LILY BOREHOLE TILTMETER FIELD GUIDE

Jewell Instruments

MAKING SENSE OUT OF MOTION

The intent of this Technical Note is to provide an abbreviated set of commands and procedures to initially check out the functionality of a Lily Borehole Tiltmeter, and configure it for storing data to the non-volatile memory. Refer to the LILY Self-Leveling Borehole Tiltmeter Manual for complete detailed information.

INITIAL CHECK-OUT PROCEDURES

Before installing your Lily, verify that it is functioning properly by following the steps below. Refer to the firmware command summary in Section 8.3 of the manual. The following instructions assume that the operator is using HyperTerminal (Windows 95 and later) or any other suitable program to communicate with the Tiltmeter:

1. On your computer open HyperTerminal. Select the proper COM port and baud rate. The default baud rate for your Tiltmeter is 19200 and the default output is on the RS-232 port.

    NOTE: double-check your RS-232 or RS-485 converter's DB9 pinout against the pinout for the Lily's DB9s. See tables A1-A3 in the manual.

2. Plug in the power supply, then attach the barrel connector to the Lily cable.

3. Back in HyperTerminal, you should notice the power-up screen.

4. Type the command *9900XYC2. If properly attached, the Tiltmeter will now start outputting data through the serial port at a rate of 1 reading per second, and the data will be displayed in HyperTerminal.

    NOTE: The Tiltmeter firmware commands are case sensitive.

5. Tilt the unit in the +X and then the +Y direction (Figure 6 in manual). Next, tilt it in the –X and –Y directions. Verify that the tilt values move through the full measurement range (Section 3) and that the sign (polarity) of the output changes on opposite sides of null.

6. While holding the unit more or less vertical, rotate the unit and observe that the compass reading is changing.

7. Type the command *9900XYC-OFF to stop the output.

8. Your LILY Tiltmeter is now ready for installation.

AFTER INSTALLATION PROCEDURES

Use with a PC or Data Logging Equipment

Follow the procedure in this subsection when using the Lily with data logging equipment. Reference the next subsection when using the data logging capability of the Lily internal memory.

1. Connect the Lily to both a DC power supply and PC (or other data logging equipment).

   NOTE: Ensure connections to the equipment match with the connections in tables A1-A3 in the manual

2. Issue commands to initiate output data samples from the Lily and level the Lily. Refer to the commands in the table below.

   NOTE: Each command must start with *9900 and end with a carriage return or line feed character.

3. After the leveling process is complete and both outputs show zero, the unit is ready for further use. Use the commands shown in the table below to set time and adjust the output data rate.

   NOTE: The manual contains other commands which can alter data sample output formats, and enabling or disabling compass, power supply, and timestamp outputs. Refer to Appendix B for a full summary.

Table 1: Command Table – Initiating output and leveling

COMMANDS	FUNCTION	NOTES
*9900XYC2	This command starts data output from the Lily.	This will stream an output every second
*9900XY-LEVEL,1	This command begins the leveling process.	Let it run through the complete leveling process before stopping it.
*9900XY-LEVEL,0	This command resets the Tiltmeter so that it can be re-leveled again later.	Use this only if leveling did not complete.

Table 2: Command Table – resetting the time & data, and setting the data sample output rate

COMMANDS	FUNCTION	NOTES
*9900SET-TIME, sec, min, hour, day, month, year **Example**: *9900SET-TIME,01,45,18,29,03,15	Sets the current Lily time to a specific time. Each input is two characters long. **sec** 00-59, **min** 00-59, **hour** 00-23, **day** 00-31, **month** 00-12, **year** 00-99	The Lily does not store the time when DC power is removed. The timestamp should be issued every time upon power-up.
*9900XYC2	Command forces the Lily to output one sample per second	1 sample / second
*9900XYC3	Command forces the Lily to output one sample per 10 seconds	1 sample / 10 seconds
*9900XYC4	Command forces the Lily to output one sample per minute.	1 sample / minute

Utilizing the Data Logging Capability of the Lily

The Lily is shipped with a fixed amount of non-volatile memory available for data storage. There are two basic memory storage modes for the Lily. The first is Standard Memory Mode. In this mode, the tiltmeter stores X tilt, Y tilt, temperature data samples, and the user has the option to also store parameters such as compass heading, power supply voltage, and timestamp. The second memory storage mode is the Advanced Memory Mode. In this mode, the Lily automatically stores X tilt, Y tilt, temperature, data samples, and compass heading, power supply voltage, and timestamp parameters.

