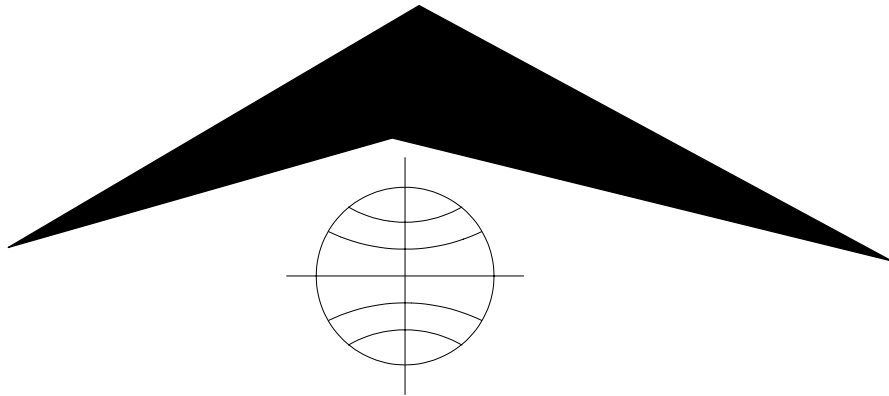


2DVA-1000 and SLP-4493 Borehole Deviation Probes



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General Information

Overview

The 2DVA-1000 and SLP-4493 systems report borehole inclination, bearing, true vertical depth, northing, and easting. These parameters are calculated in real time using the quantities measured by the probe.

The probes contain a three axis magnetometer and a three axis accelerometer. These measurements are temperature corrected by a downhole microprocessor. Additional measurements such as natural gamma or caliper may be added to the probe as options. These values are transmitted to the surface for processing.

Surface equipment necessary to operate the system includes an MGX II portable logger, a winch, and a PC running either the LogShell or MSLog data acquisition software. The surface equipment contains circuitry to supply power to the probe and a modem to provide communications between the PC and the probe.

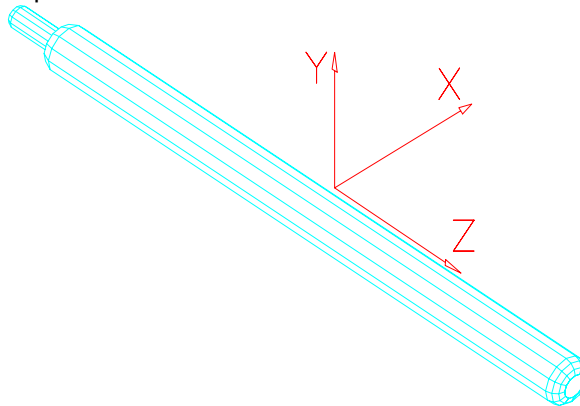
Modem note

The MGX II standard FSK modem is used to communicate with this probe. It may be necessary to tune the modem when operating the MGX II with this probe on different or longer wirelines than the MGX II was originally tested with. See the MSLog Help Topic Appendix - MGX II Modem Tuning. Consult Mount Sopris Instruments for more information.

Controls, Connectors, and Layout

The 2DVA-1000 and SLP-4493 probes have no external controls available to the user. The standard probe top is an MSI single conductor probe top, or a 4 conductor MSI quick disconnect connector. A 4 conductor GOI probe top is available as an option.

These probes measure the magnetic field and acceleration in three different directions, that is, along three orthogonal axis. The probes have an index mark (a 'V') stamped on the lower part of the housing. This mark indicates the side of the probe from which the positive X axis extends. The Z axis is the longitudinal axis and points down. The Y axis is defined using a right hand coordinate system where the cross product of X and Y equal Z. The X and Y axis are in the horizontal plane when the probe is vertical.



Theory of Operation

The 2DVA-1000 and the SLP-4493 use three flux gate magnetometers to measure the magnetic field in the direction of each of the axis shown in the illustration above. Three piezo electric accelerometers measure the acceleration due to gravity. These accelerometers are oriented along the same axis as the magnetometers.

