2PIA-1000
POLY INDUCTION PROBE,
2EMA-1000 Conductivity Probe
(2EMB-1000 and 2EMC-1000)
EMP-2493 and EMP-4493

Mount Sopris Instrument Co., Inc.
Golden CO U.S.A.
September 5, 2002

Table of Contents

Tables and Figures

The majority of information in this manual is from:

Geonics Limited, 1992, “Geonics EM39 Borehole Conductivity Logger Operating Manual”, Geonics Limited, Mississauga, Ontario, Canada.
Geonics Limited, 1986 Technical Note TN-20, “Geonics EM39 Borehole Conductivity Meter Theory of Operation”, Geonics Limited, Mississauge, Ontario, Canada.

General Information

Overview

The 2PIA-1000, 2EMA-1000 and EMP-2493 probes measure the conductivity and magnetic susceptibility of the material around the probe. The 2PIA-1000, probe is provided with the standard Poly probe top, which will enable the user to run the induction tool beneath the 2PGA-1000, Poly - Gamma. It can be run stand alone when used with the 2ADP-1000 probe top adapter.

The 2EMA-1000, probe indicates a tool with the Mount Sopris Instruments single conductor probe top attached while the 2EMB-1000, version has the Mount Sopris 4 conductor probe top. The 2EMC-1000, version has the GOI 4 conductor probe top.

The EMP-2493 is the original designation for the 2EMA-1000 and the EMP-4493 is the four-conductor probe top version. The very first versions of these probes had a different pulse driver circuit than is now used in the 2EMA-1000. The original pulse driver put out a smaller pulse height. Many EMP-2493 have been updated with a pulse drive circuit with characteristics similar to the 2EMA-1000. If you have the original pulse drive electronics you should select the appropriate tool driver in MSLog otherwise the tool driver for the 2EMA-1000 is correct. In all other respects the EMP-2493 is the same as the 2EMA-1000 and comments concerning the 2EMB-1000 and 2EMC-1000 apply to the EMP-4493.

These probes are based on the Geonics EM-39 slimline induction tool. Conductivity is measured in millisiemens per meter (mS/m) and the Magnetic Susceptibility is measured in percent of primary magnetic field. The tool has been optimized for conductivity readings therefore Magnetic Susceptibility measurements may be qualitative rather than quantitative.

In the following document the probes will be referred to generically as the induction probe. Features specific to individual models will be referred to by model number as above. References to the 2EMA-1000 are applicable to the 2EMC-1000 and 2EMB-1000 other than the cable head type they are used with. Earlier versions of the probe such as the EMP-2493 are essentially the same except a few that have the original pulse drive circuitry.

Some models, except for the 2PIA-1000, have Magnetic Susceptibility outputs connected as the negative pulse output. Some tool, driver files have this channel enabled some do not. Consult Mount Sopris Instruments with questions.

Controls, Connectors, and Layout

Controls for the induction probe consist of a rotary switch located inside the probe. To manually set this range switch you will need to open the probe by unscrewing the housing at the joint just above where the black heat shrink ends at the probe top. Remove housing and locate the range select switch using Figure 1. Set the switch as per Table 2. To have the tool select two ranges automatically refer to Table 3. Note that when the automatic selection is desired the switch must be set to position 5, for the surface equipment to be able to switch ranges in the tool. The factory setting is position 5, for the range switch.

Connectors for the 2PIA-1000 consist of the slip ring connector on top of the probe top. This connector mates with an identical connector when the tool is attached to a 2PGA-1000 Poly - Gamma or a 2ADP-1000 Poly top adapter. The slip ring connector has 6 conductors, with 1 being the inner most ring and continuing to the outer ring which is number 6. The ring functions and labels are listed below

Ring	Signal	Origin
1	Not used	Not used
2	Power	CL, center cond.
3	Not used	Not used
4	External Pulse input	Poly Gamma tool, 2ADP
5	Power	Armor
6	Mag Sucep Pulse output	From the EM-39 tool

Table 1 2PIA-1000 Poly Probe Top Connector

Layout for the tool in general is as follows, starting at the bottom of the tool. On the bottom of the housing is a black Delrin thread protector that can be removed and replaced with the weight section provided with the probe. The top of the housing is about 16cm below the probe top. At the top of the probe is the thread protector and Poly or other style probe top. Internal electronics from the bottom of the tool consist of a series of coils and In-phase and Quadrature phase support electronics. Next would be the amplifier board connected to the anticoincidence board. These two boards perform the range switching and pulse driving capabilities of the tool.

Theory of Operation

The conductivity measurements are made by using a magnetic field to induce an electric field, which in turn produces electric currents in the material being surveyed. Because the magnitude of these currents is proportional to the conductivity of the material being measured, the magnetic field generated by the induced electric currents is measured. At high conductivities the accuracy of the induction tool diminishes due to skin effect.

