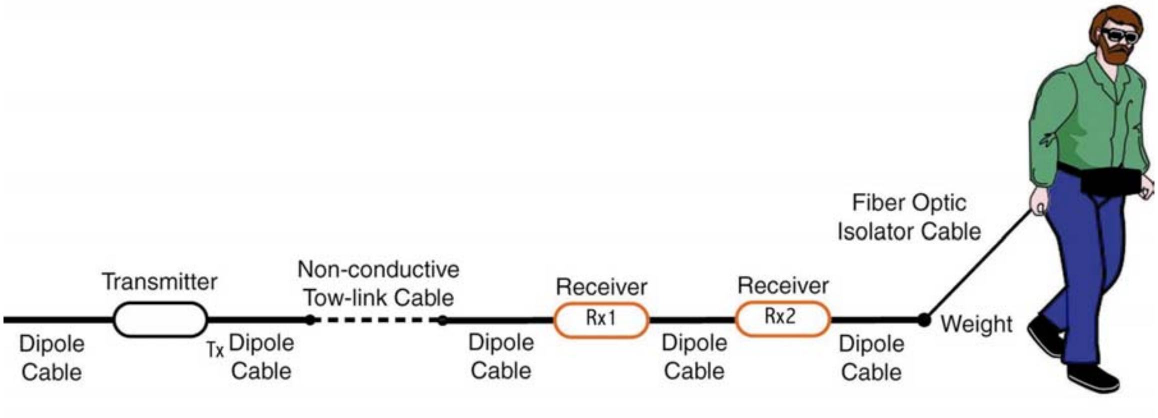
"VARIABLE" is selected in this field when the operator plans to do several passes on a single line (or multiple lines) using different separations for different passes. This permits the operator to change geometries without leaving the survey mode.

Chapter 12: OhmMapper TR2 and OhmMapper TRN Operation and Tow-Vehicle Safety Release Setup.

INTRODUCTION:

The designation TRN refers to the multireceiver version of the OhmMapper. The “N” is used to indicate the number of receivers used. For example an OhmMapper TR4 has four receivers and an OhmMapper TR5 has five receivers. The maximum number of receivers possible for a TRN is five. The use of the TRN version of the OhmMapper allows data acquisition of data for up to five receivers simultaneously. This will greatly improve survey time. Each receiver shares a common dipole cable with its neighbor. This means each additional receiver is one cable length farther away from the transmitter. The the figure below for details.

The operation of the OhmMapper TR2 is nearly identical with that of the OhmMapper TR1 with the exception that there are two receivers in the OhmMapper TR2 array, as opposed to a single receiver in the OhmMapper TR1. However with more then two receivers there are some additional changes in the setup. For this reason we will first discuss the OhmMapper TR2 configuration then all other configurations (TR3, TR4, and TR5).



The dual-receiver OhmMapper TR2 can also be used as a standard single-receiver OhmMapper TR1 as described in the standard OhmMapper TR1 Operator’s Manual. Either receiver can be used..

PRINCIPLE OF OPERATION:

In the TRN configuration receiver Rx1 (closest to the transmitter) is the master for data communication and all other receivers (Rx2 in the diagram above) are the slaves. Rx1 will lock on to the transmitter signal and determine the transmitter current. The current information, along with its data, is sent from Rx1 toRx2 through the common dipole cable. Rx2 will detect that Rx1 is connected and sending it data. It will then use the current level detected by Rx1 and not try to determine the current independently. It then sends both the data from Rx1 and its own Rx2 data to the next receiver in the array, or to the G-858 logging console if it is the receiver nearest to the console.

SURVEY SETUP:

The second receiver in the TR2 array shares a common electrode with the first receiver in the array. Thus the separation of the second receiver to the transmitter is one cable length (half an N-space) greater than the first receiver in the array as follows:

Receiver #2 Receiver #1 separation Transmitter

2.5m 2.5m 2.5m 5m 2.5m 2.5m
_________Rx2_________Rx1________------------------________Tx______
dipole cable---dipole cable---dipole cable------rope-----dipole cable--dipole cable

In the example above each dipole cable is 2.5 m long. Therefore the total receiver dipole length for each receiver and for the transmitter is 5 meters. If the rope length (separation between dipoles) is 5 m, the N-space for Rx1 is 1n and for Rx2 is 1.5n.

In this example if the rope length were increased to 10 meters the n-space for Rx1 is 2n and for Rx2 it is 2.5n. Therefore by first walking up the profile line with a rope length of 5 meter and back down the line, along the profile, with a separation of 10 meters an equivalent of 4 passes with n-space of 1, 1.5, 2, and 2.5 will be made.

Take special note that the second receiver is always one cable length (half-N) greater than Rx1. In the TR2 configuration there are two receivers and three receiver dipole cables in the array as shown in the diagram above. In a TR4, for example, with 2.5m cables and a 5 meter rope lengths Rx1 would be at 5 meters separation from the transmitter, Rx2 at 7.5m, Rx3 at 10m, and Rx4 at 12.5m. If the rope were increased to 15m then Rx1 would be at 15m separation, Rx2 at 17.5m, Rx3 at 20m, and Rx4 at 22.5m.

GRAPHIC DATA DISPLAY ON G-858 CONSOLE

The data display during data acquisition can be set to either show receiver #1 or receiver #2. This is controlled in the SETUP menu by scrolling down to GRAPHIC DISPLAY OF, and selecting either FIELD1 or FIELD2. Selecting FIELD1 will cause data from receiver #1 to be displayed in the graphic window, and selecting FIELD2 will display data from receiver #2.

OHMAPPER TEST

See the OhmMapper TR1 Operation Manual, Chapter 9: System Setup, OhmMapper Test for a detailed description of the numbers displayed in the OhmMapper Test. When using both receivers in the TR2 mode the OhmMapper Test screen will display normalized voltages, receiver battery voltage, transmitter battery voltage, transmitter current level, and receiver gain as sent from both receivers. The first set of numbers in the string corresponds to those of Rx1 (nearest the transmitter) and the second set of numbers are from Rx2 (nearest the operator). If, for example, a TR4 is being used the data from all receivers are displayed on the screen in the order of Rx1, Rx2, Rx3, then Rx4.

SPECIAL CONSIDERATIONS FOR THE TR3, TR4, AND TR5

G-858 Console Setup: In order to accommodate more than two receivers the "CONFIGURATION" menu must be set to store all the serial string. After turning on the G-858 console and selecting OhmMapper go to "SYSTEM SETUP" and select "CONFIGURE". Use the up/down arrow keys to go to the first field in the menu. If the field does not say "STORE ENTIRE STING AS SERIAL" use the left/right arrow keys to select "STORE ENTIRE STRING AS SERIAL". The menu can be exited by pressing the ESC key.

If you are using a TR3, TR4, or TR5 and "CONFIGURE" is not set to "STORE ENTIRE STRING AS SERIAL" none of the data from receivers TR3, TR4, and TR5 will be stored and will never be able to be recover or used.

Processing in MagMap2000: After a TRN (either TR3, TR4, or TR5) data file has been download to MagMap2000 it must be converted to an ASCII file that recognizes multiple receivers. This is done in the following manner in MagMag2000.

1) First use MagMap2000 to download the OhmMapper data file from the G-858 console to your Windows computer.
2) Close the file.
3) Click on "FILE" from the MagMap2000 menu bar.
4) Select "BINARY 858->ASCII, which will convert the binary data file into a multireceiver ASCII file.
5) Select the BIN file you want to convert (Input file).
6) Give the STN file you want to create a name and path (Output file)
7) Make sure "OUTPUT ALL DATA" is not checked.
8) Click "DECOMPRESS AS OHMMAPPER TRN DATA"
9) Click "OK"
10) The STN file can now be opened and all data will be available.

This process does not need to be followed for either the TR1 or TR2 since the G-858 console will automatically format the date for up to two receivers.

SETUP OF SAFETY-TOW QUICK RELEASE (AXIAL LOAD LIMITER)

Instructions for use of the OhmMapper's Axial load limiter

This document describes the operation of an axial load limiter, designed for use with the OhmMapper when its sensor string is pulled behind a motor vehicle. When properly installed, the load limiter will prevent damage to the sensor string caused by excessive tension: the release mechanism is adjusted to release the pin when the axial load on the pin reaches 130 lb (+/- 5 lb). The load limiter comprised of a release housing, a release pin, and two cable clamps (figure 1).

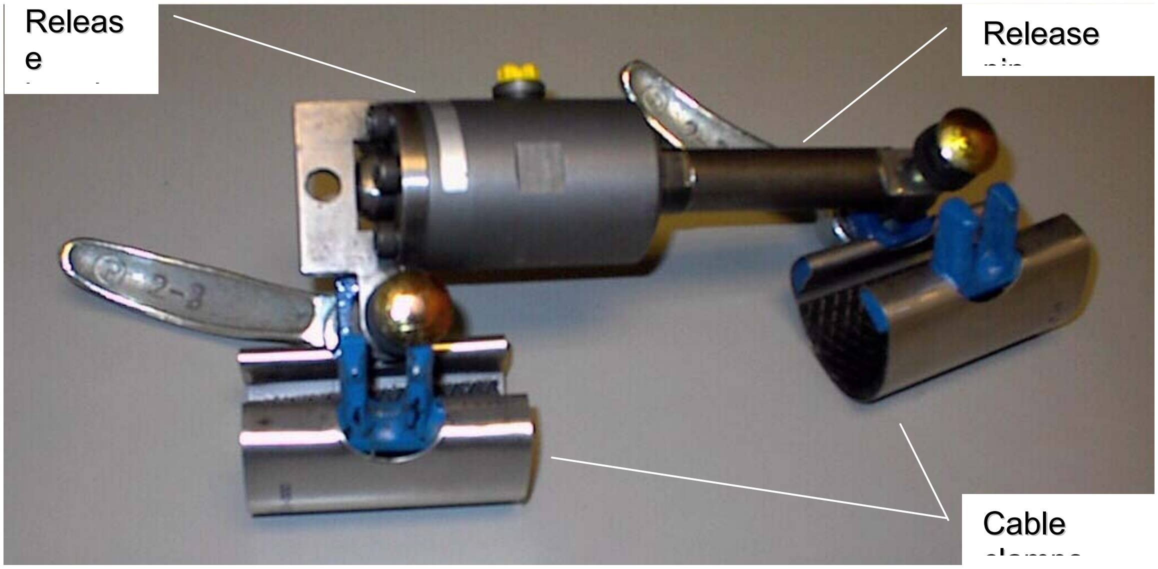


Figure 1

Begin installation of the load limiter by opening the cable clamps completely. This is done by unscrewing the clamp handle enough to allow the bolt head cap to clear the lug slot (figure 2).

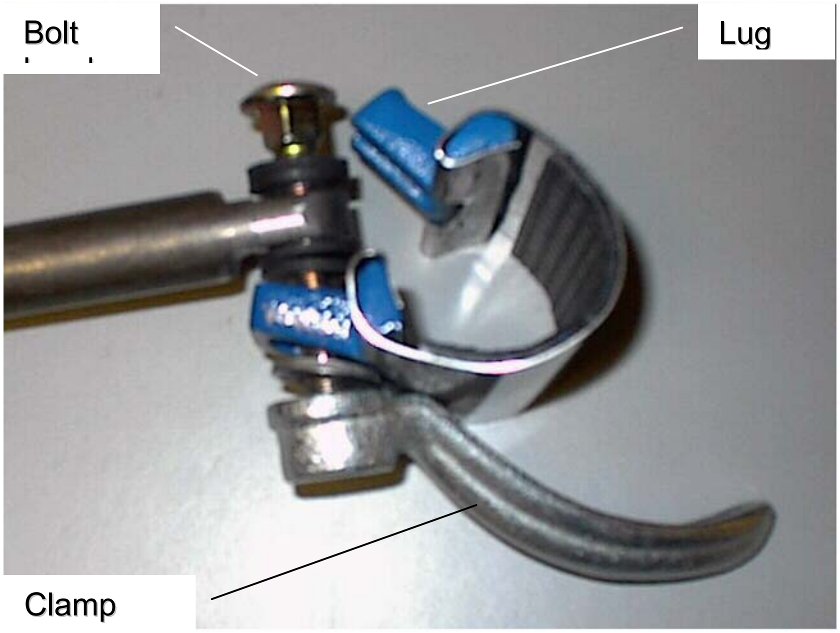


Figure 2

Install the load limiter at the junction of the tow cable and a service cable that is connected to the OhmMapper's console cable. Place the tow cable in the cable clamp on the release pin and position it so that the cable's bend limiter is flush with the edge of the clamp (figure 3).

Figure 3

Place the service cable in the cable clamp on the release housing (figure 3). The service cable is an ordinary OhmMapper dipole cable that is long enough to reach the console cable.

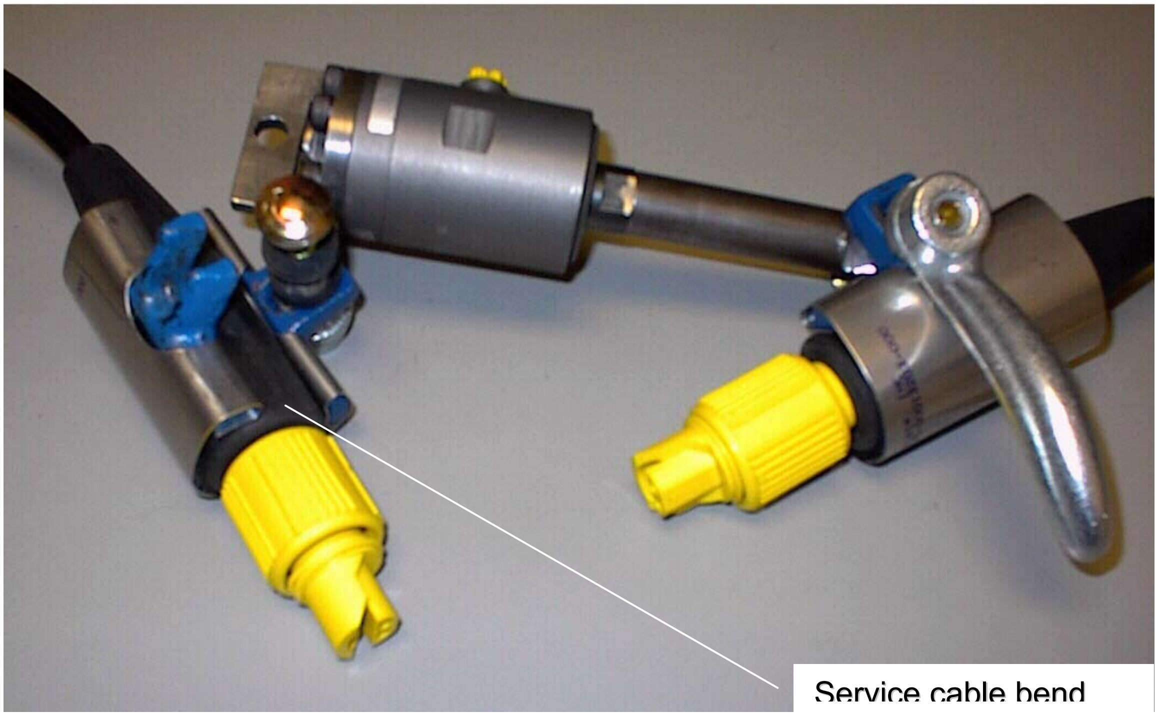


Figure 4

Mate the service and tow cables to bring the service cable's bend limiter flush with the edge of the clamp.

Figure 5

Slide the bolt head down into the clamp lug and tighten the clamp by spinning the clamp handle clockwise. The clamp is fully tightened when the clamp's jaws begin to squeeze both sets of rubber spacers against the sides of the release pin (figure 6). This will cause slight elastic deformation of the bend limiter.