Specifications

2DVA-1000

Length	59.4 inches, 151 cm
Diameter	1.50 inches, 3.81 cm
Weight	16 lbs, 7.3 Kg
Operating Temperature	0 - 70 degrees C
Maximum Pressure	200 Bar (3000 psi)
Directional Accuracy (Azimuth)	+/- 0.5 degrees
Range of measurable inclination	0 - 90 degrees
Operating Voltage	52-88 VDC
Operating Current	150 mADC
Communications	9600 Baud 8 bits 1 stop no parity

SLP-4493

Length	47 inches, 119 cm
Diameter	1.75 inches, 4.5 cm
Weight	16 lbs, 7.3 Kg
Operating Temperature	0 - 70 degrees C
Maximum Pressure	200 Bar (3000 psi)
Directional Accuracy	+/- 0.5 degrees
Range of measurable inclination	0 - 90 degrees
Operating Voltage	36-72 VDC
Operating Current	100 mADC
Communications	9600 Baud 8 bits 1 stop no parity

Installation

Installing the 2DVA-1000 or SLM-4493

No installation procedure is required for these probes other than providing a safe, secure, shock resistant storage place for the probe.

If you are using the Logshell acquisition software, install the proper probe driver by selecting 'Configure' from the main menu. Select 'Probe' and then 'Install'. Look for the 2DVA-1000 or the SLM-4493 probe driver (depending on which probe you have). Use the arrow keys on the keyboard to highlight the proper probe driver and press enter. Exit from the configure menu.

If you are using the MSLog acquisition software, install the 2DVA-1000 probe driver (SLM-4493 not available with MSLog) by using the MSLConfig program. Press the 'Install / Change Tool Selection' button. Click on the 2DVA-1000 tool driver in the source tool driver pane. Click on the 'Add' button, then press 'OK'. Exit MSLConfig with OK.

Operating Procedure

Operation

Attach the probe to the cable head as usual (make sure that the power to the logger is off). Make sure that the PC and the logger are connected by a serial cable, and that the PC has booted up. Power up the logger. Use one of the following sets of instructions.

Logshell Instructions

1. Start Logshell. Select Log from the main menu. Then select the proper probe driver for your probe. Name the data file to be recorded, and then select 'Log' from the logging menu. After a few seconds the software should begin reporting data.

No calibration is needed other than for the local magnetic declination. To do this, select 'Calibrate' and the 'Edit Values' from the main menu. At the calibration screen, press F5 until the Bering channel appears. Enter 0.0 for the Low Input. Enter the local magnetic declination for the Low Reference. Enter 1.0 for the High Input, and the local magnetic declination plus 1.0 for the High Reference. Press the Control and Enter keys at the same time. If desired, Press 'Save Calibrations' from the Calibration sub-menu.

2. Log the probe as usual at a speed less than 20 meters per minute. These probes can only send data about once per second. If the digitize interval and the logging speed are such that a digitize event occurs more often than once per second, then the digitize interval in the recorded data will not be the specified interval. Since the attitude of a borehole does not change quickly, data taken at 0.5 meter or 1 foot intervals will allow a wide range of logging speeds without a detrimental affect on data quality.
3. Northing, Easting, and True Vertical Depth are reset to zero whenever the user selects 'Probe Control' and then 'Reset Endpoints'.
4. For more information on Logshell software settings and logging, consult the Logshell user manual. You may have to experiment with logging speed and the possible use of centralisers to get the most repeatable results.

