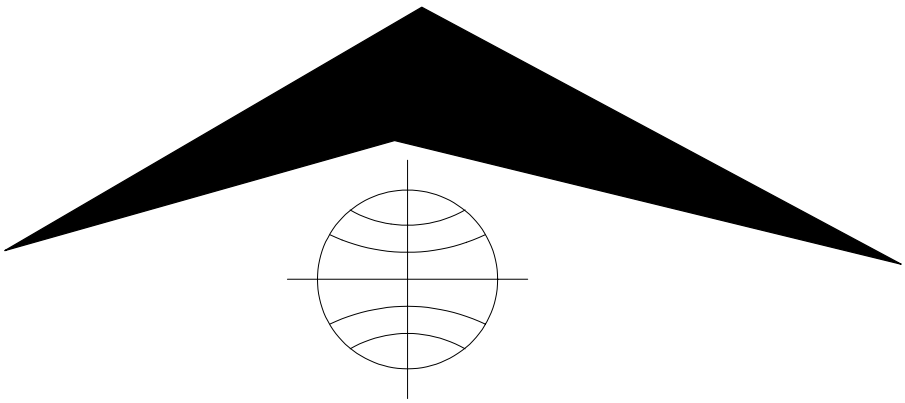
Fluid Resistivity/ Temperature Probe
Models: 2PFA-1000, 2SFA-1000, 2SFB-1000, 2WQA-1000, 2WQB-1000, 2WQC-1000



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Golden CO, U. S. A.
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General Information

Overview

The 2PFA-1000, combination temperature/fluid resistivity probe, provides valuable information for the hydrologist and groundwater scientist concerning borehole fluid character and flow. The 2PFA-1000 is configured as a "Poly" probe, with a quick-connect probe top that allows it to be easily attached to either a Poly gamma probe or fitted with a probe top adapter to run in stand alone mode. Other versions of this probe, designated 2WQA-1000, 2WQB-1000, or 2WQC-1000 are stand-alone probes with respectively, a Mount Sopris single conductor, four-conductor, or GO/I four-conductor top. Finally, the measurements are also available as a factory-mounted sub that is mounted permanently to the bottom of the 2PEA-1000, Poly Electric (2SFA-1000) or 2PCA-1000, Poly Caliper (2SFB-1000) or 2CAA-1000 Caliper (2SFB-1000) probes.

Theory of Operation

The 2PFA-1000 and its various configurations include a seven electrode mirrored Wenner array for measuring borehole fluid resistivity and a temperature sensor based on a fast response semiconductor device whose output voltage changes linearly with temperature. The resistivity array is an internal cylindrical array open at the bottom of the probe. Borehole fluid passes by the array as the probe is lowered in the hole. The array is completely shielded from the outside borehole, so that only fluid resistivity is measured. The temperature sensor is located at the top of the sensor body, in the center of the three exit ports where the borehole fluid returns to the well bore. The "K" factor for the Wenner array is empirically derived, and is approximately 12, when checked for fluid resistivity ranging from 3 to 78 ohmmeters.

Specifications

Diameter	1.5 inches	38 mm
Length	depends on configuration (2WQA-1000 is 22inch, or 56cm)	
Weight	depends on configuration (2WQA-1000 is 5 lbs or 2.3 kg)	
Range		
Fluid Resistivity	0-100 Ohm-meters	
Temperature	-20 to +80 degrees Celsius	
Resolution		
Fluid Resistivity	0.05%	
Temperature	0.1 degrees Celsius	
Accuracy	Better than 1% (both sensors)	

Installation

The 2PFA-1000 uses the tapered lead 6-ring connector common to the Poly family of probes. It is connected to the Poly Gamma or the optional single conductor adapter by simply unscrewing the bull plug (CCW) and screwing the 2PFA-1000 CW onto the mating connector. A firm hand tight connection is all that is required. A layer of electrical tape can be applied if desired.

The 2SFA-1000, 2SFB-1000 subs are installed at the factory, and should not be removed in the field unless proper procedures are available and performed by a qualified electronics technician.

The 2WQA-1000, 2WQB-1000, 2WQC-1000 versions use MSI single conductor, MSI 4 conductor, or Gearhart 4 conductor tops, ready to connect to their respective mating cable heads.

Operating Procedure

Operation

Operation of the 2PFA and its siblings requires that the probe be connected to the cable head. *Make sure that probe power is off before connecting or disconnecting the probe to avoid the chance of electrocution or damage to the equipment.* Normally, **no calibrations are necessary, as the probes are calibrated at the factory**. If re-calibration is desired, see below. Instructions for logging vary depending on your equipment. Follow the appropriate instructions below.