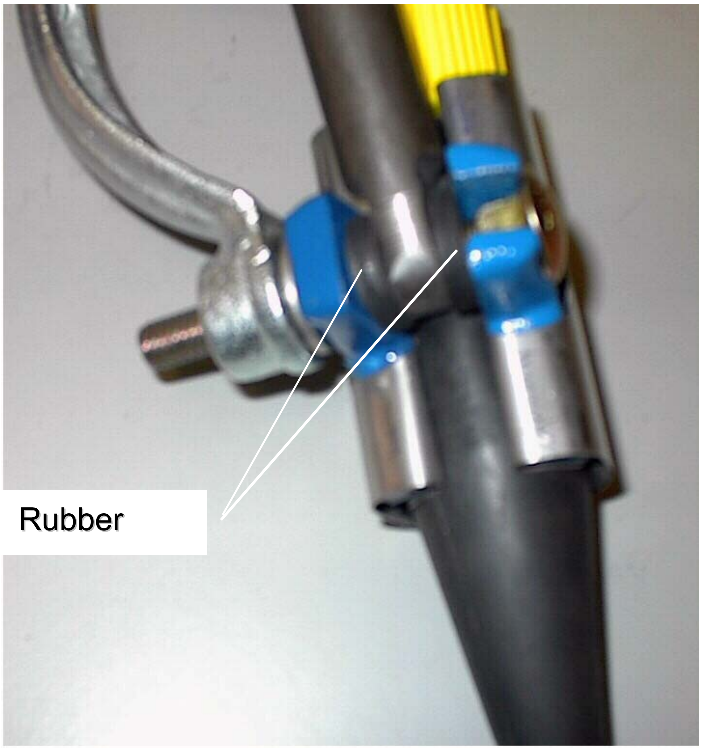


Figure 6

Tighten the cable clamp on the service cable so that the clamp begins to deform its bend limiter. Figure 7 shows the load limiter completely installed. Note at that NEITHER locking ring is attached to the opposing connector.

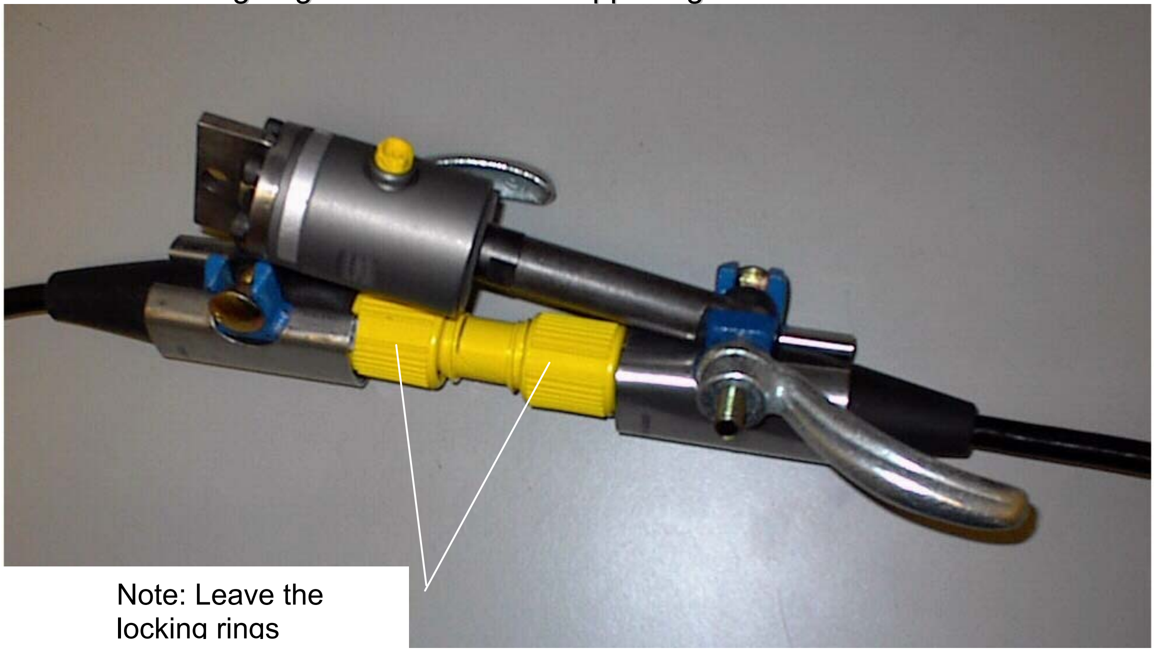


Figure 7

The load limiter is attached to the vehicle via a coupling that is passed through the hole in the bracket attached to the release housing. Take care that the coupling is short enough to keep the load limiter and service cable from dragging on the ground.

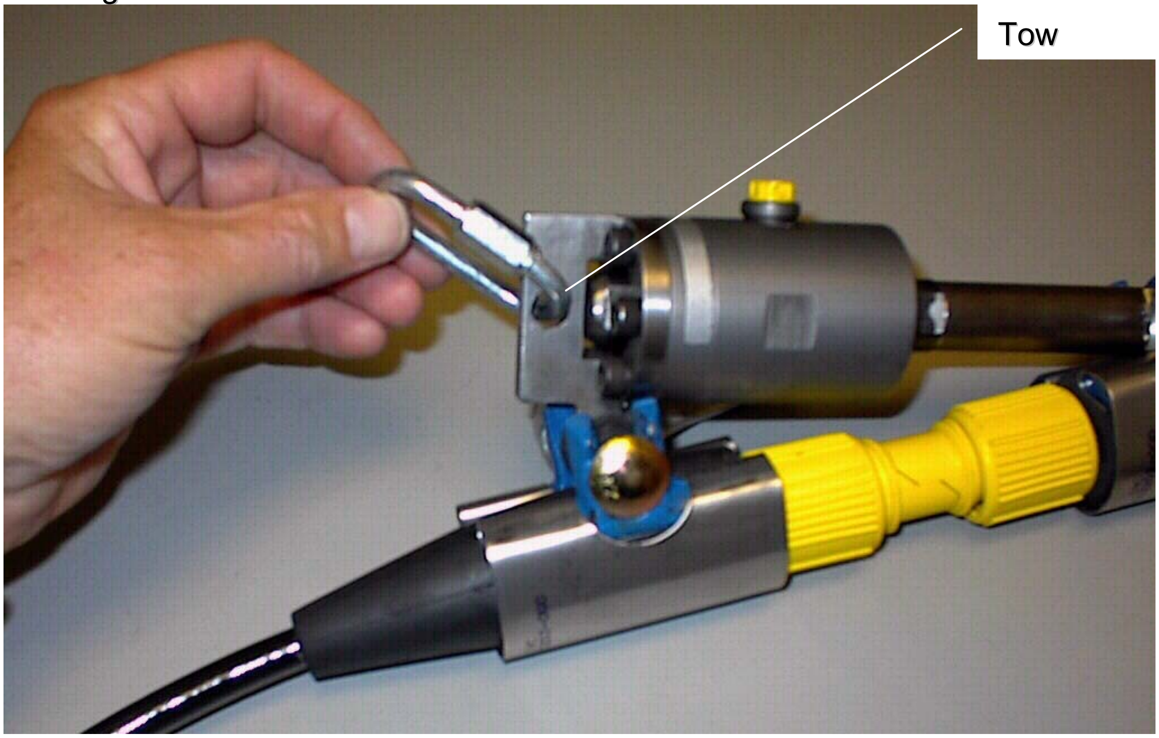


Figure 8

The release pin will separate form the release housing it the axial load on the mechanism exceeds its release setting. Should this happen the tow cable will also separate form the service cable, data transmission will stop, and the OhmMapper console will indicate a fault. You will need to reattach the release pin and reconnect the cables before data collection can continue. In order to reconnect the release pin do the following: 1) remove its cable clamp from the tow cable; 2: wipe off the free end of the release pin; 3) insert the pin into the opening in the release housing; 4) strike the very end of the release pin with a hammer to drive it into the housing (figure 9); 5) continue tapping on the pin until it reemerges from the other end of the housing. Proceed as be for to reconnect the cables and clamp the tow cable to the release pin. It is important to remember that the locking rings should not be connected in order to allow the cables to separate if the resistivity array is snagged and the quick-release separates.

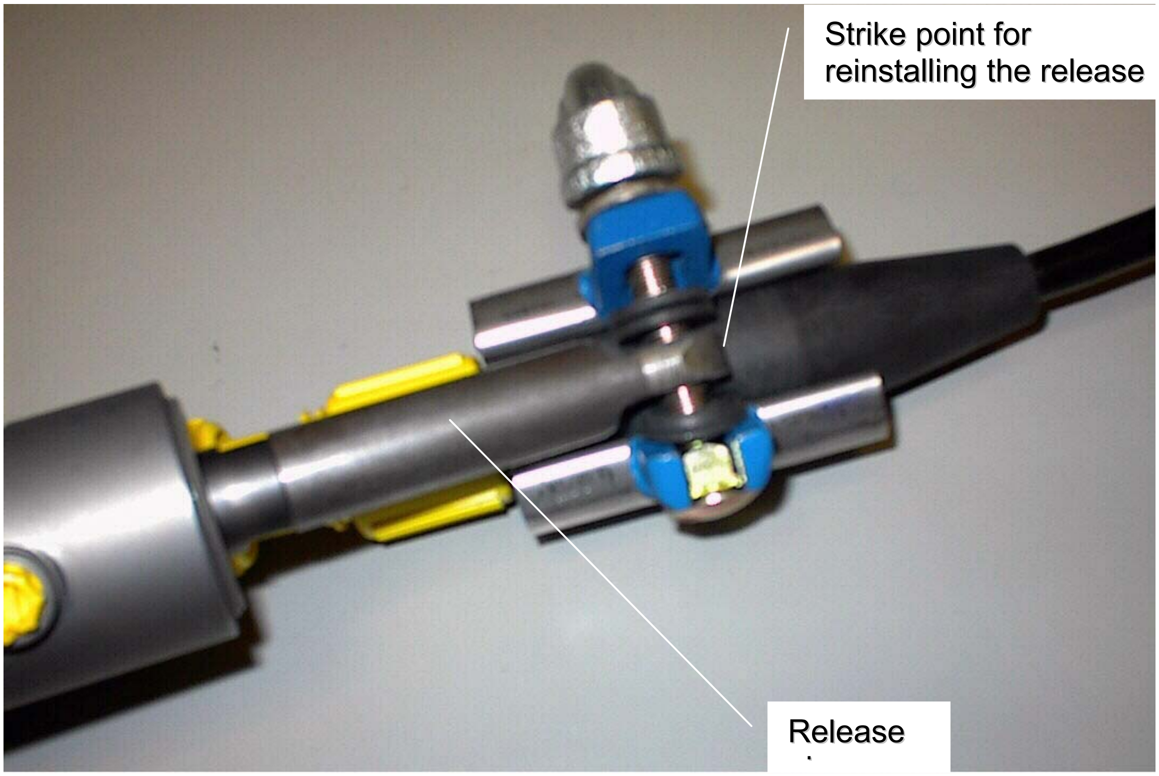
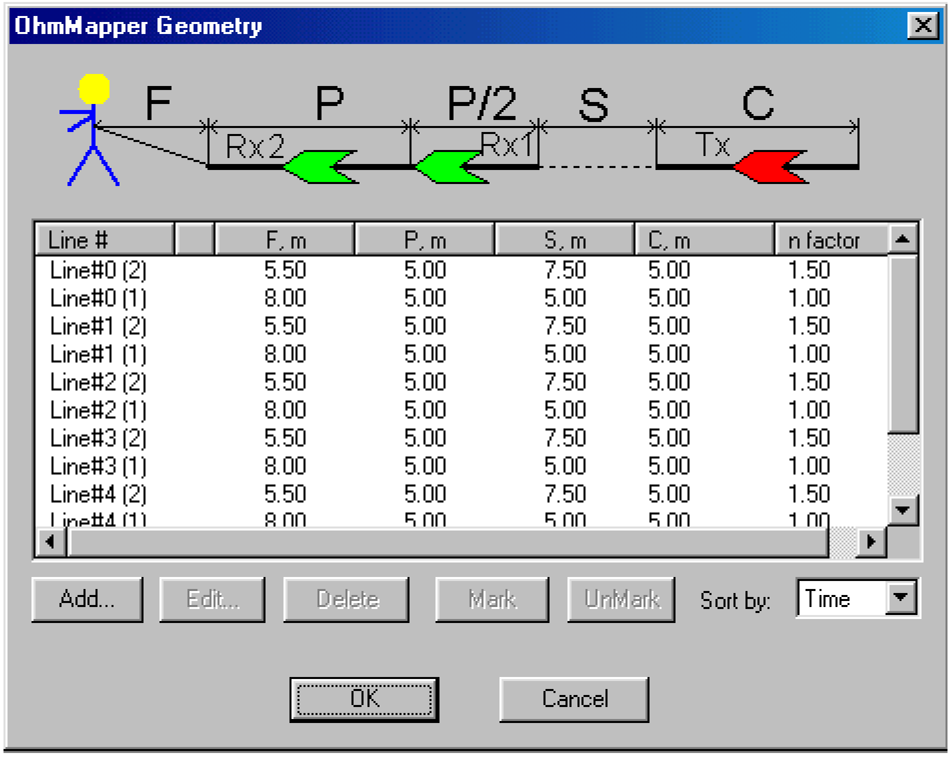


Figure 9

TREATMENT OF TR2 DATA IN MAGMAP2000

Once OhmMapper data files have been downloaded from the G-858 console to MagMap2000 all the data positioning, processing, and contouring capabilities described in the *MagMap2000 OhmMapper User's Guide* are applicable. The following changes will be noted when the data file contains data from two receivers:

EM Geometry: The table of array geometries shows two receivers for each pass. Receiver #2 is nearest the operator and receiver #1 is nearest the transmitter. This is shown in the EM Geometry table below.



Line #	F, m	P, m	S, m	C, m	n factor
Line#0 (2)	5.50	5.00	7.50	5.00	1.50
Line#0 (1)	8.00	5.00	5.00	5.00	1.00
Line#1 (2)	5.50	5.00	7.50	5.00	1.50
Line#1 (1)	8.00	5.00	5.00	5.00	1.00
Line#2 (2)	5.50	5.00	7.50	5.00	1.50
Line#2 (1)	8.00	5.00	5.00	5.00	1.00
Line#3 (2)	5.50	5.00	7.50	5.00	1.50
Line#3 (1)	8.00	5.00	5.00	5.00	1.00
Line#4 (2)	5.50	5.00	7.50	5.00	1.50
Line#4 (1)	8.00	5.00	5.00	5.00	1.00

Sort by: Time

Creation of Planview Map: Planview maps are created in the same manner as with the TR1. Right click the mouse in the operator position map and select PLOT RESISTIVITY MAP. Simply mark all the lines that you desire for example select LINE#0(2), LINE#1(2), LINE#2(2), and LINE#3(2) for a planview map using only receiver #2 for lines 0, 1, 2, and 3.

Creation of a pseudosection: A pseudosection made from TR2 data is done in the same way as from TR1 data. After right clicking and selecting PSEUDOSECTION you can click on INSPECT LINES to verify that both receivers have been marked to use in the section.

Viewing raw data (uV/mA) in MagMap2000

To see the raw voltage amplitudes (normalized by current) place the mouse arrow on the olive-green background of the operator position map. Right click and select PLOT OHMMAPPER READINGS. You will see a graphic display of the raw data with microVolts per milliamp on the vertical axis, and time on the horizontal axis. To see data from both receivers put the mouse arrow on the light-blue background of the OhmMapper Readings screen and right click. Select PLOT SENSOR SETUP. Hold down the CTRL key and right click to highlight the sensor(s) you want displayed. Sensor 1 means Rx1 and Sensor 2 means Rx2.

Chapter 13: Fundamental and Operational Theory

Resistivity Theory

The fundamental theory of resistivity measurement is based on Ohm's Law, which states that R = V/I (resistance = voltage/current). In a more general and practical sense for geoelectrical measurements, $\rho = E/J$ where ρ is resistivity, E is electric field, and J = current density. This is Ohm's Law in its differential vectorial form. In practical terms if one can measure the electric field at a known current one can calculate the resistance of the total volume of earth between the transmitter and receiver (to the limits of the depth of detection of the transmitter signal). In order to determine the apparent resistivity measurement one must know the geometric factors of the transmitter and receiver dipole lengths as well as the distance separating the transmitter and receiver.

In traditional dipole-dipole resistivity a depth sounding is made by varying the transmitter/receiver distance as is shown below:

←-------------Tx-----------→   ←-------------Rcvr-----------→ Station 1

←-------------Tx----------→   ←-------------Rcvr-----------→
Station 2

The voltage measurement made at the receiver in Station 1 is a result of the apparent resistivity of the earth between the transmitter and receiver to a depth which is determined by the length of the Tx and Rcvr dipoles used and the separation between the transmitter and receiver. The voltage measured in Station 2 represents a reading of a greater volume of earth and corresponds to transmitter currents flowing deeper into the earth.