The magnetic field at a given point is composed of the primary magnetic field and the magnetic field produced by the material as a result of being immersed in the magnetic field. The ratio between these fields is the magnetic susceptibility. The magnetic susceptibility measurement works best when the conductivity is low. A different probe model is available that has a modified coil array, which is optimized for the magnetic susceptibility measurements. Consult factory for more information about this type of tool.

The coil array in the induction probe has been designed so that it is not sensitive to material at a radial distance smaller than about 10 cm from the probe axis. The reason for this is to reduce sensitivity to the borehole fluid. The vertical resolution of the tool is 65 cm. This is measured as the vertical distance where the response is more than half the maximum response to an infinitely thin bed. The volume of investigation is similar to that of the 40 cm normal resistivity probe, therefore the induction tool and the normal resistivity tool give similar responses. The shape of the volume of the investigation is radically different between the two tools. See Geonics technical note TN-20 for more details on the theory of the induction logging and the response of the EM-39 conductivity probe.

The receiver circuit rectifies the received signal using a synchronous rectifier and generates two DC voltages, one proportional to the average value of the quadrature phase component of the received signal (with respect to the primary magnetic field), and another proportional to the in phase component of the received signal. The quadrature phase component is proportional to the conductivity and the in phase component is related to the magnetic susceptibility.

These DC voltages are then converted into pulse trains whose frequencies are proportional to the measurements. These pulses are sent up the logging cable for counting at the surface. The probe sends an ~ 12.5 KHz pulse train to indicate a measurement of zero, and ~ 17.5 KHz pulse train indicates a full, scale measurement. Positive pulses are sent and represent the millisiemens per meter (conductivity). Negative pulses are sent to indicate either the magnetic susceptibility if the tool is connected to a 2ADP-1000 adapter or the gamma count rate from the Poly - Gamma tool if the unit is connected to a 2PGA-1000.

The reason a zero count rate of 12.5 KHz was selected is that in the presence of metallic objects negative readings occur. These objects are commonly smaller than the volume of the investigation of the probe, thus the mechanism used to subtract the primary field and the response from borehole fluid can cause negative readings. This can be useful information.

Range of measurement is controlled, by changing the gain of the receiver circuit. The gain can be changed manually in the probe or by applying different polarities to the probe for power. These polarities set a latching relay in the tool, which controls the gain setting. Only two different ranges are achievable by this method.

Installation

WARNING Fragile

Because the tool housing is non-metallic, thin wall fiberglass it should be treated with extra care. Do not drop, bend, or otherwise stress the tool or leakage can result from fractures in the fiberglass housing or its metal joints.

Installing the 2PIA-1000

Installation of the probe only requires that you have decided to either run the tool under the Poly Gamma or as a standalone probe. In the standalone mode you should attach the 2ADP-1000 Poly to MSI single conductor cablehead adapter to the top of the probe. Next attach the probe string onto a Mount Sopris single conductor cablehead connected to the winch. The 2PIA-1000 probe is constructed of lightweight fiberglass and may need an additional weight section installed when logging in mud - filled boreholes. To do this, loosen the setscrew in the black Delrin cone on the bottom of the probe and unscrew the cone. Install the weight section in the reverse manner.

Installing the 2EMA-1000, EMP-2493

As this probe runs only stand alone you attach the probe to the appropriate cable head and winch. The 2EMA-1000 probe is constructed of lightweight fiberglass and may need an additional weight section installed when logging in mud - filled boreholes. To do this, loosen the setscrew in the black Delrin cone on the bottom of the probe and unscrew the cone. Install the weight section in the reverse manner. Select the appropriate tool driver.

Range Selection

Range selection is determined by the wiring of jumpers in the probe. If the probe has the factory setup then the polarity of the voltage to the probe selects one of two ranges. The third range can be manually selected by removing the housing of the probe and manually selecting the proper range with the range select switch as detailed below. The probe can also be set to operate in one range regardless of the polarity of the voltage applied to the probe top by setting the Range select switch to the desired position 2 through 4.

