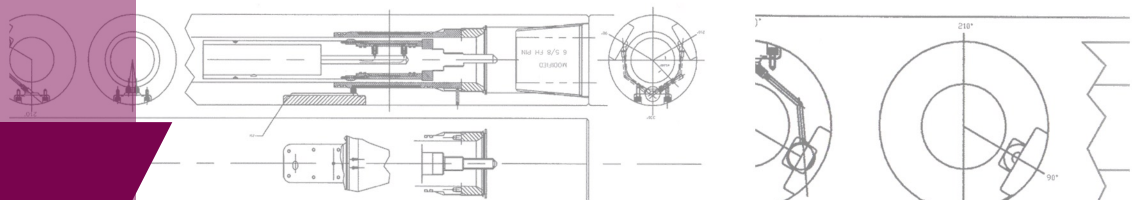
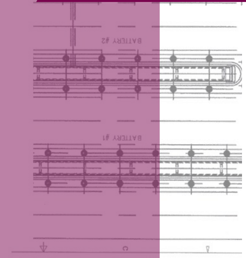
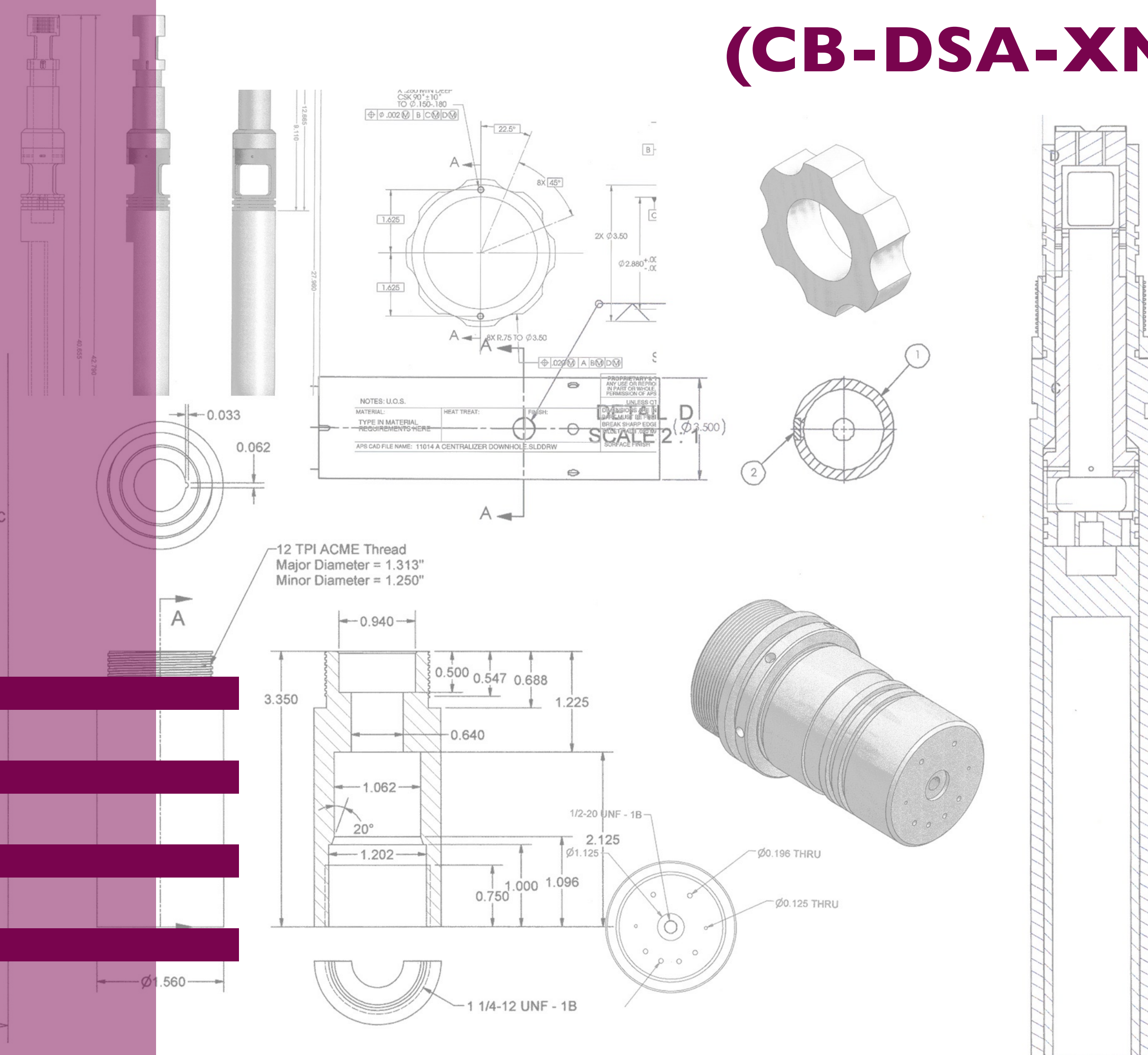
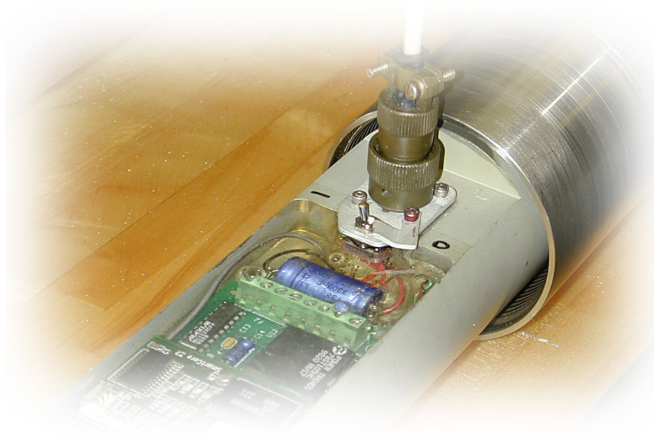