Capacitively-coupled resistivity

In a capacitively-coupled resistivity meter the transmitter uses the capacitance of an antenna to couple an AC signal into the ground. In the OhmMapper the antenna is a coaxial cable and the signal is approximately 16.5 kHz. The capacitance of the cable is determined primarily by the length of the cable, where a longer cable has a greater capacitance, and thus the capability to couple more current into the ground. The conductors in the cable act as one plate of a capacitor and the earth acts as the other plate, with the insulating sheath as the capacitor's insulator. Since an AC signal can pass through a capacitor the transmitter current in the transmitter cable will pass into the ground. The capacitance of the receiver cable is similarly charged, allowing the receiver electronics to measure the AC voltage at the transmitter frequency. This provides an AC equivalent of a traditional DC resistivity measurement.

Operational limits

In a capacitively-coupled resistivity meter there are certain factors the operator needs to be aware of as these can limit the performance of the instrument.

Skin-depth effects: The OhmMapper uses an approximately 16.5 kHz AC signal. In highly conductive ground the attenuation of the transmitted signal is much greater than in resistive ground. This will mean that the receiver will be able to detect the transmitter farther away in resistive ground, thus a deeper survey can be preformed.

Standing water: The correction factor for antenna length assumes a uniform current fall-off along the cable. If part of a cable is in standing water and part is not this assumption may not be true and the calculation of apparent resistivity values can be affected.

More details of Capacitively-Coupled, AC Resistivity Theory

Introduction:

Before describing the Ohmmapper, it is worthwhile to review just what an Ohm is and why you may want to map them.

In the late 1700's, when electricity was first being discovered, people knew that there was an electromotive force that tried to cause charges to move from one place to another. It caused "like charges" to repel each other and "opposite charges" to attract. Mr. Volta spent a fair amount of his time studying properties of electricity and got a unit of measure, the Volt, named after him as a result. The Volt is the unit of measure for the electromotive force. Often this is referred to as voltage or potential.

Scientists had also figured out that they could measure the rate at which the charge passed through a given point. Mr. Ampere realized that this charge would flow down a copper wire in a manner much like water flows in a pipe. He developed a device to measure this rate of flow and thus got his very own unit of measure named after him, the Amp. He may also be the person that coined the term "current" for the flow of electrical charges.

Now we come to the hero of our story, Mr. Ohm. It was only when Mr. Ohm came along that anyone succeeded in relating the electromotive force in Volts to the current in Amps. He realized that this flow of charge through a wire would not happen without causing some friction. He called this friction "resistance." After several false starts he came up with the simple formula:

$$I = E/R$$

This is the famous "Ohm's Law", which simply says that you divide the Electromotive force (measured in Volts) by the Resistance (measured in Ohms) to get the current (measured in Amps). There is a rumor that using "I" to stand for current is because it originally stood for "intensity".

People quickly saw that you could rearrange this to two other forms:

$$E = IR \quad \text{and} \quad R = E/I$$

and with this simple set of equations most of the mysteries of electricity could be explained.

It was at about this same time that people realized that if you make an iron wire that is the same dimensions as a copper wire, the iron wire will have a higher resistance. This difference in resistance is due to a property of the material. They decided to call this property "resistivity". Iron has a higher resistivity than copper.

Once folks realized that different materials have different resistivities, they figured out that this was a good way to identify materials. However, there was a problem:
If you make a copper wire twice as long, that makes the wire's resistance twice as high. The resistivity of copper has not changed. All that has changed is the shape ("geometry") of the wire. This again is much like water flowing in a pipe. If water encounters some amount of friction flowing through a mile long pipe, it will encounter twice as much friction if another mile of pipe is added on the end. Just as making a pipe bigger around lowers its friction, making a wire bigger around lowers its resistance.

If we are going to determine what material an object is made of, based on its resistivity, the first step is to find out what the resistivity of that object is. The measurement must be made to depend only on the material the object is made of. We need a measurement that does not depend on the shape of the object. For example, doubling the length of a copper wire should leave this measurement unchanged. The measurement should also not depend on where the measuring device is placed (on the object). When measurements are corrected for both the shape of the object and the placement of the measuring device, they are said to be "corrected for the geometry." When values are corrected for the geometry, they are usually expressed in Ohm-Meters.

Up to here, the discussion has centered on electric currents flowing like water in pipes. When the object having its resistivity measured is the earth, the "water in a pipe analogy" no longer works. Instead, imagine a very large flat floor with a drain hole in it. We begin pouring water onto the floor. Some of the water will take the direct route straight to the drain. Most of it, however, will take a curved path. It will spread out, curve around and come back together at the drain.

In a similar way, the electrical current that a resistivity measurement system puts into the soil follows a curved pattern. A resistivity measurement system always has two "current electrodes" that it uses to force a current to flow through the soil. The current enters the soil at one "current electrode", spreads out, curves around, and comes back together at the other "current electrode". This is happening in three dimensions: the electrical current spreads out to the left, to the right and down into the soil.

Because the soil has resistance, whenever there is a current flowing in the soil, according to Ohms Law, there must be some voltage. From the E = IR form of Ohm's Law, we know this voltage will depend on the current and the resistance. Our goal is to determine the resistance. If we knew the current and the voltage, we could use the R = E/I form of Ohm's Law to find the resistance.

We can measure the voltage in the soil if we place two more electrodes on the ground and measure the voltage between them. These electrodes are called the "potential electrodes".

If we know the positions of the "current electrodes" and the "potential electrodes", we can use this and the calculated resistance to figure out a resistivity value. This resistivity isn't the resistivity of one small chunk of the soil, but is, instead, some sort of average of a large volume of soil under the resistivity measurement system. For this reason this measured resistivity is usually called "apparent resistivity".

The soil we are measuring must not all have the same resistivity. If it did the ohmmapper would be of little practical value. The resistivity of the soils and rocks varies over a very wide range. Since the Ohmmapper measures the resistivity of the soil beneath it, a map can be made (from the data gathered while moving the Ohmmapper over the surface) that will show areas of higher and lower resistivities. Those resistivities can be used to identify geologic formations and other things of interest under the ground.

At this point, I expect some readers (who have actually seen an Ohmmapper) are wondering just how the Ohmmapper manages to put this electrical current into the soil and measure the voltage it produces without any obvious electrical connections to the soil. To explain this, we need to go back to those folks in the late 1700's.

Mr. Leyden knew that he could create an electrostatic charge by simply rubbing a glass rod with a piece of wool. To store an electrostatic charge, he invented a device now called the Leyden jar. Mr. Leyden took an ordinary glass jar and wrapped the bottom of its outside with metal and coated the inside with metal. He hung a wire from the lid into the inside of the jar. He found that this device could store a charge. It was soon discovered that larger ones would store more charge than smaller ones, if the voltages were all the same. This property of the Leyden jar is called its capacitance.

For some reason, Mr. Faraday's name got used for the unit of capacitance and the unit is called the Farad.

The modern version of Mr Leyden's invention is called a capacitor. Modern capacitors are seldom built with glass. Any nonconductive material, sandwiched between two conductors, will work.

Lest anyone think that all of these people back in the late 1700's were outright geniuses: One day Mr. Leyden decided he wanted to find out what the magic fluid he was storing in his jars tasted like. He attempted to drink from a charged Leyden jar. When his lips made contact with both the inside and the outside of the jar he got quite a shock. We know this story because he lived to tell us what he did.

In Mr. Leyden's day, no one knew that atoms have electrons. Today, we do, so we can explain what is happening. Metals are good conductors because the electrons in them are free to move around. In metals, the electrons in the outer-most orbit around an atom are so far away from their atom and so close to the neighboring atom that you can't really say any given electron belongs to any given atom. The situation is more like a sea of electrons washing around the atoms.

Electrons repel each other. If you bring some electrons near one end of a piece of metal, those electrons will repel the electrons in the metal. The electrons on the surface of the metal will be pushed in to the metal. These electrons will repel their neighbors and push them away. Those neighbors will repel the next ones and so on, all the way through the metal.

For this reason, a charge put into a capacitor on one conductor seems to come out on the other conductor. It is not actually the same electrons. It is, instead, an equal number of electrons that were repelled by their neighbors, which, in turn, were repelled by their neighbors and so on, all the way back to the ones that were repelled by the electrons on the first conductor.

If we take a capacitor and put a charge on one of the conductors, and then take it back off, the electrons on the other conductor will be repelled only during the time the charge is on the first conductor. If we alternate applying the charge and removing it, an equal charge will flow in and out of the other conductor. Therefore, an AC (alternating current) voltage applied to one conductor of a capacitor will appear on the other conductor.

This ability to cause a charge to move in and out of one conductor by applying an alternating voltage to another nearby conductor is called "Capacitive Coupling". This principle is used in two places in the Ohmmapper. The transmitter uses capacitive coupling from its electrode to the soil to cause the current to flow within the soil. The receiver detects the voltages in the soil because of the capacitive coupling from the soil to the receiver's electrodes.

At this point I need to introduce two new words. The first is "reactance". Imagine that there is an AC current flowing back and forth through a capacitor. Because the capacitor is being charged up in one direction, discharged and then charged in the other direction, there is an AC voltage on the capacitor. Here we have an AC voltage caused by an AC current so there is a strong temptation to use the R = E/I form of Ohm's Law to find a resistance. However, we can't call what we calculate a resistance, because it is an effect of the capacitance. For some reason, lost in the mists of time, it is called "reactance" and the symbol used for it is "Xc".

The 3 forms of Ohm's law can each be written using Xc:

E = IXc   I = E/Xc and Xc = E/I

The voltage produced by a current flowing through a resistance happens as the current is flowing. In the case of capacitive reactance, however, it is quite different. At the point in time when the current stops flowing in one direction and is about to start flowing in the other, the capacitor has its highest charge and hence its highest voltage. The voltage is said to lag the current, because it reaches its peak value after the current does.

A smaller valued capacitor will reach a higher voltage when storing the same charge. The charge the capacitor must store is determined not only by the amount of current charging it. It also depends on how long the current is allowed to flow into the capacitor. If the frequency of an AC current applied to a capacitor is increased, the time the current flows in any one direction will be less and so the charge put on the capacitor will be less.

By stirring these facts around with a little mathematics, we can come up with an equation to get Xc:

Xc = 1/(2.PI.F.C)

Where:

Xc	is the reactance in Ohms
PI	is the usual 3.14159... etc. thing
F	is the frequency in Hz (Cycles per second)
C	is the capacitance in Farads

"Impedance" is a general term that can be used to mean resistance or reactance or some combination of the two. For our purpose, "impedance" is used only for the combination. If only resistance is being discussed, the word "resistance" will be used.

An Ohmmapper's electrodes:

The electrodes used on the Ohmmapper look, externally, like electrical cables. Internally, they have a twisted pair of two wires of modest gauge, a nonconductive filler to pad the diameter out to the desired size and then a copper braid wrapped over the filler. Over the copper braid, a tough outer insulation is placed. It is this copper braid that acts as the electrode for the ohmmapper. The capacitive coupling from the copper braid to the soil couples the transmitter's current from its electrodes to the soil. The voltage on the soil is capacitively coupled into the braid on the receiver's electrodes.

In the traditional, or galvanic, soil resistivity measurement system, the electrodes are conductive rods that are driven into the soil. These electrodes are often called "point electrodes" because they only make contact to the soil at a single point.

The electrodes of the Ohmmapper are quite different. They capacitively couple to the soil over their entire length. For this reason they are called "line electrodes".

The explanation of why the transmitter's current couples into the soil evenly along its entire length, requires the following facts:

> The resistance of the copper braid in the electrode cable is very low.
>
> The diameter of the copper braid in the electrode cable is held very near constant by the manufacturing process.
>
> Even with small changes in the height of the electrode above the soil, the capacitance per meter of electrode is nearly constant down its length.
>
> The voltage required to cause the transmitter's current to pass through the capacitive reactance from the electrode to the soil is much larger than the voltage required to cause the current to flow within the resistance of the soil.

Given all of the above, it is the capacitive reactance from the electrode to the ground and the AC voltage on the electrode that control the current flowing into the ground. We know that the capacitance per unit length is very nearly constant down the length of the electrode. From this we know that the capacitive reactance per unit length must also be nearly constant. Since the resistance of the copper braid is very low, from the

$$E = IR$$

form of Ohms law, we know that the transmitter's current flowing down the electrode cable will produce very little difference in voltage from one end of the electrode cable to the other. Since the current flowing in to the soil is determined by two values that are very nearly the same at all points down the cable, it is logical that the "current per unit length" must also be very nearly the same at all points down the cable.

The receiver's electrodes receive a voltage that is the average of the voltages on the soil they are over. To explain why this is true, one more fact must be added to the above points.

> The receiver does not take any current away from its electrode cable. Any AC current that capacitively couples into the cable at one point along its length must capacitively couple out of the cable at another point along its length. The AC current coupling Out of the cable will only match the AC current coupling In to the cable if the AC voltage On the cable is equal to the average of the AC voltage on the soil it is over.

The Ohmmapper transmitter:

The Ohmmapper's transmitter causes an AC current to flow in the ground. Because the only path for the AC current from one electrode to the other is via the soil, the transmitter can determine the current it is producing in the soil by measuring the current flowing into one of the electrodes. Using this measurement, the transmitter can quickly adjust its output voltage until some desired amount of current is produced.

The output of the transmitter is an AC current of 0.125, 0.25, 0.5, 1, 2, 4, 8, or 16mA. This current is very tightly regulated, (1%) so that the receiver only needs to know which range the transmitter is on. The transmitter automatically selects the correct range for the electrodes used and the soil conditions.

The transmitter encodes the current range onto the AC signal used for the measurement. It also encodes a 2Hz signal onto the AC signal. The encoded 2Hz signal is used by the receiver to get in step with the transmitter. It also serves as a reference frequency for the decoding of the current setting.

The operation of the power output stage is monitored. If the voltage required to cause the specified current gets close to the limit of the system, the transmitter will switch to the next lower current setting at the next 0.5 second increment. This places the change in current such that the receiver's cycle will start right at the change. In this way the transmitter can, change currents without causing an error in the receiver. The output stage is also checked to see if it is running at less than 1/3rd of its full power. If it is the power will be increased to the next higher setting.

The transmitter output is a good sinewave. Internally it is created by what is called a "class D" power amplifier. This allows us to have good efficiency while transmitting a sinewave. The natural output impedance of the transmitter power stage is high. This prevents short term changes in the output current. The actual transmitted current is measured by a current sensing circuit and this is used as a feedback to regulate the current. This gives an output impedance well above 10M Ohms.

The transmitter can produce output voltages of up to 1000VRMS and currents of up to 16mA, but not at the same time. The output power never exceeds 2 Watts.

The Ohmmapper receiver:

The input to the receiver has an impedance of greater than 10M Ohms at the operating frequency. This high impedance is required to prevent any current from flowing from the electrode into the receiver. At other frequencies its input impedance is lower. This was done to reduce the effects of cultural noise such as the 50 or 60Hz mains frequencies.

The difference in voltage between the two electrodes is filtered and amplified. The filters only pass a band of frequencies about 25Hz wide. These filters are tuned to the transmitter's frequency. There is an automatic fine tuning system that matches the filter exactly to the transmitter's frequency. The amplifiers gain can selected by the processor in the receiver. The gain can be set to multiply the signal by 1, 4, 16, 64, 256, 1024, 4096 or 8192.

The gain of 1 allows the system to work with a 2V AC signal. In most environments the 256, 1024 or 4096 gain is used. The processor selects the gain that makes the signal going into the analog to digital converter as large as possible without risking exceeding the range of the converter.

The ADC is more than "20 times over sampled". This means that it measures the AC voltage much more often than is needed to accurately measure the amplitude of the received signal. The over sampling allows many more ADC readings to be used for each output number. This greatly improves the ability of the system to pick signals out of the noise. The samples are digitally filtered to give an overall system band width of about 4Hz. This means that noise at frequencies more than 2Hz either way away from the transmitter's frequency are strongly rejected.

The receiver knows that it is in fact measuring the transmitted signal when it can detect the 2Hz and 4Hz modulation the transmitter places on the signal. The receiver phase locks its self to the transmitter's 2Hz so that 2 receivers measuring the same transmitted signal will run in exact lock step. This means that two receivers could be used with no electrical connection between them. The 4Hz modulation is used to indicate the current setting of the transmitter. In this way we do not need an electrical connection to the transmitter.