Probe Range Select Switch Position	Conductivity Range
2	0 - 10,000 milliSiemens/meter
3	0 - 1000 milliSiemens/meter
4	0 - 100 milliSiemens/meter
5*	Select Range “A” or “B” from the surface

Table 2 Range Select Switch

Range Selection	Range “A”	Range “B”
0-100 mS/m	JP12 to JP11	JP12 to JP13 *
0-1000 mS/m	JP10 to JP11 *	JP10 to JP13
0-10000 mS/M	JP11 to JP 9	JP9 to JP13

Table 3 Range Jumper Installation

Note: Only two jumpers are to be installed at any one time.
* denotes factory setting

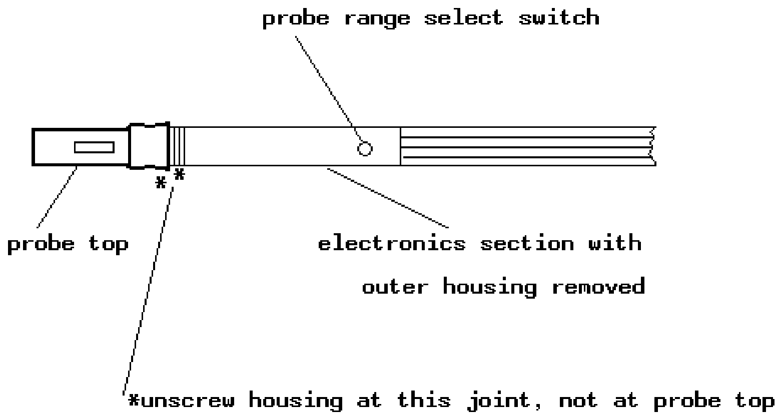


Figure 1 Probe Range Select Switch

Operating Procedure

Operation

The operating procedures described below will include MGX and MGX II versions. In most cases the range of measurement control will be done from the surface. If you choose to do this manually, refer to the Controls section of this manual.

MSLog

1. Select the correct tool driver from the Tool panel selection box. If the correct one is not available run MSLConfig to install it.
2. In the Tool panel, click the Power On button.
3. Click the Depth panel upper right corner icon. Click Zero Tool.
4. If you wish to fill out the header, in the Acquisition panel click Header button.
5. In the Acquisition panel, click Record and select a file name.
6. Turn on the desired, Depth Sampling mode.
7. If you are printing, turn on the printer in MCHCurve.
8. Log to the desired interval as normal. Refer to the MSLog manual for additional information on logging.
9. When done, in the Acquisition panel, click Stop.
10. In the Tool panel, click the Power Off button before removing the probe.

Logshell

If the probe or combination of the Poly gamma and Poly Induction are to be used with an MGX series logger, the **PULSE 2** position on the Probe Select switch must be used for logging. **Range 'A'** is selected by placing the Probe Power switch in the **ON (Close)** position, while **Range 'B'** is selected by placing the Probe Power switch in the **OFF (Open)** position.

If the probe is being operated with an UM-4591, a HLM-4180, a FLM-4180, or a GLM-4180, set the range of the probe by momentarily setting the caliper control to CLOSE to select range 'A', and OPEN to select range 'B'. Probe operation is then accomplished using the conventional settings on these modules. *This only applies to the 2EMC-1000 and 2EMB-1000 if they are properly wired for four-conductor operation.*

For use with the Series 5, Altlogger, the probe wiring may be configured in a number of ways depending on the 4pulse adapter configuration. Consult Mount Sopris Instruments.

If the probe or combination is to be operated with an MGX II logger, choose the corresponding probe driver for the proper range and combination of tools and the unit will provide proper power and polarity to the probe.

The probe can be logged at a speed of approximately 30 ft/min or 10 m/min with good results and no loss of resolution. The probe is extremely lightweight and may require the addition of an optional bottom weight when logging in heavy muds. Consult the factory for details. The zero point or depth reference of the probe is the thickened ring located 91.4 cm (36 in.) below the probe top joint.

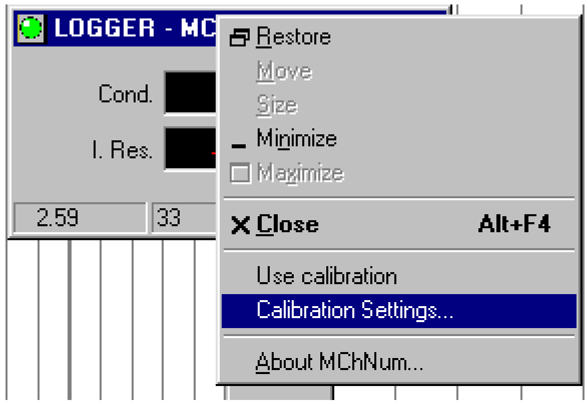
Performance Checks and Calibrations

Although the instrument is set to read correctly at the factory, it is necessary to check the instrument calibration before logging the tool. For highest accuracy, it is recommended to perform these calibrations prior to logging. Allow the probe to operate under power for at least 10 minutes, in borehole fluid, prior to making any calibrations