MSLog v6.x - v7.0 Instructions

1. Start MSLog. Select the proper probe driver. After all of the browsers have started, press the power button. When the little yellow MGX II processing box goes away, select time digitizing and turn digitizing on. MChNum should start reporting numbers.
2. No calibration is needed other than the local magnetic declination. To Do this, go to the MChNum system menu (right click on the icon in the upper left hand side of the MChNum window). Select 'Calibration Settings'. Enter 0.0 for the first point Value, and enter the local magnetic declination for the first point Reference. Enter 1.0 for the second point Value, and enter the local magnetic declination plus 1.0 for the second point Reference. Press the 'Store' button. Press the 'Close All' button on the dashboard. One by one select each browser from the list presented by the dashboard and press the 'Start' button.
3. Log the probe as usual at a speed less than 20 meters per minute. These probes can only send data about once per second, so adjust the depth digitize interval and the logging speed accordingly. The dashboard will indicate data errors if you log too fast for the current settings. Since the attitude of a borehole does not change quickly, data taken at 0.5 meter or 1 foot intervals will allow a wide range of logging speeds without a detrimental affect on data quality.
4. Northing, Easting, and True Vertical Depth can be preset to any desired value by proper calibration of these channels. Start the calibration menu as described above. Select the desired channel. Entering 0.0 and 1.0 for the Value for the first and second points. Enter the desired preset value for the first point reference. Enter the desired preset value plus 1.0 for the second point Reference.
5. For more information on MSLog software settings and logging, consult the MSLog user manual (available as online help). To access MSLog's online help, right click on the

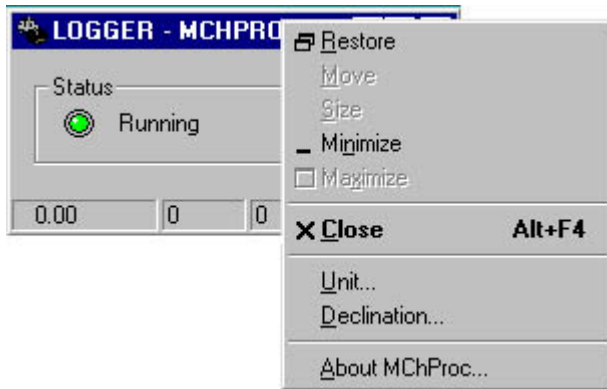
dashboard and press 'Help Index'. You may have to experiment with logging speed and the possible use of centralisers to get the most repeatable results.

MSLog V7.4x forward Instructions

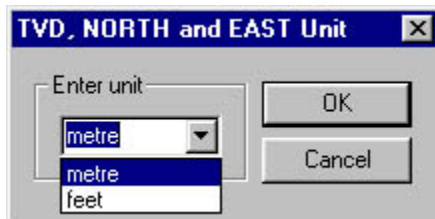
1. Make sure MGXII is powered up and a serial cable is connected between the PC and the logger.
2. For the Windows Operating System, make sure that you quit all other applications before running MSLog. Other programs may interfere with the serial port communications or take too much processing time away from the acquisition program.
3. After the Tool selection is made, press the Tool Power On button. When the system is initialized, you may begin logging. Deviation can be logged up or down. Normal logging speed is 3 meters/min (15 ft/min).
4. Be sure to Start the processor MChProc and other processors and Browsers as required. Right click on the top of MChProc and set the appropriate depth units and local Declination offset. See below.
5. Select the desired Acquisition Sampling mode, and press the Acquisition Record button to turn the recording function on before beginning logging, or no data will be recorded to disk. Use the Log Settings and Depth Settings selection of the MchCurve Browser to make changes to plot parameters.
6. Endpoints will be set to zero, log to the bottom. Stop Acquisition. Reselect the tol file (which causes the endpoints to reset) and then return log to the surface. TVD will be negative and Northing and Easting will be the inverse of the down log.
7. When you reach the top or bottom of the logging interval, press the Acquisition Stop button to turn off data recording. Turn Tool Power Off before removing the probe from the cablehead.

Browser details

Deviation tool files enable access to MchProc dialogs allowing the setting of Units of measure and Declination Offset. To access them, right click the top of MchProc as shown in the following graphic.

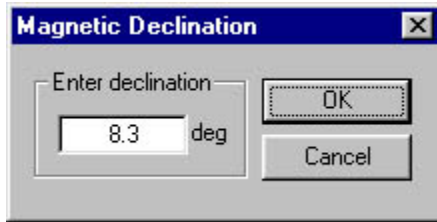


Clicking Unit opens the following dialog:



Select the units, meters (metre) or feet you wish to use for the deviation TVD, Northing, Easting calculations.

Clicking Declination opens the following dialog:



Enter the Magnetic Declination offset for your location.

