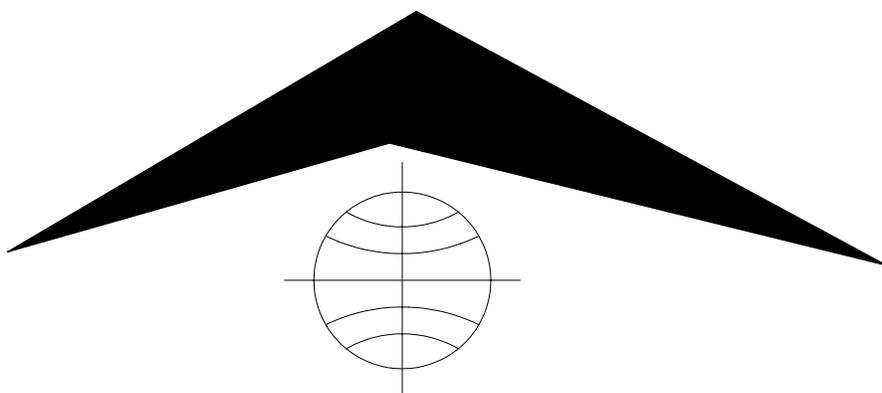


2DVA-1000 Borehole Deviation Probe



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Table of Contents

General Information.....	3
Overview.....	3
Controls, Connectors, and Layout.....	3
Theory of Operation.....	3
Specifications	4
Installation.....	5
Installing the 2DVA-1000.....	5
Operating Procedure	6
Operation.....	6
MSLog v6.x - v7.0 Instructions	6
MSLog V7.4x forward Instructions.....	6
Matrix V8.x Instructions.....	7
Browser details.....	7
MchNum and Deviation Logging	8
Caution:.....	8
Performance Checks and Calibrations.....	8
Preventative Maintenance	9
Wellcad Processing notes	10
Importing Data	10
Reprocessing raw data from the 2DVA-1000.....	10
Troubleshooting.....	11
Problems with the Probe	11
Disassembly Instructions.....	11
Schematics	12
Appendix.....	13
Suggested QA Procedure	13

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.

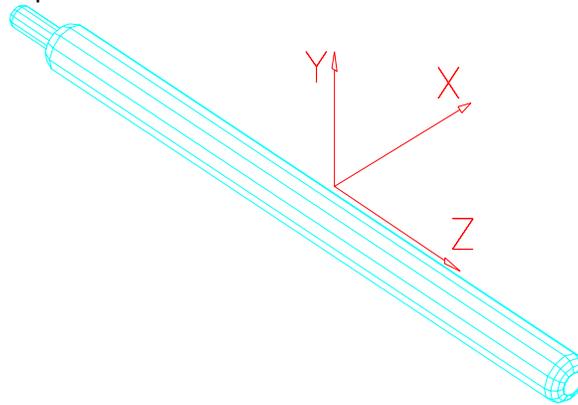
The probe contains a three axis magnetometer and a three axis accelerometer. These measurements are temperature corrected by a downhole microprocessor. Additional measurements such as natural gamma or caliper may be added to the probe as options. These values are transmitted to the surface for processing.

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.

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 GOI connector. A 4-conductor MSI probe top is available as an option.

These probes measure the magnetic field and acceleration in three different directions, that is, along three orthogonal axes. 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) +/- 1.0 degrees
(Tilt) +/- 0.3 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

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 MSLog or Matrix acquisition software, install the 2DVA-1000 probe driver by using the MSLConfig or for the Matrix the MTXFileConfig 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 or MTXFileConfig 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. Turn Logger Power on. Use one of the following sets of instructions.

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.

- 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.

Matrix V8.x Instructions

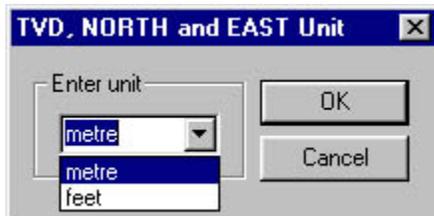
- Make sure Matrix power is turned on and the USB cable is connected between the PC and the logger.
- For the Windows Operating System, make sure that you quit all other applications before running Matrix.
- After the Tool selection is made, press the Tool Power On button. When the system is initialized, you may begin logging. Deviation can be logged up or down. Normal logging speed is 3 meters/min (15 ft/min).
- 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.
- 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.
- Endpoints will be set to zero, log to the bottom. Stop Acquisition. **If you wish to use the WellCAD closure testing (deviation module required), log back up without resetting the TVD, Northing and Easting.** If not, to reset those values to zero, 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.
- 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.