Logging Instructions for MSLog with the MGX II

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. **It is advisable to power the probe while it is in the hole for a few minutes to warm up the electronics before logging for optimum accuracy**.
3. Place the tool in the borehole and position the top of the tool at the zero depth point. Click the Depth panel upper right corner icon. Click Zero Tool. If you cannot place the tool top at depth reference (perhaps the bridle will not go through a sheave), press the Change Depth button and enter the depth of the bottom of the 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. Place the probe at the beginning of the interval to be logged. Usually, temperature – fluid resistivity logs are run from the top to the bottom to avoid disturbing the water column before measurement.
7. Turn on the desired, Depth Sampling mode.
8. If you are printing, turn on the printer in MCHCurve.
9. Log to the desired interval as normal. Refer to the MSLog manual for additional information on logging.
10. When done, in the Acquisition panel, click Stop.
11. In the Tool panel, click the Power Off button before removing the probe.

Logging Instructions for Logshell with the MGX II

1. Select the proper probe from the LOG menu. If the correct one is not available, use the CONFIGURE menu item to install it.
2. Use the DATA FILE menu option to name the output file.
3. When you select LOG from the LOG menu, the acquisition program will begin and power will be applied to the tool. **It is advisable to power the probe while it is in the hole for a few minutes to warm up the electronics before logging for optimum accuracy**.
4. Place the tool in the borehole and position the top of the tool at the zero depth point. Set the depth to zero using the SYSTEM CONTROL menu. If you cannot place the tool top at depth reference (perhaps the bridle will not go through a sheave), enter the depth for the top of the probe.
5. Place the probe at the beginning of the interval to be logged. Usually, temperature – fluid resistivity logs are run from the top to the bottom to avoid disturbing the water column before measurement.
6. Turn on the output file using the DATA FILE menu item.
7. If you are printing, turn on the printer using the PLOT MENU.
8. Log to the desired interval as normal. Refer to the Logshell manual for additional information on logging.
9. When done, select the EXIT/POWER OFF menu item.

Logging Instructions for Logshell with the MGX

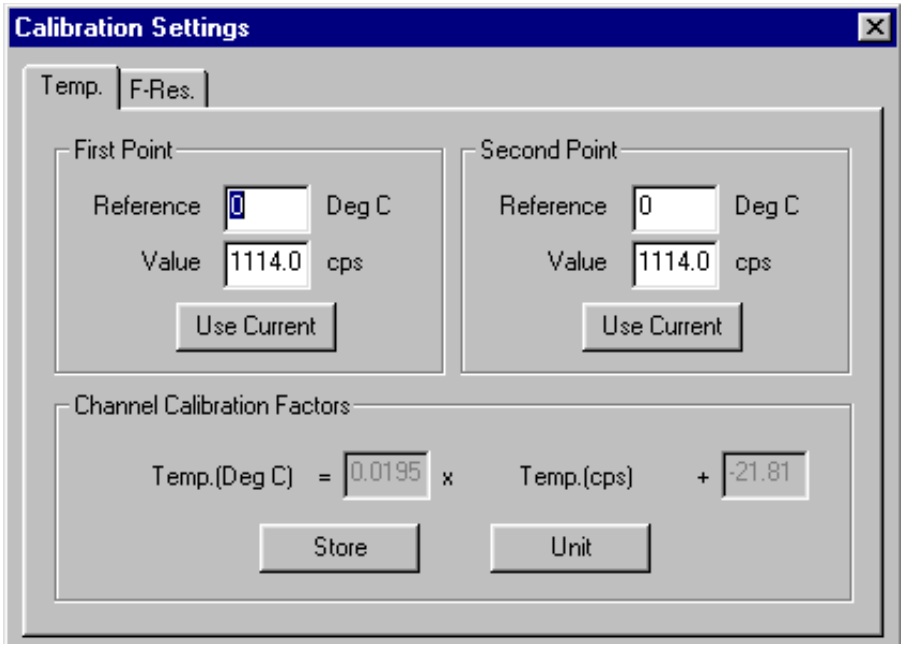
1. Select the proper probe from the LOG menu. If the correct one is not available, use the CONFIGURE menu item to install it.
2. Use the DATA FILE menu option to name the output file.
3. Place the tool in the borehole and position the depth reference point on the tool zero depth point. Set the depth to zero using the DEPTH menu. If you cannot place the tool's depth reference at zero depth, enter the depth for reference point on the tool.
4. When you select LOG from the LOG menu, the acquisition program will begin. Place the PROBE SELECT switch in the PULSE 2 position. Place the PROBE POWER switch in the ON position. **It is advisable to power the probe while it is in the hole for a few minutes to warm up the electronics before logging for optimum accuracy**.
5. Place the probe at the beginning of the interval to be logged. Usually, temperature – fluid resistivity logs are run from the top to the bottom to avoid disturbing the water column before measurement.
6. Turn on the output file using the F6 key.
7. If you are printing, turn on the printer using the F7 key. Then start the plot using the F9 (logging down) or Alt-F9 (logging up) keys.
8. Log to the desired interval as normal. Refer to the Logshell manual for additional information on logging.
9. When done, place the PROBE POWER switch in the OFF position.