MchNum and Deviation Logging

Below is MchNum display of deviation data using MchProc. The TVD, Northing, and Easting endpoints are set to zero by either closing and restarting the browsers or reselecting the tol file at the end of a down or up run.



Caution:

This probe measures the direction of the earth's magnetic field, and since this field is weak, care must be taken not to subject the probe to external magnetic fields. These external fields may permanently magnetize parts of the probe making it necessary to re calibrate the magnetometers. Calibration of the magnetometers must be done at the factory. For these reasons, the probe should not be stored in a steel container or near steel objects. Drill rods are commonly magnetic and should be avoided. Logging in steel casing not only causes the Bearing measurement to be invalid, but may cause magnetization of the probe if done repeatedly.

Performance Checks and Calibrations

Usually, having the sensor in question measure a set of known standards checks the performance of a geophysical probe. The probe is then calibrated so that the sensor output accurately indicates the value of the standard being measured. Unfortunately, the sensors in the 2DVA-1000 and the SLP-4493 must be calibrated at the factory. Placing the probe in known orientations and observing the values reported by the data acquisition software can test the functionality of the sensors in the 2DVA-1000 and the SLP-4493. For example, suspend the probe so that is plumb, the observed inclination should be 0.0 +/- 0.5 degrees. Place the probe on a horizontal surface (confirm that the surface is horizontal), the observed inclination should be 90.0 +/- 0.5 degrees. Place the probe on a table made of non-magnetic material (i. e. wood or plastic) and verify that when the bottom of the probe is pointed in a known direction, a good

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compass indicates the same direction as that reported by the deviation system (+/- 0.5 degrees) when the compass is pointed in the same direction as the probe.

Preventative Maintenance

The 2DVA-1000 and the SLP-4493 probe should require no maintenance other than a few salient points. Keep the probe and the probe top connector clean. When the probe is transported, it needs to be contained in a vibration damped container to minimize stress on the piezo electric crystals used to measure acceleration.

The probe top connector should be periodically cleaned with oil free contact cleaning solvent. As mentioned in the Operating Procedure section, the probe should be kept away from strong magnetic fields, and repeated proximity to material with a high magnetic permeability such as iron and steel.

Troubleshooting

Problems with the Probe

The 2DVA-1000 and the SLP-4493 probe should give years of reliable service if it is properly maintained. If problems arise with the probe, check for simple problems first. Make sure that the probe is getting power. The SLP-4493 should get about 40 -50 VDC at the cable head. The 2DVA-1000 should get about 60 -70 VDC at the cable head. Verify that the surface equipment is functioning normally and that the modem is functioning normally. If the probe is getting the correct amount of power, and is still not responding, consult a qualified electronics service technician. If the probe responds, but needs calibration consult Mt. Sopris Instrument Co. to send the probe in for calibration.

Disassembly Instructions

To disassemble the probe, remove the six hex head cap screws near the top of the probe. Next, carefully pull the probe top out of the probe housing, use caution so that the wires connecting the probe top to the rest of the probe are not stressed or broken. Disconnect the probe top from the rest of the probe by releasing the connector keeping them together. Finally, unscrew the probe housing from the bronze probe base using non marring strap wrenches.

CAUTION: This probe housing is made from aluminum and will deform quite easily, so do not use a chain vise or pipe wrench of any kind as it may permanently damage the housing and or threads of connecting parts. Carefully pull the probe housing off of the probe using care not to damage any of the enclosed electronics.

To reassemble, inspect all 'O' rings for damage, replace if necessary and then assemble in the reverse sequence of disassembly.

Schematics

Drawing Number	Title
<u>2DVA-1000</u>	
500S-2090	Poly Deviation Interface
500S-2092	Poly Deviation Wiring
500S-2093	Mod/Demod Deviation Probe
2DVA-1100	Poly Deviation Housing Assy.
2DVA-1200	Poly Deviation Electronics Assy.
<u>SLP-4493</u>	
500S-1110	Gamma Probe Card
500S-1276	Modulator/Demodulator
500S-2012	SLP Interface Board
500K-2021	SLP Wiring Diagram

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.