To calibrate the probe, connect the probe to the logging system as discussed in the Installation section of this document. Turn power to the probe on utilizing one of the various types of data acquisitions systems discussed in the Operating procedure section. Place the probe in borehole fluid and allow it to warm up. Pull the probe from the borehole and hold the probe at the cablehead/probe top joint and elevate the probe in a vertical direction so the bottom of the probe is pointing straight up in the air and is at least 3 meters above the ground. Ensure that the person and or device holding the probe in this position does not have any metal objects attached, such as a watch, screws, or duct-tape, as these items are conductive. Also ensure that the tools are at least 3 meters from any metal buildings, vehicles, even the logging unit. Set the data acquisition equipment to read zero conductivity at this point; this is the first calibration point. To obtain the second calibration point, two methods can be used. The first method discussed utilizes a calibration coil. This coil is placed over the conductivity probe. Located on the coil is a switch to choose different values for the second calibration point. Depending on the range setting of the tool certain values may over - range the tool, so it is important to know what range the tool is functioning in before making a calibration. When the probe value for the second calibration point has been chosen, set the acquisition equipment to read this value. If a calibration coil is unavailable set the acquisition system for the second calibration point to a value of the frequency of pulses from the tool at the zero point plus 5000 (i.e. if zero is 12500 counts then the second calibration number would be 17500. Also be sure that you adjust the scaling of the probe file to match the range of the tool (i.e. 100mS/m, 1000mS/m or 10000mS/m). The frequency output of the probe with respect to conductivity is quite linear and with only one point, zero, we can establish the full scale calibration point with reasonable accuracy by adding 5000 to the frequency that represents zero conductivity. For this method to work properly it is essential that the scaling or output of the probe file (i.e. RgtOut or High Ref. number is set equal to the range in which the tool is operating.

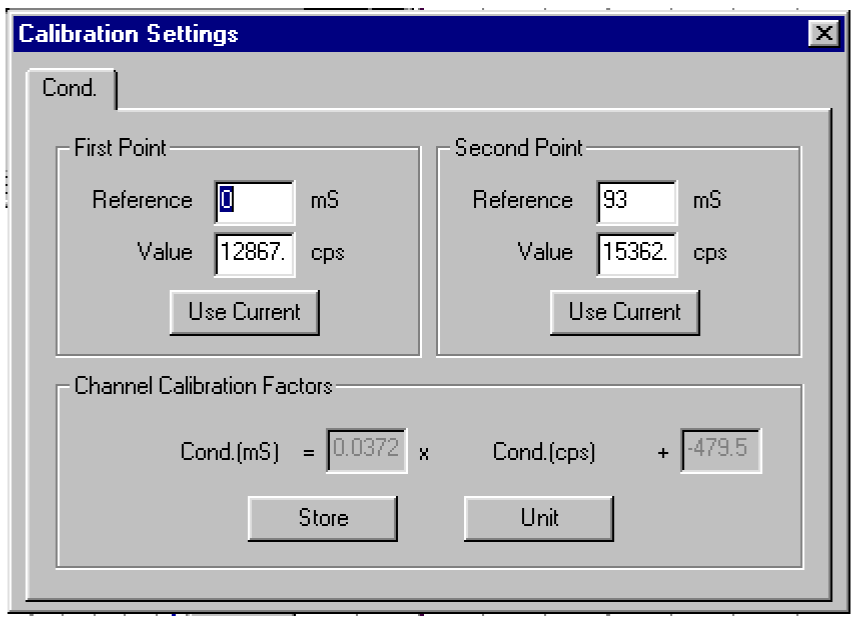
MSLog calibration

1) Turn Probe power On.
2) Turn Sampling to Time and On.
3) Lower the Probe without a weight into the borehole fluid and allow it to warm up for 10-15 minutes or until the Induction channel stops drifting.
4) Right click on MCHNum.
5) Uncheck Use calibration
6) Right click on MCHNum.



7) Click Calibration Settings..

8) Quickly pull the probe from the borehole and hold it into the air bottom end up. You should be away from any metal objects that would disturb the measurement.



9) Press the First Point Use Current button to capture the frequency of the input at the zero Reference.
10) When you have a calibration standard
    a. Slide the calibration standard over the probe. Select the proper setting for the range of operation. In this example the 0-100 range is selected and the switch setting of 93 is entered in the Reference for the Second Point.
    b. Hold the probe with the calibration standard over the end into the air.
    c. Press the Second Point Use Current button to capture the frequency of the input at the 93 ms (in this example) Reference.
11) When you don't have a calibration standard.
    a. Note the First Point Value.
    b. Add 5000 to the First Point Value and enter it in the Second Point Value box.
    c. Enter the full, scale value for the operating range you have selected into the Second Point Reference box. In the example above you would enter 100.
12) Press Store to save the values to the tool driver file.
13) Press the X in the upper right corner of the browser to close the dialog.