At power on the receiver does the following:

1 Say "Ver 1_0"
2 Adjust the gain
3 Say "Set gain"
4 Take 1/2 seconds worth of data
5 If the gain needs readjusting, restart from step (2)
6 Say "Phase A"
7 Take 1/2 seconds worth of data
8 Say "Phase B"
9 If the gain needs readjusting, restart from step (2)
10 Use all of the data so far to look for the transmitter
11 If we are not confident about the phase go to (4)

The receiver will stay in this part of the code and produce the "Phase A" and "Phase B" messages until it finds what it believes is the transmitter. It then does two more checks to make sure it really has a good solid lock on the signal from the transmitter. During this time it will say "Phase C" and "Phase D". After this it should begin to produce readings.

When running the receiver does the following:

12 Measure for 1/2 second

13 Determine if the gain needs to change
14 Find the phase of the 4Hz to determine the current
15 Find the phase of the 2Hz and trim the timing
16 If the transmitter's signal is gone go to (2)
17 Calculate the voltage that 1mA would have made
18 Send the results
19 Go to 12

Any gain change called for by any given cycle will not be applied until after the next reading. This means that it would take 8 seconds to step through all 8 of the gains.

Data is sent electrically out of the receiver and along the electrode cable.

Cables and stuff:

We are using a shielded cable with a strength member built into it and a cable jacket that takes wear well. The cables are a wear item. The receiver and transmitter electrodes are the same type of cable. A 2 meter electrode can be made by simply plugging 2 one meter electrodes together.

The electronics bottles have an expendable plastic cover. This cover is held in place by the leading connector and the bottle.

The transmitter is only powered on when complete cables are connected. This means that the terminating plugs must be on the end of the electrodes before it will transmit, thus the 1000VRMS is never on an exposed surface.

Understanding "skin depth":

The "skin depth" effect places a limit on how far into the soil the Ohmmapper can see. In order to understand what causes this effect we need to introduce a few more of the things discovered by those clever folks back in the late 1700s.

It had been discovered that, whenever an electric current flows it creates a magnetic field. People first noticed the effect when they placed a compasses near a wires. Every time they sent a current through the wires the needles of the compasses moved. If they turned off the current the needle went back to pointing north like compasses normally do. If they reversed the direction the current flowed the compass needle was deflected in the other direction. The magnetic field created by the current is always at right angles to the direction the current is flowing.

A man by the name of Mr Faraday discovered an effect we today call "Faraday induction". Mr. Faraday discovered that if he swept a magnet past a wire, it produced a voltage in the wire. The faster he moved magnet the higher the voltage he produced. If he swept the magnet past in the other direction the direction of the voltage also reversed.

A person by the name of Mr. Lens put the fact that electric currents create magnetic fields and Mr. Faraday's observations together. Mr. Lens thought to himself "When the current flowing in a wire is changed, the magnetic field around the wire will be changed. This changing magnetic field will induce a voltage in the wire." Experiments showed that changing the current in a wire did indeed cause a voltage to appear on the wire. The direction of the induced voltage was always such that it worked against any attempt to change the current. Today this is referred to as "Lens's Law". The tendency of a change in current to create a voltage is referred to as inductance. The unit of measure for inductance is the Henry.

Much like in the case of capacitive reactance, we have a voltage being caused by an AC current. In this case the effect is called inductive reactance and given the symbol "Xl". Unlike the case of the capacitor, the more rapidly the current changes back and forth the higher the voltage that will be produced. Xl can be calculated with the equation:

Xl = 2.PI.F.L

Where:

Xl	is the reactance in Ohms
PI	is the usual 3.14159... etc. thing
F	is the frequency in Hz (Cycles per second)
L	is the inductance in Henrys

As you may expect inductive reactance has its own form of Ohm's law.

E = IXl I = E/Xl and Xl = E/I

The Ohmmapper causes an AC current to flow in the soil. This current will cause a small voltage to be produced. From Len's law we know that this AC voltage will try to prevent the AC current from flowing.

Lens's law is not too hard to picture in the simple case of a wire. The AC current flowing in the soil is spread out through the soil, so it is a bit more complicated. The magnetic field created by an AC current flowing in one part of the soil will spread out through the soil and create voltages in other parts of the soil. The current that is flowing in the very top of the soil creates a voltage that tends to block the current from flowing in deeper parts of the soil.

In very resistive soils, the voltage created by any given current flowing in the resistance of the soil will be large compared to the voltage caused by the inductance of the soil. For this reason, the skin effect is not a problem in very resistive soils.

If the soil is not very resistive, the voltage created by the inductance can be large enough that it reduces the current flowing deep in the soil and crowds more of the current up near the surface.

Many people at this point will want to ask the question "Don't these voltages caused by the inductance offset the reading of the Ohmmapper?" The answer is, yes, but by a lot less than you might expect.

It is important to remember that the voltage caused by the inductance and the voltage caused by the resistance are out of step with each other. The voltage due to the resistance is produced when the current flows. The voltage due to the inductance is produced when the current changes. Its peak actually happens at the instant the current has stopped and is reversing directions.

There is a method to calculate the sum of two voltages that are out of step in this way. To add the two voltages you square each of them, add the squares together and then square root the sum. Proving this is the correct procedure is left as an exercise for the reader (ie: I'm too lazy to do it now so just trust me).

If we try a couple of examples, it should be obvious why the voltage due to the inductance is less of a problem than may be expected. Take the case where the voltage due to the inductance is 20% of the voltage due to the resistance. To make the math easy we can assume the voltage due to the resistance is just 1V. First we must square the two numbers. The square of 1 is 1. The square of 0.2 is 0.04. We add to get 1.04 and then square root to get 1.02. What at first looks like a major of 20% in fact only changes the reading by 2%.

In the real world, the voltage due to the inductance will never be as much as half of the voltage due to the resistance, but even for this extreme case the effect is not very large. One squared is one. A half squared is 0.25. The square root of 1.25 is 1.12 so even in this extreme example the error is only 12%. In practice, the receiver and transmitter would have to be so far apart that the receiver would not be able to detect the transmitter in order to get proportions as bad as these.

Chapter 14: Some Troubleshooting Hints

PROBLEM: No signal detected at console: If the blue light is blinking on the receiver (Rx) it has detected and phase locked onto the transmitter (Tx) signal. If you are not seeing anything on the OhmMapper Test screen the problem is somewhere in the communication link between the output of the receiver and the input of the logger. This could be in any of the components but I it is less likely the problem is the receiver itself. Lets try to troubleshoot the source.

1. The receiver: It is possible to have a failure in the receiver communication circuitry, but not likely. Generally if the Rx works (it can power up and detect the Tx signal) the communication from the Rx also works. The most common cause of an error here happens in the lab when testing the OhmMapper and simply turning the Rx chassis around backwards. That is, plugging the optical wand into the flat end of the Rx instead of the pointed end.

Solve this by making sure the front (pointed) end of the Rx is talking to the console, not the flat end.

2. Bad dipole cable: (Shorted or open dipole cable either on the pointy, front, end of the Rx or used as the tow cable.) The digital data is sent up to the console on the center conductor of the dipole cable. If there is a short on the center conductor it doesn't cause any problem on the transmitter because the center conductor is shorted anyway by the shorting plugs and there is no digital signal for the Tx in any case. If the bad cable is used on the back end of the Rx it will still function because the center conductor is not used since the voltage measurement is made on the coax shield, not the center wire. You will only see the problem if the shorted (or open) conductor is in the communication path.

Troubleshoot this by swapping the suspect cables with others to see if the problem goes away. If it does you can usually use the cable on the transmitter but not on the front of the receiver.

You can also see if a bad dipole cable is the problem simply by eliminating the cable in the path. Plug the RCVR end of the optical wand directly into the pointy end of the Rx and the CNSL end directly into the orange connector on the console cable. If you get communication the problem was a bad dipole cable.

3. Optical wand: The optical wand must be oriented properly. The RCV end must go to the receiver and the CONSL end must go to the console. This is because there is an electrical-to-optical converter at one end and an optical-to-electrical converter at the other end and they must be correctly oriented to work.

The optical wand can develop a light leak which interferes with the optical data transmission. If the problem only occurs in the bright sunlight, but not in the shade this is the problem. Try to cover the wand with a dark cloth to see if the problem goes away. If so it has a leak and must be replaced. It is also possible one of the converters in the wand is either broken or not getting power from the console.

4. Console cable: There is a converter in the console cable that amplifies the output of the optical-to-electrical converter in the wand to a pseudo-RS232 signal level to be read by the console. If the converter is not getting power or is broken it won't work. This could be caused by a bad connection where the power cable from the battery belt connects to the console cable power connector or by a bad connection to the orange connector on the console cable. The loss of communication may be from a bad connection where the RS232 connector on the console cable connects to the console. If there is a problem in the console cable it must be replaced or repaired.

5. Bad RS232 COM1 port in the logging console. This problem is unlikely with the OhmMapper but, of course, it could happen.

6. The BAUD rate setting is changed in the console software. The baud rate for COM PORT 1 must be set at 1200 baud. If not it won't log OhmMapper data. Go to SYSTEM SETUP, COM PORT SETUP, COM1 BAUD RATE should be set to 1200.

If there is not communication between the receiver and the G-858 console the most likely problem is either a bad dipole cable, bad wand, or bad console cable.

Appendix 1: Surveying Principles

This section outlines the principles of performing a OhmMapper survey. It covers setting up and performing the survey and locating items of interest within anomalies.

Guidelines for Small OhmMapper Surveys

The general comments below cover only the site layout and preparations for a survey. The survey objectives, determination of parameters for the instrument data collection and the actual data processing and map preparation are covered elsewhere.

In order to accomplish a successful ground survey, each element of data acquisition, path over the ground from which the data are recorded, and processing of the data into map form, must be handled in a precise and accurate manner. Each element is completely interdependent upon the others and if one is compromised in quality or accuracy then all are compromised. During a survey, possibilities for error are numerous and great care and concentration are required to avoid mistakes, some of which may be so serious as to require starting the survey over. The focus should be toward completing the survey completely error-free.

Typically, the most difficult surveys are those involving detection of small targets and the presentation of an accurate contour map. In these cases, the survey must include: a close line spacing (1-2 m) with precise tracking in both the X- and Y- directions, and absolutely no mistakes in procedure and data processing.

Number of People

Under certain conditions, the survey can be laid out and run by one individual; but this is rare and risky. It is far better to have a minimum of two people closely involved and ideally, three or even four people. Not only must the layout and marking of the survey lines be considered but also an individual must be designated to maintain a separate survey log.. Note also that the operator doing all of the walking may require relief, for often times the terrain and distance conspire to make his job very grueling.

Survey Efficiency

Speed and cost-efficiency in completing the survey is of course the ideal objective. This does not, however, require the use of innovative short cuts, new gadgetry or excessive manpower, but rather the avoidance of mistakes and errors. To prevent wondering off line even once in the course of a survey, with all of the attendant time spent sorting out and making the corrections, easily justifies a slower but more positive method. Efficiency will only be achieved by avoiding confusion, the correction of errors, and by the use of fail-safe procedures. All of the methods suggested below are simple low tech, and relatively slow, but proven effective. They can easily be improved upon but only at the risk of greater time, survey quality, or greater cost. So in the beginning, keep it as simple as possible.

Layout of the Survey Track

Having determined the optimum line spacing, lay out the survey area in a square or rectangular format with the lines running N to S if possible. Use a Theodilite if available, otherwise use a measurement tape (non-stretch) of the required length. Designate one side of the area to be the "baseline" and layout and mark on this line each survey profile. If the site will be reoccupied in the future, it may be desirable to drive a one-meter iron rod (re-bar) into the ground at each corner of the survey area as a permanent marker. Since the profile line markers may not be visible at a distance, a method must be found that will allow the OhmMapper operator to locate and follow the line: e.g. a light cord or rope stretched on the ground between the beginning and end of each line; a long PVC pipe or other colored marker to be held at the end of each line and then sequentially moved; use of spray paint to mark a series of dashes along the path of each line, etc.

If the terrain is rough or bushy, ground markers along each line will be essential. Otherwise, if the terrain is flat and each end of the line is readily visible, a marker at each end and in the center may suffice. (The operator should have at least two markers to line up on when starting a line.) Whatever method is chosen, it must be easily moved in a coordinated way, and must give the operator a precise direction.

Note that coordination between the people moving the markers is sometimes difficult and frequently a source of error. In addition, if the survey lines are closely spaced, e.g., one- or two-meter separation, the operator may have trouble distinguishing between which marker to head for. The most certain and positive method in all cases is to mark the path by stretching a light string or rope the entire length of the pathway; or, to paint or otherwise mark the ground at short intervals.

If the area to be surveyed is larger than say 100 x 100 meters or difficult to walk through, then the area should be broken up into convenient sub-sections which overlap by at least one profile line. If some sections of line are not passable, then provision should be made for the operator to detour around them but only after establishing a procedure to stop/start (pause) and annotate the data. (This must be foolproof, simple and fully coordinated with the data processing.) Note that the OhmMapper operator must be aware of what line he is on at all times and the line number must agree with the line number recorded in the data. This is once again a frequent source of error and should be double-checked by another person.

In no case should a survey be started until all lines have been laid out and marked, and all aspects of the survey carefully re-checked. A few hours more or less at this stage means very little. What is crucial is to prevent major errors (or even minor ones) that may cost extra days of time and effort.

Survey Accuracy

Commercial survey specifications may allow an "off line" error of up to ±20% (or more) of the line separation. For a target having an anomaly extending over several lines, this amount of location error does not prevent the object's detection but does distort the anomaly’s shape and its true location. Large changes in speed along the profile line will have a similar effect but can be prevented by the use of intermediate waypoints. (The worst case condition would be “off line” by +20% in one direction and "off line” by -20% in the opposite direction with each line having a 10% change in speed.) Location errors of this magnitude will not seriously change the overall correctness of the final map, considering that this type of survey is primarily for detection/location. This is not the case, however, if the location errors substantially exceed ±20%, e.g., off by one or more line separations. This amount of error may cause targets of interest to go undetected, or target anomalies to be shifted in location, resulting in, at worst, an erroneous map or at best an untrustworthy one. Careful layout and accurate tracking along the line will avoid these problems.

Survey Credibility

How does a client or survey manager know that a survey has been conducted properly and that the results are correct and believable? He examines the finished contour map for gross errors in data fit, location of target signatures, and overall map quality.

1) Selected anomalies that have been detected are re-acquired to see if they are in the proper location.
2) The raw data are examined to insure that line numbers are correct, data corrections have been properly executed, etc.
3) Selected tests are made on the finished data, e.g., a plot of “stacked profiles” to determine that start/stop points are correct, speed changes are not excessive, there are no data gaps, etc.

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Appendix 2: Advanced Information

This information is supplied for those interested in some of the more technical aspects of the OhmMapper. Look in this chapter for some answers to frequently-asked-questions.

Memory Usage

Inside the OhmMapper, readings and positions (Marks and Lines) are simply stored in compressed format sequentially, with a time stamp. The MagMap2000 program will put the first reading following a mark exactly at that mark. The last reading before a Line event will be placed at that position.

Readings average about 3 bytes each, and positions about 10 bytes. GPS strings average about 30 bytes per reading. There are 2.5 Mbytes of memory in the unit. There is no limit to what portion of this memory used by each file.

Some memory is wasted by using additional files. Each new file must start on a 64K boundary. An average of 32K will be wasted, then, by opening each additional file.

File Formats

The following information is supplied for those users who wish to perform manipulations on the data beyond that which MagMap2000 is capable of. This section will explain the various file formats used in the data analysis process.

Binary File

This file has the .BIN extension, and is a raw dump of the data contained inside the memory of the OhmMapper Console. This data is not stored in a user readable format. It is compressed in a manner unique to the requirements of the operation of the OhmMapper. Furthermore, each new revision of the OhmMapper firmware may cause changes in this file format. Do not attempt to modify files of this type.

ASCII File

This file has the .STN extension, and is in a user-readable format. This file is created by the program BINTOASC.EXE. This program is run with the default parameters from the MagMap2000 program. It may also be run directly from the DOS prompt, and given many options which will adjust the format of the output. Please see the section later in this appendix describing the operation of BINTOASC.

The ASCII file contains lines which are a record of events from the perspective of the OhmMapper. Events may be either data readings, MARK, END LINE, or PAUSE key presses, RS232 input strings, or field notes. Each event is recorded in the order it was received, and given a time stamp.

Note: The ASCII file lists these events backward in time, i.e., last-in-first-out.

Each line in the ASCII file starts with a number, referred to as the TYPE in the following discussion. The TYPE indicates what information follows. The table below shows the TYPE for each of the events.