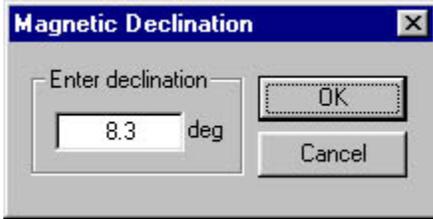


Clicking Unit opens the following dialog:



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. 8.3 is the value for Denver CO, USA.

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 using an APS 544 sensor 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 recalibrate 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. Normally, steel casing and steel drill rod can be slightly magnetic but they are not usually magnetic enough to cause the 544 electronics to become magnetized. It would take a significant magnetic field such as 10 Gauss to cause any magnetic perming in the 544. If this occurred, azimuth errors would be introduced. Logging in steel casing not only causes the Bearing measurement to be invalid, there is also the possibility that repeated logging in steel casing may cause magnetization.

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 it is plumb, the observed inclination should be 0.0 +/- 0.5 degrees. Place the probe

2DVA-1000 and SLP-4493 Borehole Deviation Probes

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 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.

Wellcad Processing notes

Importing Data

Import data in the same fashion as for any normal well log. Be aware of whether any declination adjustment was made to the data during data recording. See the previous operating procedure section on Browser details for MCHNum.

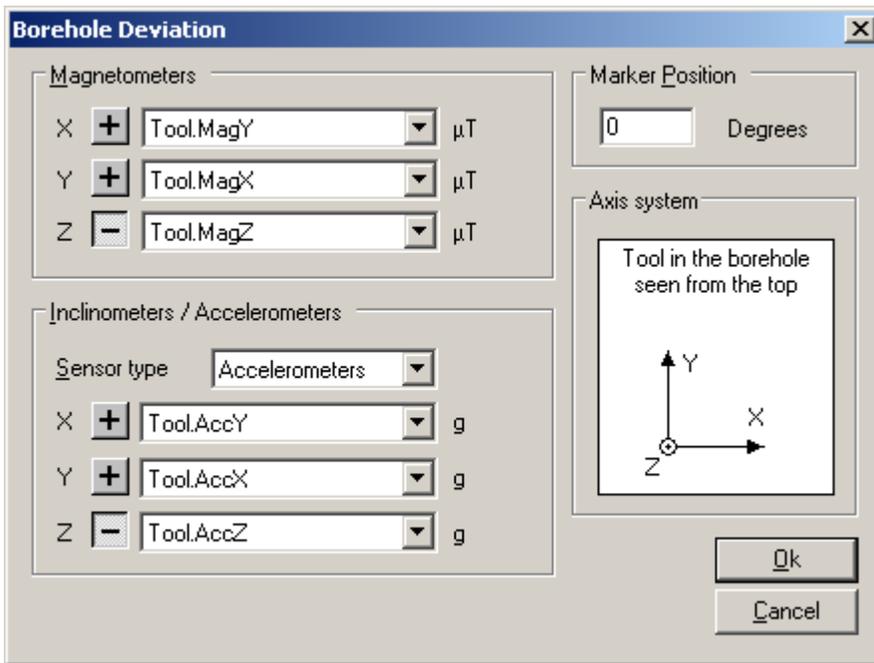
If there was a substantial amount of steel surface casing then you may have to reprocess the data from the point the tool exited the casing.

If no further processing is required then the data can be used as is. If reprocessing of the raw, deviation data or display in bull's-eye or profile is required then you will need the Wellcad Deviation module installed.

Reprocessing raw data from the 2DVA-1000

The input data from the 2DVA-1000 Magnetometers and accelerometers can be reprocessed to create new azimuth and tilt traces. This can be done by creating formulas or through Common Processes, Deviation, Azimuth and Tilt.

The dialog that appears has a Axis system based on the FAC40 Televiewer. The 2DVA-1000 uses a different coordinate (axis) system and the values in the dialog need to be rearranged as shown below:



Note that as opposed to the defaults, the X and Y Magnetometers and X and Y Accelerometers have been swapped and the Z Magnetometer and Z Accelerometer have a negative sign in front of them. The Axis system diagram does not change to match.

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

2DVA-1000

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.

SLP-4493

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 Acquisition programs record 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.