14) On the MSLog Browsers and Processors menu press Close all.
15) Select each Browser or Processor from the menu individually and press the Start button. Wait until the browser or processor Connects then select the next one in the list, press Start and so on until all the processors and browsers are running. This is necessary so that the browsers and processors can read the new calibration information stored in the tool driver file in step 12 above.

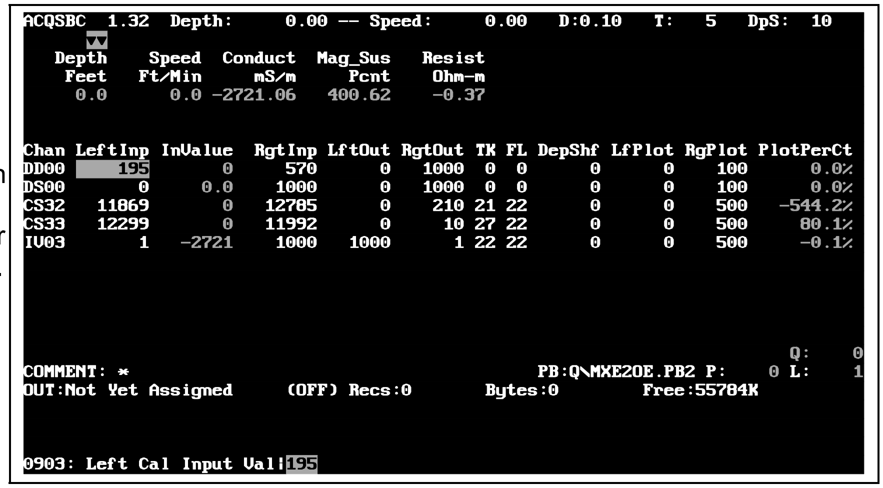
Logshell calibration

The following is a brief, step by step, procedure for Logshell users of both the MGX and MGX II loggers. Items in ( ) will be information regarding the MGX II version of Logshell.

1) Connect the probe or probes to the Logger and activate LOGSHELL.

2) Select the **LOG** option from the menu and select the probe driver from the **Probe** menu.

3) Enter the data file name at the **DataFile** menu and set the depth at the **Depth** menu.



4) When you have reached the ACQSBC or the (PolyLog) screen you are ready to check the probe calibration. For MGX users choose the proper **Probe Select Switch** position and the proper **Probe Power Switch** position for range selection.. For MGX II users, the system has already powered the probe and you must choose **Calibrate** from the menu.

5) The factory calibration factors for conductivity are seen in the **CS32** line. As seen in the figure, **LeftInp** is **11869**. This number is equivalent to 0 conductivity. This equivalence is set, by placing the number **0** in the **LftOut** column.

6) Verify the number **0** is in the **LftOut** column of the **CS32** line. If it is not, move the cursor to that position press <**0**> and then <**ENTER**>.

7) Hold the probe at the cable head/probe top joint and elevate the probe in a vertical direction so that the probe bottom is pointing straight up in the air and is at least three meters above the ground. Make sure that you do not have any metal objects such as a watch or a ring on the hand holding the probe and that no conductive objects are nearby. You may have to move a few yards away from any nearby buildings or power lines.

8) While the probe is held in the air, verify that the number in the **InValue** column of the **CS32** line matches the **LeftInp** number **11869**. If the number does not match, move the cursor to the **CS32** line, and while the probe is held in the air as described above, press **F3**. This copies the **InValue** number into the **LeftInp** column of the **current** line.

9) Set the MGX Probe Power switch so that it selects the 0-1000mS/m range. The default factory setting will be to operate with the switch in the **ON(Close)** position.

10) Place the calibration ring on the probe as shown in Figure 2.

11) As seen in the figure above, **RgtInp** is **12785**. This number is equivalent to 210mS/m conductivity. This equivalence is set, by placing the number **210** in the **RgtOut** column. Verify the number **210** is in the **RgtOut** column of the **CS32** line. If it is not, move the cursor to that position press <**210**> and then <**ENTER**>. With the calibration coil in

position **b**, note the number in the **InValue** column. Press <**F4**>. This copies the **InValue** number into the **RgtInp** column of the **current** line.

Note: In calibration coil position **a,** the coil can be used to calibrate the equipment to 12.4 mS/m, which is better for operating the probe int the 0 - 100 mS/m range. Repeat step 11 replacing the number **210** with **12.4**.

12) Perform this step only if a second calibration point is not available (if you don't have a test coil). Note the number in the **LeftInp** column of the **CS32** line. This is the zero input frequency. Add **5000**(cps) to this number. Move the cursor to the **RgtInp** column of the **CS32** line. Type the calculated number into that column and press <**ENTER**>. Move the cursor to the **RgtOut** column, press <**1000**> and <**ENTER**>.