TYPE	Event
0	OhmMapper Reading
3	Position Event
6	Discontinuity Event
9	PAUSE key press
12	UNPAUSE key press
21	RS232 string
33	Field note

Positions events and discontinuities are caused by MARK or END LINE key presses. Typically, a discontinuity event is associated with the beginning of a line.

The C-program lines which BINTOASC uses to create these files are shown below.

TYPE 0: Readings

```
fprintf(pAscFile, "%-2u %10.3lf %10.3lf %.2d:%.2d:%.2d.%.2d
%.2d/%.2d/%2.d %3u\r\n",
       type,                  // 0 in this case
       reading1,              // reading from receiver 1
       reading2,              // reading from receiver 2
       hours,                 // time of day
       minutes,
       seconds,
       hundredths,
       month,                 // date
       day,
       year,
       status );              // G-858 internal information.
```

Example:

```
0   49881.953  49874.396 11:02:08.60 06/01/95   0
```

TYPE 3: Position events.

```
fprintf(pAscFile, "%-2u %12.2lf %12.2lf %.2d:%.2d:%.2d.%.2d
%.2d/%.2d/%2.d %10ld %11ld %11ld %3u\r\n",
       type,                  // 3 in this case
       x_position,            // X coordinate
       y_position,            // Y coordinate
       hours,                 // time of day
       minutes,
       seconds,
       hundredths,
       month,                 // date
       day,
       year,
       Number_of_Readings,    // Number of readings since last position or
                              //    discontinuity
       Line,                  // Line number
       Station,               // Mark Number
       Status );              // G-858 internal information.
```

Example: (some blanks omitted to fit onto a single line)

```
3       26.00       0.00 11:02:08.70 06/01/95      168       13      0   5
```

TYPE 6: Discontinuity events.

```
fprintf(pAscFile, "%-2u %12.2lf %12.2lf %.2d:%.2d:%.2d.%.2d
%.2d/%.2d/%2.d %10ld %11ld %11ld %3u %10ld\r\n",
       type,                  // 6 in this case
       x_position,            // X coordinate
       y_position,            // Y coordinate
       hours,                 // time of day
       minutes,
       seconds,
       hundredths,
       month,                 // date
       day,
       year,
       Number_of_Readings,    // Number of readings since last position
       Line,                  // Line number
       Station,               // Mark Number
       Status,                // G-858 internal information.
       Positions );           // Number of positions since last discontinuity
```

Example: (some blanks omitted to fit onto a single line)

```
6       26.00       0.00 11:02:08.70 06/01/95      168       13      0   5
3
```

TYPE 9: Pause event

```
fprintf(pAscFile, "%-2u %.2d:%.2d:%.2d.%.2d %.2d/%.2d/%2.d\r\n",
       type,                  // 9 in this case
       hours,                 // time of day
       minutes,
       seconds,
       hundredths,
       month,                 // date
       day,
       year ) ;
```

Example:

```
9  18:49:44.90 05/31/95
```

TYPE 12: Unpause event

```
fprintf(pAscFile, "%-2u %.2d:%.2d:%.2d.%.2d %.2d/%.2d/%2.d\r\n",
       type,                  // 12 in this case
       hours,                 // time of day
       minutes,
       seconds,
       hundredths,
       month,                 // date
       day,
       year ) ;
```

Example:

```
12 18:49:44.90 05/31/95
```

TYPE 21: RS232 event

```
fprintf(pAscFile, "%-2u %s %.2d:%.2d:%.2d.%.2d %.2d/%.2d/%2.d\r\n",
       type,                  // 21 in this case
       input_string,          // ASCII string received from RS232
       hours,                 // time of day
       minutes,
       seconds,
       hundredths,
       month,                 // date
       day,
       year ) ;
```

Example:

```
21 $GPGGA,015009.00,3725.9975,N,12209.9992,W,2,4,002.5,00025.1,M,-
028.4,M,001,0000*65 18:49:44.90 05/31/95
```

TYPE 33: Field note

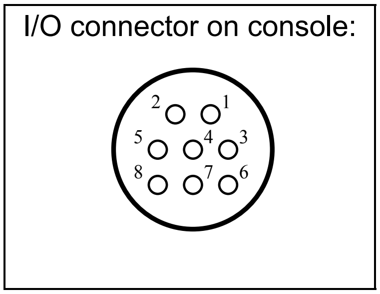
```
fprintf(pAscFile, "%-2u %s %.2d:%.2d:%.2d.%.2d %.2d/%.2d/%2.d\r\n",
       type,                  // 33 in this case
       input_string,          // ASCII string received from RS232
       hours,                 // time of day
       minutes,
       seconds,
       hundredths,
       month,                 // date
       day,
       year ) ;
```

Example:

```
33 Fell down 18:49:44.90 05/31/95
```

I/O Connector Pinout

There are 3 inputs on the I/O connector which simulate END LINE, MARK and ENTER key presses. Momentarily connecting the corresponding pin to pin 4 is equivalent to pressing the key on the keypad:



Pin Number	Function
1	Ground
2	RS232 Receive
3	RS232 Transmit
4	Ground
5	Mark
6	Audio
7	Line
8	Enter

Field Notes

You may extract the field notes into a file in much the same manner as extracting GPS data (se Chapter 9). This is done by using the BINTOASC program with options to tell it to only extract the field notes.

Type the following line at the command prompt:

```
BINTOASC input.bin output.txt -R0 -M0 -D0 -P0 -U0 -S0
```

where

input is the name of the file containing the binary downloaded data (you must type the .BIN extension

output is the filename you wish for the GPS data (you must give it an extension. The TXT extension is a suggestion, however, you may use what you wish.)

-R0 ... The options tell the program not to extract everything except the field notes. They are a dash, a letter, and the numeral zero.

You will now have created a file of the field notes, along with some G-858 formatting information. Lines will be as shown below:

```
33 Fell into a hole 10:59:14.80 06/01/95
33 Ran into a tree 11:16:25.40 06/01/95
33 Fell into a hole 12:01:36.80 06/01/95
```

Please contact Geometrics for information regarding availability of programs which automate usage of these features.

This page intentionally left blank.

Appendix 3: Third-Party Resistivity Software

The Geometrics MagMap2000per software currently can export OhmMapper data in both RES2DINV by Dr. M.H. Loke format and RESIX2DI format from Interpex, Inc. Additional information about exporting to RES2DINV is given in the Geometrics MagMap2000 manual, chapter 7.

RESIX from INTERPEX

The following is the file format for the data file exported from the MagMap2000 software for use by the RESIX 2D resistivity inversion program from Interpex.

Interpex 2-D file format

"/" in first column indicates header or comment item. Spacing is base electrode spacing (smallest spacing). Left electrode is location of leftmost (1st) electrode. Client .... Date are self-explanatory. Array types are as follows:

DIPO Dipole-dipole

PDIP Pole-dipole

DIPP reverse pole-dipole ("dipole-pole") WENN Wenner array

SCHL Schlumberger ("Schlumberger-Wenner" array) POLP Pole-pole array

Unused header items may be omitted.

LINE name of line comment - this line defines the name of the profile

Data follows with index of Tx (leftmost transmitter electrode number), index of Rx, depends on array, Apparent resistivity value and IP value. File shown only has apparent resistivity.

Rx index:

For pole-pole, dipole-dipole and pole-dipole, it is the typical "n" number - the number of electrode spacings between rightmost Tx and leftmost Rx electrodes.

For Wenner, it is the factor times the base electrode spacing (a=Rxindex * SPACING)

For Schlumberger, it is the integer part of the AB/2 distance, in terms of electrode spacings: AB=1+2 * Rxindex

*Further into the file is a header item called SPACE FACTOR. This is the integer factor to multiply the base electrode spacing to get the actual electrode spacing. So this means that Dipole-dipole and pole-dipole arrays can be run with a = SPACING, a = 2 * SPACING, a = 3 * SPACING, ETC. For Schlumberger, it is the MN spacing, so that MN = SPACING, MN = 3 * SPACING, etc. Data values following the line*

/ SPACE FACTOR : 2

assume a spacing factor of 2 until another space factor is encountered.

Pole-pole and Wenner data can only utilize a SPACE FACTOR of 1.

Data are internally stored in a 3-D array RHO-A(IRX,ITX,ISPACE), where IRX is the Rx index, ITX is the Tx index and ISPACE is the SPACE FACTOR. All arrays are dynamically allocated so there are no artificial limits on size of data set.

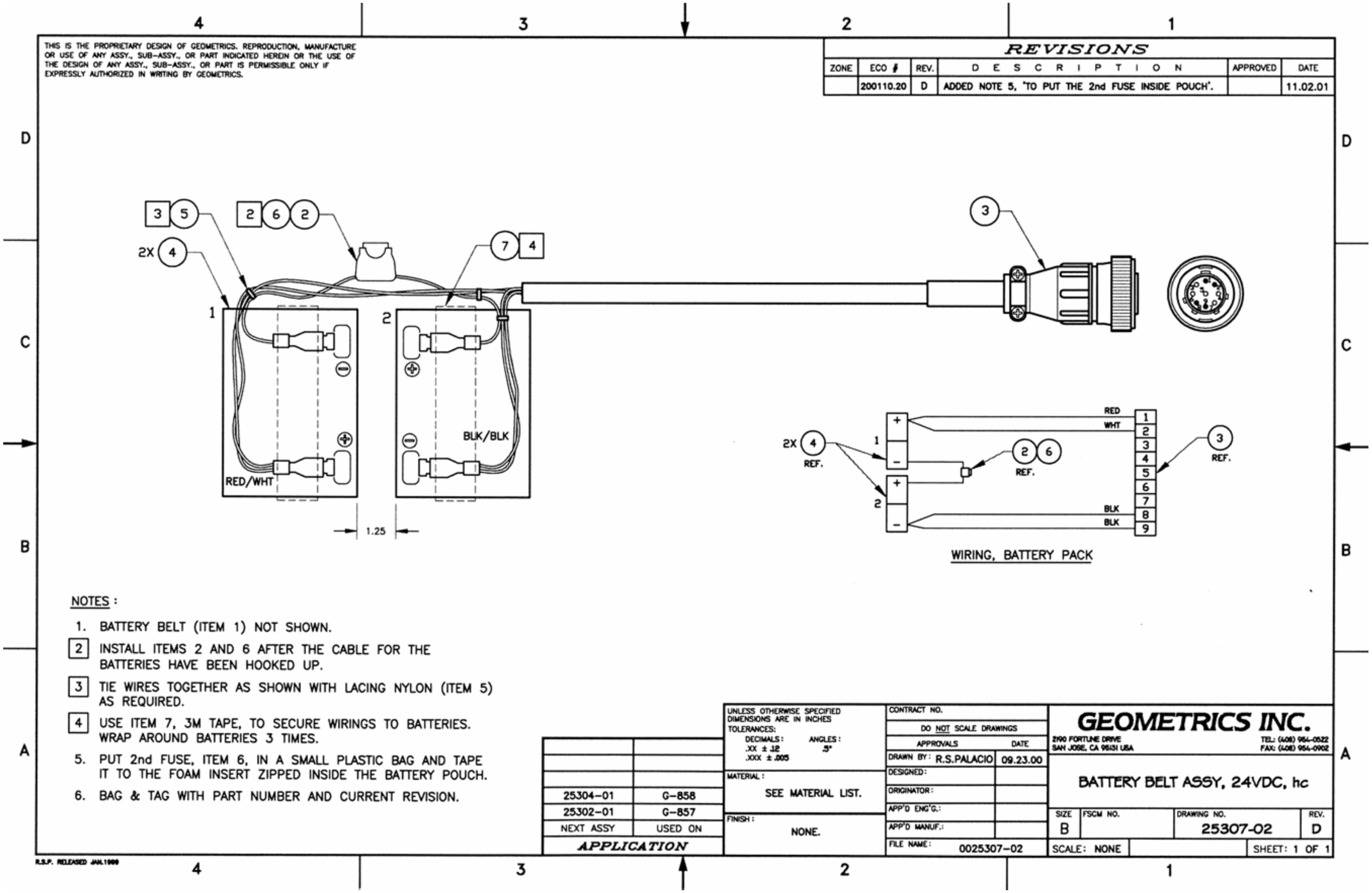
Sample file:

```
/ SPACING       :   10.0
/ LEFT ELECTRODE :    0.0
/ CLIENT        : Company name
/ COUNTY        : MOHAVE                  / PROJECT       : SITE 34 A
/ AZIMUTH       :
/ LOCATION      : Texas                   / EQUIPMENT     : ETW
/ DATE          : 95-04-13
/ ARRAY TYPE    : DIPO
LINE TESTLINE  DATA: TX INDEX, RX INDEX, RHO-A, IP-VALUE
1,  1,    97.665,
1,  2,   100.586,
1,  3,   101.535,
1,  4,   102.471,
1,  5,   103.902,
1,  6,   106.257,
1,  7,   109.940,
1,  8,   114.559,
```

```
2,   1,     97.676,
2,   2,    100.643,
...  ...      ...
...  ...      ...
...  ...      ...
...  ...      ...
...  ...      ...
...  ...      ...
...  ...      ...
...  ...      ...
20,   1,     97.695,
20,   2,    100.643,
20,   3,    101.536,
21,   1,     97.676,
21,   2,    100.586,
22,   1,     97.666,
/ SPACE FACTOR   :     2
2,   1,    101.221,
2,   2,    104.121,
2,   3,    110.892,
2,   4,    105.892,
2,   5,     64.420,
2,   6,     61.777,
2,   7,     65.823,
2,   8,     69.807,
3,   1,    101.428,
3,   2,    105.466,
...  ...      ...
...  ...      ...
...  ...      ...
...  ...      ...
16,   2,    107.560,
16,   3,    110.893,
```

```
17,  1,  102.469,
17,  2,  105.467,
18,  1,  101.799,
18,  2,  104.122,
19,  1,  101.428,
20,  1,  101.221,
```

Appendix 4: Cable Drawings



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REVISIONS

ZONE	ECO #	REV.	D E S C R I P T I O N	APPROVED	DATE
	200110.20	D	ADDED NOTE 5, 'TO PUT THE 2nd FUSE INSIDE POUCH'.		11.02.01

WIRING, BATTERY PACK

NOTES :

1. BATTERY BELT (ITEM 1) NOT SHOWN.
2. INSTALL ITEMS 2 AND 6 AFTER THE CABLE FOR THE BATTERIES HAVE BEEN HOOKED UP.
3. TIE WIRES TOGETHER AS SHOWN WITH LACING NYLON (ITEM 5) AS REQUIRED.
4. USE ITEM 7, 3M TAPE, TO SECURE WIRINGS TO BATTERIES. WRAP AROUND BATTERIES 3 TIMES.
5. PUT 2nd FUSE, ITEM 6, IN A SMALL PLASTIC BAG AND TAPE IT TO THE FOAM INSERT ZIPPED INSIDE THE BATTERY POUCH.
6. BAG & TAG WITH PART NUMBER AND CURRENT REVISION.

25304-01	G-858
25302-01	G-857
NEXT ASSY	USED ON

APPLICATION

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES:
DECIMALS: .XX ± .12 .XXX ± .005
ANGLES: .5°

MATERIAL : SEE MATERIAL LIST.