In either storage mode, the user can configure how often the Lily stores the data. The total number of samples saved to non-volatile memory is a function of the number of parameters stored. For instance, if the users wish to store all possible parameters, then the available memory to store sample data is decreased. Also, the time to fill the non-volatile memory is a function of the sample rate. If the sample rate is very high, like 10 samples/second, then the memory will fill quickly. The user is advised to review the table on page 22 of the manual which helps predict the time to fill the memory for the memory mode and sample rate.

In either storage mode, the user must first set the memory storage mode, initiate memory storage, and finally set the output sample rate. The following two subsections outline two procedures for memory storage for the two memory modes.

Follow the procedures in the subsequent sections to initialize data logging within the Lily and then retrieve the stored data.

STANDARD MEMORY MODE:
MINIMAL PARAMETER DATA STORAGE, & LONGEST DURATION

Use the following commands in the order shown below to initiate storing data to the Lily's non-volatile memory with the longest possible duration. In this example, X tilt, Y tilt, temperature data samples as well as the timestamp will be saved. In the example below, 49124 total samples can be stored. At a sample rate of 1 sample per 24 hours (*9900XYC7), the memory will fill up in approximately 49124 days (135 years!).

Upon power-up, type the commands in the order provided in Table 3.

Table 3: Command Table – Standard Memory Mode

COMMANDS	FUNCTION/SYNTAX	NOTES
*9900SET-TIME, sec, min, hour, day, month, year	Sets the current Lily time to a specific time. Each input is two characters long. [see Table 2]	The Lily does not store the time when DC power is removed. The timestamp should be issued every time upon power-up.
*9900XYC-OFF	Turns off any previous data logging and disables output sample data.	
*9900XY-TOGGLE-AMEM	This command enables or disabled the advanced memory mode.	Issue this command until Lily returns the string: "Advanced memory logging OFF". Be patient waiting for the Lily to respond!
*9900XY-TOGGLE-TIMESTAMP	Enables and disables timestamp in the output data string.	Issue this command until Lily returns the string: "Timestamp ON"
*9900XY-TOGGLE-SUPPLYVOLTAGE	Enables and disables the power supply voltage in the output data string	Issue this command until Lily returns the string: "Supply Voltage OFF"
*9900XY-SET-MAG,0	Turns off the compass heading in the output data string.	The Lily will repeat the command back to the terminal.
*9900XYC2	This command sets the output sample rate to 1 sample per second.	Review the output format. Ensure you see Xtilt, Y-tilt, Temperature, Timestamp, and Serial Number.
*9900XYC7	This command sets the output sample rate to 1 sample per 24 hours.	This will actually be the rate at which data is stored.
*9900$start,Jewell Instruments, LLC	This command will include a 23character string at the beginning of the non-volatile memory.	In the example here, the string is "Jewell Instruments, LLC"
*9900XY-MEMS	This command starts the data logging. Once this command is issued, the data samples are stored in memory and the data output to the terminal stops.	The Lily will repeat the command back to the terminal when it has started. Be patient!
*9900XY-MSTAT	This command provides the number of samples collected and show the amount of memory available.	The format will look something like this: 01: Flash Status (in Samples) (Used/Total): (3/49124)Issuing this command multiple times will allow the user to see the sample number incrementing.At a sample rate of 1 every 24 hours, the first sample won't be taken for 24 hours.

ADVANCED MEMORY MODE:
MEDIUM DURATION

Use the following commands in the order shown below to initiate storing data to the Lily's non-volatile memory. In this example, X tilt, Y tilt, temperature data, and all parameters are saved. In the example below, 36854 total samples can be stored. At a sample rate of 1 sample per minute (*9900XYC4), the memory will fill up in approximately 26 days.

Upon power-up, type the commands in the order proved in the table below.