Note: The frequency output of the probe with respect to conductivity is quite linear and with only one point, zero, we can establish the full scale calibration point with reasonable accuracy by adding 5000 to the frequency that represents zero conductivity. This second number then represents 1000mS/m in the example above. If a different scale is used, 5000 plus the zero value from the **LeftInp** column will be equal to that range full scale value i.e. 100 or 10,000mS/m. <u>For this method to work accurately it is essential that the **RgtOut** column number is set equal to the range in which you are operating the probe!</u>

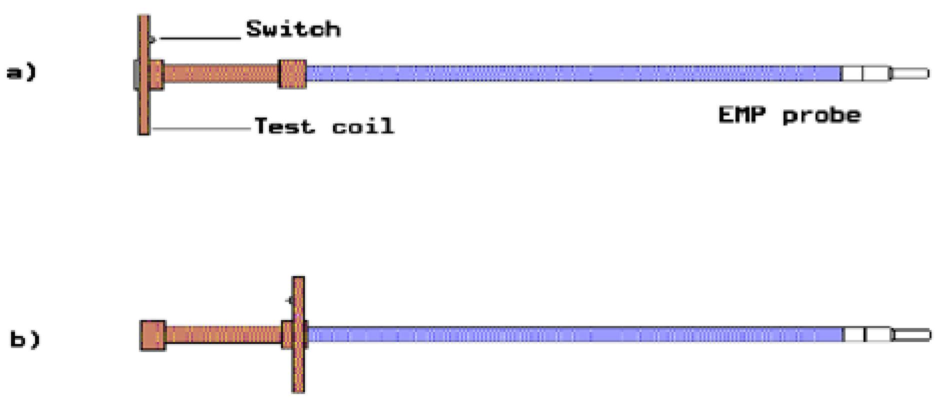


Figure 2 Calibration Set-up with Geonics Test Coil

Preventive Maintenance

The 2PIA-1000, probe, should provide long life with no maintenance. If the accuracy of the probe is suspect, proceed to align the probe as follows.

Adjusting the Anticoincidence Circuit:

1. Remove the housing from the probe top. Remove the outer shields by unsoldering the wire braid and green wire attached to the braid. Slide each shield down about 6 inches.
2. Locate R15 and R36 on the rectifier board then connect P29-2, P29-3 and P29-6 together. See Figure 4 for component placement.
3. Connect the probe to the logging cable and power up tool. Looking at the Input value on the acquisition screen adjust R3 and R7 for 12.5 KHz.
4. Turn off power to the tool. Remove the shorts on P29 and re-solder R15 and R36.
5. Reinstall the shield and **be sure to solder the green wire to the braid**. Inspect the O-ring on the probe top for cleanliness, cuts or abrasions then replace the housing.

Null Adjustment:

1. Remove the tool from its external housing. Locate and identify adjustment slots on the end of the probe. Use Figure 3 as a reference.
2. Connect the probe to the logging cable and power up tool. Get the tool at least 3 meters from any metal object and as high off the ground as reasonable.
3. Set the range switch on the probe to the 100mS/m range. See Figure 1 for switch location and Table 2 for switch position.
4. Adjust control 2 for conductivity and control 3 for magnetic susceptibility on the probe to obtain a zero of 12.5 KHz on both channels. See Figure 3 for controls. There could be interaction between controls therefore it may be necessary to repeat this process.
5. Turn off power to the tool. Reinstall the shield and be sure to solder the green wire to the braid. Inspect O-ring on the probe top for cuts or abrasions. Replace housing.

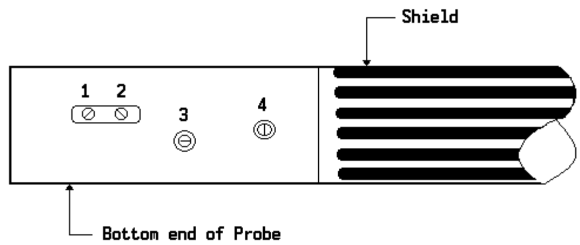


Figure 3 Linearity and Null Adjustment

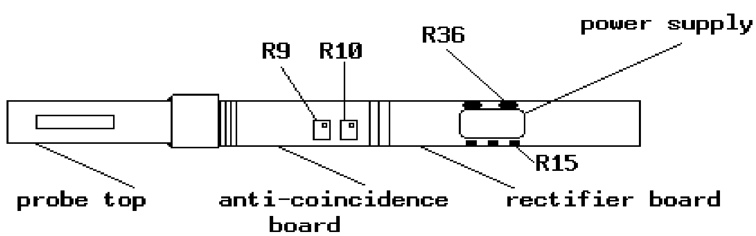


Figure 4 Location of Discrete Components

Troubleshooting

Problems with the Tool

In the event the tool develops a problem, follow the troubleshooting procedure listed below.