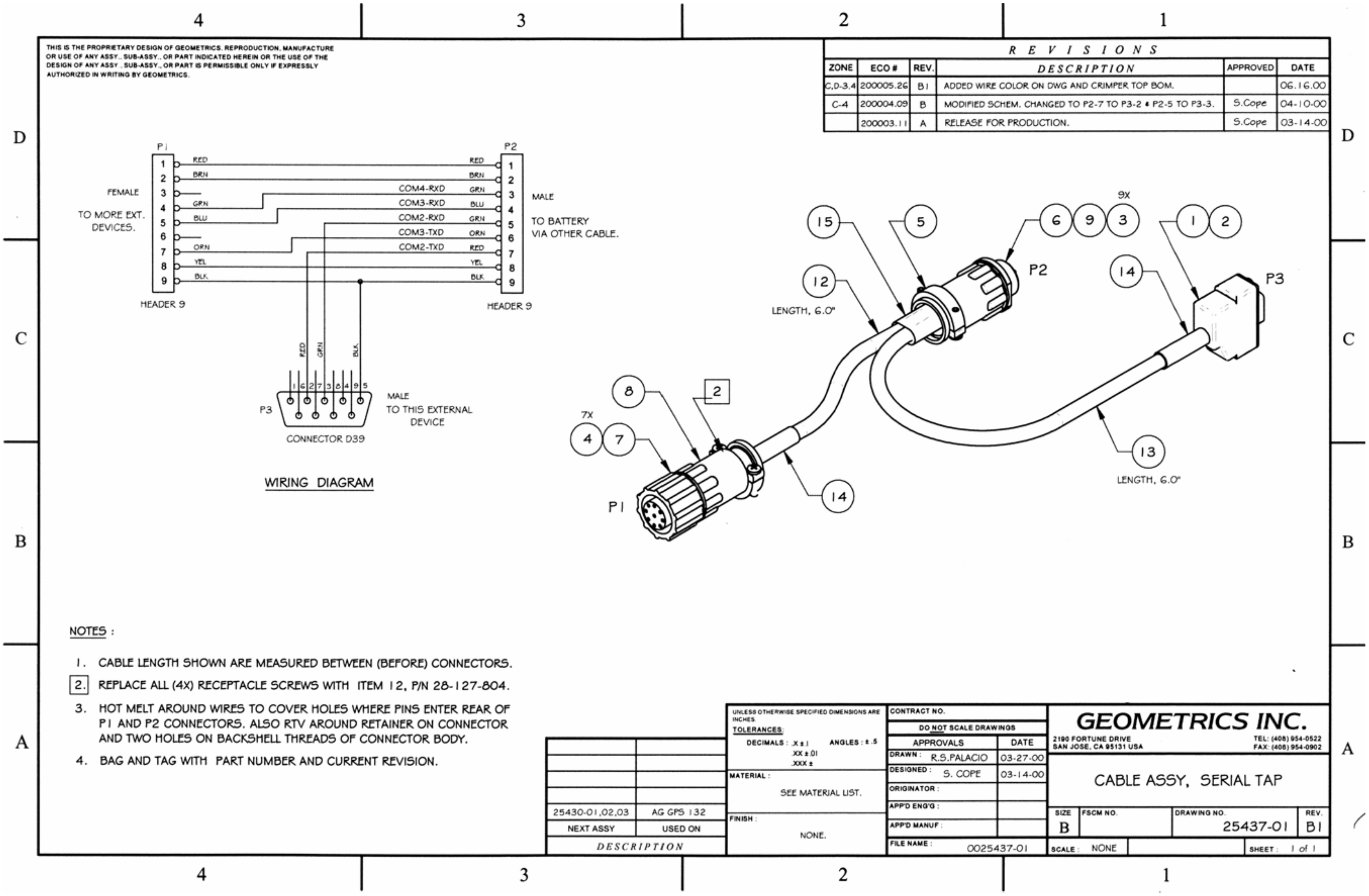
FINISH : NONE.

CONTRACT NO.
DO NOT SCALE DRAWINGS
APPROVALS DATE
DRAWN BY: R.S.PALACIO 09.23.00
DESIGNED:
ORIGINATOR:
APP'D ENG'G.:
APP'D MANUF.:
FILE NAME: 0025307–02

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

BATTERY BELT ASSY, 24VDC, hc

SIZE B
FSCM NO.
DRAWING NO. 25307-02
REV. D
SCALE: NONE
SHEET: 1 OF 1



R E V I S I O N S

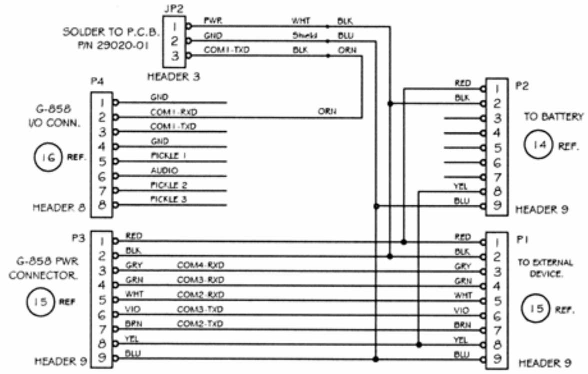
ZONE	ECO #	REV.	DESCRIPTION	APPROVED	DATE
C,D-3,4	200005.26	B1	ADDED WIRE COLOR ON DWG AND CRIMPER TOP BOM.		06.16.00
C-4	200004.09	B	MODIFIED SCHEM. CHANGED TO P2-7 TO P3-2 & P2-5 TO P3-3.	S.Cope	04-10-00
	200003.11	A	RELEASE FOR PRODUCTION.	S.Cope	03-14-00

NOTES :

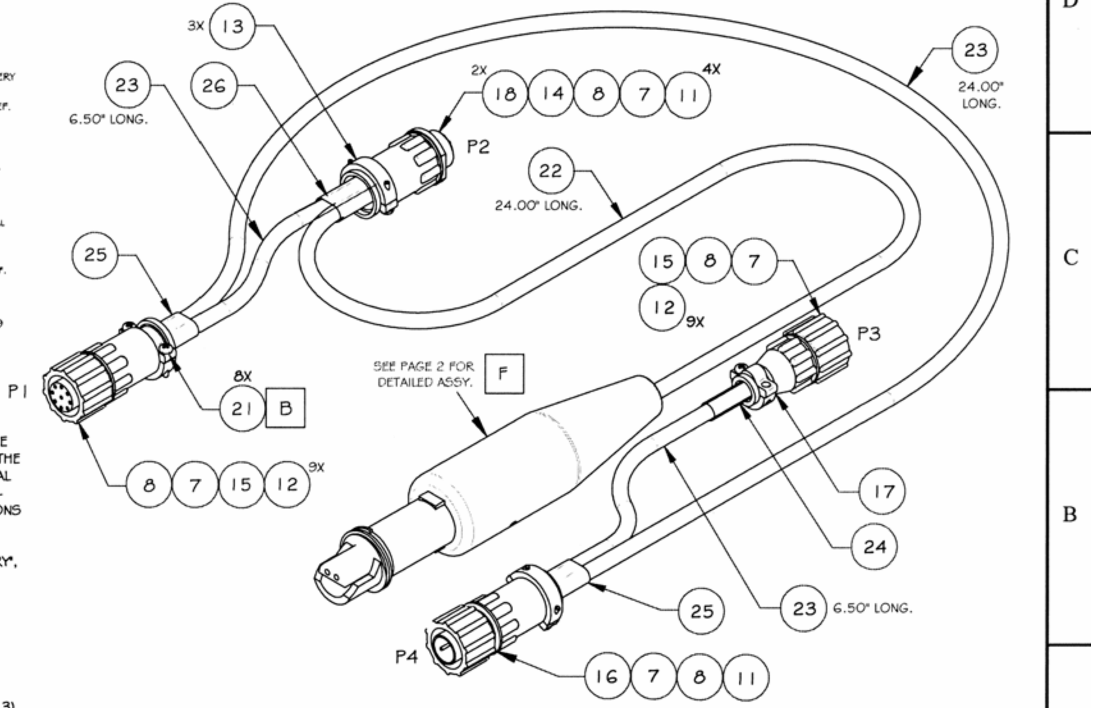
1. CABLE LENGTH SHOWN ARE MEASURED BETWEEN (BEFORE) CONNECTORS.
2. REPLACE ALL (4X) RECEPTACLE SCREWS WITH ITEM 12, P/N 28-127-804.
3. HOT MELT AROUND WIRES TO COVER HOLES WHERE PINS ENTER REAR OF P1 AND P2 CONNECTORS. ALSO RTV AROUND RETAINER ON CONNECTOR AND TWO HOLES ON BACKSHELL THREADS OF CONNECTOR BODY.
4. BAG AND TAG WITH PART NUMBER AND CURRENT REVISION.

R E V I S I O N S

ZONE	ECO #	REV.	DESCRIPTION	APPROVED	DATE
	200203.34	H	REPLACED 29084-01 WITH 29084-02. S.COPE		04.05.02



WIRING DIAGRAM



NOTES :

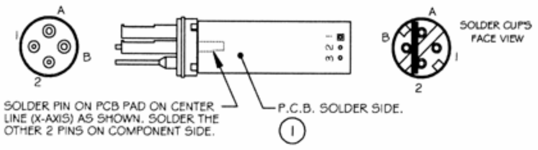
A. USE BELDEN 9540, STYLE 2464, ITEM 23, FOR ALL CBL SHOWN EXCEPT FOR THE PIECE, ITEM 22, RUNNING FROM P2 TO THE HERMAPHRODITIC CONN. HOUSING THE OHMMAPPER PHOTO-PREAMPLIFIER BOARD. ASSEMBLE AND TEST THE ELECTRICAL CONTINUITY AND ISOLATION OF THE CABLE EXCLUDING THE OHMMAPPER PHOTO-PREAMPLIFIER BOARD, ITEM 1, AS SHOWN ON THE SCHEMATIC. CPC CONNECTIONS SHOULD BE INTERNALLY SEALD USING DOW 3145 RTV ADHESIVE and HOT MELT (ITEM 7 and ITEM 8) AND THE CONNECTORS STRAIN RELIEFS SHOULD ABUT TO WHITE SHRINK TUBING LABEL AS FOLLOWS: P1; "EXTERNAL DEVICE", P2; "BATTERY", P3; "CONSOLE POWER, P4; "CONSOLE SERIAL".

B. REPLACE ALL (8X) RECEPTACLE SCREWS WITH ITEM 21 (P/N 28127-804).

C. DIMENSIONS SHOWN ARE MEASURED BETWEEN CONNECTORS.

D. CONNECTOR SHOWN IS P/N 29058-01. HOWEVER THE HOUSING HAVE TO BE MODIFIED, REFER TO ITEM 4.

E. PHOTO-PREAMPLIFIER BOARD (ITEM 1), GASKET (ITEM 2), AND PIN/SOCKET (ITEM 3) ASSEMBLY DETAIL ;



29000-01	OHM MAPPER
NEXT ASSY	USED ON
DESCRIPTION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE INCHES.
TOLERANCES:
DECIMALS : .X ± .5 ANGLES : ± .5
.XX ± .25
.XXX ± .005
MATERIAL : SEE MATERIAL LIST.
FINISH :

CONTRACT NO.
DO NOT SCALE DRAWINGS

APPROVALS	DATE
DRAWN : R.S.PALACIO	03.12.99
DESIGNED : J.Johnston	08.02.00
ORIGINATOR :	
APP'D ENG'G. :	
APP'D MANUF. :	
FILE NAME : 0029033-01	

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

CABLE ASSY, CONSOLE

SIZE	FSCM NO.	DRAWING NO.	REV.
B		29033-01	H

SCALE : NONE SHEET : 1 of 2

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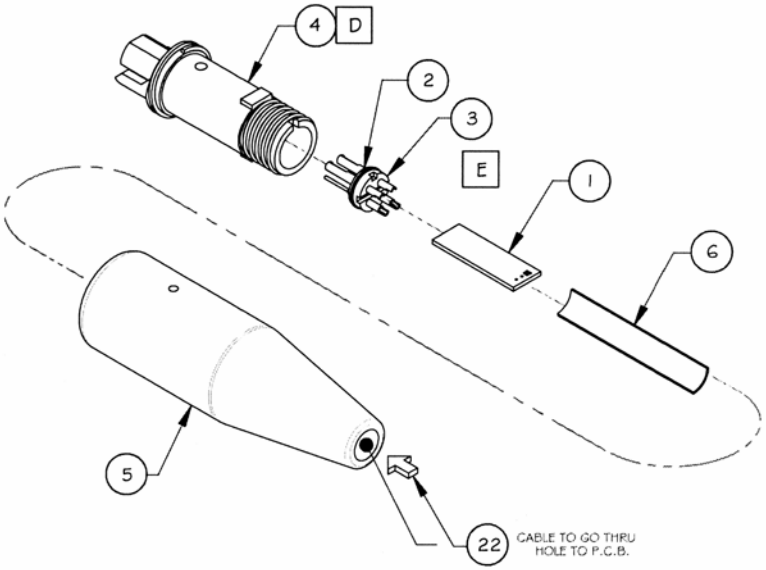
R E V I S I O N S

ZONE	ECO #	REV.	DESCRIPTION	APPROVED	DATE
			SEE PAGE 1 FOR CURRENT REVISION.		

F ASSEMBLY INSTRUCTIONS ;

1. POSITION THE BEND RELIEF, ITEM 5, ON THE CABLE.
2. STRIP THE OUTER POLYURETHANE JACKET TO EXPOSE 2.00" OF THE CABLE' CORE. SEPARATE THE KEVLAR BRAID AND DRAW IT BACK OUT OF THE WAY IN ORDER TO EXPOSE THE MYLAR BINDER.
3. REMOVE THE MYLAR BINDER EXPOSING 2.00" OF BRAIDED SHIELD.
4. SEPARATE THE SHIELD AND SELECT APPROX. 10 ADJACENT STRANDS AND TWIST INTO A WIRE SMALL ENOUGH TO FIT THROUGH THE CONNECTION HOLES ON THE PCB, ITEM 1. TRIM THIS WIRE TO A LENGTH OF 3/4". PLACE 3/8" OF CLEAR SHRINK TUBING, ITEM 26, ON WIRE AND SHRINK TO FIT. TRIM TO LEAVE APPROX, 3/8" OF WIRE EXPOSED. TRIM AWAY THE REMAINING SEPARATED SHIELD.
5. TRIM THE BLK AND WHT WIRES TO 3/4". STRIP APPROX. 3/8" OF INSULATION FROM BOTH WIRES. THIN THE NUMBER OF EXPOSED STRANDS TO ALLOW THE WIRE TO PASS THROUGH HOLES IN THE CKT BRD.
6. SOLDER THESE THREE WIRES TO THE P.C.B.,ITEM 1, SHOWN ON THE SCHEM. & TRIM AWAY EXCESS.
7. TEST THE CABLE ELECTRICALLY USING A WORKING OHMMAPPER RECEIVER, OPTICAL ISOLATOR, AND CONSOLE. IF IT TESTS OK PROCEED. OTHERWISE RE-CHECK SOLDER CONNECTIONS TO CABLE AND PIN WAFER OR SEEK ASSISTANCE IN LOCATING THE PROBLEM.
8. COVER THE COMPONENT SIDE OF THE PCB, ITEM 1, WITH A LAYER OF RTV, ITEM 7, APPROX. 1/8" THK. AND ALLOW IT TO DRY.
9. DRAPE THE KEVLAR FIBERS ON EITHER SIDE OF THE PCB, ITEM 1, AND SECURE THEM NEAR THE PIN WAFER BY BINDING THEM TO THE BOARD WITH A SHORT PIECE OF KEVLAR YARN.
10. PUSH THE PCB, ITEM 1, INTO THE HOUSING, ITEM 4, PLACE A SPLINT, ITEM 5, WITH ITS CONCAVE SIDE INWARD, INSIDE OF THE HOUSING OPPOSITE THE GLUE HOLE AND SCREW THE BEND RELIEF, ITEM 6, INTO PLACE. EXAMINE THE FIT OF THE PIN WAFER WHERE ITS PIN PROTRUDE FROM THE HOUSING: THE RUBBER SEAL AROUND THE MALE PINS SHOULD FORM A TIGHT SEAL AGAINST THE HOUSING. IF THIS SEAL IS PROPERLY SET YOU SHOULD NOT BE ABLE TO BLOW AIR INTO THE FRONT OF THE CONNECTOR; TRY IT I.
11. TEST THE CBL ELECT'LLY USING A WORKING OHMMAPPER RECEIVER, OPTICAL ISOLATOR & CONSOLE.
12. IF TEST IS GOOD PROCEED. OTHERWISE REMOVE THE BOARD FROM THE HOUSING, LOCATE THE DEFECT, AND REPAIR IF POSSIBLE.
13. PLACE A STRIP OF MASKING TAPE OVER THE GLUE HOLE ON THE HOUSING AND OVER THE VENT HOLE ON THE TUBE. USING AN EXACTO KNIFE CUT A SMALL HOLE IN THE TAPE TO EXPOSE THESE HOLES. THIS TAPE PROTECTS THE WORK PIECE FROM EXCESS GLUE.
14. PRE-POSITION STRIP OF MASKING TAPE NEAR THE GLUE HOLE AND VENT HOLE TO SEAL THESE HOLES WHEN GLUING IS COMPLETE.
15. INJECT DP-100 EPOXY, ITEM 10, USING A MIXING NOZZLE, ITEM 9, INTO THE HOLE IN THE HOUSING WHILE THE TUBE IS HELD VERTICAL WITH THE VENT HOLE ABOVE THE HOUSING. CONTINUE INJECTING EPOXY UNTIL IT APPEARS AT VENT HOLE AND THEN COVER THE VENT WITH MASKING TAPE.
16. SLOWLY WITHDRAW THE MIXING NOZZLE WHILE INJECTING ENOUGH EXTRA EPOXY TO FILL THE VOID LEFT BY REMOVAL OF THE NOZZLE AND THEN COVER THIS HOLE WITH ITS TAPE STRIP.
17. AFTER ABOUT 10 MIN. THE TAPE CAN BE REMOVED AND THE CABLE CAN BE PLACED IN THE HOT BOX FOR CURING.
18. TEST USING TEST INSTRUCTION, ITEM 27.