Core Barrel Drill String Acceleration Measurement Tool with Extended Memory (CB-DSA-XM)



3/2004



Core Barrel Drill String Acceleration Tool with Extended Memory (DSA-XM)

Operation Instructions

Table Of Contents

Section I

Overview

These operating instructions describe logging operations with the Modified Drill String Acceleration Measurement Tool (DSA-XM). The DSA-XM tool attaches to the top of a core barrel and records drill string acceleration and fluid pressure during the process of coring. The acquired data may be used for: 1) drill string vibration analysis; 2) heave evaluation; 3) a reference signal for seismic-while-drilling (SWD) measurements; 4) drilling equipment performance evaluation; and 5) geotechnical applications such as sediment compaction analysis.

This document describes DSA-XM Tool operation including hardware and software setup, tool initialization, measurement and calibration procedures, and offloading and handling of recorded data.

The DSA-XM Tool operates as a memory tool recording drill string acceleration and ambient pressure at a specified sampling rate. The tool does not need connection to the logging cable, and the data are off-loaded to computer after the tool is retrieved from the hole. The DSA-XM starts and stops data recording at a predetermined hole depth (calculated from a pressure sensor signal). During the processes of initialization and memory data offloading, communication with the tool is handled by the DSA-XM VI LabVIEW program.

The tool uses two accelerometers – a one-axial (vertical) High Sensitivity Accelerometer (HSA) and a three-axial Low Sensitivity Accelerometer (LSA) – and can operate either in "ACCELERATION" mode (both LSA and HSA signals are recorded at a high sampling rate), or in "PRESSURE" mode (LSA signals and ambient pressure are recorded at a high sampling rate). In both modes the tool also records ambient pressure at low sampling rate – 1 sample per second.

The DSA-XM was developed as a modification of the DSA tool used in ODP operations from 1999-2001. The modified tool has a longer data recording time, higher reliability and improved operational capabilities. The DSA-XM allows data recording on consecutive coring trips, and its use of hot-swappable nonvolatile memory modules virtually eliminates long delays related to data retrieval procedures. The tool continuously monitors battery voltage and temperature inside the electronics module and preserves recorded data even in cases of battery failure or at temperatures in excess of the maximum specified for tool operation.

Important: Exceeding temperatures of 100°C (212°F) in the electronics module and battery compartment can cause permanent damage to electronic components and/or battery disintegration. Always check expected borehole conditions before using the tool!

Section II

Specifications

Acceleration measurement range (HSA channel):	-2 g to +2 g
Acceleration measurement range (LSA channel):	
Option 1:	-4 g to +4 g
Option 2:	-25 g to +25 g
Maximum acceleration sampling rate (all channels):	100 samples/sec
Pressure sampling rate:	1 Hz
Frequency bandwidth (HSA channel):	0 – 2 Hz
Frequency bandwidth (LSA channel):	
at 100 samples/sec sampling rate:	0 – 50 Hz
at 50 samples/sec sampling rate:	0 – 25 Hz
Temperature measurement range:	0° – 85° C
Temperature resolution:	0.5° C
Pressure measurement range:	
Option 1:	0 – 10,000 psi
Option 2:	0 – 15,000 psi
Pressure resolution:	4 psi
Pressure measurement precision:	0.1% FS
Total data recording time:	
at 100 samples/sec sampling rate:	2.9 hr
at 50 samples/sec sampling rate:	5.8 hr
Power source:	6 AA alkaline batteries
Total operating time from one set of batteries:	at least 18 hr

Section III

Tool Setup and Software Installation

Note: The instructions in this section are applicable only if you are receiving shipment of the DSA-XM Tool. If the tool is already on the ship, skip this Section and proceed to Section IV.

A. Unpack and disassemble the DSA-XM tool. Pull out the electronics cartridge from the pressure case (see document "Core Barrel Tool Assembly and Disassembly"). Check the batteries (there should be no visible damage or stains on them) and replace them if necessary. To replace the batteries, remove the screws and open the lid of the battery compartment. Extract the old or damaged AA cells from their holders, discard them appropriately, and install the new ones. The batteries are connected in series: "+" should be connected to the "+" terminal of the battery holder.

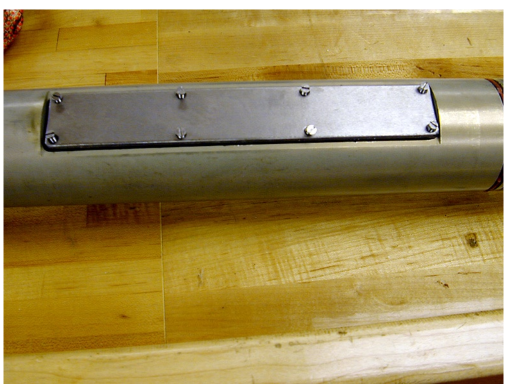


Figure 1. Battery cover on the DSA-XM.

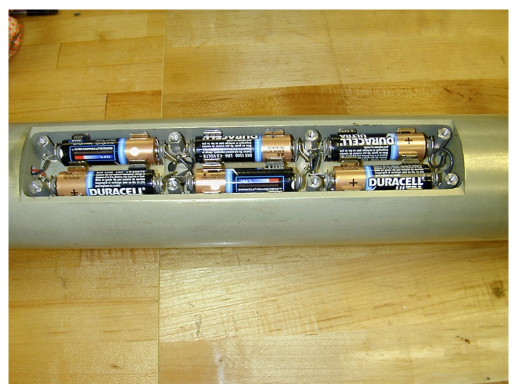


Figure 2. Battery compartment with 6 AA batteries.