No data from the probe.

1. Are the MGX switches set correctly? **PULSE 2** and **ON or OFF** positions
2. Are the PROBE CURRENT and PROBE POWER LED's on? (MGX users)
3. MGX II users, is the correct probe driver chosen?
4. MGX II, is the TO PC light flashing?
5. Is the proper voltage applied to the cable line conductor wire? Approximately 68 volts D.C., for the MGX and 68 to 72 volts D.C. for the MGX II.
6. Are the cables between winch, MGX unit and the PC connected properly?
7. Check the logging cable for conductive leakage across the center conductor to ARMOR.
8. If an oscilloscope is available verify if the probe is sending pulses, if not consult Mount Sopris.
9. Is the slip ring connector on the probe top clean?

Disassembly Instructions

The 2PIA-1000, probe, should never be disassembled unless service is necessary. In the event service is necessary, it should be returned to Mount Sopris Instruments, or a qualified technician. In the event you need to get into the probe, unscrew the housing from the probe top at the junction about 2" just above where the black heat shrink ends on the housing. Before reinstalling the housing inspect the o-ring on the probe top for any damage like cuts or abrasions. This is very important. If the O-ring fails borehole fluid can fill the tool and damage the tool permanently. Flooded tools usually require complete replacement of the electronics.

WARNING: Because the tool housing is non-metallic, thin wall fiberglass it should be treated with extra care. Do not drop, bend, or otherwise stress the tool or leakage can result from fractures in the fiberglass housing.

Appendix

Suggested QA Procedure

General notes for Quality Assurance are presented here for users who need to utilize these techniques when collecting data. These users will need to periodically calibrate their equipment using equipment whose calibration is traceable to an approved standard. Details of these calibrations must be recorded.

When an instrument is calibrated, records need to be kept regarding the calibration standard(s) used and what was changed on the instrument to calibrate it. Typically, the corrections made to the instrument involve changing constants that are used to scale the raw instrument reading so that the proper value is reported. The constants must be recorded during a calibration procedure. The Mt. Sopris family of Acquire programs records the calibration constants that were used to acquire the data. This aids the QA process, but does not replace the need for recording these constants at the time of calibration. The reason for this is that the length of time since the last calibration is unknown with only this information.

The device providing the standard must be traceable to an accepted standard. Examples of organizations providing standards for measuring instrumentation are: The U. S. National Bureau of Standards; The American Petroleum Institute; and the American Society for Testing Materials. For example, if the voltmeter or the density standard used for calibration is not traceable to an approved organization, such as those listed above, the calibration should not be considered valid. Records should be kept indicating the last time that standard being used for calibration was calibrated or checked against an approved standard. The QA procedure necessary for some programs mandate that the calibration standards be periodically checked against a standard approved by a proper agency.

A QA procedure may dictate that data taken from a given locale be associated with records indicating the exact time and location that the data was collected. The data itself may have to be collected in a certain format to meet requirements. Often, QA procedure specifies that surveys must be repeated and the data from the successive surveys compared. This technique is used to eliminate poor or invalid data.

Technical Addendum

Induction Probe Calibration Procedure Update

Models affected: 2PIA-1000, 2EMA-1000, EMP-2493, and EMP-4493

The temperature of the induction tool is important when it's calibrated. Whenever there is a substantial difference between the temperature of the borehole and the temperature of the probe during calibration there can be a shift in the observed log, possibly resulting in negative conductivity numbers being reported for numbers near 0.

From experience with Geonics EM-39 based Mount Sopris Induction tools, the following method of calibration is suggested for the most reliable results.

We recommend that the probe be placed in the borehole, power applied, and the probe allowed to warm up for at least 10 to 15 minutes before calibration. After the warm up, stabilization period, the probe should be quickly removed from the borehole and a zero and second calibration point determined and recorded using the EMP-N294 Induction Probe Calibrator. Do this as rapidly as possible to make sure the probe does not have a chance to change temperature. This is a greater concern on sunny days. The probe can then be returned to the borehole for logging. If you do not do this, the probe calibration will drift until the probe thermally stabilizes.

After logging, another quick calibration can be performed to determine if there was any appreciable change in the calibration numbers. If there is a large difference, then it's likely the probe should have more time to stabilize in the borehole before calibration.

Operating in air filled versus water filled holes may require a different amount of time for the probe to stabilize. This is due to the fact that water provides a better heat sink, allowing the probe to come to thermal equilibrium sooner in water.