G BAG AND TAG WITH PART NUMBER AND CURRENT REVISION.



F CONNECTOR SUB-ASSY

NEXT ASSY	USED ON
	OHM MAPPER

DESCRIPTION

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE INCHES.
TOLERANCES:
DECIMALS : .X ± .5 ANGLES : ± .5
.XX ± .25
.XXX ± .005

MATERIAL : SEE MATERIAL LIST.

FINISH :

CONTRACT NO.
DO NOT SCALE DRAWINGS

APPROVALS	DATE
DRAWN : R.S.PALACIO	03-12-99
DESIGNED :	
ORIGINATOR :	
APP'D ENG'G. :	
APP'D MANUF. :	

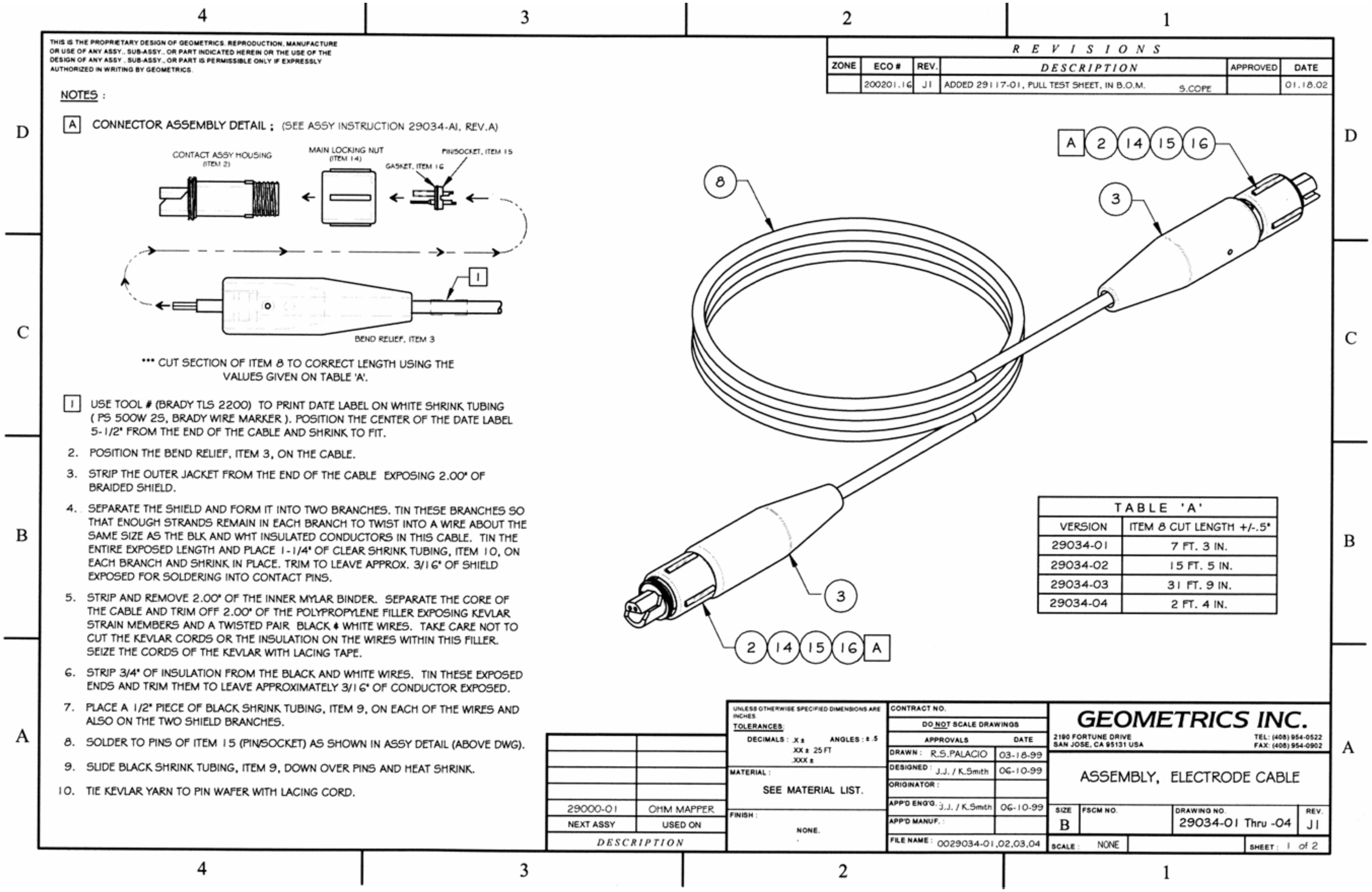
FILE NAME : 0029033-01

GEOMETRICS INC.

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

CABLE ASSY, CONSOLE

SIZE: B
FSCM NO.
DRAWING NO. 29033-01
REV. H
SCALE : NONE
SHEET : 2 of 2



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R E V I S I O N S					
ZONE	ECO #	REV.	DESCRIPTION	APPROVED	DATE
	200201.16	J1	ADDED 29117-01, PULL TEST SHEET, IN B.O.M. S.COPE		01.18.02

NOTES :

A CONNECTOR ASSEMBLY DETAIL ; (SEE ASSY INSTRUCTION 29034-AI, REV.A)

*** CUT SECTION OF ITEM 8 TO CORRECT LENGTH USING THE VALUES GIVEN ON TABLE 'A'.

1. USE TOOL # (BRADY TLS 2200) TO PRINT DATE LABEL ON WHITE SHRINK TUBING (PS 500W 25, BRADY WIRE MARKER). POSITION THE CENTER OF THE DATE LABEL 5-1/2" FROM THE END OF THE CABLE AND SHRINK TO FIT.
2. POSITION THE BEND RELIEF, ITEM 3, ON THE CABLE.
3. STRIP THE OUTER JACKET FROM THE END OF THE CABLE EXPOSING 2.00" OF BRAIDED SHIELD.
4. SEPARATE THE SHIELD AND FORM IT INTO TWO BRANCHES. TIN THESE BRANCHES SO THAT ENOUGH STRANDS REMAIN IN EACH BRANCH TO TWIST INTO A WIRE ABOUT THE SAME SIZE AS THE BLK AND WHT INSULATED CONDUCTORS IN THIS CABLE. TIN THE ENTIRE EXPOSED LENGTH AND PLACE 1-1/4" OF CLEAR SHRINK TUBING, ITEM 10, ON EACH BRANCH AND SHRINK IN PLACE. TRIM TO LEAVE APPROX. 3/16" OF SHIELD EXPOSED FOR SOLDERING INTO CONTACT PINS.
5. STRIP AND REMOVE 2.00" OF THE INNER MYLAR BINDER. SEPARATE THE CORE OF THE CABLE AND TRIM OFF 2.00" OF THE POLYPROPYLENE FILLER EXPOSING KEVLAR STRAIN MEMBERS AND A TWISTED PAIR BLACK & WHITE WIRES. TAKE CARE NOT TO CUT THE KEVLAR CORDS OR THE INSULATION ON THE WIRES WITHIN THIS FILLER. SEIZE THE CORDS OF THE KEVLAR WITH LACING TAPE.
6. STRIP 3/4" OF INSULATION FROM THE BLACK AND WHITE WIRES. TIN THESE EXPOSED ENDS AND TRIM THEM TO LEAVE APPROXIMATELY 3/16" OF CONDUCTOR EXPOSED.
7. PLACE A 1/2" PIECE OF BLACK SHRINK TUBING, ITEM 9, ON EACH OF THE WIRES AND ALSO ON THE TWO SHIELD BRANCHES.
8. SOLDER TO PINS OF ITEM 15 (PIN/SOCKET) AS SHOWN IN ASSY DETAIL (ABOVE DWG).
9. SLIDE BLACK SHRINK TUBING, ITEM 9, DOWN OVER PINS AND HEAT SHRINK.
10. TIE KEVLAR YARN TO PIN WAFER WITH LACING CORD.

TABLE 'A'	
VERSION	ITEM 8 CUT LENGTH +/-.5"
29034-01	7 FT. 3 IN.
29034-02	15 FT. 5 IN.
29034-03	31 FT. 9 IN.
29034-04	2 FT. 4 IN.

29000-01	OHM MAPPER
NEXT ASSY	USED ON
DESCRIPTION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE INCHES.
TOLERANCES:
DECIMALS : .X ± ANGLES : ± .5
.XX ± .25 FT
.XXX ±
MATERIAL : SEE MATERIAL LIST.
FINISH : NONE.

CONTRACT NO.
DO NOT SCALE DRAWINGS

APPROVALS		DATE
DRAWN :	R.S.PALACIO	03-18-99
DESIGNED :	J.J. / K.Smith	06-10-99
ORIGINATOR :		
APP'D ENG'G. :	J.J. / K.Smith	06-10-99
APP'D MANUF. :		
FILE NAME :	0029034-01,02,03,04	

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

ASSEMBLY, ELECTRODE CABLE

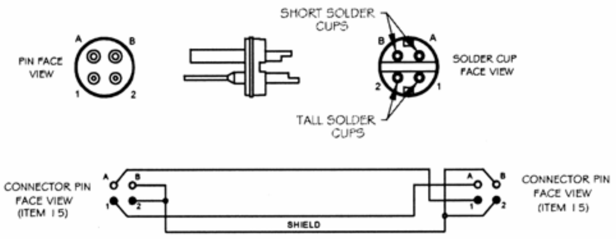
SIZE	FSCM NO.	DRAWING NO.	REV.
B		29034-01 Thru -04	J1

SCALE : NONE SHEET : 1 of 2

R E V I S I O N S					
ZONE	ECO #	REV.	DESCRIPTION	APPROVED	DATE
			SEE PAGE 1 FOR DESCRIPTION of CHANGE AND REV. LEVEL.		

11. APPLY CONTACT CEMENT, ITEM 5 , TO GASKET AND SURFACES ON HOUSING AND PIN WAFER THAT CONTACT THE HOUSING. PLACE A LOCKING NUT ON A MODIFIED CONN. HOUSING, ITEM 2, AND INSERT THE PIN/SOCKET & GASKET ASSY INTO THE HOUSING.
12. PRESS THE PIN WAFER INTO POSITION USING TD99186. EXAMINE THE FIT OF THE PIN WAFER WHERE ITS PINS PRO OTRUDE FROM THE HOUSING: THE RUBBER SEAL AROUND THE MALE PINS SHOULD FORM A TIGHT SEAL AGAINST THE HOUSING. IF THIS SEAL IS PROPERLY SET YOU SHOULD NOT BE ABLE TO BLOW AIR INTO THE FRONT OF THE CONNECTOR; TRY IT!
13. PERFORM STEPS 3 THROUGH 12 ON THE OTHER END OF THE CABLE AND TEST THE CABLE USING THE TEST PLUGS ON TOOL #TD99171. IF THE CABLE TESTS BAD, REMOVE THE BEND RELIEF(S) AND LOCATE THE FAILURE. IF THE CABLE TESTS OK PROCEED.
14. ATTACH THE CONNECTORS TO THE END CAPS OF TOOL #TD99177 AND SECURE IN PLACE W/ THE CONNECTOR'S LOCKING RINGS.
15. APPLY MASKING TAPE STRIPS OVER THE GLUE HOLE ON THE HOUSING AND THE VENT HOLE ON THE BEND RELIEF. CUT A SMALL HOLE IN THE TAPE TO ALLOW GLUING AND VENTING. PREPOSITION MASKING TAPE HOLE COVERS NEAR BOTH HOLES TO PREVENT LEAKAGE AFTER GLUE INJECTION IS COMPLETE.
16. CLAMP TOOL TD#99177 IN A VISE WITH THE CONNECTOR ENDS POINT DOWN AND THE GLUE HOLE FACING YOU.
17. INJECT DP-100 5-MIN. EPOX, ITEM 7, USING A MIXING NOZZLE, ITEM 6, INTO THE GLUE HOLE UNTIL EPOXY APPEARS AT THE VENT HOLE.
18. COVER THE VENT HOLE WITH ITS TAPE STRIP. SLOWLY WITHDRAW THE MIXING NOZZLE WHILE INJECTING ENOUGH EXTRA EPOXY TO FILL THE VOID LEFT BY REMOVAL OF THE NOZZLE TIP AND THEN COVER THIS HOLE WITH ITS TAPE STRIP.
19. REPEAT STEPS 17 AND 18 ON THE OTHER END OF THE CABLE.
20. AFTER ABOUT 10 MIN. THE TAPE CAN BE REMOVED AND THE CABLE CAN BE PLACE IN THE HOT BOX FOR CURING.
21. AFTER A 24 HRS. HOT BOX CURE, PULL-TEST ON THE TEST-RACK AS SPECIFIED ON THE PULL TEST PROCEDURE, ITEM 5.

B. ASSEMBLY WIRING DIAGRAM ;



C. BAG AND TAG WITH PART NUMBER AND CURRENT REVISION.

29000-01	OHM MAPPER
NEXT ASSY	USED ON
DESCRIPTION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE INCHES.
TOLERANCES:
DECIMALS : .X ± ANGLES : ± .5
.XX ± 25 FT
.XXX ±

MATERIAL :
SEE MATERIAL LIST.

FINISH :
NONE.

CONTRACT NO.	
DO NOT SCALE DRAWINGS	
APPROVALS	DATE
DRAWN : R.S.PALACIO	03-18-99
DESIGNED : J.J. / K.Smith	06-10-99
ORIGINATOR :	
APP'D ENG'G. J.J. / K.Smith	06-10-99
APP'D MANUF. :	
FILE NAME : 0029034-01,02,03,04	

GEOMETRICS INC.
2190 FORTUNE DRIVE
SAN JOSE, CA 95131 USA
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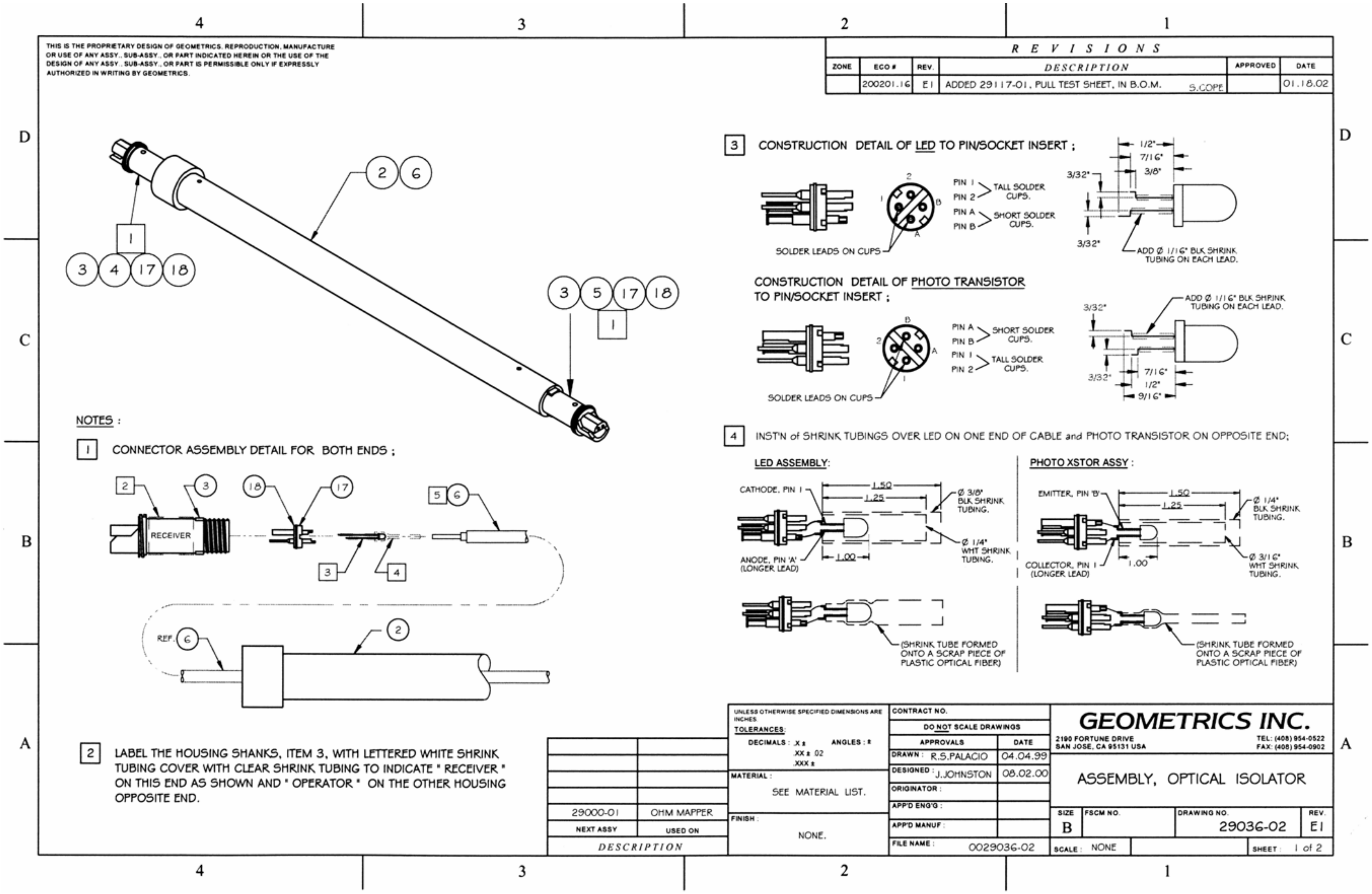
ASSEMBLY, ELECTRODE CABLE