B. The DSA-XM was designed to allow for customization of sensor selection depending on the particular application needed. The most commonly customized sensor is the three- axis accelerometer shown in Figure 3. This sensor is available in 4g or 25g ranges. The 4g model is typically installed for most applications. In applications where the widest range of accelerations is expected to be encountered, the 25g accelerometer must be installed. The installation process is very simple and takes only a few steps: Disconnect the silver barrel connector (and mounting bracket if necessary), then remove the screws holding the accelerometer in place. To install the accelerometer, simply reverse the process.

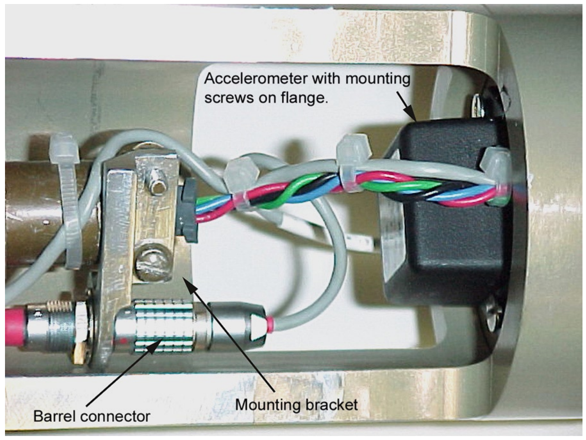


Figure 3. Close-up of the DSA-XM accelerometer and associated hardware.

C. Replace the #230 sized O-rings in the end cap of the tool. Do not use more Lubriplate 930 grease on the O-rings and threads than necessary. Cover them with a thin layer of grease and be sure to wipe out any extra grease to prevent contamination of the rest of the tool as it is assembled.

D. Check to ensure that the memory module (MM) is properly installed in the tool. See Section IV for memory module installation instructions.

E. The DSA-XM software is supplied on an installation CD-ROM. To install the software, run the "Setup.exe" program located in the \Installer\disks directory and follow the Installer instructions. The program will create a "DSAXM" directory in C:\Program Files\ and copy program files into it. The Setup program also creates a "Data" subdirectory where it places necessary support files. After completing setup you must manually copy the Hyperterminal settings file "DSA.ht" and the DSAXM serial port configuration file "dsaxm.cfg" to the root directory on drive C.

Note: You need to be logged in as Administrator to install the DSA-XM software if your computer runs WindowsNT or Windows 2000.

F. Hyperterminal 6.1 or later is necessary for DSA-XM operation. Run the Hyperterminal installation program included in the "Hyperterminal" directory on your installation CD-ROM if this program was not installed earlier. Do not use the Hyperterminal utility supplied with

Windows98/NT/2K. Create a "Data" directory on drive C:\ if it was not created earlier. This is a default directory where the DSA-XM program places data files. Place a shortcut icon of the DSAXM LabView program on the Windows desktop. Rename the icon to "DSAXM."

For the DSA-XM program to operate properly, you need to change the Windows date and clock settings to present the date in DD:MM:YY format and the time in military 24h format (HH:MM:SS). You will need to change the regional settings on your computer to "English(Canadian)" or "English(United Kingdom)" to be able to set the date format .

Section IV

Preparing the DSA-XM for Logging

A. Remove the DSA-XM Tool electronics cartridge from the pressure case. Make sure that the power switch is turned off. If necessary, install a set of fresh "AA" batteries in the battery compartment as described in Section IIIA.

B. Remove the memory module (MM) from its antistatic package and install it on the DSA-XM board. The memory module should be firmly pressed into the socket on the PC board - double check that both MM bottom connectors are properly seated in the DSA-XM board sockets. (Incorrect installation can permanently damage the MM!) Once the MM is seated, secure it with the nylon retaining nuts. (See Figure 4, below.)

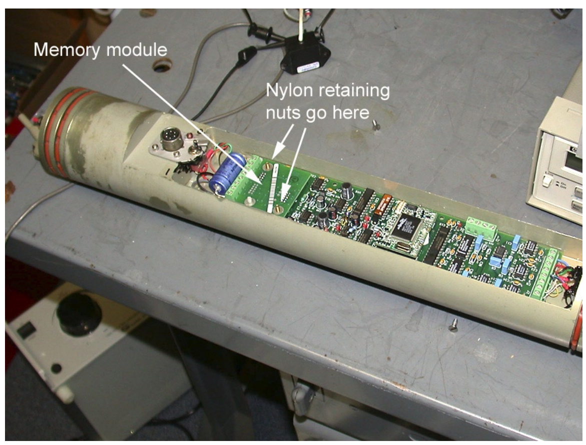


Figure 4. The DSA-XM board with the memory module installed.

C. Set up the serial connections. By default the DSA-XM software uses a single serial port COM2 and appropriate 2-port serial data switch (see Figure 7) to communicate with the DSA-XM logging tool and the DSA-XM Memory Reader, but this configuration can be changed by the user if necessary. The serial port assignment for communicating with the DSA-XM logging tool can be changed by changing the properties of the serial connection from within the Hyperterminal program and saving the changed version of the Hyperterminal settings file "DSA.ht."

Note: Never change the name or location of this file in the system.

To change the serial port assignment for the DSA-XM Memory Reader: 1) open the "dsaxm.cfg" file using the Windows "Notepad" text editor; 2) change the port name; and 3) save the changed file at its previous location.