Table 4: Command Table – Advanced Memory Mode

COMMANDS	FUNCTION/SYNTAX	NOTES
*9900SET-TIME, sec, min, hour, day, month, year	Sets the current Lily time to a specific time. Each input is two characters long. [see Table 2]	The Lily does not store the time when DC power is removed. The timestamp should be issued every time upon power-up. This is a fault in the Pico Tec program.
*9900XYC-OFF	Turns off any previous data logging and disables output sample data.	
*9900XY-TOGGLE-AMEM	This command sets the output sample rate to 1 sample per minute.	Issue this command until Lily returns the string: "Advanced memory logging OFF". Be patient waiting for the Lily to respond!
*9900XYC2	This command sets the output sample rate to 1 sample per second.	Review the output format. Ensure you see X-tilt, Y-tilt, Compass, Temperature, Timestamp, Power Supply Voltage, and Serial Number.
*9900XYC4	This command sets the output sample rate to 1 sample per minute.	This will actually be the rate at which data is stored.
*9900XY-MEMS	This command starts the data logging. Once this command is issued, the data samples are stored in memory and the data output to the terminal stops.	The Lily will repeat the command back to the terminal when it has started. Be patient!
*9900XY-MSTAT	This command provides the number of samples collected and show the amount of memory available.	The format will look something like this: 01: Flash Status (in Samples) (Used/Total): (3/36854)Issuing this command multiple times will allow the user to see the sample number incrementing.At a sample rate of 1 every 24 hours, the first sample won't be taken for 24 hours.

RETRIEVING THE STORED DATA AND RESTARTING DATA LOGGING

Use the following commands in the order provided to retrieve the stored data from the Lily. When the Lily provides the data, the user must have a method of capturing it. Most often a terminal program, like HyperTerminal or RealTerm, will have the capability to store the data printed by the Lily to the Terminal into a text file. Assuming the user has not changed the default output data format (not covered in this Technical Note) then the format of the data will be comma-separated-variable (CSV).

From the terminal, type the commands in the order proved in the table below.

Table 5: Command Table – Retrieving the Stored Data and Restarting Data Logging

| COMMANDS	FUNCTION/SYNTAX	NOTES
*9900XY-MSTAT	This command provides the number of samples collected and shows the amount of memory available.	The format will look something like this: 01: Flash Status (in Samples) (Used/Total): (3/49124)Issuing this command allows the user to see the number of samples stored.
*9900XYC-OFF	Turns off any previous data logging to non-volatile memory.	
*9900XY-MEMD	This command reads the data from the nonvolatile memory and transmits it to the terminal	Before issuing this command, the user should enable storing of the data on the PC into a text file (or equivalent). This command can also be issued multiple times without fear of losing the data in nonvolatile memory. The total number of samples saved into the files should match the sample number returned from the MSTAT command above.
*9900XYC\<value>	This command sets the output sample rate to 1 sample per.	Issue this command to re-start outputting the sample rate. The user may change to a new value or use the same rate as before.
*9900XY-MEMS	This command re-starts the data logging. Once this command is issued, the data samples are stored in memory and the data output to the terminal stops.	The Lily will repeat the command back to the terminal when it has started. Be patient! Once this command is issued, all previously stored data is lost!

HELPFUL FIELD DIAGRAMS
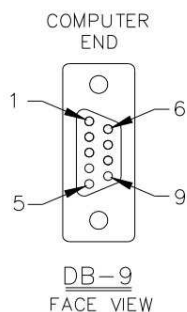
Figure 1: Female DB9 and Pin Number Orientation (left),RS-232 & RS-485 DB9s (right)
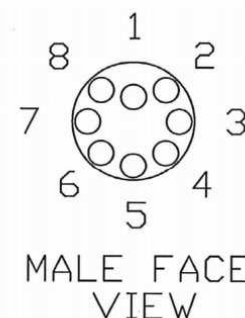

Figure 2: Male Bulkhead Connector showing +X & +Y axis Orientation (left) and Pin Number Orientation (right)

LILY EXTERNAL CONNECTIONS TABLE

LILY FUNCTION	BULKHEAD CONNECTOR (MCBH8M) PIN NUMBER	RS-232 CONNECTOR (DB9) PIN NUMBER/FUNCTION	RS-485 CONNECTOR (DB9) PIN NUMBER/FUNCTION
Power (7V to 28V)	3		
Ground	1	5 (Ground)	
Tx (RS-232)	6	2 (Rx)	
Rx (RS-232)	4	3 (Tx)	
Tx+ (RS-485)	5		4 (Rx+)
Tx- (RS-485)	2		5 (Rx-)
Rx- (RS-485)	7		9 (Tx-)
Rx+ (RS-485)	8		8 (Tx+)