Performance Checks and Calibrations

The 2PFA series of probes and subs may be re-calibrated in the field, if desired. An accurate thermometer and fluid conductivity/resistivity cell is needed. A good temperature bath is also required, to allow a large mass of water to stabilize at a known temperature. Be sure that the thermometer is placed very close to the sensor to minimize errors. Standard chemical solutions can be purchased from lab supply vendors to calibrate the resistivity array. Contact Mount Sopris for details. Salt-water solutions can be mixed for this procedure, but changes in temperature during mixing can make true resistivity of such solutions difficult to measure.

Calibration Instructions for MSLog

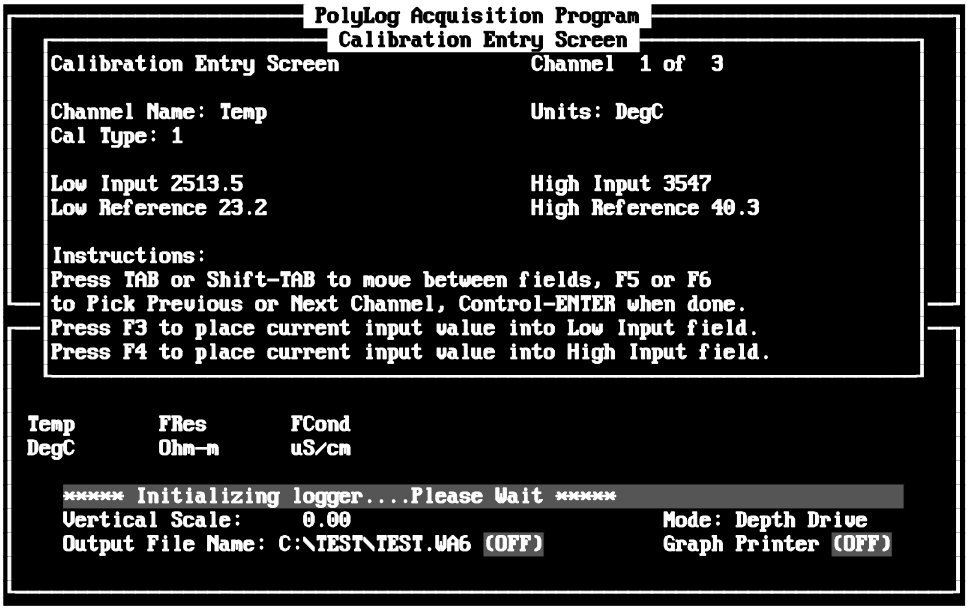
1) Turn Probe power On.
2) Turn Sampling to Time and On.
3) Connect a calibration standard as described above.
4) Allow to warm up for 10-15 minutes.
5) Right click on MCHNum.
6) Uncheck Use calibration
7) Right click on the MCHNum title bar.
8) Click Calibration Settings.
9) Enter the value of the calibration standard (i.e. 5 ohm-m) in the Reference edit box for the first point.



10) Press the First Point Use Current button to capture the raw tool output for the first calibration point.
11) Connect a different calibration standard as described above.
12) Enter the value of the second calibration standard (i.e. 200 ohm-m for a 10 ohm calibration resistor connected to the 64 inch normal electrode) in the Reference edit box for the first point.
13) Press the Second Point Use Current button to capture the raw tool output for the second calibration point.
14) Press Store to save the values to the tool driver file.
15) Press the X in the upper right corner of the browser to close the dialog.
16) On the MSLog Browsers and Processors menu press Close all.
17) 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.