To set up the serial connections, unpack the DSA-XM Memory Reader (Figure 5) and connect it to a 2-port serial data switch with a 9-pin RS-232 serial cable (see Figure 7). The DSA-XM tool should also be connected to the serial data switch; the cable used for this is an RS-232 modified on one end with a circular connector for connecting to the tool's electronics module (see Figure 6). Lock the circular connector onto the tool by gently rotating the connector's outer shell. **Do not apply excessive force!** Then connect the output of the serial data switch to the serial port of the PC DAS assigned to DSA-XM operation. The overall configuration is shown in Figure 7.

Figure 5. Serial port of the DSA-XM Memory Reader. The serial port shown here should be connected to the 2-port serial data switch.

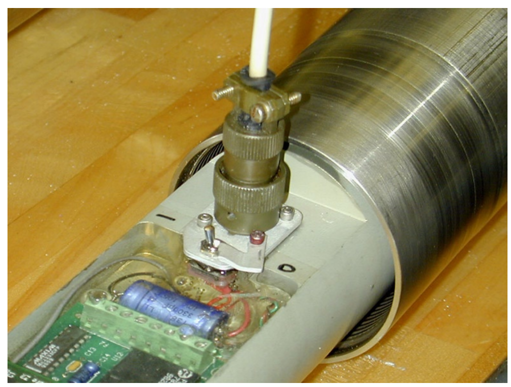


Figure 6. Close-up of the modified RS-232 serial cable connected to the DSA-XM's electronics module. Note also the power switch in front of the connector.

When interfacing to the tool, make sure that the 2-port serial switch is set to "TOOL." Similarly, when interfacing to the memory reader, make sure that the serial switch is set to "READER." Obviously, you need to ensure that the serial switch is set properly; otherwise, communication between the devices will not occur.

D. Make sure that the serial switch located on the back of the PC DAS's serial communication strip is set to serial (OFF) before turning the computer on and initializing the tool (see Figure

8). The switch should not be turned ON until after the computer has booted up.

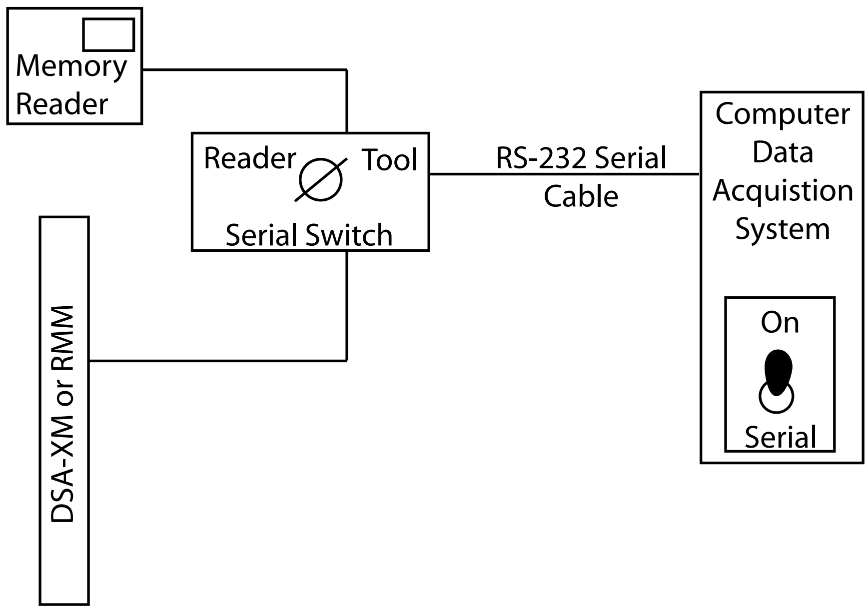


Figure 7. Wiring scheme for communication among the DSA-XM, memory reader and PC DAS.

Figure 8. The serial switch on the back of the PC DAS.

Section V

Tool Initialization

A. Turn the computer on. When the computer boots up you will see the Windows Program Manager window with icons representing major applications. Turn the PC DAS serial switch to ON. Launch the DSA-XM data acquisition program by double-clicking on the "DSAXM" icon. You will see the following screen:

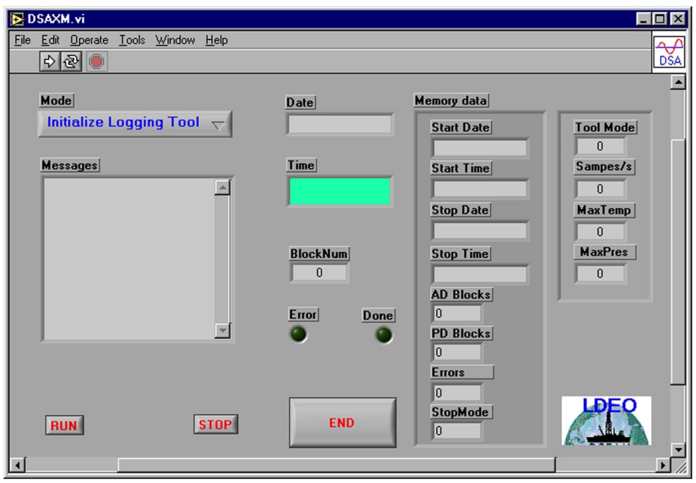


Figure 9. Startup screen of the DSA-XM data acquisition program.

B. Start the program by clicking the white arrow in the top left corner of the menu bar. Set the Mode menu to "Initialize Logging Tool" mode and click the RUN button. The program starts the HyperTerminal application with the proper parameter settings for communication with the DSA-XM tool (see Figure 10, next page) and displays the current date and time in the appropriate format in the "Date" and "Time" indicators. The serial communication settings should be as follows:

```
Baud rate - 57600
Data Bits - 8
Parity - none
Stop Bits - 1
Flow Control - none
```

[Note: The above information is provided for your reference only. The serial port should initialize correctly and automatically upon launching, and you should not attempt to change them manually unless advised to do so by the BRG engineer.]