Specifications

Power Requirements
D.C. voltage at probe top Min. 30 VDC Max. 80 VDC @ 50mA to 90mA depending on tool configuration
Cable Armor Negative and Pos, not polarity dependant
Center conductor Pos and Negative, not polarity dependant

Tool Output
Pulse type, positive and negative going, 1.25uS wide from ~ 12.5 KHz to 17.5 KHz

Radius of Investigation
Radius of maximum sensitivity 28 cm
Minimum radius of sensitivity 10 cm

Vertical Resolution
65 cm

Ranges or Scales
100mS/m, 1000mS/m, 10000mS/m
Accuracy
5% of full scale

Resolution
0.02 % of full scale

Repeatability
+/- 2% full scale for temperature changes less than 10 degrees Centigrade

Noise level
Less than 0.5 mS/m

Measurement point
91.4 cm (36") from the joint of the probe top
Temperature range
-30 to 50 degrees Centigrade
Operating frequency
39.2KHz

Primary field source
Self contained dipole transmitter
Sensor
Self contained dipole receiver
Coil separation
50 cm

Maximum depth
1000 m (water filled)

Length
170 cm

Diameter
3.65 cm

Weight
3.2 kg (without weight section)

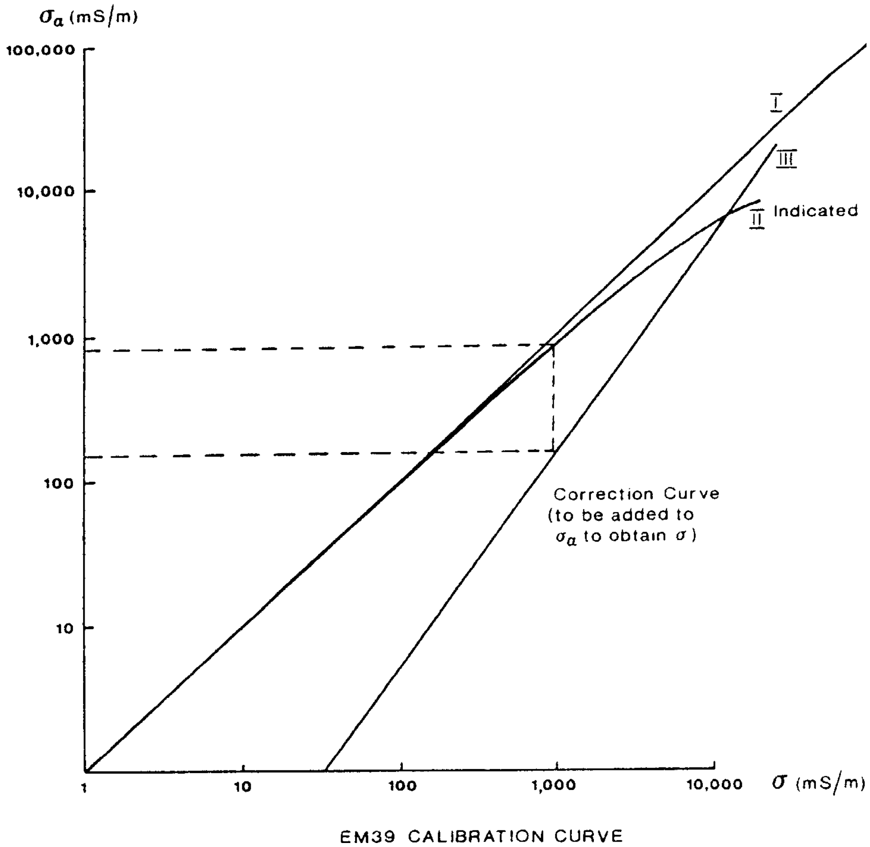


Figure 5 EMP/EM39 Calibration Curve

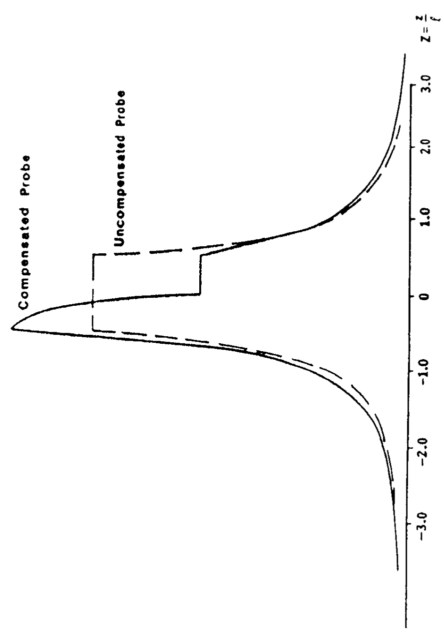


Figure 6 Vertical Response with λ = 58cm

Schematics

2PIA-1000 Poly Induction Probe

Drawing Number 500S-2078   50002078A.S01 - S03   Title: EMP/Poly EMP Anticoincidence