Calibration Instructions for Logshell with the MGX II

1) Turn Probe power On.
2) Connect a calibration standard as described above.
3) Allow to warm up for 10-15 minutes.
4) Select the CALIBRATE function in the POLYLOG menu. A screen will appear as follows:



MGX II Example

5) Select either Fluid Resistivity or Temperature (F5 or F6 to toggle between selections). The Low and High Reference fields should be updated by the user, to display the measured low and high values, from your precision thermometer and resistivity meter.
6) Use the F3 (low end) and F4 (high end) keys to write the digital values corresponding to the actual values into the probe file. Check the calibration values several times to verify that they are stable.
7) Then press CONTROL ENTER to exit, and SAVE CALIBRATIONS to save. The new calibration values will be written into the probe file in the active directory. If the new calibration is to be used globally for all new logs, copy the probe file into the directory where LOGSHELL is installed to over-write the old probe file (*.PB4).

Calibration Instructions for Logshell with the MGX

1) Turn Probe power On.
2) Connect a calibration standard as described above.
3) Allow the probe to warm up for 10-15 minutes in the borehole environment.
4) Bring up the ACQUIRE Status screen (text screen) in the LOG mode, and you will see the following information:

```
ACQSBC  1.34  Depth:     1.87 -- Speed:     0.00   D:0.10   T:   5   DpS:  10
    ▼▼
   Depth     Speed    Pulse1      Temp    Pulse2     F_Res    F_Cond
    Feet    ft/min       cps     DegC       cps      OhmM     uS/cm
    1.87       0.0      0.00   -25.07      0.00    132.39     75.52


Chan LeftInp InValue  RgtInp LftOut RgtOut TK FL DepShf LfPlot RgPlot PlotPerCt
DD00     195       0     570      0   1000  0  0      0      0      0
DS00       0     0.0     100      0    100  0  0      0      0    -10      0.0%
CS32       0       0    1000      0   1000  0  0      0      0      0
CS32    1333       0    4923 2.3000     76  4  0      0     12     16   -926.6%
CS33       0       0    1000      0   1000  0  0      0      0      0
CS33   30070       0   10480 9.9000 89.700  7  0 0.1650      0     50    264.8%
IV06       0  132.39       1      0  10000 10  0 0.1650      0  10000      0.8%




                                                                      Q:     0
COMMENT: *                                    PB:MXW2WE.PB2   P:     0 L:     1
OUT:Not Yet Assigned     (OFF) Recs:0       Bytes:0        Free:83344K


Err: 102 *50 Scans: No serial data received
```

MGX Example

5) The example shows the ACQSBC status screen for a probe calibrated with the following values:

	LftInp	RgtInp	LftOut	RgtOut
Temperature (2nd line CS32)	1333 cps	4923 cps	2.30 deg. C	76 deg. C.
Fluid Resistivity (2nd line CS33)	30070 cps	10480 cps	9.90 ohm-m	89.7 ohm-m

6) The Inp values are the values sent up the cable by the probe, measured in cps (counts per second). The sensors send the data as DC pulses (positive for temperature and negative for fluid resistivity). The logger counts the pulses and sends them to the PC where they are displayed in the InValue column. The current value for a given temperature or fluid resistivity value is copied into the calibration field (LftInp or RgtInp) by pressing the F3 or F4 key. F3 copies the current value into the low end (LftInp) field and F4 key copies the current value into the high end (RgtInp) field. The values in these fields correspond to the real values measured with the calibration standards (precision thermometer and fluid resistivity meter).
7) The values read from the standards must be entered into the LftOut and RgtOut fields by highlighting these fields with the cursor and typing in the new values and hitting <enter>.
8) To save the calibration data, press F2. The newly calibrated file will be saved in the current directory. If this file is to be used for subsequent logging, copy to the directory where LOGSHELL was installed. You cannot calibrate the Fluid Conductivity channel (IV06) as it is derived mathematically from CS33.

Preventive Maintenance

The only maintenance required for the 2PFA probe series is to be sure to thoroughly clean the interior of the sensor array (electrodes and temperature sensor) with soft brush and clean fresh water and allow to dry before storing. All threads should be cleaned and greased, and all o-ring surfaces and O-rings should be cleaned and coated with silicone grease. Clean logging equipment provides trouble-free logging.

Schematics

Drawing Number	500S-2100.S01	Title	Pwr. Sup. and Temp. Cir.
Drawing Number	500S-2100.S02	Title	Current Generator Circuit
Drawing Number	500S-2100.S03	Title	Voltage Measuring Circuit
Drawing Number	500S-2100.S04	Title	Anti-Co and Pulse Driver Cir.
Drawing Number	Wiring Diagram	Title	2PFA-1000 Wiring Diagram
Drawing Number	Wiring Diagram	Title	2WQA-1000 Wiring Diagram
Drawing Number	Wiring Diagram	Title	2SFA-1000 Wiring Diagram
Drawing Number	Wiring Diagram	Title	2SFB-1000 Wiring Diagram