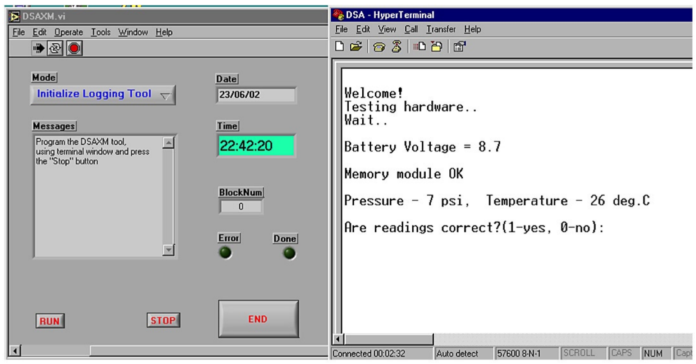


Figure 10. The DSA-XM self-diagnostics routine.

C. Turn on the DSA-XM tool power switch (see Figure 6) and move the safety clamp into locking position to prevent the switch from flipping back. With the cursor placed at the beginning of the Hyperterminal window, press the "Enter" key to start communication with the tool. If the tool is connected properly you will see a welcome message and a message from the DSA-XM self-diagnostics routine (see Fig. 10, above, and Appendix A: DSA-XM Sample Dialog). If the diagnostics message is "Memory Module OK" and temperature and pressure readings are correct (any pressure reading within 0 – 20 psi range is acceptable), you can start initializing the tool. If you get an error message (**"ERROR! Please check memory module!"**), you most likely did not properly install the memory module on the board. In this case, turn off the tool and carefully repeat the memory module installation.

You may get a **"Please replace battery!"** message if the battery voltage in the tool is lower than 6.5V. Be sure to replace the battery in this case. In general you should use your judgment when deciding on battery replacement. Refer to the chart in Appendix B to determine the remaining time of the tool operation at the present battery voltage and compare it with the expected duration of data recording, **plus** a generous safety margin (2-3 hr). Remember that battery capacity can be substantially diminished by low ambient temperature.

D. In addition to choosing the mode of operation, the initialization procedure includes:

1. *Setting the sampling rate*. A sampling rate of 50 samples/second is appropriate for most tasks and allows for lengthening of the recording time.

2. *Synchronizing the DSA-XM clock with the PC DAS date and time*. To synchronize the clocks, use the information from the DSAXM program indicators displaying current date and time. Type the time data in the DSAXM terminal window when prompted by the program. The easiest method is to type a number of seconds in advance and hit <CR> at the moment the clock indicator shows the predetermined time.

3. *Setting the starting depth.* You should set the initial depth to 300 m LESS then the actual depth where you want to start logging. (For example, set the starting depth to 2700m if the water depth is 3000m). If you want to check the tool's operation in the lab you should set the initial depth to 0.

   The tool always shows you the settings you typed and asks for confirmation of your input ["Correct? (1-yes, 0-no):"]. Type "0" if you mis-typed data and you will be able to repeat your input. **You must use the suggested format for date and time**.

   A sample dialog for tool initialization is given in Appendix A.

E. When you receive the "Disconnect serial line" message, disconnect the interface cable from the tool's connector and prepare the DSA-XM tool for logging.

Section VI

Logging Operations

For proper depth correlation with other logs and core data you should record depth data as described in Section VIII of this document.

A. Assemble the tool and attach it to the core barrel. Remember that the batteries in the DSA-XM tool last a relatively short time, so you should make every effort to minimize the time interval between tool initialization and recording.

B. While manipulating the tool on the rig floor use the assistance of the drilling crew and follow their directions.

C. After the tool is retrieved, disconnect it from the core barrel, bring it to the Downhole Measurements Lab, and position it on the tool bench.

D. If for any reasons you have concerns that something could go wrong during offloading of the data from the memory module, you can use the tool's diagnostic mode to get information about memory content, timing of recording, and possible errors before disconnecting and attempting to read the MM. To do this, reconnect the serial cable to the tool as described in Section IV, Part C of this manual (without turning the tool off). Press the "Enter" key to re-establish communication with the tool, and choose Mode 3 from the Main Menu as shown in this fragment of tool-operator dialog below. [Operator's input is printed in **Bold.** Every operator's message should be terminated with a <CR>]

MAIN MENU

Accel - 1
Pressure - 2
Diagnostics - 3
Test - 4

Choose option(1-4): **3** <CR>
Start date: 28/06/02
Start time: 17:43:03

Stop date: 28/06/02
Stop time: 17:44:37

AD Blocks: 37
PD Blocks: 1
Errors: 0
Stop: 4

End of diagnostics
Press CR to continue: <CR>

You can also check the tool's operation by choosing Mode 4 from the Main Menu, as shown in the fragment of tool-operator dialog below:

MAIN MENU

Accel - 1
Pressure - 2
Diagnostics - 3
Test - 4

Choose option(1-4): **4** <CR>
Starting real time test...
Press CR to stop test

ACCX	ACCY	ACCZ	ACCH	TEMP	PRES
1121	2016	2036	2051	24	18
1118	1994	1994	2056	24	14
1119	2111	2106	2063	24	14
1117	2056	2075	2054	23	14
1119	1975	1984	2054	24	14
1119	2081	2071	2061	24	14
1119	2094	2106	2055	24	14
1119	1993	2014	2049	23	14
1119	1995	1993	2055	24	14
1118	2112	2105	2063	23	14

……………………………………….
<CR>

End of test mode
Press CR to continue: <CR>

In this mode the DSA-XM outputs measurement data to the Hyperterminal window in real time approximately once per second.