SIZE	FSCM NO.	DRAWING NO.	REV.
B		29034-01 Thru -04	SEE Page 1
SCALE : NONE		SHEET : 2 of 2	


4
3
2
1
D
C
B
A
THIS IS THE PROPRIETARY DESIGN OF GEOMETRICS. REPRODUCTION, MANUFACTURE OR USE OF ANY ASSY., SUB-ASSY., OR PART INDICATED HEREIN OR THE USE OF THE DESIGN OF ANY ASSY., SUB-ASSY., OR PART IS PERMISSIBLE ONLY IF EXPRESSLY AUTHORIZED IN WRITING BY GEOMETRICS.
REVISIONS
ZONE
ECO #
REV.
DESCRIPTION
APPROVED
DATE
200201.16
E1
ADDED 29117-01, PULL TEST SHEET, IN B.O.M.
S.COPE
01.18.02
2
6
1
3
4
17
18
3
5
17
18
1
NOTES :
1 CONNECTOR ASSEMBLY DETAIL FOR BOTH ENDS ;
2
3
18
17
5
6
RECEIVER
3
4
REF. 6
2
2 LABEL THE HOUSING SHANKS, ITEM 3, WITH LETTERED WHITE SHRINK TUBING COVER WITH CLEAR SHRINK TUBING TO INDICATE " RECEIVER " ON THIS END AS SHOWN AND " OPERATOR " ON THE OTHER HOUSING OPPOSITE END.
3 CONSTRUCTION DETAIL OF LED TO PIN/SOCKET INSERT ;
2
1
B
A
PIN 1
PIN 2
TALL SOLDER CUPS.
PIN A
PIN B
SHORT SOLDER CUPS.
SOLDER LEADS ON CUPS
1/2"
7/16"
3/8"
3/32"
3/32"
ADD Ø 1/16" BLK SHRINK TUBING ON EACH LEAD.
CONSTRUCTION DETAIL OF PHOTO TRANSISTOR TO PIN/SOCKET INSERT ;
B
2
A
1
PIN A
PIN B
SHORT SOLDER CUPS.
PIN 1
PIN 2
TALL SOLDER CUPS.
SOLDER LEADS ON CUPS
3/32"
ADD Ø 1/16" BLK SHRINK TUBING ON EACH LEAD.
3/32"
7/16"
1/2"
9/16"
4 INST'N of SHRINK TUBINGS OVER LED ON ONE END OF CABLE and PHOTO TRANSISTOR ON OPPOSITE END;
LED ASSEMBLY:
CATHODE, PIN 1
1.50
1.25
Ø 3/8" BLK SHRINK TUBING.
Ø 1/4" WHT SHRINK TUBING.
1.00
ANODE, PIN 'A' (LONGER LEAD)
(SHRINK TUBE FORMED ONTO A SCRAP PIECE OF PLASTIC OPTICAL FIBER)
PHOTO XSTOR ASSY :
EMITTER, PIN 'B'
1.50
1.25
Ø 1/4" BLK SHRINK TUBING.
Ø 3/16" WHT SHRINK TUBING.
1.00
COLLECTOR, PIN 1 (LONGER LEAD)
(SHRINK TUBE FORMED ONTO A SCRAP PIECE OF PLASTIC OPTICAL FIBER)
29000-01
OHM MAPPER
NEXT ASSY
USED ON
DESCRIPTION
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE INCHES.
TOLERANCES:
DECIMALS : .X ± .XX ± .02 .XXX ±
ANGLES : ±
MATERIAL :
SEE MATERIAL LIST.
FINISH :
NONE.
CONTRACT NO.
DO NOT SCALE DRAWINGS
APPROVALS
DATE
DRAWN : R.S.PALACIO 04.04.99
DESIGNED : J.JOHNSTON 08.02.00
ORIGINATOR :
APP'D ENG'G :
APP'D MANUF :
FILE NAME : 0029036-02
GEOMETRICS INC.
2190 FORTUNE DRIVE
SAN JOSE, CA 95131 USA
TEL: (408) 954-0522
FAX: (408) 954-0902
ASSEMBLY, OPTICAL ISOLATOR
SIZE B
FSCM NO.
DRAWING NO. 29036-02
REV. E1
SCALE : NONE
SHEET : 1 of 2

REVISIONS					
ZONE	ECO #	REV.	DESCRIPTION	APPROVED	DATE
			SEE PAGE 1 FOR DESCRIPTION OF CHANGE.		

5. INSERT ITEM 6 TO ITEM 2. REFER TO DWG ON NOTE 1 AND SCHEMATIC SHOWN BELOW FOR CABLE ORIENTATION ;

6. PLACE THE PHOTO ASSY (NOTE 3) ON THE EXPOSED P.O.F. THE EXPOSED END OF THE P.O.F. SHOULD TOUCH THE LED/PHOTO XSTOR. IF IT DOESN'T TOUCH, TRIM THE SHRINK TUBING OR REPEAT (NOTE 6) UNTIL IT DOES.

7. REMOVE THE PHOTO ASSEMBLY (NOTE 3) AND SMOOTH THE EXPOSED P.O.F. BY MELTING IT SLIGHTLY WITH A LOW POWER HEAT GUN.

8. REPEAT NOTE 6 AND 7 ON THE OTHER END OF THE CABLE. PLACE PHOTO ASSY'S ON BOTH ENDS OF THE CABLE AND TEST BY CONNECTING TO A WORKING OHM MAPPER RECEIVER AND 858 DATA LOGGER. A SUCCESFUL TEST REQUIRES THAT COMMUNICATION IS MAINTAINED WHEN THE OPTICAL CABLE IS WITHIN 0.0" TO 0.5" OF EITHER THE LED OR PHOTO XSTOR.

9. ASSEMBLY INSTRUCTIONS PER FIGURE ON NOTE 1 ;
   - A. PUSH THE PHOTO TRANSISTOR ASSEMBLY INTO THE HOUSING, ITEM 3, AND SEAT IT FIRMLY USING A NARROW BLUNT TOOL. IF THE GASKET ON THE PIN WAFER IS PROPERLY SET YOU SHOULD NOT BE ABLE TO BLOW AIR INTO THE FRONT OF THE CONNECTOR; TRY IT !.
   - B. PLACE THE PHOTO TRANSISTOR & HOUSING ASSY ON THE EXPOSED P.O.F. AND SLIDE THE OTHER END OF THE P.O.F. INTO THE END OF THE TUBE WITHOUT THE COLLAR. SCREW THE HOUSING INTO PLACE.
   - C. PUSH THE PHOTO DIODE ASSY INTO ITS HOUSING AND SEAT IT FIRMLY USING A NARROW BLUNT TOOL AS IN STEP 'A'.
   - D. SLIP THE THE PHOTO DIODE ASSEMBLY ON THE EXPOSED P.O.F. AND SCREW THE HOUSING INTO PLACE.
   - E. TEST AGAIN AS IN STEP "8".
   - F. IF THE TEST IS GOOD PROCEED TO STEP 'G'. OTHERWISE REMOVE THE HOUSING FROM EACH OF THE TUBE AND CHECK FOR ALIGNMENT.
   - G. PLACE A STRIP OF MASKING TAPE OVER THE GLUE HOLE ON THE HOUSING AND ALSO OVER THE VENT HOLE ON THE TUBE. USING AN EXACTO KNIFE CUT A SMALL HOLE IN THE TAPE TO EXPOSE THESE HOLES. THIS TAPE PROTECTS THE WORK PIECE FROM EXCESS GLUE.
   - H. PRE-POSITION STRIPS OF MASKING TAPE NEAR THE GLUE HOLE AND VENT HOLE TO SEAL THESE HOLES WHEN GLUING IS COMPLETE.
   - I. INJECT DP-100 EPOXY, ITEM 15, USING A MIXINGH NOZZLE, ITEM 14, INTO THE HOLE IN THE HOUSING WHILE THE TUBE IS HELD VERTICAL WITH THE VENT HOLE ABOVE THE HOUSING. CONTINUE INJECTING EPOXY UNTIL IT APPEARS AT THE VENT HOLE AND THEN COVER THE VENT WITH MASKING TAPE.
   - J. SLOWLY WITHDRAW THE MIXING NOZZLE WHILE INJECTING ENOUGH EXTRA EPOXY TO FILL THE VOID LEFT BY REMOVAL OF THE NOZZLE TIP AND THEN COVER THIS HOLE WITH ITS TAPE STRIP.
   - K. AFTER ABOUT 10 MIN. THE TAPE CAN BE REMOVED AND THE CABLE CAN BE PLACE IN THE HOT BOX FOR CURING.
   - L. REPEAT STEPS 'G' THROUGH 'K' ON THE OTHER END OF THE ISOLATOR.

10. TEST USING TEST INSTRUCTION, ITEM 13.

11. BAG AND TAG WITH PART NUMBER AND CURRENT REVISION.

SEE PAGE 1.	
NEXT ASSY	USED ON
DESCRIPTION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE INCHES
TOLERANCES:
DECIMALS : .X ± .XX ± .02 .XXX ±
ANGLES : ±
MATERIAL : SEE PAGE 1.
FINISH :

CONTRACT NO.
DO NOT SCALE DRAWINGS

APPROVALS	DATE
DRAWN : R.S.PALACIO	12.30.99
DESIGNED : J.JOHNSTON	08.02.00
ORIGINATOR :	
APP'D ENG'G :	
APP'D MANUF :	

FILE NAME : 0029036-02

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

ASSEMBLY, OPTICAL ISOLATOR

SIZE	FSCM NO.	DRAWING NO.	REV.
B		29036-02	SEE Page 1

SCALE : NONE
SHEET : 2 of 2

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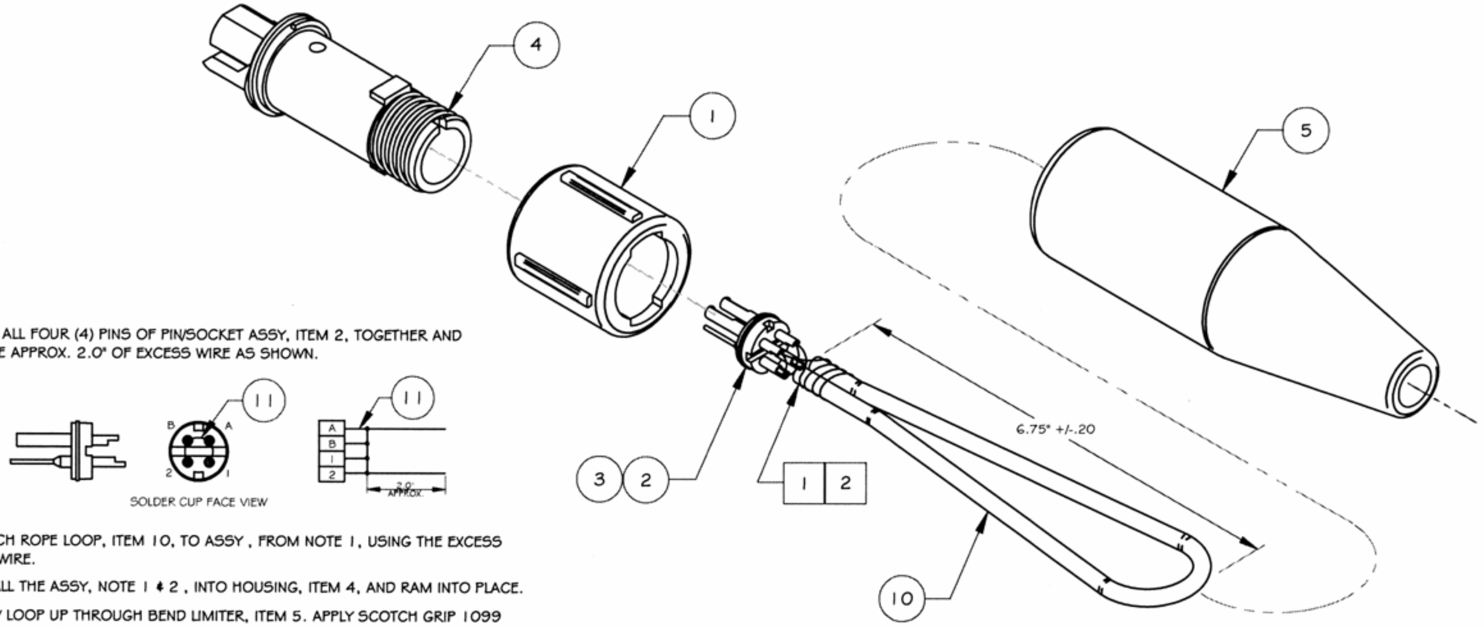
R E V I S I O N S

ZONE	ECO #	REV.	*DESCRIPTION*	APPROVED	DATE
	200201.16	D1	ADDED 29117-01, PULL TEST SHEET, IN B.O.M. S.COPE		01.18.02



NOTES:

1. WIRE ALL FOUR (4) PINS OF PIN/SOCKET ASSY, ITEM 2, TOGETHER AND LEAVE APPROX. 2.0" OF EXCESS WIRE AS SHOWN.

SOLDER CUP FACE VIEW

2. ATTACH ROPE LOOP, ITEM 10, TO ASSY , FROM NOTE 1, USING THE EXCESS 2.0" WIRE.
3. INSTALL THE ASSY, NOTE 1 & 2 , INTO HOUSING, ITEM 4, AND RAM INTO PLACE.
4. DRAW LOOP UP THROUGH BEND LIMITER, ITEM 5. APPLY SCOTCH GRIP 1099 TO THREADS OF HOUSING AND SCREW INTO PLACE.
5. PREPARE THE ASSEMBLY, NOTE 1 TO 4, FOR GLUING AS SHOWN ON 29034-01 DWG ASSY INSTRUCTION AND INJECT EPOXY INTO HOUSING UNTIL IT APPEARS AT VENT HOLE.
6. BAG AND TAG WITH PART NUMBER AND CURRENT REVISION AFTER THE GLUE HAS SET.

29004-01	OHM MAPPER
29010-01	OHM MAPPER
NEXT ASSY	USED ON
DESCRIPTION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE INCHES.
TOLERANCES:
DECIMALS : .X ± .XX ± .03 .XXX ± .005 ANGLES : ± 1

MATERIAL :
HOUSTON GEOPHYSICAL PRODUCTS, INC.
KAM-4A ASSY W/ SHORTING BARS,
P/N A0003-008

FINISH :

CONTRACT NO.

DO NOT SCALE DRAWINGS

APPROVALS	DATE
DRAWN : R.S.PALACIO	07.28.99
DESIGNED : J.Johnston	02.28.01
ORIGINATOR :	
APP'D ENG'G. :	
APP'D MANUF. :	

FILE NAME : 0029037-01

GEOMETRICS INC.

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

SHORTING PLUG

SIZE	FSCM NO.	DRAWING NO.	REV.
B		29037-01	D1

SCALE : NONE SHEET : 1 of 1