E. Disassemble the tool, **and with the DSA-XM software still running,** re-attach the serial cable and press "enter" twice. A prompt from the tool will be displayed. **Now** turn the tool's power switch off, remove the memory module locking nut and carefully disconnect the memory module from the tool's main board. Place the MM into an antistatic bag if you do not plan to read the MM data immediately. It is also recommended that you install a new MM into the tool at this time.

Now you are ready to read the data from the tool's MM.

Section VII

Off-loading Data from the Memory Module

A. Make sure that the Memory Reader is powered up (the power LED is "ON") and press the "Reset" button. Carefully place the Memory Module (connectors up) on the Memory Reader standoffs and secure it with a locking nut. Attach the flat cable to the MM connector and make sure that both rows of pins on the MM connector are properly connected.

Figure 11. The DSA-XM Memory Reader.

B. Press the "Start" button on Memory Reader, the "Ready" LED should turn on. Press the "Read" button. The "Ready" LED should momentarily turn off and then turn on again. At this point the MM is ready for data reading. If, instead of this sequence, both the "Ready" and "Done" LEDs start blinking it signals that the Memory Module test failed. The most common reason for this is that you did not connect MM properly. Repeat the procedures described in Part A of this section and try again.

C. Start the DSAXM program in "Read Memory Module" mode. To do so first click on the "Stop" button to finish operations with the DSA-XM. The program will shut down the Hyperterminal window after closing the application dialog. Set the mode control to "Read

Memory Module" and click the "RUN" button (see Figure 12, below).

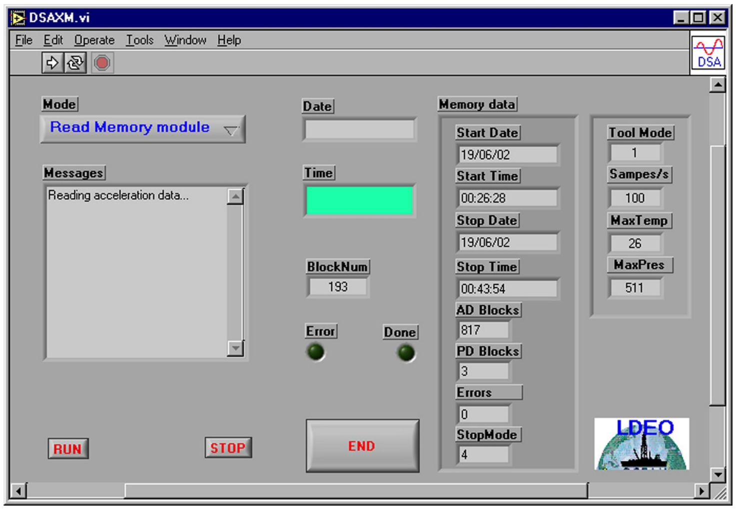


Figure 12. The DSAXM program with "Read Memory Module" mode selected.

D. The program will display additional data panes with diagnostic, timing and operational data read from the MM, and will then prompt you for acceleration and pressure data file names (Figures 13 and 14). Although you can change the file name in the dialog we do not recommend doing so unless you have to make several records with the same date. If you do change the file names, make sure you still use the proper file extensions: ".acd" for acceleration data files and ".psd" for pressure data files.

The most important diagnostic information is the code for the completion of data recording. It is given in the "Stop Mode" window at the bottom of the "Memory data" pane:

0	-	normal completion (stopped after reaching pressure threshold)
1	-	recording terminated - memory full
2	-	tool operation terminated because of maximum operating temperature
3	-	tool operation terminated because of low battery voltage
4	-	recording terminated by user
13	-	hardware failure

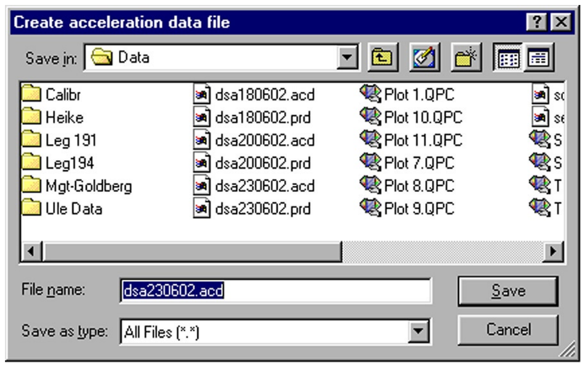


Figure 13. Creating an acceleration data file.

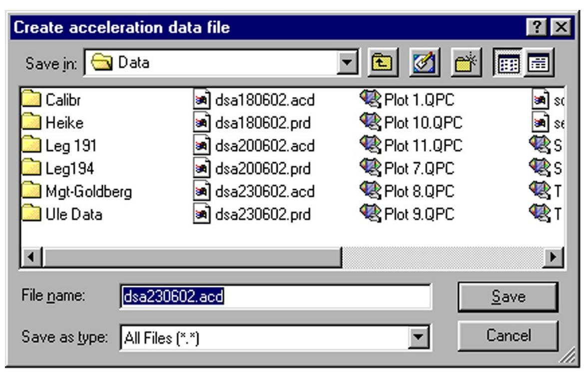


Figure 14. Creating a pressure data file.

Section VIII

Data Processing and Calibration

Since the DSA-XM tool can be used with different types of accelerometer sensors having varying sensitivities, the tool records acceleration data for all channels as direct analog-to-digital converter (ADC) output codes. These data can be converted to standard acceleration values expressed in G or m/s^2 units as described below.

The manufacturer calibrates each accelerometer installed in the tool individually, and you should have its Certificate of Conformance (Appendix C) containing calibration data at room temperature – in particular Zero-G voltage (V) and sensitivity (V/G) for each axis.

Acceleration A for any axis can be calculated from manufacturer calibration data using formulae (1) or (2), for acceleration in G or m/s^2 respectively:

$$A = K_g * (N - N_0) \qquad (1)$$
$$A = K_m * (N - N_0) \qquad (2),$$

where $K_g = 1.221*10^{-3} / S$, $K_m = 1.1974* 10^{-2} / S$, and $N_0 = 819 * U_0$

and:

S is accelerometer sensitivity in Volts/G, and U_0 is Zero-G voltage in Volts for this axis.

Equations (1) and (2), while being precise enough for many practical applications of the tool, do not take into account temperature drift of sensitivity and offset voltage of the accelerometer, signal conditioning electronics, and the A/D converter. They also ignore errors caused by misalignment of the sensor. If necessary some of these sources of error can be eliminated and measurement precision improved by calibration of the tool *in-situ* and deriving the value of channel offset N_0 from measurement data instead of using Zero-G voltage from the manufacturer's certificate.

Since LSA data are less sensitive to error factors mentioned above, this procedure should be performed only for the HSA sensor.

For calibration you need to initialize DSA-XM in the "TEST" mode and record data while the tool is exposed to the Earth's gravitational field in two opposite directions, thus applying +G and –G signals to the accelerometer. You must average readings for at least 100 seconds in each direction to compensate for the effect of measurement instabilities (as well as possible heave effect if calibration is being done on the ship).

From these measurements you can derive values for K_g, K_m, and N_0 as follows:

$K_g = 2/(N_+ - N_-)$ (3)
$K_m = 19.613/(N_+ - N_-)$ (4)
$N_0 = (N_+ + N_-)/2$ (5),

where N_+ and N_- are average HSA readings for +G and –G signals respectively.

To calculate the value of N_0 from measurement data (and thus minimize the influence of temperature and DC offset of the accelerometer) you need to calculate the running average of measurement data for approximately the same time interval (100 s), so the averaging should be done for 10,000 samples at 100 samples/sec or for 5000 samples at 50 samples/sec.

We recommend using KaleidaGraph software for data processing, since it does not have the size limitations of Excel and offers superior data processing capabilities, including pre-written macros for statistical operations.

Section IX

Optional Recording of Uphole Acceleration Data

Once the DSA-XM is in the hole you can start recording uphole acceleration data. You can use for this purpose one of the LabVIEW applications developed for recording Wireline Heave Compensator (WHC) data: Heave.vi or TAP.vi.

The user interface and operation of both applications is very similar, so this section will describe only TAP.vi usage. Neither the WHC nor MAXIS system is operational in the drilling process, but to preserve TAP.vi functionality you should establish serial communication with both. To do this the Schlumberger engineer must turn on the MAXIS depth simulation mode and the WHC controller (NEMA box in the winch cabin). There is no need to power the electrohydraulics system but make sure that the moving part of the system is not in the end position (to prevent sending error signals to the WHC controller). Obviously in this setup logging depth/speed data won't be valid, but you will record uphole acceleration and heave data at a sampling rate of 4 samples/sec.

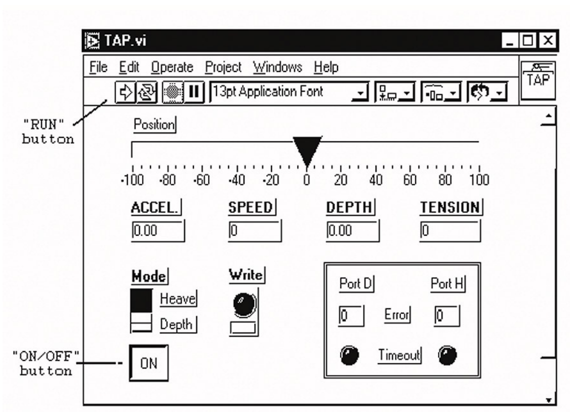


Figure 15. Screen shot of the TAP.vi application.

A. Start recorder operation by clicking the "RUN" button. If the MAXIS logging system and serial line is operating you will see:

STATUS window - blank or "No error" message
MESSAGE window - changing alphanumeric message (ASCII representation of MAXIS binary data - for diagnostic purposes only)
DEPTH window - depth data changing according to tool movement

STEP LED - blinking when the depth changes by 1 m

You will also see windows with additional logging information:

INITIAL DEPTH - MAXIS depth at the moment when the program started
INITIAL TIME - PC clock time when the program started
ELAPSED TIME - time interval in seconds from the program start
TIME - current PC clock time
DATAFILE SIZE - size of recorded data file in bytes

B. You will be prompted with a data file name. Change it ONLY if you need to record more than one depth file with the same date. Date should always be present in the data file name.

C. By default the program is recording depth/time data and the WRITE LED is blinking with a periodicity of approximately 1 second. You can stop recording by clicking the RECORD button. It will then change color and the WRITE LED will stop blinking. You still can observe depth/time data in the windows of the front panel. To resume data recording click the RECORD button again.

NOTE: Make sure that you start depth recording before the DSA-XM Tool starts taking measurements (i.e., about 300m ABOVE the sea floor, or at a predetermined recording depth, for logging mode "Down," or 300m BELOW the predetermined depth when the tool moves uphole and you have chosen the logging mode "UP"). Do not interrupt depth recording during tool operation.

D. At the end of logging operation stop the depth recording by clicking the POWER switch. Quit LabView by choosing option "EXIT" from the LabView File menu.

Section X

Data File Structure and Data Processing

The DSA-XM data files are a sequence of ASCII lines separated by LF and CR characters, starting with a header. The first line of the header shows the type of data (e.g., "Acceleration data" or "Temperature data"), and the next two lines contain the date of logging and starting time of recording in HH:MM:SS format.

If the tool operates in the temperature measurement mode, the next lines contain temperature (in degrees C) calculated from YSI resistance. The temperature data resolution is 0.002°C, and the sampling rate is one reading per second.

In the accelerometer mode the tool outputs direct accelerometer sensor readings digitized by internal A/D converter. The data format is unsigned integers with 16-bit resolution. These data may be converted into absolute acceleration using either the results of DSA-XM static calibration procedure or a set of coefficients supplied with the tool..

The DSA-XM TOOL data file can be loaded directly into Kaleidagraph for plotting and/or data processing.

Before using the pressure data for depth calculation we recommend smoothing them by running an averaging program (e.g., Kaleidagraph macro) with a window width of 5.

IMPORTANT: You must present to LDEO original (unedited) data files produced by the DSA-XM TOOL and MAXIS.vi programs.

Appendix A: DSA-XM Sample Dialog

Operator's input is printed in **Magenta Bold.**
Every operator's message should be terminated with a <CR>.
Comments printed in *blue italics*.

Battery voltage = 8.7 — *The tool measures and reports battery voltage.*

Memory module OK — *The memory module passed diagnostics test.*

Pressure - 14 psi, Temperature -28 deg. C — *The tool tests sensors and signal conditioning electronics.*

Are readings correct?(1-yes, 0-no): **1**

MAIN MENU

Accel - 1
Pressure - 2
Diagnostics - 3
Test - 4

Choose option(1-4):**1** — *Operator chooses acceleration mode.*

Set sampling rate (1 - 50 s/sec, 2 - 100s /sec): **1** — *Operator chooses 50 s/sec sampling.*

Sampling rate - 50 samples/sec
Correct? (1-yes, 0-no):**1**

Set Date (dd/mm/yy): **23/06/02**

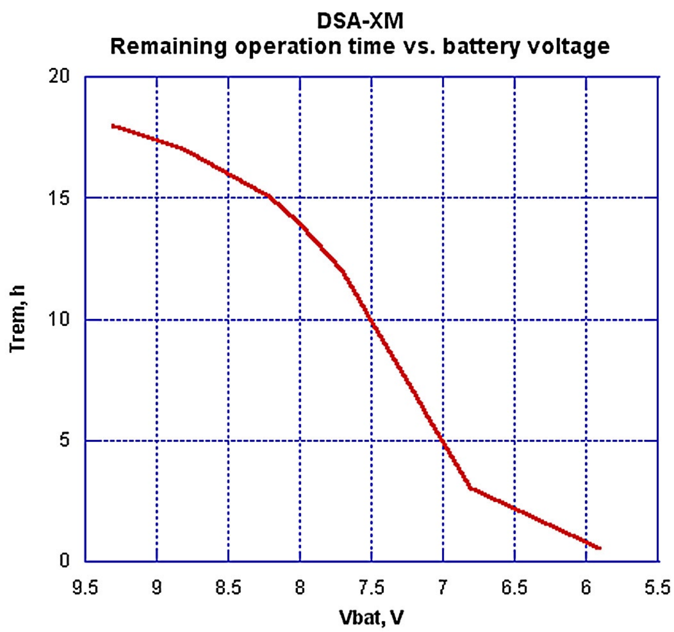
Set Time (hh:mm:ss): **22:39:50**

Make sure that both date and time are in the suggested format, and that you do not omit zeros.

Date: 23/06/02
Time: 22:39:50
Correct? (1-yes, 0-no):**1**

Set initial depth (m):**1600**	*Operator sets initial depth to 1600 m.*
Initial depth -1600 m Correct? (1-yes, 0-no):**1**	
Disconnect serial line	*Serial line should be disconnected from the tool within 10 seconds after getting this message.*
Start logging	*It is safe to close the tool and prepare it for logging.*

Appendix B: Operation Time vs. Battery Voltage



Appendix C: Certificate of Conformance (sample)

Certificate of Conformance **Crossbow** 2.12

calibration date: 01/17/2002

Calibration Data: Room Temperature

	X Axis	Y Axis	Z Axis
Zero-G Voltage	2.497	2.481	2.524
Sensitivit	0.503	0.498	0.498

Part Number	CXL04LP3
Serial Number	114959

Options: DC Coupled

Wiring Diagram:

Color	Pin	Function
Red	1	5 Vdc
Black	2	Ground
White	3	X-axis
Yellow	4	Y-axis
Green	5	Z-axis

Thank you for choosing a Crossbow sensor. This worksheet is designed to help you get started. Refer to the product data sheet for more complete information.

Definitions
Zero-G Voltage : This number is the output voltage of the sensor with zero applied acceleration measured at the factory on the day of the calibration.

Sensitivity : This number is the sensor's sensitivity in Volts per G.

Calibration
The simplest method of field calibration is to record the sensor's output voltage when exposed to the Earth's gravitational field. Expose the sensor to +1G to obtain a more positive reading than the zero-G voltage. Expose the sensor to -1G to obtain a more negative reading than the zero-G voltage. The offset is defined as the average of the +1G and -1G voltages. The sensitivity in Volts per G is one-half the difference of the +1G and -1G voltages. Please note that this technique only works on DC coupled sensors. If your sensor is AC coupled, a shaker is required for proper calibration.

Technical Support
For further technical assistance, contact Crossbow Technology.

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